No. 52

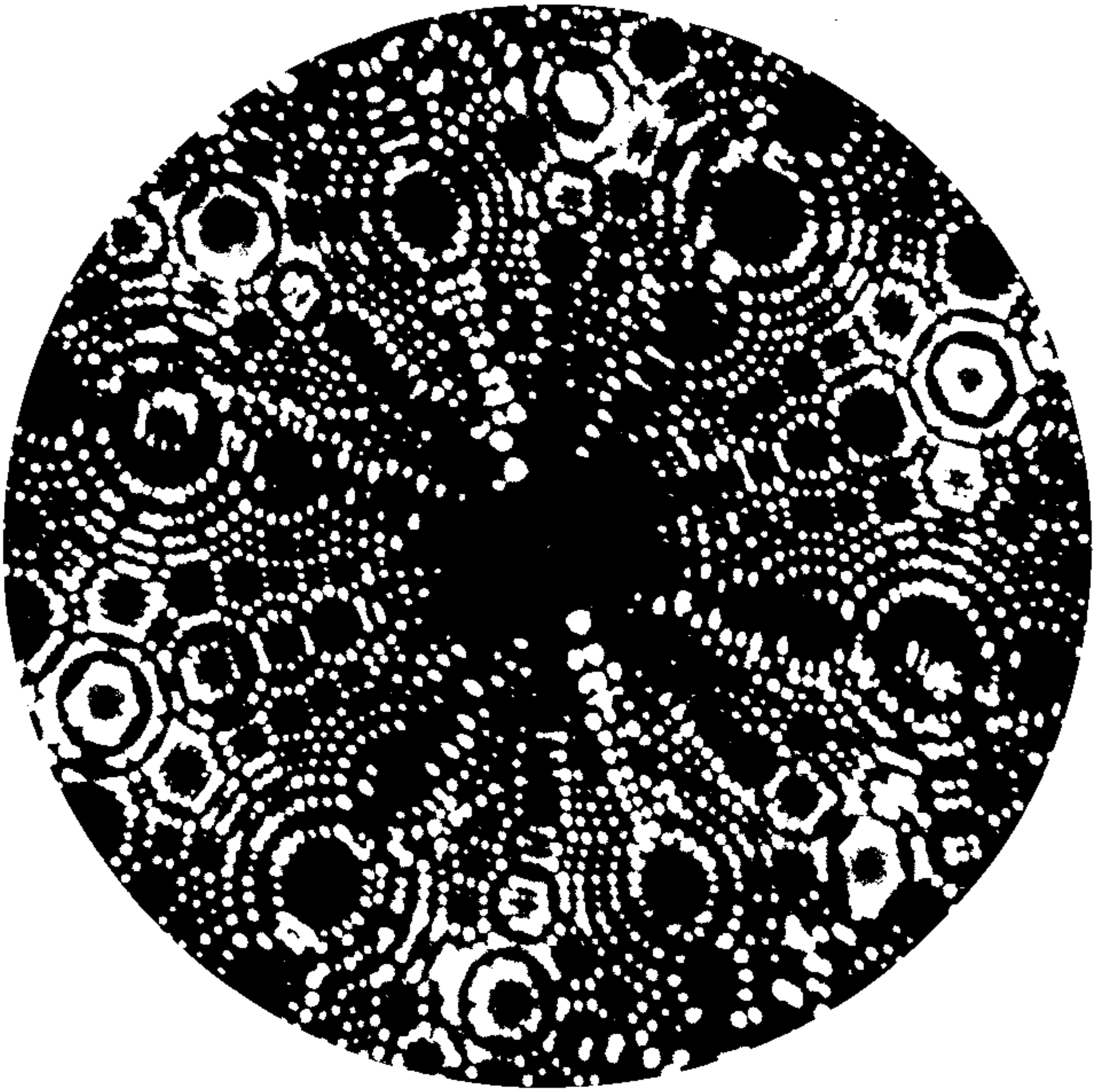
Science and technology in countries of Asia and the Pacific

Policies, organization and resources

La science et la technologie dans les pays d'Asie et du Pacifique

Politiques, organisation et ressources

Science policy studies and documents
Études et documents de politique scientifique



unesco

Previous titles in this series - Ouvrages déjà publiés dans la même collection - Títulos publicados en esta serie:

No. 1. La politique scientifique et l'organisation de la recherche scientifique en Belgique (Paris, 1965).
No. 2. Science policy and organization of scientific research in the Czechoslovak Socialist Republic (Paris, 1965).
No. 3. National science policies in countries of South and South-East Asia (Paris, 1965).
No. 4. Science policy and organization of research in Norway (Paris, 1966).
No. 5. Principles and problems of national science policies (Paris, 1967).
  Principes et problèmes des politiques scientifiques nationales (Paris, 1967).
No. 6. Structural and operational schemes of national science policy (Paris, 1967).
  Schémas structurels et opérationnels d'une politique scientifique nationale (Paris, 1967).
  Version arabe (Fez, 1967).
1 No. 7. Science policy and organization of research in the USSR (Paris, 1967).
No. 8. Science policy and organization of scientific research in Japan (Paris, 1968).
No. 9. Science policy and the organization of scientific research in the Socialist Federal Republic of Yugoslavia (Paris, 1968).
No. 10. National science policies of the U.S.A. Origins, development and present status (Paris, 1968).
No. 11. The promotion of scientific activity in tropical Africa (Paris, 1969).
  Déploiement de l'activité scientifique en Afrique intertropicale (Paris, 1969).
1 No. 12. Science policy and organization of research in the Federal Republic of Germany (Paris, 1969).
No. 13. Bilateral institutional links in science and technology (Paris, 1969).
  Les liens bilatéraux entre institutions dans le domaine de la science et de la technique (Paris, 1969).
No. 14. La política científica en América Latina (Montevideo, 1969).
No. 15. Manuel d'inventaire du potentiel scientifique et technique national (Paris, 1969).
  Manual for surveying national scientific and technological potential (Paris, 1969).
2 Manual del inventario del potencial científico y técnico nacional (Montevideo, 1970).
  Пособие по инвентарному описанию научно-технического потенциала (Париж, 1970).
No. 16. Proceedings of the symposium on science policy and biomedical research (Paris, 1969).
  Comptes rendus du colloque sur la politique scientifique et la recherche biomédicale (Paris, 1969).
2 No. 17. Politiques scientifiques nationales en Europe / National science policies in Europe (Paris, 1970).
No. 18. The role of science and technology in economic development (Paris, 1970).
  Le rôle de la science et de la technologie dans le développement économique (Paris, 1970).
No. 19. National science policy and organization of research in Israel (Paris, 1970).
No. 20. Política científica y organización de la investigación científica en la Argentina (Montevideo, 1970).
3 No. 21. National science policy and organization of research in Poland (Paris, 1970).
No. 22. National science policy and organization of research in the Philippines (Paris, 1970).
No. 23. La politique scientifique et l'organisation de la recherche scientifique en Hongrie (Paris, 1971).
No. 24. La politique scientifique et l'organisation de la recherche en France (Paris, 1971).
No. 25. Science policy and the European States (Paris, 1971).
3 La politique scientifique et les Etats européens (Paris, 1971),
No. 26. International aspects of technological innovation (Paris, 1971).
  Les aspects internationaux de l'innovation technologique (Paris, 1971).
No. 27. National science policy and organization of scientific research in India (Paris, 1972).
No. 28. Science policy research and teaching units/Unités de recherche et d'enseignement en politique scientifique (Paris, 1971).
No. 29. La política científica en América Latina - 2 (Montevideo, 1972).
No. 30. European Scientific Co-operation: priorities and perspectives (Paris, 1972).
4 La coopération scientifique européenne : priorités et perspectives (Paris, 1972).
No. 31. National science policies in Africa / Politiques scientifiques nationales en Afrique (Paris, 1974).
No. 32. La politique scientifique et l'organisation de la recherche scientifique dans la République populaire de Bulgarie (Paris, 1974).
No. 33. (1) Science and technology policies information exchange system (SPINES). Feasibility study (Paris, 1974).
4 No. 33. (2) Provisional world list of periodicals dealing with science and technology policies (Paris, 1974).
No. 34. Science policy and organization of research in Sweden (Paris, 1974).
No. 35. Science and technology in African development (Paris, 1974).
  La science et la technologie au service du développement en Afrique (Paris, 1974).
No. 36. La politique de la science et de la technologie en Roumanie (Paris, 1976).
No. 37. La política científica en América Latina - 3 (Montevideo, 1975).
5 No. 38. National science and technology policies in the Arab States / Politiques scientifiques et technologiques nationales dans les États arabes (Paris, 1976).
No. 39. SPINES Thesaurus. A controlled and structured vocabulary of science and technology for policy-making, management and development (Paris, 1976) (In 3 volumes, format 24 × 31 and 31 × 48 cm).
No. 40. Méthode de détermination des priorités dans le domaine de la science et de la technologie (Paris, 1977).
  Method for priority determination in science and technology (Paris, 1978).
  Método para la determinación de prioridades en ciencia y tecnología (París, 1979).
No. 41. Science and technology in the development of the Arab States (Paris, 1977).
  La science et la technologie dans le développement des États arabes (Paris, 1977).
  Version arabe (Paris, 1977).
No. 42. La política científica en América Latina - 4 (Montevideo, 1979).
No. 42. Add. Presupuestación nacional de actividades científicas y tecnológicas (Montevideo, 1980).
No. 43. National Science and Technology Policies in Europe and North America / Politiques scientifiques et technologiques nationales en Europe et Amérique du Nord (Paris, 1979).
No. 44. Science, Technology and Governmental Policy. A Ministerial Conference for Europe and North America - MINESPOL II (Paris, 1979).
  Science, technologie et politique du Gouvernement. Une Conférence ministérielle pour l'Europe et l'Amérique du Nord - MINESPOL II (Paris, 1979).
No. 45. Unesco's Activities in Science and Technology in the European and North American Region (Paris, 1979).
  Activités de l'Unesco en science et technologie dans la région d'Europe et d'Amérique du Nord (Paris, 1979).
No. 46. An introduction to Policy Analysis in Science and Technology (Paris, 1979).
  Introduction à l'analyse politique en science et technologie (Paris, 1981).
  Introducción al análisis de la política científica y tecnológica (París, 1981).
No. 47. Societal Utilization of Scientific and Technological Research (Paris, 1981).
No. 48. Manuel de budgétisation nationale des activités scientifiques et technologiques (Paris, 1981).
  Manual on the national budgeting of scientific and technological activities (Paris, 1984).
No. 49. World directory of research projects, studies and courses in science and technology policy / Répertoire mondial de projets de recherche, d'études et de cours dans le domaine des politiques scientifiques et technologiques / Repertorio mundial de proyectos de investigación, estudios y cursos relativos a las políticas científicas y tecnológicas (París, 1981).
No. 50. Thesaurus SPINES - Un vocabulaire contrôlé et structuré pour le traitement de l'information relative à la science et la technologie au service du développement (Paris, 1984).
No. 51. Unesco science and technology activities in Asia and the Pacific (Paris, 1984).
  Activités de l'Unesco en science et technologie en Asie et dans le Pacifique (Paris, 1985).
No. 52. Science and technology in countries of Asia and the Pacific - Policies, organization and resources / La science et la technologie dans les pays de l'Asie et du Pacifique - Politiques, organisation et ressources (Paris, 1985).
No. 53. La sexta reunión de la Conferencia permanente de organismos nacionales de política científica y tecnológica en América Latina y el Caribe (Montevideo, 1983).
No. 54. Informes nacionales y subregionales de política científica y tecnológica en América Latina y el Caribe (Montevideo, 1983).
No. 55. Science, Technology and Development in Asia and the Pacific - CASTASIA II (Paris, 1983).
  Science, technologie et développement en Asie et dans le Pacifique - CASTASIA II (Paris, 1983).
No. 56. Science policy and organization of research in the Republic of Korea (Paris, 1985).
No. 57. Science and technology policy and the organization of research in the German Democratic Republic.
No. 58. Comparative study on the functions, performance and effectiveness of national science and technology policy-making bodies in the countries of West Africa / Étude comparative sur les fonctions, la performance et l'efficacité des organismes directeurs de la politique scientifique et technologique nationale dans les pays de l'Afrique de l'Ouest.
No. 59. World directory of national science and technology policy making bodies / Répertoire mondial des organismes directeurs de la politique scientifique et technologique nationale / Repertorio mundial de organismos responsables de la política científica y tecnológica nacional (Paris, 1984).
No. 60. Manuel pour le développement d'unités de documentation et de bases de données bibliographiques nationales pour la politique scientifique et technologique (Paris, 1984).
No. 61. Technology assessment: review and implications for developing countries. (Paris, 1984).
No. 62. National and sub-regional reports on science and technology policies in Latin America and the Caribbean (Part II), (Montevideo, 1985).
No. 63. Actividades de la Unesco en ciencia y tecnología en América Latina y el Caribe (Montevideo, 1985).
  Unesco science and technology activities in Latin America and the Caribbean (Montevideo, 1985).

Note (January 1985)
Numbers 1 through 31, 33 through 35, 37 through 39, 41 (Eng. and Fr.), 42 and 43 are out of print. These numbers may however be purchased in microfiche form.

Science and technology in countries of Asia and the Pacific

Policies, organization and resources

La science et la technologie dans les pays d'Asie et du Pacifique

Politiques, organisation et ressources

unesco

ISBN 92-3-002078-8

Published in 1985
by the United Nations Educational,
Scientific and Cultural Organization
7, place de Fontenoy, 75700 Paris (France)

Printed in the workshops of Unesco

Table of Contents
Table des matières

Preface

The Unesco series 'Science policy studies and documents' forms part of a programme 'to collect, analyse and disseminate information concerning the organization of scientific research in Member States and the policies of Member States in this respect' authorized by resolution 2.1131 (b) adopted by the General Conference of Unesco at its eleventh session in 1960, and confirmed by similar resolutions at each subsequent session.

This series aims at making available to those responsible for scientific research and development throughout the world, factual information concerning the science and technology policies of various Member States of the Organization as well as normative studies of a general character.

The *country studies* are carried out by the governmental authorities responsible for policy making in the field of science and technology in the Member States concerned.

The selection of the countries in which studies on the national scientific and technological policy are undertaken is made in accordance with the following criteria: the originality of the methods used in the planning and execution of the national science and technology policy, the extent of the practical experience acquired in such fields and the level of economic and social development attained. The geographical coverage of the studies published in the series is also taken into account.

The *normative studies* cover planning of science and technology policy, organization and administration of scientific and technological research and other questions relating to science and technology policy.

This same series also includes *reports of international meetings* on science and technology policy convened by Unesco.

As a general rule, the country studies are published in one language only, English, French .or Spanish, whereas the normative studies and the reports of meetings are published in all three languages.

The present publication contains the Country Reports presented to the Second Conference of Ministers Responsible for the Application of Science and Technology to Development and those Responsible for Economic Planning in Asia and the Pacific, 'CASTASIA II', convened by Unesco and held at Manila in the Philippines from 22 to 30 March 1982. These Country Reports are preceded, in this publication, by a 'Regional Overview' which briefly summarizes the present state of science and technology and their role in economic development in the Asia and Pacific region. The 'Regional Overview' is followed by the Country Reports which are presented in either English or French, according to the choice of the country concerned, and arranged in English alphabetical order.

To achieve some uniformity and comparability in the presentation of these Country Reports the Unesco Secretariat prepared 'Guidelines for the Preparation of Country Reports on Science and Technology Policy' (UNESCO/NS/ROU/474).[1] Therefore Country Reports, where feasible, presented information under the following headings:

Part 1. **General features of the country:** geopolitical setting; general socio-economic setting; a brief description of the development process and developmental prospects.

Part 2. **Science and technology policy framework:** the national developmental policy and its goals and objectives; the relationship between the national developmental policy and the national science and technology policy; the mechanisms for integration; the policy-making machinery for science and technology.

Part 3. **Scientific and technological potential:** institutional network of organizations performing scientific and technological activities; human resources engaged in the fields of science and technology; financial rsources allocated to research and experimental development (R&D); institutional mechanisms for surveying the national science and technology (S&T) potential.

Part 4. **Policy issues in scientific and technological development:** major national developments likely to influence science and technology in the future; major achievements and problems; future objectives and priorities in S&T policies for development; national policy for S&T co-operation and multilateral and bilateral programmes.

Part 5. **Bibliography.**

Each Country Report is introduced by a two-page presentation of 'General' data on the particular country. This data has been summarized from United Nations publications prepared on the basis of official government replies to questionnaires.[2] The 'General' data are followed by data on 'Science and Technology' for each country which the Member States were asked to provide by completing three tables for their Country Report.

The three data tables on science and technology were:

Table 1: Nomenclature and networking of S&T organizations;
Table 2: Scientific and technological manpower;
Table 3: R&D expenditures.

However, many countries of the Asia and Pacific region were not able to provide the information in the form requested and, in this publication, an absence of information indicates that the Member State did not provide such data in the tabular format. Nevertheless, it may be provided in the text of the Country Report.

In the case of most Member States of Unesco, the preparation of the Country Report and the accompanying tables was undertaken by a National Liaison Committee for CASTASIA II which was constituted by the Unesco National Commission in each Member State. The establishment of National Liaison Committees and the preparation of the Country Reports began in July 1980.

The officially designated National Liaison Committee for CASTASIA II consulted, where necessary, with the Unesco Secretariat. Of the thirty countries invited to participate in CASTASIA II (twenty-nine Member States of Unesco and the territory of Hong Kong) twenty-three prepared Country Reports for presentation at the CASTASIA II meeting in Manila.

In addition, the Unesco Secretariat prepared a brief Country Report for the Member State of Samoa, and the USSR prepared a report on the Kazakh Soviet Socialist Republic, both of which were presented to the conference and have been included in this publication. The territory of Hong Kong presented information to the conference which, in this publication, has been summarized by the Unesco Secretariat according to the format of the Country Report Guidelines.

In addition, the Central Planning Office of Fiji completed a report according to the Country Report Guidelines format which was presented to the conference by the Unesco Secretariat, and this report has also been included here. These respective reports are included in this publication by the Unesco Secretariat in the belief that such information will prove useful to those wishing to have information on the state of science and technology, and their present and proposed role in development, in the many countries of the Asia and Pacific region.

Statements and opinions expressed in the National Summaries are the sole responsibility of the Member States. Moreover, the designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Unesco Secretariat concerning the legal status of any country or territory, or of its authorities, or concerning the delimitations of the frontiers of any country or territory.

---

1. See Annex A, which includes all the technical abbreviations and definitions used in the preparation of the Country Reports and in this publication.
2. See Annex B 'Sources used in the preparation of General Country Data'.

Préface

La série des « Études et documents de politique scientifique » de l'Unesco s'inscrit dans le cadre d'un programme qui a pour but « le rassemblement, l'analyse et la diffusion d'informations concernant l'organisation de la recherche scientifique dans les États membres et la politique suivie par ces États en matière de recherche scientifique et technique ». Ce programme a été autorisé par la résolution 2.1131(b) que la Conférence générale de l'Unesco a adoptée à sa onzième session, en 1960, et qu'elle a confirmée par des résolutions analogues à chacune des sessions suivantes.

Cette série vise à fournir aux responsables de la recherche et du développement scientifiques dans le monde des informations concrètes sur la politique scientifique des divers États membres de l'Unesco, ainsi que des études normatives de caractère général.

Les *études nationales* sont faites par les autorités responsables de la politique scientifique des États membres concernés.

Les selection des pays faisant l'objet de telles études s'opère en fonction des critères suivants : originalité des méthodes de planification et d'exécution de la politique scientifique nationale, expérience pratique acquise en la matière et niveau du développement économique et social atteint par le pays. On tient compte également de l'importance de la région géographique couverte par les études publiées.

Les *études normatives* portent sur la planification de la politique scientifique, l'organisation et l'administration de la recherche scientifique et technologique et d'autres questions concernant la politique scientifique.

Dans la même série paraissent des *comptes rendus de réunions internationales* sur la politique scientifique organisées par l'Unesco.

En règle générale, les études nationales ne paraissent que dans une langue, anglais, français ou espagnol, alors que les études normatives et les comptes rendus de réunions sont publiés dans les trois langues.

La présente publication contient les rapports nationaux présentés à la Deuxième Conférence des ministres chargés de l'application de la science et de la technologie au développement et des ministres chargés de la planification économique en Asie et dans le Pacifique (CASTASIA II) réunie par l'Unesco à Manille, Philippines, du 22 au 30 mars 1982. Ces rapports nationaux sont précédés d'un « Aperçu régional » qui fait le point de la situation de la science et de la technologie et de leur rôle dans le développement économique de l'Asie et du Pacifique. L'Aperçu régional est suivi des rapports nationaux qui sont rédigés soit en anglais soit en français et disposés selon l'ordre alphabétique anglais.

Afin d'en uniformiser la présentation et de faciliter les comparaisons, le Secrétariat de l'Unesco avait rédigé des « Directives pour la préparation des rapports nationaux sur les politiques scientifiques et technologiques » (UNESCO/NS/ROU/474).[1] Les auteurs des rapports nationaux ont donc, chaque fois que cela leur a été possible, groupé les informations données sous les rubriques suivantes :

Première partie. **Caractéristiques générales du pays :** cadre géopolitique ; cadre socio-économique général ; brève description du processus et des perspectives de développement.

Deuxième partie. **Cadre des politiques scientifiques et technologiques :** la politique nationale de développement, ses buts et ses objectifs; rapports entre cette politique et la politique scientifique et technologique du pays; mécanismes d'intégration ; mécanismes d'élaboration des politiques scientifiques et technologiques.

Troisième partie. **Potentiel scientifique et technologique :** réseau des institutions qui exercent des activités scientifiques et technologiques; ressources humaines engagées dans le domaine de la science et de la technologie ; ressources financières allouées à la recherche et au développement expérimental (R-D) ; mécanismes institutionnels pour l'inventaire du potentiel scientifique et technologique.

Quatrième partie. **Politiques de développement scientifique et technique : questions majeures :** principales évolutions nationales susceptibles d'avoir une incidence sur la science et la technologie dans l'avenir; principales réalisations et grands problèmes ; futurs objectifs et priorités des politiques de développement de la science et de la technologie ; politique nationale de coopération scientifique et technologique et programmes multilatéraux et bilatéraux.

Cinquième partie. **Bibliographie.**

Chaque rapport national est précédé de deux pages de « Généralités » sur le pays. Les données générales y mentionnées ont été extraites des publications des Nations Unies établies à partir de réponses officielles des gouvernements à des questionnaires.[2] Elles sont dans chaque cas suivies d'informations sur « la science et la technologie » que les États membres ont été invités à fournir en remplissant trois tableaux.

Ces trois tableaux de données sur la science et la technologie étaient les suivants :

Tableau 1 : Nomenclature des organisations S-T et liens existant entre elles;
Tableau 2 : Personnel scientifique et technique;
Tableau 3 : Dépenses de R-D.

Cependant, de nombreux pays d'Asie et du Pacifique n'ont pu fournir les informations sous la forme demandée; il en résulte des lacunes dans les tableaux bien que les informations correspondantes figurent parfois dans le texte du Rapport national lui-même.

Dans la plupart des États membres de l'Unesco, l'établissement du rapport et des tableaux qui l'accompagnent a été assuré par un Comité de liaison national pour CASTASIA II constitué par la Commission nationale pour l'Unesco avec le gouvernement de l'État membre. Le mise en place des comités de liaison nationaux et la préparation des rapports nationaux ont débuté en juillet 1980.

Les Comités de liaison nationaux pour CASTASIA II ont consulté au besoin le Secrétariat de l'Unesco. Sur les 30 pays invités à participer à la Conférence (29 États membres de l'Unesco et le territoire de Hong Kong), 23 ont présenté un rapport national à la réunion de Manille.

Le Secrétariat de l'Unesco a établi un rapport national succinct pour l'État membre de Samoa, et l'URSS un rapport supplémentaire sur la République socialiste soviétique du Kazakhstan ; les deux documents ont été présentés à la Conférence et sont inclus dans la présente publication. Le territoire de Hong Kong a soumis à la Conférence des information que le

Secrétariat de l'Unesco a résumées pour leur donner la présentation demandée dans les Directives pour la préparation des rapports nationaux.

Le Secrétariat a également saisi la Conférence du rapport que l'Office central de planification de Fidji avait élaboré conformément aux dites Directives et qui est lui aussi inclus dans la présente publication.

Le Secrétariat de l'Unesco espère que les informations données dans ces différents rapports seront utiles à ceux qui souhaitent connaître la situation de la science et de la technologie et se faire une idée de leur rôle présent et futur dans le développement de nombreux pays de la région de l'Asie et du Pacifique.

Les opinions exprimées dans les résumés nationaux présentés par les États membres n'engagent que les autorités compétentes concernées. Par ailleurs, les désignations employées et la présentation adoptée dans cette publication ne sauraient être interprétées comme exprimant une prise de position du Secrétariat de l'Unesco sur le statut légal ou le régime d'un pays ou d'un territoire quelconque, non plus que sur le tracé de ses frontières.

---

1. Voir l'Annexe A, où l'on trouvera toutes les abréviations et définitions utilisées pour l'établissement des rapports nationaux et de la présente publication.
2. Voir l'Annexe B « Sources utilisées dans la préparation des informations générales sur chaque pays ».

Regional overview

PART 1

General features

(1) The twenty-nine Asia and Pacific Member States of Unesco[1] and the territory of Hong Kong are located within an area extending to the east between longitudes 20° East and 172° West, and from latitudes 48° South to 82° North. Nineteen countries are located wholly or partly on the subcontinent of Asia, and the remaining eleven countries are located in either the Indian Ocean or the Pacific Ocean regions.

(2) Most of the countries of the Asia and Pacific region are, individually, facing grave problems in ensuring the harmonious integration of science and technology with socio-economic development planning, and these difficulties are freely acknowledged and discussed in each Country Report. Such problems may account for the difficulty which many countries experienced in preparing a wide-ranging review of the application of science and technology to development such as their Country Reports required. However, the Member States perceive that many of these national problems are also common to the region and that, to some considerable degree, the ultimate solution of these problems requires urgent regional as well as national action. As a result, there is a sense of common purpose and regional commitment in the Country Reports regarding present developmental problems and their feasible solution, and a vital interest in all matters that relate to the application of science and technology for development. None the less, great differences exist between the countries of the region in respect of size, geographical features, climate, environment, population size and density, natural resources and, especially, in their stage and pattern of development, and these differences result in considerable variation between countries in the application of science and technology for development.

(3) Among the Member States of the Asia and Pacific region there is considerable climatic variation, from the continental extremes of the USSR to the slight seasonal temperature variability of the oceanic tropical countries. This climatic variation reflects the wide geographical dispersion of the Member States. However, because seventeen countries are situated or have a large part of their territory located between the Tropic of Cancer and the Tropic of Capricorn, while two other countries have some part of their territory lying within those tropics, the monsoons of this region are of particular climatic significance.

(4) Physically, there are great contrasts within the region. It contains mountain ranges, including the world's highest mountain, as well as flat river-plain areas and featureless small coral islands. Within the Asia and Pacific region physical extremes combine with geographical size to produce vast arid and semi-arid zones, as well as extensive tropical rain-forest areas. However, the region is not only characterized by these contrasting physical land features, for it is also dominated by its proximity to two large ocean masses. It is significant that twelve countries of the region have coastlines facing onto the Indian Ocean and eighteen have coastlines extending onto the Pacific Ocean, with only four of the countries being landlocked with no direct access to the sea.

(5) The territorial size of Member States in the Asia and Pacific region varies widely, from 298 square kilometres for the Maldives to 22.4 million square kilometres for the USSR. There are three large countries, namely USSR, China and Australia with 22.4, 9.6 and 7.7 million square kilometres respectively, and four very small countries, namely the Maldives, Singapore, Tonga and Hong Kong with 298,581, 699 and 1 045 square kilometres respectively. Eleven of the countries have an area of less than 200 000 square kilometres and seven have an area of more than 1 million square kilometres.

1.1 Population

(6) In general, the Asia and Pacific region is heavily populated and it contains two thirds of the world's population. Two of the most heavily populated nations of the world, China and India, are located in the region yet, by contrast, Tonga, the Maldives and Western Samoa have populations of less than 200 000.

(7) For many countries in the region, both large and small, the continuing population growth is proving to be a problem and is offsetting major gains being made in the growth of the domestic economy. Population growth rates in the region are generally high. Figures given for twenty-seven Member States of the region in the World Bank's 'World Development Report 1981' indicate that two countries, Pakistan and Bangladesh, had average population growth rates for the period 1970-1979 of 3 per cent or more. Eighteen of these countries are listed as having average annual population growth rates of 2 per cent or more. Other sources covering the period 1975-1978 (see SC.82/CASTASIA II Ref. 3), list Mongolia, Philippines and Pakistan as countries with population growth rates over 3 per cent per annum and indicate that, in all, nineteen countries exceeded a 2 per cent growth rate. Inasmuch as thirteen countries of the region were classified as having per capita incomes of less than $300 in 1979, the implications of these large populations and high population growth rates in the region are serious, especially when the four high income countries of the region, Australia, Japan, New Zealand and the USSR, had average population growth rates of only 1.1 per cent, 1.0 per cent, 0.4 per cent and 0.9 per cent respectively for 1975-1978. Therefore, it is important to note that when average population growth rates of low-income countries for the periods 1960-1970 and 1970-1979 are compared, the World Bank figures show an increased rate in four countries, a constant rate in two countries, and a decreased rate in four countries (with no suitable figures available for Democratic Kampuchea, Samoa or the Maldives).

(8) Population densities in the region vary greatly, from 4 785 persons per square kilometre in Hong Kong to one per square kilometre in Mongolia (1979 figures). In general, population density correlates inversely with per capita income, the notable exceptions being Singapore, Japan and Hong Kong. However, in Asia and the Pacific it is no longer possible to simply correlate low GDP growth rates with high population densities, as was broadly feasible in the past. Countries with the very highest population densities, Hong Kong (4 785 per sq km) and Singapore (3 883 per sq km) have high annual economic growth rates averaging 9.4 per cent and 8.4 per cent respectively for 1970-1979. Similarly, the Republic of Korea with a population density of 384 per sq km had an average economic growth rate of 10.3 per cent for 1970-1979. These

---

[1] Democratic Republic of Afghanistan, Australia, Bangladesh, Burma, China, India, Indonesia, Islamic Republic of Iran, Japan, Democratic Kampuchea, Democratic People's Republic of Korea, Republic of Korea, Lao People's Democratic Republic, Malaysia, Maldives, Mongolia, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Samoa, Singapore, Sir Lanka, Thailand, Tonga, Turkey, Union of Soviet Socialist Republics, Socialist Republic of Viet Nam.

figures now contrast with those of both New Zealand, with a population density of 12 per sq km and an average economic growth rate of only 2.3 per cent, and Australia, with a density of 2 per sq km and an average economic growth rate of 3.2 per cent for 1970-1979.

(9) Within the region, life expectancy at birth generally reflects the per capita income. Low income countries generally have a life expectancy figure which is well below that of the high income countries. The notable exceptions are Viet Nam, China and Sri Lanka which, based on 1979 figures, have life expectancies of 63, 64 and 66 years respectively; life expectancy figures which align with those of middle-income countries such as Mongolia, Malaysia or Thailand.

(10) Clearly, as the Country Reports testify, the problems presented by the large and increasing population in the region are pressing ones in Asia and the Pacific. On the one hand, the high population offers a manpower base with a vast potential yet, on the other hand, it is a continuing consumer barrier to the attempts to attain economic development and growth. The result is that, despite many years of development, some low income countries of the region are still forced to concentrate on meeting their population's basic needs for food, water, shelter and services.

1.2 Land resources

(11) While a few countries of the Asia and Pacific region can be regarded as highly industrialized, most are characterized by their continuing heavy dependence on agriculture. The vast majority of the population depend on agriculture for a livelihood and subsistence farming is extensively practised. Among low income countries in the region the weighted average of the labour force engaged in agriculture is 71 per cent, with 93 per cent in Nepal and 79 per cent in the Democratic Republic of Afghanistan. Even in middle income countries 42-44 per cent of the labour force is engaged in agriculture.

(12) The four largest countries in the region, the USSR, China, Australia and India, are highly developed agricultural countries, yet all of these countries have large arid zones which are unsuitable for cultivation. In general, the tropical countries of the region have excellent agricultural resources which have been largely exploited by traditional methods, though agriculture is more subject to climatic and natural constraints in the continental countries of South and Central Asia and the islands of the Pacific and Indian Oceans.

1.3 Water resources

(13) Rivers play a major part in the agriculture of most of the countries of Asia and the Pacific, and the development of river control and irrigation systems has been a major feature in the history of many of these countries and a continuing concern of recent developmental planning.

(14) Seventeen of the countries of the region are in the monsoonal zone and their rainfall patterns reflect this. The result is a hazardous agricultural dependence on the arrival, duration and extent of monsoonal rains, as well as a dry season which poses particular problems of water retention. In the non-monsoonal countries of the region there is seasonal rain or snow, and in each of those countries there are areas, sometimes quite vast in the case of Australia and China, which have a very low mean average rainfall.

Country	Area (sq km)	Mid-year estimated population 1979 (millions)	Density 1979 (per sq km)	Annual rate of increase of population 1975-78 %
	(1)	(2)	(3)	(4)
Afghanistan, Democratic Rep. of	647,497	15.5	23.9	2.3
Australia	7,686,848	14.3	1.9	1.1
Bangladesh	143,998	88.9	617.4	2.4
Burma	676,552	32.9	48.6	2.2
China	9,596,961	964.5	100.5	1.4
Democratic Kampuchea	181,035	8.6 (1978)	47.5	1.9
Hong Kong	1,045	5.0	4,784.7	1.6
India	3,287,590	659.2	200.5	2.1
Indonesia	2,027,087	142.9	70.5	2.4
Iran	1,648,000	37.0	22.5	2.2
Japan	372,313	115.7	310.8	1.0
Lao People's Democratic Rep.	236,800	3.3	13.9	2.4
Korea, Dem. People's Rep. of	120,538	17.5	145.2	2.5
Korea, Rep. of	98,484	37.8	383.8	1.6
Malaysia	329,749	13.1	39.7	2.9
Maldives	298	0.14 (1978)	473.2	2.4
Mongolia	1,565,000	1.6	1.0	3.0
Nepal	140,797	14.0	99.4	2.2
New Zealand	268,676	3.2	11.9	0.4
Pakistan	803,943	79.7	99.1	3.0
Papua New Guinea	461,691	2.9	6.3	2.9
Philippines	300,000	46.7	155.7	3.3
Samoa	2,842	0.15 (1978)	54.2	0.6
Singapore	618	2.4	3,883.0	1.2
Sri Lanka	65,610	14.5	221.0	2.0
Thailand	514,000	45.5	88.5	2.5
Tonga	699	0.9 (1978)	134.5	—3.0
Turkey	780,576	44.2	56.6	2.3
USSh	22,402,200	264.1	11.8	0.9
Viet Nam	329,556	52.9	160.5	2.3

(15) Historically, there has been a consistent trend in many countries of the region towards intensive development of water resources for domestic and agricultural purposes. In some countries this water resource development resulted in an intensification of traditional farming practices and an increase in the carrying capacity of the land. In South Asia this development involved exploitation of underground water and progressive improvement of the necessary technologies. Later, techniques which enabled further utilization of underground water were promoted in arid zone areas of Australia.

(16) Water resources have also been extensively exploited for hydro-electricity generation and other purposes related to modern industrial development and urban growth. Yet Hong Kong, Singapore and most large cities of the low income and middle income countries are all experiencing difficulties in this regard; Hong Kong is using a desalination process to obtain adequate potable water. Nevertheless, the high rainfall of the region leaves considerable scope for further water resource development, especially in the tropical highlands and in the Himalayan and Hindukush ranges of Central Asia where the water resources offer great scope for energy production in addition to the usual irrigation for agriculture.

1.4 Coastal resources

(17) Coastal resources constitute an important asset for all the countries of this region except those four which are land-locked. For countries whose coastlines face the Indian or Pacific oceans the fishing industry has always been economically significant and, in the smaller island nations of the Pacific and Indian ocean where the ratio of land to sea area is low, the importance of fishing has even been greater than agriculture. The Maldives provides an outstanding example of the importance of fishing to an island economy since the Maldives, even now, remains a country with a heavy dependence on fishing. In general, the fishing industry in the developing countries of the region is small-scale and uses traditional methods, though mechanization, refrigeration, and modern handling and packaging technologies are becoming more widely used.

(18) Because of the importance which these countries attach to the preservation of coastal fishing resources there is considerable concern regarding the proper management of coastal zones and the entire oceanic region. Overfishing and coastal resource exploitation in the region are of major regional concern. Smaller countries which rely for subsistence on the traditional, smaller-scale fishing technologies are concerned at the widespread use of modern, deep sea trawling equipment by developed countries. In the Pacific region there is also considerable concern over the pollution of the area by industrialized countries on the Pacific rim, as well as by nuclear testing and radioactive waste disposal.

(19) Most of the countries of the region have a great interest in promoting marine sciences in order to ensure improved management and further exploitation of their coastal zone's mineral, especially petroleum, and other resources. For this reason there is considerable interest in discussions on the 200-mile Exclusive Economic Zone (EEZ).

1.5 Renewable natural resources

(20) Agricultural foodstuffs, livestock and livestock by-products, timber, and marine and freshwater fish are important renewable natural resources in many Asia and Pacific countries. Agricultural food crops constitute the principal renewable resource in the region. In many of the lower income and middle income countries of the region the majority of the population is engaged in agriculture and, in some cases, 80 per cent of the population lives in rural villages and is dependent on agricultural production. In these countries the agricultural products are locally consumed and only a small amount is for export. Among the high income countries the position varies from the situation in Australia and New Zealand, where agricultural production is important since expert earnings yet absorbs 10 per cent or less of the workforce, to the agricultural dependency of Japan and the subordinate position of agriculture to industry in the USSR.

(21) Livestock production is a major activity in most of the countries of the region and is an important source of food and raw materials in developing countries. Animal by-products such as hides and wool are exported or, more frequently in the less agriculturally prosperous developing countries, are used in handicraft industries. In the more highly industrialized countries, livestock production is chiefly for export in the form of meat and allied products.

(22) The remaining two major renewable resources in the region are timber and fish. Because of the tropical climate dominating the region there are favourable conditions for natural and plantation timber production. In countries such as Malaysia and Indonesia timber is an important export commodity. With twenty-six of the countries having access to the sea, and with inland fishing and fishpond culture being widely practised, fishing is an important industry while fish are a major source of renewable protein for some countries of Asia and the Pacific.

1.6 Non-renewable natural resources

(23) In the region there are countries which have vast mineral resources and others which are notably deficient. The USSR, China and Australia have extensive proven reserves of minerals and are engaged in further exploration and development thereof. However, the smaller island nations of the Pacific and Indian oceans can only look, in the future, to prospecting off-shore to obtain marine resources. Other countries in the region have proven resources which are being exploited, such as tin and oil in Malaysia, oil and natural gas in Indonesia, natural gas in the Democratic Republic of Afghanistan and Bangladesh, and copper in Papua New Guinea. Yet most lack and have to import minerals for industrial production and, in this regard, the region includes four significant examples of mineral-dependent industrialized countries, namely: Japan, the Republic of Korea, Singapore and Hong Kong.

(24) A small group of nations in the region possess petroleum or natural gas in quantities sufficient to ensure self-sufficiency. However for the majority of the nations of the Asia and Pacific region, the price fluctuations and uncertainties arising from OPEC action in 1973 amount to a calamity which they are still struggling to overcome by rationalizing production and consumption, by adopting alternative sources of energy or, most importantly, by exploration and exploitation of their own natural gas and petroleum resources.

(25) The Country Reports indicate quite clearly the enormous importance that is being attached to the development of a national capacity to discover and effectively exploit new mineral and, especially, new energy resources. Modern methods of exploration and resource surveying are being utilized and R&D funding is being directed towards supporting such scientific work. Similarly, a high priority has been given to scientific research on new, alternative energy sources in order to reduce dependence on non-renewable resources. It would be difficult to overstate the concern which oil-importing nations in the Asia and Pacific region express in their Country Reports regarding the effects of the present oil marketing and price uncertainties on their strategies for national development.

1.7 Economic development

(26) Measuring economic development in terms of per capita GNP, in 1979 the Asia and Pacific region was estimated to contain thirteen countries with per capita incomes of less than US $300, five with per capita incomes between US $300-699, five with per capita incomes between US $700-2 999 (six if Iran is included), four with incomes between US $3 000-6 999 and two with per capita incomes over US $7 000.

GNP per capita (1979)	Country
Over $7,000	Australia, Japan
$3,000-$6,999	Hong Kong, New Zealand, Singapore, USSR
$700-$2,999	Korea (DPR), Korea (Republic), Islamic Republic of Iran (1978), Malaysia, Mongolia, Turkey
$300-$699	Indonesia, Papua New Guinea, Philippines, Thailand, Tonga
Less than $300	Democratic Republic of Afghanistan, Bangladesh, Burma, China, India, Kampuchea, Lao DPR, Maldives, Nepal, Pakistan, Samoa, Sri Lanka, Viet Nam

(27) The group with the lowest per capita GNP includes countries which are heavily dependent on traditional agriculture. However, it also includes two countries with a significant industrial capacity, namely China and India, and five countries whose industrial sector contributes a quarter or more of the nations's GDP. Generally, countries in the less than $300 per capita GNP group have population densities exceeding 50 per sq km. The countries with a high per capita GNP are either heavily industrialized, as with Japan and the USSR, or moderately industrialized and relying on sizeable export earnings from agricultural products, minerals or manufactured goods, as in the case of New Zealand, Australia and Singapore respectively.

(28) The average annual growth of per capita GNP between 1960-1979 in the low income group of countries has been erratic. Some countries have achieved little or no growth, Sri Lanka and Pakistan have grown at rates between 2-3 per cent, and China 3-4 per cent. Among the industrialized middle or high income countries, the Republic of Korea, Hong Kong, Singapore and Japan have registered average annual per capita GNP growth rates of over 7 per cent between 1960-1979. In recent years, GNP growth rates in the region have suffered from the price rises in petroleum-based fuels and the developed world's recession.

(29) Economic growth in the region has been influenced by recent, and in some cases continuing, military conflict and social upheaval. This has particularly been the case in the Indochina group of countries and in West and Central Asia.

(30) It should be noted that not all countries of the region regard GNP derived figures as reliable indicators of relative levels of development. While per capita GNP figures may provide some guide to the quality of life, there are cases where other socio-economic indicators may provide a necessary corrective to the implications of per capita GNP figures. In the Country Reports this point of view was most forcefully expressed by Sri Lanka which argued that, while per capita GNP figures place Sri Lanka among the poorest countries of the world, when reference is made to other socio-economic indicators such as infant mortality, life-expectancy and literacy etc., in what it calls a PQLI (Physical Quality of Life Index), Sri Lanka's socio-economic development is on a par with many developed countries.

(31) As between the middle and low income countries the per capita GNP income and economic growth figures indicate an intra-regional discrepancy for, with the exception of the Indochina region, the South-East Asian countries generally have higher growth and income figures than the South Asian countries.

(32) Within the developing countries of Asia and the Pacific concern is frequently expressed that economic development should benefit the whole society, and the Country Reports indicate that the countries are committed to a programme of economic development which shall ensure and promote a distribution of the benefits of development to the less well-off segments of the population.

(33) Most of the countries of the region, with the exception of the four high income countries of Japan, Australia, USSR and New Zealand, are accepting foreign aid from multilateral and bilateral government sources to develop their countries; some are also using foreign private capital. The role that such foreign investment plays in economic development is outlined in the Country Reports and varies from country to country. Quite apart from such assistance to industrial development, foreign aid has also had a considerable impact on agriculture, health and education. Some Country Reports critically evaluate the effects of foreign aid on national development efforts and include criticisms of aid to education, as well as a questioning of private investment as it influences national development programmes and policies.

1.8 Education

(34) Recent information on educational indicators is available for most of the countries of the region. The average annual percentage increase in first and second level school enrolments during the eight to ten years ending in 1978 (or the latest year available) shows the groupings among the countries of the region. In the four high income countries there is a low or negative increase in enrolments, with a low of —1.4 per cent for the USSR and a high of 1.3 per cent for Japan. There is a consistently high growth pattern among the middle income countries of South-East Asia, with the exception of Singapore (—0.7 per cent) and Hong Kong (0.5 per cent). The major variations occur as between the low income countries. For instance, six of the countries increased enrolments at rates between 1.2 per cent and 2.7 per cent, four had increases of over 5 per cent, and three of over 9 per cent.

(35) These enrolment figures, when compared with figures from the other major regions of the world, indicate that the region of Asia and the Pacific is consistently behind world averages for all levels of education, ahead of some African levels, and generally behind Latin America, particularly in the rate of enrolment increase.

(36) Within the Asia and Pacific region, the countries of the Oceanic region have much higher enrolment ratios at all levels than the Asia region countries, ratios which exceed world totals and approximate those of Europe.

(37) Some countries of the region have large numbers of students studying abroad; illustrative figures for 1978 are: Iran (67 900), Malaysia (22 324), Hong Kong (22 141), China (21 039), Viet Nam (15 158), Japan (14 399), India (13 311), and Thailand (10 243).

(38) The higher education enrolment figures per 100 000 population (1977) show subregional patterns similar to those found from increases in first and second level enrolment figures. In the case of the four high income countries of the region the higher education enrolment figures range from 1 952 to 2 430 per 100 000 population. Among the middle income countries, only the Philippines (2 081) attains those levels while only the Republic of Korea and Singapore exceed 1 000. The range among the middle income countries is from 263 to 2 081 per 100 000. The known range among the low income countries is from 30 to 740 per 100 000.

(39) Public education expenditure (1978) expressed as a percentage of GNP ranges from 0.6 per cent to 6.8 per cent. It exceeds 5 per cent in the case of the high income countries of the region. Among the middle income countries it ranges from 2.2 per cent to 6.8 per cent, and among the low income countries it ranges from 0.6 per cent to 6.0 per cent. Whereas no middle income country spent less than 2 per cent on public education, at least six low income countries are known to have spent 2.0 per cent or less on public education in 1978.

(40) While the developing countries of Asia and the Pacific still do not generally attain the educational levels of either the high income countries of the region nor of Europe and Northern America, the region has increased its enrolment ratios. In particular, the secondary and tertiary enrolment ratios have increased, relatively, much more than primary education. Most countries of the region have some form of government supported education which extends from primary to tertiary education. Five countries indicate that they are engaged in a major effort to establish an educational system, whilst three other countries indicate they are concerned with

post-war educational reconstruction. For the rest of the developing countries of the region, the Country Reports indicate that the framework of an educational system has been established.

Summary of Educational Statistics

Country	Average Annual Enrolment Increase (%) (1970-78)	Number of Students Studying Abroad (1978)	Higher Education Enrolment per 100,000 (1977)	Education Public Expenditure as % of GNP (1978)
Afghanistan, Dem. Rep. of	6	1,527	79	1.7
Australia	1 (1972-78)	3,336	2,145	6.2
Bangladesh	2 (1974-78)	1,818	224	2.2
Burma	2.2 (1970-77)	176	204	1.7(a)
China	5.9 (1977-78)	21,039	—	—
Democratic Kampuchea	17.3 (1970-72)	—	143	—
Hong Kong	0.5	22,141	803	2.7
India	2.7	13,311	740	2.9
Indonesia	5.4	8,523(b)	222	2.0
Iran	8.1 (1970-76)	67,900	494	5.7(b)
Japan	1.3	14,399	2,150	5.7
Korea DPR	—	—	—	—
Korea Rep.	2.5	6,438	1,015	2.5
Lao PDR	9	2,073(c)	30	—
Malaysia	3.2	22,324	368	6.3(d)
Maldives	—	—	—	0.6
Mongolia	5.3 (1970-75)	—	689	—
Nepal	12.4 (1972-78)	1,452	191	1.6
New Zealand	0.8	1,243	2,430	5.4
Papua New Guinea	4.7	306	263	6.8
Pakistan	6.0	4,458	185	2.1
Philippines	3.0	3,046	2,081	2.2
Samoa	3.3	302	—	6.0(d)
Singapore	—0.7	3,619	1,035	2.5
Sri Lanka	2.6	2,772	122	1.4
Thailand	3.6	10,243(a)	494	3.4
Tonga	1.9	349	304 (1974)	4.7(a)
Turkey	2.4	11,889	745	3.6
USSR	—1.4	1,224	1,952	6.2(e)
Viet Nam	1.2 (1975-78)	15,158	246	—

(a): 1977 (b): 1976 (c): 1974 (d): 1975 (e): NMP not GNP

Gross enrolment ratios by levels and regions

Region	First level		Second level		Third level		All levels	
	1965	1977	1965	1977	1965	1977	1965	1977
Asia*	68.0	74.0	27.1	33.9	3.9	6.5	37.1	49.9
Oceania	104.1	102.5	53.7	64.5	9.6	16.9	60.2	63.0
Europe	109.2	104.6	53.3	78.4	9.7	18.3	59.8	67.5
Africa	52.9	73.3	7.5	18.0	0.9	2.3	24.2	36.0
Latin America	85.5	110.0	21.0	31.0	3.6	11.5	42.9	56.0
Northern America	123.0	120.0	76.1	82.9	30.2	44.0	81.2	80.3
World Total	82.3	87.3	32.2	40.0	7.7	11.9	45.2	49.4

* Excluding China, Viet Nam and Korea DPR.

Part 2

Science and Technology Policy Framework

2.1 Development Policy Framework

(41) Almost all the countries of the region which prepared Country Reports indicate that national development plans exist for their countries, along with some organization and process which is responsible for economic and social development. This can take the form of a commission, ministry of planning, council, board, agency or secretariat. The constitution and powers of these bodies vary according to the political system of the country, but each involves centralized control over a development plan, combined in some manner with the co-ordination of all technical ministries and developmental agencies and the participation of central, regional and local administrations in the formulation and implementation of developmental plans.

(42) In many of the countries of the region these planning institutions have a long history. Such countries have evolved a system of long-range, intermediate (usually five years), and annual plans which is integrated on a rolling basis according to broad indicative economic and social objectives which may, from time to time, be modified in the light of circumstances. Such plans seek to identify projects and assign them a priority according to their prospective role in assisting the achievement of national development goals.

(43) The successful attainment of planned development involves the exploitation of natural resources, the establishment of an infrastructure physically able to exploit such natural resources, and the development of human resources to enable this process to be independently implemented. Building up the physical infrastructure involves the construction of transport, power, communication, health, education, housing and social facilities which are necessary for the implementation of agricultural, industrial and service sector projects. While there are, in the region, some developed countries which gained this physical infrastructure without specific planned development, there are many developing countries which have, within the last three decades, planned the development of such physical resources and have assigned priorities to the development of those resources by reference to national development plans.

(44) The developing countries of the region rely heavily on promoting agriculture and agricultural industries, though in almost all cases the national development plans give more emphasis to increasing industrialization. This industrialization is usually based on natural resource development for national economic growth. It also aims to promote an export capability in order to gain foreign exchange. Some of the countries of the region have a long history of exporting commodities for manufacture overseas and, in such cases, these commodities have provided the focus or the funds for an industrialization programme. However, countries such as Nepal, Kampuchea, Laos, Maldives, Samoa, Tonga and Viet Nam have no such agricultural assets to aid industrialization.

(45) As a corollary to the exploitation of natural resources and the building up and strengthening of a developmental infrastructure, these plans also emphasize the systematic development of human resources to provide a national, independent, trained manpower capability. This involves considerable expenditure on education and on allied infrastructural services.

(46) The four high income countries of the region certainly no longer need to be concerned with fundamental developmental problems nor with meeting minimal welfare needs of their population. These industrialized countries have long been engaged in sophisticated developmental activity and have overcome any onerous constraints facing their development. Nevertheless, in most of the nations of the region, natural resources have not been fully developed, the manpower potential of individual countries has not been fully exploited, and the physical infrastructure is still in the process of being built up.

(47) In spite of this, it is an important feature of development in the low income and middle income countries of the region that, at a time when the essential infrastructure is still being established, sophisticated scientific and technological projects are none the less being rapidly implemented. Large developing countries such as China, India, Indonesia and many other smaller nations are promoting sophisticated developmental projects such as nuclear power stations and high technology industries while, simultaneously, the basic developmental infrastructure is still being built up.

(48) In most of the developing countries of the region increasing agricultural productivity is an important part of the development strategy and, for this reason, agricultural projects which improve soil, crop yield and the conservation of water resources are emphasized. In this regard the developing countries of the region exhibit two major problems. The first is the problem facing the heavily populated countries of the tropics of increasing agricultural productivity and national self-sufficiency in monoculture cultivating areas, especially, the rice crop areas. The second problem facing the heavily populated areas of the monsoonal semi-arid areas is to reduce the hazard of agricultural dependence on a single crop in areas of irregular or low rainfall. This second problem is complicated by the widespread incidence of soil degradation which is accompanied by desert encroachment in some countries.

(49) In most of the developing countries of the region the promotion of marine and fresh-water fishing is also emphasized. This is encouraged both to provide an additional source of protein for human nutrition and also as an alternative source of income.

(50) Industrialization is, and has always been, a major goal of developing countries committed to some form of planned development. The establishment of heavy industry is seen as essential for eventual agricultural and industrial progress of a country, while light industrial development is seen as being a means of providing employment to the rapidly increasing population of the country and to those unable to find employment in agriculture.

(51) In addition, national developmental objectives and strategies now take account of other factors. In the past, development programmes usually emphasized the need to minimize dependence on foreign capital and foreign aid, and the need to diversify the economy, however, since 1973, there has been widespread concern to maximize national self-sufficiency in energy resources and to promote alternative, especially renewable, sources of energy. Also, among countries which have been heavily dependent on a single resource for their foreign exchange earnings, there has been a pronounced effort to maximize resource earnings and to diversify their economies.

2.2 Development Policy and Science and Technology Policy

(52) The Country Reports indicate the commitment by governments to the use of science and technology for national

development and outline how this commitment is implemented in practice. The national plans adopted by many countries in the region emphasize the importance of science and technology for eventual economic development. In these plans high priority is given to the elaboration of a science and technology policy, the planning of scientific and technological education, the promotion of scientific and technological research and development, and the creation of a science and technology services infrastructure. These issues have attained sufficient importance for development planning authorities to synthesize them under a single heading of science and technology, and frequently devote a section to them in the published national development plan. There is, of course, wide variation in the particular developmental emphases that each country places on education, scientific research, technological development or infrastructural build-up, and these emphases reflect the individual priorities and needs of each nation.

(53) This interrelationship between science and technology and national development has promoted a trend in the region toward the establishment of institutional links between economic planning organizations and organizations responsible for science and technology planning and administration. In countries where science and technology policy-making and co-ordination has been institutionally formalized there is usually a centralized process for integrating science and technology policy and planning within the overall economic development programme, though the procedure by which this is done varies according to the political system and the economic development ideology. In some countries a more consultative and less institutionally centralized process exists for the co-ordination of science and technology policy with economic development policy as, for instance, in Japan and Australia, or Singapore and Hong Kong. A less centralized and institutionalized approach to the integration of science planning and development planning is also found in smaller countries such as Papua New Guinea, the Maldives, Tonga, or Samoa which are at an embryonic stage of development. For, in these countries, the developmental programme has not yet reached a stage where such integrating mechanisms are required, nor have the foundations been laid to make feasible a national science and technology programme which would be capable of promoting national development. Nevertheless, the majority of the countries of the region are attempting to integrate science and technology policy with national development planning through formal co-ordinated machinery and it is only in the more advanced and high income countries of the region that such integrating machinery is more informal and more decentralized, relying primarily on sectoral consultation and co-operation.

(54) However, the Country Reports indicate that the system of co-ordination, whether consultative or institutional, is not always working satisfactorily, especially in the developing countries. Whether this is due to inherent planning and co-ordination difficulties, to some dissatisfaction with the pace of development, to the failure to use science and technology effectively for development, to a weakness in the national science and technology system or to a combination of these factors, is not always made clear in individual Country Reports.

2.3 Policy-making Machinery for Science and Technology

(55) The Country Reports confirm that the concept of science and technology policy-making has been accepted throughout the region wherever the task of economic development is being seriously addressed by a developing country. Even the more developed countries of the region which have not adopted the institutions of state planning have, nevertheless, frequently established science and technology policy-making and co-ordinating authorities.

(56) Of the developed and the developing countries of the region, almost all have reported the existence of a national organization concerned with science and technology policy-making at a high government level. The only countries which are known not to have such an organization are the very small island nations of Asia and the Pacific. In twenty-three countries these policy-making bodies take various forms: national commissions, committees or boards (10); ministries or departments (10); national councils (11); an agency (1); and a cabinet committee (1). The operational pattern for such high-level national science policy-making organizations varies considerably from country to country; in these twenty-three countries, the policy-making bodies appear to offer advice directly to the highest level of national executive authority.

(57) Similarly, twenty-three countries of the region also indicate that they have created a substructural agency which co-ordinates and plans science and technology. This often involves the same science and technology policy-making organizations mentioned earlier. In nineteen countries the same organizations perform both policy-making and S&T co-ordination and planning.

The role of such bodies is to co-ordinate and plan science and technology activities in relation to the following problems; ensuring co-ordination between decentralized regions within a country; ensuring co-ordination between technical agencies of government; co-ordinating and planning scientific activities in the various sectors of scientific research, or co-ordinating scientific activity between private and public sector organizations. These complex problems of co-ordination occur in all the countries in the region whether developed or developing, except where the country is very small, developmentally static, or where there has been a prolonged period of social unrest such as in the Indochina group of countries.

(58) The system of national science policy-making in the Asia and Pacific region can claim to be rapidly advancing at the institutional level. In addition to having established national policy-making, planning and co-ordinating authorities, bodies responsible for promoting research in major science disciplines have been established and new research fields have been promoted. Energy research, nuclear research and space, electronics or environmental research are all being promoted in the region under co-ordinated scientific research programmes. Some countries are also considering problems such as technology transfer or the encouragement of a private sector research and development capability, and have taken steps they deem appropriate in each case.

(59) Nevertheless, in the developing countries of Asia and the Pacific the existence of an extensive institutional system for science and technology policy-making and planning does not necessarily indicate strong public support for the growth of science and technology, nor a clear or effective role for science and technology in development. In a few instances, science policy-making and planning organizations have proliferated without contributing satisfactorily to the national science and technology programme. In other cases, the process of science and technology policy-making is highly bureaucratized, does not significantly involve the science community, fails to meet the requirements of the users of science and technology, and does not involve all the sectors concerned with a national science and technology policy, especially agriculturalists and industrialists. These problems are mentioned explicitly or by implication in the Country Reports and have to be evaluated by reference to each country's particular circumstances. Such problems should not obscure the strong institutional base which exists for science and technology in Asia and the Pacific, nor should it obscure the general trend towards direct participation in decision-making by the science community.

PART 3

Scientific and Technological Potential

3.1 Institutional Network

(60) Despite the strength of the institutional network outlined above, the science and technology infrastructure of many of the developing countries of the region still suffer from one or more of the following defects: excessive dependence on central government support; failing to strongly integrate with the users of technology; being highly derivative and directed by international research pressures; failing to play a large part in the resolution of major developmental problems facing individual countries; and, an inability to fulfil national hopes, expectations or investment.

(61) All the Country Reports have outlined their national scientific and technological organizations and their research potential. The scale of the R&D institutional structure reflects the level of national development, for R&D has only been established very recently in most developing countries. Yet, the surprising feature of some of the low income developing countries of the region is the range and apparent sophistication of some of the research programmes being undertaken. For instance, among the fifteen low income countries of the region there are at least six countries with an atomic energy research programme. Similarly, low income countries such as Bangladesh, India and Pakistan use modern remote sensing research techniques, and satellite technology has been developed in India and is being utilized in Indonesia, Bangladesh and the South Pacific countries. These apparent anomalies between the economic status of a country and its science activities are becoming more common in the developing nations of Asia and the Pacific.

3.2 Human Resources

(62) Among the countries of Asia and the Pacific there is universal recognition of the importance of human resource development as a necessary step towards socio-economic development. In most of the developing countries of the region over the last twenty years there has been a heavy emphasis on the provision of primary and secondary schooling for the broad mass of the population. Previously, these developing countries had serious problems to overcome for primary and secondary education had not been broad-based and, in former colonies, tertiary education had only been promoted in a few nations prior to national independence. Primary and secondary level schooling has since expanded in most of the region, accompanied by a relatively more rapid extension of tertiary level education in countries where such education had not been promoted.

(63) This rapid expansion of all educational levels in the developing countries of the region has created a vast manpower potential. At the same time, there is evidence in the Country Reports of the unemployment of scientific and technical personnel. In countries such as Sri Lanka, India, Pakistan, Bangladesh and the Philippines there has been an over production of middle level trained manpower. This has led, in national terms, to a great loss through the 'brain-drain' of this skilled manpower which has migrated to developed countries or to other developing countries.

(64) This brain-drain phenomenon has been a feature of the Asia and Pacific region for some time, though not always consistently affecting the same countries. The continuation of this phenomenon clearly indicates an imbalance in the educational system, which may be an acceptable cost to some countries but not to all. For instance, Bangladesh, Sri Lanka, India and the Democratic Republic of Afghanistan all recognize that their countries have benefitted to some extent from the repatriation of income by their expatriated personnel. The Country Reports canvas both sides of the argument regarding whether countries should allow the migration of such trained manpower. None the less, the brain-drain problem highlights difficulties being experienced by countries of the region in matching employment opportunities with educational training.

(65) The middle income countries of the region are generally in a process of rapid development which involves considerable expenditure on education and manpower training. In the region, the countries with the lowest third level education enrolment per hundred thousand population are Laos and the Democratic Republic of Afghanistan, which are both low income countries, and the five countries with the highest enrolments are the four high income countries of the region and the middle-income Philippines.

(66) While some of the countries in the region are extremely short of trained manpower, for instance the Democratic Republic of Afghanistan, Nepal, Malaysia, Indonesia and others, nevertheless, there exists in Asia and the Pacific a vast stock of scientists, engineers and technicians. In the 1970s, most countries in the region registered high average annual increases in the overall numbers of scientists and engineers. The Republic of Korea registered the highest average annual increase between 1967 and 1979 with 14.5 per cent. Only Sri Lanka registered an annual average decline in such manpower, —1.3 per cent between 1973 and 1977. The Country Reports discuss the manpower problems facing each country and describe how the scientific and technological manpower is being utilized, however, at this point in time, low income and middle income countries are generally unable to indicate the numbers engaged in research and development.

(67) Within the high income countries of the region, scientists and technologists are predominantly employed in private enterprise in Japan, in government service and tertiary education in Australia and New Zealand, or in the public sector in the USSR. Among the developing countries of the region the dominant pattern is for scientists and technologists to be employed in government service rather than in private enterprise, even where private enterprise is encouraged and active.

(68) The prevailing pattern in the region is for each country to seek to train its own nationals to meet the S&T manpower requirements of the country. However, there are some countries such as Papua New Guinea which still rely heavily on expatriate manpower, though this is usually counterbalanced by efforts to train local personnel.

(69) The Country Reports also indicate that, in the developing countries in the region, there is concern about the quality of the science and technology education, and the relevance of this training to employment possibilities and national development needs.

(70) In countries such as Japan and the Republic of Korea a high status is accorded to scientists and technologists, however this conflicts with the regional pattern. Generally, and especially in developing countries, there is evidence that science and technology are still not seen as providing an attractive career and the Country Reports outline steps being taken to overcome this in each case.

(71) Developing countries of the region generally offer some opportunity for women to gain high level training with subsequent access to research careers, but this policy operates

within a cultural and historical setting which, in the past, usually restricted the role of women. As a result, women do not normally play a major role in the science and technology work force except in some socialist countries. Where this problem is discussed in the Country Reports, it is stated that this situation is changing.

	R&D Expenditure		
	Year	Per capita (US $)	As percentage of GNP
Afghanistan, Dem. Rep. of			
Australia	1976	70.69	1.0
Bangladesh	1974	0.18	0.2
Burma	1975	0.06	0.1
China	1978		1.8(a)
Democratic Kampuchea			
Hong Kong	1976	0.0	0.0
India	1977	0.76	0.5
Indonesia	1976	0.35	0.2
Iran	1974	1.69	0.3
Japan	1979	182.17	2.1
Lao PDR	1970	...	...
Korea DPR			
Korea Republic	1979	9.58	0.6
Malaysia	1970	...	...
Maldives			
Mongolia	1972	3.12	0.13(b)
Nepal			
New Zealand	1975	39.47	0.9
Pakistan	1973	0.22	0.2
Papua New Guinea	1973	...	...
Philippines	1976	0.73	0.3
Samoa	1978	22.01	...
Singapore	1978	5.28	0.2
Sri Lanka	1975	0.47	0.2
Thailand	1979	...	0.26
Tonga			
Turkey	1979	9.34	0.6
USSR	1979	117.66	4.9(c)
Viet Nam	1979	1.07	...

Source: Unesco Statistics on Science and Technology - latest available data (December 1981), CSR-S-11, Paris; and CASTASIA II Country Reports, 1982

(a) From CASTASIA II Country Report of China and based on Gross National Income

(b) From CASTASIA II Country Report of Mongolia

(c) Based on Net Material Product.

3.3 Expenditure on Research and Development

(72) Expenditure on research and development in the region as a percentage of the Gross National Product (GNP) has increased over the last two decades, rising from between 0.1-0.3 per cent in the mid-1960s to 0.2-0.4 per cent by the end of the 1970s. With the exception of Japan and Singapore, most of this expenditure is from government sources. In 1979, the USSR spent 4.6 per cent of its Net Material Product on research and development, Japan 2.1 per cent of its GNP, India 0.6 per cent, Indonesia 0.4 per cent and the Philippines 0.17 per cent.

3.4 Surveying of S&T Potential

(73) It is evident from the difficulties experienced in obtaining complete manpower, institutional and financial data on science and technology activities from the countries of the region that there are inadequate facilities for surveying, monitoring and evaluating such information in the nations of the region. Seventeen countries have specialized bodies which collect and evaluate information related to their science and technology potential, though only twelve at most could claim to deal comprehensively with the problems of such S&T assessment.

PART 4

Policy Issues in Scientific and Technological Development

4.1 Major Developments

(74) Most countries record as major developments over the last decade the creation of organizations to co-ordinate and plan scientific and technological activities, as well as to co-ordinate science and technology planning with national development goals. Such achievements include the establishment of national councils controlling science and technology as well as the strengthening of professional academies and associations. In addition, the middle income countries, and some of the low income countries such as Bangladesh, China and India, report a considerable extension of their science and technology organizational structure and wide-ranging R&D activities. This progress, when considered in relation to the expansion of education outlined earlier, confirms the great prospects which now exist for science and technology within the region.

(75) A major achievement in the development of science and technology in the region is the continuing regional success with increasing agricultural production. Another major achievement has been the improvement of tertiary education in the region, for this has resulted in indigenous manpower being trained to supervise national development programmes. For the larger countries of the region, such as China and India, there has been diversified industrialization and the establishment of a complementary science and technology capacity related to that industrialization. Despite the world slow-down in economic growth some countries of the Asia and Pacific region, such as Indonesia and Malaysia, continue to show GNP growth rates double those of the average obtaining in the Western industrialized countries.

4.2 Problems

(76) With the exception of the four high income countries, the Asia and Pacific region is generally subject to problems of great magnitude. These include unemployment, the increasing population, inadequate nutritional levels, low living standards, and poor health services, all of which have been evident for some time. These problems have been the subject of remedial action and motivate the planned development programmes of the national governments. The fact that only a few countries of the middle income group have been able to achieve any major amelioration of these problems indicates that there are major tasks ahead for science and technology in the region.

(77) The large populations and the continuing high birth-rates constitute major problems which are recognized in the research priorities and developmental programmes of the countries of the region. Between 1975-1978 the average annual rate of population increase for the high income countries was low with Australia 1.1 per cent, Japan 1.0 per cent New Zealand 0.4 per cent and USSR 0.9 per cent. Of the remaining countries of the region only China, Kampuchea, Hong Kong, Republic of Korea, Samoa, Singapore and Tonga (with a unique decrease of —3.0 per cent) were below 2 per cent. All other countries were over 2 per cent and the Philippines, Pakistan and Mongolia were 3 per cent or more. The consequences of this population growth for the urgent application of science and technology for development in the region are implicitly recognized by affected countries.

(78) Most Country Reports highlight the significance for each country of the changes in the relative costs of petroleum-based energy. In the Asia and Pacific region this is a problem which has directly affected the trends in scientific research and experimental development (R&D) in both developed and developing countries, as well as fundamentally changing the programme for national development of non oil-producing countries. This has been magnified by the effects of the widespread economic recession in the developed countries which has undermined the export-led strategy for economic development being pursued by developing countries in the region.

(79) The other major problem of developing countries is to decrease their national dependence on agriculture whilst providing alternative sources of employment. Until the countries can overcome this agricultural dependence it is difficult for them to begin to resolve the specific problems of unemployment and underemployment of skilled manpower and to obtain balanced growth in the various fields of science and technology education and research. The Country Reports outline how countries perceive these problems and indicate the strategies being adopted to resolve them, for instance, with high technology industries in the Republic of Korea or Industrial Promotion Zones in Sri Lanka.

(80) With regard to the integration of trained manpower with scientific and technological development, some developing countries refer to the problems presented by expatriate education and training of scientists and technologists. Not only does this expatriate training frequently result in a heightened 'brain-drain', it also presents infrastructural problems for the reabsorption of manpower trained in foreign countries.

(81) A general weakness in policy-making for science and technology, and an inadequate science and technology planning capacity are acknowledged by most developing countries. The Country Reports discuss these weaknesses and add that they are magnified by the low level of managerial skill available to superintend the application of science and technology to development. Such manpower problems are still common in the developing countries of the region especially when, in some cases, an 'internal brain-drain' takes skilled manpower from the public to the private sector.

(82) The Country Reports indicate that the developed countries of the region have some problems with regard to environmental protection and pollution control. In the developing countries of the region recognition is also being given to environmental problems and the use of science and technology to assess the ecological consequences of planned development projects.

4.3 Objectives and Priorities

(83) While there is great variation in the circumstances of, and priorities being pursued by, the various countries of the region, there is universal agreement on the need to establish a science and technology policy capability supported by a corresponding co-ordinating apparatus, and which also possesses the mechanisms to gain advice from all sectors of the society interested in the application of science and technology to development. The Country Reports indicate that continuing priority is being given to the training of high level science and technology manpower, technicians and R&D management personnel. There is also an emphasis on the necessity for establishing scientific and technological services and upgrading science and technology education and training.

(84) Research priorities vary from one country to the other.

Some common priorities are: the conservation and exploration of energy resources and the promotion of alternative, preferably renewable, sources of energy; marine research to more efficiently survey marine natural resources as well as to promote and improve the fishery industry; forestry research in terms of conservation and environmental rehabilitation as well as for energy and lumber; agricultural research; nuclear research; space; electronics; and new materials research. Other priorities include communications, health, population control and the development of resource-related technologies such as remote sensing.

4.4 Scientific and Technological Co-operation

(85) Within the Asia and Pacific region, scientific and technological co-operation is highly organized and widely accepted, as is developmental co-operation. The countries have entered into many bilateral agreements with other nations of the region, as well as outside Asia and the Pacific. Similarly, most countries in the region participate fully in international science and technology programmes with the United Nations and its affiliated organizations, are members of international scientific and technological organizations such as ASCA, ICSU, CSC, RCA, etc., as well as participating, where eligible, in organizations such as ASEAN, CMEA, or the Colombo Plan which have science programmes. This extensive involvement in scientific and technological co-operation, and the number of organizations engaging in such activities, constitute a powerful base for future co-operation in those areas.

(86) The Country Reports emphasize that national developmental problems must be resolved from a national science and technology base. However, they also indicate that many countries of the region recognize the difficulty of promoting national science and technology for development on the basis of their own present resources. Some Country Reports state, in this connection, that there is an international bias against the developing countries of Asia and the Pacific in the present international organization of scientific research and the economic control of technology. As a result, most developing nations are eager for regional co-operation in science and technology programmes.

Aperçu régional

Première partie

Considérations d'ordre général

(1) Les 29 États d'Asie et du Pacifique qui sont membres de l'*Unesco* et le territoire de Hong Kong sont situés dans une* région s'étendant d'ouest en est du 20^e degré de longitude Est au 172^e degré de longitude Ouest, et du 82^e degré de latitude nord au 48e degré de latitude Sud. Dix-neuf pays sont situés entièrement ou partiellement dans le sous-continent asiatique; les onze autres se trouvent soit dans la région de l'Océan Indien soit dans celle du Pacifique.

(2) La plupart des pays d'Asie et du Pacifique ont individuellement beaucoup de mal à assurer l'intégration harmonieuse de la science et de la technologie à la planification du développement économique et social, et ils ont ouvertement reconnu et examiné les problèmes dans leurs rapports nationaux. Voilà peut-être pourquoi ils ont souvent eu quelque peine à établir le vaste aperçu des modalités d'application de la science et de la technologie au développement que ces rapports exigeaient. Cependant ils ont conscience du fait que nombre de leurs difficultés sont communes à la région et que, dans une très large mesure, elles ne pourront en définitive être résolues si une action n'est pas menée d'urgence à l'échelon régional et non pas uniquement national. Aussi les rapports nationaux font-ils apparaître, de la part des Etats, une volonté commune de travailler ensemble, au plan régional, à resoudre les problèmes qui se posent, et on constate un vif intérêt pour toutes les questions touchant à l'application de la science et de la technologie au développement. Tous ces pays diffèrent néanmoins grandement, tant par leurs dimensions que par leurs caractéristiques géographiques, leur climat, leur environnement, l'importance et la densité de leur population, leurs ressources naturelles et, surtout, leur stade et leur mode de développement, d'où des divergences considérables dans leurs modalités d'application de la science et de la technologie au développement.

(3) Les États membres de l'Asie et du Pacifique ont des climats très variés : les uns, comme l'URSS, ont un climat continental aux températures extrêmes, d'autres, comme les pays tropicaux, ont un climat océanique avec de légères variations saisonnières. Cette situation est due à la très grande dispersion géographique de ces États. Toutefois, dix-sept pays étant situés entièrement ou en partie entre le Tropique du Cancer et le Tropique du Capricorne, les moussons y revêtent une importance particulière.

(4) Physiquement, la région est très contrastée. On y trouve aussi bien des chaînes de montagnes, y compris le sommet le plus haut du monde, que des plaines arrosées par des fleuves ou de petits îlots de corail. Les extrêmes s'ajoutant à l'immensité des espaces, on rencontre dans la région à la fois de vastes zones arides ou semi-arides et de grandes étendues de forêt tropicale où les pluies sont abondantes. Mais ces contrastes ne sont pas les seules caractéristiques de la région car elle est également influencée par la proximité de deux grands océans. Douze pays sont en bordure de l'Océan Indien, et dix-huit en bordure du Pacifique; seuls quatre pays sont enclavés, sans accès à la mer.

(5) La dimension territoriale des pays d'Asie et du Pacifique est très variable, puisqu'elle va de 298 km^2 dans le cas des Maldives à 22,4 millions de km^2 dans celui de l'URSS. Trois grands pays, à savoir l'URSS, la Chine et l'Australie, ont respectivement 22,4, 9,6 et 7,7 millions de km^2; par contre quatre très petits pays, à savoir les Maldives, Singapour, Tonga et Hong Kong ont respectivement 298, 581, 699 et 1045 km^2. Onze pays ont une superficie inférieure à 200 000 km^2 et sept une superficie supérieure à un million de km^2.

1.1 Population

(6) Dans l'ensemble, la région de l'Asie et du Pacifique est fortement peuplée, puisqu'elle rassemble leux deux tiers de la population mondiale. Deux des pays les plus peuplés du monde, la Chine et l'Inde, y sont situés; par contre, Tonga, les Maldives *et le Samoa occidental comptent moins* de 200 000 habitants.

(7) Pour de nombreux pays de la région, grands et petits, la croissance démographique continue pose un problème et neutralise les progrès économiques réalisés sur la plan national. Les taux de croissance démographique sont généralement élevés dans la région. Les chiffres fournis pour 27 États membres de la région dans le « Rapport sur le développement dans le monde » publié par la Banque mondiale en 1981 indiquent que deux pays, le Pakistan et le Bangladesh, ont eu pour la période 1970-79 un taux de croissance démographique égal ou supérieur à 3 %. Selon le même document, dix-huit de ces pays ont eu un taux de croissance démographique annuel moyen égal ou supérieur à 2 %. D'autres sources pour la période 1975-78 (voir SC.82/CASTASIA II Ref. 3) nous apprennent que la Mongolie, les Philippines et le Pakistan ont un taux de croissance démographique supérieur à 3 % par an et que celui de dix-neuf pays a dépassé 2 %. Etant donné que 13 pays de la région avaient en 1979 un revenu par habitant inférieur à 300 dollars, cette situation a de sérieuses conséquences, d'autant que les taux de croissance démographique des quatre pays à revenu élevé de la région - l'Australie, le Japon, la Nouvelle Zélande et l'URSS - n'ont été en 1975-78 que de 1,1 %, 1,0 %, 0,4 % et 0,9 % respectivement. Si l'on *compare les taux moyens de croissance démographique* des années 1960-70 et des années 1970-79 dans les pays à faible revenu, il faut noter, car cela est important, que d'après les chiffres de la Banque mondiale, les taux ont augmenté dans quatre pays, sont demeurés constants dans deux pays et ont diminué dans quatre pays (on ne dispose pas de chiffres fiables pour le Kampuchea démocratique, Samoa et les Maldives).

(8) Le densité de la population dans la région est extrêmement variable ; elle va de 4 785 habitants au km^2 à Hong Kong à un habitant au km^2 en Mongolie (chiffres de 1979). D'une façon générale, la densité de la population est inversement proportionnelle au revenu par habitant, à l'exception notable de Singapour, du Japon et de Hong Kong. Mais il n'est plus possible aujourd'hui, en Asie et dans le Pacifique, de se borner à établir une corrélation, comme on pouvait plus ou moins le faire dans le passé, entre le faible taux de croissance du PIB et la densité de la population. Les pays ayant les densités de population les plus fortes comme Hong Kong (4 785 habitants au km^2) et Singapour (3 885 habitants au km^2) ont des taux de croissance économique annuelle élevés qui se sont situés autour de 9,4 % et de 8,4 % respectivement pour la période 1970-1979. De même, la République de Corée, qui compte 384 habitants au km^2, a eu en 1970-79 un taux de croissance

---

* République démocratique d'Afghanistan, Australie, Bangladesh, Birmanie, Chine, Inde, Indonésie, République islamique d'Iran, Japon, Kampuchea démocratique, Malaisie, Maldives, Mongolie, Népal, Nouvelle Zélande, Pakistan, Papouasie-Nouvelle-Guinée, Philippines, République de Corée, République démocratique populaire Lao, République populaire démocratique de Corée, Samoa, Singapour, Sri Lanka, Thailande, Tonga, Turquie, Union des Républiques socialistes soviétiques, République socialiste du Vietnam.

économique moyen de 10,3 %. Ces chiffres contrastent avec ceux de la Nouvelle Zélande qui, avec une population de 112 habitants au km^2, a un taux de croissance économique moyen de 2,3 seulement et avec ceux de l'Australie qui, avec une population de 2 habitants au km^2, a eu, en 1970-1979 un taux de croissance économique moyen de 3,2 %.

(9) Dans la région, l'espérance de vie à la naissance est généralement fonction du revenu par habitant. Dans les pays à faible revenu, l'espérance de vie est souvent inférieure à ce qu'elle est dans les pays à revenu élevé. Le Vietnam, la Chine et Sri Lanka constituent des exceptions remarquables : d'après les chiffres de 1979, l'espérance de vie y est respectivement de 63, 64 et 66 ans ; ces chiffres correspondent à ceux de pays à revenu moyen comme la Mongolie, la Malaisie et la Thaïlande.

(10) De toute évidence, comme le montrent les rapports nationaux, les problèmes démographiques qui se posent aux pays de la région sont des problèmes pressants. D'un côté, une population nombreuse est une réserve importante de main d'œuvre, mais c'est, de par la consommation accrue à laquelle elle donne lieu, également un obstacle aux efforts de croissance économique. Si bien que, malgré des années de développement, certains pays à faible revenu de la région sont encore contraints de chercher avant tout à satisfaire les besoins élémentaires de leur poulation sur le plan de l'alimentation, de l'eau, du logement et des services.

1.2 Ressources en terres

(11) Si quelques pays d'Asie et du Pacifique peuvent être considérés comme très industrialisés, la plupart continuent à être lourdement tributaires de l'agriculture. La grande majorité de la population vit d'une agriculture essentiellement de subsistance. Parmi les pays à faible revenu de la région, la moyenne pondérée de la population active s'adonnant à l'agriculture est de 71 % (93 % au Népal et 79 % en Afghanistan). Même dans les pays à revenu moyen, de 42 à 44 % de la population active pratiquent l'agriculture.

(12) Les quatre pays les plus étendus de la région - l'URSS, la Chine, l'Australie et l'Inde - ont une agriculture très développée et, pourtant, il ont tous de vastes zones arides qui ne sont pas cultivables. En général, les pays tropicaux de la région ont d'excellentes ressources agricoles largement exploitées par les méthodes traditionnelles ; toutefois, l'agriculture est plus exposée aux rigueurs climatiques et aux catastrophes naturelles dans les pays continentaux de l'Asie centrale et méridionale, ainsi que dans les îles des Océans Pacifique et Indien.

1.3 Ressources en eau

(13) Les fleuves jouent un grand rôle dans l'agriculture de la plupart des pays d'Asie et du Pacifique et la mise en place de systèmes de régularisation des cours d'eau et d'irrigation a été l'un des événement majeurs de l'histoire de nombre de ces pays qui continuent à en faire l'axe de la planification du développement.

(14) Dix-sept des pays de la région subissent l'influence de la mousson comme le montre la répartition des précipitations. L'agriculture est donc soumise aux caprices de la mousson car elle dépend de l'arrivée, de la durée et de l'abondance des pluies - ainsi qu'à la sécheresse qui pose des problèmes particuliers de rétention d'eau. Dans les pays de la région non exposés à la mousson, il y a des chutes de pluie ou de neige saisonnières et, dans chacun d'eux, il existe des zones, très vastes dans le cas de l'Australie et de la Chine, où la pluviosité moyenne est très faible.

Pays	Superficie (en km^2)	Population estimée à la mi-1979 (en millions)	Densité 1979 (au km^2)	Taux annuel d'accroissement de la population 1975-78 %
	(1)	(2)	(3)	(4)
République dém. d'Afghanistan	647 497	15,5	23,9	2,3
Australie	7 686 848	14,3	1,9	1,1
Bangladesh	143 998	88,9	617,4	2,4
Birmanie	676 552	32,9	48,6	2,2
Chine	9 596 961	964,5	100,5	1,4
Kampuchea démocratique	181 035	8,6 (1978)	47,5	1,9
Hong Kong	1 045	5,0	4 784,7	1,6
Inde	3 287 590	659,2	200,5	2,1
Indonésie	2 027 087	142,9	70,5	2,4
Iran, République islamique d'	1,648,000	37.0	22,5	2.2
Japon	372 313	115,7	310,8	1,0
République dém. populaire lao	236 800	3,3	13,9	2,4
République pop. dém. de Corée	120 538	17,5	145,2	2,5
République de Corée	98 484	37,8	383,8	1,6
Malaisie	329 749	13,1	39,7	2,9
Maldives	298	0,14 (1978)	473,2	2,4
Mongolie	1 565 000	1,6	1,0	3,0
Népal	140 797	14,0	99,4	2,2
Nouvelle-Zélande	268 676	3,2	11,9	0,4
Pakistan	803 943	79,7	99,1	3,0
Papouasie-Nouvelle-Guinée	461 691	2,9	6,3	2,9
Philippines	300 000	46,7	155,7	3,3
Samoa	2 842	0,15 (1978)	54,2	0,6
Singapour	618	2,4	3 883,0	1,2
Sri Lanka	65 610	14,5	221,0	2,0
Thaïlande	514 000	45,5	88,5	2,5
Tonga	699	0,9 (1978)	134,5	3,0
Turquie	780 576	44,2	56,6	2,3
URSS	22 402 200	264,1	11,8	0,9
Viet Nam	329 556	52,9	160,5	2,3

(15) Tout au long de l'histoire, nombre de pays de la région se sont efforcés sans relâche d'exploiter de manière intensive leurs ressources en eau pour les besoins des ménages et de l'agriculture. Dans certains d'entre eux cette mise en valeur des ressources en eau a eu pour effet de rendre plus intensifs les modes de culture traditionnels et d'augmenter la capacité de mise en culture des terres. En Asie du Sud-Est, il a fallu pour ce faire exploiter les eaux souterraines et améliorer progressivement les technologies nécessaires. A une date ultérieure on a également fait appel à la technique pour tirer davantage parti des eaux souterraines dans les zones arides d'Australie.

(16) Les ressources en eau ont aussi été largement exploitées pour la production d'énergie hydro-électrique et pour d'autres objectifs liés au développement industriel moderne et à l'urbanisation. Pourtant, Hong-Kong, Singapour et la plupart des grandes villes des pays à revenu faible ou moyen se heurtent à des problèmes dans ce domaine ; Hong Kong utilise un procédé de dessalement de l'eau de mer pour obtenir de l'eau potable. Cependant, vu la forte pluviosité dans la région, les possibilités sont grandes d'exploiter davantage les ressources en eau, surtout dans les hautes-terres tropicales et dans les chaînes de l'Himalaya et de l'Indou-Kouch, en Asie centrale, où les ressources en eau constituent un vaste potentiel utilisable non seulement pour l'irrigation des terres cultivées mais aussi pour la production d'énergie.

1.4 Ressources côtières

(17) Les ressources côtières constituent un atout important pour tous les pays de la région, à l'exception des quatre qui n'ont pas d'accès à la mer. Dans les pays dont le littoral est en bordure de l'Océan Indien ou de l'Océan Pacifique, la pêche a toujours constitué une ressource économique considérable et, dans les petites îles des Océans Indien et Pacifique où la mer occupe plus de place que la terre, l'industrie de la pêche a beaucoup plus d'importance que l'agriculture. Les Maldives offrent un excellent exemple du grand rôle joué par la pêche dans une économie insulaire car elles demeurent encore aujourd'hui largement tributaires de cette activité. D'une façon générale, l'industrie de la pêche dans les pays en développement de la région est organisée à une faible échelle et elle emploie les méthodes traditionnelles bien qu'on ait de plus en plus recours à la mécanisation, à la réfrigération et aux techniques modernes de manutention et d'emballage.

(18) Tous ces pays tiennent à préserver leurs ressources halieutiques côtières ; aussi sont-ils très soucieux de bien gérer leur littoral ainsi que l'ensemble de la région océanique. La pêche et l'exploitation excessives des ressources côtières sont au premier plan de leurs préoccupations. Les pays les plus petits, qui ne pratiquent pas une pêche à grande échelle et utilisent les techniques traditionnelles, s'inquiètent de voir les pays développés se servir des techniques de pêche hauturière au chalut. On s'inquiète aussi beaucoup dans la région du Pacifique de la pollution de la région par les pays industrialisés en bordure de l'Océan, ainsi que par les essais nucléaires et le rejet de déchets radioactifs.

(19) La plupart des pays de la région sont très soucieux de promouvoir les sciences de la mer pour être en mesure de mieux gérer et exploiter les diverses ressources, notamment minérales, de leurs zones côtières et tout spécialement le pétrole. C'est pourquoi la question de la Zone économique exclusive (ZEE) fait l'objet de vives discussions.

1.5 Ressources naturelles renouvelables

(20) Les denrées alimentaires, les produits et sous-produits du bétail, le bois et les poissons de mer et d'eau douce constituent d'importantes ressources naturelles renouvelables dans nombre de pays d'Asie et du Pacifique. Le production vivrière agricole constitue la principale ressource renouvelable de la région. Dans de nombreux pays de la région à moyen ou faible revenu, la majeure partie de la population s'adonne à l'agriculture ; dans quelques-uns, 80 % de la population vit de cette activité dans les zones rurales. Dans ce dernier cas, les denrées agricoles sont consommées sur place et seule une petite quantité est réservée à l'exportation. Dans les pays à revenu élevé, la situation est variable : en Australie et en Nouvelle-Zélande la production agricole fournit des recettes d'exportation considérables bien qu'elle mobilise à peine 10 % de la population active ; le Japon est tributaire de l'étranger sur le plan agricole et, en URSS, l'agriculture est subordonnée à l'industrie.

(21) L'élevage de bétail tient une place de premier plan dans la plupart des pays de la région ; il constitue une source importante de denrées alimentaires et de matières premières dans les pays en développement. Les sous-produits d'origine animale comme les peaux et la laine sont exportés ou, dans les pays en développement où l'agriculture est relativement moins prospère, servent souvent à la production artisanale. Dans les pays les plus industrialisés, la production animale est principalement destinée à l'exportation sous forme de viande ou de produits dérivés.

(22) Les deux autres grandes ressources renouvelables de la région sont les bois d'oeuvre et le poisson. Le climat tropical dominant dans la région crée des conditions favorables à la production de bois d'oeuvre, dans les zones à l'état naturel ou dans des plantations. Des pays comme la Malaisie en exportent de grandes quantités. D'autre part, comme vingt-six pays ont un accès direct à la mer, et que la pêche en eau douce et la pisciculture sont largement pratiquées, le rôle de la pêche est grand et le poisson constitue une source appréciable de protéines renouvelables dans certains pays d'Asie et du Pacifique.

1.6 Ressources naturelles non renouvelables

(23) Certains pays de la région disposent d'importantes ressources minérales alors que d'autres en sont remarquablement dépourvus. L'URSS, la Chine et l'Australie ont des grandes réserves prouvées de minéraux dont elles s'emploient à développer l'exploitation tout en multipliant les travaux d'exploration. En revanche, les petits pays insulaires des Océans Indien et Pacifique peuvent seulement envisager pour l'avenir de prospecter au large des côtes pour se procurer des ressources marines. D'autres pays de la région ont des réserves prouvées qu'ils exploitent : étain et pétrole en Malaisie, pétrole et gaz naturel en Indonésie, gaz naturel en Afghanistan et au Bangladesh, cuivre en Papouasie-Nouvelle-Guinée. Il n'en reste pas moins que la plupart des pays n'ont pas suffisamment de minéraux et doivent en importer pour leur production industrielle; c'est le cas notamment de quatre nations industrialisées, le Japon, la République de Corée, Singapour et Hong Kong.

(24) Quelques pays de la région possèdent suffisamment de pétrole et de gaz naturel pour satisfaire leurs propres besoins. Mais, pour la majorité des pays d'Asie et du Pacifique, les fluctuations des prix et les incertitudes résultant de l'action de l'OPEP en 1973 représentent une véritable calamité qu'ils s'efforcent encore de surmonter en rationalisant la production et la consommation, en recourant à d'autres sources d'énergie ou surtout en prospectant et en exploitant leurs propres ressources en gaz naturel et en pétrole.

(25) Les rapports nationaux montrent très clairement que les pays sont extrêmement désireux de se doter de leurs propres moyens pour la découverte et pour l'exploitation effective de nouvelles ressources minérales et, notamment énergétiques. Ils ont recours à des méthodes modernes de prospection et d'inventaire des ressources et emploient les crédits de R-D pour financer des travaux scientifiques à cet effet. Ils considèrent également comme hautement prioritaire la recherche scientifique sur les sources d'énergie de rechange afin d'être moins tributaires des ressources non renouvelables. On ne saurait trop souligner combien les pays importateurs de pétrole en Asie et dans le Pacifique se déclarent inquiets dans leurs rapports nationaux des répercussions que les incertitudes en matière de commercialisation et de prix du pétrole ont sur leurs stratégies de développement national.

1.7 Développement économique

(26) Si l'on mesure le développement à l'aune du PNB par habitant, on s'aperçoit que la région comptait en 1979 treize pays où le revenu par habitant était inférieur à 300 dollars E.U., cinq pays où il se situait entre 300 et 699 dollars E.U., cinq où il était de 700 à 2 999 dollars E.U. (six si l'on inclut l'Iran), quatre où il se situait entre 3 000 et 6 999 dollars E.U., et deux où il était supérieur à 7 000 dollars E.U.

PNB par habitant (1979)	Pays
Plus de $7 000	Australie, Japon
$3 000 - $6 999	Hong Kong, Nouvelle Zélande, Singapour, URSS
$700 - $2 999	Corée (RPD), Corée (République de), Malaisie, Mongolie, République islamique d'Iran, Turquie
$300 - $699	Indonésie, Papouasie-Nouvelle-Guinée, Philippines, Thailande, Tonga
Moins de $300	Afghanistan (République dém. d'), Bangladesh, Birmanie, Chine, Inde, Kampuchea démocratique, RDP lao, Maldives, Népal, Pakistan, Samoa, Sri Lanka, Viet Nam

(27) Le groupe de pays où le PNB par habitant est le plus faible comprend des nations lourdement tributaires de l'agriculture traditionnelle. Mais il comprend aussi deux pays, la Chine et l'Inde, qui ont des moyens de production industrielle appréciables, et cinq pays où le secteur industriel fournit un quart ou plus du PIB national. D'une façon générale, les pays appartenant au groupe où le PNB par habitant est inférieur à 300 dollars ont une densité de poulation supérieure à 50 habitants au kilomètre carré. Les pays qui ont un PNB élevé par habitant sont des nations fortement industrialisées comme le Japon et l'URSS, soit des nations qui sont modérément industrialisées et qui tirent des recettes considérables de l'exportation de produits agricoles, de minéraux ou d'articles manufacturés, comme la Nouvelle-Zélande, l'Australie et Singapour respectivement.

(28) Le croissance moyenne annuelle du PNB par habitant entre 1960 et 1979 dans le groupe de pays à faible revenu a été très irrégulière. Le taux de croissance a été faible ou même nul dans certains pays ; il s'est situé entre 2 et 3 % à Sri Lanka et au Pakistan et entre 3 et 4 % en Chine. Parmi les pays industrialisés à niveau moyen ou élevé, la République de Corée, Hong Kong, Singapour et le Japon ont enregistré des taux moyens annuels de croissance supérieurs à 7 % pendant la période 1960-79. Ces dernières années, les taux de croissance du PNB dans la région ont subi le contrecoup de la hausse des prix des combustibles dérivés du pétrole et de la récession dans les pays développés.

(29) Le croissance économique dans la région a été contrariée par les récents conflits militaires et bouleversements sociaux qui, parfois, se poursuivent encore. Cela a été particulièrement le cas du groupe de pays indochinois et des pays d'Asie occidentale et centrale.

(30) Il convient de noter que les pays de la région ne considèrent pas tous les chiffres tirés du PNB comme des indicateurs fiables des niveaux relatifs de développement. Ces chiffres peuvent donner une idée du niveau de vie mais il est des cas où d'autres indicateurs socio-économiqes peuvent leur apporter un correctif nécessaire. Sri Lanka fait valoir avec force dans son rapport national que le chiffre de son PNB par habitant place certes le pays au nombres des plus pauvres du monde mais que si l'on se réfère à d'autres indicateurs socio-économiques comme la mortalité infantile, l'espérance de vie ou le taux d'alphabétisation (autant d'indices de la qualité de la vie), le développement socio-économique de Sri Lanka n'a rien à envier à celui de bon nombre de pays développés.

(31) Pour ce qui est des pays à revenu faible ou moyen, les chiffres du PNB par habitant et les taux de croissance montrent qu'il y a de grosses différences à l'intérieur de la région ; en effet, si l'on excepte la péninsule indochinoise, il apparaît que les pays du Sud-Est asiatique ont dans l'ensemble un revenu et un taux de croissance supérieurs à ceux de l'Asie du Sud.

(32) Les pays en développement d'Asie et du Pacifique affirment souvent leur souci de voir le progrès économique profiter à l'ensemble de la société et ils signalent dans leurs rapports nationaux qu'ils se sont engagés à réaliser des programmes de développement économique devant assurer et promouvoir la distribution des bienfaits de la croissance aux milieux les plus défavorisés.

(33) La plupart des pays de la région, à l'exception des quatre pays à revenu élevé - Japon, Australie, URSS et Nouvelle-Zélande - acceptent une aide bilatérale et multilatérale de gouvernements étrangers pour assurer leur propre développement ; certains font également appel aux capitaux privés étrangers. Le rôle que jouent de tels investissements dans le développement économique, variable d'un pays à l'autre, est précisé dans les rapports nationaux. L'assistance étrangère n'a pas seulement facilité le développement industriel, elle a également eu des effets considérables sur l'agriculture, ainsi que les secteurs de la santé et de l'éducation. Certains rapports nationaux formulent des critiques au sujet des répercussions de l'aide étrangère, sur les efforts de développement national, dans le domaine de l'éducation notamment, et s'interrogent au sujet de l'incidence des investissements privés sur les programmes et politiques de développement national.

1.8 Education

(34) On dispose pour la plupart des pays de la région de données sur les indicateurs concernant l'éducation. L'augmentation moyenne annuelle des effectifs de l'enseignement primaire et secondaire de 1968-70 à 1978 (ou l'année la plus récente pour laquelle on dispose de chiffres) permet d'établir des groupements à l'intérieur de la région. Dans les quatre pays à revenu élevé, les effectifs sont en faible augmentation, voire en diminution (cela va de —1,4 % pour l'URSS à 1,3 % pour le Japon). Dans les pays à revenu moyen d'Asie du Sud-Est, l'augmentation est régulièrement forte, à l'exception de Singapour (–0,7 %) et de Hong Kong (0,5 %). C'est entre les pays à revenu faible que les écarts sont les plus marqués. C'est ainsi que le taux d'accroissement des effectifs s'est situé entre 1,2 % et 2,7 % dans six de ces pays, qu'il a été supérieur à 5 % dans quatre d'entre eux et à 9 % dans trois autres.

(35) Une comparaison de ces données avec celles des autres grandes régions du monde, montre que les chiffres de la région de l'Asie et du Pacifique sont au-dessous de la moyenne mondiale à tous les niveaux d'éducation, qu'ils sont supérieurs à ceux de l'Afrique pour certains niveaux, et qu'ils sont généralement inférieurs à ceux de l'Amérique latine, notamment en ce qui concerne le rythme d'accroissement des effectifs.

(36) A l'intérieur de la région, les pays d'Océanie ont des taux d'inscription très supérieurs à ceux des pays d'Asie, à tous les niveaux, supérieurs à la moyenne mondiale et proches de ceux de l'Europe.

(37) Certains pays de la région ont un grand nombre d'élèves ou étudiants à l'étranger. Les chiffres pour 1978 sont les suivants; Iran (67 000), Malaisie (22 324), Hong Kong (22 141), Chine (21 039), Vietnam (15 158), Japon (14 399), Inde (13 311) et Thaïlande (10 243).

(38) Les taux d'inscription dans l'enseignement supérieur (par 100 000 habitants) en 1977, font apparaître des regroupements sous-régionaux semblables à ceux qui se dégagent des taux de progression des effectifs dans l'enseignement primaire et secondaire. Dans le cas des quatre pays à revenu élevé de la région, les chiffres pour 100 000 habitants oscillent entre 1952 et 2430. Dans le cas des pays à revenu moyen, seules les Philippines atteignent ce niveau (2081) et seules la République de Corée et Singapour dépassent 1000 unités. Pour l'ensemble de ces pays à moyen revenu, l'éventail va de 263 à 2081 étudiants pour 100 000 habitants. Il est de 30 à 740 par 100 000 habitants pour les données connues des pays à revenu faible.

(39) Les dépenses consacrées à l'enseignement public exprimées en pourcentage du PNB oscillent entre 0,6 % et 6.8 %. Elles sont supérieures à 5 % dans les pays à revenu

élevé. Dans les pays à revenu moyen, elles se situent entre 2,2 % et 6,8 % et, dans les pays à faible revenu, entre 0,6 % et 6 %. Alors qu'aucun des pays à revenu moyen n'a dépensé moins de 2 % pour l'enseignement public, six des pays à faible revenu lui ont consacré au maximum 2 % du PNB en 1978.

(40) Si les pays en développement d'Asie et du Pacifique n'ont pas encore atteint, en général, un niveau d'éducation comparable à celui des pays à revenu élevé de la région ou celui de l'Europe et de l'Amérique du Nord, les taux d'inscription y ont augmenté. Cette progression a été beaucoup plus forte dans l'enseignement secondaire et supérieur que dans l'enseignement primaire. Il existe dans la plupart des pays, sous une forme ou une autre, des institutions éducatives soutenues par l'État, depuis l'enseignement primaire jusqu'à l'enseignement supérieur. Cinq pays signalent qu'ils s'emploient activement à mettre en place un système d'éducation et trois autres se déclarent en train de reconstruire un système d'éducation disloqué par la guerre. Quant au reste des pays en développement de la région, ils indiquent dans leur rapports nationaux que les bases de leur système éducatif sont établies.

Résumé des statistiques de l'éducation

Pays	Augmentation annuelle moyenne des effectifs (%) (1970-78)	Nombre d'étudiants à l'étranger (1978)	Effectif dans l'enseignement supérieur (pour 100 000 hab.) (1977)	Dépenses d'éducation (secteur public) en % du PNB (1978)
Afghanistan, Rep. dém. d'	6	1,527	79	1.7
Australie	1 (1972-78)	3,336	2,145	6.2
Bangladesh	2 (1974-78)	1,818	224	2.2
Birmanie	2.2 (1970-77)	176	204	1.7(a)
Chine	5.9 (1977-78)	21,039	—	—
Kampuchea démocratique	17.3 (1970-72)	—	143	—
Hong Kong	0.5	22,141	803	2.7
Inde	2.7	13,311	740	2.9
Indonésie	5.4	8,523(b)	222	2.0
Iran, Rép. Islamique d'	8.1 (1970-76)	67,900	494	5.7(b)
Japon	1.3	14,399	2,150	5.7
République dém. pop. de Corée	—	—	—	—
République de Corée	2.5	6,438	1,015	2.5
République dém. pop. lao	9	2,073(c)	30	—
Malaisie	3.2	22,324	368	6.3(f)
Maldives	—	—	—	0.6
Mongolie	5.3 (1970-75)	—	689	—
Népal	12.4 (1972-78)	1,452	191	1.6
Nouvelle-Zélande	0.8	1,243	2,430	5.4
Papuasie-Nouvelle-Guinée	4.7	306	263	6.8
Pakistan	6.0	4,458	185	2.1
Philippines	3.0	3,046	2,081	2.2
Samoa	3.3	302	—	6.0(d)
Singapour	—0.7	3,619	1,035	2.5
Sri Lanka	2.6	2,772	122	1.4
Thaïlande	3.6	10,243(a)	494	3.4
Tonga	1.9	349	304 (1974)	4.7(a)
Turquie	2.4	11,889	745	3.6
URSS	—1.4	1,224	1,952	6.2(e)
Viet Nam	1.2 (1975-78)	15,158	246	—

(a): 1977 (b): 1976 (c): 1974 (d): 1975 (e): PMN et non PNB

Taux d'inscription brut, par niveau et par région

Région	Premier niveau		Deuxième niveau		Troisième niveau		Tous niveaux	
	1965	1977	1965	1977	1965	1977	1965	1977
Asie*	68,0	74,0	27,1	33,9	3,9	6,5	37,1	49,9
Océanie	104,1	102,5	53,7	64,5	9,6	16,9	60,2	63,0
Europe	109,2	104,6	53,3	78,4	9,7	18,3	59,8	67,5
Afrique	52,9	73,3	7,5	18,0	0,9	2,3	24,2	36,0
Amérique latine	85,5	110,0	21,0	31,0	3,6	11,5	42,9	56,0
Amérique du Nord	123,0	120,0	76,1	82,9	30,2	44,0	81,2	80,3
Total mondial	82,3	87,3	32,2	40,0	7,7	11,9	45,2	49.4

* A l'exclusion de la Chine, du Vietnam et de la Corée (RPD)

Deuxième partie

Cadre des politiques dans le domaine de la science et de la technologie

2.1 Cadre des politiques de développement

(41) Presque tous les pays de la région ayant présenté des rapports nationaux précisent qu'ils ont des plans de développement et qu'un dispositif et des procédures ont été mis en place pour assurer le progrès économique et social. Ce mécanisme peut se présenter sous la forme d'une commission, d'un ministère de la planification, d'un conseil, d'un office ou d'un secrétariat. La nature et les pouvoirs de ces organes varient en fonction du régime politique du pays mais il impliquent tous l'exercice d'un contrôle centralisé du plan de développement, associé, d'une manière ou d'une autre, à la coordination de l'action de tous les ministères techniques et organismes de développement, ainsi que la participation des administrations centrales, régionales et locales à l'élaboration et à la mise en oeuvre du plan.

(42) Dans nombre de pays de la région, ces organes de planification ont une longue histoire. Ces pays ont mis au point un système de plans à long terme, de plans à moyen terme (en général des plans quinquennaux) et de plans annuels, qui sont intégrés, dans une programmation continue, en fonction des grands objectifs économiques et sociaux susceptibles d'être modifiés au gré des circonstances. On s'efforce d'établir des projets précis et de leur assigner un rang de priorité déterminé par la mesure dans laquelle ils contribueront sans doute à la réalisation des objectifs de développement national.

(43) Un plan de développement, pour réussir, suppose l'exploitation des ressources naturelles, la mise en place d'une infrastructure, et le développement des ressources humaines, pour que l'oeuvre puisse être menée à bien en toute autonomie. La constitution d'une infrastructure implique la création d'un réseau de transports, l'exploitation des ressources énergétiques, le développement des secteurs de la communication, de la santé, de l'éducation, du logement et des services sociaux. Tout cela est nécessaire à la mise en oeuvre de projets dans les secteurs de l'agriculture, de l'industrie et des services. Certains pays développés de la région ont mis en place une telle infrastructure sans avoir eu recours à une véritable planification mais nombre de pays en développement ont, au cours des trente dernières années, établi des plans de mise en valeur des ressources et défini des priorités cohérentes avec les plans nationaux de développement.

(44) Les pays en développement de la région sont étroitement tributaires du développement de l'agriculture et des industries agro-alimentaires mais les plans nationaux de développement font presque toujours une place plus importante à l'industrialisation. Celle-ci est généralement fondée sur la mise en valeur des ressources naturelles destinée à assurer la croissance économique. Elle vise aussi à donner au pays des moyens d'exportation lui permettant de se procurer des devises. Certains pays de la région exportent depuis fort longtemps des produits de base qui sont ensuite manufacturés à l'étranger; aussi ont-ils soit axé sur ces produits leur programme d'industrialisation, soit tiré de ces exportations les crédits nécessaires pour leur industrialisation. Mais des pays comme le Népal, le Kampuchéa, la République démocratique populaire lao, les Maldives, Samoa, Tonga et le Vietnam, n'ont pas de telles ressources agricoles à mettre au service de leurs programmes d'industrialisation.

(45) L'exploitation des ressources naturelles et la mise en place ou le renforcement de l'infrastructure vont de pair avec la mise en valeur systématique des ressources humaines, à laquelle les plans font une large place pour la formation d'une main d'oeuvre nationale, autonome et qualifiée. Il faut pour cela faire des investissements considérables dans l'éducation et les infrastructures connexes.

(46) Les quatre pays à revenu élevé de la région n'ont plus à se préoccuper des problèmes fondamentaux du développement ni de la satisfaction des besoins élémentaires de leur population. Ces pays industrialisés ont depuis longtemps atteint un haut niveau de développement et, en ce qui les concerne, le plus dur est fait. Et pourtant, dans la plupart des pays de la région, les ressources naturelles n'ont pas été pleinement exploitées, les ressources potentielles en main d'œuvre n'ont pas été développées au maximum, et la mise en place des infrastructures n'est pas terminée.

(47) Il est néanmoins très intéressant de constater que dans les pays à revenu faible et moyen de la région, où la mise en place des infrastructures est loin d'être achevée, des plans scientifiques et technologiques d'une extrême complexité sont en bonne voie de réalisation. De grands pays comme la Chine, l'Inde, l'Indonésie, et nombre de pays plus petits, se dotent de centrales nucléaires et d'industries fondées sur des technologies très avancées alors que, dans le même temps, ils poursuivent la mise en place des infrastructures de base.

(48) Dans la plupart des pays en développement de la région, l'accroissement de la productivité agricole est un élément important de la stratégie du développement; c'est pourquoi on met l'accent sur des projets visant à amender les sols, à augmenter le rendement des cultures et à préserver les ressources en eau. Ces pays se trouvent confrontés à deux grands problèmes. Le premier concerne les régions tropicales extrêmement peuplées où il s'agit d'accroître la productivité agricole et, là où est pratiquée la monoculture, celle du riz notamment, d'arriver à l'auto-suffisance. Le second concerne les secteurs très peuplés des zones semi-arides exposées à la mousson, où les précipitations sont faibles ou irrégulières; on cherche dans ce cas à réduire les risques inhérents à la monoculture. Ce second problème est aggravé par la dégradation fréquente des sols qui va de pair dans quelques pays avec le phénomène de la désertification.

(49) Dans la plupart des pays en développement de la région, on s'efforce de promouvoir la pêche en mer ou en eau douce afin de disposer d'une source supplémentaire de protéines et, aussi, de revenu.

(50) L'industrialisation est, et a toujours été, l'un des objectifs majeurs des pays soucieux de planifier leur croissance. La mise en place d'une industrie lourde est jugée indispensable au progrès du pays, tant au plan agricole qu'industriel. Quant au développement de l'industrie légère, il permet de procurer des emplois à la population en croissance rapide et à tous ceux qui ne trouvent pas de travail dans l'agriculture.

(51) Les objectifs et stratégies du développement national tiennent aussi compte d'autres facteurs. Dans le passé, les programmes de développement mettaient surtout l'accent sur la nécessité de réduire la dépendance à l'égard de l'aide et des capitaux étrangers et de diversifier l'économie. Depuis 1973, on a cherché par tous les moyens à assurer l'auto-suffisance énergétique et à trouver d'autres sources d'énergie, notamment renouvelables. Et les pays qui, pour se procurer des devises, sont extrêmement tributaires de l'exportation d'une ressource unique se sont employés à en tirer le maximum de revenu et à diversifier leur économie.

2.2 Politique de développement et politique relative à la science et à la technologie

(52) Les rapports nationaux indiquent que les gouvernements se déclarent prêts à mettre la science et la technologie au service du développement et montrent comment cet engagement se traduit dans la pratique. Les plans nationaux adoptés par de nombreux pays soulignent l'importance de la science et de la technologie pour le développement économique. Un rang de priorité élevé est accordé à l'élaboration d'une politique de la science et la technologie, à la planification de l'enseignement scientifique et technique, à la promotion de travaux de R-D scientifique et technologique et à la mise en place d'une infrastructure de services scientifiques et technologiques. Ces questions sont devenues suffisamment importantes pour que les responsables de la planification les regroupent dans une seule rubrique relative à la science et à la technologie, et une section leur est souvent consacrée dans le document du plan national de développement. Bien entendu, tous les pays ne prêtent pas une égale attention à l'éducation, à la recherche scientifique, au développement technologique ou à la mise en place des infrastructures et ces différences d'accent reflètent les priorités et les besoins individuels des différents pays.

(53) Du fait de ces relations entre la science, la technologie et le développement national, les pays de la région ont été amenés à établir des liens institutionnels entre les services responsables de la planification de l'économie et les organismes de planification et de gestion scientifiques et technologiques. Dans les pays où l'établissement et la coordination de la politique scientifique et technologique ont été institutionnalisés, il existe en général un système centralisé d'intégration de la politique scientifique et technologique au programme global de développement économique; la démarche suivie dépend toutefois du régime politique et de la conception du développement des nations. Certains pays disposent d'un système relativement plus consultatif et moins centralisé pour assurer la coordination de la politique scientifique et technologique et de la politique de développement économique; c'est le cas par exemple du Japon et de l'Australie, de Singapour et de Hong Kong. Et des pays comme la Papouasie-Nouvelle-Guinée, les Maldives, Tonga ou le Samoa, qui sont relativement petits et dont le développement ne fait que commencer, ont une méthode d'approche moins centralisée et institutionnalisée de l'intégration de la science et de la planification du développement. En effet, le programme de développement de ces pays n'est pas encore arrivé au stade où ces mécanismes d'intégration sont nécessaires et on n'y a pas encore mis en place les fondations qui rendraient possible un programme national de science et de technologie capable de promouvoir le développement national. Néanmoins, la majorité des pays de la région s'efforcent d'intégrer la politique scientifique et technologique à la planification du développement national par des dispositifs officiels bien coordonnés, et c'est seulement dans les pays les plus avancés et les plus prospères que ces dispositifs sont informels et plus décentralisés et se fondent avant tout sur la coopération et la consultation sectorielles.

(54) Cependant les auteurs des rapports nationaux font observer que les systèmes de coordination, consultatifs ou institutionnels, ne fonctionnent pas toujours de manière satisfaisante, surtout dans les pays en développement. Mais ils n'expliquent pas toujours clairement si cette situation est imputable aux difficultés inhérentes à la planification et à la coordination, à l'insuffisance du rythme de développement, à l'incapacité de mettre la science et la technologie au service du développement, à la faiblesse de l'appareil scientifique et technologique national ou à une combinaison de tous ces facteurs.

2.3 Dispositif sur lequel s'appuie la politique scientifique et technologique

(55) La lecture des rapports nationaux confirme que le concept de politique scientifique et technologique a été accepté par tous les pays en développement qui se sont attaqués sérieusement à la tâche du développement économique. Et même les pays les plus développés qui ne sont pas dotés des instruments de la planification étatique, ont dans bien des cas mis en place des institutions chargées de l'établissement de la coordination de la politique scientifique et technologique.

(56) Presque tous les pays de la région, développés ou en développement, ont signalé l'existence, à un niveau élevé, d'un organe national dont la mission est de définir la politique scientifique et technologique. Seules les très petites îles d'Asie et du Pacifique en sont dépourvues. Les organes existant dans 23 pays revêtent diverses formes : commissions, comités ou offices nationaux (10); ministères ou départements ministériels (10); conseils nationaux (11); agence (1); conseil de cabinet (1). Le fonctionnement de ces organes nationaux varie considérablement d'un pays à l'autre; dans ces 23 pays, ils semblent donner des avis directement à l'échelon le plus élevé de l'Exécutif.

(57) Vingt-trois pays indiquent également qu'ils ont créé un organe de planification et de coordination de la science et de la technologie. Il s'agit souvent des mêmes institutions que celles dont il vient d'être question. Dans 19 pays, un seul organe est chargé à la fois de définir la politique et de planifier et coordonner les activités scientifiques et techniques.

Le rôle prévu est de coordonner et de planifier les activités scientifiques et technologiques et, en particulier, d'assurer la coordination entre les régions décentralisées du pays et entre les services techniques officiels et de coordonner et de planifier les activités scientifiques de recherche dans les divers domaines du secteur public et du secteur privé. Ces problèmes complexes de coordination se posent dans tous les pays de la région, qu'ils soient développés ou en développement, sauf lorsqu'il s'agit d'un très petit pays où la situation n'évolue pas, ou d'un pays qui a connu une période prolongée de troubles sociaux comme c'est la cas dans les pays indochinois.

(58) La mise en place de politiques scientifiques dans les pays d'Asie et du Pacifique progresse rapidement au niveau institutionnel. Outre les autorités susmentionnées, il a été créé des organes chargés de promouvoir la recherche dans les grandes disciplines scientifiques, ce qui a ouvert de nouvelles voies à explorer. La recherche dans les domaines, énergétique, nucléaire et spatial, ainsi que dans les secteurs de l'électronique et de l'environnement, est encouragée dans la région dans le cadre de programmes scientifiques coordonnés. Certains pays étudient aussi le problème du transfert de la technologie ou de la promotion d'un secteur privé de la recherche et du développement, et ils ont pris les mesures qu'ils ont jugées appropriées à cet égard.

(59) Néanmoins, l'existence dans les pays en développement d'Asie et du Pacifique d'un vaste système institutionnel pour la politique et la planification scientifiques et technologiques ne signifie pas nécessairement que la science et la technologie sont énergiquement soutenues par les pouvoirs publics et qu'elles sont véritablement au service du développement. Dans quelques cas, les organismes de ce genre ont proliféré sans contribuer de manière satisfaisante à la réalisation du programme national de science et de technologie. Dans d'autres cas, l'appareil est fortement bureaucratisé, n'obtient pas un concours important des milieux scientifiques, ne répond pas au besoins des utilisateurs de la science et de la technologie et n'englobe pas tous les secteurs que la politique scientifique nationale devrait intéresser, en particulier les secteurs agricole et industriel. Ces problèmes sont mentionnés explicitement dans les rapports nationaux ou apparaissent implicitement à leur lecture et on ne peut s'en faire une juste idée qu'en fonction de la situation particulière de chaque pays. Ils ne doivent pas nous faire oublier que la science et la technologie reposent sur des bases institutionnelles solides dans les pays d'Asie et du Pacifique ni masquer la tendance générale d'une participation directe des milieux scientifiques à l'élaboration des politiques.

Troisième partie

Le Potentiel scientifique et technologique

3.1 Réseau institutionnel

(60) Malgré la solidité du dispositif institutionnel que nous venons de décrire, l'infrastructure scientifique et technologique de nombre de pays de la région présente encore un ou plusieurs des défauts suivants : elle dépend de façon excessive du soutien gouvernemental ; elle n'est pas pleinement intégrée aux secteurs utilisateurs, est trop soumise à des pressions internationales ; ne joue pas un rôle de pointe dans la solution des grands problèmes de développement nationaux ; ou ne répond pas à l'attente du pays ni à ses besoins d'investissement.

(61) Dans leurs rapports nationaux, tous les pays décrivent leurs organismes scientifiques et technologiques et indiquent leur potentiel de recherche. L'importance des structures institutionnelles R-D donnent une idée du niveau de développement national puisque la R-D n'a été introduite que récemment dans la plupart des pays en développement. Mais, il faut le constater avec étonnement, certains de ces pays à faible revenu ont entrepris d'ambitieux programmes de recherche de pointe. C'est ainsi qu'au moins six des quinze pays à faible revenu de la région ont un programme de recherche nucléaire. Des pays à faible revenu comme le Bangladesh, l'Inde et le Pakistan utilisent des techiques modernes de télédétection ; la technologie des satellites a été dévelopée en Inde et elle est actuellement utilisée en Indonésie, au Bangladesh et dans les pays du Pacifique Sud. Ces anomalies apparentes entre le niveau économique d'un pays et ses activités scientifiques sont un phénomène de plus en plus courant dans les pays en développement d'Asie et du Pacifique.

3.1 Ressources humaines

(62) Les pays d'Asie et du Pacifique reconnaissent tous que pour assurer leur progrès socio-économique, ils doivent auparavant apprendre à tirer parti de leurs ressources humaines. La plupart des nations en développement de la région se sont efforcées au cours des vingt dernières années de donner une éducation primaire et secondaire à la grande masse de la population. Ces nations avaient eu auparavant de graves problèmes du fait que l'enseignement primaire et secondaire n'y était pas généralisé ; en outre, seules quelques anciennes colonies étaient dotées avant l'Indépendance d'un système d'enseignement supérieur. L'instruction primaire et secondaire s'est depuis lors développée dans la plupart des pays de la région ; quant à l'enseignement supérieur, il s'est implanté, à un rythme encore plus rapide, dans les pays où il n'existait pas encore.

(63) Cette extension rapide de l'éducation, à tous les niveaux, a permis de constituer une vaste réserve de main d'oeuvre. Mais les rapports nationaux signalent qu'il y a beaucoup de chômage parmi le personnel scientifique et technique. Dans des pays comme Sri Lanka, l'Inde, le Pakistan, le Bangladesh et les Philippines, on a formé trop de cadres moyens, d'où un « exode des compétences » vers les pays développés ou d'autres pays en développement qui représente une lourde perte pour la nation.

(64) Cet exode des compétences est un phénomène relativement ancien en Asie et dans le Pacifique, mais il ne se manifeste pas en permanence dans les mêmes pays. Il traduit un déséquilibre du système d'éducation qui peut paraître un prix à payer acceptable à certains pays mais pas à tous. Par exemple, le Bangladesh, Sri Lanka, l'Inde et l'Afghanistan reconnaissent que le rapatriement des sommes gagnées par leur personnel outre-mer leur a été dans une certaine mesure profitable. Les auteurs des rapports nationaux s'interrogent tous sur la question de savoir s'il faut ou non autoriser l'émigration de personnel qualifié. Quoi qu'il en soit, ce problème montre bien les difficultés qu'éprouvent les pays à équilibrer offres d'emploi et possibilités d'éducation.

(65) Les pays à revenu moyen de la région sont pour la plupart en voie de développement rapide et ils ont de ce fait d'énormes dépenses d'éducation et de formation. Les pays qui ont le moins d'étudiants dans l'enseignement supérieur (par 100 000 habitants) sont la République démocratique populaire lao et l'Afghanistan, qui sont tous les deux des pays à faible revenu, et les cinq pays qui en ont le plus sont les quatre pays à haut revenu et un pays à revenu moyen, les Philippines.

(66) Certains des pays de la région connaissent une grave pénurie de main d'oeuvre qualifiée ; c'est le cas notamment de l'Afghanistan, du Népal, de la Malaisie et de l'Indonesie. Cela n'empêche pas que les pays d'Asie et du Pacifique disposent d'une vaste réserve de scientifiques, d'ingénieurs et de techniciens. Dans les années 1970, le nombre de scientifiques et d'ingénieurs a nettement augmenté dans la plupart des pays de la région. C'est en République de Corée qu'il a le plus augmenté entre 1967 et 1969 avec une progression moyenne annuelle de 14,5 %. Il a baissé uniquement à Sri Lanka -1,3 % entre 1973 et 1977. Dans leurs rapports nationaux, les pays présentent les problèmes de main d'oeuvre auxquels ils doivent faire face, et expliquent comment est utilisé leur personnel scientifique et technique. Mais, à ce stade, les pays à revenu faible ou moyen sont généralement incapables d'indiquer le nombre de personnes travaillant dans le secteur de la R-D.

(67) Dans les pays à revenu élevé dans la région, les scientifiques et les technologues sont employés dans le secteur privé (Japon), sont fonctionnaires de l'Etat ou professeurs dans l'enseignement supérieur (Australie et Nouvelle-Zélande) ou travaillent dans le secteur public (URSS). Dans les pays en développement de la région, les scientifiques et les technologues travaillent en général dans le secteur public plutôt que dans le secteur privé même quand celui-ci est actif et qu'on lui prodigue des encouragements.

(68) Dans l'ensemble, les pays de la région cherchent généralement à assurer la formation de leurs propres ressortissants pour faire face aux besoins de main d'oeuvre scientifique et technique. Il est cependant des pays comme la Papouasie-Nouvelle-Guinée qui font largement appel à la main d'oeuvre étrangère, mais il s'efforcent également de former du personnel local.

(69) Les rapports nationaux indiquent aussi que les pays en développement de la région sont très soucieux de la qualité de l'enseignement scientifique et technologique et de son adaptation aux possibilités d'emploi et au besoins nationaux de développement.

(70) Dans des pays comme le Japon et la République de Corée, les scientifiques et les technologues ont beaucoup de prestige, situation qui est en contraste avec les tendances générales dans la région. En effet, et surtout dans les pays en développement, on considère encore que la science et la technologie n'offrent pas de carrières attrayantes. Les rapports nationaux indiquent les mesures qui sont prises pour que les choses changent à cet égard.

(71) Les pays en développement de la région offrent généralement aux femmes certains possibilités de recevoir une formation de haut niveau et d'accéder aux carrières de la

recherche, mais cette action s'insère dans un contexte où historiquement et culturellement, les femmes ont d'ordinaire eu dans le passé un rôle restreint. Aussi les femmes n'occupent-elles pas une place importante dans le domaine de la science et de la technologie, sauf dans quelques pays socialistes. Les auteurs des rapports nationaux qui mentionnent ce problème déclarent que cette situation est en train de changer.

	Dépenses de R-D		
	Année	Par habitant (en $ E.U.)	en % du PNB
Rép. dém. d'Afghanistan			
Australie	1976	70,69	1,0
Bangladesh	1974	0,18	0,2
Birmanie	1975	0,06	0,1
Chine	1978		1,8(a)
Kampuchea démocratique			
Hong Kong	1976	0,0	0,0
Inde	1977	0,76	0,5
Indonésie	1976	0,35	0,2
Rép. islamique d'Iran	1974	1,69	0,3
Japon	1979	182,17	2,1
Rép. dém. pop. lao	1970	...	...
Rép. pop. dém. de Corée			
République de Corée	1979	9,58	0,6
Malaisie	1970	...	...
Maldives			
Mongolie	1972	3,12	0,13(b)
Népal			
Nouvelle Zélande	1975	39,47	0,9
Pakistan	1973	0,22	0,2
Papouasie-Nouvelle-Guinée	1973	...	...
Philippines	1976	0,73	0,3
Samoa	1978	22,01	...
Singapour	1978	5,28	0,2
Sri Lanka	1975	0,47	0,2
Thaïlande	1979	...	0,26
Tonga			
Turquie	1979	9,34	0,6
URSS	1979	117,66	4,9(c)
Viet Nam	1979	1,07	...

Sources : Unesco, Statistiques relatives à la science et à la technologie - dernières données disponibles (décembre 1981), CSR-S-11, Paris; et CASTASIA II - Rapports nationaux, 1982.

Notes :

(a) CASTASIA II, Rapport national de la Chine, sur la base du Revenu national brut

(b) CASTASIA II, Rapport national de la Mongolie

(c) *Sur la base du Produit matériél net.*

3.3 Dépenses en matière de recherche et développement

(72) Les sommes consacrées aux travaux de R-D par les pays de la région, exprimées en % du PNB, ont augmenté au cours des vingt dernières années; elles sont passées de 0,1 - 0,3 % vers 1965 à 0,2 % - 0,4 % à la fin des années 1970. Sauf au Japon et à Singapour, la plupart de ces dépenses sont assumées par le secteur public. En 1979, l'URSS a consacré 4,6 % de son produit matériel net à la R-D, le Japon 2,1 % de son PNB, l'Inde 0,6 %, l'Indonésie 0,4 % et les Philippines 0,17 %.

3.4 Inventaire du potentiel scientifique et technologique

(73) La difficulté à obtenir des payss de la région des informations complètes sur leurs activités dans le domaine de la science et de la technologie (notamment sur le plan de la main d'œuvre, des institutions et du financement) montre à l'évidence que les nations de la région ne sont pas suffisamment équipées pour recueillir et évaluer ce type de données. Dix-sept pays ont des organes spécialisés chargés de recueillir et d'apprécier des renseignements concernant leur potentiel scientifique et technologique, mais il n'y en a que douze tout au plus qui peuvent vraiment s'acquitter de cette tâche.

Quatrième partie

Développement scientifique et technologique - questions majeures

4.1 Principales réalisations

(74) La plupart des pays de la région jugent extrêment importante la création au cours de la dernière décennie d'organes chargés de planifier et de coordonner les activités scientifiques et technologiques, ainsi que de coordonner cette planification avec les objectifs nationaux de développement. Ils ont notamment confié à des conseils nationaux la responsabilité de la science et de la technologie et ils ont renforcé les associations et institutions professionnelles. En outre, les pays à revenu moyen et certains des pays à faible revenu comme le Bangladesh, la Chine et l'Inde signalent un développement considérable de leurs structures organisationnelles de S et T, et ils sont très actifs dans le domaine de la R-D.

(75) L'un des principaux résultats du développement de la science et de la technologie dans la région est l'accroissement général de la production agricole. Il faut signaler aussi l'amélioration de l'enseignement supérieur qui a permis de former du personnel autochtone capable de prendre en main le développement national.

Dans les grands pays de la région, comme la Chine et l'Inde, on note une industrialisation diversifiée et la mise en place à partir de là de moyens complémentaires de S et T. Malgré le ralentissement mondial de la croissance économique, le taux de croissance du PNB de certains pays d'Asie et du Pacifique - comme l'Indonésie et la Malaisie - continue d'être le double du taux moyen des pays de l'OCDE.

4.2 Problèmes

(76) A l'exception des quatre pays à revenu élevé, les nations d'Asie et du Pacifique se heurtent généralement à des problémes de grande ampleur. Il s'agit notamment du chômage, de la croissance démographique, des carences nutritionnelles, des bas niveaux de vie, de l'insuffisance des services de santé. C'est l'existence de ces problèmes qui a incité les gouvernements à prendre des mesures correctrices et à mettre sur pied des programmes de développement planifié. Le fait que seuls quelques pays à revenu moyen aient réussi à résoudre partiellement ces problèmes donne une idée des tâches considérables que la science et la technologie devront accomplir dans la région.

(77) L'importance numérique de la population et la persistence de taux de natalité élevés posent de gros problèmes qui figurent au nombre des sujets prioritaires de recherche et qui sont reconnus dans les programmes de développement des pays de la région. De 1975 à 1978, le taux annuel moyen de croissance démographique a été assez faible dans les pays à revenu élevé : Australie 1,1 %, Japon 1 %, Nouvelle-Zélande 0,4 % et URSS 0,9 %. Parmi les autres pays, seuls la Chine, le Kampuchéa démocratique, Hong Kong, la République de Corée, le Samoa, Singapour et Tonga (qui a enregistré une diminution exceptionnelle de -3 %) ont eu des taux inférieurs à 2 %. Dans tous les autres, le taux de croissance démographique a été supérieur à 2 % ; dans le cas des Philippines, du Pakistan et de la Mongolie, il a été égal ou supérieur à 3 %. Les pays de la région reconnaissent implicitement les conséquences de cette poussée démographique constante pour l'application urgente de la science et de la technologie au développement.

(78) La plupart des pays en développement soulignent les répercussions nationales des modifications du coût relatif de l'énergie pétrolière. Dans la région Asie-Pacifique, c'est un problème qui a eu des incidences directes sur l'évolution de la recherche scientifique tant dans les pays développés que dans les pays en développement et qui a modifié de taçon radicale les programme de développement des pays non producteurs de pétrole. La crise a été amplifiée par les effets du vaste mouvement de récession économique dans les pays développés qui a mis en échec la stratégie de croissance économique des pays en développement de la région, stratégie fondée sur les exportations.

(79) L'autre grand problème est la nécessité pour ces pays d'être moins tributaires de l'agriculture et de créer d'autres sources d'emploi. Tant qu'ils n'y seront pas parvenus, il leur sera difficile de tenter de résoudre les problèmes du chômage ou du sous-emploi de la main d'oeuvre qualifiée et d'obtenir une croissance équilibrée dans les divers domaines de l'éducation et de la recherche scientifiques et technologiques. Les rapports nationaux montrent comment les divers pays perçoivent ces problèmes et quelles sont les stratégies qu'ils adoptent pour les résoudre, par exemple en créant des industries fondées sur une technologie sophistiquée (République de Corée) ou des Zones de promotion industrielle (Sri Lanka).

(80) En ce qui concerne l'intégration de la main d'oeuvre qualifiée à l'effort de développement scientifique et technologique, certains pays en développement évoquent les difficultés posées par l'éducation et la formation à l'étranger des scientifique et des techniciens. En effet, il en résulte fréquemment un accroissement de l'exode des compétences et en outre, cela pose des problèmes d'infrastructure quand il s'agit d'absorber cette main d'oeuvre formée à l'étranger.

(81) La plupart des pays en développement de la région reconnaissent la faiblesse de leur politique scientifique et l'insuffisance de leurs moyens de planification scientifique et technologique. Les auteurs des rapports nationaux étudient ces lacunes qui, selon eux, sont amplifiées par le bas niveau du potentiel de cadres dont dispose le pays pour contrôler l'application de la science et de la technologie au développement. Ce problème de main d'oeuvre est encore très courant dans les pays en développement de la région, surtout dans les cas où un « exode interne des compétences » draine le personnel qualifié du secteur public vers le secteur privé.

(82) Les rapports nationaux montrent que la protection de l'environnement et la lutte contre la pollution posent des problèmes aux pays développés de la région. Les pays en voie de développement ont eux aussi conscience des questions d'environnement et des possibilités d'utiliser la science et la technologie pour évaluer les conséquences écologiques des projets de développement planifié.

4.3 Objectifs et priorités

(83) Certes, les pays de la région sont dans des situations très diverses et les priorités qu'ils se sont assignées ne sont pas les mêmes mais il soulignent tous la nécessité d'établir des services chargés de définir une politique scientifique en s'appuyant sur un appareil de coordination scientifique et technologique et sur la possibilité d'obtenir des avis de tous les secteurs de la société qui s'intéressent à l'application de la science et de la technologie au développement. Les rapports nationaux montrent que l'on continue à donner la priorité à la formation de cadres scientifiques et technologiques de haut niveau, de techniciens et de personnel de direction pour la R-D. L'accent est également mis sur la nécessité de mettre en place des services scientifiques et d'élever le niveau de l'éducation et de la formation scientifiques et techniques.

(84) Les priorités en matière de recherche varient d'un pays à l'autre. Voici quelques-uns des objectifs prioritaires : conservation et prospection de ressources énergétiques et promotion d'autres sources d'énergie, de préférence renouvelables, recherche marine permettant de mieux dresser l'inventaire des ressources marines et de promouvoir l'industrie de la pêche, recherche forestière pour la sauvegarde ou la restauration de l'environnement, ainsi que pour l'obtention d'énergie et de bois ; recherche agricole, recherche nucléaire, recherche spatiale, recherche électronique, recherche de nouveaux matériaux. Figurent également parmi les domaines prioritaires : les communications, la santé, la maîtrise démographique et le développement de technologies axées sur les ressources comme la télédétection.

4.4 Coopération scientifique et technologique

(85) Le coopération scientifique et technologique est très bien organisée dans la région et elle est partout acceptée au même titre que la coopération en matière de développement. Les divers pays ont conclu de nombreux accords bilatéraux à l'intérieur mais aussi à l'extérieur de la région. En outre, la plupart des pays de la région participent activement à la réalisation de programmes internationaux en coopération avec l'ONU et ses institutions spécialisées, et ils sont membres d'organisations scientifiques et technologiques internationales comme l'ASCA, le CIUS, le CSC, la RCA, et ils prêtent leur concours, lorsque cela est possible, à des organisations comme l'ASEAN, le CAEM ou le Plan de Colombo, qui ont des programmes scientifiques. Cette activité intense au service de la coopération scientifique, ainsi que le nombre d'organisations à l'oeuvre dans ce domaine, assurent pour l'avenir une assise solide à la coopération scientifique et technologique.

(86) Les auteurs des rapports nationaux soulignent que la solution du développement national doit être recherchée sur une base scientifique et technologique nationale. Mais ils indiquent aussi que de nombreux pays de la région admettent qu'il leur est actuellement difficile de promouvoir la science et la technologie nationales et de les mettre au service du développement en ne comptant que sur leurs propres ressources, d'autant, soulignent-ils, qu'il existe sur le plan international une certaine prévention contre les pays en développement d'Asie et du Pacifique, dans l'organisation internationale de la recherche scientifique et de la maîtrise économique de la technologie. Aussi la plupart des pays en développement souhaitent-ils vivement que s'instaure une coopération régionale dans le domaine des programmes de science et de technologie.

Country Reports
Rapports nationaux

DEMOCRATIC REPUBLIC OF AFGHANISTAN

Table of Contents

AFGHANISTAN

GEOGRAPHY

Capital city: Kabul
Main ports: Kabul
Land surface area: 647,497 sq km

POPULATION (1978)

Total	15.1 million
Density (per sq km)	23
Urban/rural ratio	...
Average rate of growth (1970-1978)	2.2%[1]

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	44.9	10.3	8.5	32.2	4.1	100%

SOCIO-ECONOMIC

Labour force (1978)

Total	3.7 million*
Percentage in agriculture	...

Gross National Product (1978)

GNP at market prices	US $2,290 million
GNP per capita	US $150
Real growth rate of GNP per capita (1970-78)	2.7%

Gross domestic product

Total (in current producers' values)	US $3,260 million
Percentage by origin	
Agriculture	49%
Manufacturing, mining & quarrying, electricity, gas and water, construction	25%

Government finance

National budget	...
As percentage of GNP	...
External assistance (official, net: 1976)	...
As percentage of GNP	...

Experts (1978)

Total experts of goods	US $322 million
Average annual growth rate (1970-78)	2.4%

External debt (1978)

Total public, outstanding + disbursed	US $1,216 million
Debt service ratio (% GNP)	1.3
(% Exports of goods and non-factor services)	13.7

Exchange rate (1978): US $1 = 45.00 Afghanis

EDUCATION

Primary and secondary education (1978)

Enrolment, first level	942,787
As % of (6-13 years)	21%
Enrolment, second level	107,879
As % of (14-17 years)	6%
Combined enrolment ratio (6-17 years)	17%
Average annual enrolment increase (1970-78)	6.08%

Higher education (third level) (1978)

Teaching staff, total	869[1]

Students and graduates by broad fields of study	Enrolment	Graduates[2] (1977)
Social sciences and humanities	10,818	590
Natural sciences	1,475	159

---

1. *Source:* World Bank Atlas 1980
2. Universities only

Engineering	4,292	268
Medical sciences	2,632	206
Agriculture	1,901	219
Other and not specified		
Total	**21,118**	**1,442**
Number of students studying abroad:	1,527	

Education public expenditure (1978)

Total (thousands of Afghanis)	2,635,050
As % of GNP	1.7%
Current, as % of total	81.4%
Current expenditure for third level education, As % of total current expenditure	19.1%

Table 1. Nomenclature and Networking of S&T Organizations

I - First level - POLICY-MAKING and
II - Second level - PROMOTION & FINANCING

Country: Afghanistan

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
The Academy of Sciences of Afghanistan	Highest organization for achieving scientific research and developmental objective of the country	President of High Council is the Prime Minister	Laboratories, departmental committees and administrative staff	Various educational, research institutions and industries in general
National Commission for Science and Technology	Devise policies in regard to science and technology and coordinate the related issues in the educational institutions and industrial sectors	President of the High Council is the Prime Minister or Deputy Prime Minister	*Ad hoc* committees from academic and industrial sectors	Various educational, research institutions and industries in general
Science Center of Ministry of Education	Improvement of teaching in the areas of natural sciences and mathematics and provision of laboratory equipments for high schools	Deputy Minister of Education as the direct upper link	Departments for the various subjects and workshops	Educational departments of provinces and high schools in general
Kabul University Research Center	To guide and coordinate scientific research activities in the University	Minister of higher and vocational education as the higher authority	*Ad hoc* committees and administrative staff of the Center	Colleges of the University and other national and internationally related organizations
Science ant Technology Department of the State Committee for Planning	Responsible for planning and coordinating the related activities through the country both in governmental and private sectors	Prime Minister or Deputy Prime Minister as the Head of the Committee	Various departments within the administrative system of the committee and the planning dept. of other governmental departments and ministries	Ministries of the governmental and private sectors of industries

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages	
		Upstream	Others
Kabul University	Training in the various scientific fields at the Bachelor of Science degree level, conducting basic and applied research	Ministry of Higher and Vocational Education	Universities in other countries through contracting and bilateral assistance. And cooperation with other international organizations
Polytechnique Institute	Training in the fields of constructions, mining and geology, and chemical technology		Some of the universities and other educational institutes of USSR
Nangarhar University	Training in the fields of medicine, agriculture, engineering and education		Do not have any foreign contacts at present
Vocational Education Schools throughout the country (total of 17)	Training at the levels of grade 12 and grade 14		Outside linkages have been with the USSR W.Germany and U.S.A.
Center for Engineering Consulting Services and Applied Research (CECSAR)	Conducting a wide range of consulting and applied research services for the governmental departments and private enterprises. All academic staff and technicians of the college of engineering can participate in the activities	Dean of College of Engineering of Kabul University. All routine work of this Center is carried by a committee within the college	Other governmental establishments where their facilities may be required for completing the given projects

Establishment	Function	Linkages	
		Upstream	Others
Water and Power Engineering Company	Working as the design and consulting institute for the Ministry of Water and Power. The compagny may work independently or may have joint ventures with other international organizations	A Board, comprising several ministers headed by the Minister of Water and Power, is the highest authority to guide this company	With other consulting establishments within the country and may establish temporary linkages with relevant foreign establishments
Other design and operational offices within the government departments	The offices and institutes are primarily responsible for designing and other scientific activities of the respective departments of the government	Normally ministers of the respective departments of the government	Normal Linkages within the respecive department or ministry. These offices may have foreign advisors or experts to conduct the routine work

Table 2 - Scientific and Technological Manpower

Country: Afghanistan

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total Stock (thousands)	of which working in R&D
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965										
1970										
1975										
1979	15.2	11							20	
1985										
1990										

Table 3 - R&D expenditures
(information unavailable at time of publication)

Country: Afghanistan
Currency:

Table 3a: Breakdown by source and sector of performance

Year:

Unit:

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive				
Higher education				
General service				
Total				

Table 3b: Trends

Year	Population (millions)	GNP (in)	Total R&D expenditures (in)	Exchange rate US $1 =
1965				
1970				
1975				
1979				
1985				
1990				

PART 1.

General features

1.1 GEOGRAPHY AND CLIMATE

The Democratic Republic of Afghanistan lies in the heart of Asia, situated completely between parallels 29°30' and 38°30' latitude north and 60°30' and 75° longitude east. Occupying an area of approximately 647 500 square kilometres the country is, in the main, a highland mass lying mostly at an altitude of 1200 metres or more. The Hindukush range, which is a continuation of the Himalayas, extends from the northeastern part of the country, where it is called the Pamir, for about 1000 kilometres in a southwest direction through the heart of the country. The country is divided into two geographical areas comprising the valleys of the north which are fertile, and the rocky southern section which is partly forested and rich in timber.

Afghanistan has four principal topographical zones featuring as many descending levels of altitude. The first is the Hindukush and its auxiliary ranges; the second is the generally barren and rugged foothills of these ranges, the third is the gently sloping plains and steppes watered by rivers flowing from these ranges; and the fourth is the unproductive wastelands. This varied topography has made surface transportation across the country very difficult.

Afghanistan is a landlocked country with over 1100 kilometres bordering the Union of Soviet Socialist Republics (USSR) in the north. In the east and south lies Pakistan where the Pashtoon Tribes live since being separated from Afghanistan during British rule. In the west lies Iran, while there is a small border strip with the People's Republic of China in the east.

Afghanistan has a few large rivers which are mostly absorbed inland or disappear in the neighbouring countries, the exception is the Kabul River which flows into the Indus River and thus into the Indian Ocean. The main rivers of the country are the Helmand, the Amu (the Oxus), the Kabul (its largest tributary is the Kunar River), the Harirud, the Kokcha, the Murghab, the Kunduz and the Farah. All these rivers originate from the Hindukush Range and result from melting snow precipitated during the winter season.

Generally, the climate of the country is cold in winter and hot in summer. Normally the extreme temperatures range from minus 25 to plus 45 degrees centigrade during the year. Also the range of temperature between one place and another varies greatly. Even during peak summer temperatures a place only few miles away can be quite pleasant, while during the coldest winter a moderate climate can be found in some part of the country. There are clear blue skies and plenty of sunshine throughout the whole year.

Average rainfall ranges from 10-15 cm. in the drier lower areas of the west and the north, to 25-40 cm. in the east. The maximum precipitation of about 90 cm. annually occurs in the Salang Pass which is part of the Hindukush Range, about 100 km. to the north of Kabul.

1.2 MAJOR CENTRES AND PEOPLES

For administrative reasons the country is divided into 26 provinces, each with an appointed provincial centre. Kabul, the Capital, is by far the largest cultural, social and commercial centre with a population of about one million. Other large cities are Herat in the west, Kandahar in the southwest, Jalallabad in the east, Mazar-i-Sharif and Kunduz in the north.

The population is now estimated at 15.2 millions based on the population census conducted during the year 1979. Ninety per cent of the total population including Kuchies (Nomads) live in rural areas. The density of the population is governed by the presence of water and the opportunities for cultivation. The birthrate is estimated at 50.5 per thousand and the deathrate at 26.5 per thousand, with an annual growth rate of 2.3 per cent.

Historical events and geographical conditions have provided Afghanistan with a rich variety of peoples and languages. While there are many live languages spoken in the country, Pashto and Dari are the most widely spoken which both stem from Indo-European languages.

1.3 AGRICULTURE

Afghanistan has much pastoral land and the country's economy is based mainly on agricultural production. Some of the important agricultural products earning foreign exchange are raw cotton, raisins, carpets and rugs, dried and fresh fruits, wool and karakul skins. Only 22 per cent of the total 64.75 million hectares of land is suitable for cultivation; however, where irrigation is possible good crops may also be obtained.

Recognizing the importance of agriculture in the nation's economy, the Government of the Democratic Republic has given priority to land reform. The Government is also engaged in formulating realistic programmes for improvement of land cultivation through the introduction of improved seeds, the use of chemical fertilizers, and the adoption of modern agricultural methods and machinery. This is taking place within the framework of the country's first responsive and scientific Five-Year Development Plan (1979-1984). The installation of modern facilities and the introduction of modern processing by the Government will enable the country to export more agricultural products. These products will be exported to more distant markets around the world for better prices.

1.4 MINING, INDUSTRY AND TRADE

A complete survey of the country's mineral wealth has not been carried out and commercial mining has so far been confined to coal, salt and lapis lazuli. Recent mineral exploration has discovered copper, gold, zinc, lead, barite, mica and other minerals, some of which have proved to be economically exploitable. Major iron ore deposits of excellent quality have also been discovered. Natural gas, which is piped to the Soviet Union, has become the most important export item. A limited quantity of crude oil has been extracted and it is planned to establish a medium size refinery for internal use.

The foundations for industrial production were laid during the enlightened King Amanuallh period (1919-1929) but the rate of industrialization was greatly retarded due to a lack of direction and to mismanagement on the part of subsequent regimes. The present contribution of industry to the gross domestic product is less than 10 per cent.

The establishment of a dynamic and prosperous industrial sector is one of the most important objectives of the Democratic Republic of Afghanistan. Initial efforts will be aimed at expanding existing industrial capacities to meet domestic demand for items such as textiles, edibles oils, sugar, footwear, fertilizer, cement, etc. In the Five-Year Development Plan new public and private industries will be established within the framework of the Government's basic guidelines. Exports worth about US$300 million a year before 1980 were mainly from agricultural products and natural gas. Imports, worth around $320 million a year, include mainly machinery, petroleum products, pharmaceutical and other consumer goods.

1.5 TRANSPORT

Of the 9500 kilometres of motorable roads, 2300 kilometres are hard paved, and these connect the principal regions of the country. The main highway of the country connects Afghanistan to Iran and the USSR in the west, and to Pakistan in the south and the east. Another main highway running in the north of the country connects Afghanistan to the USSR at two different border points. There are several other paved highways within the country which do not lead directly to any international routes.

The country's air transport is served by two airlines, the Ariana Afghan Airlines, which mainly serves international routes, and the Bakhtar Airlines, which is domestic. There are two international airports, Kabul and Kandahar, and local airports in most provincial centres.

Afghanistan is a landlocked country and the most convenient access to the sea lies through Pakistan. There is no railway system in the country.

1.6 EDUCATION AND HEALTH

There are 3370 Primary and Village Schools, 140 Middle Schools, 200 Lycees and 25 Vocational Schools. There are two Universities, one Polytechnic and several other Higher Learning Institutes. Compulsory and free primary education for all school age children and the expansion of free intermediate, higher, and vocational education have been targets of the Democratic Republic Government. The educational system will be geared to bring about the nation's economic progress and promote social welfare.

There are at present 1000 doctors and 70 hospitals with 3600 beds throughout the country. However, the present public health services are not adequate, and greater attention will be paid to preventive medicine.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

Before discussing science and technology issues and policies in Afghanistan it is important to have a general understanding of the overall national development plan and its basic objectives. The most important document outlining the national development objectives is the "Basic Directives and Indicative Figures of the Five-Year Economic and Social Development Plan of the Democratic Republic of Afghanistan, during the years 1358-1363 (1979-1984)". A summary of the statements made in the Five-Year Plan which are relevant to CASTASIA II is provided and this can be used as a basic reference for an analysis of the country's development aspirations.

The main objective of the Five-Year Plan is the implementation of the guidelines of the People's Democratic Party of Afghanistan. This shall be realized through participation and continuous cooperation of the working people, the rational concentration of domestic resources and foreign aid, and the effective utilization of the national human and financial resources in order to eliminate economic backwardness, promote national production, promote social progress, raise living standards, and strengthen the country's defence capability.

To achieve these objectives, the following steps are to be taken:

The development of a material and technical infrastructure for national production;

The utilization of all natural and human resources;

The establishment of new branches of industry and promotion of the industrialization of the national economy through the public sector;

The acquisition of unconditional aid from friendly countries and international organizations;

The establishment through the public sector of more electrical energy facilities, new irrigation systems and communication projects to meet the basic requirements of the country;

The expansion of public sector enterprises to optimum size and better maintenance of the present technical establishments for more efficient operation.

During the plan period, the national income shall grow by 4.5-5.2 per cent annually on the average, gross industrial production shall increase by a total of 60-70 per cent, the agriculture sector will be modernized, the irrigation system and the communication network as well as the water supply system will be improved, and 97 per cent of total investment shall be directed to public sector activities. Necessary steps will be taken to eliminate illiteracy, expand universal primary education, and to develop the public health, culture and social security of our hardworking people. Exports shall be strengthened by raising the competitive ability of Afghan agriculture and industrial goods to earn more foreign exchange.

During the plan period, a number of realistic measures shall be made to improve working conditions in the public sector:

in industrial and construction establishments, equipment of larger capacity shall be employed and optimum use of modern technology shall be made;

new establishments shall be equipped with an adequate number of skilled personnel;

modern work methods shall be introduced and a system of norms of work will be implemented in different establishments;

training of national cadres will be expanded in accordance with the economic and social development needs of the country. This training programme shall not be limited to class rooms and formal education, for on-the-job training will be considered an important part of the total training process.

2.2 DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

In addition to the directives of the Five-Year Plan, the following information will ensure a better understanding of science and technology policy in Afghanistan.

Principally, the development of the sciences in the Democratic Republic of Afghanistan will be expanded in accordance with the objectives of the Great Saur (April) Revolution of 1978 on the basis of the programme of the People's Democratic Party of Afghanistan and the Revolutionary Government. Thus, the role of the Afghan Academy of Sciences as the centre for scientific research in the country shall be expanded. During the years 1979-1984 the technical and material base of the Academy, and other research and scientific institutions, shall be strengthened. Scientific research work shall be concentrated more on problems for modernization and development of the new society of Afghanistan. At the same time, greater attention shall be paid to the solution of scientific and technical problems concerning public welfare and social progress, with a view to the cultural development of all ethnic groups in Afghanistan. Scientific and research activities shall be further expanded in the higher educational institutions of Afghanistan, and special attention shall be devoted to the training of scientific personnel

In order to expand and develop scientific activity, the following aspects shall be taken into consideration:

research regarding problems of philosophy, economics, history, and archeology;

in the area of natural sciences, the expansion of scientific activities in the fields of botany, zoology and medicine;

the expansion of research and scientific activities in the field of geology to discover useful minerals and utilize them effectively;

the carrying out of research in the areas of physics, chemistry, and applied mathematics, and further harnessing of scientific activity for the purpose of the national economy;

expansion of comprehensive scientific research work in the area of seismology;

the printing and distribution of scientific work of Afghan scholars;

expansion of contacts between the scientific institutions of the Democratic Republic of Afghanistan and international institutions and organizations.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

The global impact of increased activity in the field of sience and technology for development in the last few years has contributed to an increased awareness on the part of government departments, as well as individual scientists and technologists, in the Democratic Republic of Afghanistan. However, activities within the country at this stage have not been synchronized yet to a point where definite objectives and lines of action could be followed in the area of science and technology for development.

In order to have a picture of contemporary activities and the policy making machinery structure in Afghanistan a brief introduction to some of the important institutions concerned with science and technology is given.

(a) The Academy of Sciences of Afghanistan

The Academy of Sciences of Afghanistan was established in 1978 after the Saur (April) Revolution. The Academy has been active in establishing itself and, since then, has contributed toward its goals by publishing relevant materials. The Academy has made a draft constitution which has been forwarded to the State for approval.* The highlights of this draft constitution are outlined below and will give some insight into the intended activities of this very important institute.

The Academy of Sciences of Afghanistan will be established under the Prime Minister Office as the highest centre for the sciences and for research in Afghanistan. It also has responsibility for research in the area of natural sciences, for effective utilization of natural resources, for raising the level of production for the development of the country's economy, for research in the area of social sciences, for enriching Afghan culture, for the improvement of national languages, for the preservation of fine arts articles of historic value, and for raising the general educational level. The guidelines for the activities of the institute will be drawn by the state as follows.

Main Objectives:

scientific research and creative work to meet the country's needs in the social, economic, and cultural sectors;

preservation and enrichment of culture by paying attention to the cultures of all ethnic groups within the country;

elevating the general status of, and standard of, learning in the country;

creating scientific leadership and fostering its effective role in the building of Afghan Society through close cooperation with and exchange of experiences with other national and international scientific and research institutions;

raising the educational level, and the potential, of Academy staff members to cope with the challenges facing the institute;

publishing and disseminating new discoveries in the scientific, technical and cultural areas;

standardizing the facilities and equipment of research institutes according to their scientific requirements;

raising the level of education and specialization of the professional staff through planned cultural and scientific programmes;

coordinating the research relating to basic problems of the natural and social sciences within the country.

Organizational Structure

Departments: The Academy at present has the following scientific and research departments;

Scientific and Research Department of Natural Sciences;
Scientific and Research Department of Social Sciences;
Scientific and Research Department of Languages and Literature;
International Centre of Pashto Language;
Institutes of Encyclopedia and Cultural Writings.

Organization: The Academy will be governed by a High Council; a Scientific Council; a Scientific Council of the Scientific and Research Centre with, in addition, Department Councils and an Administrative Council.

The High Council will be presided over by the Prime Minister and will have as members the Ministers of Higher and Vocational Education, Finance, Mines and Industries, Agriculture and Land Reforms, the President of the State Planning Committee, the President of Kabul University, the Deputy President of the Academy, the President of each Department, and two advisors of the Academy and four Academicians (the highest academic rank of the Academy) appointed by the responsible authorities. All other councils will be formed mainly from academic and administrative staff of the Academy.

(b) National Commission for Science and Technology

The Commission was formally established by order of the Prime Minister in 1979. A group of learned and experienced people from various ministries was assigned to look after the coordination and proper handling of issues relating to science and technology. A detailed draft constitution of the Commission has been prepared which will be forwarded to the Government for consideration. The highlights of the proposed constitution are outlined to indicate the intended activities of this organization.

Objectives and Policy: The Commission will determine the policy and procedures with regard to the expansion, popularization, development, selection and transfer of appropriate technology, and the coordination of research activities in the areas of science and technology. All efforts will be directed to use science and technology more effectively for the overall development of the country. Some of the important tasks are that:

science and technology shall be at the service of people and be an instrument for the development of the country;

cooperation between research institutions and industry be promoted;

science and technology activities be promoted by acquired financial resources;

local industries be promoted and developed through utilization of appropriate technology;

personnel be trained in science and technology and provided incentives sufficient to avoid a brain drain of professionals.

Organization: The science and technology activities in the academic and industrial sectors will generally be supervised and directed by this Commission, but routine operational activities will be controlled by the respective institutions. The National Commission for Science and Technology will be governed by a High Council of Science and Technology which will be made up of several ministers who are mostly concerned with science and technology problems, along with the President of the National Commission. The Council meetings will be chaired by the Prime Minister or his Deputy Prime Minister. The Council will have at least one meeting during the year to discuss proposals of the Commission. The National Commission of Science and Technology will be constituted by the President, Secretary and members. Members of the Commission will be appointed by the Government from learned academic, as well as professional, people in the fields of science and technology.

There will also be three main committees of the Commission which will be primarily responsible for most of the basic activities of the Commission, namely, research in theoretical

---

* It has been indicated by the Academy's responsible authorities that the draft constitution has been forwarded to the Government and will be acted upon in the near future.

sciences, scientific and practical technical problems, and consulting problems. The above committees will be coordinating further subcommittees in their respective fields. The subcommittees will be appointed as they are needed by the Commission from learned scholars and experts from both academic institutions and industry.

(c) The Science Centre of the Ministry of Education

The Science Centre was established within the organizational structure of the Ministry of Education. The main purpose of this Centre was to strengthen natural sciences and mathematics education in the school system. Experienced teachers were appointed as supervisors and simple kits for natural sciences experiments were constructed from local, inexpensive materials. Supervisors helped teachers in various disciplines on the theoretical and pedagogic value of the new experimental facilities.

Teaching the natural sciences and mathematics is important for the development of science and technology in a society. Assisting the understanding of basic principles, promoting scientific thinking, and fostering the positive applications of these subjects in daily life have been the main objectives of this Centre. Some of the important activities performed by the Centre have been to:

publish laboratory guide books for the natural sciences and continually improve them;

produce teaching aids from local, inexpensive materials;

maintain and bring into full and effective operation existing laboratories in educational institutions;

develop curricula for the laboratory technician schools and help in their implementation;

play a leading role in in-service education and on the job training programmes of the Ministry of Education;

train a good number of the Centre's own staff through scholarships and fellowships provided by international organizations;

closely cooperate with the educational programmes for radio and television.

(d) Kabul University Research Centre

The purpose of this Centre is to guide and organize all scientific research activities in the University. The Centre was established in 1963 as an independent institute of the University. The objectives of the Centre are to:

conduct research on vital problems for rapid development, and take maximum advantage of the present scientific and technical facilities for serving the people;

restore the old culture, and further develop the contemporary culture, of the people;

expand and develop scientific resources for raising the level of knowledge;

provide the necessary equipment to enable the Centre to carry out research at national and international levels.

The tasks of the Centre are to organize, guide, and cooperate in the scientific research activities of the University and other related institutions, to provide facilities for all national and foreign research, to provide research reports and related documents from national, as well as foreign, resources, to publish research findings made at the Centre, to provide consulting services to governmental and private institutions, to establish and strengthen mutual cooperation with other scientific and research organizations within and outside the country, to conduct courses, workshops, seminars, and conferences for training students and young researchers, and to attract further cooperation from national and international institutions for the development of scientific research activities.

The Research Centre is organized through a Research Council which is made up of representatives of all university colleges who are appointed by the Deans' Council of the University. The research Council is primarily responsible for making policies and decisions with respect to scientific and financial affairs. The Council decisions are effective upon the approval of the President of the University and the Minister of Higher and Vocational Education. The Director of the Centre is appointed from the academic staff of the University and is responsible to the President of the University for the overall operation and management of the Centre. The Director chairs the Council meetings. There are ad hoc committees which can be appointed from the academic staff of the University and chaired by a member of the Research Council. The number and type of these committees is within the authority of the Research Council to determine.

The financial operation of the Research Centre will be financed through a government allocation for the expansion and development of scientific research, from financial contributions from national and international institutions for scientific research, and from income of the Centre from consulting and research services.

(e) Department of Agriculture Research and Soil Science

This Department, which started in 1965, is primarily responsible for research activities in the area of plant sciences, and for analysis and classification of soils for agricultural purposes. The Department is divided into the following sub-departments: statistics and programming, crop improvement, agronomy, insects and plant diseases, soil science, horticulture, and agricultural machinery. The Department is staffed with professional personnel which include 3 doctorates, 22 M. Sc. and 98 B. Sc. degree-holders. The sub-departments have the necessary laboratories to carry out routine research activities. The Department has four research stations around Kabul city and a total of nine research stations located in different provinces. These stations are distributed throughout the country in such a way that each station represents an area with similar agricultural problems.

PART 3.

Scientific and technological potential

Scientific and technological development in a country depends on the overall development programmes and status. The most important element for development is a sound institutional network in the country. The institutions in the educational system, as well in the production sector, should be organized in such a way that human resources as well as financial and natural resources within the country can be effectively utilized. With these factors in mind, this general picture of scientific and technological potential for Afghanistan is presented here.

3.1 INSTITUTIONAL NETWORK

An educational system can be considered as the foundation for all scientific and technological activities and development in a country. It trains qualified personnel who can then take responsibility for further development of the country. This education system should not be limited to the formal education's institutionalized classrooms, but an effort should be made to make education a life-long process where professionals are learning new and better techniques for performing their duties. The educational system in the Democratic Republic of Afghanistan can be reviewed under four headings.

Primary Schools Although the Government is planning to expand rapidly the pre-school educational system, the total percentage of children following this programme is small at the present time. Nevertheless, primary school education is the most important base of the country's educational system and elementary school education is compulsory; every effort will be made to ensure that all children of school age, which is seven years, shall attend the primary schools.

The most important step for the improvement of primary education is to prepare new teaching materials and publish sufficient books, based on the newly adopted curriculum. A series of seminars and short courses have been established for the acquaintance of teachers with the new curricula. The new educational system will comprise four years of the first primary phase and four years of the second primary phase. When this progamme is fully implemented the total middle school education will comprise ten years of school. The general primary school network shall be expanded, and the number of students at these schools by the end of the Five-Year Plan (1979-1984) shall be raised by 80-100 per cent; the number of newly enrolled students in the first grade shall be increased by 200-220 per cent. It is planned that in 1984, 100 per cent of all the seven-year-old children, amounting to more than 600 000 will be absorbed in the first grade.

Secondary Schools The secondary school system can be classified into general high schools, called Lycees, and vocational schools.

(a) Lycées

At present Lycées are following a four-year programme where graduates from the eight grade of primary schools are absorbed and will graduate after 12th grade. The curriculum in such schools is of a general nature and graduates of these schools may be admitted to any of the higher learning institutions in the country. Recently, more emphasis has been made to improve the curricula in the natural sciences, the social sciences and mathematics. The Science Centre of the Ministry of Education has been taking an active part in the development and continuous improvement of curricula in the natural sciences and mathematics for all Lycées. The Ministry of Education has introduced new social science courses since the Saur (April) Revolution.

The University entrance examination has played an important role in improving the educational level in the Lycées. Students with higher scores can choose whatever institute of higher learning they wish and, as a result, this competition has made students more serious about their studies during secondary school.

The total number of students entering the first year of the lycées in 1984 is estimated to be approximately 150 000, and the number of graduates from 12th grade in that year is estimated to be 20 000.

(b) Vocational Schools

Vocational technical education at the secondary school level started in Afghanistan with the Kabul Mechanical School in 1937, developing slowly in subsequent years. One of the reasons for this slow growth may be due to the fact that vocational education needed special facilities for laboratories and practical work which had to be imported. Another reason may have been the shortage of qualified teachers in the various specializations which were relatively new to Afghanistan.

At present, a total of six mechanical schools, three technicum schools (higher technical schools), three agricultural schools, and three arts and industrial schools are in operation throughout the country. All of these vocational schools, except the technicum, have four-year curriculum (grade 9 to 12) and the technicums are following a curriculum of six years (grade 9 to 14).

The graduates of these schools gain a wide variety of industrial skills and have made a valuable contribution to the advancement of science and technology in the country. Most of the vocational schools have been established with the help of various foreign countries, with the result that they do not follow a unified curriculum. Steps have been taken to design common curricula, where feasible, which will meet the country's requirements.

Higher Education Higher education in the country started with the Kabul Medical School in 1932. Other schools such as Law and Political Science started in 1938. Natural Sciences and Mathematics started in 1943. Letters and Social Sciences started in 1949, Theology in 1951, Engineering and Agriculture Schools in 1956, and Veterinary Medicine in 1973. These schools are operating within the Kabul University system. The Polytechnique Institute, established in 1967, is an independent institute of higher education which includes a School of Construction, a School of Geology and Mining, and a School of Chemical Technology. The Nangarhar University, located in the eastern province, began with the establishment of its School of Medicine in 1963. Presently, this University includes a School of Agriculture, a School of Engineering, and a School of Education, all established in 1978. There have been several other small institutes in the higher education area, such as the Industrial Management Institute established in 1961, and an Accounting Institute established in 1977, which have contributed to the further development of scientific and technological activities in the country.

On the Job Training Programmes As in many other countries, the new graduates of different scientific and technological educational institutes are only qualified to understand the basic principles of their respective fields and still need on the job training before they can be productive and competent professionals. This objective can be met more effectively if government departments prepare definite plans for all new graduates to be trained to solve practical problems. In the past, implementation of most of the important projects in all sectors was helped by international advisors or foreign experts through bilateral agreements but, unfortunately, a well organized complementary plan to train Afghan experts to a level where they could replace departing foreign experts did not exist.

In recent years, attempts have been made to give more direct responsibility to Afghan scientists and technologists to carry out important tasks in relevant areas. More and more planning and design work has been carried out by Afghan scientists and technologists in the general fields of engineering, economics, education and industry. Giving personal responsibility to young scientists and technologists has created competition and resulted in higher achievement. Individuals who perform successfully as leaders gain respect and prestige, which brings greater satisfaction in their work. There are many instances where Afghan institutions and consulting firms have competed with reputable foreign organizations, and have successfully completed the job given to them.

3.2 HUMAN RESOURCES

One of the main objectives of the Democratic Republic of Afghanistan is to extend the educational system to the masses. The literacy programme is aimed at completely eradicating illiteracy by offering courses for people of 9 to 50 years of age. These courses are not confined to government departments but will be offered to people from all walks of life. The enrollments in these courses will rise from one million in 1979 to three millions in 1984. It is hoped that, through a successful literacy programme, human resources can be better utilized in the agricultural, economic, and social sectors.

At present, a definite shortage of manpower in the area of science and technology exists. However, it can be concluded that the shortage of manpower will be eliminated when all school-age children are admitted to school following the full implementation of the Five-Year Development Plan. According to this plan, a great increase in the population of schools and institutions of higher education at all levels will occur. This increase is not limited solely to the population of students, for the number of new educational institutions will also increase. However, the shortage of manpower in various professions will continue until the new educational changes come into effect.

In our experience, whenever institutions of higher learning have been established they have acted like an ivory tower which pays little attention to what is needed by the respective industries. One reason for this is the fact that most of the higher learning institutions are established through bilateral technical and cultural cooperation schemes. In some cases foreign experts and educators have not taken the trouble to modify the curricula in such a way as to ensure that the graduates will be suited to local industrial requirements. Recently, steps have been taken to study the existing programmes in some of the institutions and modifications were proposed so that, in the future, more relevant curricula will be adopted.

Also, many developmental activities within the country have been directed by foreign experts with the result that related technological and scientific knowhow was directly transferred from parent organizations to which the experts belonged. Now, when Afghan experts are taking the leading role in scientific and technological activities for which foreign expertise does often not exist, it is felt that research and development activities are needed to solve the integration problems. Closer cooperation has been established between academic institutions and industry to work together on problems which do not have a known solution. Since all scientific and technological activities are controlled, and/or guided, by government institutions, it is therefore of the utmost importance that a more independent role for Afghan experts is planned and realized. Research institutions should be devoted primarily to applied research activities, which will mean working on the practical solution of existing problems in their respective areas.

A serious brain-drain problem has been emerging in Afghanistan in recent years. Earlier, the brain-drain consisted of young Afghans remaining in foreign countries where they had been sent for education and training. Also some young Afghans who, having returned to their country, and not finding working conditions which met their expectations, left to look for better opportunities. However in comparison with the brain-drain problem facing other similar countries at that time, the problem was not very serious. Indeed, Afghans with bachelor degree training within the country had a higher return percentage than those who had gone after high school graduation. Nevertheless, an attempt was made by the Government to limit scholarships to high school graduates and to send Afghans abroad for study after they had received a bachelor degree in Afghanistan.

For a long period of time many Afghans had been going to the Indian sub-continent for work during the winter season, and returning home in springtime for their routine farmwork. In recent years Afghanistan has experienced several years of drought and bad agricultural seasons. At the same time, better opportunities for work were created in Middle East oil-rich countries, especially in the neighbouring country of Iran. Large numbers of Afghans, with all levels of expertise such as professionals, technicians of varied training, and unskilled labourers, migrated to find better jobs outside the country. The number of unskilled labourers was big enough to cause a perceptible labour shortage, especially in the agriculture sector. The majority of the emigrants returned to Afghanistan, but there were a good number who settled permanently in those countries. Some approximate figures are available which show the migration problem before the Saur (April) Revolution.

For instance the number of Afghans who have been deported from Iran and handed over to the border authorities at Islam-Kala during the one-year period 1976-1977 amounted to 130.000 persons. It was further estimated that the total number of Afghans who had gone to Iran illegally during the two years 1974-1976 amounted to 250,000. The Central Statistics Department has given the following estimate for the number of Afghans who have left the country temporarily or permanently:

Experts who have at least Bachelor degree	750 to 1000
Professional staff with experience and at least 12 years' schooling	35000 to 40000
Professional and skilled workers	55000 to 65000
Unskilled workers	350 000 to 400 000

The total number of Afghans who have obtained a passport to travel abroad for various reasons during the 4 1/2-year period, 1973-1977, amount to 110 000. It is assumed that a good number of these Afghans have gone to work in Middle East countries.

There is no doubt that Afghans who go for work in the Middle East countries bring back a large amount of foreign exchange to the country, but detailed analyses to calculate the losses flowing from this brain-drain, or from the loss of this working force to Afghanistan do not exist.

3.3 FINANCIAL RESOURCES

The Government invests in science and technology for development through its established departments which carry out research or research-oriented activities. This investment includes the normal budget to cover the salaries of staff, the cost of materials used and maintenance of the facilities and equipment. Another part of the investment covers the construction of buildings and the cost of equipment needed to carry out the intended research activities. The researchers, in general, are employed by the Government and have fixed salaries. There are some exceptions to this general rule where financial incentives are given to the individuals who are performing special research. In such a case, a sum of cash is allocated in the budget of a research institute such as the Kabul University Research Centre and, after the research proposal has evolved and its relevance to the country's developmental objectives has been established, further funds for carrying out the research project may be approved. Staff members of such institutes have other primary tasks, but also carry research activities for furthering the development of the country.

There have been many instances where foreign donors, through bilateral assistance or international organizations, have assisted greatly the establishment of research-oriented centres and, in some cases, contributed to the recurring expenses of these institutions. The names of some of the centres responsible for carrying on research activities in various sectors have been mentioned before in this report.

3.4 SURVEYING OF THE SCIENCE AND TECHNOLOGY POTENTIAL

The Central Statistics Department, which was established in 1970, is primarily responsible for all statistical activities. Collecting, analysis, and publication of statistical data is the responsibility of this department. The Central Statistics Organization was responsible for the country's demographic survey which took place in the year 1979. This department is equipped with modern computer facilities and has taken steps to further establish itself by acquiring more up-to-date computer facilities and is planning to train more Afghan staff members to be skilled in the various areas covered by this department.

Another source concerned with statistical data collection, analysis and utilization is the planning department of each ministry. These planning departments, through special questionnaires, are gathering necessary statistical data which is analysed within each Ministry for further planning and plan evaluation. Such ministries are establishing linkages between these planning departments and the Central Statistics Organization.

A new State Planning Committee has been formed within the Prime Minister's Department to replace the previous Ministry of Planning. One of the reasons for this change is to strengthen and centralize the planning activities of the country. All statistical data collection and analysis, as well as control of any data in the country, will be within the authority of this Committee.

PART. 4

Policy issues in scientific and technical development

4.1 MAJOR DEVELOPMENTS

Over the years, most of the scientific activities in the country have been carried by foreign experts. Foreign experts were brought to Afghanistan through either bilateral agreements with friendly countries, as employees of the Afghan Government, or through the assistance of the United Nations organizations and other international bodies. The efforts of these experts have definitely laid the corner-stone of scientific endeavour within the country. However, in many instances, there were problems with the continuation of these projects due to the shortage of financial resources, trained manpower, and proper management. There was also a shortage of well qualified scientists and technologists who could understand the operational procedures for more sophisticated technologies, and then either modify them in such a way to fit within the existing system or find the drawbacks of the system and make improvements.

The major development in Afghanistan has been the creation of a stock of well qualified Afghans to service the professions across the country. These Afghan experts are aware that a scientific approach has to be adopted for solving Afghanistan's social, economic and cultural problems. They are also aware that the management system existing in the country needs serious attention. The majority of these Afghan experts have acquired the professional training within the country by attending local universities, while those with post-graduate training have gained this in foreign countries, mostly in the developed world. The educational background of Afghans returning home from training abroad varies greatly and this, in some cases, creates a problem of communication. However, through proper planning and management these differences can be used to make a better educational system designed for the needs of the country, and which adopts the best of other societies.

Another major development in the country is the introduction of national development plans. These plans have definite objectives which are then evaluated annually to measure their relative success. The process of planning, analysis and evaluation, by itself, brings a scientific awareness to the minds of all those concerned scientists, technologists, managers, and the government leaders. In recent years, the development planning process has started at the level of individual institutes and departments, has then been coordinated at the ministry level, and finally coordinated at the central planning level. This process gives a great number of Afghans the chance to be acquainted with the scientific approach utilized in the process of national development planning. The implementation of these plans is realized only when active participation is taken at the level of institutions or departments. Therefore, when experts at the departmental level are engaged in making these plans, more understanding and interest will certainly be created which will improve plan implementation. There are many Afghans who have acquired experiences and knowledge, over the years since developmental planning was introduced, to make better and more realistic development plans for the country within the Government's guidelines. This is considered as an important development.

4.2 ACHIEVEMENTS AND PROBLEMS

The most important achievement in developing a science and technology capacity in the country has been the establishment of several organizations and departments in the government system to guide, promote, and organize scientific and technological activities. The three most important institutions established after the Saur (April) Revolution are the Academy of Sciences of Afghanistan, the National Commission for Science and Technology, and the Department of Science and Technology within the State Committee for Planning. These organizations are newly established and are still working on their constitutions and organization. However, there has been a number of national and international seminars organized and conducted by these institutions on various aspects of science and technology. Because of these seminars, a chance has been given to many Afghans to express their views on various issues of vital importance to the country. The establishment of these new institutions and the raising of the status and effectiveness of the previous ones, indicate positive action on the part of the Government to develop science and technology. The establishment and financing of these organizations is definite proof that the Government is strengthening, and increasing, the role of science and technology for the development of Afghanistan,

Another important achievement during the last ten years has been the almost complete take-over of all scientific and technological activities by Afghan experts when, previously, the leading role was played solely by foreign experts. It is hoped that, by strengthening the educational institutions in the scientific and technological fields, Afghans will ultimately replace all foreign experts. However, some help will be needed from foreign experts in very special fields and to help Afghanistan remain abreast of rapid technological advances. This replacement of foreign experts by Afghans is not only important, from an economic point of view, because a good percentage of international assistance and bilateral aid is used to cover the expenses of those experts, but also from the point of view of continuity, because developmental programmes are hampered when foreign experts leave. Recent activities which have been conducted by Afghans with great success have proved that Afghan experts are ready to take responsibility and leadership, despite all the difficulties existing within the present management system.

Scientific and technological activities are relatively new to this society and therefore there are some problems which need serious attention. One serious problem is the old management system which cannot cope with the challenges facing it in the efficient and effective utilization of science and technology for development. The Government has realized that a more effective management system and a better administrative structure must be explored. An Institute of Management has been formed in the Ministry of Mines and Industries, mainly to study the present production system and try alternative production approaches. However, the activities of this Institute are limited and it is necessary that more attention be paid to this problem by the responsible authorities. Recently, a national survey was made to study the present administrative system and to come up with appropriate suggestions.

There has been a lack of basic guidance for the promotion of science and technology activities, and for the coordination of professional effort. Even though an effort has been made to establish norms and standards under the supervision, guidance, and control of the Department of Norm and Standards of the Ministry of Mines and Industries, yet this operation has been too slow for the total needs of the country. An example of this problem which can be cited is the non-existence of a Building Code in the country. The problems of the government design office can be imagined when designers who have different educational background have to design a building without the guidance of legal criteria. It is of the utmost importance that minimum standards and codes of practice be developed and adopted so that the designers and planners can take unified action. This will assist professional communication between scientists and technologists with different educational backgrounds. Due to the lack of definite norms and standards within the country, imported equipment for developmental projects does not match and therefore cannot be substituted when imported from other sources.

Establishing technical educational institutions which require scientific and technological apparatus and material is another problem which needs special attention. Such technical institutions should be distinguished from general education institutions discussed previously. The investment required for such technical facilities cannot be absorbed by the current budget. Such capital investment needs foreign exchange which is normally limited in Afghanistan. Therefore it is important to strengthen institutes such as the Science Centre of the Ministry of Education so that commonly used equipment can be constructed from inexpensive local materials. Attempts shall be made to attract the assistance and cooperation of friendly countries, international organizations and the United Nations system to solve the problems of the technical education sector.

The creation of a demand for Afghan scientists and technologists in the oil-rich Middle Eastern countries has been another problem which needs serious attention. Every attempt must be made to retain Afghan experts through incentives and persuasion. Losing a scientist or technologist because of the brain-drain is, for a country with a serious manpower shortage, a serious loss. It has been found that Afghans are most patriotic and will stay in their country when their minimum living requirements are met. Here, housing is one of the serious problem, and by building more housing units for local professional experts under favourable conditions the Government will make a good contribution to solving this brain-drain problem.

Until now there have not been professional societies established in the country where scientists and technologists could get together to work on problems of common interest. Through such societies, professionals of different fields could cooperate to pinpoint obstacles and search for solutions. These societies could publish journals and relevant materials to assist professional communications. For these reasons, the formation of professional societies for the academic progress and professional improvement is of the utmost importance. The Government has taken important steps to establish professional societies in the country.

As outlined earlier in this report, different organizations and departments of government are pursuing various science and technolgy activities, but without a proper system of coordination. It is important that linkages between all institutions concerned with science and technology be established so that duplication can be eliminated and a proper environment for effective cooperation be created.

4.3 OBJECTIVES AND PRIORITIES

It is stated in the Basic Directives and Indicative Figures of the Five-Year Economic and Social Development Plan (1979-1984) that, from the total investment in the public sector, more than 50 per cent will be invested in the mining and industrial sector 25 per cent in the agriculture sector and 15 per cent in the social service sector. Further details of these investment priorities indicate that the main objective of the Development Plan is the industrialization of the country. In addition, all natural resources will be explored, and exploitation of already discovered resources which are economically feasible will be initiated. Steps will also be taken to mechanize agricultural industries and to provide better services to farmers to assist them to increase production.

The role of science and technology in the ambitious plan for industrial growth is well understood. The primary objective of this industrialization, and its utilization of science and technology, is to offer better services to the toiling masses of the country. The development of the industrial sector will require a strengthening of science education and related research activities in the country. The higher education system has been given special attention. Establishing new programmes and curricula for Master's degrees and Doctoral degrees in various fields of technology are good examples of the special attention given education on the part of the Government.

There is a comprehensive effort on the part of the Government to strengthen scientific and technological activities. Establishing new science institutions to devise policies and monitor scientific activities, establishing further vocational schools and raising levels in higher education institutes, are examples which indicate the seriousness of the Government in the overall development of science and technology in Afghanistan.

From this overall analysis of the developmental plans, and the steps taken by the Government, it can be concluded that priority is given to those scientific and technological activities which will have an immediate return. Therefore, more resources and efforts will be devoted to applied research and development-related scientific activities. In the educational system, greater attention will be made to develop more practical curricula which will assist graduates to more readily accept full responsibility in industrial employment. Due to the shortage of experts, young graduates may not have the opportunity to be trained under proper supervision and therefore it is essential that their education should include practical training.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

For this review, scientific and technological cooperation can be divided into three categories of national, international, and bilateral. For promoting scientific and technological cooperation at the national level, meetings and seminars are held on various topics in Afghanistan where experts from both academic and industrial sectors are invited. There, experts share their experiences, and their views, on the means of improving various scientific and technological activities. An example of such an initiative is the National Seminar on the Engineering Curricula sponsored by the National Committee for Engineering Education and held at Kabul University on October 2-6, 1976. Representatives of different engineering education institutions and technologists from various governmental departments participated in this seminar. During the seminar, various committees were formed from the participants to evaluate the curricula of the educational institutions and to make recommendations on the modifications needed for the existing industrial situation in the country. This type of activity can establish better cooperation between educational and industrial organizations.

Most of the higher and vocational educational institutions have been established through bilateral agreement with friendly countries over the years. Bilateral science and technology assistance by developed countries has been given through the provision of technical equipment, experts and related services. Bilateral agreements have also been made with the developing countries of the region in the areas of culture and social sciences. The majority of developmental projects in the industrial, constructional and agricultural sectors have been implemented through bilateral assistance. It can be concluded that the major contribution for the overall development of science and technology, and the establishment of most industries in the country, has been through bilateral assistance.

At the multilateral level, the United Nations and other international organizations, including the World Bank, the Asian Development Bank, have made valuable contributions to the development of scientific and technological activities and the establishment of some industries in Afghanistan. These organizations have made capital investments in the development of technological activities, and also given valuable assistance by providing short and long term consultants and advisors in many areas of science technology in Afghanistan.

AUSTRALIA

Table of Contents

AUSTRALIA

GEOGRAPHY

Capital city: Canberra
Main ports: Melbourne, Newcastle, Sydney
Land surface area: 7,686,848 sq km

POPULATION (1978)

Total	14.2 million
Density (per sq km)	2
Urban/rural ratio (1976)	6.1
Average rate of growth (1970-78)	1.6% p.a.

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	26.4	9.0	8.5	43.0	13.1	100%

SOCIO-ECONOMIC

Labour force (1978)	
Total	6.4 million
Percentage in agriculture	5.9%
Gross National Product (1978)	
GNP at market prices	US $114,780 million
GNP per capita	US $8,060
Real growth rate of GNP per capita (1970-78)	1.5%
Gross domestic product (1975)	
Total (in current producers' values)	US $93,388 million
Percentage by origin	
Agriculture	5%
Manufacturing, mining & quarrying, electricity, gas & water, construction	32%
Government finance	
National budget (1978)	US $28,147 million
As percentage of GNP	24.5%
External assistance (official, net; 1976)	...
As percentage of GNP	...
Exports (1978)	
Total exports of goods	US $14,127 million
Average annual growth rate (1970-78)	4.0%
External debt (1978)	
Total public, outstanding + disbursed	...
Debt service ratio (% GNP)	...
(% Exports of goods and non-factor services)	...

Exchange rate (1978): US $1 = 0.87 Australian Dollar

EDUCATION

Primary and secondary education (1978)	
Enrolment, first level	1,669,324
As % of (6-11 years)*	111%
Enrolment, second level	1,111,308
As % of (12-16 years)	87%
Combined enrolment ratio (6-16 years)	100%
Average annual enrolment increase (1972-1978)	1.0%

---

* The enrolment ratio is the relationship between the number of all pupils enrolled (regardless of their age) and the number of the population of the relevant official ages.

Higher education (third level) (1979)

Teaching staff, total	...	
Students and graduates by broad fields of study		
	Enrolment	Graduates
Social sciences and humanities	212,161	47,053
Natural sciences	36,932	7,209
Engineering	30,942	5,073
Medical sciences	23,114	5,037
Agriculture	6,966	1,419
Other and not specified	7,381	849
Total	**317,496**	**66,640**
Number of students studying abroad	3,336	

Education public expenditure (1978)

Total (thousands of Australian dollars)	6,187,000
As % of GNP	6.2%
Current, as % of total	87.2%
Current expenditure for third level education, as % of total current expenditure	27.6 %

Table 1 - Nomenclature and networking of S&T organizations

The science and technology network in the Commonwealth sector: a concise guide to major organizational functions and interactions

I. Policy-making

Organization	Function	Interactions		
		Reports to:	Advised by:	Consult with
Federal—State Ministerial consultative bodies e.g. Australian Agricultural Council, Australian Minerals and Energy Council	Advisory Executive	Federal & State governments	Standing committees, sub-committees, Federal & State government departments	Interest groups, Universities
Australian Science and Technology Council	Advisory	The Prime Minister	Standing Committee on Technological Change	Government departments with science and technology involvement
Government departments with S&T role e.g. Departements of Science and Technology, National Development and Energy, Industry & Commerce	Control Co-ordination, Executive Advisory	Ministers	Committees	Universities, State government departments, Industry groups, other committees, other federal departments
Industry Advisory Council	Advisory	Minister for Industry and Commerce		Industry groups, Trade Unions
Uranium Advisory Council	Advisory	Minister for Trade and Resources		Mining companies, Environment groups
Commonwealth Scientific & Industrial Research Organization Advisory Council	Advisory	CSIRO	CSIRO State Committees	Department Science and Technology
Specialist Advisory Committees e.g. Meteorology Policy Committee	Advisory	Usually the Minister responsible for the specialist activity	Sub-committee	Universities, Government, Departments, CSIRO
Australian National Parks & Wildlife Service	Executive, Advisory	Minister for Home Affairs and Environment		State Government National Park Services, Department of the Capital Territory, Northern Territory Government
Great Barrier Reef Marine Park Authority	Advisory	Minister for Home Affairs and Environment	Great Barrier Reef Consultative Committee	Queensland State Government, Australian Institute of Marine Sciences, James Cook University

II. Promotion and finance

Organization	Interactions		
	Reports to:	Advised by:	Consult with
Government Departments e.g. Departments of Finance, Science and Technology, etc.	Ministers		Industrial and academic groups, agencies concerned with science and technology
Australian Research Grants Committee	Minister for Science and Technology	Sub-committees	Universities
National Health and Medical Research Council	Minister for Health	50 Committees and sub-committees	
Industrial Research Committees	Usually Minister for Science and Technology	Advisory Committees	CSIRO, Universities
National Energy Research, Development & Demonstration Council	Minister for National Development & Energy	Various committees	
Australian Industrial Research and Development Incentives Board	Minister for Science and Technology	Australian Industrial Research & Development Incentives Advisory Committee	CSIRO Universities
Primary Industries Research Councils e.g. Oilseeds Research Committee. Pig Industry Research Committee	Minister for Primary Industry		State Departments of Agriculture Industry Groups

Organization	Interactions		
	Reports to:	Advised by:	Consult with
Specialist Research Grants Committees e.g. Australian Marine Science & Technologies Advisory Committee Funding Allocation Panel. Research Fellowships Committees	Usually Minister for Science and Technology	Sub-Committees	Universities

III. Performance of Scientific and technological activities

Establishment	Function	Interactions	
		Reports to:	Consults with:
Commonwealth Scientific & Industrial Research Organization	R&D. STS	Minister for Science and Technology	*Universities, Department of Science* and Technology, Department of National Development & Energy
Academic institutions e.g. Universities and Colleges of Advanced Education	STE, R&D. STS	Governing bodies, Tertiary Education Commission	
Australian Atomic Energy Commission	STS, R&D	Minister for National Development and Energy	CSIRO
Health Research Establishments (Department of Health) e.g. National Acoustic Laboratories, Institute of Child Health	STE, STS, R&D	Department of Health	Universities
Defence Science and Technology Organization (Department of Defence)	STS, R&D	Department of Defence	Universities
Bureau of Mineral resources, *Geology and geophysics* (Department of National Development and Energy)	STS,R&D	Department of National Development and Energy	Universities, Mining interests, Geological units
Bureau of Meteorology (Department of Science and Technology)	STS, R&D	Department of Science and Technology	CSIRO
Snowy Mountains Engineering Corporation	STS, R&D	Minister for Housing and Construction	
Antarctic Division (Department of Science and Technology)	R&D	Department of Science & Technology	CSIRO, Universities
Space Tracking and Landsat Stations (Department of Science and Technology)	STS	Department of Science & Technology	NASA (U.S.)
Australian Institute of Marine Sciences	R&D	Department of Science & Technology	Universities
Anglo-Australian Telescope Board	R&D	Minister for Science and Technology (Joint British-Australian Venture. Also reports to UK Secretary of State for Education & Science)	Universities, CSIRO, Science Research Council (UK)

STE = Scientific and Technological Education and Training
STS = Scientific and Technological Services
R&D = Research and Development

Table 2 - Scientific and technological manpower

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	Number working in R&D**						Total stock (thousands)	Numbers working in R&D** (in units)
			Total number (in units)	Breakdown by field of educational training (a) (in units)						
				Natural sciences	Engineering and Technology	Agricultural sciences	Medical sciences	Social sciences		
1971	12.9	120 (b)							410 (c)	
1973/74	13.5		22,788	6,890	7,774	3,114	1,270	3,740		16,188
1976	13.9	185 (b)							538 (c)	
1976/77 (d)			20,624	6,573	6,737	2,704	1,355	3,255		12,446

** In full time equivalent.
(a) The breakdown is by field of performance of R&D, not by field of educational training.
(b) Total of persons possessing higher degrees, graduate diplomas and bachelors degrees in appropriate fields. (Available only from Census data of five year intervals)
(c) Total of persons possessing diplomas & technical certificates in appropriate fields. (Available only from Census data at five year intervals)
(d) Latest available figures from R&D survey data.
(e) Projected figures for 1985 and 1990 have not been provided. The only reliable demographic projection suggests that Australia's population at the end of the century may be about 19 million.

Table 3 - R&D expenditures

Currency: Australian dollar ($A)

Table 3: Breakdown by source and sector of performance

Year: 1976-77 (a)

Unit: thousands

Source / Sector of performance funds	National		Foreign	Total
	Government funds*	Other		
Productive	9,049	143,365 (b)	4,217	156,632
Higher education	176,459	7,095 (c)	768	184,322
General service	444,122	8,167 (d)	9,221	461,510
Total	629,630	158,627	14,206	802,464

(a) Latest available figures
(b) Private business enterprise funds.
(c) 75% private non-profit funds, remainder private business enterprise funds.
(d) 60% private non-profit funds, remainder private business enterprise funds.
* Combined Federal and State.

Table 3b: Trends
(data unavailable at time of publication)

Year	Population (millions)	GNP (in)	Total R&D expenditures (in)	Exchange rate US $1 =
1965				
1970				
1975				
1979				
1985				
1990				

PART 1.

General features

1.1 GEOPOLITICAL SETTING

Geography

The Commonwealth of Australia (mainland and Tasmania) lies almost entirely between latitudes 10°S and 44°S, and longitudes 113°E and 154°E surrounded by oceans. It is one of the developed nations of the southern hemisphere while most of its neighbours are developing nations. The land mass areas is 7 682 million square kilometres, with a coastline estimated at 47 070 kilometres. About 40 % of the land mass is north of the Tropic of Capricorn.

Australia administers a number of island territories in the Pacific and Indian Oceans and the Sub-Antarctic. It has declared a 320-kilometre fishing zone, known as the Australian Fishing Zone, and is likely, on ratification of the draft international Law of the Sea Treaty, to assume responsibility for the same area as an exclusive economic zone. It also claims the Australian Antarctic Territory which, with an area of 6.2 million square kilometres, covers almost half of Antarctica.

Population

The Australian population was more than 14.2 million in March 1978. Australia is in the early stage of a quiescent period of population growth, which on the most reliable demographic projections is expected to last until the end of the century, by which time the population may be about 19 million. There has until recently been a twenty-year period when the proportion of younger people grew faster than the older age groups but this trend is now reversed. The average age of the Australian population is expected to increase slowly to the year 2000. The population of the national capital, Canberra is about 225 000 people.

Climate

The island continent of Australia is relatively dry with 50 percent of the area having a medium rainfall less than 300 millimetres per year and 80 per cent less than 600 millimetres. Extreme minimum temperatures are not as low as those recorded in other continents because of the absence of extensive mountain masses and because of the expanse of ocean to the south. However, extreme maxima are comparatively high over the inland, mainly due to the great east-west extent of the continent in the vicinity of the Tropic of Capricorn. Normal daily maxima of 40°C are common in the inland areas, especially north of about 30°S. The northern coastal regions have typical monsoonal wet and dry seasons, with high temperatures combined with high humidities in the summer months. While winter frosts capable of damaging crops or orchards can occur throughout most of southern Australia no region suffers from extreme cold and snowfalls are confined to the mountains in the south-east.

The rainfall generally increases with proximity to the coast. Mean annual rainfall exceeds 2500 mm on the coast of Queensland and Tasmania but drops below 150 mm in central Australia. The total annual discharge of all Australian rivers is only 60% of that of the Mississippi River alone.

Generally, Australian rainfall tends to fall in sharp heavy downpours, leading to substantial run-off from the hard dry soil. Economic losses from flood are frequent on the short coastal river valleys of Queensland and northern New South Wales. Rainfall tends to a winter maximum in the south and a summer maximum in the north. It is generally erratic and unreliable. Recurrent droughts are a consistent feature, making farming difficult in many areas.

Land Resources

About 63% of Australia is covered by desert or semi-arid soil zones and 14% by skeletal soil on mountainous country which means that the vast majority of agricultural and intensive pastoral industries are confined to less than a quarter of the total area of the continent. Even in the productive areas, the Australian landscape is in general a fragile one. It is characterised by soils of inherently low fertility, many of which are located in low rainfall regions susceptible to erosion. Large areas are affected by salinity problems. However, with proper management techniques, which include addition of trace elements, stocking levels, many Australian soils can be brought to, and maintened in, a productive condition. Often, however, the economics of doing this are marginal.

Water Resources

Rainfall, or the lack of it, is the most important single factor determining land use and rural production in Australia. Australia is the driest continent in the world. The scarcity of both surface and ground water resources, together with the low rates of precipitation which restrict irrigation and other uses, has led to extensive conservation programmes of dams, reservoirs, large tanks and other storages.

Australia has limited surface water resources. Most of the interior has no drainage system and surface water runs through ill-defined channels into shallow salt 'lakes', which are dry except after infrequent rain storms. A river system draining to the sea exists only in the south-east and around the coast but this is also highly variable in flow. The most important river system is the Murray-Darling, which drains the Eastern Highlands westward to the sea in South Australia. Practically all other rivers in Australia are short, running directly from the ranges across the coastal plain into the sea.

Groundwater is available over more than 60 per cent of Australia, and is used extensively for stock watering, irrigation and urban supply. The largest groundwater source, the Great Artesian Basin extends over 1.7 million square kilometres, principally in Queensland and New South Wales, and, although too brackish for irrigation, is vital to the sheep and cattle industry. A great deal of research remains to be done on the rate of recharge of aquifers to enable groundwater yields to be managed efficiently. It is estimated that sustained annual groundwater yield, based on natural aquifer recharge is 72 000 million cubic metres.

Only 8% of estimated total water available is actually used, 1% for domestic, industrial and municipal consumption and 7% for irrigation and stock watering. 5% of cultivated land and one million hectares of pasture are irrigated, representing 0.113 hectares of irrigated land per head of population.

However to put this in perspective it must be stated that only 2% of Australia's land area is actually cultivated. 75% of irrigated land is within the Murray-Darling river system. Urban water use amounts to 2 200 million cubic metres per year for Australia. Water quality is increasingly being threatened by waste disposal, salinisation, sediment and agricultural chemical run-off.

Mineral and Energy Resources

Australia's known reserves (i. e resources which can be mined profitably at present prices) of bauxite, coal, natural gas, iron ore, manganese, nickel, uranium, and mineral sands are very large in relation to Australia's present domestic requirements, and those of copper, lead, zinc, tin, silver and salt are more than adequate. There are currently deficiencies of the minerals chromite, sulphur, certain grades of asbestos, diamonds, magnesium, molybdenum, phosphate and potassium salts.

Australia is a major minerals exporter and is one of the few developed countries which is a net exporter of energy. Australia has very large energy resources, with the exception of crude oil, which is by far the major mineral import item. Domestic production supplies about 67% of the estimated demand for crude oil with heavier imported crudes accounting for the remainder. Substantial parts of Australia's energy resources are located offshore, in Bass Strait (oil) and on the North-West Shelf (gas). There are also potentially exploitable mineral deposits on the continental shelf and in large areas covered by manganese nodules in deeper water off the south-west coast.

Non-Mineral Energy Sources

These include, hydro-electricity which is practicable only in the constant-rainfall or alpine areas Tasmania and eastern Australia where it is exploited through large-scale generating installations; solar energy, whose use for small-scale hot water and electricity generation is growing significantly; and wind energy, which has been used extensively for pumping water and also for small-scale power generation on rural properties.

Native Plant Resources

The areas of heaviest rainfall are forested and the type of forest is directly related to the rainfall. Tropical rainforests are scattered along the north-east coastal ranges while temperate rainforests occur in more southern areas. Areas of wet sclerophyll forest occur in the south-west corner of the continent and in the southern highlands. Dry sclerophyll forests spread widely into the interior and merge into open natural grassland dotted with trees or into *Acacia* bushland. In general there is a positive relationship between the height of the native vegetation and rainfall. The semi-desert and desert regions have their own plant communities adapted to the scattered and erratic rainfall. The original plants in Australia have contributed little to rural developement. With very few exceptions the economic crops, including animals, in Australia are exotic species.

Fisheries

Most of Australia is surrounded by tropical, sub-tropical or sub-Antarctic waters which have a large variety of species, only some of which are of commercial interest. Utilisation of such mixed catches often presents problems. The waters adjacent to Australia are generally poor in nutrients, with the processes which lead to high fish concentration occuring sporadically in restricted areas. The continental shelf near the most heavily populated parts of the country is generally narrow providing limited opportunities for fishing. Furthermore, the Australian per capita fish consumption is relatively low and the Australian fishing industry operates on a small scale by world standards, and suffers from some consequent economic disadvantages. The exception to these general conditions is fishing for luxury items such as rock lobsters, prawns, oysters, abalone and tuna, which make up most of the value of Australia's fishing production, and are mostly exported.

Major Urban Centres

The major urban centres are on the coastal fringe, particularly in the South-East. This distribution has been determined mainly by the history of settlement, and by climatic and resource (particularly water) availability factors. The population by international standards, is small compared with the land area, and Australia is simultaneously one of the most urbanised and most sparsely populated of nations. Demographic studies reveal that this pattern of concentration is unlikely to change in the foreseeable future.

The principal urban centres include: Sydney-Newcastle-Wollongong; Melbourne-Geelong; Brisbane; Adelaide; Perth-Fremantle; Darwin; Hobart; Canberra.

Australia's major seaports and airports are mostly located at the sea-board capital cities of each of the Australian States, including Darwing, capital of the Northern Territory. Other major sea-ports are located in other areas to handle mainly mineral and rural exports.

Transport

The motor car is the primary mode of domestic passenger travel for both the urban and non-urban transport tasks, although public transport plays a significant but declining role in urban travel, and air transport has a key role in long distance inter-urban travel. During the 1975-76 Australian financial year, road transport performed 86% of the non-urban passenger task with rail and air contributing 3.1% and 10.8% respectively.

In 1975-76, about 1 160 million tonnes of domestic freight were carried, 78% of it by road. In spite of this heavy dependence on road transport, Australia's road system for long haulage is not of high standard when compared with those of other developed countries. In terms of tonne-kilometres, 191 thousand million tonne-kilometres were carried in 1975-76, 53% of it by sea. Almost all Australia's imports and exports of goods are carried by ship. Seaborne imports and exports in 1976-77 were 27 million tonnes and 159 million tonnes respectively. The major proportion of exports were made up of bulk minerals and grain. Australia imports and exports are almost entirely carried by foreign flag vessels.

Political System

Australia has had a Federal system of Government since 1901. Under the Constitution, powers are divided between the Federal Parliament and Government and the parliaments and governments of the six Australian States, namely, New South Wales, Victoria, Queensland, South Australia Western Australia and the island State of Tasmania. There are two Federal territories, the Australian Capital Territory containing Canberra which is the Federal Capital, and the Northern Territory which is in the process of becoming self-governing. Within each State there are local government authorities which administer localised regions and municipalities.

The Australian Constitution specifies the legislative powers of the Federal Parliament. Some of the Federal Parliament's powers are exclusive, such as the raising of military forces and the imposition of customs and excise duties. Other powers are concurrent in the sense that State laws continue to operate until the Federal Parliament passes legislation which overlaps those powers. That legislation then prevails over any inconsistent State laws. State Government are primarily responsible for the administration of such fields as agriculture, water supply, electricity generation, mining, housing, education, transport, public health and environmental protection. Such matters as local roads, building control, and the provision of other basic local amenities are the responsibility of local government authorities.

The conventions of Westminster-style Cabinet Government are followed in Australia although they are not in all respects provided for in the Constitution. There are at present 26 Ministers at the Federal level the chief Minister is known as the Prime Minister.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

Social Groups

Australia's major social groups are native-born Australians of European origin, Aboriginals and immigrants not born in Australia. English is the language spoken universally in Australia.

The Australian life-style reflects the people's predominantly Western origins. Probably less than half of the Aboriginal population (139 800 at 30 June 1978) lives in tribal and mixed communities in remoter areas of the continent, mainly in the Northern Territory and in parts of Western Australia, South Australia and Queensland. Aboriginals living in towns and cities have been more affected by Western contact and many participate at various levels in the life of the community. Active programmes of special assistance in recent years have resulted in a marked improvement in the general situation on of Aboriginals, although they have not yet entirely eliminated disadvantages in term of education, health, employment and housing standards deriving from past neglect. Some 3.4 million migrants mostly from Western Europe have settled in Australia since the end of World War 2 and about 20% of today's Australians were born overseas.

Religion

At the 1976 census, 98.8% of those who stated their religion professed the Christian faith. Of these 36% were Anglican (Church of England), 33% Roman Catholic, 9.6% Methodist, 8.7% Presbyterian, 3.8% Orthodox, 1.8% Lutheran, and 1.6% Baptist. Since then the Methodist, Congregational and the majority of the Presbyterian, churches have amalgamated to form the Uniting Church in Australia. The Jewish, Moslem and Buddhist faiths are among non-Christian faiths with followers in Australia. In the 1976 census more than one million Australians stated they had no religion.

The Economy

The Australian economy, in common with other Western economies, has changed from being a predominantly private enterprise market economy to being a modern mixed economy. Some services, such as railways, most metropolitan public transport, some airlines and shipping, and telecommunications, are run by government. Approximately one person in four in the full-time workforce is a civilian employee of government (Federal, State, or local government).

Like other industrial countries Australia experienced a period of unprecedented growth from the post-war period until the early 1970s when a time of diminished certainty, security and growth followed. In this more recent period factors of worldwide impact have been the rapid increase in oil prices; the recession which began in 1974; high rates of inflation, and high levels of unemployment. Other factors that have exerted an economic influence in Australia are the mining boom of the late 1960s and early 1970s, and the wages explosion of 1973-74. Since 1975 government policy has stressed the need to fight inflation, and reduce public sector spending as requisites for economic growth and development, and to reduce the budget deficit and influence the money market.

Between 1961 and 1970 the average inflation rate as measured by the Consumer Price Index (CPI) was 2.5%. The rate was 16.7% for the year 1974-75, had been reduced to 8.2% for 1978-79, and was 10.2% for 1979-80. Increases in average weekly earnings fell from 25.7% in 1974-75 to 9.7% in 1979-80. Wage indexation was introduced in 1975. From the March Quarter of 1975 to the September Quarter 1980 the average weekly earnings (adult, male) rose by 77.8% to $A268.60. For the same period the CPI increased by 74.6%.

During the late 1960s and up to the early 1970s a significant feature of the Australian economy was the very low level of unemployment, associated with strong industrial growth and a high rate of population growth. Employment growth was strong in the period up to 1974, then moderated between 1974 and 1978 when the increase in full-time employment was moderate and part-time employment providing a major part of the growth of total employment. Employment growth was strong in 1979 and 1980.

Between 1966 and 1980 significant structural shifts occurred which altered the industrial composition of employment. To some extent the changes over the period reflect longer term historical movements such as the decreasing importance of the rural and manufacturing sectors in providing employment, and the growth in the tertiary sector. Moreover, there have been compositional shifts within sectors relating to a number of labour force characteristics, notably part-time employment, hours of work, and the female share of employment.

The largest industry sectors in Australia in 1980 by level of employment were: wholesale and retail trade, manufacturing, community services, finance and insurance, construction, and agriculture. Of these, only community services, finance, and insurance recorded growth in their sector shares of employment between 1966 and 1980. The shares of most other sectors remained virtually unchanged, except for agriculture and manufacturing whose shares declined (see table below).

**Australia: Employed persons by industry
1966 and 1980**

	1966		1980	
	Total '000	Proportion of Total Employed	Total '000	Proportion of Total Employed
Agriculture & Services to Agriculture, Inc. Forestry	429.6	8.9	407.3	6.1
Mining	58.0	1.2	84.3	1.3
Manufacturing	1,232.5	25.5	1,233.6	19.7
Construction	406.0	8.4	483.3	7.7
Wholesale & Retail Trade	993.5	20.6	1,265.4	20.3
Transport & Storage	270.0	5.6	341.8	5.5
Finance, Insurance, Real Estate, Business Services	294.4	6.1	510.5	8.2
Community Services	486.0	10.1	1,007.8	16.1
Entertainment, Recreation, Restaurants, Hotels & Personal Services	287.0	5.9	386.4	6.2
Other Industries	366.9	7.6	526.3	8.4
Total	4,823.9	100.0	6,246.7	100.0

During the first half of the 1970s the level of unemployment increased rapidly; by August 1975 215 500 persons (4.1% of the full-time labour force) were looking for work, twice as many as in the previous year and three times as many as in the late 1960s. After this initial leap unemployment continued to increase, albeit less rapidly and by August 1978 332 600 persons (6.2% of the full-time labour force) were unemployed. Since then unemployment has more or less stabilised. In August 1980 332 600 persons were unemployed seeking full-time work, and unemployment rate of 6.0%. Labour mobility statistics indicate that nearly one quarter of employees change jobs every year in Australia. However, this figure includes frequent job changes by some people and few changes by others.

In 1979-80 real Gross Domestic Product (GDP) amounted to $A69,600 million, an increase of 2.2% over 1978-79. Preliminary estimates indicate that the main sectoral contributions to GDP for the year 1977-78 were:

rural	4.8%
manufacturing	22.1%
mining	4.5%
services and other	68.6%

Trends in these percentages since 1960 show services to have increased, sharply, manufacturing to have declined, mining to have increased, and rural to have arrested an earlier decline. In 1978-79, manufacturing industry turnover was $A55 200 million, mining industry $A6 500 million, and agricultural production $A11 200 million.

In 1979-80 exports of goods and services (national accounts basis) represented 19% of Gross Domestic Product. Exports of merchandise on 1978-79 by sector are shown below in comparison with 1967-68 exports.

	1967-68 (%)	1978-79 (%)
Rural	62.1	40.6
Minerals, including coal	11.3	28.5
Manufacturers and others	26.6	30.9

The growth of Australia's traditional major exports in the rural sector, such as wheat and wool, has been slower than the overall growth in world trade in rural commodities. World trade in minerals and fuels has increased rapidly nevertheless, in this sector, Australia's exports have exceeded the overall growth rate. The effects of the projected major resource development will be an economic factor in the 1980s. Exports have decreased to traditional markets in Europe and North America.

In 1977-78 half of the manufacturing output was from the 200 largest firms while the other half was produced by approximately 30 000 medium to small firms. In 1975-76 one quarter of the manufacturing output came from approximately 90 foreign controlled firms. Major items contributing to the value of Australian manufacturing output include:

food, beverages and tobacco	18.2%
other machinery and equipment	12.5%
basic metal products	10.6%
transport equipment	9.9%

Gross agricultural output as at 1979-80 is made up from:

wool	14.7%
crops	46.1%
livestock, slaughtering	31.5%
other livestock products	7.7%

Reflecting the importance of a small number of products in Australian agriculture in 1978-79, sheep and wool contribute 17.6% to the gross value of agricultural commodities, wheat contributes 22.4% and cattle 21.1%.

Over the last decade there has been a decrease in effective rates of tariff protection for the manufacturing industry. There is, however, a considerable variation between industry groups in the effective rate of protection – from 5% for basic metal products, to almost 150% for clothing and footwear.

1.3 DEVELOPMENT SCENE

Australia has many assets which favour its development. These include a politically stable environment, vast amounts of coal permitting large-scale, low-cost electric power generation for industry, a well-educated workforce, a well-developed telecommumnications system and the ability to attract foreign investment funds for large scale development projects and other activities.

Since the late 1970s rapidly increasing investment in Australia's substantial energy resources has been occurring largely in response to the world's "energy crisis". Major developments are also occurring in coal mining, bauxite mining, alumina refining and aluminium smelting, uranium mining and shale oil mining. It is expected that the production of export of Australia's mineral resources will add significantly to economic growth during the 1980's.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

There is no explicit Australian development plan but broad national goals and objectives are laid down in the policy platform of the Government and Opposition Parties. At present, the Liberal and National Country Parties in coalition provide the Federal Government. The Australian Labor Party formed the Government for the period December 1972 to November 1975. On the basis of political and advisory processes, priorities are determined by each Federal and State Government Ministry for the various programmes and fields for which they are responsible. This forms the basis for deciding or authorising major undertakings in the public sector in the immediate years to come. The Premiers' Conference and the Loan Council play an important role in Federal and State Government negotiations.

In Australia as elsewhere in recent years, there has been increasing support for the view that adequate weight must be given in policy-making to the qualitative aspects of national growth. This situation is reflected in present policies of the Australian and State Governments in the fields of urban and regional development, protection of the physical environment, education, health and social welfare services.

Major physical undertakings for the next 10 years include a number of large-scale energy, mining and mineral projects involving very large expenditures as well as continued development of the national industrial infrastructure. Many of the large scale-projects require a high percentage of foreign investment funds, however an upper limit of 50% of foreign equity is applied to resource development projects. Others including new power station projects, in the State Government Sector will be financed by public loans. Major economic goals over the next 10 years are lower inflation, higher employment, greater productivity, maintainance of a favourable trade balance, and structural readjustment in a number of manufacturing industries to make Australian products more competitive in world markets.

Coordination between the Federal Government, the State Governments and the Northern Territory Government is exercised primarily by Federal-State Ministerial Councils, Committees and Conferences. These include:

The Premiers' Conference;
Australian Aboriginal Affairs Council;
Australian Agricultural Council;
Australian Environment Council;
Australian Fisheries Council;
Australian Forestry Council;
Australian Housing Research Council;
Australian Loan Council;
Australian Minerals and Energy Council;
Australian Transport Advisory Council;
Australian Water Resources Council;
Conference of Commonwealth and State Ministers for Immigration and Ethnic Affairs;
Standing Committee of Attorneys-General;
Standing Committee of Ministers for Consumer Affairs;
Council of Nature Conservation Ministers;
Industry Ministers Conference;
Tourist Ministers Council;
Ministers of Labour Conference.

Federal and State Ministers are advised by the policy divisions of their respective Departments and in many cases by advisory committees whose members are drawn from interested organisations and experts in the field concerned. For example, on the Federal level, the National Energy Advisory Committee advises the Minister for National Development and Energy on matters relating to national energy policy and associated issues. The Australian Manufacturing Council, and thirteen Industry Advisory Councils, advise the Minister for Industry and Commerce. The Advisory Councils cover various sectors of industry and commerce and were first established in 1976. The Advisory Councils consider issues as they relate to an industry sector and provide a means of communication between the Federal Government, manufacturing industry representatives, unions, retailers, consumers, and other interested groups. Government and Opposition parties are also represented. Examples of these Advisory Councils are the:

Automotive Industry Advisory Council;
Electronics Industry Advisory Council;
Metal Manufacturers Industry Advisory Council;
Small Business Advisory Council.

From time to time, the Federal Government and State Governments establish special committees of inquiry to examine and report on a particular area of concern. An example of such a Committee established by the Federal Government is the Committee of Inquiry into Technological Change in Australia, which was set up in December 1978 and which issued its report in April 1980.

2.2 DEVELOPMENT POLICY AND SCIENCE/TECHNOLOGY POLICY

The formulation and coordination of development policy has been outlined in Section 2.1 of this Report. The formulation of national science and technology policy is handled in a similar way but predominantly at the Federal level. The machinery designed to develop science and technology policy is explained in detail in Section 2.3 of this Report. A number of Ministries in the Federal Government have interests in science and technology matters and a number conduct and/or finance research and development work. Consequently development policy and scientific/technology policy meet at the Federal level. A similar situation exists within the State Governments.

The funding of public sector scientific and technological activity directed to development goals is primarily funded through the Federal and State Governments. A number of Federal Government granting schemes exist to advance such research to demonstration and application. Three of these are listed in Section 2.3 of this Report. The stimulation of research and development within Australian industry is an important element of the Government's long term industry policy aimed at the development of a stronger and more specialised manufacturing base in Australia. The objective of industrial research and development (IR&D) incentives is to promote the development, and improve the efficiency, of Australian industry by encouraging IR&D in Australia, for developing new and improved products and processes. The Government's IR&D policy is implemented principally through the Industrial Research and Development Incentives Act (see Section 3.3).

There are no specific formal arrangements by which the innovation potential of science and technology research results are taken into account in the setting of development goals and objectives. Each Ministry considers promising research results within the context of its own responsibilities for development. The major proportion of total Federal Government research and development funding is allocated to the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Defence Science and Technology Organisation and the Industrial Research and Development Incentives Scheme described in section 3.1.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

Historical background

Until 1972 there was no national arrangement below the level of the Federal Government Cabinet for integrating advice, and assessing relative priorities in scientific and technological fields; the only exception was in the defence sector. Within the Commonwealth Scientific and Industrial Research Organisation (CSIRO), an Advisory Council prepares advice for the Executive of the CSIRO on work related to the objectives of the organisation, while State Committees integrate suggestions from State Government sources.

The Federal Government acknowledged the growing importance of scientific and technological matters in national government with the establishment of a Ministry of Science (now Science and Technology) in December 1972. An Australian Council for Science and Technology was also formed in 1972, but met only once before being disbanded following a change of Government. An Interim Australian Science and Technology Council was formed in 1975; it was the then Government's declared intention to make the Council a statutory body. The Government changed again in November 1975, and an Advisory Group was formed in 1976 to advise the Prime Minister on the role of, and terms of reference for, a science and technology advisory council. The report presented to Parliament by the Group indicated that there was widespread support for the creation of a permanent and independent advisory body on science and technology and recommended the establishment of a permanent Australian Science and Technology Council (ASTEC). Accordingly, in April 1977 the Prime Minister announced in Parliament that an Australian Science and Technology Council would be established as a permanent statutory body to give independent advice to the Government on science and technology. The Act giving effect to this decision was proclaimed on 21 February 1979.

Bodies involved in policy making

Responsibility for aspects of Government interests in science and technology is exercised by both Federal and State Governments. The Federal Government provides over half of the funds expanded on research and development in Australia and has exclusive responsibility for defence science. State Governments have a particular but not exclusive interest in applied research and in the application of science. A major role in agriculture, coastal and inland fisheries, forestry, mining, water resources, regional and urban planning, and environmental protection is played by the States.

At the Federal level, there are several Ministries having an interest in science and technology. Each has a policy unit which considers policy matters in the areas of science and technology, particularly in the context of the responsibility of the Ministry and its involvement in scientific and technological research. Parliamentary committees with an interest in science and technology include the Senate Legislative and General Purpose Standing Committees on Science and the Environment, and on National Resources, and also, though to a lesser extent, the House of Representatives Standing Committees on Environment and Conservation, and on Road Safety. The Senate Standing Committee on Science and the Environment has very wide terms of reference covering policy and R & D efforts in the physical, social and life sciences, and has oversight of the problems of pollution and preservation of the environment. It produced a progress report on policy matters for science and technology in November 1977, a report in May 1979 on an open inquiry into industrial research and development, and an investigation of developments in the Alligator Rivers region of the Northern Territory, particularly the likely effects of uranium mining on the Kakadu National Park. The Standing Committee on Science and the Environment is also inquiring into marine science in Australia. The Senate Standing Committee on National Resources produced a report on solar energy in 1977, on alternatives to petroleum-based fuels in 1980, and is currently investigating the aluminium industry and the Commonwealth's role in water resources.

Australian Science and Technology Council

Since 1977, ASTEC has developed as a separate advisory and coordinating body for providing science and technology policy advice to the Federal Government. In the Australian Science and Technology Council Act, 1978, ASTEC was given the following terms of reference:

The functions of the Council are to investigate, and to furnish information and advice to the Commonwealth Government in respect of matters relating to science and technology, including the following matters:

the advancement of scientific knowledge;

the development and application of science and technology likely to be of national importance;

the adequacy, effectiveness and overall balance of scientific and technological activities in Australia;

the identification and support of new ideas in science and technology likely to be of national importance;

the practical development and application of scientific discoveries;

the fostering of scientific and technological innovation in industry, and

the means of improving efficiency in the use of resources by application of science and technology.

The members of ASTEC are drawn from scientists, industrialists and other persons eminently knowledgeable in a number of fields such as science, technology, industry, political science, industrial relations, etc. The Prime Minister has Ministerial responsibility for ASTEC.

The Council provides reports and recommendations on science and technology topics both on its own initiative and in response to requests by the Governement. To this end, the Council seeks information and comment from the general community as well as from the scientists and technologists. Government departments and agencies also provide information and comment whenever requested by Council or on their own initiative. In addition, monthly Council meetings are attended by Permanent Heads of relevant Departments and agencies or their representatives, to facilitate contact. However, part of each Council meeting is restricted to Council members only to allow discussion of matters referred to the Council in confidence, or for formulation of confidential advice to Government.

ASTEC's strategic advisory role often interacts with the operations of individual departments and agencies. The Council needs to be aware, at an early stage, of major departmental initiatives in science and technology and especially of those which may have implications for the allocation of major resources. ASTEC is then able to comment and to advise the Government on the strategic implications of these initiatives at the appropriate time. Conversely, Ministers of Permanent Heads are able to seek ASTEC's comments on an informal basis on matters under consideration.

The Council prepares reports on special topics such as Energy Research and Development in Australia, the Direct Funding of Basic Research and Industrial Innovation, and provides the Government with independent comment on matters discussed in detail by other committees such as the Report of the Independent Inquiry into CSIRO, the report of the Study Group on Structural Adjustment and the Report of the Committee of Inquiry into Technological Change in Australia. It also advises on science and technology priorities in the Budget context. The Government announced on 18 September 1980 its acceptance of the recommendation of the Committee of Inquiry into Technological Change in Australia that a Standing Committee of ASTEC be established to monitor and evaluate the effects of introducing new technologies in Australia and to make recommendations on the benefits of such technologies.

The Council works through a system of committees, often with one or more members from outside the Council, to consider matters of concern requiring detailed investigation before consideration by the full Council. These committees consult widely with interest parties and with experts in the relevant fields of science. Most committees are ad hoc, established to undertake a particular study. The Prime Minister has stated that AMSTAC will work closely with relevant Ministers, particularly the Minister for Science and Technology, and that other similar advisory committees will be established as standing committees of ASTEC, particularly in areas of science and technology which involve a number of ministerial portfolios.

The Ministeral Councils mentioned earlier in Section 2.1, such as the Australian Agricultural Council and Australian Environment Council, are concerned primarily with broader economic, social or environmental goals, but also give attention to underlying science matters.

The Department of Science and Technology provides policy advice to the Minister for Science and Technology on matters relating to his portfolio. The Department assists in the formulation and implementation of Federal Government policy for science and technology. A number of science and technology committees exist to provide advice to the Minister for Science and Technology. These include:

The Antarctic Research Policy Advisory Committee (ARPAC);

the Australian Liaison Committee on Remote Sensing by Satellite (ALCORSS);

the Meteorology Policy Committee (MPC); and

the Astronomy Advisory Committee (AAC).

However, there is one Standing Committee, the Australian Marine Sciences and Technologies Advisory Committee (AMSTAC), to provide advice and coordination in the marine science and technology field. AMSTAC has set up the following working groups to undertake specific tasks:

Research Vessels Working Group;

Costal and Ocean Engineering Working Group;

Working Group on Oils spills and Countermeasures;

Working Group on Marine Taxonomy;

Working Group on Archiving;

Working Group on Physical Survey Methods for Marine Data Collection (formely Remote Sensing).

Bodies providing auxiliary scientific and technological services

Several Federal Government bodies have responsibilities to provide auxiliary functions such as the promotion and financing of research and development and scientific and technological services. These include:

the Australian Research Grants Committee (ARGC) which advises the Minister for Science and Technology on grants for fundamental scientific research;

the National Energy Research, Development and Demonstration Council (NERDDC) which advises the Minister for National Development and Energy on the coordination of the national energy research, development and demonstration effort. The Council also advises the Minister on grants for the expansion of energy research and development;

the National Health and Medical Research Council (NH&MRC) which advises the Minister for Health on a number of matters relating to national health including medical research and grants for medical research; and

the Antarctic Research Policy Advisory Committee (ARPAC) which was established in 1979 to advise the Federal Government on the form and content of Australia's Antarctic research programme.

The Department of Science and Technology provides a number of scientific and technological services in addition to its other major function of assisting in the formulation and implementation of Federal Government policy for science and technology, as described earlier.

Libraries and library-based information services are operated by State and regional authorities. The National library of Australia (NLA), a statutory authority, comprises three specialist divisions: Australian National Humanities Library (ANHUL), Australian National Social Sciences Library (ANSOL); and the Australian National Science and Technology Library (ANSTEL). The NLA has assumed the role of coordinating information systems and services and has initiated the development of resource-sharing networks. However, there is no formal national machinery for the systematic organisation and coordination of scientific and technological .information services. Library-based services for scientists and technologists are provided by the National Library of Australia, CSIRO, State and municipal libraries, and libraries operated by tertiary education institutions and industrial organisations.

Increasingly, computer-based information systems offering bibliographic services are being established. Numerical data-bases are not so common but recognition of their relevance to practising scientists and to policy-makers is increasing. Important organisations in this field include the Australian National Science and Technology Library, Federal Government departments and agencies (Defence, Science and Technology, Australian Bureau of Statistics, Australian Atomic Energy Commission, CSIRO, and others) and industry (ICI Australia Ltd, Australian Paper Manufacturers, Australian Mineral Foundation). Nation-wide information and inquiry services are provided by CSIRO to industry and the general public. International linkages to overseas data-bases have been established by several organisations.

Some State governments have established science and technology advisory bodies (NSW) and energy advisory bodies (NSW, Victoria, Western Australia, Queensland). The latter are of long standing, reflecting dual State/Federal responsibility in the energy field. The New South Wale was the first such advisory body established by a State Government in Australia. It advises the Premier of New South Wales, and conducts studies relevant to science and technology of interest to the State Government.

Role of Non-Government bodies in policy-making

In Australia, the establishments and organisations active in science and technology include higher education institutions, business enterprises, private non–profit research institutions, academies and professional associations. This complex array of organisations may fill advisory, funding, coordinating or performing roles and many organisations have several roles. Members of these organisations also serve on committees set up to advise Ministers on specific aspects of science and technology.

The private sector input to policy-making in science and technology is exercised through membership of advisory bodies, submissions to Government and other political processes. The role of the academic community in science and technology policy-making is exercised through membership of advisory bodies, and submissions to Government Professional associations of scientists and technologists similarly influence and contribute to the policy-making process. In particular, science academies contribute considerably to the process collectively through their committee structure and thtrough their members. These academies are:

the Australian Academy of Science;
the Australian Academy of Technological Sciences;
the Academy of the Social Sciences in Australia.

The Consultative Committee of the Australian Academies, consisting of the three above learned academies as well as the Australian Academy of the Humanities, was formed in early 1981 and will meet annually to discuss matters of mutual interest and report back to the four governing bodies. The Australian Academy of Science, through sectional and standing committees is well as *ad hoc* committees, is a significant link in the chain of communication between scientist and government. Communication between government and the technology area of the science-technology spectrum is facilitated by the Australian Academy of Technological Sciences established in 1976.

The most broadly based of the scientific societies is the Australian and New Zealand Association for the Advancement of Science (ANZAAS) which addresses problems of national importance. Its Commission for Science Policy, during its period of operation in 1973-74, provided a focus for policy advice from within the broad coverage of ANZAAS. Other non-Government bodies are giving increasing attention to matters of sciences and technology policy including the Royal Australian Chemical Institute (RACI), the Institution of Engineers, the Australian Institute of Physics and the Australian Marine Sciences Association. There are several groups within the manufacturing sector, for example the Australian Industrial Research Group (AIRG) and some of the Industry Advisory Councils and the Australian Manufacturing Council (AMC), which from time to time provide advice to the Government on industrial research and development.

National institutions established to provide services related to technology transfer

National institutions established to provide services related to technology transfer include:

the Department of Science and Technology;
the Technology Transfer Council;
the Productivity Promotion Council of Australia;
the Industrial Design Council of Australia;
CSIRO;
the Department of Primary Industry.

The Department of Science and Technology develops and provides advice to the Government on policies and strategies to stimulate and maintain productivity improvement at the national and industry levels. Its responsibilities include increasing entreprise productivity through improved mechanisms for facilitating the transfer and diffusion of new technology.

The Technology Transfer Council is an incorporated company which was jointly established by the Government and the metals industry. The Technology Transfer Council is undertaking a pilot programme of technology transfer in the metals manufacturing industry involving the establishment of a National Technical Referral Network intended to assist in the effective application of technology in manufacturing industry.

The Industrial Design Council of Australia is a voluntary association representative of industry, commerce and Government which encourages better design in the production process. In particular the Council encourages improved productivity, sales and profits, and promotes a healthy, vigorous manufacturing industry. The Productivity Promotion Council of Australia was established in 1969 as a national non-profit organisation. It conducts programmes and provides advice to industry and commerce in all States, by disseminating technical information, developing manpower skills, work task and process design, reducing costs of physical distribution and assisting invention and innovation.

The Standards Association of Australia is responsible for the preparation of Australian standards for materials and products, and standard codes of practice. The Association publishes Australian standards and promotes their adoption. Standards are prepared only after a full inquiry has shown that the project is a desirable one and worth the effort involved. The Technology Transfer Council, the Industrial Design Council, the Productivity Promotion Council and the Standards Association receive Federal Government sugport. Table I gives a register of organisations and their functions in respect of S & T in Australia.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL FRAMEWORK

In Australia the organisations active in science and technology comprise

- Commonwealth and State Governments-statutory bodies and departments;
- tertiary education institutions - universities, colleges of advanced education, and institutes of technology. Some of these operate consultant companies which draw on the expertise of the staff of their parent institutions;
- business enterprise - principally primary and extractive industries, and processing and manufacturing industries, and associated research organisations;
- private non-profit research institutions;
- academies and professional associations;
- interface organisations - such as research associations, and trust funds.

Government responsibility for science and technology in Australia is shared by Federal and State Governments. The Federal Government, however, has exclusive responsibility for defence and telecommunications science and technology. The major institutions performing scientific and technological activities are described as follows.

Commonwealth Scientific and Industrial Research Organization (CSIRO)

CSIRO was established by the Science and Industry Research Act of 1949. Under the Act, CSIRO replaced the former Council for Scientific and Industrial Research established in 1926. The Organization was restructured by amendments made to the Act in 1978. When the Organization was first set up, its research centered on solving the problems then facing agriculture and industry. Today its research extends not only to those areas but into others such as the environment, human nutrition, conservation, urban planning. The range of CSIRO's activities makes it one of the most comprehensive research organisations in the world.

CSIRO is governed by an Executive comprising three full-time Members, including the Chairman, and five part-time Members. The Chairman is also Chairman of the Organization and Chief Executive. In 1976 the Government instituted an Independent External Inquiry into the CSIRO and the Science and Industry Amendment Act (1978) implemented some of the recommendations of this inquiry. In 1978 the CSIRO was restructured into 5 research Institutes which incorporate 38 research Divisions and 6 smaller research units. The institutes are:

- Institute of Animal and Food Sciences;
- Institute of Biological Resources;
- Institute of Earth Resources;
- Institute of Industrial Technology;
- Institute of Physical Sciences.

Each Institute is headed by a Director, each Division by a Chief, and each Unit by an Officer-in-charge.

A Bureau of Scientific Services, headed by a Director, is responsible for facilitating and promoting technology transfer and information flow, fostering cooperative technical assistance programmes, and providing advice and assistance to the Executive, Directors and Divisions in these areas. CSIRO has a staff of about 7 000 people and an overall budget in 1979-80 of $A192.6 million directly appropriated to the Organization. Of the total funds to be spent directly by CSIRO some 92% is spent on in-house research, 6% on central administrative services and 2% on external grants and studentships.

The functions of the Organization are:

- to carry out scientific research directed to assisting Australian industry, furthering the interests of the Australian community, contributing to the achievement of Australian national/international objectives and responsibilities, and any other purpose determined by the Minister;
- to facilitate the application or use of research results;
- to liaise between Australia and other countries on scientific research;
- to train research workers in science and to cooperate with relevant tertiary education institutions;
- to establish and award fellowships and studentships for research, and to make grants in aid of research;
- to recognise, cooperate with and make grants to industrial scientific research associations;
- to establish, develop and maintain standards of measurement of physical quantities and to promote their use, and the development of the calibration;
- to collect, interpret and disseminate information relating to scientific and technical matters; and
- to publish scientific and technical reports, periodicals and papers.

CSIRO publications include the annual report of CSIRO, the reports of the five Institutes, the Bureau of Scientific Services and the regular reports of the 38 Divisions. CSIRO also publishes the results of its scientific research in scientific journals both in Australia and overseas. It publishes selected items in specialist trade publications, in various non-specialist magazines and in the mass media, and makes films for screening to both specialist and general audiences. The CSIRO also publishes the Australian Science Index, a classified index of articles published in Australian scientific and technical serials, and the CSIRO Index which is an index of CSIRO published papers.

The Australian Atomic Energy Commission (AAEC)

The Australian Atomic Energy Commission (AAEC) is a statutory body which facilitates the development of Australia's uranium resources, sells products of atomic energy and undertakes research and development. Activities are controlled by a Commission of five which is responsible to the Minister for National Development and Energy. The AAEC's current programme emphasises nuclear power, safety and the environment, uranium and nuclear fuel, radio isotopes and radiation and international relations.

Commonwealth Serum Laboratories Commission

The functions of the Commonwealth Serum Laboratories Commission are to produce and sell such biological products of a kind used for theurapeutic purposes as are prescribed, and undertake research in connection with any such prescribed product, and to carry out any other research determined by the minister for Health.

Australian Institute of Marine Science (AIMS)

The Australian Institute of Marine Science (AIMS) is mainly concerned with multi-disciplinary research projects focussed on tropical marine sciences. AIMS research projects fall into four main areas: marine food webs, reef-building organisms and coral reefs, tropical oceanography, and marine pollution. Specific programmes undertaken by the Institute cover inshore productivity, plankton behaviour, ultraplankton, coral taxonomy, coral calcification, reef diagenesis, oceanographic mixing processes as related to recycling and budgets of plant nutrients, and pollution studies of trace metals.

Federal Government Departments

In addition to the major statutory bodies a number of Federal Government Departments undertake significant research. Typical of these are the Department of Science and Technology (meteorology and Antarctic research), the Department of National Development and Energy (Bureau of Mineral Resources, Geology and Geophysics), the Department of Health and the Department of Defence.

State Government Departments

A number of Departments in the various States Governments conduct research work in their own research institutes and research stations. Their work is more applied in nature and concerns areas for which the States have prime responsibility e.g. agriculture, soil conservation, and fisheries, etc.

Universities and Colleges of Advanced Education

There are 19 Australian universities. All are autonomous bodies established under Act of the various State Parliaments – except for the Australian National University, which is established under a Federal Act. They are controlled by their own governing bodies but are almost completely dependent on Federal Government financing for their operations. The universities submit proposals for their development to the Universities Council, which in turn reports to the Tertiary Education Commission (TEC). The TEC, after consultation with the States and appropriate authorities advises the Federal Government on the financial needs of the universities, colleges of advanced education and the technical and further education colleges, and on the overall balanced development of the Australian post-secondary system. Research in science and technology is carried out in all universities as part of the normal duties of the academic staff.

Colleges of advanced education (CAEs) were first established following the 1965 Report of a Committee on the Future of Tertiary Education in Australia. Some 35 former Institutes of technology, technical colleges, and other specialist tertiary institutions then became tertiary level colleges of advanced education. With the establishment of a number of new institutions and the inclusion, in 1973, of 32 former State Teachers and pre-school teacher training colleges, there are now over 80 such colleges. The colleges have a strong vocational and applied orientation. They are often active in fields not covered by universities in the same State and thus complement the activities of the universities. The needs of the CAEs are assessed by the Advanced Education Council, which, like the Universities Council, reports to the TEC. Research in science and technology in many of the CAEs is limited and usually oriented to local regional problems and interests.

Research Organisations Associated with Higher Education Institutions

Several of the tertiary education institutions have established independent commercial companies to promote and manage research and consultancy services to industry, commerce, government and the community. Examples are:

Unisearch Ltd, associated with the University of New South Wales;

Wait-Aid Ltd, associated with the Western Australian Institute of Technology;

Technisearch Ltd, associated with the Royal Melbourne Institute of Technology;

SARDD, associated with the Swinburne College of Technology;

Techsearch Inc. , associated with the South Australian Institute of Technology;

TUNRA Ltd. , the University of Newcastle's research associations and

INSEARCH, associated with the New South Wales Institute of Technology.

These organisations play an important role in promoting and facilitating communication between the higher education and other sectors. They undertake investigational and research projects in the fields of science and engineering and increasingly in management and marketing. Results are confidential to the client and are published only with the consent of the client.

Research Associations

A feature of industrial research is the group of research organisations known as Research Associations. An Association is owned by the companies who cooperated to establish it to conduct research in their particular industry. Research Associations are non-profit companies financed partly by industry and partly by government. Currently the Federal Government, through CSIRO, supports 4 out of a total of 14 Research Associations. These are the Bread Research Institute of Australia, the Brick Development Research Institute, the Sugar Research Institute, and the Australian Welding Research Association. Following its consideration of the Report of the Committee of Inquiry into Technological change in Australia (CITCA), the Federal Government has agreed to support the establishment of new research associations. In addition, CSIRO contributes to the running of the Australian Wine Research Institute. Associations not financially supported directly by CSIRO include the Australian Minerals Industry Research Association, the Australian Engineering and Building Industries Research Association, and the Australian Coal Industry Research Laboratories Ltd. As well as those organisations which involve some form of Government assistance, there are others which are totally industry-financed and staffed. These include the following organisation:

The Australian Industrial Research Group (AIRG)

The Australian Industrial Research Group (AIRG) is an association of research and development managers employed in Australian industry. It represents some 3 000 full-time professional researchers, who are backed by another 8 000 (approximately) people in development and technical services. AIRG aims to improve the quality of research management in Australia and to stimulate and develop an understanding of research as a force in economic, industrial and social activities.

Private Non-Profit Institutes

Private non-profit institutes include those trusts, foundations, institutes and other organisations which do not have the financial welfare of industry as their objective and are not Government agencies. Expenditures by private non-profit organisations comprises less than 1% of the gross national expenditure on research and development and is concentrated in the biological and medical sciences. Some of the main organisations are:

the Walter and Eliza Hall Institute of Medical Research, Melbourne;
the Australian Council for Educational Research (ACER), Melbourne;
the Howard Florey Institute of Experimental Physiology and Medicine, Melbourne;
the Ludwig Institute for Cancer Research, Sydney;
the Royal Children's Hospital Research Foundation;
the Red Cross Blood Transfusion Services;
Institute of Medical and Veterinary Sciences, Adelaide;
Victorian Institute of Marine Sciences (VIMS); and
Waite Agricultural Research Institute, Adelaide.

National and Regional Facilities

Australia has a number of regional and national facilities which are used by workers from various institutions both within Australia and overseas. Examples include the Australian Institute of Nuclear Science and Engineering (AINSE) through which researchers can have access to the Australian Atomic Energy Commission's Research Establishment at Lucas Heights in N.S.W. ; the Anglo-Australian Telescope at the Siding Spring Observatory, near Coonabarabran in N.S.W.; the Parkes Radio Observatory at Parkes, N.S.W.; and the National Nuclear Magnetic Resonance Centre at the Australian National University in Canberra. These facilities are all expensive and are run to ensure the best use by the scientific community.

3.2 HUMAN RESOURCES

A country's ability to use science and technology for its own development depends to a large extent on the quantity and quality of the trained manpower it makes available for research and new technology. Australian expenditure and manpower allocated to research and development for the rural, manufacturing, mining, and tertiary industries gives some indication of the scientific and technological resources it can put to the service of both national and overseas development.

Australian universities, colleges of advanced education and various institutions providing post-secondary technical education are the principal sources of scientific and technical manpower within the country.

A comprehensive survey of manpower in Australia was made in conjunction with the 1976 national census. This showed that scientific and technical personnel accounted for 2.8% of the workforce.

In 1976, 6.3% of the Australian population held a post-secondary qualification. The educational attainment of the population in 1976 not including that at the trade level, is shown as follows:

Field	Degrees of Equivalent	Diploma	Technical Level Qualifications
Social Sciences	60,365	63,380	89,256
Natural Sciences	40,696	5,877	7,068
Medical Sciences	38,932	21,413	179,669
Engineering, Architecture and Technology	35,795	25,763	123,753
Agricultural Sciences	8,730	7,223	14,450
Sub-total Science and Engineering	184,518	123,656	414,196
Humanities[1]	78,238	200,323	11,281
Not Specified	7,236	833	3,650
Total	269,992	324,812	429,127

[1] Includes Teacher Training, Fine Applied Arts, and Religion.

Current figures for the migration of people with scientific and technical qualifications are not available, although the number has increased since 1973. In 1973 there were 8 170 permanent immigrants in this category, but only 4 206 permanent departures. For the six years 1968 to 1973, the net gain was 36 162 people. It has not been possible in Australia to quantify the extent to emigration of highly qualified personnel. Many research scientists take up scholarships or posts overseas as part of their career development then return eventually to posts in Australia. Universities have sabbatical leave arrangements for their academic staff.

Broad features of research and development (R&D) manpower effort are illustrated as follows:

Broad Features of R&D Manpower Distribution 1976-1977

(a) Distribution of manpower involved in gross expenditure on research and development (GERD) by sector

	Man-years	% of R&D Manpower	% of Australian Workforce
Higher Education	15,290	35	0.24
Commonwealth Government	12,982	30	0.20
Private Enterprise	7,895	18	0.12
State Government	6,829	16	0.11
Private Non-Profit	579	1	0.01
Totals	43,575	100	0.69

(b) Type of manpower distribution

Researcher		52%
Other than research students	38%	
Research students	14%	
Technician		29%
Other		19%
		100%

Table 2 of this Report summarises the current state and trends of human resources in science and technology. Education in Australia experienced strong growth over the 20 years to 1977, in a number of ways. The proportions of students continuing their education beyond the non-compulsory stage has grown strongly, as did the percentages of population in the 17-22 age group who enrolled at universities and colleges of advanced education. At the same time, the proportion of the population in this age group grew steadily as a result of demographic trends since World War II. All these trends led to strong growth in tertiary education over the period, with the number of universities, for example, increasing from 9 to 19, and public expenditure on universities increasing from $73 million in 1961-62 to $727 million in 1978-79. In 1978-79, colleges of advanced education received $497 million and technical and further education institutions received $496 million. Since 1977, however, the retention rates in the final years of secondary school are levelling out, and population projections suggest that tertiary education will see low growth rates from 1981 to 1986, and a decline in enrolments from 1991 to 1996.

There is no national plan to train particular numbers of scientists and technologists. The quality and relevance of training of scientists and technologists in Australia is internationally well-regarded and an adequate number of Ph. D. students is being trained in Australia to meet Australian science and technology research and development needs.

CSIRO and the universities provide a well-based career development for research scientists in Australia. The interests of research scientists and other scientists and technologists are generally protected by their staff associations (unions). Scientists and technologists employed in the Public Services of the Federal and State Governments have their own staff associations.

3.3 FINANCIAL RESOURCES

Australia does not have a central science coordinating body nor is there a single budgetary channel for funds in support of research and development. Such funds are obtained individually by a wide range of Commonwealths State, higher education and private bodies from Commonwealth and State Governments, the business enterprise sector and private bodies and persons. Within the Government sphere, expenditure on particular science or technology based services, such as meteorology and communications, is known. But the same is not true for all such services. In private industry, data on non-research and development scientific and technological activities are harder to obtain.

Higher Education

Although the States are responsible for tertiary education within their own boundaries, financial support is now provided mainly by the Federal Government. The Federal Government provides 95% of the higher education sector's funds for research and development. Total research and development expenditure in the higher education sector represents 25% of gross expenditure on research and development (1976-77). The major portion (64%) of research and development performed in the higher education sector is directed to the advancement of knowledge. The remainder is devoted primarily to research and development in health, agriculture, economic services, manufacturing and education.

Federal Government support for higher education is provided mainly through the Councils of the Tertiary Education Commission – the Universities Council (UC), the Technical and Further Education Council (TAFEC), and the Advanced Education Council (AEC). In 1976, intramural expenditure on research and development by universities (including an imputed fraction of teaching and research activities) was 31% of all university expenditure. In addition, a small but growing amount of research and development was performed in colleges of advanced education. Basic research accounted for most (66%) of this effort in the higher education sector with the balance of the effort largely being applied research. The natural sciences accounted for 71% of total expenditure.

University research is financed from four main sources: general recurrent funds recommended by the Universities Council, special grants for research recommended by the Council, grants from other Government sources, and grants, contracts and donations from private sources. The main granting schemes for research and development in higher education are administered by the:

Australian Wool Corporation (AWC);
Australian Research Grants Committee (ARGC);
National Health and Medical Research Council (NH&MRC);
National Energy Research , Development and Demonstration Council (NERDCC);
Australian Meat Research Committee (AMRC);
Wheat Industry Research Council (WIRC);
Department of Aboriginal Affairs (DAA) grants;
Water Research Fund (WRF);
Australian Marine Sciences and Technologies Advisory Council Funding Advisory Panel (AMSTAC-FAP).

The four principal granting schemes providing support for university research are those administered by the Australian Research Grants Committee (ARGC), the National Health and Medical Research Council (NH & MRC), the National Energy Research, Development and Demonstration Council (NERDCC), and the Australian Marine Sciences and Technologies Advisory Council-Funding Advisory Panel (AMSTAC-FAP). The ARGC assess proposals in the natural sciences, the social sciences and the humanities. The prime criterion for support is the excellence of the proposal.

Federal Government funds are sometimes supplemented by State Governments or by funds from levies on specific industry (for example, the wool, wheat, and beef and sheep meat industries) for that purpose. Fellowships and similar awards, while providing some additional funds, are more significant for their prestige than for their contribution to overall funding levels. For example, ten Queen Elizabeth II Fellowships and five Queen's Fellowships in Marine Science are usually awarded annually.

Rural research

A considerable part of Australia's research and development effort is in the rural sector. Research in this sector is based on complex inter-relationships, formal and informal, between State and Federal Government departments and agencies, inter-governmental committees, funding bodies, the higher education institutions, and private industry. Over 85% of expenditure is provided, approximately equally, by State and Federal Governments. The major performer of rural research in the federal sphere is CSIRO. State Governments are also important performers of research through their departments of agriculture and forest services.

Rural Industry Research Funds (RIRFs) are a feature of Australian rural industry. Thirteen statutory and a number of non-statutory Funds have been established by agreements within each industry. The levies contributed by industry members are matched by the Federal Government. Thus, producers contributed about half of the funds allocated for research by the RIFs in 1973-74 (16% of the total allocations to research agencies). The allocation of funds is recommended by committees comprising representatives from rural industry, CSIRO, Department of Primary Industry, universities and nominees of the Australian Agricultural Council. The allocations are formally ratified by the Federal Minister for Primary Industry. The Commonwealth Council for Rural Research and Extension (CCRRE) was established in August 1978 to advise the Federal Minister for Primary Industry on the entire range of rural research and extension being undertaken in Australia and on the relationship of this research to the role of agriculture in the Australian economy.

Industrial research and development

As stated earlier in this report (see 2.2), the Government's industrial research and development (IR&D) policy is implemented principally through the Industrial Research and Development Incentives Act. Funding of the Industrial Research and Development Scheme in the 1981/82 budget was $A49.0 million. The Act provides for three types of incentives – commencement grants, project grants and "public interest" projects.

Commencement grants ($A10.5 million in 1981/82) are designed to encourage companies to establish a R&D capability:

the grants are payable up to a maximum of $A40 000 (taxable) per grant year or

50% of a company's eligible expenditure, whichever is smaller.

Project grants ($A32.7 million in 1981/82) are selective and designed to provide on-going support to companies with established industrial R&D facilities:

project grants agreements ire for periods normally not exceeding five years

payments are limited to 50% of eligible expenditure by the project with a ceiling limit of $A750 000 (taxable) per annum.

Public interest projects ($A6.0 million in 1981/82) are funded under Section 39 of the Act:

this work is approved by the Minister for Science and Technology and is contracted out to private industry through the IR&D Incentives Board. There are no ceiling limits and the Commonwealth provides 100% funding of Section 39 contracts.

Other initiatives taken by the Government include increasing the proportion of Government R&D contracted out to industry and increasing its support for new and existing research associations. The Government also provides support for Pilot Programmes ($A0.7 million in 1981/82) designed to provide practical experience in technology transfer and the encouragement of innovation. Under the latter heading, support is provided to assist individual inventors/technology-based small enterprises to gain access to the full spectrum of services, facilities and finance required to take inventions or developments through to the market place.

Overall expenditure

Gross expenditure on research and development (GERD) in 1976-77 (most recent available figures) was $A802 million, or 1% of gross domestic product. GERD was distributed in the following ways:

by sector of performance

Commonwealth Government	40%
Higher Education	23%
Private Enterprise	20%
State Government	16%
Private Non-profit	1%

to natural sciences 90%, to social sciences 10%

to basic research 30%, to applied research 45%, to experimental development 25%

to end use or purpose excluding private enterprise

economic development	58%
advancement of knowledge	21%
defence	11%
community welfare	10%

Trends in GERD between 1973-74 and 1976-77 (most recent surveys) have been:

total GERD fell by about 12% (in real terms);

research and development (R&D) expenditure in Federal Government, and in higher education, has stayed about constant; State Government R&D expenditure rose 16%; and private enterprise expenditure on R&D fell 45% (all in real terms).

Federal Government research expenditure

Federal Government research is conducted mainly in a few, principal R&D agencies, chiefly the CSIRO ($A192.6 million in Australian financial year 1979-80 on agricultural, environmental and industrial research), the Defence Science and Technology Organisation ($A101 million in 1979-80 on defence science and engineering), the Australian Atomic Energy Commission ($A14 million out of total budget of $A26 million in 1979-80 on atomic energy and nuclear science and technology) and Telecom Australia ($A27 million in 1979-80 on telecommunications).

Higher education R&D is conducted principally in the universities where intramural expenditure on R&D including a fraction of teaching and research activities represented 31% of total university expenditure. State Government R&D is devoted substantially to primary industry (two-thirds of all State Government R&D effort). R&D in private enterprise is concentrated (77%) in manufacturing industry, with machinery and equipment, chemicals, petroleum and coal products, and basic metal products dominating. Table 3 summarises R&D expenditures.

3.4 SURVEYING OF THE SCIENCE AND TECHNOLOGY POTENTIAL

Institutional and organisational arrangements have been made for the collection and analysis of numerical data and other information on the resources available for the national science and technology effort.

Science indicators

Project SCORE (Survey and Comparisons of Research Expenditures) measures the financial and manpower resources devoted to Australian research and experimental development. Four Project SCORE surveys have been undertaken. These were for the financial years 1968-69, 1973-74, 1976-77 and 1978-79. The 1978-79 survey has not yet been published. The survey is now being conducted triennially. Studies are being made to determine the feasibility of developing suitable output indicators in key areas of the national scientific and technological endeavour.

Research Directory

An Australian Research Directory was produced in January 1979 on microfiche by the then Department of Science and the Environment in collaboration with CSIRO following suggestions by the Australian Industries Research Group on ways of improving communications among individual scientists and between scientists and the rest of the community. It was based on information collected during the 1976-77 Project SCORE survey. The directory listed 13 000 research projects in the natural and selected social sciences and included details of research projects, the names of project leaders, departmental objectives and specialised facilities in universities and colleges of advanced education.

Science Statement

A first Science Statement was prepared by the then Department of Science and the Environment in accordance with the stated government policy of advising Parliament on trends in research and development. It was published in April 1980 and was a post-Budget analysis. It was the first attempt to bring together a consolidated statement of Federal Government funding of R&D.

Following a Government decision to produce the Statement annually, the second report in the series was retitled Science and Technology Statement to represent its coverage more accurately, and to take proper account of the association between science and technology in government policy machinery. The Science and Technology Statement 1980-81 describes, at the broad programme expenditure level, the resources devoted by the Australian Government to R&D in the financial years 1978-79 to 1980-81, and to a wider range of S&T activities in 1979-80 and 1980-81.

PART 4

Policy issues in scientific and technological development

4.1 MAJOR DEVELOPMENTS

Developments which have occurred in Australia over the past 10 years and which have had or are expected to have a major impact on the conduct of research, on the increase of the national science and technology capacity and on conditions in which science and technology are applied, are listed below. The developments include the establishment of:

- the Ministry of Science (now Science and Technology) (1972);
- the Australian Institute of Marine Science, near Townsville, Queensland (1972);
- the Australian Biological Resources Study (1973) conducted by the Bureau of Flora and Fauna of the Department of Home Affairs and Environment;
- the Great Barrier Reef Marine Park Authority (1975);
- the National Nuclear Magnetic Resonance Spectrometer Centre in Canberra (1975);
- the Australian Academy of Technological Sciences (1976);
- the Department of Productivity 1976 (disbanded and amalgamated in part with the science elements of the then Department of Science and the Environment to form the Department of Science and Technology in November 1980);
- the Australian Science and Technology Council (ASTEC) (1977);
- the New South Wales Science and Technology Council (1977);
- Australian LANDSAT receiving facilities (1977 to 1980);
- Commonwealth R&D funding through the National Energy Research, Development and Demonstration Council (NERDDC) (1978);
- Commonwealth R&D funding through the Australian Marine Sciences and Technologies Council (AMSTAC).

Other major developments have been:

- the Report of the Committee of Inquiry into the CSIRO and the adoption of its recommendations by the Government and CSIRO (1977 to 1980);
- the commissioning of the Anglo-Australian Observatory in New South Wales (1975);
- the entering by Australia into science and technology Agreements with the USSR (1975 – suspended following Soviet intervention in Afghanistan), India (1975), the Federal Republic of Germany (1976), the People's Republic of China (1980), Japan (1980), and Mexico (1981) in addition to that with the USA (1968);
- metric conversion of weights and measures in Australia (1970 to 1980);
- the OECD review of Australian scientific and technological activities (1974);
- the Senate Standing Committee on Science and the Environment Report of Inquiry into Industrial R&D (1979);
- the Report of the Committee of Inquiry into Technological Change in Australia (1980);
- the review of the Industrial Research and Development Act (1980/81).

A number of other recent inquiries are expected to have a significant influence on research and development in Australia. These include the inquiries into the research activities and capacity of the Australian Atomic Energy Commission (AAEC), and into the Bureau of Mineral Resources, Geology and Geophysics (BMR) and the Bureau of Meteorology.

4.2 ACHIEVEMENTS AND PROBLEMS

Recent achievements in developing the science and technology capacity of Australia have been outlined in Section 4.1 above. Considerable progress has been made in recent years towards the development of a satisfactory scientific infrastructure and a highly capable scientific workforce but there is much to be achieved. The major problem in further developing Australian science and technology is the need improve coordination of the national scientific effort and to improve and expand links between the national scientific effort and national development.

The problem is compounded by the absence of specifically defined goals for national development, although in 1981 the Australian Science and Technology Council (ASTEC) produced a report on Basic Research and National Objectives. There is a need to use more fully expertise within the universities in industrial research and development. Although there was a fall in industrial research and development during the 1970's it is hoped that this trend will be reversed by recent initiatives described in "Industrial research and development " (section 3.3).

Efforts are being made to more clearly identify and coordinate, at least at the Federal Government level, the nature and extent of the research effort. Improved coordination in science and technology has occured in recent years as a result of the effective operation of advisory councils and committees, such as ASTEC and NEAC, which report to the Federal Government and Federal-State Ministeral Councils and Committees (listed in Section 2.1 of this report).

4.3 OBJECTIVES AND PRIORITIES

Major science and technology policy objectives and priorities for Australia have been identified by ASTEC and advised to the Federal Government in its Report "Science and Technology in Australia 1977-78". The report reviewed the Australian science and technology scene in depth and on the basis of that review made recommendations to the federal Government on a wide range of issues such as ways of strengthening and improving industrial research and development, marine sciences and technologies, information transfer, science and technology in tertiary education, health research, agricultural research and international cooperation.

The Federal Government is progressively considering the ASTEC recommendations and has implemented many of them including most of the high priority ones which generally cover fields of industrial research and development, marine science and basic research. There is not however any single national science and technology development plan laying down objectives, time-table and priorities in precise terms. Australia tends to adopt a flexible approach to the development of its scientific and technological capability. As mentioned above, however ASTEC has recently investigated the relationship between basic research and national objectives, and has identified Australian objectives to which basic research can contribute. These include a wide range of both socio-economic and cultural objectives.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

Australia's main channels at Federal Government level for scientific and technological cooperation with other countries are:

bilateral agreements for scientific and technological cooperation;

science liaison offices;

scientific and technological aspects ot the Australian development assistance programme;

agreements and arrangements in specific fields;

multilateral cooperation arising from membership of international organisations - governmental and non-governmental;

ad-hoc exchange of scientific information between Governments and between Government research bodies and their counterparts overseas; and

bilateral cultural agreements containing provisions for scientific and technological cooperation.

Bilateral science and technology agreements

National policy for cooperation in science and technology involves foreign policy considerations as well as scientific and technological considerations. Proposals for new bilateral cooperative arrangements in science and technology are evaluated against a number of criteria including the scientific capability of the prospective partner. As a general rule, Australian policy is to enter into bilateral science and technology arrangements where it is clear that there will be mutual benefit resulting from the ensuing cooperation.

Major cooperative programmes are conducted under bilateral science and technology Agreements which are as follows:

the U.S./Australia Agreement for Scientific and Technical Cooperation;

the India/Australia Science and Technology Agreement;

the Federal Republic of Germany (FRG)/Australia Science and Technology Agreement;

the Japan/Australia Science and Technology Agreement;

the U.S.S.R./Australia Agreement on Scientific and Technical Cooperation, unilaterally suspended by the Federal Government early in 1980;

the China/Australia Science and Technology Agreement;

the Mexico/Australia Science and Technology Agreement.

These are administered on the Australian side by the Department of Science and Technology. The Australian Government also provides financial assistance for the agreements between the Australian Academy of Science and the Australian Academy of Technological Science with Academia Sinica, China.

All seven agreements are "umbrella" agreements which means they contain provision to include sub-arrangements or "memoranda of understandings" in specific fileds between agencies of Australia and the other country concerned. A number of these sub-arrangements exist and they include:

U.S./Australia Agreement

Memorandum of Understanding between the Australian Department of Science and Technology and the United States National Aeronautics and Space Administration (NASA) relating to the establishment and operation of a LANDSAT station in Australia.

Memorandum of Understanding between CSIRO and the United States Office of Water Resources Research, Department of the Interior of Water Resources Research, Department of the Interior for the exchange of water resources – related technical information.

India/Australia Agreement

An arrangement for a specific agricultural research programme between the Indian Council for Agricultural Research and the Australian Department of Science and Technology.

FRG/Australia Agreement

A memorandum of understanding on coal liquefaction pilot studies involving the FRG Ministry for Research and Technology and an FRG industrial consortiom with, on the Australian side, the Federal Department of National Development and Energy and the State Governments of New South Wales, Queensland and Victoria.

Science liaison offices

Science liaison offices are located within Australian diplomatic missions and are staffed by science attachés or counsellors with diplomatic accreditation. At present, science liaison offices are located in London, Tokyo and Washington. Australia maintains a science and environment counsellor at its permanent OECD delegation in Paris and atomic energy counsellors in Vienna, London, Tokyo and Washington. The role of the scientific counsellors includes: the collection and dissemination of scientific and technological information, representation at conferences, arranging meetings and hospitality on behalf of visiting scientists, providing advice to Australian diplomatic missions on questions involving science and technology, and acting as an agent for Australian science and technology organisations.

Australian development assistance policies

In 1980-81, Australia's net overall official development assistance was estimated at $A547.86 million representing 0.42% of Gross National Product. Papua New Guinea in particular remains the central focus of Australia's development assistance receiving approximately 48% of the total aid budget. The balance is directed towards ASEAN member countries, the nations of the South Pacific, countries in South Asia, East Africa and the Island States of the Indian Ocean.

Australian Development Assistance Bureau (ADAB)

The Australian Development Assistance Bureau (ADAB) initiated a progamme in 1979 known as the Australian Science, Technology and Research Cooperation (AUSTREC) Programme which was intended to strengthen and draw together within a coordinated framework, the range of existing aid activities (including those in the training, bilateral and multilateral areas) and new aid initiatives in the science and technology area. The UASTREC programme is designed to make Australia's science and technology efforts more effective without requiring the establishment of costly new institutional arrangements in Australia.

The Consultative Committee on Research for Development (CCRD) was established by the Minister for Foreign Affairs in November 1977 to assist ADAB to indentify and make specific recommendations concerning research and research-related projects, institutions and programmes which benefit developing countries and which might be assisted under Australia's aid programme.

Australian Universities International Development Programme (AUIDP), formerly known as Australian Asian Universities Cooperation Scheme (AAUCS)

Through the Australian Vice-Chancellors's Committee, Australian universities are collaborating with selected universities in Indonesia, Malaysia and Singapore with the assistance of other Australian tertiary institutions, Government Departments and the private sector. The Australian Universities International Development Programme (AUIDP) is funded by ADAB and receives contributions in kind from Australian and Asian universities. The Scheme, which began in 1969, has been growing steadily and in 1980-81 had an annual budget of $A1.2 million. Over two hundred Australian academics have participated in the Scheme.

AUIDP programmes are directed towards assisting associated universities with staff development programmes in associated universities overseas. In Indonesia, assistance comprises training course, visiting assignments and the secondment of Australian staff in a number of disciplines. In Malaysia and Singapore, the emphasis is on faculty development. In all three countries, direct Australian participation in development is supported by a comprehensive post-graduate fellowship programme.

CSIRO Centre for International Research Cooperation

The Centre for International Research Cooperation (CIRC) was established with CSIRO in mid-1978 to :

provide an identifiable focal point for CSIRO support for research cooperation in developing countries;

be responsible for planning and evaluating CSIRO's contribution to the science and technology component of Australia's assistance to those countries;

encourage, in collaboration with Directors of CSIRO Institutes and Chiefs of CSIRO Divisions, the efficient deployment of CSIRO resources for this purpose.

Most of the assistance projects for developing countries, in which CSIRO becomes involved, contain a strong research component or require specialist advice from CSIRO scientists. In addition, a number of CSIRO Divisions and laboratories provide training for scientists and technical officers from developing countries. With only a small core staff, the role of the CIRC is essentially one of coordination. Once projects have been established, the Centre is concerned mainly with general liaison and policy matters, while the day-to-day management of the projects is left to the Divisions concerned.

Agricultural exchanges

The Federal Department of Primary Industry is responsible for a programme of agricultural exchanges with other countries. The objective of the programme is to foster a mutually beneficial exchange of information and expertise in the application of technology to a wide range of agricultural and forestry activities. To date exchanges have only been conducted with the People's Republic of China with three missions to China from Australia and six missions to Australia from China having occurred since mid 1978. A number of missions are planned for the future.

A significant component in the planning of any particular exchange is the provision made for promoting up to date information on the latest technical and scientific advances in the area of agricultural activity of most interest to a particular mission. This is done through provision of translated copies of any background documents, through visits to Departments, research stations, experimental farms or education institutions, and through round table discussions.

Multilateral cooperation

Australia participates in the science and technology activities of the UN and its agencies. Australian experts and consultants contribute to international science and technology programmes conducted by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Food and Agricultural Organization (FAO), the World Health Organization (WHO), the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) and the Economic and Social Commission for Asia and the Pacific (ESCAP). It is also a member of the Association for Science Cooperation in Asia (ASCA) and is active in the science and technology activities of the Organization for Economic Cooperation and Development (OECD) of which Australia is a member.

Australia has a number of bilateral and multilateral development assistance programmes as mentioned above. Australia, through the Australian Academy of Science, is a member of the 19 unions of the International Council of Scientific Unions (ISCU).

PART 5.

Bibliography

Sources used in the preparation of this report include the following:

ASTEC. *The Australian Context for Science and Technology*. Canberra, 1980.

Australian National Paper for the United Nations Conference on Science and Technology for Development (1979). Australian Government Publishing Service, Canberra, 1979.

Department of Science and the Environment, *Australia: Country Report for Seventh ASCA Meeting,* Canberra, 1979.

Australia Handbook (1979-80). Australian Government Publishing Service, Canberra, 1980.

O.E.C.D., *Review of National Science Policy: Australia.* Paris, 1977.

ASTEC. *Science and Technology in Australia (1977-78).* (Volumes 1A, 1B, and 2). Australian Government Publishing Service, Canberra, 1978/79.

Australian Government Directory (1980). Australian Government Publishing Service, Canberra, 1980.

Science Statement (1979-80). Australian Government Publishing Service, Canberra, 1980.

Department of Productivity Annual Report (1978-79). Australian Government Publishing Service, Canberra, 1979.

CSIRO *Annual Report (1978-79).*

Project SCORE 1976-77: All Sector Results. Australian Governement Publishing Service, Canberra, 1980.

Department of Science and the Environment. *Annual Report (1978-79).* Australian Government Publishing Service, Canberra, 1979.

Australia's Overseas Development Assistance Program (1980-81). Budget Paper No. 8, Australian Government Publishing Service, Canberra, 1980.

Australian Bureau of Statistics (ABS) *Australian National Accounts (1978-79).* (ABS cat. No. 5204.0).

ABS. *Foreign Control in Manufacturing Industry, Study of Large Enterprises,* 1975-76 (ABS Cat. No. 5315.0).

ABS. *Exports and Imports of merchandise at Constant Prices, Australia* (Various issues) (ABS Cat. No. 5421.0).

ABS. *The Labour Force.* (ABS Cat. Nos. 6302.0 - 6204.0).

ABS. *Consumer Price Index, Quarterly* (various Issues) (ABS Cat. No. 6401.0).

ABS. *Value of Agricultural Commodities Produced in Australia* (1978-79). (ABS Cat. No. 7503.0).

ABS. *Manufacturing Establishments: Details of Operations, by Industry Class, Australia, 1978-79* (ABS Cat. No. 8203.0).

ABS. *Censuses of Manufacturing, Electricity and Gas Establishments, Industry Concentration Statistics Australia, 1977-78.* (ABS Cat. No. 8297.0).

Year Book, Australia, No. 64, 1980. Australian Bureau of Statistics.

Annex

LIST OF ABBREVIATIONS USED IN REPORT

AAEC	Australian Atomic Energy Commission
AAUCS	Australian-Asian Universities Co-operation Scheme
ACER	Australian Council for Educational Research
ADAB	Australian Development Assistance Bureau
ADL	Australian Development Laboratories
AEC	Advanced Education Council
AICL	Australian Innovation Corporation Limited
AIMS	Australian Institute of Marine Science
AINSE	Australian Institute of Nuclear Science and Engineering
AIRDIB	Australian Industrial Research and Development Incentives Board
AIRG	Australian Industrial Research Group
ALCORSS	Australian Liaison Committee on Remote Sensing by Satellite
AMC	Australian Manufacturing Council
AMRC	Australian Meat Research Committee
AMSTAC	Australian Marine Sciences and Technologies Advisory Council
AMSTAC-FAP	Australian Marine Sciences and Technologies Advisory Council - Funding Advisory Panel
ANHUL	Australian National Humanities Library
ANSOL	Australian National Social Sciences Library
ANSTEL	Australian National Science and Technology Library
ANZAAS	Australian and New Zealand Association for the Advancement of Science
ARGC	Australian Research Grants Committee
ARPAC	Antartic Research Policy Advisory Committee
ASCA	Association for Science Co-operation in Asia
ASEAN	Association of Southeast Asian Nations
ASTEC	Australian Science and Technology Council
AUSTREC	Australian Science, Technology and Research Co-operation
AWC	Australian Wool Corporation
BMR	Bureau of Mineral Resources, Geology and Geophysics
CAE's	Colleges of Advanced Education
CCRD	Consultative Committee on Research and Development
CIRC	Centre for International Research Co-operation
CPI	Consumer Price Index
CSIRO	Commonwealth Scientific and Industrial Research Organization
DAA	Department of Aboriginal Affairs
ESCAP	Economic and Social Commission for Asia and the Pacific
FAO	Food and Agricultural Organization
FRG	Federal Republic of Germany
GERD	Gross Expenditure on Research and Development
DGP	Gross Domestic Product
ICI	Imperial Chemical Industries
ICSU	International Council of Scientific Unions
IOC	Intergovernmental Oceanographic Commission
IR&D	Industrial Research and Development
LANDSAT	An Earth-sensing satellite launched and operated by NASA
MPC	Meteorology Policy Committee
NASA	National Aeronautics and Space Administration (of the U. S. Government)
NEAC	National Energy Advisory Committee
NERDDC	National Energy Research, Development and Demonstration Council
NH&MRC	National Health and Medical Research Council
NLA	National Library of Australia
NSW	New South Wales
OECD	Organization for Economic Co-operation and Development
RACI	Royal Australian Chemical Institute
R&D	Research and Development
RIRF	Rural Industrial Research Fund
SARDD	Swinburne Applied Research and Development Division
SCORE	Survey and Comparisons of Research Expenditures
S&T	Science and Technology
TAFEC	Technical and Further Education Council
TEC	Tertiary Education Commission
TUNRA	The University of Newcastle's Research Associates Limited
UC	Universities Council
UNESCO	United Nations Educational, Scientific and Cultural Organization
VIMS	Victorian Institute of Marine Sciences
WHO	World Health Organization
WIRC	Wheat Industry Research Council
WMO	World Meteorological Organization
WRF	Water Research Fund

BANGLADESH

Table of Contents

BANGLADESH

GEOGRAPHY

Capital city: Dacca
Main ports: Chittagong, Chalna
Land surface area: 143,998 sq km

POPULATION (1978)

Total	84.7 million
Density (per sq km)	588
Urban/rural ratio (1974)	0.1
Average rate of growth (1970-78)	2.8%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	46.0	10.9	9.0	29.9	4.3	100%

SOCIO-ECONOMIC

Labour force (1974)	
Total	20.5 million
Percentage in agriculture	77.1%
Gross national product (1978)	
GNP at market prices	US $7,280 million
GNP per capita	US $90
Real growth rate of GNP per capita (1970-78)	0.2%
Gross domestic product	
Total (in current producers' values)	US $7,671 million
Percentage by origin	
Agriculture	54%
Manufacturing, mining & quarrying, electricity, gas & water, construction	13%
Government finance	
National budget (1978)	...
As percentage of GNP	...
External assistance (official, net: 1976)	US $534 million
As percentage of GNP	8.1%
Exports	
Total exports of goods (1978)	US $576 million
Average annual growth rate (1970-78)	— 4.7%
External debt (1978)	
Total public, outstanding + disbursed	US $2,798 million
Debt service ratio (% GNP)	1.3
(% Exports of goods and non-factor services)	11.7

Exchange rate (1978): US $1 = 15.00 Taka

EDUCATION

Primary and secondary education (1978)	
Enrolment, first level	8,312,011
As % of (5-9 years)	67%
Enrolment, second level	2,658,783[1]
As % of (10-14 years)	25%
Combined enrolment ratio (5-14 years)	47%
Average annual enrolment increase (1974-1978)	2.0%[1]

---

[1] Excluding teacher training at the second level

Higher education (third level) (1978)

Teaching staff, total	15,784	
Students and graduates by broad fields of study		
	Enrolment	Graduates
Social sciences and humanities	103,131	14,805
Natural sciences	31,585	4,296
Engineering	3,972	257
Medical sciences	8,335	1,078
Agriculture	2,656	558
Other and not specified	4,817	
Total	**154,496**	**20,994**
Number of students studying abroad:	1,818	

Education public expenditure (1978)

Total *(thousands of Taka)*	2,389,714
As % of GNP	2.2%
Current[2], as % of total	63.1%
Current expenditure for third level education[3], as % of total current expenditure	21.3%

---

[2] Relates to current expenditure of the Ministry of Education only

[3] Relates to expenditure of the Ministry of Education only and include expenditure for intermediate colleges and intermediate sections of degree colleges (grades XI and XII)

Table 1 - Nomenclature and networking of S& T organizations

I - First level - POLICY-MAKING

Country: Bangladesh

Organ	Function	Linkages		
		Upstream	Downstream	Major collateral
NCST (National Council of Science and Technology)	Control and coordination	President of the Republic	All sector organization, engaged in scientific & technological R&D action	Planning Commission/ Ministry of Finance

II - Second level - PROMOTION & FINANCING

Organization	Linkages		
	Upstream	Downstream	Others
Government	Government	Research Organization and Non-government Organization (NGO). Names of NGOs have been furnished in Annex 2	

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages	
		Upstream	Others
R&D Institutes under government, universities, research councils	R&D, STET, STS	Government	
Semi-government organizations etc.			

Table 2 - Scientific and technological manpower

Country: Bangladesh

Year	Population (millions) (b)	Scientists and engineers					Technicians	
		Total stock (thousands) (c)	Breakdown by field of educational training				Total stock (thousands)	of which working in RD
			Natural and Social sciences	Engineering and Technology	Agricultural sciences	Medical sciences		
1965								
1970								
1975								
1979 (a)	88.677	10,257	8,737	4.89	232	799		
1985	98.50	64,719	55,129	30.85	1,463	5,042		
1990	110.36	125,738	107,105	5,994	2,844	9,795		

(a) Estimate based on 1980 of Universities

(b) Projection of population is based on annual growth rate of 2.36 (1981 census)

(c) Total stock of scientists and technologists for the year 1980 has been compiled from the source of university's records. The output figure of 1980 has been considered as the 'base' for the projection of year to year production of scientists and engineers

Table 3 - R&D expenditures

Country: Bangladesh
Currency: Taka

Table 3a: Breakdown by source and sector of performance

Year: 1980

Unit: million

Sector of performance \ Source	National		Foreign	Total
	Government *funds*	Other *funds*		
Productive	7.333	—	3.070	10.403
Higher education	48.280	—	11.950	60.230
General service	51.790	—	24.014	75.804
Total	107.403	—	39.034	146.437

Table 3b: Trends

Year	Population (millions)	GNP (in million (a))	Total R&D expenditures (in million (a))	Exchange rate 1 US$ = Taka
1965	61.6	20,030	80.12	About Rs 4.00
1970	70.8	131,333	125.33	About Rs5.00
1975	78.96	101,393	456.27	Tk. 8.0992 (on 22.1.75)
1979	88.68	176,700	883.5	Tk.15.5209 (on 21.6.79)
1985	98.06	245,520	1,227.6	
1990	108.53	333,477	2,334.34	

(a) *Source:* Bangladesh Planning Commission
Note: GNP of 1979, 1985 & 1990 are at 1979 prices

PART 1.

General features

1.1. GEOPOLITICAL SETTING

Official Name

The official name of the country is the "People's Republic of Bangladesh".

Location

Bangladesh is located between 20°35' and 26°75' latitude north, and between 88°03 and 92°75 longitude east. It is bounded by India on three sides east, north and west. There is also a small boundary with Burma in the south-east. In the south lies the Bay of Bengal.

Area

The total land area of Bangladesh is 143 998 sq. km. with land surface area of 134 614 sq. km. and a water surface area of 9 884 sq. km. Bangladesh also has a territorial waters area of over 117 065 sq. km.

Population

On the basis of the 1981 census the population of the country is 89.94 million. The male and female share of the population is 51.52% and 48.48% respectively. The annual growth rate, based on 1981 census, is 2.36% of the total population. Density of population is 1 566 persons per square mile (including the river area) and 1 675 persons per square mile (excluding river area). Dacca is the capital of Bangladesh and its population is 3.45 million (1981 census).

Climate

The country generally enjoys a tropical monsoon climate. While there are six seasons in a year, three, namely winter, summer and monsoon, are prominent. Winter, which is quite pleasant, begins in November and ends in February. Although a minimum temperature of 36°F has been recorded, there is not usually such fluctuation from the daily minimum of about 45°F -55°F and daily maximum of 75°F-85°F. The hot and dry summer starts from March and lasts up to the end of May. The highest ever recorded temperature in summer is 116°F. The monsoon starts in June and lasts up to October. The average annual rainfall varies from 52 inches in Sibganj (Rajshahi) to 209 inches in Sunamgonj (Sylhet). The monsoon season accounts for 80% of the total annual rainfall. In the advancing monsoon period, the weather breaks with occasional nor'westers accompanied by thunderstorms, hail-storms and heavy rainfall. This is followed by occasional 'depressions' in the Bay of Bengal, and many of these develop into cyclonic storms.

Landform

Bangladesh, generally speaking is a flat deltaic plain formed of old and new alluvium. The areas of old alluvium are located high above the general level of the plain, while the areas of new alluvium lie in the flood plains of the rivers. As the whole country is intersected by a network of rivers, the areas covered by recent alluvium are very large. Almost 90% of the land area of the country is alluvium of recent and older origin. The plain lies almost at sea level in the south and rises gradually towards the north.

The south-western part of the country forms into a high moribund delta and the rivers flowing through it are either dead or dying. The south-eastern part of the delta is active and a number of rivers flow through it. The land is fertile , but saline water intrudes through the large estuaries which lie there. There is an extensive hilly area in the eastern border (Chittagong Hill Tract). The highest peak in the country of 3 454 feet is at the south-eastern extremity of the area. The north-eastern part is occupied by a large depression commonly known as 'Haor' and extends over a large area in the districts of Sylhet and Mymensingh. Depressions are also found elsewhere, caused by the changes of the river courses or by differential sedimentation. Low hills and hillocks border the plain in Sylhet district.

Being an alluvial formation the soils of the country are very fertile, but there are two major problems which restrict increases in the cropping intensity. These two problems are droughts in the dry season, and floods during the monsoon period.

Water Regime

A vast amount of water flows through Bangladesh. It is estimated that in an average year 870 million acrefeet (MAF) of water flows into the country from India and Nepal. The amount of rainfall received within the country is estimated at 203 MAF. Evaporation, evapotranspiration and deep percolation losses probably account for about 120 MAF. This means that about 953 MAF flow out to sea, 914 MAF through the Ganges-Brahmaputra delta within Bangladesh, and 39 MAF through the rivers of the Chittagong region and the eastern part of Noakhali. The rise and fall of the rivers is governed principally by the amount of rainfall in the Assam, Bhutan and Nepal Himalayas.

River System

The pride of Bangladesh is her waterways; the large network of rivers, streams and canals which total about 15 000 miles in length. The country is crisscrossed by the Padma (Ganges), Meghna, Jamuna (Brahmaputra), Tista, Karnaphuli, Sangu, and their innumerable tributaries and distributaries. The Ganges-Brahmaputra river system forms in the Bengal Basin a delta of about 25 00 square miles extent. In the south-western part of the country, the waterways are so plentiful that they form a veritable maze. The rivers are an important part of the physical environment of Bangladesh and play a very significant role in the life of its people. They provide cheap means of transport, serve as drainage channels, and ensure an abundant supply of fish.

Water Table

The water table is generally high over most of the country. The highest level varies from 2 to 6 feet below the surface in the delta areas. During dry months the water level goes down to 50 feet or more in the upland Barind tract. Over the greater part of the country, however, the water table remains between 4 and 10 feet.

Main Crops

Bangladesh is one of the most fertile tropical lands. Rice, jute, sugarcane, tabacco, oil seeds, tea, wheat, pulses and potatoes are the principal crops. Bangladesh is the largest jute producing country in the world. The jute is of superior quality and 70% of the export proceeds of the country are earned from raw jute and jute products. Among the fruits, bananas, pineapples, mangoes, jackfruits, guavas, plums and cocounut are important.

Flora and Fauna

The country produces sufficient quantities of quality timber, bamboos, and canes. Total forest area is roughly 16 % of the land area. About 4% of the land area is occupied by mangrove forest. The planting of rubber has been undertaken recently in the hilly regions and extraction of rubber has already started.

Wild animals are found in the forest area of the country. Of them, tigers, elephants, deer, monkeys, boars, bears, leopards and crocodiles are worth mentioning. About 900 species and sub-species of tropical birds are found in the country. Of them 200 are of seasonal and migratory types.

Fish Wealth

Bangladesh is rich in fish. Hundreds of varieties of tropical fish abound. Hilsa, lobsters, and shrimps are some of the fish which are exported. The territorial zone of the Bay of Bengal abounds with varieties of marine fish.

Mineral Resources

The country is not poor in mineral resources. Several gas fields have been discovered from which natural gas is produced. The proven gas reserves equal 9.175×10^{12} c. ft. Coal deposits have been found at a depth of 3 000 feet. Other minerals found include limestone, hardrocks, lignite, glass sand, white clay, radio-active minerals in beach sand, etc.

Principal Industries

Although Bangladesh is mainly an agricultural country, she has some large-scale industries based on indigenous raw materials. Among them jute manufacturing, paper and news-print, rayon, sugar, cement and chemical fertilizers are important. Other notable industries are cotton textile, hand-loom industries, engineering, steel and re-rolling, oil refinery, electric cable and ship building.

Major Urban Centres

Dacca is the capital city and the largest metropolis. Chittagong with a population of 1.38 million, is the second largest city. Rajshahi, Khulna, Jessore, Faridpur, Kushtia, Pabna, Rangpur, Dinajpur, Mymensingh, Sylhet, and Comilla are some of the important towns in the country.

Seaports and Airports

The port of Chittagong is the major seaport of Bangladesh and is truly the lifeline of the country's economy. During 1977-78 the port received 1 912 ships and handled 5.2 million tons of export and import cargo. Chalna port is the second seaport of the country. It is situated at a distance of 32 miles downstream from Khulna. During 1977-78 the port received 1 003 vessels and handled 1.8 million tons of cargo.

Dacca has an international airport named Zia International Airport which is connected by Bangladesh Biman with London, Athens, Rome, Amsterdam, Dubai, Abu Dhabi, Jeddah, Doha, Bahrein, Tripoli, Bombay, Bangkok, Calcutta, Kuala Lumpur, Singapore, Karachi, Kathmandu and Tokyo.Many other international airlines operate flights through Zia International Airport. The domestic stations are Dacca, Chittagong, Cox's Bazar, Comilla, Ishardi, Jessore, Saidpur, and Sylhet. An international flight from Chittagong to Calcutta also operates regularly. During 1977-78 Bangladesh Biman carried about 400 000 passengers between home airports and 104 454 passengers on its overseas network, and carried about 7 million pounds of cargo from the country.

Executive

The country is governed by a Presidential form of government. The President is elected in accordance with law by direct election. The President, as Head of State, takes precedence over all other persons in the State. The Vice-President is appointed by the President.

The President holds office for a term of five years from the date on which he enters upon his office. The executive authority of the Republic vests in the President and is exercised by him, either directly or through officers subordinate to him in accordance with the constitution.

There is a Council of Ministers consisting of a Prime Minister, one or more Deputy Prime Ministers and other Ministers, State Ministers and Deputy Ministers to aid and advise the President in the exercise of his functions.

The supreme command of the defence services of the country vests in the President and the exercise there of is regulated by law.

The President can be removed on ground of incapacity if a motion to this effect is passed by the votes of not less than three-fourths of the total Members of the Parliament.

The Legislative Body

According to the Constitution the legislative powers of the Republic vest, subject to the provisions of the Constitution, in the Parliament. The Parliament shall consist of 300 members to be elected by persons of 18 years of age and above in accordance with law from single territorial constituencies by direct election. There shall be 30 reserved seats exclusively for women members who shall be elected by the 300 members aforesaid, but this shall not prevent women from being elected to any of the 300 general seats.

The Parliament shall be summoned, prorogued and dissolved by the President.

The Judiciary

Supreme Court is the highest judiciary in the country which is headed by the Chief Justice. The Supreme Court consists of two divisions viz., the Appellate Division and the High Court Division. There are courts at district, sub-divisional and other levels to try civil and criminal cases.

The Chief Justice and other judges are appointed by the President.

Administrative Structure

Administratively, the country is divided into four Divisions, each under a Divisional Commissioner. There are 20 districts under the four Divisions. A district is administered by a senior officer known as the Deputy Commissioner who is assisted by Additional Deputy Commissioners. Each district is sub-divided into sub-divisions and the Officer-in-Charge of a sub-division is called the Sub-Divisional Officer. There are several police stations in each sub-division.

The Inspector-General of Police is the head of the police administration in the country. Under him there are Deputy Inspector-Generals of Police. The district and sub-divisional police administration is run by a Superintendent of Police and a Sub-Divisional Police Officer respectively. The Chief Police Officers in the capital of Dacca and the port city of Chittagong are called Metropolitan Police Commissioners. The administration at the level of police stations and at the lowest level of Union Parishad (Council) are administered by a Police Inspector and a Union Parishad Chairman respectively.

1.2 SOCIO-CULTURAL & ECONOMIC SETTING

Social Groups

The biggest social group of people in Bangladesh is the Bangalee group. The Bangalees constitute more than 97% of the population of Bangladesh. Other ethnic groups such as Mongoloid, Proto-Australoid and Dravidian groups are common in the tribal population of the country. In the Bangalee group there had been an intermingling with people of Turkic, Semitic and Aryan-Caucasoid origin.

Religious Groups

Islam is professed by 85.39% of the population according to the 1974 census. The Hindus are divided into two groups, the Caste Hindus and Scheduled Castes. The Caste Hindus form 6.89% of the total population. The Scheduled Castes form 6.64% of the total population. The Buddhists comprise 0.61% of the total population and the Christians 0.31%. The tribal ppopulation of the country is intermixed with different religions. There are Buddhists, Christians, Hindus and Animists within the tribal groups.

Language Groups

Bengali is the mother tongue of over 97% of the population within Bangladesh. Bengali has a number of dialects and sub-dialects. English is still used for commercial, legal and some official transactions. Arabic is widely read by the Muslims.

Economy

With some 65 000 villages, agriculture is of paramount importance to Bangladesh. Nine-tenths of the population depend, directly or indirectly, upon it. Over half of the national product is from the agricultural sector. Even if Bangladesh is substantially industrialized, it will remain very largely dependent upon agriculture because most of the industries must be based upon agriculturally produced raw materials. Agriculture, therefore, will remain the basis of Bangladesh's economy for a long time to come, and the only way to improve the lot of the majority of its people will be to improve agricultural productivity. Being conscious of this situation, the government has given the highest priority to this sector as a national development strategy.

Since the reconstruction period of 1972-73, to recoupe the widespread damage caused by the War of Liberation to life, property, industry, trade and commerce, there has been a steady economic growth in different economic sectors like agriculture, rural development, natural resources, water and power, transport and communication, trade and commerce, industry, finance and banking.

There has been a steady growth in the country's export trade in recent years. As against the figure of Tk.5 520 million in 1975-76, the export in 1977-78 was of the value of Tk.7 480 million, showing an increase of 35%. The export earning from non-jute items increased to 31% in 1977-78 as against only 19% in 1975-76. Principal exports are raw jute, jute manufactures, tea, hides and skins, newsprint and fish.

Trade Balance

The valued foreign trade of country during 1978-79 period was exports (f.o.b.) Tk.9 632 million and imports (c.i.f.) Tk.21 727 million.

1.3 DEVELOPMENT SCENE

Planning is now an integral part of development in Bangladesh. The task of planning for the economic development of the country is very formidable. It is a small country of 143 998 sq.km. with an excedingly high population of 89.94 million, a high density of population of 1 566 persons per square mile and a poor per capita annual income of Tk. 1 200 (US$80).

The First Five-Year Plan was launched in 1973, but several developments in the national and international fields thwarted its implementation. These included very serious resource constraints following natural calamities such as flood and drought, and a four-fold rise in oil prices. But 1975-76 period marked a turning point in the economy of Bangladesh. The difficulties of reconstruction were largely overcome and some resilience and buoyancy were perceptible. Prudent and pragmatic economic policies and planning, coupled with some favourable conditions helped to bring about an optimistic trend in the economy.

The GDP in real terms increased by 97%. Production surpassed all previous benchmarks and industrial output increased by 5%. Actual investment during the year 1975-76 was Tk.8 500 million as compared to Tk.5,000 million in 1973-74 and Tk.5 250 million in 1974-75. Export earnings increased to Tk.5 072 million, marking an increase of about 6% over the 1974-75 figure. Imports of foodgrains went down to an all-time low of 1.5 million tons compared to nearly 2.3 million tons in 1974-75. The import policy was designed for maximum utilization of industrial capacity through adequate importation of raw materials and spares.

Meanwhile, a two-year short-term plan for 1978-80, before entering the new decade, was launched with a total provision of Tk.38 610 million. Of this amount, Tk.32 610 million was earmarked for the public sector and Tk.6 000 million for the private sector.

This two-year interim plan gave the preparatory base for launching the Second Five-Year Plan in July 1980 for the period 1980-85. Development expenditure earmarked for the major sectors during the Second Five-Year Plan is as follows:

Sectoral Allocation of the SFYP

	Financial Outlay		
	Total	Pub. Sector	Priv. Sector
	Taka %	Taka %	Taka %
1. Agriculture	7,435 (29.05)	6,500 (32.30)	935 (17.09)
2. Industry	4,385 (17.13)	3,275 (16.27)	1,110 (20.29)
3. Power, Natural Resources & Scientific & Technological Research	2,915 (11.39)	2,915 (14.49)	— —
4. Transport	3,720 (14.53)	2,635 (13.09)	1,085 (19.84)
5. Physical Planning & Housing	2,220 (8.67)	1,220 (6.06)	1,000 (18.28)
6. Communication	835 (3.26)	835 (4.10)	— —
7. Health, Population & Family Planning	1,240 (4.85)	1,210 (6.01)	30 (0.55)
8. Socio-Economic Infra-Structure	1,565 (6.12)	1,535 (7.63)	30 (0.55)
9. Trade and other services	1,280 (5 00)	— —	1,280 (23.40)
Total	25,595 (100)	20,125 (100)	5,470 (100)

PART 2.

Science and technology framework

2.1 DEVELOPMENT POLICY FRAMEWORK

In this age of modern science and technological advancement Bangladesh, a newly emerged nation, has been trying to meet the demand of its people by means of activities formulated by its development policy. The world is developing very fast and, to keep pace with this, Bangladesh can no longer remain dependent on others for years to come. Our dependence on foreign countries is due to a deficiency in food, energy, industry and technology. Due to our deficiency in food, a major part of the foreign exchange is being utilized to import foodgrains. To minimize the import of foodgrains and to become self-sufficient in food, agriculture has been given the highest priority in the development strategy of the Second Five-Year Plan.

The Second Five-Year Plan (SFYP) 1980-85 has been formulated in the context of overwhelming problems of the new nation, which emerged through a war of liberation, to improve the living standard of a population mostly living in the rural area.

In the past, the high growth rate of population on one hand, and the slow growth of the economy on the other have rather accentuated the problems over time. The country's problems are so massive that only humble success can be achieved in the medium-term plan period. Aware of these limits, the SFYP was formulated with the following objectives:

to bring about a noticeable improvement in the standard of living by ensuring adequate supplies of the basic needs;

to bring about significant improvement in the quality of life in the rural areas through greater participation of the masses in development activities through local bodies;

to expand opportunities for gainful employment beyond the growth of labour force, so that people have access to resources for their basic needs;

to eliminate illiteracy and make a significant progress towards comprehensive development of human resources;

to reduce the rate of population growth;

to attain a high degree of self-reliance;

to move towards a more equitable distribution of income, resources, and opportunities for better social justice;

to accelerate food production beyond self-sufficiency in the shortest possible time;

to accelerate the pace of economic development.

The central theme of the SFYP is, therefore, to create such conditions as would help to eliminate development problems and thereby significantly improve the quality of life of the common people. As a necessary condition, the economy would have to be taken progressively to a higher level of income and employment. The Second Plan will attempt to bring about a decisive change in the pattern of growth inherited from the past by focusing on rural development, which constitutes the core of the Plan. All other objectives and strategies will be built around this core.

Rural development will be all-embracing, comprehending economic, social and cultural development, and will also include action in the field of education and health care. But because the foundation of welfare is output, the corner-stone of rural development will be agricultural development which, in the short run such as that of the SFYP, will act as the prime-mover of the economic prosperity of the rural area. The strategy for agricultural development will be to broaden the modern technological base for rapid transformation of traditional agriculture. To attain this, not only will adequate resources be made available to the rural sector, but also an equitable share in the resources and economic benefits shall be assured to each segment of the rural community.

The SFYP also aims at development of scientific and technological skill among the working class by providing technological support. In order to accelerate the pace of rural development and retain as much benefit from it as possible for the rural community, the SFYP will initiate the development of a chain of rural industries and service centres in support of the rural sector. These industries will provide inputs and services to agriculture, process agricultural raw materials, and manufacture goods to meet the demands of rural households.

Development Planning Procedures

The Five-Year Plan constitutes the basis of all development planning. Initially, the sectoral allocations are made by the Planning Commission on the basis of the requirements and total fund availability. Sectoral organizations then formulate the development projects on the basis of these allocations. These projects are then examined and approved at various levels. The implementation of the projects are then done on the basis of allocations made in the Annual Development Plan (ADP). The ADP is prepared from the already phased out annual developing programmes of the projects. The financial component of the ADP constitutes the Annual Development Budget.

The ADP is formulated by the Planning Commission with inputs from sectoral organizations. Once the ADP is approved by the Parliament and authenticated by the President, programmes under it are then implemented subject to financial controls and restrictions by the Ministry of Finance. The project evaluation is done by the Project Implementation Division of the Ministry of Planning and its findings are examined once a month by the National Economic Council, which is headed by the President of the People's Republic of Bangladesh.

2.2 DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

At present, science and technology development is done within the overall framework of National Development Policy. The Planning Commission, with a small Scientific and Technological Research (STR) Sector looks after the development policy matters of science and technology in the country. Unfortunately the STR Sector does not even run the scientific research programmes of vital sectors such as agriculture, water and power, natural resources, rural development, education, health and engineering. These are being looked after by respective development sector departments, and concerted effort in the formulation of a national science and technology development policy is lacking.

Realizing these deficiencies and recognizing the importance of the contribution of science and technology to the development of the socio-economic conditions of the nation, a National Science and Technology Policy has recently been formulated embracing essential responsibilities such as planning, budgeting, coordination, promotion, execution and proper evaluation of scientific and technological activities relevant to the country's needs; so as to cover the following broad aspects of scientific and technological development in the country:

- to create a condition favourable to the development of science and technology;
- to develop scientific and technological capability to generate, select, adopt, absorb, use, maintain and operate technology;
- to identify national needs where science and technology are to be applied for socio-economic development, and to tailor science and technology to these needs;
- to identify the most appropriate technologies for utilization of major indigenous resources;
- to develop close interaction and cooperation between scientists and technologists;
- to link scientific and technological development to an effective manpower planning, and integrate it into the overall national development plan;
- to develop close links between producers and users of technology; and
- to generate a capacity for innovation among the citizens and give them the means to try out their new ideas and build self-confidence.

Implementation of this policy has just been started under the control and supervision of a permanent body – The National Council of Science and Technology (NCST). This body will be responsible for formulation, implementation and supervision of the national scientific and technological development programmes and for making them consonant with the economic development goals and objectives of the country.

So far as the funding is concerned, the present system of normal and development budgeting practised by the Ministry of Finance and the Planning Commission is being followed. Considering this to be inadequate, the new National Science and Technology Policy has put forward the policy suggestion that a minimum of 5% of the G. D. P. be allocated for S&T activities. Besides, a National Science Foundation (NSF) shall be created to promote science and technological activities in the country. The broad policy for the utilization of the S&T budget and the NSF will be made by NCST.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

At the time of independence Bangladesh did not inherit any scientific and technological policy-making bodies. To organize the scientific and technological development of the country, a Scientific and Technological Research Division was created. Under this division various scientific and technology policy formulation and implementation bodies were organized. In 1977, a National Council of Science and Technology was also established. This was an advisory body at the highest level of government, with the President of the Republic as the Chairman and 21 other members including 14 scientists, technologists, and economists, and 7 permanent secretaries of the concerned ministries.

Due to the advisory status of this body, it was not possible for it to formulate any national science policy nor prepare the national science and technology plan which was entrusted to the Council. In view of this, and recognizing that a national science and technology policy embracing essential responsibilities such as planning, budgeting, coordination, promotion, execution and evaluation of S&T activities was needed. A national S&T policy was formulated by the Government in 1980. Under this national policy the National Council of Science and Technology (NCST) has been constituted as the only organization for the overall formulation, implementation, and coordination of national scientific and technological research and development activities in the country. It has been decided that all existing National Research Councils in the country shall be reorganized into sectoral coordinating Research Agencies/Organizations, and shall function under the general guidance of the NCST.

The National Council of Science and Technology (NCST) shall have the following functions in respect of all research institutions and sectoral coordinating Agencies/Organizations engaged in science and technology activities in the country:

- preparation and review of National Science and Technology Policy and Planning;
- approval of research plans and programmes of all sectoral coordinating agencies and different research organizations;
- evaluation of Science and Technology activities of sectoral research organizations, projects, scientists and technologists.

The National Council of Science and Technology shall have full-time members, as well as part-time members, drawn from eminent scientists and technologists of the country and to be determined by the Government from time to time.

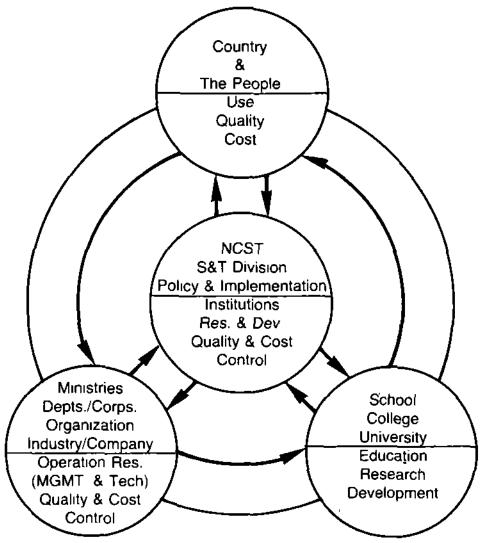
The NCST will be headed by the President of Bangladesh, and composed as follows:

President of Bangladesh	Chairman
Vice-President	Vice-Chairman
Minister/State Minister, Science and Technology Division	Vice-Chairman
Two Ministers with Science/ Technology background to be nominated by the Chairman	Members
Secretary-in-Charge Natural Science and Energy Wing (S&T Division)	Member (ex-officio)
Secretary-in-Charge Engineering Sciences Wing (S&T Division)	Member (ex-officio)
Secretary-in-charge Agricultural Sciences Wing (S&T Division)	Member (ex-officio)
Secretary-in-charge Medical Sciences Wing (S&T Division)	Member (ex-officio)
Secretary-in-Charge Information and Coordination Wing (S&T Division)	Member (ex-officio)
Secretary Science and Technology Division	Member-Secretary to the Council

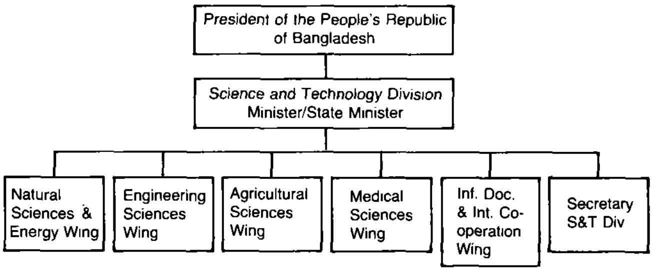
The NCST may be assisted by technical committees, expert panels, advisory panels, consultants, thinktanks, etc. The members of the NCST will be senior and experienced scientists and technologists of the country who will be philosophers, thinkers and planners and who have well-established capabilities in their professions.

Pursuit of Science and Technology will be carried out in such places, namely, research institutions under the Science and Technology Division, educational institutions (Schools, Colleges and Universities) and Industries (Private and Public sector) and other places as determined by the NCST and other places as determined under a National Research Policy formulated by the NCST. National Science and Technology activities within the conceptual framework of this policy statement are as follows:

Network of National Science and Technology Activities



The Science and Technology Division will be the Administrative Division for the NCST. For the present it will have five wings. The heads of these wings will be ex-officio members of the NCST and will exercise all secretariat powers of that level. All research organizations under the Science and Technology Division will be re-organized under the five wings ot the Division as shown below:



Besides, a National Science Foundation shall be created to promote science and technological activities in the country. A fund for this foundation will be created from a government grant and also from the input of at least 10% of the annual budget of the industries (private and public) to undertake research and training activities in the field of science and technology. The utilization policy of the Science and Technology fund and National Science Foundation fund will be made by the NCST and the Science and Technology Division will coordinate the action.

Based on the indigenous national capabilities and resources, problem-solving and innovatory research and development activities shall be given priority in the National Science and Technology Policy. The R&D activities will include research and development of new processes, strains, methods, techniques, mechanisms, systems, etc. and verification of them under field conditions for their practical application, adaptation, and mass production. The ground organization engaged in R&D activities are shown below:

Bangladesh Atomic Energy Commission (BAE);
Bangladesh Council of Scientific and Industrial Research (BCSIR);
Bangladesh Jute Research Institute (BJRI);
Bangladesh Space Research an Remote Sensing Organization (SPARRSO);
Museum of Science and Technology;
Bangladesh National Scientific and Technical Documentation Centre (BANSDOC);
Bangladesh Standards Institution;
Central Testing Laboratory;
Bangladesh Agricultural Research Council (BARC);
Bangladesh Medical Research Council (BMRC);
Environment Pollution Control;
Building Research Institute.

The network of S&T organizations in Bangladesh and their functions and linkages has been shown in Table 1.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

Science and Technology activities under the S&T Division of the Government are being carried out mainly in the following national institutions:

Bangladesh Atomic Energy Commission (BAEC)

The BAEC programme of research and development is directed towards peaceful uses of atomic energy. Its current activities relate mainly to agriculture and bio-sciences, physical sciences, and technology. In agriculture and bio-sciences, efforts are concentrated on nuclear agriculture, pest control, and food preservation, and nuclear medicine. The activities in nuclear agriculture are being carried on at the Institute of Nuclear Agriculture at Mymensingh. Pest control and food preservation programmes are being continued at the Irradiation and Pest Control Research Institute at Savar near Dacca, one of ten such institutes to be set up at a cost of TK.710 million. Clinical research diagnosis and treatment of different disorders are done at the Institute of Nuclear Medicine at Dacca. The other institutes are the research reactor project at Savar, atomic energy medical centres at Chittagong, Rajshahi, Sylhet and Dinajpur, beach sand exploitation centres at Cox's Bazar, and a Uranium and Thorium Survey Project. The Rooppur Nuclear Power project is at the advanced stage of planning.

Bangladesh Council of Scientific and Industrial Research (BCSIR)

BCSIR's effort are directed to undertaking research and experimental development with a view to developing appropriate technology for economy exploitation of the nation's resources in the industrial sector, as well as adaptation and indigenization of technologies. It carries out its R&D activities in three laboratories at Dacca, Chittagong and Rajshahi; while its engineering and process development activities are carried out at the Pilot Plants and Process Development Centre located in Dacca. In addition to these, the Institute of Food Science and Technology, the National Energy Institute and the Leather Research Centre are now in the process of development through up-grading of corresponding existing divisions of the BCSIR Laboratory, Dacca. BCSIR has several on-going development projects under the Second Five-Year Plan aimed at upgrading its R&D capability. The broad fields covered by the BCSIR's R&D programme are food science and technology, energy sources, glass and ceramics, leather and animal by-products, natural products including herbal medicine and drugs, as well as technological development. The BCSIR has succeeded in developing over 70 industrial processes which have been licensed to different industrial entrepreneurs for commercial production. A good number of these processes are already in production.

Bangladesh Space Research and Remote Sensing Organization (SPARRSO)

SPARRSO, formerly Bangladesh Landsat Programme, is a multisectoral resources survey and environmental monitoring programme, based on the analysis of satellite imagery from the Landsat earth observation satellite. The multidate and multicolour Landsat imagery has wide application in resource evaluation, planning, management, and development. An interim meteorological ground station has been set up at Dacca, which receives meteorological data from various weather satellites. This is being updated to an advanced meteorological ground station. The projects under implementation also include establishment of a ground station for receiving images from Landsat/SPOT.

Museum of Science and Technology (MST)

The MST has been playing a significant role in spreading the knowledge of science in the country. It is engaged in organizing science clubs and amateur science activities throughout the country. It also organizes the annual science week programmes to popularize scientific and technological pursuits in the country.

BANSDOC

Bangladesh National Scientific and Technical Documentation Centre collects and archives scientific documents and assists the research organization with the available scientific information in relevant fields. At present, it is also organizing a national science library.

Environment Pollution Control

Under the Environment Pollution Ordinance of Bangladesh, 1977, the Environment Pollution Control Directorate was constituted during the financial year 1977–78. The prime objective of this organization is to make programmes for keeping the environment, air, water and soil free from pollution by industrial wastes. Presently this organization is also engaged in popularizing the use of bio-gas and solar energy in the country.

BJRI

The Bangladesh Jute Research Institute is engaged in evolving high-yielding jute varieties and also evolving use of jute fibres for various industrial products. From their evolved jute fibre 'NOVOCEL', production of various types of 'NOVTEX' products have been made possible. Under the joint collaboration of Bangladesh Jute Research Institute, the Bangladesh Jute Mills Corporation, the Bangladesh Textile Mills Corporation, and under the supervision of S&T Division, there is a project which is producing various jute fabrics using 'NOVOTEX' jute fibre.

Bangladesh Standards Institute

This Institute was established in 1977 as an autonomous organization. Since ist inception it has standardized 451 products which mainly included agricultural and food products. In the other fields of jute products, chemical products and electrical equipment and machineries, standardization has been prepared. At present, the Institute is organizing the programme for switching over to the metric system in the country.

Central Testing Laboratory

The Central Testing Laboratory of Bangladesh was established in 1955. The quality standard of the imported and exportable materials of various organizations are tested in this centre. The Government has approved and allocated fund for the development of this centre as a National Testing Laboratory. Establishment of a branch testing laboratory in Chittagong is under consideration by the Government and an allocation of TK.250 million has been made for the project under SFYP.

Building Research Institute

In the light ot the acute problems of housing and availability of sufficient building materials in the country, various research organizations are engaged in research to evolve cheap building materials out of agricultural and industrial by-products. In addition to various research programme in this field, the Building Research Institute is engaged in research programmes to evolve planning, designing and development of low-cost houses.

Bangladesh Medical Research Council (BMRC)

In 1972 BMRC was established with a view to conduct medical research in the fields of diagnosis of diseases and their treatment procedures. Various research projects have been undertaken under the Council and the research findings are published in the local and foreign medical journals. The Council has also planned to organize village–oriented community medical research to make available the benefits of the research findings to the majority of the country's population in rural areas.

Bangladesh Agricultural Research Council (BARC)

It serves as the national organization and coordinating agency for research in all sectors of agricultural science. The council identifies problems in various sectors of agricultural science and determines priorities for research, and draws up long-term and short-term programmes of research within the framework of the national policy on agricultural development. It scrutinizes and approves research proposals, and evaluates and coordinates research activities of various R&D organizations in agricultural science. The organization is working under the administrative control of the Ministry of Agriculture.

Road Research Laboratory

The aims and objectives of the Road Research Laboratory are to help provide a research base for the development of better road communication facilities in the country, economically and scientifically. It conducts research to evaluate utility of local resources for road construction materials and carries out testing on various construction materials.

3.2 HUMAN RESOURCES

The development and application of science and technology depends mainly on the availability of a critical, competent manpower at all level of scientific and technological activities. The education and training system in Bangladesh, generally followed the same pattern of organizational structures, methods and curricula as it inherited from the colonial period. Such arrangements, inevitably, failed to correspond to the needs and conditions of an independent country. As a result, the system faced enormous problems. Principal among these were the inadequacy of real resources for education and training. The universities and technological institutes at higher level fostered non-functional understanding of science and technology, which particularly made the scientists and technologists not very useful from the standpoint of applied scientific and technological production and competence. It may be generally stated that supply of the manpower for S&T development showed a marked deficiency in quality and an imbalance between categories, which affected the whole manpower pyramid.

The country did not have an effective advanced system of science and technical education and had to send its students to the developed countries for higher academic degree or training. This created a host of problems, particularly the so-called brain-drain. After a few years, students were supposed to return to the country and utilize their knwoledge and experience acquired abroad for development of the country. It was found that many of them did not return, and were lost to the country. Moreover, the kind of knowledge and skills which they acquired abroad were often not relevant to the country and, as a result, they could not significantly contribute to the country's development. The scientists and technologists who did return to the country very soon become frustrated for various reasons and desperately tried to go abroad again. As a result, there has been a severe brain-drain in the past.

The National S&T policy that has been formulated provides guidelines for sound manpower training programmes and career-building opportunities for the young scientists and technologists to meet the need of the country. Accordingly, a young scientist/technologist will be trained at home (through both academic and in-service training) and abroad for the first ten years of this career, and then he will be set to creative work. He will pursue his further training through short refresher courses or through attendance at short seminars, symposiums and workshops to derive direct benefit for furtherance of their R & D activities.

Scientists and technologists will also be trained in management, administration, and development programmes with a broader and clearer perspectives.

Besides building up professionals, technicians, managers and skilled workers by improving training facilities in the country, high-quality manpower needed to provide leadership and to maintain the continuity of the build-up process will be created. This will be done in the country, and also abroad, in cooperation with advanced countries on the basis of a sister institution concept under national and international support.

The number of scientists and technologists who were engaged in teaching and research activities in the universities and major R&D organizations in the country has been shown in the following table, along with the projected manpower to be available in the S&T fields in the country till 1990.

Scientists and Technologists in the Universities as on 1980*

	Scientists (in Natural Science)			Technologists			Social Scientists	
	Ph.d.	M Sc	B.Sc.	Ph D	M Sc	B.Sc	Ph D.	M A /M Sc
Dacca Univ	147	170	2				42	138
Rajshahi Univ	60	152	—					
Chittagong Univ.	19	108	6				9	73
Jahangirnager Univ	20	51	8				5	19
Agriculture Univ	98	226	21	6	16	23	8	16
Engineering Univ.	6	39	—	47	161	30	—	—
	350	746	37	53	177	53	64	246

Note: The country has an estimated stock of about 40,000 post-graduate scientists/technologists of which 10,727 are engineers, 9,146 are registered medical doctors, and 5,329 are agricultural graduates and under-graduates. It has also a stock of more than 100,000 lower-level scientific and technical personnel. The country has more than 73 R&D organizations and supporting institutions.

Scientists and Technologists in Major R&D Organization as on 1978**

Institutions/ Organizations	Public Sector Organization						Private Sector		
	Scientists			Technologists			Scientists/ Technologist		
	Ph.D.	M Sc.	B.Sc.	Ph.D.	M.Sc.	B.Sc	Ph D	M.Sc.	B Sc
Agriculture Research Institution	23	400	76						
Bangladesh Jute Res. Institutes	14	147	47		62				
Livestock Research Institute	—	12	25						
Fisheries Research Organisation	—	22	10						
Silk Research Institute	1	4	3						
Academy for Rural Development		30	26						
Medical Research Institutions	10	23	61						
Institute of Nuclear Agriculture	7	21	14						
Bangladesh Council of Scientific & Industrial Res.	54	117	27	8	3	3			
Bangladesh Atomic Energy Commission	58	93+(M.B.B.S.)			41				
Central Drug Lab	1	2	4						
Diabetic Assn.	3	16	10						
Cholera Res. Lab.	8	31	12						
Defence Science Organization	3								
Marine Biological Laboratory		1							
Pfizer Lab. Ltd.							1	10	60
	182	926	315	8	106	3	1	10	60

* *Source:* University Grants Commission of Bangladesh
** *Source:* BANSDOC

Projected Scientific and Technological Manpower (based on Output data of 1980)

Year	Population (1,000,000)	Scientists & Engineers				
		Total stock (1,000)	Breakdown by field of education training			
			Natural & Social Science	Agricultural Science	Engineering & Technology	Medical Science
1980*	88.677	10,257	8,737	232	489	799
1981	89.94	20,659	17,598	467	985	1,609
1982	92.01	31,301	26,663	708	1,492	2,438
1983	94.13	42,188	35,937	954	2,011	3,286
1984	96.29	53,325	45,424	1,205	2,542	4,154
1985	98.50	64,719	55,129	1,463	3,085	5,042
1986	100.77	76,375	65,057	1,727	3,641	5,950
1987	103.08	88,298	75,213	1,997	4,209	6,879
1988	105.45	100.495	85,603	2,273	4,790	7,829
1989	107.88	112,973	96,232	2,555	5,385	8,801
1990	110.36	125,738	107,105	2,844	5,994	9,795

Note:

1. Projection of population is based on annual growth rate of 2.36 (1981 census).
2. Total stock of scientists and technologists for the year 1980 has been compiled from the source of university's records. The output figure of 1980 has been considered as the 'base' for the projection of year-to-year production of scientists and engineers.

* Source of base figure of 1980 output: Returns from the universities, University Grants Commission of Bangladesh.

3.3 FINANCIAL RESOURCES

The Government financing for research is done through a normal budgeting mechanism and through development programmes. Financial outlays are determined on the basis of requirements put forward by the Research and Development (R&D) organizations.

In the Second Five-Year Plan, attempts have been made to assess the financial requirement for implementation of the R&D programme in its totality. It is estimated that an amount of Tk.8 380 million would be spent in various sectors for research, engineering development, and supporting services. The total estimated financial outlay for the projects of all sectors, other than the STR Sector, is given below:

Name of the sector	**Estimated provision** *(in million Takas)*
Agriculture	2 400
Industry	1 570
Flood control and water resources	750
Transport and Communication	210
Health	390
Education	50
Natural Resources	260
Power (for Rooppur Nuclear Power Plant)	1 000
Others	200
Total	6 830

Financial Allocation for STR Sector

An allocation of Tk. 1 550 million has been made for the STR Sector in SFYP to complete 22 on-going projects and to undertake second phase of some of the on-going projects and a few new projects. The agency-wise break-up of allocation of the STR Sector is given below:

Name of the Agency *	**SFYP Allocation** *(in million Takas)*
BAEC	710 (FEC** : 350)
BCSIR	460 (FEC : 180)
SPARRSO	200 (FEC : 100)
MST	100 (FEC : 25)
S&T Division	80 (FEC : 50)
Total	1 550 (FEC : 705)

Phasing of the SFYP

The plan is formulated to secure inter-sectoral consistency for the terminal year as well as for the Plan period as a whole. A phasing of the Plan over the five-year period is presented below:

Phasing of Financial Development Outlay
(in million Takas 1979-80 prices)

Year	Total	Public Sector	Private Sector
1980-81	32,770	26,810	5,960
1981-82	40,240	32,430	7,810
1982-83	49,180	39,000	10,180
1983-84	60,180	46,830	11,330
1984-85	73,580	56,130	17,450
Total	255,950	201,250	54,700

In the absence of year-to-year inter-sectoral balances, the annual phasing given is mostly indicative, designed to show a uniform rate of acceleration of 22.5% for the total Plan period. This signifies an annual escalation of about 20% for the public sector and 30% for the private sector development outlay. The actual development outlay and foreign aid inflow during the intra-plan years may conceivably be different from what is shown in the above table. Inflationary pressure will warrant appropriate changes in the annual plan outlays.

Due to financial resource constraints, and on the basis of available fund, the original total fund outlay of Tk.255 950 million of the SFYP is being revised. It has been estimated that the allocation outlay will be reduced to about Tk.200 000 million of which about Tk150 000 million will be earmarked for public sector and Tk.50 000 million for the private sector. Accordingly, original SFYP allocation outlays for R&D programmes will be revised. On the basis of priority of R&D activities, the allocation has been revised.

** Allocations of the agencies which have been transferred to STR Sector after the formulation of the SFYP has been included in their original sectors are not here.

** Foreign Exchange Component.

The agency-wise break-up of revised allocations of the Science and Technology Research Sector during the Annual Development Plan (ADP) of 1980-81 is given below.

Revised ADP of 1980-81
for R&D activities in STR Sector
(million Takas)

Agency	ADP Allocation	Total FEC
Bangladesh Atomic Energy Commission (BAEC)	85.10	47.75
Bangladesh Council for Scientific and Industrial Research (BCSIR)	49.00	24 00
Bangladesh Space Research & Remote Sensing Organization (SPARRSO)	47 60	34.20
Bangladesh Jute Research Institute (BJRI)	56.00	19 00
National Museum of Science & Technology (MST)	6.60	1.60
Environment Pollution Control (EPC)	2.00	—
Science & Technology division	1.50	—
Grand Total	247.80	126.50

Revised ADP of 1980-81
for R&D activities in Industry Sector
(million Takas)

Agency	ADP Allocation	FEC
Bangladesh Jute Mills Corporation (BJMC)	0 70	—
Ministry of Jute	13.725	9.60
Bangladesh Handloom Board	1.51	—
Bangladesh Sugar & Food Industries	2 438	0.50
Bangladesh Standard Institution	0.50	—
	17.863	10.10

Revised ADP of 1980-81
for R&D activities in Agriculture Sector
(million Takas)

Agency	ADP Allocation	FEC
Ministry of Agriculture	84.50	52.50
Bangladesh Agriculture Research Institute (BARI)	30.70	15.20
Bangladesh Agriculture research Council (BARC)	20.555	11.393
Cotton Development Board	20 30	—
Planning Commission	0.30	—
Bangladesh Rice Research Institute (BRRI)	18.00	2 00
Bangladesh Sugar & Food Industries (BSFI)	5.90	2.40
Bangladesh Agricultural Development Corporation (BADC)	3 50	—
Forest Department	1.80	—
Directorate of Fisheries	22.15	12.50
	207.705	90.993

Revised ADP of 1980-81 for R&D activities in Food Control and Water Resources
(million Takas)

Agency	ADP Allocation	FEC
Survey, Investigation and Feasibility Study Cells (BWDB)	86.00	32.50

Revised ADP of 1980-81
for R&D activities in Transport Sector
(million Takas)

Agency	ADP Allocation	FEC
Roads and Highway Department	8.00	—
Bangladesh Water Inland Transportation Authority (BWITA)	20.80	5 70
Department of Shipping	0.30	—
	29.10	5 70

Revised ADP of 1980-81
for R&D activities in Communication Sector
(million Takas

Agency	ADP Allocation	FEC
Planning Commission Communication Sector	0.15	—

Revised ADP of 1980-81
for R&D activities in Population Control & Family Planning Sector
(million Takas)

Agency	ADP Allocation	FEC
Bangladesh Institute Development Studies	1.00	—

Revised ADP of 1980-81
for R&D activities in Manpower & Labour Sector
(million Takas)

Agency	ADP Allocation	FEC
Directorate of Labour	0.25	
Department of Inspection for Factories and Establishments	0 35	—
	0.60	

3.4 SURVEYING OF S&T POTENTIAL

A Survey Cell, known as NCST Survey Cell, has been constituted under S&T Division for surveying and documentation of S&T potential within the country. On the basis of a nationwide survey, the cell has recently documented the S&T potentials and R&D activities of various organizations and their on-going research projects and the achievements made so far.

There are more than 80 R&D Institutes and supporting technical facilities such as libraries, information and documentation centres, computer services, etc. These are under the administrative control of the universities, research councils, government ministries/departments, development boards, industrial corporations, non-governmental and international organizations. Nearly 3 000 scientists and technologists, post-graduates, and about an equal number of scientific and technical assistants are employed in these institutions. Names of the R&D organizations and their controlling authorities have been furnished in Annexure 1.

PART 4.

Policy issues in scientific and technological development

4.1 MAJOR DEVELOPMENTS

Building a viable S&T system and S&T capability is a long-term process. The country has the potential and there is now both the political will and a national commitment for building this capability. With the political determination to break through the stagnation in the field of science and technology, the country has formulated the National Science and Technology Policy. Under this policy, aggregation of the country's institutions for science and technology has been conceived.

To develop S&T capabilities in the country, the government has also launched a nationwide movement for popularization of science and technology and for creation of an environment in which government officials and the general public can apply scientific principles to their daily living, and develop a scientific approach to thinking and living with increased recognition and understanding of the role of science and technology in socio-economic development on the country. The progamme includes in broad terms:

(a) Support to non-governmental scientific and technological organizations

Since 1976, the S&T Division has been granting funds to the Bangladesh Science Academy, Bangladesh Association for Advancement of Science, Institute of Engineers, Bangladesh Association of Scientists and Scientific Profession and Discipline Societies to help them to hold seminars, conferences publish bulletins and journals. Such support is being increased every year.

(b) Scientific and Technological Exhibition

The National Science and Technology Museum displays devices derived from various theories of science and models of various instruments, processes and techniques with a view to increasing public understanding of scientific principles and their practical applications, to encourage the people's creative abilities and interest, and to increase the number of science-minded people. The Museum also organizes science clubs in educational institutions and arranges science exhibitions there. The S&T Division now provides substantial grants to educational institutions all over the country to organize science clubs and science exhibitions.

National Science Week

National Science Week is now observed as an annual feature to be held all over the country in the beginning of each year. The programme for a Science Week includes scientific and technological exhibitions, an essay competition, a speaker's forum and debates, film shows and demonstration. The Science Week contributes much to the development of education. It also encourages innovative works by individuals or groups or institutions by their exposition and award of prizes for superior works.

The industrial base in Bangladesh is very small and the inhouse R&D activity is absent. The national measures envisage stengthening and building up of R&D institutions under the research councils, universities, development boards and government departments to carry out industrial research and development. These institutions would, no doubt, establish industrial liaison and extension units to keep the industry informed about the status of research in their laboratories and to effect interaction between the laboratories and industry.

Besides, the new National S&T Policy has provided for the creation of an operation research cell in every sizeable industrial establishment for the evaluation and analysis of the efficient functioning of their organization, such as maintenance, productivity, and technical and personnel management. Operation research problems of a technical nature which may not be solved by them will be referred to the S&T Division for finding solutions in the national S&T research organizations or in the universities, as decided by S&T Division.

The rural sector occupies the most dominant position in Bangladesh economy and hence the main programmes of development in the subject areas like food and agriculture, health and nutrition, industry, physical infra-structure, water resources and energy have been planned to be oriented towards rural development. It has now been decided to establish a National Centre for Rural Technology in the Bangladesh University of Engineering and Technology. The main function of this centre would be to adapt, adopt and improve available technology and diffuse them throughout the country. Initially this centre would give priority to the following areas:

agro-based food and cash products of both plant and animal origin;
shelter;
clothing;
health;
transport; and
energy

A detailed programme of developing tools, techniques and appropriate technology for rural industries on the various aspects of the above areas has been worked out.

In addition to this National Centre, there would be a number of village technology centres set up in the various regions of the country. These centres would carry out:

extension service on rural technology;
run rural industries, either on a cooperative or private ownership basis;
demonstrate scientific inputs and devices which could use resources in the villages;
train rural personnel; and
operate testing, maintance and repair services.

These centres are expected to have a great multiplying effect all over the country in due course of time.

4.2 PROBLEMS AND ACHIEVEMENTS

Bangladesh, being financially handicapped and technologically less developed, had to negotiate from a position of extreme weakness; in various ways the donor countries served to perpetuate their hold on capital and technology. In most of the transactions there was no provision for built-in manpower training components for strengthening indigenous capabilities. Another basic problem was that technology was not freely traded; technology became a means of creating monopoly power. Such monopoly conditions were closely tied with the technological stagnation and dependence of the country. Even information about the range of available technological alternatives, their precise characteristics and their implications for the criteria of appropriateness were not readily available, and if available it was very costly and difficult to acquire.

The major internal constraints to choice and selection of technology were the lack of skills, institutional support, and of capital. Industry and government generally lacked the system of staff development to provide opportunities for them to acquire the skill and self-confidence to make technological decisions. They could not stimulate the growth of effective expertise, high-level managers and administrators. The stock of such skilled individuals was quite meagre.

The country had no coherent technology policy and plan which sets national priorities based on sound analysis. In particular, there was no clear policy on the role of imported technology and capital in national development. The institutional support for technology transfer was extremely weak. The country had no proper machinery for regulation of technology imports, nor effective national programmes or centres to provide the information, training and extension services in order to strengthen capabilities in selecting and negotiating for technology nor any arrangement to identify, adapt and develop technology appropriate to local conditions in order to supplement and to further indigenous development of the more advanced processes acquired from abroad.

The country's overall infrastructure for science and technology was also weak and not very effective; in particular it could not build up engineering design, consultant and technical capabilities. The country could not also acquire the capability to analyse and to make its own decisions about the various components of technologies in specific projects; in other words it had not the capacity to unpack technologies so as to enable it to procure different components from the most competent sources exercising its prerogative and judgement to choose.

In addition to these specific limitations which created difficulties in the choice, transfer and development of industrial technology there had been a number of other factors which generally impeded promotion of science and technology for development in the country. These are outlined below:

(1) The country lacked the political will and appreciation of the role of science and technology in development and consequently very meagre financial support was given to the development of a scientific and technological infrastructure.

(2) Arrangement for development of proper manpower was quite inadequate resulting in a shortage of competent scientists, technologists, entrepreneurs and managerial skills and supporting scientific and technical staff. There was also a severe brain-drain.

(3) There was a lack of understanding between the two major participants in the national effort, namely the administrators and working scientists/technologists. The latter group was not involved in development issues and development processes in general, and the role of S&T in particular including choice of technologies, that were appropriate to the development objectives of the country.

(4) There was hardly any assessment of the applied R&D needs of the nation in the production and service sectors before building and staffing the R&D establishments. In the majority of these institutions the key personnel had no appropriate training and experience, resulting in inept management of the institutions.

(5) In the absence of planning of R&D activities in terms of national needs and priorities, the programme in these institutions has not been, in general, related to the development objectives in the various sectors of economy. Research projects were selected by staff without industrial experience and without consulting industry. They rather represented weak extensions of science practised in the advanced countries and were also thinly spread over many areas with small, sub-critical size in terms of manpower, financial outlay and physical facility in each area.

(6) There was no feedback from users of technology, neither there was any link with any demand from the production and service sectors. The institutions had not the means to communicate with or sell their services to industrial firms.

(7) There was an absence of machinery to coordinate, integrate and evaluate the results of R&D and work carried out by the various institutions in the country.

(8) The R&D institutions were very much lacking in expertise and physical facilities for development works which would enable them to use knowledge gained from research for the production of useful materials, devices, systems, methods or processes. These institutions were particularly deficient in the engineering aspect of development which was concerned with actual construction, assembly, lay-out, and testing of models for pilot process and procedures to produce a system that would work. Practically nothing was done to transfer their results to industry and service sectors. The institutions had no linkages with engineering consultancy companies or development corporation. As a matter of fact, there was hardly any engineering consultancy company or development corporation competent to take up these works in the country.

(9) The R&D institutions had no role in the import or choice of technology; they had no part to play in unpacking the technology and adapting it to suit local conditions.

(10) The R&D support institutions which provided information, statistical services, data processing, computer services, equipment and instruments repair and maintenance services, testing facilities, techniques and standards, quality control were extremely weak.

(11) Scientific and technical communication both internally and externally was extremely weak. There was very little production or publication of S&T literatures in the country. The supply and circulation of books and journals from abroad were also very much limited.

> In the achievement side, formulation of National Science and Technology Policy and its implementation through the constitution of the National Council of Science and Technology with full-time members, is an example of determined effort by the Government to fulfill the national aspiration for science and technology developments in the country.

4.3 OBJECTIVES AND PRIORITIES

The country has now taken effective steps through the new S&T policy to build up and strengthen the scientific and technological infrastructure for acquiring the capability for mixing, adopting, experimenting, adapting, developing and applying science and technology for implementation of the national goals and development objectives.

The guidelines for scientific and technological development under the new S&T Policy are:

> to create a climate favourable to the development of science and technology;
>
> to strengthen research and development institutions for undertaking research and development on selected subject areas related to development objectives; top priority would be given on engineering and innovative aspects of development to enhance the capacity for technology supply, particularly by generation of indigenous technology;
>
> to promote effective design and engineering consultancy service;
>
> to strengthen extension services, particularly in the selected subject areas;
>
> to strengthen information and documentation system and promote scientific and technological communication;
>
> to promote application of science and technology for integrated rural development;

to intensify prospecting and development of natural resources, prepare sufficient inventory of national resources and to make efficient use of available resources;

to build up an effective institution for regulation of Technology Transfer;

to build up a National Centre for Transfer and Development of Technology (NCTDT);

to build up an Institution for domestic innovation and commercialization of technology – National Research and Development Corporation (NRDC); and finally, the most important one is

proper scientific manpower planning and training.

Priorities

The new national science and technology policy has identified the following priorities:

i) Based on the indigenous national capabilities and resources, problem-solving and innovatory R&D activities shall be given priority in the National S&T Policy.

ii) The R&D activities will include research and development of new things, processes, strains, methods, techniques, mechanisms, systems, etc. and verify them under field conditions for their practical application, adaptation and mass production. This activity will include development of prototypes, making pilot plants and after successful test, release their research results to the various implementing and developing agencies, such as relevant ministries, departments, organizations, corporations, public and private industries for mass production and utilization.

iii) The educational institutions through effective curriculum should groom future researchers for the S&T activities of the country. High-quality scientific and technological manpower needed to provide leadership be also created through higher training and research.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

Bangladesh has now formulated policy guidelines and priorities and undertaken certain measures for acquiring the scientific and technological capacity to implement her socio-economic goals. The country has the potential, and there are now both political will and national commitment for building this capability. The country, however, needs international cooperation and assistance on short-term, medium-term and long-term bases in the projects for training of local experts and, thereby, gaining science and technology capabilities as early as possible. The training programmes related to the various projects should be based as far as possible in the country's own institutions. Until these institutions are fully developed to cater for such training they should establish joint programmes of training in specific projects with institutions in the advanced countries.

It is envisaged that a local institution would enter into an agreement with the institution abroad and prepare a joint programme of training for the project. The guides from the foreign institution should work in the local institution for a reasonable period, mutually agreed upon, depending upon the programme. The trainees after finishing the programme to the maximum possible extent at the local institution would join the foreign institutions to complete the assigned training programme there and then return to the country and receive a degree/diploma from the local institution. The local guides should also work for some time in the foreign institution when trainees are there. The trainees after completion of their training would join the assigned project in the country. This link programme of training would make training meaningful and relevant to the country's needs. Simultaneously with the link programmes, long-term measures are to be taken up to develop the local institutions to their full capacity to cater for post-graduate training at expert level.

Most of the technology in Bangladesh was obtained through credit or aid provided by friendly countries and international financing institutions. The Government of the aid-giving countries and the international economic assistance institutions provided, through their official relations under bilateral and multilateral agreements, technological information to the country in the course of sponsoring particular projects. In this process they also exerted a broad influence over the economic policies of the country including its policies with respect ot technological decisions. Most of such assistance provided through bilateral arrangements was tied to purchases within the lending government economy. As a result, the range of technological alternatives from which choices might be made was very much restricted; and that led in many cases to inappropriate use in a relatively high cost market. Moreover, maintenance of imported plants required imports of spares, whose supply was subject to long delays and also to political considerations. In many cases the material to be processed were also tailored to the plants and had to be imported. The country, in addition, had to import plant and equipment from a number of countries with different standards, which were not interchangeable. This fragmented the local market for engineering goods. In some cases even the products and processes could pay little regards to local needs and conditions. Such technologies might enable enterpreneurs to earn short-term profits, but they tended to disrupt the social structure. All these factors generated and tended to perpetuate technological dependence which was inimical to the acquisition of a self-reliant technological capability and to domestic innovation in the country.

The Government of Bangladesh is now in the process of establishing a new social and economic order which rejects dependence and inequality. The development strategy of the country is now being oriented towards the basic needs of the masses of the people not towards the satisfaction of the needs of a dominating class or elites. It is also felt that a strategy of self-reliance pertinent to the development process, irrespective of degree of the development of the country, would best serve the achievements of such goals.

There is now the political will, and sound industrial and investment policies; these must be reinforced by technological skills and the capability to meet national objectives so as to enable the country to break loose from its present position of technological dependence.

The country needs a diversity of technologies. Only a part of these technologies, at least, can be provided by advanced countries; but this part can become useful if it is selected carefully and then adapted to local conditions. Many of the technologies needed cannot come from outside because they simply do not exist in the advanced countries. They have to be developed by the country itself on the basis of science and technology knowledge accumulated by its own people. In short the country must acquire the capability for mixing, adopting, experimenting, adapting, developing and applying technologies massively. It is gratifying that the Government has now recognized these needs and has taken effective steps to create an appropriate infra-structure, formulate policy, and plan for acquiring the desired capability. The country has formulated the science and technology policy which envisages strengthening and building up of institutions for development of indigenous technology, domestic innovation, and their commercialization. For gaining technological capability the country has been linked up with international scientific cooperation programmes.

S&T Cooperation

Bangladesh has been participating in some international and regional cooperation programmes in the field of science and technology. These cooperation programmes have been operated through bilateral and multilateral agreements with UN Inter-governmental and Governmental Agencies.

(a) U.N. Agencies

Among the U.N. Agencies, the UNDP, IAEA, UNESCO, FAO, WHO and WMO are providing assistance in promoting research and development in Bangladesh. The assistance is generally in the form of training fellowships, and supply of equipment and experts' services.

(b) Inter-Governmental Agencies

These are the Colombo Plan and the Commonwealth. The Colombo Plan involves 21 member nations representing the South-East Asian developing countries and advanced countries like Australia, Britain, Canada, Japan, New Zealand and the United States. Technical assistance under the Plan and the Commonwealth Programme is mainly an effort to stimulate transfer of skill and technical expertise to the developing countries in the region. This has been generally done by training of scientific and technical personnel and providing experts and equipment.

Bangladesh is also participating in two other regional organizations for cooperation in research and development. They are the Association for Science Cooperation in Asia (ASCA), and the Regional Cooperation Agreement for Research, Development and Training related to Nuclear Science and Technology (RCA).

ASCA was formed in 1971. The following countries are participating: Australia, Bangladesh, Japan, India, Indonesia, Burma, Malaysia, Pakistan, the Philippines, South Korea, Sri Lanka and Thailand. The object of the Association is to bring together all these nations to share the knowledge and pool their resources for solving problems of mutual interest.

RCA has been co-sponsored by the IAEA and 10 countries in the region, including Bangladesh, are participating. The cooperative programme is financed by the UNDP.

(c) Governmental Bilateral Agreements

The agreement regarding the areas and form of cooperation are negotiated by the corresponding governmental agencies. In this way the Government of Bangladesh has entered into bilateral agreements with some countries in Asia, Europe, Australia and North America.

In general terms it may be said that S&T cooperation on the above lines has been quite limited and not very effective. There has been more stress on technical assistance than on scientific and technological development. The extent of scientific and technological cooperation in any particular area is not worth analysing as this has been quite insignificant in all areas.

PART 5.

Bibliography

Statistical Pocket Book of Bangladesh 1979, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh.

1979 Statistical Year Book of Bangladesh, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh.

Current Scientific and Technological Research Projects in the Universities and Research Institutes of Bangladesh, Bangladesh National Scientific and Technical Documentation Centre (BANSDOC), Dacca.

Meet Bangladesh, (First Edition), Department of Films and Publications, Government of Bangladesh, 1979.

National Paper of Bangladesh (Presented in UN Conference on Science and Technology for Development, Vienna, Austria, 20-31 August 1979), National Council for Science and Technology, Government of Bangladesh.

National Science and Technology Policy of Bangladesh, S&T Division, Cabinet Secretariat, Government of People's Republic of Bangladesh.

HABITAT: United Nations Conference on Human Settlements Regional Conference, Teheran, June 14-19, 1975, Ministry of Public Works and Urban Development, Government of the People's Republic of Bangladesh.

Survey of Scientific and Technological Potential in Bangladesh, BAEC (Bangladesh Atomic Energy Cd Technology Division, Government of the People's Republic of Bangladesh.

The Second Five-Year Plan, 1980-85, Planning Commission, Government of the People's Republic of Bangladesh, Dacca, May 1980.

Revised Annual Development Programme, 1980-81, Planning Commission, Government of the People's Republic of Bangladesh.

Rashid, Haroun-or *Geography of Bangladesh, University Press Limited* Dacca, 1977.

Returns from the Universities, University Grants Commission of Bangladesh, Dacca.

ANNEX 1

Names of R&D organizations

1. SCIENCE & TECHNOLOGY DIVISION

(a) BAEC (Bangladesh Atomic Energy Commission)

- i) Institute of Nuclear Agriculture (INA), Mymensingh
- ii) Institute of Nuclear Science and Technology (INST), AERE, Savar
- iii) Beach Sand Exploitation Centre, Cox's Bazar
- iv) Exploration of Uranium and Thorium in Bangladesh, Dacca
- v) Computer Centre (CC), AERE, Savar
- vi) Institute of Food and Radiation Biology (IFRB), AERE, Savar
- vii) Institute of Electronics and Material Science (IEMS), AERE, Savar
- viii) Institute of Nuclear Medicine (INM), AERE, Savar
- ix) Atomic Energy Medical Centre (AEMC), Sylhet
- x) Atomic Energy Medical Centre (AEMC), Dinajpur
- xi) Atomic Energy Centre, Dacca
- xii) Atomic Energy Medical Centre, Chittagong
- xiii) Atomic Energy Medical Centre, Rajshahi

(b) BCSIR LAB, DACCA (Bangladesh Council for Scientific and Industrial Research)

- i) Institute of Food, Science and Technology
- ii) Institute of Fuel Research and Development
- iii) Glass and Ceramics Division
- iv) Natural Products Division
- v) Physical Instrumentation Division
- vi) Analytical Division
- vii) Industrial Physics
- viii) Leather Research Centre
- ix) Pilot plant and Process Development Centre
- x) Pilot (Experimental) Plant Study of Jutton
- xi) Fibre and Polymer Division

Rajshahi Laboratory

- i) Lac and Khair Division
- ii) Oils, Fats and Waxes Division
- iii) Fruit Processing and Preservation Division
- iv) Fibres and Silk Division
- v) Workshop

Chittagong Laboratory

- i) Plant Science Division
- ii) Chemistry Division
  - a. Medical Chemistry Section
  - b. Pharmaceutical Chemistry Section
  - c. Bio-Chemistry Section
- iii) Pharmacology Division
- iv) Microbiology Division
- v) Workshop Division

(c) Bangladesh Space Research and Remote Sensing Organization (SPARRSO), Mohakash Biggyan Bhaban, Agargaon, Sher-e-Bangla, Nagar, Dacca

(d) House Building Research Institute, Mirpur, Dacca

(e) Road Research Intitute, Mirpur, Dacca

(f) Environment Pollution Control, Lalmatia, Mohammadpur

(g) Bangladesh Jute Research Institute (BJRI), Sher-e-Bangla, Nagar

2. MINISTRY OF TEXTILES

- i) Sericulture Research Institute, Rajshahi

3. MINISTRY OF PETROLEUM AND MINERAL RESOURCES

- i) Geological Survey of Bangladesh, Segunbagicha, Dacca
- ii) Petrobangla, Motijheel Commercial Area, Dacca

4. MINISTRY OF INDUSTRIES

- i) Sugar Cane Research Institute, Ishardi, Pabna
- ii) Jute Textile Research Institute, Dacca
- iii) Institute of Leather Technology, Dacca

5. MINISTRY OF COMMERCE

- i) Bangladesh Tea Research Institute, Sreemongal, Sylhet

6. MINISTRY OF POWER, WATER RESOURCES & FLOOD CONTROL

- i) River Research Institute, Green Road, Dacca

7. MINISTRY OF HEALTH AND POPULATION CONTROL

- i) Institute of Post-Graduate Medicine and Research, IPGMR, Dacca
- ii) Cholera Research Laboratory, Mohakhali, Dacca
- iii) National Institute of Preventive and Social Medicine, Mohakhali, Dacca
- iv) Institute of Disease of Chest, Sher-e-Bangla Nagar, Dacca
- v) Cancer Research Institute
- vi) Institute of Public Health, Mohakhali, Dacca
- vii) National Nutrition Laboratory, Mohakhali, Dacca

8. MINISTRY OF EDUCATION

- i) Institute of Nutrition, Dacca University, Dacca
- ii) Institute of Scientific Instrumentation
- iii) University of Dacca
- iv) University of Rajshahi
- v) University of Chittagong
- vi) Agricultural University, Mymensingh
- vii) Bangladesh University of Engineering and Technology
- viii) Jahangirnagar University

9. MINISTRY OF DEFENCE

i) Defence Science Organization, Dacca Cantonment, Dacca
ii) Bangladesh Meteorological Department, Sher-e-Bangla Nagar, Dacca

10. MINISTRY OF FISHERIES AND LIVESTOCK

i) Fresh Water Fisheries Research Station, Chandpur, Comilla
ii) Marine Biological Laboratory and Aquarium, Cox's Bazar, Chittagong
iii) Fisheries Technological Research Station, Chandpur, Comilla
iv) Livestock Research Institute, Mohakhali, Dacca
v) Poultry Research Institute, Mohakhali, Dacca
vi) Central Cattle Breeding Station, Dairy Firm, Dacca
vii) Animal Husbandry Research Institute, Comilla
viii) Veterinary Research Institute, Dacca

ANNEX 2

Names of non-governmental organizations which receive financial grants from science and technology division

	Name of Organization
1.	Bangladesh Association for Advancement of Science
2.	Bangladesh Physical Society
3.	Bangladesh Botanical Society
4.	Bangladesh Soil Science Society
5.	Bangladesh Zoological Society
6.	Bangladesh Pharmaceutical Society
7.	Bangladesh Nutrition Society
8.	Bangladesh Society of Microbiology
9.	Bangladesh Phyto-Pathological Society
10.	Community Health Research Association
11.	Bangladesh Diabetic Association
12.	National Recreation Association
13	Bangladesh Chemical Society
14.	Bangladesh Bio-Chemical Society
15.	Bangladesh Society for Natural Science
16.	Society for Conservation of Nature and Environment
17.	Bangladesh Biggyan Unnyon Samity
18.	Bangladesh Photographic Society
19.	Chittagong Science Council
20.	Commonwealth Human Ecology Council, Bangladesh
21.	Bangladesh Computer Society
22.	Bangladesh Mathematical Society
23.	Society International for Islam and Modern Age
24.	Bangladesh Women's Science Association
25.	National Geographical Association, Jahangirnagar University, Savar, Dacca
26.	Monsoon Regional Environment Society
27.	Bangladesh Geo-Physical Society
28.	Zoological Society, Rahshahi University
29.	Bangladesh Geographical Society, Dacca University

ANNEX 3

National Committee for Castasia II

The Country Report of Bangladesh on Science and Technology Policy has been prepared by the National Committee for CASTASIA II constituted as follows under Science and Technology Division, Cabinet Secretariat, Government of the People's Republic of Bangladesh's Notification No. S-IX-17(12)/80/3258(7) dated 13.12.1980.

Dr Anwar Hossain . . . . Chairman
Chairman
Bangladesh Atomic Energy Commission
Dacca

Dr Erfan Ali . . . . Member
Member (Dev.)
Bangladesh Council for Scientific and Industrial Research
Dacca

Mr. Obaidul Huq . . . . Member
Deputy Adviser
Science and Technology Division

Mr. M. U. Chaudhury . . . . .Member-Secretary
Director
Bangladesh Space Research and Remote
Sensing Organization (SPARRSO)

The secretarial service was provided by SPARRSO. Mr. M. H. Quamrul Huda, Principal Scientific Officer, SPARRSO, provided the technical support in drafting the report which was compiled by Mr. M. U. Chaudhury, Director, SPARRSO.

CHINA

Table of Contents

PEOPLE'S REPUBLIC OF CHINA

Geography

Capital city: Beijing,
Main ports: Tientsin, Dailien, Tsingdao, Shanghai
Land surface area: 9,596,961 sq km

POPULATION (1978)

Total	933.0 million
Density (per sq km)	97
Urban/rural ratio	...
Average rate of growth (1970-78)	1.6%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	35.0	10.5	9.9	36.4	8.2	100%

SOCIO-ECONOMIC

Labour force	
Total	...
Percentage in agriculture	...
Gross national product (1978)	
GNP at market prices	US $219,010 million
GNP per capita	US $230
Real growth rate of GNP per capita (1970-78)	...
Gross domestic product	
Total (in current producers' values)	...
Percentage by origin	
Agriculture	...
Manufacturing, mining & quarrying, electricity, gas & water, construction	...
Government finance	
National budget	...
As percentage of GNP	...
External assistance (official, net; 1976)	...
As percentage of GNP	...
Exports	
Total exports of goods (1978)	US $10,680 million
Average annual growth rate (1970-78)	...
External debt (1978)	
Total public, outstanding + disbursed	...
Debt service ratio (% GNP)	...
(% Exports of goods and non-factor services)	...

Exchange rate (1978): US $1 = 1.60 Yuan

EDUCATION

Primary and secondary education (1978)	
Enrolment, first level	146,240,000*
As % of (7-12 years)*	118%
Enrolment, second level	65,483,000*
As % of (13-16 years)	79%
Combined enrolment ratio (7-16 years)*	102%
Average annual enrolment increase (1977-1978)	5.9%
Higher education (third level) (1978)	
Teaching staff, total	...

---

*The enrolment ratio is the relationship between the number of all pupils enrolled (regardless of their age) and the number of the population of the relevant official ages

Students and graduates by broad fields of study:

	Enrolment	Graduates
Social sciences and humanities	571,363	98,756
Natural sciences	64,170	12,743
Engineering	37,529	7,833
Medical sciences	112,990	27,459
Agriculture	61.627	16.534
Other and not specified	8,643	1,256
Total	**856,322**	**164,581**
Number of students studying abroad:	21,039	

Education public expenditure

Total	...
As % of GNP	...
Current, as % of total	...
Current expenditure for third level education, as % of total current expenditure	...

Table 1 - Nomenclature and networking of S&T organizations

I - First level - POLICY-MAKING

Country: China

Organ	Function	Linkages		
		Upstream	Downstream	Major collateral
The State Commission on Science & Technology of the People's Republic of China (SCST)	Making, executing and co-ordinating state policies on the sciences and raising important proposals on policies	State Council	Commissions on science and technology at all provincial and local levels throughout the country, the bureaus on science of all commissions and ministries of the state council	Chinese Academy of Sciences, National Association of Science and Technology, and other R&D institutes
Administration in charge of scientific and technological personnel of the State Council	Making, executing and co-ordinating the state policies regarding scientific and technological personnel	State Council	Divisions in charge of scientific and technological personnel at all local levels throughout the country	SCST
Patent Administration of the State Council	Making, executing the state policies in relation to patents	State Council		SCST
The Chinese Academy of Sciences	Making, executing and co-ordinating the policies on R&D for the whole Academy system	National People's Congress	Provincial academies and R&D institutes	SCST, the National Science Association and other Commissions and Ministries of the State Council
Commissions and Ministries of the State Council* such as:	Making, executing and co-ordinating:			SCST
The State Agricultural Commission	— the state policies on agricultural sciences & technology;	State Council	Provincial commissions on agriculture,	Chinese Academy of Sciences
The State Energy Commission	— the state policies on energy;		Provincial energy commissions,	
The State Economic Commission	— the state policies on economic and technological development;		Provincial economic commissions,	
The State Commission of Capital Construction, etc.	— the state policies on the technological affairs in the basic constructions, etc.		Provincial commissions on basic construction, etc.	

* Commissions and ministries of the State Council are functional and administrative organizations in charge of making those scientific and technological policies in relation to their respective sectors. They are not S&T organizations

II - Second level - PROMOTION & FINANCING

Organization	Linkages		
	Upstream	Downstream	Others
National Association of Science and Technology		Provincial associations of science and technology of the country and all specialized associations of natural sciences	SCST and Chinese Academy of Sciences
The Chinese Academy of Sciences	National People's Congress	Provincial academies and R&D institutes under its direct control	SCST
National Association of Popular Science and Technology Writings		Local association of popular science and technology writings	SCST
China National Publications Import & Export Corporation	SCST	Local branches	S&T organizations all over the country
China National Scientific Materials and Instruments Company	SCST	Local branches	S&T organizations all over the country
Chinese Research Institute of Scientific and technological Information	SCST	Local Information Institutes	S&T organizations all over the country

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages	
		Upstream	Others
Branches and R&D institutes directly subordinate to the Chinese Academy of Sciences (such as institute of physics, institute of chemistry, institute of math., institute of optical science, institute of sonic science, etc. - totalling 112 institutes in all)	Mainly conducting the theoretical research on basic sciences, alco conducting some research and development of applicable technology	The Chinese Academy of Sciences	SCST, high educational institutes, industrial organizations, agricultural organizations
R&D institutes directly subordinate to the commissions or ministries of the State Council (such as Chinese Academy of Agriculture, Chinese Academy of Forests, Chinese Academy of Medicine, Chinese Academy of Iron & Steel, Chinese Academy of Geology, Chinese Academy of Petroleum and Chinese Academy of Architecture, etc.)	Mainly engaged in R&D concerning their respective work, also involved in some basic research in certain areas of their own work	Commissions and ministries of the State Council	SCST
Research institutes of universities and colleges	Mainly involved in basic research, also conducting some development research of applicable technologies	Educational Ministry	SCST
Research institutes of local commissions on science and technology	Mainly conducting R&D to meet the needs for local development of technologies	Superior local science commissions	Concerned local science commissions
R&D departments of industrial organizations	Mainly involved in development research and applied research serving production	Local authorities of industry administration	Concerned local science commissions

Table 2 - Scientific and technological manpower

Country: China

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total stock (thousands)	of which working in R&D (thousands)
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agricultural sciences	Medical sciences	Teaching		
1952	574.82	425.0								
1960	662.07	1,968.9								
1978	958.09	4,345.1	1,880,100							
1979	970.0	4,705.1	1,996,200	221,900	840,700	110,600	312,300	510,500	2,708.9	2,495.0
1985										
1990										

Table 3 - R&D expenditures

Country: China
Currency: Yuan (R.M.B.)

Table 3a: Breakdown by source and sector of performance

(data unavailable at time of publication)

Year: Unit:

Source Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive				
Higher education				
General service				
Total				

Table 3b: Trends

Year	Population (millions)	Gross Industrial & Agricultural Output (in million)	Total R&D expenditures (in million)	Exchange rate US $1 = Yuan
1965	725.4	223,500	2,717	2.46
1970	825.4	313,800	2,996	2.46
1975	919.7	446,700	4,031	1.86
1978	958.1	563,100	5,333	1.68
1985				
1990				

PART 1.

General features of the country

1.1 GEOPOLITICAL SETTING

Geographical features

The People's Republic of China lies in the eastern part of Asia occupying an area of about 9 600 000 square kilometres, about one-fifteenth of the total land area of the world, and equal to the area of whole Europe, and ranking third in area among all countries next only to the Soviet Union and Canada. China's continental frontiers extend more than 20 000 kilometres, and its seashore coastline is over 18 000 kilometres long. China has a vast expanse of territorial sea, covering more than 5 000 islands including Taiwan Island, Hainan Island and the South China Sea Islands.

China has a varied topography and terrain. Of the total land area, mountainous regions constitute about 33% plateaux about 26% basin areas about 19% plains about 12% and hilly areas about 10%. The area of land under cultivation is over 100 million hectares. The nation's terrain slopes down to the east from the west, and from the Pamirs on the north-western and of the Tsinghai-Tibetan Plateau extend a number of huge mountains sloping down towards the east. The world's highest peak, Mount Jolmo Lungma, lies on the borderline between China and Nepal. The world's tallest mountains, the Himalayas, extend from China to her neighbouring countries, Pakistan, India, Nepal, etc.

China has abundant rivers, mostly flowing from the west to the east, and those with drainage areas of over 100 square kilometres number 5 000. China's longest river, the Yangtse River, which is the third longest in the world, is 6 300 kilometres long with a yearly discharge of 1 000 billion cubic metres. The Huanghe (the Yellow River), China's second longest river, is 5 400 kilometres long with a yearly drainage of 50 billion cubic metres.

The distribution of China's water resources is extemely unbalanced. While, in the south, the yearly average rainfall is more than 2 000 mm, in the north it is only 500-600 mm. In the vast regions of arid and semi-arid land in the north-west, the yearly average rainfall is under 400 mm. With the expansion of the irrigated area and the construction of more new factories and mines, water supply in some big cities, and in the industrial and mining bases has become a problem as well in the north. These problems are now being actively solved.

As for the climate in China, a country with a vast expanse of territory, the tropical, sub-tropical, temperate and frigid climates are all combined here. But the bulk of the country is in the temperate zone. There is a wide difference of temperature between the north and the south. In Heilungkiang Province, the average temperature in January is under 20 degrees below zero Centigrade. However, during the same month in Guangzhou Province, the average temperature is well over 10 degrees Centigrade. Influenced by the climate over the Pacific Ocean, China's climate is characterized by an obvious monsoon. Every summer and autumn, the coastal regions are often under the attack of typhoons from the Pacific.

China is rich in natural resources. In agriculture, the south is abundant in rice while, in the north and north-east, wheat, barley, maize, and millet, etc. are grown. The north-east is abundant in beans and sorghum. Also grown in China are various kinds of vegetables, industrial crops such as cotton, jute, tobacco, fruit, medicinal herbs, and oil crops. For mineral resources, China has fairly rich deposits of coal, iron, petroleum, copper, aluminium, tungsten, antimony, molybdenum, tin, manganese, lead, zinc, mercury, vanadium, titanium, and other rare-earth metals, etc. In the last twenty years, new deposits of petroleum have again and again been discovered in China's underground, continental shelves, and coastal waters.

Principal cities, seaports, airports and communications in general

According to 1979 statistics, China has fifteen big cities, each with an urban population of over one million. Among them, Beijing, Shanghai and Tientsin are the three municipalities directly under the Central Government. Beijing has an urban population of 4.34 million, Shanghai 5.88 million and Tientsin, 3.66 million.

Principal seaports are Tientsin, Dailien, Tsingdao, Shanghai, Qinhuangdao and nine others. The yearly volume of freight handled there totals about 200 million tonnes. In civil aviation, more than eighty cities are linked with the capital, Beijing, by air. China maintains twelve international air routes, with a total mileage of 160 000 kilometres. China has such international airports as Shanghai, Guangzhou, Hangzhou, Urumuchi and Tientsin, etc. where jumbo jet airliners can take off and land. China has 50 000 kilometres of railway, 876 000 kilometres of highway, and 108 000 kilometres of navigable rivers.

Political system

The People's Republic of China is a socialist state. According to the Constitution:

> "All power in the People's Republic of China belongs to the people. The organs through which the people exercise power are the National People's Congress and local People's Congresses at all levels. The National People's Congress and local People's Congresses at all levels and all other organs of state practise democratic centralism."

China's organs of state include the National People's Congress, the State Council, local People's Congresses at various levels, the People's Courts and the Peoples procuratorates.

The system of People's Congresses is China's fundamental political basis. The National People's Congress is the highest organ of state power. The state Council is the Central People's Government, it is the highest administrative organ of state, and the executive organ for the National People's Congress.

The characteristic feature ot the political system of a socialist state lies in its representation of the people's interests, its exercise of the people's volition, and its full guarantee of democratic rights to the masses. The people are the real masters of the organs of state power.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

Social structure

In 1979, the population of the whole nation (including Taiwan Province) was 970 million, 80% of which lived in the rural areas, with approximately 300 million working in agriculture. Workers and staff members, including those working for the ownership by the whole people and those working for the collective ownership of the cities and towns, numbered over 99 000 000.

China is a unitary, multi-national state, comprising the Han, the Mongolian, the Hui, the Tibetan Uighur, the Miao, the Ui and other nationalities, fifty-six in all. The Hans constitute 94% of the nation's population. Regions mainly inhabitated by national minorities have, and use, their own national languages.

Religions

The Constitution of the People's Republic of China protects the people's freedom to believe in religion, and religious believers from discrimination. Their way of life, habits and custom are respected and protected.

Buddhism, Christianity, Catholicism and Islam are preached in China. Buddhists are scattered all over the country. They have their own institution, the China Buddhist Association, the promote their contact with Buddhist circles in other countries. The Christians have set up the China Christian Committee of Patriotic Movement; besides their religious activities at home, they also have friendly contact with Christian institutions abroad. In China there are a large number of Muslims and they have established the China Islamic Association, to promote various kinds of religious activities and friendly international contact.

Principal economic sectors

China is a big country with a diversified national economy. Over the past thirty years, the industrial structure has undergone marked changes. We have established such industries as metallurgy, coal, electricity, petroleum, petrochemical, machine–building, electronics, automobile, aviation, shipbuilding, textile, sugar-refining, paper-making, and food-processing etc. In 1949, of the total value of industrial and agricultural output, agriculture made up 70%, light industry 22.1% and heavy industry 7.9%; but, in 1979, agriculture constituted 30%, light industry 31% and heavy industry 39%.

Foreign trade

China has trade relations with 130 countries and regions. In 1979, the total amount of China's foreign trade was about 45.5 million yuans. China mainly exported agricultural produce, sideline agricultural products, and light industrial products. These made up about two-thirds of the total amount of exports. China also sold part of her petroleum, manufactured goods, and mining products. She mainly imported factory and mining equipment, steel, iron, fertilizer and grain.

1.3 ECONOMIC AND SOCIAL DEVELOPMENT SCENE

General survey

Old China was a semi-feudal, semi-colonial country with and extremely backward economy and culture. After the liberation of the whole nation, New China traversed a period of recovery. From 1952 we began to go in for economic and cultural development in a planned way. Over the past thirty years, fairly rapid progress has been made in industry, agriculture, culture, education, science and technology and many other fields. Between 1950 and 1979 the rate of average annual growth in the value of the industrial output was 13.3%, and in the value of agricultural output was 4.5%.

In China's agriculture, there are mainly two kinds of ownership of the means of production, namely, "collective ownership" and "ownership by the whole people", with the farmer as the chief type and comprising about 80% of the value of the gross agricultural output. In 1979, the nation's gross grain output was 332.12 million tonnes. Over the past three decades, the gross grain output has nearly tripled as compared with that of the preliminary stage after liberation.

In 1979, the land area ploughed by tractors was 42% of the total area under cultivation, and the area irrigated by power was 56.3% of the total irrigated area.

In Old China, culture, education, science, and technology were extremely backward. In 1949, throughout China there were only about 200 institutions of higher learning with a total enrolment of 110 000 students, an average of 2.2. college students for every 10 000 persons. In New China, education has developed. In 1979, there were 600 institutions of higher learning with a total enrolment of 1 020 000 students, an average of 10 college students in every 10 000 persons. The were 1.2 million students studying in special or technical secondary schools, 59.05 million students studying in middle schools, 146.43 million pupils studying in primary schools, and 860 000 students in various kinds of courses of higher learning for adults. In 1979, in the units and enterprises under the ownership by the whole people, there were 4.705 million scientists and technicians (among them, nearly 2 million were either college graduates of with some higher level of education). Personnel specially engaged in scientific research numbered more than 310 000. The Chinese Academy of Sciences has 117 research institutes with 23 000 specialized scientific researchers. By relying on its own scientific and technological personnel China has made considerable achievement in economic development, in national defence, as well as in the improvement of the people's livelihood.

With the development of the national economy, the people's living standards have risen. In 1979, the yearly average wage of those working for the ownership by the whole people, not in collective enterprises, was 705 yuans, an increase of 9.5% as compared with that of 1978: the natural growth rate of the nation's population was 1.17%, the birth rate 1.79% and the death rate 0.62%.

Advantages and difficulties of development

China is abundant in natural resources as well as human resources and, in addition, has a suitable climate. The people are industrious and resourceful. After liberation, a profound socio-economic transformation was carried out throughout China. As a result, the system of exploitation of man by man was abolished and the socialist system was firmly established. Under the leadership of the Communist Party of China, the people of all nationalities united as one to go in for modernization with one mind and with a common goal. This is the fundamental reason why great achievements have been made in China's economic and social development. It is also and advantage for further development in the future.

However, for a very long period before liberation, China had been under the yoke of a semi-feudal, semi-colonial system; the economy was very backward, the level of education, culture, science and technology was very low. China was highly populated, and the overwhelming majority of the people were peasants. The productivity was low. Since liberation, although great efforts have been made to develop her economy, culture, science, and technology, and remarkable achievements have been gained, nevertheless, China's backwardness and poverty have not been changed in the main. In 1979, the average national income per capita was only Renminbi 347 yuans. China is still short of enough modern scientific and technological personnel, and the nation was inexperienced in modern construction and modern management. As a result, some mistakes were made and some setbacks were met within our work, such as the imbalance in economic development and the excessive capital investment, etc. Nor can some mistakes be avoided in the future. All these must be overcome in our current efforts for modernization.

PART 2.

Science, technology and development policy framework

2.1. DEVELOPMENT POLICY FRAMEWORK

Development targets

In February 1978, the First Session of the Fifth National People's Congress put forward a long-range programme for building modern agriculture, modern industry, modern national defence, and modern science and technology. In view of the actual development of the national economy in the past years, China needs to make necessary readjustments in its national economy. With the whole strategy of socio-economic development, greater importance should be attached to satisfying the basic needs of the people. In readjusting the national economy, priority should be given to the development of agriculture, light industry, and the manufacture of necessities for the daily life of the people. We should speed up the development of energy resources and communications, and make the structure of various sectors of the national economy more rational. The rate of national capital accumulation should be properly lowered and the part of national income to be spent on consumption should be gradually enlarged. The investment on science, education, public health and culture should be increased as far as possible.

In view of the fact that China has a population of about 1 000 million, the problems of national capital accumulation, consumption, development, and the people's livelihood, are not matters that can be easily solved. It is therefore, impossible to realize China's modernization at a very high speed. We strive to achieve a continuous, steady development at a medium tempo. We hope to reach a "well-to-do" level by the end of this century.

Procedure in making a development programme

As an integrated system, the economic and social development programme includes long-term, medium-term and short-term plans, as well as national, sectoral, regional, and enterprise plans. Long-term plans are chiefly aimed at setting strategic targets for economic and social development, making macroeconomic predictions, deciding on rational overall arrangements and formulating major policies on technology and the economy. Medium-term plans decide on the orientation of investment, priorities, the scale of capital construction, and the tempo of development, etc. Short-term plans mainly deals with the finance of a fiscal year, the credit, the balance of goods and materials and the other concrete measures for development. The contents of the programme should include such plans as concern national income, the development of the various sectors of the national economy, the balance of international payments, environmental protection, population, and social welfare, etc.

The nation's long-term and medium-term plans are to be formulated by the State Council. The State Council is responsible for holding meetings of leadings officials of various departments and regions, as well as experts, in order to make major economic decisions and to decide on the overall balance of major targets for development. In accordance with this, the State Planning Commission must submit an outline programme and organize the drawing up, from below to above, of draft programmes by various departments and regions. The Commission will then be responsible for the overall balance of all items and for the drawing up of a draft national programme. The Commission will submit the programme to the State Council for examination and approval, and finally to the National People's Congress for ratification.

In accordance with the requirements set by the State Planning Commission, various departments and regions will, respectively, work out their own plans. Local plans must be studied by local planning commissions for an overall balance. Annual plans are to be made on the basis of a yearly demarcation as indicated in medium-term plans. The State Planning Commission will put forward control figures, on the basis of which draft plans will be drawn up and submitted from below to above by the various levels. Finally the State Planning Commission will coordinate all this, determine the overall balance, and submit the plans to the National People's Congress for ratification.

The Governement holds regular meetings of experts to size up, assess, supervise, and sum up the execution of the plans.

2.2. DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

Development policy

China is a big country with a vast territory, a big population, complicated conditions, a backward economy and a low-level of science, culture and education. Therefore, China's development guidelines and policies must stem from its own features and go their own way for development, instead of simply copying models from any other nations.

China adheres to the principles of maintaining independence and keeping the initiative in her own hand, regenerating through self-reliance and arduous struggle, and building up the country through thrift and hard work. These are China's fundamental guidelines for her socialist construction. The basic substance of these guidelines is to have faith in, and rely on, the wisdom and strength of our own people and to go all out to make the country strong. However, maintaining independence and keeping the initiative in our own hands does not mean closing the country to international intercourse; also, regenerating through self-reliance does not mean blind opposition to everything foreign. China has consistently attached importance to actively promoting its economic, scientific and technological cooperation with other countries on the basis of equality and mutual benefit.

China makes arrangements for national economic plans according to the priorities for agriculture, light industry and heavy industry. We give the first priority to agriculture in our economic development because agriculture involves the problem of feeding a population of 1 000 million, and it is both the major source of raw materials for light industry and an important source of capital accumulation for the state. Without a powerful agriculture, there can be no healthy development of industry or the whole national economy. In developing agriculture, we adopt the policy of suiting concrete measures to local conditions and developing a diversified economy. While the steady increase in the nation's grain output must be guaranteed, great effort should be made to develop various kinds of industrial crops, forestry, husbandry, fishery and rural sideline production, and to maintain ecological balance.

Light industrial and textile industrial products make up 43,7% of the value of China's gross industrial output. These products constitute about 50% of the total value, both in the domestic retail market and in the purchases for foreign trade. The capital accumulation provided by the light and textile industries makes up about 30% of the nation's revenue. Therefore, any neglect of the light and textile industries is bound to lead to heavy losses for the whole national economy. In future, the proportion represented by these two industries in the value of the gross industrial output should be enlarged step by step.

The development of energy resources and communications should be accelerated. The requisite policy must open up, and save, energy resources simultaneously. In the years to come, especially, various technical and management measures must be taken, and the industrial structure must be properly re-adjusted, so as to save on energy consumption as far as possible.

China pursues the policy of combining plan-adjustment with market-adjustment. It is an important feature of our socialist economy to develop the national economy in a planned and proportional way and to work out an overall balance. This guarantees the coordinated development of the whole national economy. In the meantime, we actively promote commodity production, attach great importance to the law of value and the functions of the market, protect competition, and make use of economic levers to develop the economy and combine plan-adjustment with market-adjustment.

We should develop our national economy according to our capability; we must not act beyond objective possibilities. The rate of national capital accumulation, which was too high in the past, must be lowered step by step. In future, economic development, for the most part, will not depend on constructing a lot of new enterprises but on tapping of latent power, on making innovations, on the technological transformation of the existing enterprises, and on raising labour productivity and economic benefit.

We should go all out to develop scientific, educational and cultural undertaking so as to speed up the training of qualified personnel for our construction, and to coordinate economic exploitation with intellect exploitation. It is necesseray to open up more avenues for people to study, to actively set up various forms of higher education, to gradually enlarge school enrolment, and to speed up the reform of secondary education and its structure. Great effort should be made to promote technological and vocational education. In-service education should be provided in a planned way for those already in their occupations. Training courses should be organized for them to learn science, technology, economic management and general knowledge.

International cooperation should be actively promoted and the import of technology should be given due attention. This should be based on the specific circumstances of our country. It is necessary to define priorities, assimilate what is important, and to form complete sets of the imported technology.

Family planning work must be done well so as to effectively control the rise in population. One child for each couple should be encouraged and rewarded. If possible, social security should be provided for aged people who have no children.

On the basis of the development of production, the material and cultural life of the people should be improved step by step. In the final analysis, the goal of China's drive for modernization is to meet the material and cultural needs of the working people to the greatest extent. This goal should have its concrete manifestations in employment, increased income, improved medical care, labour protection, increased funds for material and cultural consumption, and other measures. The development of the national economy should eventually manifest itself in an improved livelihood for all: the people.

Science and technology policy

The development of science and technology is part of the nation's integrated development. The formulation of a science and technology policy must be based on the nation's general policy for development, and the former must be coordinated with the latter so as to promote the development of the national economy. At the same time, due attention must be also given to the trends in scientific and technological development in other countries and the objective laws of science and technology.

At present, China's general and specific policies for developing science and technology are the following:

(1) Science and technology on the one hand, and the economy and society on the other hand, should coordinate with each other in their development, and with the promotion of economic and social development as the first and foremost task. When making major decisions and programmes for economic and social development, the state must pay full attention to science and technology as factors. Likewise, when determining the priorities for the development of science and technology, the state must consider the necessities, and the possibilities, existing at the particular stage of economic and social development. We should continue to develop new technology which directly affects economic development and the modernization of national defence, nevertheless, we should pay greater attention to research on, and exploitation of, productive technology to make it serve economic development.

(2) Stress is being laid on research on productive technology and the correct selection of technology so as to form a rational technology structure. At present, special attention should be given to strengthening the weak links in technological research and exploitation. In view of the special circumstances of China, our technological structure should remain as a multi-layered structure of automation, mechanization, semi-mechanization and manual labour, which will exist for a fairly long period. It is not possible to go in too much for technology that is capital intensive. In the near future, it is necessary to develop and improve the labour-intensive technologies.

(3) The exploitation of technology, and its popularization in various factories, mines and other enterprises should be strengthened. The enterprises must go in for technological innovation, and new technology, on a large scale. Scientific research institutes and institutions of higher learning are being encouraged to give active support to technological research in factories, mines and other enterprises.

(4) The steady progress of elementary research must be guaranteed. Economic development and technological progress require a certain reserve capability in basic research, a capability which always plays an important role in the integrated development of modern science. Basic research which is closely connected with the economy must be promoted and strengthened in a planned way. But, in the near future, we cannot go in too much for large-scale scientific research projects that require a huge investment. With the guidelines of maintaining independence, keeping the initiative in our own hands and regenerating through self-reliance, we will actively learn and assimilate advance foreign science and technology and use that which can be applied to the actual conditions of China.

(5) An important way in which China's science and technology can develop is to master, assimilate and digest the scientific and technological achievements of foreign countries. Though China has achieved some results in science and technology which have attained advanced world levels, yet, seen from the nation's situation as a whole, China remains at the stage of trying to master, assimilate and digest foreign scientific and technological achievements. We need not grope for everything from scratch but can make use of the results achieved in other countries and, in this way, we may save a lot of investment and time. What is to be learnt from other countries must be based on our own economic needs, technological foundation, and other conditions. A possible tendency to concentrate on pursuing everything that is up to date should be avoided. Also, our learning the advanced technology of other countries should never mean the weakening of our own scientific and technological research. For, on the contrary, it should become an important way to strengthen our own capabilities in science and technology.

(6) The management system of scientific and technological research should be perfected so as to facilitate scientific and technological development. In this respect we still have some problems, for instance, the dispersal of research personnel, the repetition in some research projects, the appropriation of scientific research funds depending entirely on the state, and the lack of an economic motivating force to popularize innovation on the part of research units and production units. China is now making re-adjustments and reforms. When we carry out research projects we are experimenting with various patterns of management; and it has recently been recommended that:

> Each project is managed by a special group, while various levels should take their respective responsibility; the results must be appraised among persons of the same profession and contracts should be signed to define the rights and obligations of each contracting party.

(7) It is necessary to enliven the atmosphere of learning, to protect the freedom of academic research, and to carry out earnestly the policy of letting a hundred schools of thought contend. In the field of science, free debate among different schools of thought should be encouraged. It is objectionable to use administrative power for forcibly propagating one school of thought while forbidding another.

(8) The work of spreading scientific and technological knowledge should be strengthened. Effective measures should be taken to heighten the scientific accomplishment of leading officials so as to help them master intellectual work and become specialists. Scientific and technological knowledge should be spread among the broad masses of workers and peasants by way of lectures on science and technology, by holding various kinds of training courses and exhibitions, by showing popular science films and television programmes, and by publishing popular science books in large numbers.

Coordination of science and technology policy with development policy

The formulation of the correct development strategy and policies is of first importance to a country. The development strategy is the fundamental guiding principles on which a country determines what orientation, aims, ways and means, and steps it should take in the course of its development. When the development policy is being formulated, it is essential to consider the political, economic, social and other conditions of the country. It is also necessary to make a careful study of the present state of affairs, the trends and the potentialities of the scientific and technological development in other countries in order to forecast what effects science and technology will produce on national development. All these factors must be put under consideration in the development programme so as to make it scientific and far-sighted. Science and technology must work in coordination with the development policy, meet the requirements of the latter, and make proper arrangements in accordance with the state's short, medium and long term requirements.

In China, the development of science and technology and the application of major scientific and technological achievements are all incorporated in the overall programme for the development of the state. Therefore, what we call the development policy covers the substance which makes use of science and technology to promote development. Likewise, what we call the science and technology policy refers to the application of science and technology in this development.

Sources of funds for scientific and technological activities

Generally speaking, our funds for scientific and technogical activities come from three sources.

First, the funds for the development of science and technology (including the capital investment on science and technology) are allocated to various organizations by central and local financial departments at various levels. At present, this includes the bulk of the funds for scientific and technological activities.

Second, every year the state allocates a certain sum of funds to be used for experimentation with new products, major pilot plan and major scientific research projects. Part of this appropriation is in the hands of the State Science and Technology Commission, to be used for the nation's major projects. Another part is used through various departments and provinces to subsidize various units involved in scientific research.

Third, according to the production needs, factories, mines and other enterprises will allocate a certain sum of money out of the enterprise's funds which is to be used for scientific research. Besides, scientific research institutes may gain some earnings by rendering services to other units or by fulfilling tasks entrusted to them. Part of the earnings may be used for science and technology research funds by their own respective units.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

Historical evolution

The contents of the science and technology policy itself are extensive, ranging from major decisions on science and technology, such as the nation's developmental strategy, to local, specific technical policy. Usually, the formulation of science and technology policy cannot be completed by one, or even a few departments in isolation, and major policies must be submitted to the State Council for final examination and approval.

During the initial period after the founding of the People's Republic of China, the Chinese Academy of Sciences was the highest organ for scientific research throughout China and, at the same time, it took on some of the administrative functions involved in leading the nation's scientific and technological work. Major policies on science and technology were proposed by the Chinese Academy of Sciences and put into force with the approval of the Government Administration Council (later the State Council). With the development of science and technology undertakings, the State Council set up the State Science Planning Commission in 1956. In 1958, the State Technology Commission was set up. In 1961, the two Commissions were merged into one, the State Science and Technology Commission. Since then, the Commission has become the chief governmental organization responsible for the formulation of China's science and technology policy. The Commission was disbanded for a time after 1969, and was re-established in late 1977.

The State Science and Technology Commission

Under the State Council, the State Science and Technology Commission (S.S.T.C.) is the ministry in charge of scientific and technological work. In its professional role, the Commission provides guidance to the scientific and technological work of various central government departments and local authorities, and coordinates among them. Its basic responsibilities are:

to formulate science and technology policy;
to decide on the nation's major projects;
to draw up scientific and technological development programmes;
to coordinate scientific and technological activities among various departments and provinces;
to allocate and supervise the use of funds for experimentation with new products, subsidiary funds for major scientific research projects and the funds for major pilot plan projects;

to supervise scientific and technological personnel;
to appraise, register and popularize the application of scientific and technological achievements;
to provide some material facilities for scientific and technological work;
to coordinate international interflow and cooperation in science and technology, etc.

The S.S.T.C. engages scientists from all disciplines to form a certain number of expert groups which give advice to the various departments on research and development work, on branches of learning, and on special fields of study.

When formulating a science and technology policy, the S.S.T.C. first seeks opinions, on a broad scale, from the scientific and technological personnel of various departments. The S.S.T.C. expounds and probes the relevant policies through expert groups or special meetings, and then sums up the correct view from all sources, consults with departments concerned, and drafts policy documents to be submitted to the State Council for consideration and approval.

Other bodies and subsidiary organizations for the promotion of scientific and technological development

In China, apart from the S.S.T.C. and local science and technology commissions, there are also many other bodies and organizations responsible for scientific and technological activities and for rendering assistance to those activities. Chief among them are the Chinese Academy of Sciences, the Chinese Academy of Social Sciences, research institutes of various industries (such as the Chinese Academy of Agronomy, The Academy of Forestation, the Academy of Medical Science, the Research Institute of Steel Industry, the Research Institute of Non-ferrous Metals, the Research Institute of Chemical Industry, the Research Institute of Petroleum Science, the Research Institute of Mechanics, the Academy of Geology, etc.).

Besides, there are many academic societies and organizations, such as the Chinese Association of Science and Technology, the Chinese Association of Popular Science and Technology Publications, etc. The Chinese Association of Science and Technology is sub-divided into nearly 100 specialized academic societies and institutions for the natural sciences. In the last two years, the national institutions under the Chinese Association of Science and Technology have held nearly 1 000 large-scale seminars and submitted more than 100 000 papers on all subjects, thus making positive contributions to the promotion of our scientific and technological undertakings and to the perfection of our science and technology policy. The Chinese Association of Popular Science and Technology Publications has done a lot of useful work in organizing various kinds of scientific and technological exhibitions, academic competitions, and summer camps for science and technology.

To facilitate the development of science and technology, China has also set up various kinds of companies, such as the China Scientific Instruments Company, the China Import and Export of Books Company, the China Scientific and Technological Audio-visual Service, etc.

Organizations for the exchange of information and technological interflow

The Chinese Research Institute of Scientific and Technological Information is the working centre for the nation's scientific and technological information. It shoulders the tasks of collecting, sorting, storing, indexing, translating and publishing scientific and technological information both at home and abroad. Many departments and provinces have also set up their own research institutes for scientific and technological information from different specializations and for different purposes. The departmental research institutes are responsible mainly for the collection and provision of scientific and technological information for a particular discipline. Local research institutes are mainly responsible for the collection and exchange of scientific and technological information in a particular region. There is a division of work among the various institutes, which keep constant contact with one another. From time to time the Chinese Research Institute of Scientific and Technological Information provides the leading authorities in the different professional departments with information on trends in scientific and technological development from other countries for their reference, thus also playing a positive role in the shaping and formulating of China's science and technology policy.

In rural areas, the work of spreading scientific and technological knowledge and popularizing scientific and technological achievements is chiefly done by the country science and technology commissions and the country research centres for agronomy. Generally speaking, there are no agrotechnical stations or scientific farming groups in the rural communes and production brigades.

The importation of foreign technology is under the unified control of special organizations which are responsible for the digestion and assimilation of imported technology. The S.S.T.C. is responsible for the technical appraisal of imported technology, for instance, whether it is up to date and whether it is practicable.

PART 3

Scientific and Technological Potential

3.1 INSTITUTIONAL NETWORK

China's scientific and technological institutional network may be considered under five headings:

i. The Chinese Academy of Sciences and the local academies under its leadership as a whole system

The Chinese Academy of Sciences is the overall working centre for the nation's natural science research work. Its main tasks are to study and develop basic theories, new theories and new technologies in the natural sciences, and to work in coordination with concerned departments so as to solve major general problems of science and technolgy in the national economy and in defence construction, with its emphasis being on basic research and its enhancement.

ii. The scientific research and design institutes under various ministries of the State Council and in the various provinces

With a view to the requirements and features of their respective ministries or provinces, these institutes are mainly engaged in applied research, development research and, if conditions permit, also in some basic research.

iii. The research laboratories in colleges and universities

A large number of qualified scientists are concentrated in more than 600 colleges and universities throughout China. Colleges and universities are both training centres and scientific and technological research centres. They are an important component of China's scientific and technological institutional network. Starting from their own specializations they are also engaged in basic research, applied research, and development research.

iv. The scientific and technological personnel in factories, mines, other enterprises, and in the rural areas

Working in close relationship to their productive activities, they are engaged in technological research, and the application and popularization of their innovations.

v. The scientific and technological personnel in national defence institutes

They are mainly engaged in new technological research as required by national defence.

The S&T personnel at the above-mentioned five institutional facets work in close cooperation with each other, while there is also a division of work.

3.2 THE TRAINING AND USE OF SCIENTIFIC AND TECHNOLOGICAL PERSONNEL

From 1949 to 1979, our colleges and universities turned out more than 2 million graduates in science, engineering, agronomy, medicine and many other disciplines. They have become the backbone of our current scientific and technological work and are playing an extremely important part in the promotion of China's scientific and technological development, as well as the whole national economy.

According to the statistics for 1978, among the 4.34 million scientists and technicians working for the units of the ownership by the whole people, 10 000 were postgraduates, 1.88 million were graduates from colleges and universities, 1.66 million were graduates from special or technical secondary schools, 76 000 were graduates from factory-run colleges or spare-time colleges, and 710 000 had different educational backgrounds. Of the 4.34 million scientists and technicians, 1.41 million were women, about one-third of the total.

During the period between 1966 and 1976, the training of qualified scientific and technological personnel was seriously disrupted and damaged, and many scientists and technicians were persecuted, thus greatly hampering the growth and use of such personnel. As a result of this, there was a serious, though temporary, shortage of scientific and technological manpower.

In recent years, the Government has done a lot to materialize the policy towards intellectuals and to help those scientists and technicians, who were not doing work in accordance with their specialization, to return to their appropriate positions, to bring their specialized knowledge into full play, and to gradually improve their living and working conditions. All this has achieved good results in bringing into play their initiative and enthusiasm. Meanwhile, the Government is taking various steps to open more avenues for people to study, actively developing regular and spare-time education, and intensifying the technical training and re-education of workers and staff members from whom scientific research personnel, engineers and technicians can be trained. In this respect, obvious achievements have been made. From this year on, the system of academic degrees will be adopted. At present, in spite of all this, China is still short of qualified scientists, especially first-rate scientists and technicians.

3.3 THE PROBLEM OF IMPORT AND EXCHANGE OF SCIENTIFIC AND TECHNOLOGICAL PERSONNEL

For the realization of its modernization, China gives great importance to the import of scientific and technological personnel from abroad. Under various forms, scholars, experts and other scientific and technological personnel are invited to China to give lectures or to cooperate in some scientific research for long or short periods. Many departments and organizations in China have invited experts in all specializations, among whom many are foreigners of Chinese origin or Overseas Chinese.

Our scientific and technological personnel are also often invited to work or to give lectures in other countries for a certain period. With the approval of the government, some of them, as they have relatives abroad, have gone there to be reunited with their relatives and friends and to work there.

3.4 FUNDS FOR SCIENTIFIC RESEARCH

The past and the present

Before liberation, China spent very meagre funds every year on the development of science. During the initial period after liberation, the People's Government allocated more and more funds for scientific research year after year. According to incomplete statistics, the funds allocated from state revenue for scientific research and its capital construction (not including the expenditures spent on scientific research by colleges and universities, factories, mines and other enterprises) amounted to 56 million yuans in 1953 and 5 333 million yuans in 1978. In

1978, the funds allocated from state revenue for scientific research were about 1.8% of the gross national income and about 4.8% of the total financial expenditure of the government for that year.

In recent years the state's investment in scientific research has continued on the increase and this will continue to be so in future; however, our funds for scientific research are still insufficient. We must make greater efforts to have a marked increase in funds in the coming five to ten years.

The system of making appropriations

Every year the Ministry of Finance makes appropriations for scientific research in accordance with the state's financial plans. Part of the funds will go down to one lower level after another, through administrative channels, for research institutes to use (including the expenditure for scientific and technological undertakings, on capital construction funds, and on the wages of staff members). The other part of the funds will be disposed of by the State Science and Technology Commission as subsidies for some major scientific research projects, intermediate experiment projects and experimentation with new products.

In making their plans for scientific research funds, research institutes may first propose how much they need. The higher authorities will give the proposals preliminary consideration with a view to the tasks assigned each particular institute. Finally, the plans will be submitted to the planning authorities for overall consideration, balance and approval. When the Ministry of Finance has made the appropriations, various other ministries and departments will give the finalized sums to the research institutes concerned in accordance with their different circumstances.

The appropriations for scientific research are made from state revenue on the basis of the requirements for research projects of the different organizations. So long as the research projects have been approved and included in the national or regional plans, the allocation of funds is assured. But some self-decided research projects, and some research subjects which are not needed by the state, very often cannot get funds.

3.5 INVESTIGATORY AND STATISTICAL AGENCIES ON THE SCIENTIFIC AND TECHNOLOGICAL POTENTIAL

The State Science and Technology Commission, the Scientific and Technological Personnel Bureau under the State Council, and some other departments concerned, are responsible for having all the scientific and technological personnel classified and counted, and for submitting the statistical figures to the departments concerned for their reference. In 1978, the State Statistical Bureau, the Science and Technology Commission under the State Council, and the State Scientific and Technological Personnel Bureau made a joint survey on the total number of scientific research units and personnel, thus playing a positive part in the overall planning for the development of China's science and technology.

PART 4.

State of Affairs and Issues in Scientific and Technological Development

4.1 THE PROGRESS OF MAJOR DEVELOPMENTS

During the 17 years between 1949 and 1966, China's science and technology developed fairly rapidly. In 1956, the State Science Planning Commission, under the State Council, gathered together more than 600 scientists and technologists and worked out the National Programme for Scientific and Technological Development (1958-1967). In accordance with that Programme, a number of departments of newly emerging science and technology were set up or expanded over a short period. In 1962, the Programme was basically fulfilled five years in advance.

Afterwards, under the direction of the State Science and Technology Commission, a ten-year programme (1963-1972) was formulated and our scientific and technological undertakings developed anew until the ten years from 1966 to 1976, when these undertakings also suffered heavy losses. During those ten years, except for some achievements in some individual fields and projects, China's scientific research was basically stagnant in many fields. Heavier losses were suffered in the training of qualified personnel.

In October 1976, the Chinese people smashed the "Gang of Four" and again put forward the grand plan of building a powerful China with the four modernizations; the modernization of science and technology being the key link in the realization of the modernization of agriculture, industry and national defence. The Government attaches great importance to the development of scientific and technological work. In March 1978, the National Conference of Science was held in China, with 6 000 delegates participating. At the Conference, an 8-year programme (1978-1985) for scientific and technological development was put forward and a series of important general and specific policies on scientific and technological development were formulated, and experimental and testing centres and subsidiary units were either restored or newly set up. The Conference produced important results for China's scientific and technological development.

4.2 ACHIEVEMENTS AND PROBLEMS

As regards scientific and technological development, among other examples the following achievements may be enumerated:

i. In the field of natural resources and agriculture. A general survey and study on the natural resources throughout China was made, the nation's agriculture was divided into districts and the first draft of a comprehensive division of China's agricultural districts was written; a number of fine varieties of wheat, rice, cotton and tobacco were bred and popularized (for the most part, these new varieties increased production from 20% to 30%); hybrid rice was grown in large areas; wheat stripe rust was placed under control; the techniques of biological prevention and cure of plant diseases and insect pests were popularized; and Eastern Asia locusts were stamped out.

ii. In the field of medicine and public health. We reached advanced international levels in research work on acupuncutal anaesthesia, microscopic surgery, the prevention and cure of plague on the human body and schistosomiasis; and the early-stage detection of carcinoma of the liver, esophagus, paranasal sinus, pharynx and larynx.

iii. In industry. China succeeded in manufacturing a plant with an annual output of 300 000 tons of synthetic ammonia and 240 000 tons of urea (carbamide). We established and developed our technology for continental stratigraphic exploration of petroleum and we made positive progress in the overall exploitation of metal intergrowth mines.

iv. In the field of new technology and national defence. We established and developed a number of newly emerging sciences and technologies such as atomic energy, jet technology, electronics, semi-conductors, computers, automation, laser and infra-red technologies.

Some positive achievements were also scored in studies of elementary theories of the natural sciences such as the synthetic crystalline of insulin, geomechanics, theoretical mathematics, and the establishment of straton models, etc.

In the past ten years or more, we met with the following major problems in the development of science and technology:

i. As a result from the disturbance and damage of the politically "leftist" deviationist line, China's science and technology could not develop continuously, steadily and with coordination. After the smashing of the "Gang of Four", these difficulties were solved in the main.

ii. Scientific and technological achievements could not be quickly applied to our economic development. There was a lack of close coordination between scientific research, design and production.

iii. In drawing up scientific and technological development plans, the targets were sometimes set too high, ignoring the actual capability of the nation for economic development.

iv. There was a shortage of scientific and technological personnel, especially first-rate scientists and management personnel.

v. We lacked experience in management. There were also some short-comings in the management and structure of the scientific and technological undertakings.

4.3 MAJOR OBJECTIVES AND THE PROBLEM OF MANAGEMENT

In view of the existing problems mentioned above, the major objectives of our science and technology policy include the following:

i. The phenomena of looking down on science and technology and scientific and technological personnel must be wiped out; the erroneous attitude of ignoring the laws of science and acting blindly on one's own subjectivism must be overcome.

ii. It is necessary to further perfect our strategic guidelines on scientific and technological development and to guarantee the close combining of science, technology and economic construction so they may develop in coordination. To promote economic development, to improve the people's livelihood, and to satisfy their basic needs, should be made the first and foremost tasks of scientific and technological development.

iii. As regards the scientific and technological development programme drawn up in the past, necessary re-adjustments should be made in accordance with China's actual conditions so as to make the programme more suitable to the actual level and requirements of our social and economic development. As for the tempo and scale of our scientific and technological development, necessary alterations should be made in the selection of some large-scale scientific research projects. Our basic perspectives for the scientific and technological development in the future are:

a. To strengthen the technological transformation of industry and agriculture, and to make proper arrangements for the tasks in agriculture, in energy resources, in resources and environmental protection, in materials, in machine-building and electronic technology, and in transportation and communications.

In agriculture, to actively popularize the scientific and technological research achievements already made, to improve the ecological environment, to select and breed fine varieties, to draw up properly the natural divisions of regions and agricultural programmes, to develop a diversified economy in line with local conditions and capabilities, and to strengthen the scientific and technological research of agricultural industries.

In the field of energy sources, to pay close attention to technological transformation with an emphasis on the saving of energy, to make a success of exploring conventional sources of energy and nuclear energy, and to develop research work on the new sources of energy.

In the field of natural resources and environmental protection, to develop research work for a thorough investigation of resources, the rational exploitation and exploration, and the prevention of pollution.

In the field of materials, to do good research work on comprehensive exploration and exploitation of metal materials and to strengthen research work on synthetic chemical materials, building materials, and new materials for national defence.

In the field of machine-installation and electronic technology, to heighten the technological level of the machine-building industry as well as the quality of products, to improve the stability and reliability of elementary electronic products and to lower the costs of production.

In the field of transportation and communications, in a coordinated way to develop various forms of transportation, including railways, highways, waterways and airways, and to actively develop waterway transportation and modern means of communications step by step.

b. To improve the people's livelihood and the general level of the people's health. To develop in a big way the research work on light, textile and food processing industries, to strengthen the research work on prevention and cure of malignant tumours and cardiac and vascular diseases, and to improve scientific research on birth control.

c. To strengthen the research work on new technology, including electronic computer technology, atomic energy, laser, remote-sensing and superconduction technology.

d. To guarantee the steady development of elementary research, including high-energy physics, solid-state physics, molecular biology and applied mathematics, especially to strengthen those kinds of basic research that are closely connected with economic development.

e. To strengthen research work on scientific forecasting and modern management.

f. To improve the basic means of scientific research.

iv. The management structure of science and technology should be reformed. This includes many aspects and, among others, the most important ones are:

a. To enlarge the power for self-determination by scientific and technological units, to expand their power in determining research topics and in administering their working personnel, finance and material, and to bring their initiative into play.

b. To popularize the research projects contract system for an experimental period, to gradually change the previous practice of using scientific and technological results without giving rewards into one which uses them and gives rewards, and to actively strive to prepare for the establishment of the patent system in China.

c. To reform the practices for administering the funds for scientific research, to gradually establish "scientific and technological development foundations" for the major projects of basic, applied and development research and, in the meantime, to open up other channels and sources of funds for science and technology; to increase the total amount of the nation's funds for science and technology and their proportion of the value of the gross industrial and agricultural output.

v. To formulate specific policies for various professions, such as an energy resources policy, a resources exploitation policy, an equipment policy and a computer standardization policy, etc.

vi. To strengthen the education and training of scientific personnel. A part from regular colleges and universities where qualified personnel and better educated post-graduates are trained according to plans, there are also many other avenues, such as spare-time colleges, correspondence colleges, telecourse colleges, short and medium term training courses, and spare-time training courses for adults, all for the purpose of training large numbers of scientific and technological personnel. It is necessary to overcome the phenomena where qualified personnel are doing work which is not their specialty. New ways should be found in order to send more students abroad for further studies as well as for actively importing scientists and technicians from abroad.

4.4 THE PROMOTION OF INTERNATIONAL SCIENTIFIC AND TECHNOLOGICAL COOPERATION

The principles of cooperation

The Chinese Government consistently adheres to the principles of giving importance to strengthening scientific and technical cooperation with other countries. The various forms of cooperation are important ways to promote friendship, mutual assistance and the common prosperity of all nations, and they are also an important means for establishing a new international economic order.

In carrying out such cooperation, China maintains that unequal relations and irrational restrictions in the international exchange of science and technology should be changed. China is opposed to the big nations bullying the small and the strong nations bullying the weak by means of their superiority in science and technology, thus damaging the interests of others. China is for ever-lasting and fruitful cooperation among nations on the basis of full equality and mutual benefit.

China's scientific and technological cooperation with other countries

For long, China has been developing various types of activities in her scientific and technical cooperation with the Third World countries, providing, as much as she can, more than sixty countries with economic and technical assistance. The technical assistance which China has provided for the Third World countries includes that in agriculture, forestry, water conservation, electricity, light industry, food processing, textile industry, metallurgy, chemical industry, civil engineering communications and other areas.

China has signed government agreements on scientific and technical cooperation of government agreements on cooperation in industry, economic development, and science and technology with Korea, Argentina, Pakistan, Bangladesh, Thailand, the Philippines, Libya, Zambia, Mexico, Chile, Romania, Yugoslavia, Hungary, Poland, Czechoslovakia, Bulgaria, and the German Democratic Republic. From 1978 to date, China has signed agreements on scientific and technological cooperation with France, Britain, the German Federal Republic, Italy, Sweden, the United States, Greece, Denmark, Finland, Belgium, Luxemburg, Australia and Japan. Under these agreements, extensive activities and cooperation on more than 200 projects, including those for basic research, industrial and agricultural production and new-emerging technology have been completed.

The same period has witnessed great development in non-governmental cooperation and interflow on science and technology between China and other countries. In 1979, several thousand people exchanged visits, thus promoting direct contact between research institutes and academic organizations as well as scientists. For instance, the Chinese Academy of Sciences has established direct contact with the Max Planck Society and the Humboldt Foundation in West Germany, with an exchange of visits between scholars every year.

China's scientific and technological cooperation with other countries takes varied forms which include: inviting foreign experts to China to give lectures, organizing research work to be jointly done by Chinese and foreign experts or scholars, participating in international academic organizations, organizing and participating in international academic conferences and seminars, holding training courses for foreign students, and developing such activities so as to combine technical cooperation and trade, etc.

Another aspect of the international cooperation is to strengthen our cooperation with the United Nations scientific and technological system. Since 1971, when China was restored to its rightful position as a founding member of the United Nations, China has participated in the activities of UNESCO, UNIDO, UNCTAD, FAO, WHO and ILO, etc. Since 1979, China has been an active supporter and participant to the United Nations Conference on Science and Technology for Development and the UN Centre for Science and Technology for Development. In the scientific and technological cooperation with the United Nations, China has provided some funds, scientific and technological results, and given some assistance to the Third World countries; China has also enjoyed some assistance from the United Nations Organization, including assistance for some fairly large-sized research projects.

FIJI*

---

* Prepared by Unesco from information provided by the Central Planning Office, Fiji

Table of Contents

Table 1 - Nomenclature and networking of S&T organizations

(data unavailable at time of publication)

I - First level - POLICY-MAKING

Country: Fiji

Organ	Function	Linkages		
		Upstream	Downstream	Major collateral
....	....	....	....	....

II - Second level - PROMOTION & FINANCING

Organ	Linkages		
	Upstream	Downstream	Other linkages
....	....	....	....

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages	
		Upstream	Other major
....	....	....	....

Table 2 - Scientific and technological manpower

Country: Fiji

Year	Population (millions)	Scientists and engineers and technicians					
		Total stock (thousands)	Natural sciences	Engineering and Technology	Agricultural sciences	Medical sciences	Social sciences
1965							
1970							
1976	0.59	11,179	293	1,644	1,839	292	7,111
1979							
1985							
1990							

Table 3 - R&D expenditures
(data unavailable at time of publication)

Country: Fiji
Currency:

Table 3a: Breakdown by source and sector of performance

Year: Unit:

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive				
Higher education				
General service				
Total				

Table 3b: Trends

Year	Population (millions)	GNP (in)	Total R&D expenditures (in)	Exchange rate US $1 =
1965				
1970				
1975				
1979				
1985				
1990				

PART 1.

General features

1.1 GEOPOLITICAL SETTING

Fiji is located in the Pacific Ocean, between parallels 15°-22° latitude south, and meridians 177° and 174° longitude east. The land surface area is 18 271 sq. km., and the population was estimated to be 638 000 in 1980, with 80 000 living in Suva, the capital city.

The Fiji Group of islands has the typical, tropical, oceanic type of climate. The two main islands of Viti Levu and Vanua Levu each has a wet and dry side, the wet of windward side being in the southeast and the dry or leeward side in the north and west. The prevailing winds of Fiji are southeast tradewinds. The average rainfall is about 340 cm per annum and the temperature varies from 15-35 degrees centigrade.

Land and Water Resources

A large portion of the land in Fiji is steep and mountainous, thus making it unarable, and forest areas make up 45% of Fiji's total land mass. However, an equable tropical climate, with a clear division into wet and dry regions, makes possible some agricultural diversification. Sugar, the backbone of the economy is grown on the leeward side of the two main islands of Viti Levu and Vanua Levu. Rice is also grown in the wet areas of these two islands. Coconut is found on southern (wet) Vanua Levu and on the outer islands of eastern Viti Levu. Other Land resources include cocoa, ginger, passionfruit, vegetables, bananas and citrus. Forestry (pine) is fast emerging as an exportable crop. Major water resources are fish (fresh and canned), prawns, crabs and seashells for local consumption.

Other Natural Resources

Other natural resource includes gold, thermal and geothermal energy, hydroelectricity, copper (yet to be exploited) and small deposits of manganese and phosphate.

Major urban centres are Suva (the capital city), Lautoka, Nadi, Ba, and Labasa on the island of Vanua Levu.

The major seaports are Suva and Lautoko, while Nadi is the international airport.

Political System

Fiji is an independent member of the British Commonwealth. Ties with the United Kingdom are through the Governor General of Fiji and the parliamentary system is based on the Westminster model of a two party system with two Houses: a Lower House (a House of Representatives with 52 members based on ethnic composition; and an Upper House (Senate) constituted of 22 members. The functions of the Senate are mainly symbolic, however the House of Representatives is the supreme law making body and it chooses the Prime Minister and forms the Government with elections every 5 years. The Government is organized into various ministries, the Ministers of which supervise the Civil Service which administrates the country.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

Of the total population of 600 000 in 1980, indigenous Fijians accounted for 44% and Indians accounted for 50%. The remainder were made up of Europeans, Chinese, part-Europeans and Pacific Islanders.

For the Fijians, Europeans and some Indians, Christianity, is the main religion; for Indians the main religions are Hinduism and Islam. The official language is English, but the mother tongue of most Indians is Hindustani while Fijian is the language of the indegenous population.

Economy

The economy of Fiji is primarily agrarian and sugar is its backbone. Apart from sugar (which accounts for 65-70% of domestic exports), major export earners are copra, coconut oil and fish. Rising export earners are timber, ginger, some food products (biscuit and other bakery products) and a few manufactured products (cement, paint). Gold which used to be an important export earner has been declining. Tourism is another key economic factor and is the second largest industry after sugar.

The re-export of crude oil and fish accounts for a substantial amount of the total exports and, since the country has been importing more than it exports, it has continuously recorded a trade deficit. The major import items are manufactured goods, machinery, food and mineral fuels, the latter increasing in their relative share due to the higher oil prices. In 1980, with total exports of $295.6 million and imports of $458.7 million, the trade deficit stood at $163.1 million.

1.3 DEVELOPMENT SCENE

Fiji gained independence in 1970 and since then it has made considerable progress. GDP, at real 1977 prices, has grown from $370.1 million in 1970 to $670.8 million in 1980, that is, at a rate of 6.1% per annum; per capita income grew at an average annual rate of 4% from $710.4 in 1970 to $1051.4 in 1980. However growth has been uneven and fluctuating. Considerable progress has been made with infrastrutural development in the construction of highways and rural roads, jetties, airstrips, irrigation and hydro-electricity etc. Some success has been achieved in diversifying the economic base of the country from primary to agro-processing industries. However, some major problems have been encountered. The country is still heavily dependent on two major industries, namely sugar and tourism, and thus economic performance is adversely affected by the vulnerability of these two sectors to both internal factors such as weather in the case of sugar, and external forces such as recession in major trading industrialized countries. With a small population and limited resources there is not much scope for industrialization and import substitution. The country still imports a lot and there is also considerable dependance on foreign investment, borrowing, and aid. Also, self-sufficiency in food has still not been achieved. However, most of these problems are transient, and moves are underway to increase economic production, to diversify the economic base and to place greater emphasis on regional development. Another major problem facing the country is the increasing rate of unemployment, for job creation is not keeping pace with increases in the labour force.

The major assets of the country include a literate labour force, political stability, and the much greater scope for the processing of agricultural products such as, for instance, sugar into alcohol and ethanol etc.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

The major development objectives of the current five year development plan for 1981-85 (DP8) are:

(i) to strengthen and further diversify the economic base of the country:

(ii) to promote a more equitable distribution of the benefits of development;

(iii) to ensure that opportunities for productive and rewarding social and economic activity are available for those who want it as far as possible;

(iv) to promote policies and attitudes which will increase self reliance;

(v) to promote a greater sense of national unity within the framework of a multi-ethnic society; and

(vi) to promote regional and international cooperation.

Therefore, DP8 attempts to translate over-all national development objectives into sectoral and regional development objectives, policies, and stategies, which in turn are translated into detailed programmes and projects.

The basic strategy of DP8 is one of investing considerably in the increase and diversification of the public sector's output, and in encouraging industrial development which is linked to primary production. The government has attempted to allocate public sector resources for investment in productive activities, and is also encouraging local and foreign private investment in socially and economically desirable directions. It also seeks to re-orient investment regionally to assure an improved spatial distribution of economic activity and, hence, its benefits.

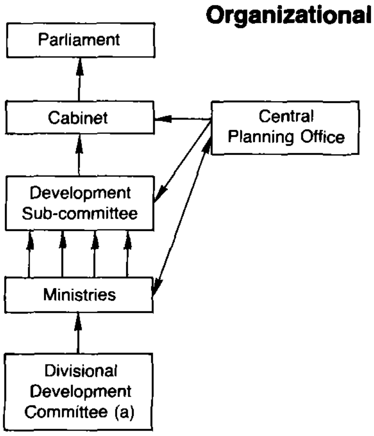
Major undertakings during the plan include the completion of the multi-million hydro-electricity project, the establishment and development of 3 rural growth centres as part of regional planning, numerous agricultural projects for cocoa, citrus, and ginger etc. the setting up of an ethanol plan using sugar, and construction of a dam for provision of water (the Nadi-Lautoka Regional Water Scheme), etc.

Procedures for development planning

The Central Planning Office (CPO) is responsible for the coordination and preparation of development plans and it also is responsible for the monitoring, and review, of the plans. Programmes, policies and projects are identified and formulated through close co-operation with the various ministries, for instance, in Agriculture, Commerce and Industry, Lands, Mineral and Mines, Urban Development, Housing, Social Welfare, Fijian Affairs and Rural Development, Forests, and Works, etc. The co-operation of, and consultation with, divisions such as provincial and advisory councils and local government is also sought.

Once a draft plan is prepared by the CPO it goes to the Development Sub-Committee (DSC) composed of civil servants such as permanent secretaries and heads of departments, for endorsement. After DSC approval it goes to Cabinet for final approval and printing. The plan is then tabled in Parliament where it is debated before being enacted.

Organizational Chart



Note

(a) made up of Advisory Council, Provincial Council and District Development Committees etc.

Prior to DP8 for 1981-85, while the relationship between development policy and science and technology policy was not specifically spelled out, none the less the government ensured, through its various ministries and agencies, that technology policy was consistent with the development objectives of the country: that is, it examined the appropriateness, the employment creation aspects, the use of local inputs and the development of local skills etc. In fact, science and technology policy in Fiji is still in its early stages but, for the first time, as part of new policy initiatives, the government has tried to explicitly incorporate technology policy in its overall development policy. As stated in DP8, it has become increasingly recognized in Fiji in recent years that the choice of technology in industry, agriculture, transport and construction has very significant implications for the degree of success in the implementation of Government objectives. During the DP8 period there will be an emphasis on improving the capacity of the government and the private sector to evaluate, choose and bargain for foreign technology, and, where feasible, to generate it locally. Details are covered in sectoral programmes and projects.

During 1982, a technology policy assessment mission will carry out a comprehensive review of existing government policy, both explicit and implicit, towards technology imports, adaptation and local innovation. Emphasis would be on:

(i) assessing the effectiveness of existing procedures for identifying, screening and controlling the terms for acquisition of imported technologies;

(ii) recommending policies for assuring that limited funds available for local R&D are used wisely; and

(iii) recommending means of aligning Fiji's policies toward technology with its natural development strategy.

2.2 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

Outlining Fiji's national S&T policy-making bodies, there is no one national body. Instead there are numerous government ministries, agencies, statutory bodies and institutions involved in R&D. Over the years there have been a large number of inexpensive technologies developed, used of adapted in Fiji and tested on a modest scale, generally on a part-time basis by interested skilled individuals. A list of bodies involved in S&T policy formulation includes the Ministry of Agriculture, especially the Ministry's Research Station at Koronivia; the Fiji

College of Agriculture which engaged in developing varieties of seed, livestock. etc. ; the Public Works Department which is concerned with solar water heaters; the Ministry of Forests (solar timber and crop driers); the Ministry of Energy (alternative sources of energy); and the Ministry of Commerce and Industry (ceramics/clay, charcoal and wood stoves). Considerable research work is also done at the government owned Fiji Institute of Technology (FIT) on cheap building materials. The Fiji Sugar Corporation (FSC) is involved in research on new varieties of cane. The Government also benefits from the services of the regional University of the South Pacific (USP) which, through its various schools and institutes, is actively involved in research such as on seawave energy, gasohol, and biogas etc.

The promotion and financing of R&D and scientific and technological services (STS) is largely by the ministries and other government institutions and agencies (FIT, FCA etc.) which obtain their funds from the government through the normal annual budget allocations. Also aid and grants are channelled to these ministries and agencies through the formal budget mechanisms. Promotion of R&D and STS is done by ministries through booklets, broadcasting, and information services etc. The FSC has its own funds, the FIT gets government grants while the USP, apart from getting grants from the governments of the member states (80% form the Government of Fiji) also obtains funds from various bilateral and multilateral agencies.

The private sector's role in S&T policy making can be said to be negligible, for example, some local blacksmiths are engaged in making more appropriate farm implements etc. As far as the academic community is concerned, there are some science associations mainly involved in seminars and conferences such as the Fiji Agricultural Science Association, the Science Teachers Association, and some other associations; academic work is done by the School of Natural Resources at USP.

With respect to national institutions established to provide services related to technology transfer one can cite only a few, for example, the extension service section of Ministry of Agriculture, the FSC, and the Rural Technology Workshop which has been recently set up to co-ordinate, display and disseminate technology related to rural development.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

The range of institutions performing scientific and technological activities are certain government ministries (e. g. Agriculture, Energy, Commerce, Public Works, Forestry), statutory bodies and educational institutions (FSC, FIT, FCA), regional bodies (e. g. USP's School of Natural Resources, and the School of Agriculture in Western Samoa). The major organizations such as FSC (formerly the CSR), the Ministry of Agriculture and FCA also have a long history. The USP is relatively large with better research facilities, but is relatively new. These major institutions have proved themselves quite useful and effective in their respective fields, however, there is still room for improvement.

3.2 HUMAN RESOURCES

In the absence of any detailed statistics on manpower it is difficult to provide qualitative and quantitative information relating to human resources development in science and technology in Fiji. While there are now increasing number of students graduating with B.Sc. and B.A., most of them lack adequate specialization in any field of study. There is still only a small number of graduates with Masters and Doctorate degrees. There are no statistics available for people specifically engaged in R&D. However, according to the 1976 Census, there were some 11 179 scientists and engineers in the country.This figure comprised 293 natural scientists, 1 644 engaged in engineering and technology, 9 290 engaged in medical sciences, 1 839 involved in agricultural sciences and 7 111 social scientists. It must be noted, however, that these groupings include technicians as well, and the social science category is inflated due to large numbers of primary and secondary school teachers - no distinction has been made between science and humanities teachers. Thus, there is no way of gauging how many of these 11 160 are strictly engaged in R&D at this time.

3.3 FINANCIAL RESOURCES

There is, in fact, no special funds set aside for research as such. The ministries and agencies concerned receive their annual budget allocation and then allocate amount for various activities they carry out, including research. No statistics on funds going towards R&D are available.

PART 4.

Policy isues in scientific and technological development

4.1 MAJOR DEVELOPMENTS

One cannot think of any major development which has made a major impact on the conduct of research of led to an increase in the national S&T capacity. Nonetheless, over the years there has been considerable awareness generated among both the government and the public on the need to choose appropriete technology for development. The setting of a regional university (USP) in Fiji in 1969 has improved research capabilities in Fiji through consultancy work and research papers, etc. On the national scene, the Ministry of Agriculture, the Fiji Sugar Corporation, and the FIT, continue to do research work in their respective fields. Meanwhile, the number of graduates has increased over the years.

4.2 ACHIEVEMENTS AND PROBLEMS

Achievements have included the development and application of certain appropriate technologies, along with a greater caution in the importation and application of foreign technologies. Major problems still remain with respect to the quality and quantity of manpower for R&D, and the amount of finance going towards R&D is still negligible.

4.3 OBJECTIVES AND PRIORITIES

As a result of these problems a Technology Policy Assessment Mission has been commissioned to carry out a comprehensive survey of the country's S&T policy. The government would, where possible, try to implement these recommendations.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION.

There is no S&T co-operation policy as such with other countries, however, some discussion does take place with other Pacific island countries, including Australia and New Zealand, and through such regional bodies as SPEC and the SPC.

PART 5.

Bibliography

Development Plan (1981-85), Suva, Central Planning Office, 1980.

Census of Population, Suva, Bureau of Statistics, 1976.

HONG KONG*

---

*Prepared by Unesco from documents tabled at CASTASIA II meeting by the Hong Kong delegation.

Table of Contents

HONG KONG

GEOGRAPHY

Capital city: Victoria
Main ports: Hong Kong Harbour
Land surface area: 1,045 sq km

POPULATION (1978)

Total	4.6 million
Density (per sq km)	4,408
Urban/rural ratio	...
Average rate of growth (1970-1978)	1.9%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	27.3	12.4	11.0	39.8	9.4	100%

SOCIO-ECONOMIC

Labour force (1978)	
Total	2.2 million
Percentage in agriculture	1.2%
Gross National Product (1979)	
GNP at market prices	US $15,400 million
GNP per capita	US $3,340
Real growth rate of GNP per capita (1970-78)	6.9%
Gross domestic product (1975)	
Total (in current producers' values)	US $7,548 million
Percentage by origin	
Agriculture	1%
Manufacturing, mining & quarrying, electricity, gas and water, construction	28%
Government finance	
National budget (1977)	...
As percentage of GNP	...
External assistance (official, net: 1976)	...
As percentage of GNP	...
Exports (1978)	
Total exports of goods	US $11,499 million
Average annual growth rate (1970-78)	4.8%
External debt (1978)	
Total public, outstanding + disbursed	US $223 million
Debt service ratio (% GNP)	0.7
(% Exports of goods and non-factor services)	...

Exchange rate (1977): US $1 = 4.66 Hong Kong Dollars

EDUCATION

Primary and secondary education (1978)	
Enrolment, first level	553,530
*As % of (6-11 years)	110%
Enrolment, second level	453,546
As % of (12-18 years)	60%
Combined enrolment ratio (6-18 years)	80%
Average annual enrolment increase (1970-78)	0.5%

---

*The enrolment ratio is the relationship between the number of all pupils enrolled (regardless of their age) and the number of the population of the relevant official ages.

Higher education (third level) (1978)

Teaching staff, total 4,691

Students and graduates by broad fields of study ....

	Enrolment	Graduates
Social sciences and humanities	27,534	4,215
Natural sciences	3,971	513
Engineering	20,255	2,645
Medical sciences	1,140	163
Agriculture	...	...
Other and not specified	61	100
Total	**52,961**	**7,636**

Number of students studying abroad: 22,141

Education public expenditure (1978)

Total (thousands of Hong Kong Dollars)	1,887,620
As % of GNP	2.7%
Current, as % of total	93.1%
Current expenditure for third level education, As % of total current expenditure	...

Table 1. - Nomenclature and networking of S&T organizations

(Data unavailable at time of publication)

I - First level - POLICY-MAKING

Organ	Function	Linkages		
		Upstream linkages	Downstream linkages	Major collateral linkages
....	....	....	....	....

II - Second level - PROMOTION & FINANCING

Organization	Linkages		
	Upstream	Downstream	Other linkages
....	....	....	....

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages	
		Upstream linkages	Other major linkages
....	....	....	....

Table 2 - Scientific and Technological Manpower

(Data unavailable at time of publication)

Country: Hong Kong

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total stock (thousands)	of which working in R&D
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965										
1970										
1975										
1979										
1985										
1990										

Table 3 - R&D expenditures

(data unavailable at time of publication)

Country: Hong Kong
Currency:

Table 3a: Breakdown by source and sector of performance

Year: Unit:

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive				
Higher education				
General service				
Total				

Table 3b: Trends

Year	Population (millions)	GNP (in)	Total R&D expenditures (in)	Exchange rate US $1 =
1965				
1970				
1975				
1979				
1985				
1990				

Introduction

Since 1980, the Hong Kong Government and its advisers have been considering two major reports which have important implications for science and technology in the territory.

The report of the Advisory Committee on Diversification (ACD) of Hong Kong industry published in December 1979 emphasises the need to coordinate and increase Hong Kong's scientific and technological resources and further expand training in these areas. Early in 1981 the Hong Kong Government received a private report following a study, by Cremer and Warner, of the organization of science and technology within the Hong Kong Government and the connections between this organization and the tertiary education sector, the subvented organizations and the private sector. As a consequence of these two reports, considerable reorganization and better coordination of scientific and technological facilities in Hong Kong is underway.

The timing of CASTASIA 1982 was such that there was little point in describing the scientific and technological scene in Hong Kong as it was up to a year ago. On the other hand, the reorganization is by no means complete, although the new pattern is beginning to emerge.

PART 1.

General features

1.1 GEOPOLITICAL SETTING

Hong Kong is a territory ruled by The British Government situated on, and adjoining, the south-east coast of mainland China between longitudes 113°50' and 114°25' East and latitudes 22°10 and 22°35' North.

Population

The total estimated population at the end of 1981 was 5 207 000, comprising 2 716 800 males and 2 490 200 females. This represents an increase of 27% on the 1971 population estimate of 4 090 500.

The average annual rate of increase over the 10-year period was 2.4% with the rate fluctuating from year to year because of changes in the migration flow. During the years 1978-80 in particular, there was large-scale immigration from China, both legal and illegal, and a massive influx of boat refugees from Vietnam. At the same time, the rate of natural increase dropped steadily over the period from 15 to 12 per thousand. This was the result of the birth rate declining from 20 per thousand in 1971 to 17 per thousand in 1981, and the death rate remaining stable at about five per thousand.

Land Surface

Hong Kong, with a land area of only 1 061 square kilometres, is one of the most densely populated places in the world. The 1981 Census recorded an overall density per square kilometre of 4 760. But this figure conceals wide variations in density between individual areas. The density for the metropolitan areas of Hong Kong Island, Kowloon, New Kowloon and Tsuen Wan was 28 479 people per square kilometre; but for the New Territories it was 792 per square kilometre.

Climate

Although Hong Kong lies just inside the tropics it has a remarkably temperate climate for nearly half the year.

An average of 13 tropical cyclones, of varying intensity, enter the South China Sea each year mostly between July and October and about five of them become typhoons, that is, with winds exceeding 33m/s near the centre. The mean annual rainfall is 2 225 mm of which about 80% falls between May and September.

Land Usage

Hong Kong's land area totals 1 064 square kilometres. Of this, 9.2% is used for farming, 74.8% is marginal land with diffrent degrees of sub-grade character, and built-up areas comprise the remaining 16%. The need to establish new towns and expand residential areas in the New Territories has resulted in an encroachment on agricultural land. The losses, however, have been partially offset by highly intensive farming. The City and New Territories Administration is responsible for land tenure and certain aspects of land development in the New Territories.

Class	Approximate area (sq km)	Percentage of whole
Urban built-up lands	96	9.0
Rural developed lands	74	7.0
Woodlands	125	11.7
Grass and scrub lands	624	58.7
Badlands	46	4.3
Swamp and mangrove lands	1	0.1
Arable	80	7.5
Fish ponds	18	1.7

Natural Resources

Apart from providing decomposed rock material as fill for reclamation, the hills that make up most of the total area of Hong Kong have little economic value. Soils are thin and nutrient-deficient, supporting only a sparse cover of grass or scrub except in protected valleys or in water catchment areas where a policy of afforestation has succeeded in establishing hardy pines with some deciduous trees. While Hong Kong does possess some deposits of iron, lead, zinc, tungsten, beryl and graphite, they have been mined only in small quantities.

Because Hong Kong lacks large rivers, lakes and underground water supplies, reservoirs have had to be constructed in large valleys such as Tai Lam Chung, in the New Territories, and in coastal inlets such as Plover Cove and High Island where the land has been reclaimed from the sea. The areas surrounding Hong Kong's reservoirs and their water catchments have become part of the government's Country Parks Scheme. The most important agricultural area Hong Kong possesses is the flat alluvium around Yuen Long in the New Territories.

Shipping

Hong Kong is one of the major ports of the world in terms of the tonnage of shipping using its facilities, cargo handled and the number of passengers carried. Victoria Harbour has an area of some 6 000 hectares and varies in width from 1.6 km to 9.6 km. The Kwai Chung Container Terminal which ranks among the top three container terminals in the world, handled 1.55 million TEU's (20-foot equivalent units) in 1981. The terminal has six berths totalling more than 2 300 metres. In 1981, some 10 600 ocean-going vessels called at Hong Kong and loaded and discharged more than 33 million tonnes of cargo. This included 26 million tonnes of general goods, 52% of which was containerised cargo. Although containerisation is a major cargo transport method, a considerable amount of dry cargo handled in Hong Kong is transported at some stage by lighters and junks of which there were some 2 073 at the end of 1981, some 27% of which are mechanised.

Civil Aviation

In contrast to general, world-wide trends in 1981 Hong Kong recorded a significant increase in both passenger and cargo traffic.

A total of 8.2 million passengers passed through Hong Kong International Airport representing an increase of 21% over the preceding year. The air cargo sector went through a steady year with a total throughput of 290 000 tonnes, an increase of about 12% over the previous year's total of 258 000 tonnes. The value of goods, which amounted to $56 000 million, rose by nearly 27% as compared with the preceding year. Measured against Hong Kong's total trade in terms of value, imports by air accounted for nearly 19%, exports for over 26%, and re-exports for about 24%. The United States remained the major market for both Hong Kong's exports and imports by air, and accounted for 45.2% and 20% of products respectively.

At the end of 1981, there were 31 airlines operating some 1 000 scheduled passenger and cargo services each week. International aircraft movements rose by 1.5%, from the previous year's total of 54 569 to 55 393. About 70% of the aircraft calling at Hong Kong International Airport were of the wide-bodied type.

Administrative and Political System

Hong Kong is administered by the Hong Kong Government and organised along the lines traditional for a British colony. The local head of the government is the Governor. The central government is served by two main advisory bodies – the Executive Council and the Legislative Council. The British Government's policy towards Hong Kong is that there shall be no fundamental constitutional change for which there is little or no popular pressure.

The Governor is the representative of the Queen. As head of the government, he presides at meetings of both the Executive and Legislative Councils. All Bills passed by the Legislative Council must have the Governor's assent before they become law. With strictly defined exceptions, he is responsible for every executive act of the government and consequently exerts considerable influence on the way Hong Kong is run.

The Governor is appointed by The Queen and derives his authority from the Letters Patent passed under the Great Seal of the United Kingdom. The Letters Patent create the Office of Governor and Commander-in-Chief of Hong Kong, and require him to observe its law and instructions given to him by the Queen or the Secretary of State. They also deal in general terms with such matters as the establishment of the Executive and Legislative Councils, the Governor's powers in relation to legislation, disposal of land, appointment of judges and public officers, pardons, and the tenure of office of Supreme and District Court Judges.

On September 1, 1978, the number of appointed members of the Executive Council was increased from nine to ten, making one official and nine unofficial members in addition to the five ex-officio members. The council usually meets once a week throughout the year. Its function is to advise the Governor, who is required by the Royal Instructions to consult it on all important matters of policy, subject to certain exceptions such as cases of extreme urgency. Decisions on matters considered by the Council are taken by the Governor.

In August, 1980, the maximum potential membership of the Legislative Council was increased from 50 to 54 - comprising 27 official members (including the Governor and four ex-officio members: the Chief Secretary, the Financial Secretary, the Attorney General and the Secretary for Home Affairs) and 27 unofficial members. The present actual membership is 24 official and 27 unofficial members.

The primary functions of the Legislative Council are the enactment of legislation and control over the expenditure of public funds. The Council meets in public once every two weeks throughout the year, except for a recess of about two months in August and September.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

Social Features

Buddhism, Taoism, Christianity, Islam, Hinduism, Sikhism and Judaism are practised in Hong Kong. The majority follow Buddhism and Taoism. There are 266 800 Roman Catholics and 201 045 Protestants, 30 000 Muslims, and 8 000 Hindus.

The 1981 Census indicated that the sex ratio of the population was 1 093 males to every 1 000 females which compares with 1 033 in 1971. The increase in the proportion of males over females during the 10 year period is a result of the large influx of illegal immigrants, who were predominantly young and male.

The population of Hong Kong is still young : the 1981 Census reveals that 36.1% were below the age of 20. But the median age of the population was 26, compared with 21.7 a decade ago. As a result of these changes, the proportion of the population of working age (those aged 15 to 64) has increased from 59.7% to 68.6%, indicating that there is a greater potentially productive population available to support children or those who have retired. The dependency ratio- the ratio of the young and the aged to those in the 15 to 64 age group - dropped from 674 per thousand in 1971 to 457 per thousand in 1981.

The 1981 Census showed that 57.2% of the population were born in Hong Kong. About 98% of the population can be described as Chinese on the basis of place of origin. At the end of 1981, the estimated number of non-Hong Kong, British Commonwealth citizens residing either permanently or temporarily in Hong Kong was 666 000. The estimate for non-Commonwealth permanent and temporary residents was 72 900.

Economy

In 1981, the economic conditions prevailing in the world's major industrialised countries, in particular those which represent Hong Kong's major export markets, were generally unfavourable. Yet, against this very unfavourable background the Hong Kong economy, which is highly export-dependent, achieved rapid economic growth. Preliminary estimates show that the growth rate in real terms of the gross domestic product (GDP) was 10% in 1981, easily matching growth rates achieved in the earlier post-recession years. In the circumstances this was a remarkable performance.

While growth in the economy has continued to be rapid, it must be recognised however that, unlike the previous two years, the impetus to economic growth lay with domestic demand rather than with domestic exports. The growth rate in real terms of domestic demand was 11%, significantly higher than that of domestic exports at seven per cent. Given that the export sector is still the backbone of the Hong Kong economy, the situation in which economy growth is led by domestic demand is one that inevitably causes uneasiness.

Although domestic demand played the dominant role in determining the growth rate of the economy, domestic exports held up extremely well during the year. The growth rate in real terms for 1981 as a whole, at seven per cent, was very respectable by current international experience and encouraging in view of the much larger base that had already been built up in recent years. A major reason why this was possible, despite a recession-ridden world, is that the cost/price structure of the economy had been adjusting favourably. However, with domestic demand providing the impetus to economic growth, the growth rate of imports in 1981 exceeded the growth rate of total exports. And as the terms of trade deteriorated in response to changing demand conditions, the visible trade "gap" (that is the proportion of the value of imports which is not covered by the value of total exports) widened, leading to a depreciation in the exchange value of the Hong Kong dollar. This depreciation has been helpful in maintaining Hong Kong's export competitiveness. In consequence, the very sharp slow down in the growth rate of domestic exports in 1980 was reversed in 1981.

At the same time, however, the depreciation exerted an upward pressure on prices. The rate of increase in import prices, particularly in respect of foodstuffs and fuels, was rapid. So the rate of inflation, as measured by the rate of increase in the various consumer price indexes, remained uncomfortably high. The New Consumer Price Index (A) for example, which is representative of the price increases faced by the relatively less well-off 50% of households in Hong Kong, averaged 15% higher in 1981 compared with 1980.

Despite the recessionary economic climate prevailing in some of Hong Kong's major markets, the manufacturing industry, which is heavily dependent on exports, in general performed well during the year. The value of domestic exports in 1981 amounted to $80 423 million, 18% more than in 1980.

The major factors that have given Hong Kong its international reputation as a leading manufacturing and commercial centre over the years contributed to this outcome. Among them are the consistent economic policies of free enterprise and free trade; an industrious workforce; a sophisticated commercial and industrial infrastructure; a modern and efficient seaport that includes the world's third-largest container terminal; a centrally-located airport with a computerised cargo terminal; and excellent world-wide communications.

Light manufacturing industries, producing mainly consumer goods, continue to predominate in Hong Kong. About 67% of the total industrial workforce is employed in the textile, clothing, electronic, plastic product, toy, and watch and clock industries. These industries together accounted for 72% of Hong Kong's total domestic exports.

Non-consumer electronics, which require relatively higher levels of technology, are gaining rapidly in significance. In 1981, exports of non-consumer electronic products were valued at $3 918 million, representing 43% of total electronics exports.

Primary Production

Hong Kong produces a considerable amount of its own fresh food requirements such as vegetables, poultry, eggs, pigs and fish, even though the proportion of the working population involved in fishing and farming is less than three per cent.

According to the United Nations Food and Agriculture Organisation, the territory is one of the world's highest consumers of protein per head of population, with every man, woman and child having an average daily protein intake of some 107 grams; the normal requirement is 70 grams. Local primary producers help to satisfy some of this demand, raising about 61% of the total live chicken requirements and about 21% of the live pigs slaughtered.

The territory's fishing fleet of some 5 000 vessels catches about 90% of all fresh marine fish eaten and pondfish farmers produce about 16% of the freshwater fish consumed.

In addition, farmers in the New Territories grow nearly 38% of the vegetables consumed by Hong Kong residents. The agricultural industry remains buoyant even though a mere 9.2% of Hong Kong's total land area is used for farming.

The government's policy is to foster the development of agricultural industry in Hong Kong, bearing in mind priorities in land usage and the economics of food production and supply in the region. Its objective is to ensure that the proportion of Hong Kong's food supply produced locally is maintained at a reasonable level.

An estimated 30 000 fishermen work a fleet of 5 000 vessels, of which over 90% are mechanised. There are four major types of fishing in terms of gear: trawling, lining, gill-netting and purse-seining. Trawling is the most important, accounting for 65% or 65 000 tonnes of marine fish landed in 1981. The total landed catch of live and fresh marine fish available for local consumption in 1981 amounted to 80 000 tonnes, with a wholesale value of $550 million. This represented 90% of the local consumer demand.

Pond fish farming is the most important culture activity. Fish ponds covering 1 840 hectares are in the New Territories, principally in the Yuen Long district.

In the past decade, there has been considerable development in marine fish culture. Young fish, captured from their natural environment, are fattened in cages suspended from rafts in sheltered bays throughout Hong Kong, particularly in the eastern New Territories. In 1981, live marine fish supplied by this activity from some 60 sites amounted to 960 tonnes valued at $53 million. Legislation was passed in 1980, to promote the orderly development of the marine fish culture industry in the limited sea area available.

Kaolin, feldspar and quartz are mined by opencast methods. Most of the feldspar produced is exported to Taiwan while the quartz and kaolin are consumed by local industries.

Other Light Industries

The electronics industry maintained its position as the second largest export-earner among Hong Kong's manufacturing industries. Domestic exports of electronic products in 1981 were valued at $9 174 million, compared with $8 306 million in 1980. The industry comprises 1 150 factories employing 89 485 workers.

The plastics industry fared well in 1981. Domestic exports during the year were valued at $6 706 million, compared with $5 397 million in 1980. The industry has 5 055 factories and 89 147 workers. Hong Kong continues to be the world's largest supplier of toys, which represented the bulk of the plastics industry's output.

The watches and clocks industry continued to expand in 1981. Domestic exports during the year were valued at $7 409 million compared with $6 576 million in 1980. The industry has 1 813 factory employing 49 005 workers. It is estimated that Hong Kong now supplies over 30% of world production of finished watches.

Other important light industries produce travel goods, handbags and similar articles; metal products, jewellery; domestic electrical equipment; and electrical machinery, apparatus and appliances.

Heavy and Service Industries

Hong Kong shipyards provide a competitive repair service and build a variety of vessels. Several large shipbuilding and repair yards, operational but still under construction on Tsing Yi Island, provide services to the shipping industry.

The aircraft engineering industry has a high international reputation and provides maintenance, overhaul and repair facilities for most airlines operating in Asia.

The manufacture of machinery, machine tools and their parts provides support to other local industries and also contributes to Hong Kong's export trade.

External Trade

Total merchandise trade in 1981 amounted to $260 537 million, an increase of 24% over 1980. Imports went up by 24% to $138 375 million, domestic exports by 18% to $80 423 million and re-exports by 39% to $41 739 million. Domestic exports and re-exports together, valued at $122 163 million, registered an increase of 24%.

Hong Kong is almost entirely dependent on imported resources to meet the needs of its over five million population and its diverse industries. In 1981, imports of raw materials and semi-manufactured goods totalled $55 895 million, representing 40% of total imports. Imports of consumer goods, valued at $36 975 million, constituted 27% of total imports. Imports of capital goods amounted to $20 257 million, or 15% of total imports. Imports of foodstuffs were valued at $14 660 million, representing 11% of total imports. Some $10 588 million of mineral fuels, lubricants and related materials were imported in 1981, representing eight per cent of total imports.

Japan continued to be the principal supplier of imports in 1981, providing 23% of the total. China was the second major supplier, accounting for 21% of total imports, and 49% of imported foodstuffs. The United States ranked third, providing 10% of total imports, followed by Taiwan, Singapore, Britain, the Republic of Korea and the Federal Republic of Germany.

Clothing remained the largest component of domestic exports in 1981, valued at $28 288 million or 35% of the total. Exports of miscellaneous manufactured articles, consisting mainly of plastic toys and dolls, jewellery and goldsmiths' and silversmiths' wares, and other plastic articles, were valued at $13 235 million, representing 16% of total domestic exports. Photographic apparatus, equipment and supplies, optical goods, watches and clocks amounted to $8 101 million, or 10% of the total. Domestic exports of electrical machinery, apparatus and appliance, valued at $5 812 million, contributed another seven per cent of the total. Other important exports included telecommunications and sound recording and reproducing apparatus and equipment (seven per cent of the total), textiles (seven per cent), office machines and automatic data processing equipment (three per cent), and manufactures of metals (three per cent).

PART 2.

Science and Technology Policy Framework

2.1 DEVELOPMENT POLICY FRAMEWORK

With its lack of natural resources to exploit, and its relatively huge population in a largely barren rockscape, the small territory of Hong Kong will for the foreseeable future assign considerable importance to manufacture and trade. The Government intends to continue its successful policy of non-intervention in industry affairs except where persuaded by the private sector itself.

However, there is widespread appreciation that Hong Kong's style of manufacturing, if not of trade, must continue to adapt to the growing sophistication of main world markets, and of its increasingly wealthy local population. This can only happen if the growth rate of investment in plant and equipment is sustained at a rate higher than the growth rate of the GDP, as has been the case in the past 20 years. This will require continuing confidence, and Hong Kong's government and people depend on other governments to ensure this.

Because the scope for the diversification of the manufacturing section is limited by the shortage of land, the Government is prepared to exert careful control over this aspect of development. Still, with little flat land now unoccupied, not much more can be done, given the large amount set aside for Country Park leisure areas, except to continue reclamation for new towns.

The Government has also attached great importance to the continued development of an overall strategy for environmental protection which recognises Hong Kong's special needs and problems.

China's recent drive to modernize the economy has also led to increasingly important opportunities for Hong Kong.

2.2 DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

One of Hong Kong's major needs is to widen its interests and achievements in science and technology, both for its own ends and as a crucial predicate for the movement of manufacturing and exports up-market. For many years, economic development has proceeded well ahead of educational development, particularly of pure sciences or arts. This was not so much a deliberate policy as the result of the very practical approach of a refugee population. A recent survey of students of fifth and sixth form level revealed that only 10% would prefer university study in *either* arts *or* sciences; 90% preferred those less theoretical subjects in demand in the graduate market; and these (viz. Medicine, Law, Social Work, Accountancy, Economics and Business Studies, Computer Studies) are also those where Government recognises manpower demands crucial to Hong Kong's immediate development.

At the same time, it is recognised that the development of science is an increasingly important prerequisite for economic progress and that Hong Kong will not be able to join the advanced countries (with all that entails for the lives of the people materially and spiritually) without more human investment in a wider base of education to provide support for technological change from within, as well as the continued ability to learn quickly from developments in the markets outside.

The relationship between economic development and science and technology was made very clear by a major committee comprising leading businessmen, officials and specialists which was set up in October 1977. This was termed the Advisory Committee on Diversification (ACD) and it reported in 1979. It recommended, among many other changes, the establishment of a standing Industrial Development Board to plan, monitor and advise on the next stages of industrial development.

The Industrial Development Board (IDB), chaired by the Financial Secretary, was set up in 1980 and has pushed forward in certain directions largely relevant to science and technology; in particular the need for local reference standards, quality certification, supply of technical information to industry, and transfer of technology. It has also created, with the help of a special consultancy on science in Hong Kong by Sir Frederick Warner, a more specifically science-based body. The Advisory Committee on Science and Industrial Research (ACSIR) which is chaired by a new senior official, the Science Adviser, who is now responsible for co-ordinating science and technology in Hong Kong. This has given more weight to the previous consultative scientific bodies and integrated the thrust of industrial development with academic and specialist expertise. The Science Adviser, with the help of his Committee, is able to alert government to those areas, whether of local opportunities or international advances, which Hong Kong needs to strengthen in order to keep up its development momentum.

Another recent response to the need for more streamlining of society's natural growth towards science and technology resulted from the Committee to Review Post-Secondary and Technical Education (1981), which has joined with ACD to call for more government input into technical education. Although increased technical education may cause a reduction in the much-valued mobility of the labour force, it has been spotlighted as an area where involvement of public funds is needed. A new Department of Technical Education and Industrial Training has been formed separate from the Departments of Labour and of Education, which previously shared responsibility for a field which had perhaps suffered from inadequate importance, particularly in a fast developing economy.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

Formalisation of policy on science and technology is therefore in the early stages of transformation from a period of admittedly inadequate co-ordination. The aim of the Science Adviser is to support and encourage basic services for science and research, with an emphasis on industrial growth potential for society as a whole; and, within government, to prevent inefficiencies due to duplication or poor communication between those scientific units that already exist. It is not yet considered necessary to restructure "ministerial" portfolios to create a large science organisation, but it is recognised that in these advanced and essential areas government needs to play a more positive role. The time when Hong Kong industries could rely on designs and standards of measurement provided only by overseas customers has passed.

An historical description of policy-making machinery for science and technology may therefore be brief. In fact science policy over the last two decades is the history of the (now defunct) Committee for Scientific Co-ordination, which was formed in 1962 initially to co-ordinate representation abroad and to maximise use of local specialised scientific knowledge, skills and equipment. It was chaired by the Director of the

Royal Observatory and was given the specific tasks of compiling a directory of scientific facilities and of advising the government on any scientific problem.

In 1966 the terms of reference of the Committee were expanded to include responsibilities in technology and it came to play a slightly more significant role in development. It encouraged the government to adopt metrication and computerisation for example, and later urged the centralisation of technical information and the utilization of solar energy.

The consultancy by Sir Frederick Warner, commissioned in 1980, reinforced the Committee for Scientific Co-ordination's concern about the inadequate policy-making machinery in science and consequent slowness of the government's response to industry's needs in scientific matters. The result was the creation of a senior post in Government of Science Adviser provisionnally for two years (during which time he is expected to submit detailed plans for restructuring science and technology policies), and the remaking of the Committee for Scientific Co-ordination into the stronger Advisory Committee on Science and Industrial Research which met for the first time this year.

The placement of the Science Adviser within the central policy-making machinery in Hong Kong, the Secretariat, has considerably shortened the lines of communication. The Science Adviser, and thus science, has the ear of top policy makers in the way that the Committee for Scientific Co-ordination had hoped.

At present the Science Adviser's exact position in the future structure has not been decided. Indeed, his main initial task is to recommend the structure of scientific organization in government. But he may work, as the focus of an advisory network, on a wide range of matters and he has already concentrated on some areas of greatest priority. For example, he leads a new Advisory Committee to co-ordinate Technical and Information Services for Industry (ACTIIS). He is a member of the Industrial Development Board (IDB) itself, and is closely associated with the more scientific developments in the Trade, Industry and Customs Department such as the setting up of a government Calibration and Standards Laboratory and plans for a scheme for the accreditation of laboratories in Hong Kong.

In keeping with self-help, industry-based development in Hong Kong, ancillary industry support organizations have grown up and become increasingly technical in their activities in the last 15 years. The largest among these is the Hong Kong Productivity Centre, a government subvented organization with a technical and management consultancy and training role whose job is to stimulate productivity in the broadest sense of the word. HKPC now provides consultancy to government as well as industry in much needed back-up techno-economic research, for example into the potential for micro-electronics usage and manufacture. The Hong Kong Federation of Industries and the Chinese Manufacturers Association which, unlike HKPC, are member oriented organizations, play similar roles but with main emphasis on product testing and commercial interests. The FHKI has a comprehensive library of international standards for example.

In addition, the private sector plays a direct role in policy-making relevant to science and technology, through membership of the main industry, technical education and training advisory bodies, and of the scientific committees mentioned above. ACSIR and ACTIIS contain representatives from universities as well as industry, and the IDB contains a number of leading industrialists.

At present there is no clear concentration of technology transfer effort. Promotion is done by the Trade, Industry and Customs Department, the Trade Development Council and the industry support organizations. There is little doubt that the most prolific examples of technology transfer occur in the private sector on a company to company basis, often by new companies from overseas setting up in Hong Kong. The Productivity Centre is involved in technology transfer and development. The Government recognizes that better co-ordinated and more sophisticated efforts in technlogy transfer will be required.

PART 3.

Scientific and Technological Potential

3.1 INSTITUTIONAL NETWORK

The tertiary educational institutions are the main scientific and technological bodies. Hong Kong has chosen quality rather than quantity at university level so the two universities and one polytechnic can compare well with similar international institutions. At the same time they are, in comparison with the whole population, fairly small, and the pressure for places makes undergraduate teaching a necessary priority. The University of Hong Kong, established in 1911 and using English as its medium, has 6 284 students. The Chinese University of Hong Kong, founded much more recently in 1963 and where Chinese is the principal language of instruction, is a federal body amalgamating three post-war colleges: Chung Chi College with 1 445 students; United College with 1 597; and New Asia College with 1 375. The Polytechnic is more than twice as large as both the Universities but its courses range from some residual craft work to degree level. It was founded in 1972 and occupies a very central and active site.

The Hong Kong Productivity Centre also carries out research on all matters related to productivity, and these have recently ranged from development of new technology to surveys of the role of squatters workshops in the economy.

Research has not been an outstanding aspect of Hong Kong's educational system, partly because of the attraction of immediate employment for first degree graduates and partly because of the syphoning off of talent to better-provided research establishments abroad. The government is increasingly encouraging research development and design through ACSIR and IDB. The Vocational Training Council aims to point up the varying types of education and training needed to achieve these ends through adequate provision of trained technologists and technicians.

3.2 HUMAN RESOURCES

The 1981 census investigated in detail the occupations of Hong Kong's population, including special categories of scientists and technicians and related occupations in the field of education.

The results will shortly enable us to have, for the first time, an idea of the extent of scientific expertise of all grades in Hong Kong. In addition to this, data was also collected for the 1981 Report on Post-Secondary and Technical Education.

These have made more precise the government's knowledge of the effect, for example, of the brain-drain on Hong Kong's human resources in science and technology as well as in other specialised areas. It is estimated that more than half (up to 20 000) of Hong Kong's students are studying abroad, mostly (75%) in North America. This is not necessarily a bad thing as the population thereby gains a broadening experience which its insular position otherwise makes difficult. Many students return to make use of their expertise in the extensive market for, for example, architects, engineers, accountants and lawyers. But many others use the chance of study abroad to gain employment and citizenship in an environment with more certain long term prospects and more opportunity for further academic study and special interests. This tends to produce a vicious circle as the majority of the most talented students do not have a firm commitment to bring back to Hong Kong their broad experience.

There is no doubting the commitment to education itself, at least in the sense of an aspiration for qualifications. The traditional Chinese respect for those who pass examinations, coupled with the competition for survival in a restricted environment, have instilled in Hong Kong's children, from a very early age, determination and industry in their studies, and this is an important human resource factor. Despite the temptation to find quick money-earning employment as a teenager, the universities are three of four times over-subscribed, and the growth in the number of students in sixth form in recent years has been much greater (1975-80, approximately 100%) than the growth in the relevant age group.

When it comes to estimating human resources for the next decades one has to take into account the strange population picture in Hong Kong. Because of the coincidence in 1978-80 of a big wave of young immigrants of approximately the same age as the children of the previous largest wave (1949-51) large bulges appear in the population range in contrast to a particularly small proportion of the elderly. The school population, and therefore numerical pressures for university and technical places, will not remain consistent into the late 1980's, though it may average out in the 90's. It is calculated that the number of candidates for the Advanced Level examination will increase about 70% in the next five years, and it is estimated that already the number of admissions to the universities could be 2-3 times greater without greatly reducing the academic standard, and that the standard of entrants to the Polytechnic is similarly rising.

In terms of technology in particular, manpower forecasts of supply and demand have been made by the Hong Kong Training Council, now the Vocational Training Council, a semi-independent body with charge of the new Department of Technical Education and Industrial Training. Their rough estimates are that supply of "technologists" will be about 1 500 p. a. by 1985, a 50% growth on today's level. This may be adequate to meet demand as estimated today, certainly in contrast to the shortfall in technicians and qualified craftsmen, but may well itself be a limitation on the move into higher technology in industry that a greater supply of local technologists would encourage. As regards engineers, already much in demand, Hong Kong produces half the number in proportion to the whole workforce as compared with similar South East Asian countries. The government will therefore be looking to increase the supply of human resources at all levels on the technician-to-scientist spectrum.

Graduate labour is valued in Hong Kong. Although those with minor technical qualifications initially earn as much as those with higher qualifications (because of the shortage in the market), the differentiation between them and both commercial and more advanced technology graduates extends quickly during career development. Detailed surveys show that to proceed to higher levels of education is progressively rewarding. Given the emphasis, in a non-traditionalist, semi-refugee society, on money rather than status, caste and background, etc. for prestige, this fact is encouraging for the growth in highly-educated human resources. So, the rough estimates of a local graduate labour demand of three times today's output by the turn of the century should be feasible and should not mean a lowering of standards, though adjustments to the tertiary system itself are needed to produce such numbers. The government has urged the universities to concentrate on expansion of those fields most in demand by Hong Kong's developing economy. On the scientific side this means, in particular, electronics and electronic data processing and, in general, postgraduate education, both in technology itself and also in management of technology. These improvements will take place with the help of the professional bodies who particularize the demand and align it with academic development. This, in turn, raises the appreciation among professional people for the value of research, which, in contrast to graduate qualifications themselves, has hitherto been rather undervalued in Hong Kong.

The government has investigated more radical ideas for increasing the stock of human scientific resources in Hong Kong, beyond expansion of the universities, encouragement of research, and impetus and status given to technical institutes. Distance-learning on the model of the Open University in the UK or Deakin University in Australia has been considered to fill the gap between tertiary demand and supply. But the particular physical characteristics of Hong Kong Society, with the short distances and the crowded home environment, make such schemes less applicable than elsewhere. The present extension system of evening classes using school buildings throughout the urban area caters well for the extraordinary keenness of the adult population to gain more qualifications, and almost 50 000 attend such classes each year.

PART 4.

Conclusion

Identifying the socio-economic structure of the territory of Hong Kong and placing in context the scientific and technological activities, there is now evidence that there has been insufficient coordination and encouragement of science and technology in Hong Kong in the past to meet the needs of a very fast growing economy. There has been no shortage of native intelligence, respect and drive for further education and initiative but there has been, perhaps, a priority for short term returns. In the past, this has not encouraged so readily the support of medium to long term science and technology policies, including research and development. There is now a likelihood that this policy will change. There is increasing realisation that medium to long term development of technical education, scientific research and development, and good local facilities for technical support or advice on legislative matters, needs to be encouraged.

There are fundamentally good resources to support this move. The tertiary education sector in Hong Kong is already strong and can adapt to the increasing need for training technicians and technologists. By and large, industry continues to be profitable and could re-deploy some of its profits into collaborative technical support services and medium to long term research, development, design, and market development. Hong Kong Government itself has a strong technological base to supply some technical services. It is probably the largest single technician/technologist employer in the territory, with something of the order of 1 500 technicians and technologists in the public service, not to mention a larger total in organizations such as the tertiary education institutions and subvented industry support organizations.

CASTASIA 1982 meets at a time when Hong Kong is in the middle of a detailed re-planning of its scientific and technological resources, particularly as they influence, or are influenced by, central government. Detailed planning should be complete in about a year or so.

INDIA

Table of Contents

INDIA

GEOGRAPHY

Capital city: New Delhi
Main ports: Bombay, Mormugao, Visakhapatham
Land surface area: 3,287,590 sq km

POPULATION[1] (1978)

Total	638.4 million
Density (per sq km)	194
Urban/rural ratio (1977)	0.3
Average rate of growth (1970-78)	2.1%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	40.9	10.8	9.0	34.4	4.9	100%

SOCIO-ECONOMIC

Labour force (1971)	
Total	180.5 million [2]
Percentage in agriculture	72.1%
Gross national product (1978)	
GNP at market prices	US $117,520 million
GNP per capita	US $180
Real growth rate of GNP per capita (1970-78)	1.6%
Gross domestic product	
Total (in current producers' values)	US $86,152 million
Percentage by origin	
Agriculture	36%
Manufacturing, mining & quarrying, electricity, gas & water, construction	23%
Government finance	
National budget (1977)	US $11,340 million
As percentage of GNP	10.4%
External assistance (official, net; 1976)	US $1,788 million
As percentage of GNP	2.0%
Exports (1978)	
Total exports of goods (1978)	US $6,614 million
Average annual growth rate (1970-78)	6.0%
External debt (1978)	
Total public, outstanding + disbursed	US $15,326 million
Debt service ratio (% GNP)	0.8
(% Exports of goods and non-factor services)	9.4

Exchange rate (1978): US $ 1 = 8.19 Rupees

EDUCATION

Primary and secondary education (1978)	
Enrolment, first level	68,602,224
As % of (5-9 years)	76%
Enrolment, second level	26,831,109
As % of (10-15 years)	28%
Combined enrolment ratio (5-15 years)	51%
Average annual enrolment increase (1970-1978)	2.7%[1]

---

1. Including data for the Indian-held part of Jammu and Kashmir the final status of which has not yet been determined.
2. Not including unemployed.
3. Second level education refers to general education only.

Higher education (third level) (1976)

Teaching staff, total ... ...

Students and graduates by broad fields of study:

	Enrolment	Graduates
Social sciences and humanities	3,066,726	590,926
Natural sciences	954,011	114,181
Engineering	322,878	13,611
Medical sciences	139,886	21,131
Agriculture	38,692	9,605
Other and not specified	32,808	—
Total	**4,555,001**	**749,454**

Number of students studying abroad ... 13,311

Education public expenditure (1977)

Total (thousands of Rupees) ... 25,548,000

As % of GNP ... 2.9%

Current, as % of total ... ...

Current expenditure for third level education, as % of total current expenditure ... ...

Table 1. Nomenclature and Networking of S&T Organizations

I - First level - POLICY-MAKING and
II - Second level - PROMOTION & FINANCING

Country: India

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
Cabinet Committee on Science and Technology	Providing policy guidelines for the development of Science and Technology in the country and to review its progress	Cabinet	Science Advisory Committee to the Cabinet	
Planning Commission	Formulation of plans by the most effective and balanced utilization of the country's resources and periodic appraisal of the progress achieved each stage of the plan etc.	National Development Council	Ministries State Governments	Science Advisory Committee to the Cabinet
Science Advisory Committee to the Cabinet	Formulation of science and technology policy of Government and the manner of its implementation, considering policy issues relating to the development and application of science and technology and organizational aspects of S&T organizations/institutions including measures to provide adequate linkages between educational institutions, R&D establishments, industry, etc.	Cabinet Committee on Science and Technology	Science departments/Ministries	Planning Commission
Department of Science and Technology	Formulation of policy statements and guidelines on Science and Technology and the following through of their implementation	Minister for Science and Technology	Scientific Organizations/Public Sector Undertakings/Aided Institutions	Scientific Departments, Planning Commission, State S&T Bodies, - Universities
Department of Atomic Energy (R&D)	Research in matters connected with atomic energy and the development of its uses in agriculture, biology, industry, etc.	Minister/Atomic Energy Commission	Research Stations Public Sector Undertakings/ Aided Institutions	Scientific Department, Planning Commission, Universities
Department of Space	Research in matters connected with space and development of its uses	Minister/Space Commission	Research Laboratories/ Aided Institutions	Scientific Departments, Planning Commission, Universities
Defence Research and Development Organization	Design and development of weapons and equipment based on the operational requirements defined by the services and in their indigenous production	Minister/ Department of Defence Research and Development	Research Establishments/ Aided Institutions	Scientific Departments/Universities Public Sector Undertakings
Council of Scientific and Industrial Research	Promotion, guidance and co-operation of scientific and industrial research in the country	President of the Council (Prime Minister)/Department of Science and Technology	Research Laboratories	Scientific Departments/Universities/ Planning Commission
Indian Council of Agricultural Research	Undertake, aid, promote and co-ordinate agricultural and animal husbandry education, research and its application	President of the Council (Minister)/ Department of Agricultural Research and Education	Research Stations	Scientific Departments, Agricultural Universities Planning Commission State Governments
Indian Council of Medical Research	Initiate, aid, develop and co-ordinate medical scientific research in the country, promote and assist institutions for the study of diseases, their prevention, causation and remedy	President of Council (Minister) Ministry of Health & Family Welfare	Research Institute	Scientific Departments, Planning Commission, Medical Institutions/ Universities
Department of Electronics	Promoting the acquisition of technical capability and providing the finances for the design and engineering of pilot plants and prototype production facilities etc.	Minister/ Electronics Commission	Aided Institutions, Industrial Undertakings	Scientific Departments, Planning Commission, Universities
Commission for Additional Sources of Energy	Formulating policies and programmes for and co-ordinating the development of new and renewable sources of energy	Minister	Aided Institutions, Production Units, Field Projects	Scientific Departments, Planning Commission, State Govt. Departments
Department of Environment	Formulating policy and laying down guidelines for environmental protection, conservation, and implementation thereof	Minister/NCEPC	Scientific Organizations/ Aided Institutions	Scientific Departments, Planning Commission, State Environment Boards
University Grants Commission	Promotion and co-ordination of university education and determination and maintenance of standards of teaching, examination and research in universities	Ministry of Education	Universities	Scientific Departments, Planning Commission State Governments

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
State Councils of Science & Technology (such councils have been set up in some of the states while others are in the process of being set up/ activated-total number of states 22)	Identification of problem areas and application of S&T for their solution, Promotion of S&T in the state, Organizing public discussion and debate on S&T policies, plan and programmes etc.	State Governments, Department of Science and Technology	S&T Institutions in the respective states under the control of the State Governments	National laboratories, university science departments, and professional societies
Science academies and Professional Societies viz. Indian National Science Academy, National Academy of Science and Indian Academy of Science, etc.	Organize scientific symposia, workshops, summer schools etc. and publishing scientific journals with a view to popularizing science and technology	Administrative/ Controlling Ministry/ Governing Body		University Departments, National Research laboratories, Scientific Community

Note: The first three institutions listed play a policy making role, the last has a promotional and financing role, and the rest combine both the functions.

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages	
		Upstream	Others
Institutes under Department of Atomic Energy (about 10 in number)	R&D/Scientific and Technological activities	Dept. of Atomic Energy	Research Advisory Councils, University Departments, State Governments
Laboratories under Council of Scientific and Industrial Research (about 30 in number)	as above	Council of Scientific and Industrial Research	as above
Research Establishments under Defence Research and Development Organization (about 30 in number)	as above	Defence Research and Development Organization	as above
Research Institutes under Indian Council of Agriculture Research (about 40 in number)	as above	Indian Council of Agricultural Research	as above
Research centres under Indian Council of Medical Research (about 12 in number)	as above	Indian Council of Medical Research	as above
Institutions under the Department of Science and Technology (about 15 in number)	as above	Department of Science and Technology	as above
Research Centres under the Department of Space (about 5 in number)	R&D/Scientific and Technological activities	Department of Space	Research Advisory Councils, University Departments, State Governments
India Meteorological Dept. Telecommunications Research Centre, Research, Designs and Standard Organization and other Scientific and Technological Institutions under various central ministries and State Govts. (about 400 in number)	Scientific and Technological services/R&D	Concerned Ministries State Governments	as above
Universities, institutions of national importance and institutions deemed universities (about 127 in number)	Scientific and technological education, research and training	Central Government/ State Government University Grants Commission	National Research laboratories, Scientific Departments etc.
Inhouse R&D units of public sector undertakings under various ministries (about 65 in number)	R&D/Scientific and Technological Services	Concerned Ministry	Research Advisory Councils, University Departments, State Governments
Inhouse R&D units of private sector undertaking (about 600 in number)	as above	Board of Directors	National Research laboratories, University Departments

Table 2 - Scientific and Technological Manpower

Country: India

Year	Population (millions)	Scientists and engineers								Technicians	
		Total stock (thousands)	of which working in R&D							Total Stock (thousands)	of which working in R&D
			Total number (in units)	Breakdown by field of educational training (in units)							
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences			
1965	482	261								471	
1970	539	436								739	
1975	598	626	19,360	6,858	6,746	4,852	476	428			17,116(a)
1979	659	762	28,328	9,501	10,655	6,961	679	532		1,323	24,219(b)
1985										1,704	
1990											

(a) Professional Status/breakdown of educational training is not available in respect of 11,852 personnel.
(b) Professional Status/breakdown of educational training is not available in respect of 3,980 personnel.

Table 3 - R&D expenditures

Country: India
Currency: Rupee

Table 3a: Breakdown by source and sector of performance

Year: 1978-79(a)

Unit: Million rupees

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive	632	720	—	1,352
Higher Education	91	—	—	91
General Service	3,761	—	—	3,761
Total	4,484	720	—	5,204

Table 3b: Trends

Year	Population (millions)	GNP at factor cost (in million)	Total R&D expenditures (in million)	Exchange rate US $1 = Rupee
1965	482	218,660	684	4.758
1970	539	364,520	1,396	7.509
1975	598	661,930	3,567	8.937
1979	659(b)	968,500	5,700	8.40 (approx.)
1985	n.a.	1,248,002	8,700	
1990	n.a.	n.a.	11,200	

(a) For Financial Year April to March
(b) According to the 1981 Census, India's population was 683 million.

PART 1.

General Features

1.1 GEOPOLITICAL SETTING

India is the second most populous, and the seventh largest, country in the world. It has an area of 3.29 million sq. kilometres and lies entirely in the northern hemisphere. The mainland extends between latitude 8°4’ and 37°6’ north and longitudes 68°7’ and 97°25’ east and measures about 3 214 km from north to south between the extreme latitude and about 2 933 km from east to west between the extreme longitudes. India has a population of about 685 million people.

The bulk of the population lives in the countryside with more than 70% living in 576 000 villages. There are, at the same time, a large number of urban centres and 2 700 towns and cities have a population in excess of 100 000 and 73 cities, in 1971, had a population of more than one million. The following table covers those cities and urban agglomerations which, in 1971, had a population of one million or above with decennial growth figures for 1961-71, which are in some cases based on provisional data for 1971. All important places in India are connected by rail, road and air.

	Area (1971) sq km	Population (1971) .000s	Decennial growth (%) 1961-1971
Acra*	87.8	635	25.4
Ahmedabad	93.0	1,586	38.1
Allahabad	82.2	513	19.3
Bangalore*	174.7	1,654	43.0
Bombay (Greater)	603.0	5,971	43.8
Calcutta*	568.8	7,031	22.1
Delhi*	446.3	3,647	53.9
Hyderabad*	298.5	1,796	44.0
Indore*	58.7	561	45.0
Jabalpur	221.5	535	45.4
Jaipur	206.1	615	52.0
Kanpur*	299.0	1,275	31.1
Lucknow*	127.7	814	26.0
Madras	128.0	2,469+	42.9
Madurai	20.9	549	29.1
Nagpur	217.6	866	43.3
Patna*	78.2	491	34.5
Pune	138.9	856	42.8
Varanasi*	84.5	607	19.0

* Urban agglomeration

\+ Madras urban agglomeration: 3,710 thousand

Extending from the tropics in the south to the heights of the Great Himalayas in the north, India has a varied climate. The weather changes seasonally, and from region to region. Generally, the winter months of November until March are pleasant throughout the country with bright sunny days. In the northern plains it is, at times, very cold and there are heavy snowfalls on the hills. In eastern India, however, the cold spell does not last long. In western and the southern India there is no cold spell as such, but there are several hill resorts over 1 500 to 1 900 meters above sea level which have a cool climate throughout. Elsewhere, the summer from April to June is generally hot with temperatures going up to 47°C. The country receives its annual rainfall from the monsoon which breaks about the middle of June on the west coast and is active till the middle of September. The eastern coast area also receives winter rains.

There is also a great variety in the land and water resources. All types of land characteristics exist, from the great Western Desert of the Thar to the snowy mountains of the Himalayas, the great rain valleys of Assam, the tropical forests of Central and South India, and the coastal lands. In terms of water resources, there are large numbers of major river systems including the Indus Valley system tributaries. In the north, the Ganges and the Yamuna system which travels from west to east, the Bhramputra system which joins the Ganges in the east, the great central Indian rivers, the Narmada and Tapti which flow west, and a number of southern rivers flowing into the east coast of which the Krishna, the Godavari and the Kaveri are the best known. There are also large numbers of lakes, ponds, canals and waterways.

In terms of mountains, apart from the chain of high mountains Himalayas in the north, the east coast and the west coast both have mountains known as the Eastern and the Western Ghats and there is also a central range of mountains called the Vindhyas. The eastern area of India is also mountains with a number of hills in the States of Assam, Meghalaya and the North-Eastern States.

The Indian Republic comprises 22 States, some of which are larger than Great Britain or Italy; there are nine centrally administered territories. The Head of the Republic is the President. The executive authority vests in the Council of Ministers responsible to Parliament which consists of the Rajya Sabha (Upper House) and the Lok Sabha (Lower House). The Lok Sabha is elected on the basis of universal adult franchise. The term of each Lok Sabha is five years after which elections are held. The States have Constitutional Heads who are assisted by Councils of Ministers responsible to the local legislatures which are also elected on the basis of universal adult franchise.

The administration of the country is carried out both by central and state governments. The list of subjects to be handled by the Centre, by the States, or concurrently by both are defined, and the Central and the State ministries oversee and implement the administration of these subjects. The states are, in turn, divided into districts, sub-districts and villages, each having an administrative structure. Some of these have been in existence since very ancient times as India’s civilisation is one of the world’s oldest, dating back at least to the end of the fourth millennium B.C.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

When the Aryans first came to India about 1,500 B.C. they found a highly developed urban civilisation in the country which was superior to their own. The cities were well-planned with wide roads, sanitary facilities, drainage, baths, and granaries, and the houses were built of burnt brick. Out of the intermingling of the Aryan and the pre-Aryan cultures of India developed the Hindu religion and civilisation. Later, movements to reform the Hindu faith found expression in Buddhism and Jainism. Christianity came to India in the very first century A.D. and Islam also came in the seventh century A.D. Subsequently, the Zoroastrians came from Persia and groups of Jews also came and settled in India. Another great religion which was born in India was Sikhism. Thus, almost all the religions of the world are represented in the country today and all these religions have flourished since ancient times.

Hindi is the official language of India. It is spoken by 163 million people and understood by millions more. English also enjoys the status of an official language of India and is understood by all educated people. Several major languages exist in India which are also official languages in their respective States. The principal languages spoken and number of people speaking them, according to the 1971 census, is given in the following table.

In addition, there are 844 dialects of which 47 have more than 100,000 people speaking them.

Language	Persons speaking (millions)	Language	Persons speaking (millions)
Assamese	9.0	Marathi	42.3
Bengali	44.8	Oriya	19.9
Gujarati	25.9	Punjabi	16.4
Hindi	162.6	Sindhi	1.7
Kannada	21.7	Tamil	37.7
Kashmiri	2.4	Telugu	44.8
Malayalam	21.9	Urdu	28.6

The economy is still largely based on the agricultural sector as the bulk of the population lives in the villages. Agriculture accounts for the largest single item in the domestic product, amounting to 51% of the total. In the last 30 years, however, a very large industrial base including heavy, medium and light industries has been built up, and today India is considered to be among the first ten countries of the world in terms of total industrial production. The industrial production is based largely on local resources as India has fairly extensive resources of coal, hydro-electricity and minerals such as iron, manganese, mica and aluminium; India has also discovered petroleum both on-shore and off-shore. The manufacturing sector produces and processes these resources and includes heavy industries such as steel, metallurgical, chemical and heavy engineering, and also light industries including machine tools, electrical, mechanical and electronics products, and a large variety of consumer goods.

The major foreign trade exports are jute yarn manufactures, textile yarn and fabrics, steel, iron ore and concentrates, hides and skins engineering goods, manufactured items including mechanical, electrical and electronic goods, tea, and consumer products. The major imports include machinery, iron and steel of special types, and petroleum. Certain raw materials, such as special types of raw cotton, are also imported.

The balance of trade had been developed to be almost in equilibrium, with exports equalling imports by the year 1976-77. Subsequently, the increasing growth in the price of oil, and of certain manufactured goods which have had to be imported, have put a considerable pressure on the balance of trade. However, exports continue to increase and they continue to be of the order of 85% of the imports. This, coupled with remittances from Indian technical, scientific and medical specialists, and labour working abroad, has kept the overall foreign exchange position relatively stable for the last few years. Nevertheless, the developing economy and the increasing population require continuously increasing inputs of goods and services, and hence all the production figures in India and exports have to continuously rise.

1.3 DEVELOPMENT SCENE

As mentioned in the previous paragraphs, a great deal of development has taken place in India in both agriculture and industry. Agricultural production has increased by a factor of 3 since the time of Independence in 1947, and this has made India agriculturally self-sufficient for several years now. Furthermore, a very strong industrial base has been created. Some basic indicators of growth are outlined in the table on growth performance in the five-year plans.

It will be seen from this table that the national income per capita has risen considerably. The overall production of goods and services and the generation of wealth have increased much more. However, the increasing population has been having an adverse effect on the per capita figures and, therefore, on the rate of increase in the standard of living. One of the major problems hindering the development process is this increasing population, along with the difficulty of meeting the requirements of a large, diversified country in the distribution and transportation of goods and services.

These problems have been compounded by the increasing prices of imported oil as well as other imported manufactured goods. The increase in population is a result, largely, of reductions in the total death rate and infant mortality due to improvements in health and medical facilities. Yet, stabilisation of the population is a long term goal which is complicated to achieve because it is also dependent on increases in the standard of living, education and awareness, as well as on improvements in labour and industrial productivity.

Dealing with prices and availability of outside imports is largely a question of exports and of appropriate international arrangements. In the long run, however, India has a number of local assets which help to strengthen self-reliance and self-sufficiency. It has a number of indigenous resources, including petroleum, which are expected to increase with further efforts at exploration. It has also embarked on various programmes for augmenting its indigenous energy supply from coal, hydro-electricity, nuclear and, lately, from renewable sources of energy such as solar, wind, biomass and other energies. A major asset is a large trained manpower in all fields including scientific, technical and industrial. This manpower, with increasing experience and further training, could be deployed for meeting the growing demand for goods and services.

Growth Performance in the Plans

(Annual Growth Rate Percentage)

Items	First Plan 1951-52 to 55-56	Second Plan 1956-57 to 60-61	Third Plan 1961-62 to 65-66	Annual Plan 1966-67 to 68-69	Fourth Plan 1969-70 to 73-74	Fifth Plan 1974-75(a) to 78-79(b)	1950-51 to 1978-79
1. National income	3.6	4.0	2.2	4.0	3.3	5.4(c)	3.5
2. Agricultural Production	4.1	4.0	-1.4	6.2	2.9	4.2	2.7
3. Industrial Production	7.3	6.6	9.0	2.0	4.7	5.9	6.1
4. Per Capita Consumption	1.7	1.8	0.1	2.0	0.4	2.3	1.1
5. Gross Fixed Investment	3.0	5.8	8.7	1.5	3.1	6.6	5.5

Notes: (a) *This column gives the trend rate calculated from a semilog regression. All other columns give compound growth rates between the base year before the Plan and the year of the Plan.*
(b) For the time period originally envisaged for the Fifth Plan.
(c) This is the growth rate for net national product (national income).
The growth rate of gross domestic product over this period was 5.2%.

PART 2.

Science and Technology Policy Framework

2.1 DEVELOPMENT POLICY FRAMEWORK

Recently, a new Five-Year Plan has been prepared in India which has defined the global and sectoral objectives and priorities of development. The development perspective, choice of strategy, and targets, are outlined in the Sixth Plan.

The basic task of economic planning in India is to bring about a structural transformation of the economy so as to achieve a high and sustained rate of growth, a progressive improvement in the standard of living of the masses leading to the eradication of poverty and unemployment, and provide the material base for a self-reliant socialist economy. During the thirty years of planned development, which we have now completed, impressive progress has been made in the fields of agriculture, industry, science and technology, health and education, and in the development of the infrastructure for a wide range of services. However, the progress achieved has fallen short of objective needs and expectations. In formulating the objectives and priorities of the Sixth Plan, we have to take note both of past achievements and shortcomings as well as new developments in the domestic economy and in the international economic environment. While the basic objectives of planning remain unchanged, priorities, programmes and targets must be set out after a careful evaluation of needs, constraints and potentialities.

The Sixth Plan has been formulated against a future perspective covering a period of 15 years from 1980-81 to 1994-95. This development perspective visualises accelerated progress towards the removal of poverty, the generation of gainful employment and the attainment of technological and economic self-reliance. The strategy to attain these goals has been chosen after considering a variety of feasible alternative development profiles with their attendant costs and benefits. Experience shows that a substantial acceleration in the overall rate of growth of our economy, as measured by the growth of gross domestic production in real terms, is an essential condition for the realisation of these objectives. However, there is also convincing evidence which points to the limited effectiveness of a "trickle down" effect. Therefore, consistent with our overall social and economic objectives, public policies will have to acquire a sharper redistribution focus in raising the share for the poorer sections from national income, consumption, and the utilisation of public services. Thus, specific action programmes, such as the national rural employment programmes and other anti-poverty schemes meant for selected target groups of the population, are essential components of a strategy designed to assist in the removal of unemployment and poverty.

In selecting a growth path we have to consider the trade off between a faster growth in the medium term, with the consequence that the growth might slow down later on, and, conversely, somewhat slower growth now to permit faster growth later. Although, at any given time, meaningful investment choices are limited by the fact that on-going projets absorb a substantial proportion of available investible funds, there is always some choice at the margin in the sense that the mix of new projects can be altered in favour of quick maturing and directly productive projects. However, in so far as such a choice leads to less investment in long-gestation infra-structural projects, the long-term growth rate may be adversely affected even though the short term prospects may improve.

A large number of social and economic indicators have been used in selecting the development strategy for the Sixth Plan and the decade thereafter. Some of theses indicators belong to conventional national income aggregates such as gross domestic product (GDP) and its components, and figures on consumption, savings and investment, employment, and per capita income. Others fall in the category of specific social welfare indicators such as the number of people below the poverty line, the per capita consumption basket, the life expectancy, etc. The principal indicators for the preferred alternative are shown in Annex 1 in the Table on the development perspective 1979-80 to 1994-95, while Annex 2 outlines the commodity output figures for 1979-80 and the projections for 1984-85.

In development planning evaluation and control India has a fairly long experience, as it started planning in 1951. The current plan is the Sixth Five Year Plan. For development planning purposes a Planning Commission exists at the central level, and this works with various ministries of the government at the centre and in the states. It is responsible for preparing national plans as well as state plans, and for monitoring and evaluating these plans. Mechanisms for these purposes are provided at both the central and the state levels.

2.2 DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

It has been recognized in India that Science and Technology Policy should have an intimate relation to, and contribute towards, the overall development policy. For this purpose there is a special section in the Sixth Five Year Plan document devoted to the S&T Policy for the current Five Year Plan. The policy formulation in S&T has been carried out by the machinery mentioned in Part 2.3 below. This is intimately linked, both horizontally and vertically, with the overall planning machinery in order to ensure the adequate dovetailing of the two policies. A Department of Science and Technology, the head of which is the Prime Minister, has been charged with the responsibility for coordination of S&T activities and Plan formulation at the national level.

The science and technology system in India may be viewed at three levels, namely, the national level, the agency level, and the institutional level. The national level takes into account the overall needs and the problems of the country. The National Planning Commission considers the plan for science and technology as a part of the overall socio-economic plan in consultation with the National Committee on Science and Technology. The problems at the national level include establishing the priorities for the different sectors of research and allocating resources to them, as well as generating the scientific and technological potential to achieve the national objectives. The plans of individual agencies are approved in consonance with national priorities, the requirements of other important sectors, and the availability of funds.

The second level consists of agencies like the Council of Scientific and Industrial Research, the Indian Council of Agricultural Research, the Indian Council of Medical Research, the Department of Atomic Energy, the Department of Space, the Defence Research and Development Organisation, the Department of Science and Technology, and other ministries and departments of the central government. In the case of all agencies, research plans from various constituent institutions or laboratories are referred to the corresponding agencies and the plans are viewed in the light of the broad guidelines indicated at the national level. After approval by the appropriate apex decision-making agencies, the consolidated plans are then sent to the National Planning Commission for approval. In the case of government ministries or departments such as Industry, Railways, Transport, Communication, Civil Aviation, and Energy, the research plans of the institutions are approved by the respective ministries or departments and then passed on the Planning Commission (along with their other plans) for approval.

The third level is the institutional laboratory level. At this level, research projects are formulated according to the priorities indicated by the first and the second level agencies.

The setting up of the National Committee on Science and Technology (NCST) in 1971 was an important step towards the systematic planning of science and technology for development. A major effort was made by the NCST to prepare a comprehensive science and technology plan as an integral part of the socio-economic plan (Fifth Plan, 1974-79). The planning process involved the identification of gaps in the national science and technology endeavour in 24 sectors which related to the Plan's objectives. Further, the preparation of the Science and Technology Plan involved about 2 000 scientists, technologists, planners and implementors.

In the Science and Technology Plan for 1974-79, programmers were designed to have a major socio-economic impact and the main emphasis was placed on interdisciplinary and multi-institutional projects, as well as on sponsored projects and in-house R&D in industry. Attention was given to the enhancement of science and technology inputs into areas like Khadi and village industries, as well as energy, exploration and exploitation of natural resources, agriculture, fertilizers and chemicals, coal, steel and mines, and waste utilisation etc. Three important features of this planning have been: (a) laying as much emphasis on the development of engineering, design and fabrication skills as on the development of process/product technology; (b) making the existing science and technology infrastructure more effective through the provision of additional facilities, rather than creating new organisations; and (c) emphasising rural development.

The Science and Technology Plan provided a useful check-list of programmes and projects. However, suitable mechanisms for their implementation, monitoring and review could not be devised until the middle of the Fifth Plan. At this juncture, the Planning Commission started discussions on the science and technology component of each economic ministry or department. These discussions have helped to create greater awareness in the economic ministries of the science and technology inputs which could further their sectoral objectives. As a part of this process, Special Committees for Implementation of Projects (SCIP) in each economic ministry or department were constituted to oversee the progress of science and technology projects. These have been some of the important steps in the promotion of science and technology activities on a continuing basis.

An illustration of further progress in making S&T policy consonant with development goals and objectives is the formulation of the recent Five Year Plan for overall economic and technical development. In March 1980, when the government decided to embark on the formulation of a new Five Year Plan for the period 1980-85, the Planning Commission set up working groups to go into the plans of various sectors of the economy and of various ministries. The Department of Science and Technology and the Council of Scientific and Industrial Research then deputed representatives to participate in the discussions of these working groups with the objecting of identifying S&T activities and relating these to the objectives and targets prepared for these sectors.

Meetings of scientists were also organised at various places in the country to obtain their views on the S&T component of the Sixth Plan. At the end of this exercise a Conference of scientists and technologists was organised, on 2-3 August 1980, to discuss the S&T plan frame. The views expressed in this meeting, and the background papers prepared for it, constituted important inputs for the final document on the S&T component of the Sixth Plan. Thereafter, the Planning Commission constituted a Working Group which, on the basis of five meetings held between September and November 1980, completed the final report which was suitably incorporated in the Sixth Plan document and subsequently approved by the National Development Council.

In this way an attempt was made to link S&T planning with overall development planning, and since institutional machinery exists specifically for the overall economic plan, it is possible by the processes described to increasingly link the S&T plan to the overall planning process. This method also attempts to involve a large number of scientists and technologists throughout the country in the process of thinking about, identifying, and formulating the Plan and policy so as to ensure that S&T activities are not only linked with overall economic activity, but that the potential of such activities are taken into account in the setting up of economic and social targets and objectives in the overall National Plan framework. With this method, the funding of scientific and technological activities is accepted as a part of the overall Plan, which ensures that activities are funded in accordance with the requirements of the overall Plan and that these activities contribute towards the objectives and priorities of the Plan.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

In part 2.2 a description has been given of the methods followed in India for making policy relating to S&T. The development of national S&T policy-making bodies over recent years is given below.

Prior to Indian Independence, in 1947, there were a number of science and technology institutions in the country. Notable among the institutions set up in this period were: the Survey of India (1767); the Geological Survey of India (1851); the India Meteorological Department (1875); the Indian Research Fund Association (1911) (now the Indian Council of Medical Research); the Imperial Council of Agricultural Research (1929) (now the Indian Council of Agricultural Research); and the Council of Scientific and Industrial Research (1942). In addition, there were 20 universities.

During the post-independence period, an extensive institutional network with a chain of research laboratories was set up . The Atomic Energy Commission was formed in 1956, and the Defence Research and Development Organisation was established in 1958. Realising the vital role of science and technology in national development, the Government of India gave pre-eminence to science and technology in the scheme of things. Science and education received special consideration. The Scientific Policy Resolution of 1958 indicated the government's intention to support science and technology in order to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific activity. The result has been that scientific activity has quickened in pace and broadened in scope so that now we have a substantial institutional infrastructure with capabilities in a variety of technologies covering the fields of agriculture, medicine, defence, atomic energy, space, and electronics, as well as a host of industrial technologies.

With a view to developing a suitable mechanism for obtaining scientific advice, at the highest level, the government set up the Science Advisory Committee to the Cabinet (SACC) in 1956 with explicit and wide-ranging terms of reference. This was replaced by the Committee on Science and Technology (COST) in 1968, with slightly wider terms of reference. In 1971, this was replaced by the National Committee on Science and Technology (NCST). One of its specific mandates was the preparation, evaluation, and updating of national scientific and technological plans, besides coordination and other such work.

The NCST was reconstituted in July 1977. The important terms of reference of the NCST include the formulation and implementation of the science and technology policy of the Government, the determination of priorities in science and technology, and the achievement of coordination and cooperation betwen science and technology institutions. The NCST has completed its work and its term. Now, a Science Advisory Committee to the Cabinet and a Cabinet Committee on Science and Technology have been established. The Department of Science and Technology, under the charge of the Prime Minister, acts as the nodal department for these committees.

Science and Technology programmes in the country are carried out through the Council of Scientific and Industrial Research (CSIR), the Indian Council of Agricultural Research (ICAR), the Indian Council of Medical Research (ICMR), the Defence Research and Development Organisation (DRDO), the Department of Electronics (DOE), the Department of Atomic Energy (DAE), the Department of Space (DOS), and the Department of Science and Technology (DST). In addition, there are a large number of scientific institutions attached to various ministries which carry out research programmes of practical application in their respective fields, such as irrigation, energy, civil aviation, railways, telecommunication, and meteorology etc. Also, an increasing number of public sector and private sector enterprises carry out research in their respective fields through their own R&D units. Research in universities is being carried out with the support of the University Grants Commission (UGC) and through the sponsorship of various scientific agencies. State governments maintain research establishments in selected areas of relevance to them, and State Councils on Science and Technology have been set up in some states. The activities of all these various science and technology institutions form an integral part of the national science and technology endeavour.

PART 3.

Scientific and Technological Activities

3.1 INSTITUTIONAL NETWORK

As indicated in Part 2 above a large network of institutions engaged in scientific and technological activities has been built up in India over the last three decades. This includes major scientific agencies and the laboratories and institutions under their control, as well as universities, institutes of technology, engineering and science colleges, in the public as well as in the private sector. These institutions, and the laboratories and institutions of industries, may be grouped together as under the headings of institutions in the central sector, the state sector, the public sector industries, the private sector industries, or science education and research in universities and institutes of technology.

The major share of research and development is carried out under the auspices of the central government. This includes major scientific agencies such as the Department of Science and Technology, the Council of Scientific and Industrial Research, the Department of Atomic Energy, the Department of Defence Research, the Indian Council of Agricultural Research, the Indian Council of Medical Research, the Department of Space, and the Department of Electronics. Each of these agencies has a number of laboratories and institutions under it and, together, these account for more than 77% of the total expenditure on research and development by the central sector. The balance of about 23% is carried out by various central ministries or departments through laboratories and organisations under their individual control. Two-thirds of the total R&D personnel in the country is employed in the central government which accounts for about 80% of the total expenditure on R&D and science and technology activity in the country. The major scientific agencies, as mentioned earlier, operate largely through commissions or councils which are provided with necessary administrative and financial powers of the Government of India in order to take expeditious decisions.

The state governments have also been steadily increasing their efforts in R&D and related science and technology activities, and in the year 1978-79 this effort represented 7.6% of the total national endeavour. R&D activities under the state governments are mostly of an applied nature, while the R&D in the central sector includes 16% basic research, 55% applied research, 25% experimental development, and 4% other research programmes (1978-79).The public sector enterprises also have R&D units attached to them and in 1978-79 these added up to about 12% of the total R&D expenditure at the national level. Additional activities in S&T are carried out by R&D units in private sector industries, several of whom have established in-house R&D units. The investment in these units came to about 13.8% of the total investment in R&D at the national level.

3.2 HUMAN RESOURCES

Table 2 gives a quantitative picture relating to human resource development in science and technology. The total stock of economically active scientific and technical manpower in the country has increased from 118 000 in 1950 to 1.94 million in 1978 and is expected to grow to 2.47 million in 1983. The growth rate in this manpower stock since 1950 comes to 8.5% per year, and it includes science, engineering, medical and agricultural graduates and post-graduates, engineering diploma holders, and medical licenciates. There is, however, a certain amount of unemployment within this stock of science and technology manpower which, in 1977-78, came to 12.2%. Attention is being constantly given to increasing the employment opportunities for S&T personnel, to rationalising the intake of the universities, and to reviewing the quality, adequacy and relevance of training to resolve this unemployment problem.

3.3 FINANCIAL RESOURCES

Scientific and technological activities in India are largely funded by the government. The expenditure on R&D in 1978-79 was about Rs.5.2 billion which is about 0.6% of the GNP. This may be compared with a figure of Rs. 10 million at the time of independence. Among the major organisations supporting R&D activities in the country are the Department of Science and Technology, the Council of Scientific and Industrial Research, the Department of Atomic Energy, Space and Electronics, the Indian Council of Agricultural Research, the Indian Council of Medical Research and the University Grants Commission. A significant development in recent years is the increasing investment on R&D activities by industrial enterprises. This has been made possible, partly, by various incentives and promotional measures adopted by the government. At present there are more than 400 industrial establishments with recognised R&D units.

As in other sectors, investment in science and technology is planned on a 5-year basis. For each Plan period the scientific agencies and ministries prepare detailed plans indicating the financial outlays required to undertake the activities. The draft plans are discussed in detail with the Planning Commission in the light of national development priorities. The final plan is discussed and adopted by the National Development Council which is headed by the Prime Minister who is also Chairman of the Planning Commission. Various state governments and Central ministries also participate in the deliberations of the National Development Council. While outlays for the 5 year period are indicated by the National Development Council, the actual financial resources to be made available in each year to the Plan are determined in the light of the progress made on various schemes, the targets, and the overall resources position.

The planning process referred to above actually originates at the institution or university level and culminates with its approval by the National Development Council. Each institution identifies the programmes proposed to be undertaken in a given plan period and estimates the outlays required to implement these programmes. The different national level councils and government departments consolidate the plans prepared by institutions falling under their jurisdiction and prepare the draft plans for discussion with the Planning Commission. For the preparation of the current Sixth Five Year Plan (1980-85), a meeting of scientists was convened in August 1980. The meeting identified the approach to the plan in the science and technology sector. Thereafter a working group was constituted to identify priorities and recommend programmes to be undertaken by various scientific departments.

Table 3a indicates the expenditure on R&D by different sectors in 1978-79. Table 3b indicates the trends in expenditure from 1965 to 1979 as well as projections for 1985-90.

Apart from research undertaken directly in the various laboratories and institutions falling under the purview of different scientific councils and departments, there is also a great deal of research carried out in academic and research establishments with financial support from the councils and scientific departments. Practically every scientific department and council, as well as the University Grants Commission, have some arrangement, with a budget allocation, to fund research schemes or projects in different institutions. In most cases, the mechanism for providing research support requires the submission of a detailed proposal by the prospective researcher; the proposal is examined by experts in the field and is latter considered by committees or panels set up by the departments. Proposals which are thus approved receive financial assistance for a fixed duration.

The amount of support can vary from tens of thousands to a few million, and in exceptional cases to tens of millions of rupees. The period of support may, in general, vary from one to five years. In recent years, there has been an increase in the number of programmes requiring large scale assistance. These programmes fall in priority areas identified by the government. Among these areas are new energy sources, biomedical engineering, materials science, and selected areas of the chemical and biological sciences. Funding has also been provided for the establishment of certain new facilities and centres. Another recent feature has been the funding of research in certain priority areas in public sector productive enterprises.

As already mentioned, there is an increasing interest by industry in undertaking and supporting R&D activities. Besides supporting in house R&D, industry is also sponsoring research projects at universities and research establishments. Special tax benefits have been extended to such industrial units. A number of privately funded foundations have also come up in recent years and are supporting selected research projects among other activities.

3.4 SURVEYING OF THE S&T POTENTIAL

The Department of Science and Technology is the nodal agency in India for surveying the S&T potential in the country. The Department has a unit to undertake the survey work. This unit undertakes nation wide surveys on a regular basis, and usually, this exercise is done annually and collects data for the latest 3 years. The unit renders advice on the concepts or terminology used and is also responsible for liaison with other international organisations concerned with the subject.

The survey covers approximately 1 300 statistical units. A units may be a research laboratory, a research institute, or any in-house R&D unit of the private sector or public sector. The private sector refers to the class of industries which do not generally receive government funds and who use their own resources to undertake research and development activities. The public sector consists of industries which partially receive government funds and which are under the administrative control of the government. Roughly, about 700 units belong to the institutional sector (non-productive units), and the remaining 600 are the in-house R&D units of the industries. While the number of units in the institutional sector remains more or less constant, there is almost an average increase of about 100 units every year in the productive sector. This is due to the fact that more and more industries are setting up R&D units as they receive attractive incentives and subsidies from the government of India through a scheme of registration of these units with the Department of Science & Technology

Before undertaking the survey, considerable thought is given to designing the questionnaire. Intensive discussions are held with other experts in the fields and the information needs of Unesco, and other agencies, are also taken into account. Care is taken to ensure that only questions directly or indirectly relevant to the survey are included and that these are framed in clear and concise terms. The questionnaire has an appendix at the end which contains the definitions of the various terms used.

Since the type of data required from the R&D units of the productive sector is somewhat different from that of other S&T institutions not engaged in production, two types of questionnaires have been designed to cater for these two categories of R&D units. The information is mostly collected on the basis of mail card enquiry by posting the questionnaire to directors and heads, of the various statistical units. The replies received are checked in order to ensure that they are consistent and without gaps. Wherever necessary, estimates are made. Considering the amount of work involved in processing the data, a computerised system design and software package has been developed for the storage, retrieval and processing of the data. The questionnaire has also been designed so as to be amendable to computerisation.

The results of the survey are brougth out in an annual publication entitled, "Research and Development Statistics", and the latest publication in the series relates to the year 1978-79. A sister publication, devoted exclusively to industrial research, was brougth out for the first time in 1976-77. A similar publication for the year 1978-79 is under print. The results of the survey, as reflected in the above publications are not only used by the science policy makers but also serve as base material for further research studies on the subject.

PART 4.

Policy issues in scientific & technological development

4.1 MAJOR DEVELOPMENTS

The first two decades of planned development in independent India have been a period of remarkable growth in the scientific and technological infrastructure. During this period, new organisations were created, a number of specialised research institutions established, and a sizeable base for education and training built up. The emphasis, naturally, was on the development of a scientific and technological capability in the different sectors. In the third decade, efforts were made to take stock of the situation and to consolidate the gains made so far. At the same time, a greater awareness grew in the country of the need to translate the results of scientific endeavour into benefits for the common man more quickly and more directly. Part 3 of this paper has dealt with the evolution of the S&T effort and capabilities, and of planning to make it serve and lead overall development goals.

Among the notable developments and achievements over the past 10 years in India has been the significant growth in agricultural and industrial production, which has freed the country from the necessity of importing foodgrains and expanded its industrial infrastructure and manufactured exports. Achievements of major significance include, the discovery of oil in off-shore areas, the construction and commissioning of nuclear power plants and a whole range of hydro-electric and thermal energy plants, the significant expansion of industry in the engineering, electronics and chemical sectors, and the development of a scientific capability in sophisticated areas such as space sciences, satellite launching, computer sciences, nuclear sciences, new energy resource developments, and remote sensing etc. No less significant is the eradication of small pox from the country.

The achievements mentioned above have led to a sense of fulfilment and satisfaction among scientific workers engaged in these areas. The country, however, cannot afford to rest on its laurels as the basic problems of development still remain acute, in the context of a rising population, to ensure the well-being of millions of people. Further, these problems have become more complex in the wake of international developments. While problems relating to food production and health continue to receive priority, certain other problems also required greater and more urgent attention. An example of this is the energy crisis arising from the world oil crisis of 1973. Such developments have resulted in the constant re-examination of priorities and the drawing-up of appropriate plans to meet the needs of the situation.

Among the major sectoral and organisational developments having a bearing on the conduct of research, and on the conditions in which science and technology are applied during the last decade, are:

i. The Energy Crisis

The rapid increase in oil prices and uncertainty of oil supplies from outside have led to an intensification of the search for oil within the country and its off-shore areas, as well as an emphasis on increasing the production of coal and the development of improved techniques for utilising conventional and nuclear fuels. At the same time, a major programme on new and renewables sources of energy was initiated. A Commission for Additional Sources of Energy has been set up by the Government with full executive and financial powers. The allocation for research on new and renewable sources during the Sixth Plan is about five times the amount spent in the previous five year period.

ii. Environment Degradation.

Though economic development is an over-riding consideration, the impact on the environment on account of developmental programmes and factors such as the increase in population, the denudation of forests etc. , can no longer be ignored. Research on a variety of environmental problems had to be initiated and an awareness among the people of the need to preserve the environment had to be generated. Wide-spread pollution of air and water, repeated floods in the northern part of the country, and depletion of resources and genetic material, were some of the factors which helped focus attention on the environment during the last decade. A National Committee on Environmental Planning and Coordination was set up and in 1980 a new Department of Environment was created at the Centre.

iii. Industrial Research

One of the major developments of the seventies has been the significant growth in research undertaken by the productive sector. For a long time, industry relied substantially on imports of technology from abroad. During the last decade, several incentives have been introduced for industrial organisations willing to set up R&D units. At present, there are more than 450 companies with R&D units recognised by the Government. Besides promoting the growth of indigenous technology, these units have also created additional employment opportunities for Indian scientists and engineers. Industrial units are also increasingly sponsoring research projects at universities and research laboratories. Additional benefits are available to entrepreneurs setting up industrial units based on technology developed within the country.

iv. Organisational Changes.

The seventies witnessed several changes in the organisational set up of science technology in India. New departments were created in the central government and various bodies constituted to advise the government on policy and programmes. The Department of Science and Technology and the National Committee on Science and Technology were established in 1971. In the same year, the Department of Electronics and the Electronics Commission were established. The Department of Space was set up in 1972 (The Indian Space Research Organisation had already been established in 1969). As already mentioned, additional bodies to deal with environment, and new and renewable sources of energy, have been set up. A Cabinet Committee on Science and Technology and a Science Advisory Committee to the Cabinet were constituted in 1981. These developments paves the way for the wider application of science and technology to developmental problems.

v. Plans

The Science and Technology Plan prepared by the NCST constituted a major effort to identify and analyze in detail problems of relevance in various sectors and to draw up programmes to achieve desired goals within specific time periods. Activities were identified for implementation by virtually every ministry of the central government. This has led to the creation of a climate for scientific activities within these ministries, and an

R&D climate began to permeate various government departments. As discussed in Part 2, the recently finalised Sixth Plan represents a major development in the efforts to utilise science and technology for economic and social development. The Plan covers policy and organisational questions and takes stock of existing problems. It seeks to apply science and technology for human resource development and other key sectors such as agriculture, forestry, environment, irrigation, meteorology, health, education, housing, energy, industry, rural development, atomic energy, space research, communications, and transport, etc. The Plan seeks to activate councils for science and technology at the state level in order to accelerate the wider utilisation of scientific research and technological development. Facilities and amenities for scientists have also attracted attention under the Plan.

4.2 ACHIEVEMENTS AND PROBLEMS

In the preceding chapters and in Part 4.1, a description has been given of the achievements of science and technology in the country. The Sixth Five Year Plan sums up some of the achievements in the following words:

> In the last thirty years or so, 199 universities, affiliating about 1 650 colleges, 5 institutes of technology, 150 engineering colleges and about 100 medical colleges and 350 polytechnics have been established; about 150 000 qualified scientific and technical personnel are produced every year. The total stock of scientific and technically qualified manpower is estimated at 2.5 million, ranking India as the third largest complement of such manpower in the world, occupying a unique position among developing countries. Simultaneously, about 130 specialised research laboratories and institutes have been established under the aegis of the Indian Council of Agricultural Research (ICAR), the Council of Scientific and Industrial Research (CSIR), the Indian Council of Medical Research (ICMR), the Departments of Atomic Energy, Science & Technology, Space, and the Defence Research & Development Organisation, etc. In recent years, public and private sector organisations and undertakings assisted by fiscal incentives, have established over 600 in-house research & development laboratories largely to meet their internal technological requirements. A relatively new but important development in the last fifteen years is the rapid growth of engineering consultancy organizations to provide design and consultancy services and act as a bridge between research institutions and industry. There are now over 150 such firms of varying size and capability employing over 20 000 technologists. The total expenditure on science and technology is now close to 0.6% of the GNP.
>
> Political independence has thus been matched by increasing technological independence in many areas. A range of industries, from the small to the most sophisticated, has been established covering wide areas of utilities, services and goods, and a large number of technologists are now familiar with their operations. There is now a reservoir of expertise well acquainted with the most modern advances in basic and applied areas and, equipped to make choices between available technologies, readily absorb new technologies and provide a framework for future national development. Scientists and technologists have distinguished themselves not only in class rooms and laboratories but also in factories and fields, in conceptual planning and formulation of strategies and in the implementation. Indian scientists and technologists have demonstrated on many fronts that given clearcut objectives and tasks and necessary support, they can fufil national expectations. The relevance of a large part of the effort in Indian Science and Technology to, and its correlation with, national development can be well established.

The science and technology efforts, however, need to continue to grow in quantity and quality. Problems of mismatch between production of scientific and technical manpower, and the requirements of the economy, are arising even as development proceeds. Furthermore, problems of adequate and swift transfer of technology to the production stage, and rapid dissemination and application of scientific and technical knowledge, remain. These problems are associated with those of increasing population, resource constraints and difficulties in expanding educational facilities adequately throughout the vast countryside. These issues will be discussed along with the objectives set for further action in Part 4.3.

4.3 OBJECTIVES AND PRIORITIES

The overall problems relating to science and technology and the policy objectives derived therefrom may be gauged from the following extracts from the Sixth Five Year Plan.

While the total stock of scientific and technical manpower in India appears large at first sight, yet, as a proportion of the total population it does not compare favourably with that in the advanced countries or even in some other developing countries. The fact is that the science and technology content of Indian society as it is today (as borne out by the total national investment in this sector, the number of technically qualified personnel, the facilities for science and technology education, the size of technical services, etc.), as well as its involvement in R&D, is low in comparison to the size and population of the country. A large part of the total stock of S&T manpower is not actually engaged in activities that can be constructed as scientific or technical. Even more significantly, the quality of the personnel varies widely; there is a need for a considerable reorientation and upgrading of a large proportion of this stock of manpower through appropriate training programmes.

In large areas of economic activity, relatively obsolete, cost-ineffective technology continues to be applied, the pace of scientific and technological innovation remains unimpressive, and the adoption of available scientific and technological knowledge is tardy. There are many gaps regarding new important fields, in the leadership ranks, and in excellence. While, in the early years after independence there was a rapid expansion in university education, an increase in the number and size of facilities, and the formation of new institutions, all of which contributed to the planned development, few new institutions have been started recently. In universities and several other institutions, the support provided has not kept pace with the increased need for better facilities.

There is a lack of coordination between manpower requirements (in terms of areas, levels of training, and numbers) and the actual training of personnel, which has led to a serious shortage of qualified and trained manpower in many areas. In sum, while significant advances have taken place on the science and technology front in India over the past three decades, the gap between what obtains in the country and in other advanced countries in terms of infrastucture and capabilities has significantly widened due to the much faster rate of progress in those countries. There is, therefore, no room for complacency on the basis of our past accomplishments.

In the area of application of science, success has been achieved in several fields. The need to conserve foreign exchange and considerations of national security induced the application of domestic science and technology in the substitution of imports. With the increasing emphasis on cost effectiveness in establishing domestic production and exports, a new challenge is posed to the use of domestic scientific and technological talent. There is a serious danger that this new emphasis could lead to a greater insistence on provenness and an aversion to risk; this is particularly true if suitable mechanisms (both administrative and financial) are not developed to adopt and force technological development to a point of satisfactory performance and demonstration, as well as the acceptance of risk. Calcultated risk taking, and the development of risk reduction through systematic scientific effort, is yet to be promoted adequately. A detailed strategy for major technological break-through appropriate to our resources and changing national environment has therefore to be properly formulated.

While linkages and mechanisms for the effective application of science are deficient in most fields, this lacks is specially serious in the optimal use of natural resources and in areas such as energy, health and medicine, population control, ecology and environment, and integrated industrial and rural development. This has also led to an insufficient use of the science which is generated in universities and national laboratories, thus giving rise to the often expressed feeling that the fruits of science and technology have not reached the bulk of the population and have not contributed to planned economic and social growth. Consequently, these deficiences are tending to reduce the impact of science and technolgy in dealing more effectively with the economic and social problems of the country.

While there are exceptions to this, it is clear that the major investment areas in our plans require a much more deliberate and sustained application of science and technology than hitherto. This requires not only financial support for S&T activities, but linkages between the various sectors (educational, R&D establishments, industry, and governmental machinery) and policies conducive to the use of indigenous efforts. Instruments for policy formulation and task implementation in this regard are lacking at present.

When we consider the magnitude and dimensions of India's problems of economic and social development associated with the vast and increasing population and immense poverty, especially rural poverty, it becomes clear that a massive application of science and technology has to be an essential component for their solution. Science and technology must now be considered a vital input in all investments on par with capital and trained manpower, although it has a longer gestation period. The latter implies advance planning beyond the normal five year framework. Science can, and must, establish new heights for achievement and endeavour, which are big enough to provided an exciting challenge for the country's best talent. This will generate pride and self-confidence, as well as new innovative ideas and solutions which go beyond mere import substitution. With the much lower costs at which S&T activities can be carried out in India compared to that in other countries, science and technology is the one resource which, more than any other, provides the greatest advantage and it is, therefore, only logical for us to base our strategy for economic and social growth on this important resource.

Some well-planned measures are called for to see that the talented and best trained among our post-graduate science and technology students are provided adequate incentives to take up research as a career, and that areas are defined and supported that best serve national interests and priorities towards which such talent can be directed or encouraged to work. On the one hand, we have pockets of excellence in terms of sophisticated manpower in some areas with no exploitative base, on the other, vital areas are crying out for expertise. Such mismatching needs to be avoided. Our R&D institutions have had a tendency to work on a large number of programmes that have been going on for years with a fair proportion of obsolete equipment and manpower. There is a need to modernise them and provide them the challenges that will stretch them to the full.

Science and technology must help to speedily improve production through better efficiency and fuller utilization of capabilites already created in the various sectors of the economy. Technology has to be oriented toward improving productivity. It has to help in the creation of more employment opportunities and in the reduction of drudgery, especially of the weaker sections of the community. It should strengthen the nation and reduce vulnerability. Hence, self-reliance must be at the very heart of S&T planning and there can be no other strategy for a country of India's size and endowments.

The achievement of our development goals has often been impaired due to several national disasters like floods, droughts, and communicable diseases; S&T has an important role to play in eliminating or controlling them if, instead of short term adhoc approaches, long term strategies are worked out. Problems of extreme poverty, sought to be mitigated through the minimum needs programme, are also well known. Science and technology has an important role to play in finding rational and long term solutions for such disasters and natural problems.

Science is both an outlook and a value system. Despite the tremendous growth of science, very few scientists have taken upon themselves the responsibility of creating a scientific ethos. The task of creating a scientific temper is a vital necessity for the growth of science and its utilization in the development process. There is a need to create a scientific climate and involve the people in discussions on various issues of science and technology which affect their lives. There has to be dissemination of knowledge about natural phenomena, and technological innovations, through popular science journals and other media. There is also need to promote public debate on major issues of science and technology. The full potential of science has to be utilized to eradicate the irrational attitudes which tend to hold back the nation from the path of progress.

The total role assigned to science and technology must, therefore, be to develop on a long term basis a sound base in science, in competence and in skills, and short term plans must harmonise with this ultimate objective which may have a gestation period extending well over one five year plan. The aim must be to :

attract (and retain) the very best and the young talent to contribute to science and technology and achieve originality and excellence in international terms;

improve and transform the existing structure of science and technology for this purpose (e. g. by its support for exciting areas of scientific activity, greater involvement of scientists in defining the tasks that they are expected to perform, better career prospects and amenities for scientists and technologists, improving the mobility of scientists within the country, etc.);

establish much more effective linkages, between the organizational form and the policy framework and an effective utilisation of science and technology to meet economic and social objectives; and

identify major new areas of science and technology of special significance to the country and, in some of these areas, invest in an optimal manner so as to achieve technological breakthough in the shortest possible time.

For these purposes, major fields of impact that have been given particular attention in the plan are as follows:

i – Science and technology in education for the nurturing of talent by the substantial improvement of the general science and technology facilities in universities and research institutions.

ii – Basic Research.

iii – Policy formulation and implementation.

iv – Science, technology and rural development.

v – Science, technology and human resource development in which new progammes have been initiated on science and technology for women, encouraging young scientists, involving the scientific community, and strengthening and utilizing scientific academies and professional societies have all been planned.

vi – Strengthening facilities and amenities for scientists.

vii – Activating the State Councils of Science and technology to foster science and technology in their own region and spread the application of science and technology widely.

The programmes developed in science and technology are geared towards the tasks mentioned above. It is also desired that certain well selected areas of science and technology be given special concentration and be provided with adequate resources so that a major break-through may be achieved. The identification of these "thrust" areas, and the assignment of approriate priorities, is a continuous process involving interaction amongst different groups of scientists and technologists from education and research institutions, as well as from industry. Many of these thrust areas need inter-disciplinary work encompassing different traditional disciplines such as physics, chemistry, biology and engineering. The programmes are also identified and grouped according to various sectors such as agriculture, energy, forestry, irrigation, and industry, etc.

An indication of the actual expenditure on science and technology in the five year period prior to 1980, and the outlay planned for 1980-85, is given below:

	Rupees (million) 1975-80	1980-85
Major scientific agencies (Atomic Energy, Space, Depts. of Science and Technology, Environment, Council of Scientific and Industrial Research, National Test House)	9,506.4	17,041.3
Science and technology components under various ministries and departments	16,270.7	16,090.6

4.4 SCIENTIFIC & TECHNICAL COOPERATION

India has scientific and technological exchange and cooperation programmes with many countries of the world under bilateral agreements or arrangements and also with United Nations agencies and regional and other international bodies. These programmes are carried out through agreements between governments and also agreements between research institutions, councils, universities and institutes of technology. Formal science and technology agreements or understandings at government level exist with about 30 countries.

The science and technology programmes involving other countries and international organizations are based on the principle of mutual interest. Since the basic infra-structure of science and technology in the country is fairly strong, the policy emphasizes exchange of specialised knowledge and equipment to be received by, or to be given to, the cooperating party. With the industrially advanced countries, the grogramme includes exchange of scientists at the highest level and cooperative R&D projects. With the developing countries the programmes also include offers of training facilities in India for scientists and engineers from these countries, as well as the supply of Indian specialists and specialised equipment for varying periods of time. India believes strongly in the concept of technical cooperation among the developing countries (TCDC). Various programmes of assistance to other developing countries are in existence. During the current Plan, a new scheme to support TCDC activities relating to science and technology has been launched in India by the Department of Science and Technology and a separate budget head is provided for this. This scheme will also cover new and renewable sources of energy. A Regional Centre for Transfer of Technology has been established in India under the auspices of ESCAP. A Centre of Science and Technology for non-aligned countries is also being established during this year.

India believes in actively participating in scientific cooperation activities sponsored by the United Nations and its agencies. It takes an active part in these programmes at the national, regional, and multi-regional levels. The scientific programmes of Unesco, FAO, WHO, IMO and other bodies are considered important, and India's policy is to strenghten such programmes which are useful for all parts of the world, and for developing countries in particular, while at the same time suggesting improvements in the quality and effectiveness of these programmes. Under the auspices of these programmes, India also provides places for the training of scientists and engineers in its own facilities as well as the supply of Indian specialists and experts to other countries. India also avails itself of the fellowships offered to Indian scientists and technologists under these programmes.

CASTASIA II offers an important forum for the countries of the region to discuss their national experiences, as well as their international programmes, and to arrive at fresh recommendations that would contribute to strengthening their own efforts, as well as reinforcing regional and international cooperation in science and technology.

PART 5.

Bibliography

Sixth Five Year Plan 1980-85
Planning Commission, 1981

Research and Development Statistics 1978-79
Department of Science and Technology

Research and Development in Industry 1976-77
Department of Science and Technology

A Directory of Research Institutions
Department of Science and Technology (1980)

Handbook of India
Publication Division, Ministry of Information and Broadcasting

Statistical Outline of India 1980
Tata Services limited, Bombay

India
India Institute of Foreign Trade.

ANNEX 1

Development Perspective 1979-80 to 1994-95
Selected Economic and Social Indicators

Item	1979-80	1984-85	1994-95
Gross domestic product	97,051	125,050	213,600
(Rs. crores at 1979-80 prices)	—	(5.2)	(5.5)
Electricity generation	112	191	395
(billion KWH)	—	(11.27)	(7.54)
Population (millions)	654.1	717.2	843.0
		(1.86)	(1.63)
Per capita GDP (Rs.)	1,484	1,744	2,534
		(3.28)	(3.81)
Per capital monthly	95.62	109.67	151.98
consumption (Rs.)	—	(2.79)	(3.32)
Percentage of people below poverty line	48.44	30.00	8.74
Employment (million standard person years)	151	185	248
Saving as percentage of GDP at market prices	21.24	24.48	27.52
Investment as percentage of GDP at market prices	21.76	25.11	26.92
Monthly per capita consumption	12.95	14.32	15.50
of foodgrains (kgs.)	—	(2.03)	(0.80)
Monthly per capita consumption	0.68	0.79	1.15
of sugar (kgs.)	—	(3.00)	(3.82)
Monthly per capita consumption	0.85	0.92	1.41
of clothing (meters)	—	(1.60)	(4.36)
Monthly per capita consumption	14.27	22.19	39.05
of electricity (KWH)	—	(9.23)	(5.81)
Value added in education	20.32	24.72	36.60
per capita (Rs.)	—	(4.00)	(4.00)
Life expectancy (years) Male	52.6	55.1	60.1
Female	51.6	54.3	59.8

Note: Figures in brackets represent annual compound growth rates.

ANNEX 2

Commodity Output Projections 1984-85

Item	1979-80	1984-85 (Projections)
Foodgrains (million tonnes)	109	149-154
Sugarcane (million tonnes)	128	200-215
Jute and Mesta (lakh bales)	80.3	91.0
Cotton (lakh bales)	77	92
Oilseeds (5 major) (lakh tonnes)	81	110
Tea (million kgs.)	550	705
Coffee (million kgs.)	150.00	159.45
Milk (million tonnes)	30.27	38
Eggs (millions)	12,320	16,300
Coal (million tonnes)	103.96	165.00
Lignite (million tonnes)	3.12	8.00
Crude Petroleum (million tonnes)	11.77	21.60
Iron Ore (million tonnes)	39	60
Sugar (million tonnes)	3.9	7.6
Vanaspati (thousand tonnes)	626	900
Cloth (mill and decentralised sectors) (million metres)	10,435	13,030
Jute Manufacturers (thousand tonnes)	1,336	1,500-1,540
Paper and Paper Board (thousand tonnes)	1,050	1,500
Newsprint (thousand tonnes)	47.45	180
L. D. Polyethylene (thousand tonnes)	71.3	100.0
H. D. Polyethylene (thousand tonnes)	25.4	27.0
Polyproylene (thousand tonnes)	13.4	26.0
P. V. C. (thousand tonnes)	49.9	128.0
Natural rubber (thousand tonnes)	148.47	200.0
Synthetic Rubber (SBR and PBR) (thousand tonnes)	30.3	45
Petroleum Products (incl. lubricants) (million tonnes)	25.8	35.3
Sulphuric Acid (thousand tonnes)	2,131	3,600
Caustic Soda (thousand tonnes)	549.6	850
Soda Ash (thousand tonnes)	555.8	850
Caprolactum (thousand tonnes)	13.5	18.0
D. M. T. (thousand tonnes)	27.9	56.0
Nitrogenous Fertilisers (N) (thousand tonnes)	2,226	4,200
Phosphatic Fertilisers (P_2O_5) (thousand tonnes)	757	1,400
Nylon Filament Yarn (thousand tonnes)	17.7	28.0
Polyester Filament Yarn and Staple Fibre (thousand tonnes)	32.6	73.0
Cement (million tonnes)	17.68	33.34
Pig Iron for sale (million tonnes)	1.09	1.52
Saleable Steel (Plan carbon) (million tonnes)	7.38	11.51
Aluminium (thousand tonnes)	192	300
Copper Refined (thousand tonnes)	18.8	45.0
Zinc (thousand tonnes)	52.65	85.00
Lead (thousand tonnes)	11.4	25.0
Agricultural Tractors (thousand nos.)	62.5	100.0
Machine Tools (Rs. million)	1,622	2,500
Hydro Turbines (million Kws.)	0.95	1.20
Thermal Turbines (million Kws.)	2,28	3.50
Electric Transformers (million KVA)	18.7	35.0
Commercial Vehicles (thousand nos.)	57.4	105.0
Electricity Generation (billion KWH)	112	119
Originating Traffic in Railways (million tonnes)	217.8	309

INDONESIA

Table of Contents

INDONESIA

GEOGRAPHY

Capital city: Jakarta
Main ports: Dumai, Palembang, Tandjung Priok
Land surface area: 2,027,087 sq km

POPULATION (1978)

Total	145.1 million
Density (per sq km)	72
Urban/rural ratio (1974)	0.2
Average rate of growth (1970-78)	2.5%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	40.2	11.1	9.4	34.1	5.3	100%

SOCIO-ECONOMIC

Labour force (1976)

Total	54.5 million
Percentage in agriculture	64.7%

Gross national product (1978)

GNP at market prices	US $45,780 million
GNP per capita	US $320
Real growth rate of GNP per capita (1970-78)	5.3%

Gross domestic product (1977)

Total (in current producers' values)	US $45,903 million
Percentage by origin	
Agriculture	31%
Manufacturing, mining & quarrying, electricity, gas & water, construction	35%

Government finance

National budget (1978)	US $10,024 million[1]
As percentage of GNP	20.3%
External assistance (official, net; 1976)	US $1,090 million
As percentage of GNP	3.0%

Exports (1978)

Total exports of goods (1978)	US $11,634 million
Average annual growth rate (1970-78)	7.2%

External debt (1978)

Total public, outstanding + disbursed	US $13,089 million
Debt service ratio (% GNP)	3.1
(% Exports of goods and non-factor services)	13.0

Exchange rate (1978): US $1 = 432.90 Rupiahs

EDUCATION

Primary and secondary education (1978)

Enrolment, first level	22,024,819
As % of (7-12 years)	94%
Enrolment, second level	4,467,512
As % of (13-18 years)	22%
Combined enrolment ratio (7-18 years)	61%
Average annual enrolment increase (1970-1978)	5.4%

---

[1] Expenditure of the central government only.

Higher education (third level) (1976)

Teaching staff, total	46,668	
Students and graduates by broad fields of study:		
	Enrolment	Graduates
Social sciences and humanities	164,537	14,160
Natural sciences	7,412	885
Engineering	33,086	3,033
Medical sciences	14,588	2,031
Agriculture	16,822	2,539
Other and not specified	59,881	4,018
Total	**269,326**	**26,666**
Number of students studying abroad	8,523	

Education public expenditure (1978)

Total (millions of Rupiahs)	422,002[1]
As % of GNP	2.0%
Current, as % of total	...
Current expenditure for third level education, as % of total current expenditure	...

---

[1] Refers to expenditure of the central government only.

Table 1. Nomenclature and Networking of S&T Organizations

I - First level - POLICY-MAKING

(Compiled from information in Part 2.3 infra)

Country: Indonesia

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
Ministry for Research and Technology	Policy making Co-ordination of R&D	President		PEPUNAS

PEPUNAS - National Committee for Evaluation and Formulation of Main Programmes of Research and Technology

II - Second level - PROMOTION & FINANCING

(Compiled from Part 3.3 infra)

Organization	Linkages		
	Upstream	Downstream	Others
Government funding for all ministries: i. Routine Budget Ministry of Finance ii. Development Budget Ministry for Research and Technology National Development Planning Agency State Secretary		All state research agencies, ministries and universities	
State-owned enterprises: Pertamina Bankatin Plantation Estates		Respective R&D units	

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

(Compiled from information in Part 3.1 infra)

Establishment	Function	Linkages	
		Upstream	Others
Research and development agencies of Twelve Ministries: Interior; Foreign Affairs; Justice; Information; Trade and Cooperatives; Agriculture; Communications Education and Culture; Health; Religion; Social Welfare; Manpower and Transmigration	R&D		
Research Centres of following Ministries: Industry (4 Research Centres) Mining and Industry (2 Research Centres) Ministry of Finance (1 Research Centre) Ministry of Public Works (1 Research Centre) Ministry of Defence and Security (4 Research Centres)	R&D		
Non Ministerial Government Agencies established by Presidential decree: - Indonesian Institute of Sciences (LIPI) - National Atomic Energy Agency (BATAN) - Nation Co-ordinating Body for Survey and Mapping (BAKOSURTANAL) - National Aeronautics and Space Institute (LAPAN) - Central Bureau of Statistics (BPS) - Agency for the Development and Application of Technology (BPPT) - Centre for Scientific and Technological Research (PUSPIPTEK)	Strategic, cross-sectoral and multi-disciplinary R&D; STS		
Universities	STET; R&D		
State-owned companies with research centres: Pertamina Mining companies (BANKATIN) Agricultural Estate companies	R&D		
Private company research units: Unilever Goodyear	R&D		
Private R&D institutes	R&D		

Table 2 - Scientific and Technological Manpower

Country: Indonesia

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (in units)	of which working in R&D						Total stock (in units)	of which working in R&D (in units)
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965	105	n.a.	4,032*	150	450	251	727	2,454		
1970	117	n.a.	3,817*	172	227	280	793	2,345		
1975	132	n.a.	5,618*	346	928	676	1,252	2,416		
1976		1,741,219	7,645						2,620,929	5,356
1978	137	n.a.	8,576*	608	1,597	1,695	1,406	3,270		
1985	157	n.a.	15,945*	1,119	6,116	3,308	1,722	3,630		
1990	173	n.a.	28,970*	2,059	17,308	3,341	2,233	4,029		

* University graduates output from 40 state universities (including 11 state institutes of teacher training and education)

Table 3 - R&D expenditures

Country: Indonesia
Currency: Rupiah

Table 3a: Breakdown by source and sector of performance

Year: 1979-80

Unit: thousands

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive	15,146,255	n.a.	n.a.	15,146,255
Higher Education	33,022,966	n.a.	n.a.	33,022,966
General Service	34,189,852	n.a.	n.a.	34,189,852
Total	82,359,073	n.a.	n.a.	82,359,073

Table 3b: Trends

Year	Population (millions)	GNP (in million)(a)	Total R&D expenditures (in million)(a)	Exchange rate US $1 = Rupiah
1965	105	—	—	36
1970	117	3,290,000	10,181.7(b)	381
1975	132	12,086,800	34,314.5(b)	415
1979	159	21,272,768	82,359.0(b)	615
1985	157	45,523,760	258,053.0(b)	
1990	173	88,771,370	869,303.0(b)	

(a) Specify which currency unit (e.g. thousands, millions, etc.)
(b) Development budget

PART 1

General Features

1.1 GEOPOLITICAL SETTING

The Indonesian archipelago forms a cross-road between two oceans, i. e. the Pacific and Indian Oceans and a bridge between two continents, Asia and Australia. It consists of 5 main islands (Sumatra, Java, Kalimantan, Sulawesi and Irian Jaya) and about 30 smaller archipelagoes totalling 13 667 islands and islets of which about 6 000 are inhabited.

The land area of the Republic of Indonesia is about 735 000 square miles while the sea area is about 4 times larger. The whole territory extends about 3 200 miles from east to west, from longitudes 95° to 141° East. From north to south it covers an area from latitudes 6° North to 11° South.

The rainy season in Indonesia generally prevails from the months of December to March and the dry season from May to September. The average temperature in Indonesia is around 33° centigrades. As for the higher mountainous regions, the average temperature is approximately C. 25° to 28°. The mean maximum temperature can reach C. 33° and the mean minimum temperature C.21°.

The growth rate of the Indonesian population (circa 150 million in 1980) is still high, 2.08% per annum. The population is not well distributed across Indonesia; sixty six percent live in Java which has a land area which is only 7% of the total for Indonesia.

Indonesia is endowed with rich natural resources, which consist of land resources, water resources, air resources, mineral resources, biological resources and energy resources. These natural resources, both renewable and non-renewable, have to be fully utilized as resources for national development.

Indonesia has several major urban areas where the activities of the people are concentrated, i.e. Medan, Palembang (in Sumatra), Jakarta, Bandung, Semarang, Yogyakarta, Surabaya (in Java), Denpasar (in Bali), Banjarmasin and Balikpapan (in Kalimantan), Ujung Pandang, Manado (in Sulawesi) and Ambon (Moluccas).

The structure of government in the Republic of Indonesia is contained in the Memorandum of the House of People's Representatives which was submitted for approval to the People's Consultative Assembly and sanctioned in its 4th General session, in 1966. The people's Consultative Assembly is the supreme authority, while the House of People's Representatives is the legislative body and the President and the Cabinet are the executive body.

At the present time, mineral resources and land resources have been fully utilized and have an important role in financing the economic development. The major export commodities are oil, minerals and timber. Including petroleum products, the trade balance from 1970 to 1978 showed a deficit. Mining, primary resources, transportation and telecommunications are growing at a rapid rate as a result of the application of capital intensive and advanced technology. However, an increase in employment opportunities can only be realized if secondary industries are developed with labour intensive and appropriate technology.

In order to facilitate economic activities and to enhance the mobility of people in relation to their activities, Indonesia, at present, is developing seaports and airports in most of the major urban areas.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

The population of Indonesia can be classified, not on the basis of their racial origins, but on the basis of their linguistic identifications caused by geographical diversifications into four ethnic groups, i.e. the Melanesians, the Proto-Austronesians, the Polynesians and the Micronesians. Languages and dialects spoken and written over the whole of the Indonesian archipelago, 150 to 250 in number, are usually classified according to the above mentioned ethnic denominations. The national language is called "BAHASA INDONESIA". Its lexicon and structure are based on the Malay language enriched by the lexicon of multi local languages and dialects in Indonesia.

The religion of the majority of people is Islam. Other religions of the people of Indonesia are Catholicism, Christianity, Balinese Hinduism and Confucianism.

1.3 DEVELOPMENT SCENE

National development aims at establishing a just and prosperous society with equitable material and spiritual welfare based on Pancasila (the state philosophy). The emphasis of the national development has undergone planned changes.

The First Five Year Development (1969-1974) put emphasis on the agricultural sector and industries supporting the agricultural sector.

The Second Five Year Development Plan (1974-1979) placed emphasis on the agricultural sector while promoting industries which process raw materials into basic materials. The Third Five Year Development Plan (1979-1984) puts emphasis on the agricultural sector and towards self-sufficiency in food while still promoting industries that process raw materials into basic materials.

The Fourth Five Year Development Plan (1984-1989) will put emphasis on the agricultural sector in continuing efforts towards self-sufficiency in food, while promoting industries which produce industrial machinery for light as well as heavy industries, to be further developed in the following Five Year Development Plan.

PART 2

Science and Technology Policy Framework

2.1 DEVELOPMENT POLICY FRAMEWORK

The essential goals of the Third Five Year Development Plan (PELITA III 1979-84) are to raise the living standards and levels of knowledge of the Indonesian people, to strive for more equal and just distribution of welfare for the whole population, and to lay a strong foundation for the next stage of development. To achieve these goals the plan requires that all development policies should have the following three objectives:

a more equitable distribution of development leading to the welfare of the entire population;

a sufficiently high economic growth;

a sound and dynamic national stability.

These objectives which form the three elements of the "Trilogy of Development" are closely interrelated and mutually interdependent.

The Five Year Development Plan consists of the following sectoral programmes:

i. Agriculture

Because of its size and relative importance in the economy, the agricultural sector is called upon to perform vital functions in PELITA III. The Plan envisages that this sector will provide food for the growing population and raw materials for industry as well as foreign exchange and employment opportunities, at the same time, raising the productivity of agriculture which can alleviate the poverty of millions of farmers who are still the majority of the population. In addition, higher productivity will act as a stimulus for industrial development by increasing the supply of raw materials and the effective demand for industry's products. Moreover, since agricultural production is spread throughout the country, its expansion can contribute towards a more equal distribution of growth among the various regions. Thus agricultural development in PELITA III will contribute directly to the achievement of the Plan's objective by improving the welfare of the population, promoting industrial growth and contributing towards more balanced development of the regions.

ii. Food and Nutrition

The food problem is closely related to the population problem. The increase of population in Indonesia must be balanced by an equivalent increase of food production. Therefore PELITA III has set two main targets for food programmes, namely, efforts towards self-sufficiency in food production, and improved quality and nutrition.

Policies on food production will perpetuate the existing pattern of agricultural development through the use of new technology in agricultural intensification and extension programmes.

Due to the varied social and cultural backgrounds of the Indonesian people, types of technology suitable for local conditions and acceptable to the people must be explored and developed.

As an example, the technology developed and applied in densely populated areas, e. g. Java, Madura, and Bali, must be different from the technology developed for the thinly populated areas outside Java. The technology of "Panca Usaha" (which means five efforts) has been successfully and intensively used by most farmers in Java.

This technology introduced the use of high yield seeds, fertilizers, insecticides, irrigation, and other improved cultivation techniques. This technology is labour intensive and is practised by the farmer utilizing simple and cheap equipment.

Different approaches have been applied outside Java by introducing advanced technology for the development of rice estates and rice fields using a tidal irrigation system, often combining this with transmigration schemes. Indonesia's staple food is still rice in spite of efforts to introduce a more diversified menu. It is thought that temporary crops like sorghum, corn, and others which may be developed in Indonesia will possibly provide one alternative for minimizing the dependency on rice.

To support agricultural development non-technical activities have been introduced, such as small-scale credit, village co-operation, and village banks. Yet the main problem is always the changing market which reflects changing values.

Scientific and technological activities in food processing are aimed at finding new protein rich foods by using local raw materials. These new foods must be introduced and popularized to be accepted by the people. Also, efforts to reduce wastage during rice processing have been made and other post harvest studies undertaken. Nevertheless, village technology has yet to be introduced on a large scale.

iii. Industrial Development

The target for industrial development during PELITA III will be the conversion of raw materials to semifinished or finished products. The problem of creating more job opportunities for less skilled labour is also taken into account. Around 80% of the Indonesian population live in rural areas. therefore most of the labour force (75%) and also the problems of high unemployment are located in the rural areas.

To overcome this unemployment problem there are efforts to develop small and medium-scale home industries which can absorb the existing labour force. These medium and small-scale industries should be linked to well-established large-scale industries.

In order to select the proper technology for the small and medium-scale home industries, science and technology should be able to develop technologies which also take into consideration the ecology of the industrial environment. The science and technology services in the field of standardization, instrumentation, calibration, quality control and information should be further developed. The educational system is equally important and must support such development.

Distribution of the finished products should be supported by a good transportation and communications system, since geographical distance as well as unequal distribution of the population are still crucial problems in Indonesia.

iv. Mining, Energy and Power

As a major source of foreign exchange and energy the mining sector continues to play a major role. Public revenue derived from this sector is vital to the success of the Third Five Year Development Plan. The Plan therefore provides for continued exploration and development of mining and energy resources.

For this purpose the Plan programmed action to ensure continuity and an increase in the production of materials which already have an international market. In addition, efforts to diversify the minerals produced and exported will be intensified while processing facilities will be expanded to increase the added value of minerals.

Exploration and development of energy sources such as oil and natural gas will receive first priority. Diversification of energy will be accelerated. This exploration and development of energy sources will be implemented in accordance with the national energy policy described below.

The basic objectives of the national energy policy are to assure a gradual shift from a mono-energy economy to a poly-energy one at reasonable prices for the domestic market and to ensure a continuous contribution to the balance of payments and public revenues. To achieve these objectives, exploration of conventional energy sources will be accelerated. In remote areas additional incentives will be provided to prospective investors.

v. Transport and Communications

In facing the increasing demand for communications services the existing facilities and equipment are organized in an integrated communications system. This is followed by rehabilitation and introduction of new communications facilities and isfrastructure. Communication and transportation services must be accessible to all the people. For this purpose, steps are being taken to keep transportation costs down through drawing up transportation tariffs, increasing the efficiency and improving the pattern for each type of transportation.

The development in communications and transportation is linked to increasing job opportunities and, since many communication facilities require large amounts of energy, is also closely linked with the national energy policy.

vi. Cooperatives

The efforts to promote development of cooperatives will be directed towards raising the capability of the village cooperative units and other primary cooperatives to act as independent business entities promoting cooperative activities in various sectors such as trade, agriculture, manufacturing, electricity, loans and savings accounts, and enhancing their ability to cooperate with other cooperative or non cooperative business organizations.

vii. Manpower and Transmigration

Manpower activities in the PELITA III is designed to increase employment, to distribute manpower, to increase the skills of the labour force, to foster a healthy union and employer relationship, and to increase the welfare of the workers.

During the PELITA III, labour intensive programmes will be undertaken in not less than 3 500 subdistricts (Kecamatan) which are poor, densely populated and prone to natural disaster. It is estimated that more than a million direct man-days of work will be created. At the same time, a total of 36 500 university graduates will be deployed in these areas as voluntary workers, helping the villagers in the various fields of development activities such as cooperative development, family planning, health, nutrition and training.

In addition to the transmigration programme, there is one more mechanism by which manpower is distributed regionally in Indonesia. This is the Inter-regional Manpower Distribution Programme. Through the activities of this programme a total of 250 000 workers will be distributed from Java to labour-scarce areas. In addition, its is projected that a total of 100 000 workers will find employment abroad.

viii. Housing

Housing is one basic need considered absolutely crucial in Indonesia at this time. In PELITA III, housing development policy focuses on providing accomodation for the low income group. It is estimated that in five years about 0.6 million houses should be built. In this context an integrated programme should be set up, followed by the establishment of a proper delivery system.

These steps are considered necessary because the housing programmes are closely related to land use, budgeting, environment control, and the availability of technology. Technology is needed to support the development of low cost housing.

Research and development activities for the production of low cost building materials using local indigenous raw materials, and the development of simple and low cost housing construction techniques, have been promoted and given support by the government. The government has created a favourable climate for the participation of the private sector in the construction of low cost housing through a financing policy.

The dissemination of information, concerning housing problems, to the public through the existing scientific and technological information centres in various places in Indonesia is a very important aspect.

The development of appropriate technology for producing prefabricated houses, housing elements and components is required in the transmigration areas where skilled labour is not available and where indigenous building materials have yet to be developed.

ix. Education

In the Third Five Year Development Plan the objectives of the education sector are: improvement of the quality of education, expansion of educational opportunities, an increase in the relevance of education to the needs of manpower, preparation of the young to assume future responsibilities in development, and an increase in the efficiency and effectiveness of educational management.

To improve the quality of education a national standard will be set and the curriculum will be continuously improved via feedback from the results of the implementation. A number of core subjects, e. g. language. mathematics and social studies, will be strengthened, and pre-vocational training will become an additional component of general education. Furthermore, greater attention will be given to the educational process itself, i. e. the learning process in school and out of school, involving the improvement both of the curriculum and of the methods of teaching.

Educational research and development will be continued to enable continuous improvement of the educational system. The committee for the Reform of National Education is the channel for ideas concerning fundamental educational reform. The process, as well as the management, of education will be supported and assisted by educational (and cultural) communication technology.

x. Health

The low socio-economic circumstances of the majority of the people, (low level of education and cultural background), often results in a deterioration in the ecosystem, the environment, and health and nutrition, which further results in the lowering of the people's level of resistance to disease. To solve this problem, policy in the field of health should be focused on an increase in the availability of health and medical experts, development of an infrastructure, and the promotion of society's awareness of the role of family health and environmental conditions through a public information system.

Research should be sensitive to local crops and plants which might supply the needed vitamins and nutritional content. Traditional food consumption should be studied and knowledge of local traditional customs obtained, since it may be possible to identify new high protein and vitamin rich plants and crops.

Science and technology can help to implement the above policy, through development of management, research on environment, research on infectious diseases and improvement of information technology and methods of guidance in the field of public health.

2.2 DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

The policy for the development of science and technology is aimed at the growth of a national capability in the fields of science and technology needed for development, in accordance with development needs and priorities.

Science and technology policy during PELITA III will stress manpower development, creating suitable conditions, improving facilities for science and technology activities, developing an infrastructure for science and technology and also enhancing documentation and information services in science and technology.

Varied technologies are used in the various development sectors, from the most advanced to simple village technologies. The domestic potential of science and technology should be developed. The most important factor in the development of the domestic potential for science and technology is manpower development.

Science and technology are very great ventures, which take a relatively long time and need a high budget allocation.

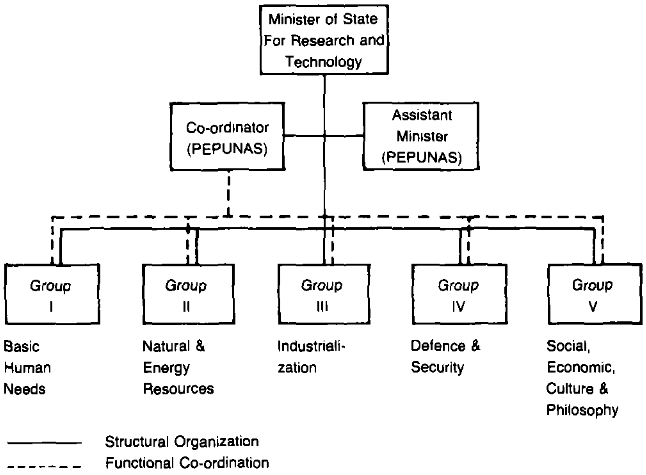
The awareness of the people is also very important. For a developing country like Indonesia, participation with the government is urgently needed.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

The Minister of State for Research and Technology has the tasks of both formulating issue policies on science and technology, and coordinating activities in research and technology.

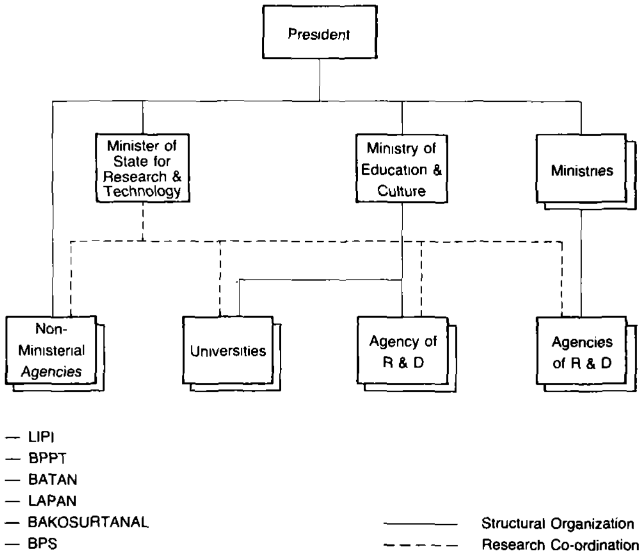
In the formulation of policies and coordination of activities in research and technology the Minister of State for Research and Technology is assisted by the National Committee for Evaluation and Formulation of Main Programmes (PEPUNAS) of Research and Technology (RISTEK).

The organisation of the National Committee for the Evaluation and Formulation of Main Programmes (PEPUNAS) of Research and Technology (RISTEK) is shown in the following diagram :



The machinery of coordination of science and technology is shown in the following diagram :

Co-ordination of Reserach and Technology



PART 3

Scientific and Technological Potential

3.1 INSTITUTIONAL NETWORK

Research and development institutions in Indonesia have various organizational structures and responsibilities. There are research institutes under the Ministerial Departments, Non-Ministerial Government Agencies, Universities, State-Owned Companies and Private Research Institutes.

According to Presidential Decrees Nos. 44 and 45 of 1974 on the "General Framework of the Organizational Structure of Ministries", each Ministry has its own Research and Development Agencies or Centres oriented to the service of their sectoral and operational needs. There are Research and Development Agencies in the following 12 Ministries: Ministry of Interior, Foreign Affairs, Justice, Information, Trade & Cooperatives, Agriculture, Communications, Education & Culture, Health, Religion, Social Welfare, and Manpower & Transmigration. These agencies are subdivided into Research Centres. There are four Research Centres in the Ministry of Industry, two in the Ministry of Mining & Energy, one in the Ministry of Finance, one in the Ministry of Public Works and four in the Ministry of Defence & Security.

There are six Non-Ministerial Government Agencies for research and technology established by Presidential Decrees, i.e. The Indonesian Institute of Sciences, the National Atomic Energy Agency, the National Coordinating Body for Survey and Mapping, the National Aeronautics and Space Institute, the Central Bureau of Statistics, and the Agency for the Development and Application of Technology. The Non-Ministerial Government Agencies undertake strategic, cross-sectoral and multi-disciplinary research and development activities.

i. Indonesian Institute of Sciences (LIPI)

LIPI is actively engaged in providing data and information for Government use and in submitting alternative recommendations regarding the formulation of national policy on science and technology. LIPI is also responsible for the progress and advancement of science and technology in Indonesia and providing services required by the scientific communities, the educational sectors and the general public. The implementation of all of these tasks is supported by scientific and technological research. LIPI is also in charge of monitoring the development of science and technology in Indonesia, especially as regards their application to the benefit and welfare of the people, and of providing a network in scientific documentation and information. LIPI has 10 research institutes and a documentation and information centre.

ii. National Atomic Energy Agency (BATAN)

The main tasks of BATAN are the carrying-out, organizing and supervising of research and the application of atomic energy for health and social welfare of the Indonesian people. It has the functions of coordinating the activities of the Ministerial Departments and Non-Ministerial Government Agencies to assure proper development of atomic energy in Indonesia and establishing cooperation with international as well as foreign national bodies working in atomic energy.

iii. National Coordinating Body for Survey and Mapping (BAKOSURTANAL)

BAKOSURTANAL has the task of producing base, topographical, meteorological and other thematic maps and of surveying, inventorying and evaluating natural resources.

iv. National Aeronautics and Space Institute (LAPAN)

The activities of LAPAN are concentrated on the use of space technology for resource inventory, weather forecasting and communication.

v. Central Bureau of Statistics (BPS)

BPS covers the collection and analysis of national statistics.

vi. Agency for the Development and Application of Technology (BPPT)

BPPT is a newly established agency which originates from the Advanced Technology Division of the State-Owned Oil Company PERTAMINA. This agency explores technologies compatible to the situation and conditions in Indonesia, and by special assignment is also responsible for their application in industries, either on its own account or as a joint cooperation with other organizations. In so doing, BPPT performs the function of technological entrepreneurship for the Government of Indonesia.

Another institute that will provide technical and laboratory services to science and research is the Centre for Scientific and Technological Research (PUSPIPTEK) located in Serpong, near the capital city of Jakarta. The centre is established as a science town to be equipped with laboratories, a computer centre and other facilities.

As stipulated by the Presidential Decree No. 43 of 1976, for its establishment, the main tasks of PUSPIPTEK are:

to develop infrastructure for research and technology needed for the acceleration of national development;

to provide facilities needed by the scientific communities;

to increase public awareness of the role of research, science and technology in development.

Universities have research and development centres oriented to support the three main tasks of the universities, i. e. education, research and community services.

Some of the state-owned companies also have research institutes of their own. These mainly belong to big companies like PERTAMINA and other mining companies, the Agricultural Estate Companies and others. The activities of these research institutes are limited to servicing and the operational needs of their mother companies. Besides the above mentioned research organizations, there are also private companies, such as Unilever Ltd. and Good Year Ltd. which possess research units of their own. Private independent research and development organizations also exist.

3.2 HUMAN RESOURCES

In 1975, it was estimated that 10 250 persons were working in various research institutes, while 331 650 persons were actually needed. According to the same estimate, around the year 2000, 389 500 researchers will be required to satisfy the needs of the country. The problem of manpower resources for research and technology will be among the strategic goals of the Minister of State for Research and Technology, so that short, medium and long term requirements could be met optimally.

Some universities in Indonesia have developed Ph. D. programmes to meet the demand for higher education and training of manpower by research institutions and universities.

Career development of researchers in Indonesia is regulated by the Decree of the Chairman of LIPI No.419 of 1980. According to the Decree, the researchers are grouped in 4 rankings, namely:

Senior Researcher,
Researcher,
Associate Researcher,
Assistant Researcher.

There is no distinction is status and opportunity between women and men researchers in Indonesia.

3.3 FINANCING RESOURCES

The main source of research funds in Indonesia is the government budget. The government research budget is composed of the budget for the Research and Development Sector and the budget of the corresponding Ministries (Defence, Public Works. the Interior, etc.). These are classified as Routine Budget and Development Budget. While routine budget is allocated directly from the Minister of Finance, the development budget has first to be approved by the Minister of State for Research and Technology, the National Development Planning Agency, and the State Secretary.

State-owned enterprises like PERTAMINA (Oil), BANKATIN (Tin-Ores), and plantation estates (rubber, palm oil, coffee, etc.), provide a limited amount of funds for research activities of their corresponding R&D divisions.

Like in other developing countries, the economic sector still has the highest priority. Budget allocation for S&T in Indonesia is still limited. This was shown in the budget allocated to S&T from the National Development Programme in 1970/1971, which was about US$14 457 831 or nearly 0.25% of GDP. The first year of the Third Five Year Development Plan (PELITA III) showed a significant increase in the budget allocated to S&T; it was US$155 903 180 or nearly 0.31% of GDP.

3.4 SURVEYING OF THE S&T POTENTIAL

The Indonesian Institute of Sciences (LIPI) is one of the centralized agencies for the collection and analysis of data and other information on the resources available for national scientific and technological efforts. The collection of data and other information is conducted by sending questionnaires to all scientific and technological institutions in Indonesia. The data and other information collected is then published, after processing manually as well as by computer, in directories on science and technology activities and resources.

PART 4.

Policy Issues in Scientific and Technological Development

4.1 MAJOR DEVELOPMENTS

Self-sufficiency in food is one of the main objectives in national development. It is done through intensification and extensification of agriculture development, improvement of the infrastructure, the transportation system and adequate stockpiling of rice.

Indonesia's exports have been very dependent on oil. A massive programme has been launched to diversify its exports and to broaden its energy regime. In the energy sector, Indonesia is pursuing the following objectives: intensification and extensification of gas and oil exploration and production, and conservation and diversification by using other energy sources for domestic consumption.

To reach those objectives the Government of Indonesia has embarked upon a massive programme to have at least 400 MW of electricity from geothermal energy by 1990; 800 MW of electricity from coal powered plant in the early 1980s. A high priority is given to developing the 31 000 MW hydropower potential. Indonesia is also developing 70 trillion cubic feet of gas reserves.

The future development of Indonesia will depend critically on its ability to make the best use of its natural resources, with a minimum of waste and for the greatest benefit of the greatest number of people. It will have to be done by broadening the scope of human activities and raising the quality of its human resources. A better quality of life and a high living standard for the majority of the Indonesian people can only be realized through accelerated growth with equity.

Growth and growth rates cannot be viewed separately from the direction of growth and the pattern of development within the broad social context. Social phenomena, poverty, unemployment and their eradication have to be regarded as economic priorities. Therefore, development policies have to be directed to provide people with basic requirements in order to accelarate the process of growth. This means that the structure of production and the utilization of productive resources must be arranged or rearranged with the above priorities in mind.

The role of research, science, and technology is to promote value added processes, and employment creation through industrial development.

4.2 ACHIEVEMENTS AND PROBLEMS

Progress has been made during the Three Five Year Development Plans. Through the input of science and technology in modern industry a gradual change has been discerned in the structural pattern of the whole economy. The size of the economy measured by gross domestic product at constant 1978 prices expanded by 2.5 times. GDP per capita rose by 2.3 times from US$160 in 1966 to US$362 in 1978. At present, Indonesia's income per capita is around US$450. For the period 1970-1978 Indonesia's GDP average annual growth rate was 7.8%; with agriculture 4.0%; industry 11.2%; manufacturing 12.4%; services 8.7% (World Bank Annual Report 1980).

In the field of science and technology proper, except for the existing institutions, the Agency for the Development and Application of Technology was created in 1970. In Serpong, 40 km south of Jakarta, a science town, the so called PUSPIPTEK Complex or Science and Technology Centre is under construction. It covers an area of approximately 1 200 sq. km which will house various laboratories, including the 30 MW Research Reactor, Materials Testing Laboratory, Energy Laboratory, Aerodynamics Laboratory, Instrumentation, Calibration, and Metrology Centre, Thermodynamics and Gas Dynamics Laboratory, etc.

All these laboratories are geared to support Indonesia's industrial development, such as the aeronautics industry, automotive industry, machine tools, shipbuilding and the energy industry.

A National Council of Standards is in the process of formation to support industrial development and which will function as the highest policy making body in standards, and as a clearing house.

The National Committee for Ocean Technology has been formed recently which coordinates activities in the field of oceanology, fisheries, marine and coastal environment, marine geology and marine geophysics, management and development of coastal zones, ocean engineering, and off-shore exploration of hydrocarbons and minerals and mariculture. A massive joint programme is now underway with France to explore the Indonesian waters.

The problem faced by Indonesia at present is the supply of adequately trained manpower, high level scientists and engineers as well as the technicians. Considering the present growth of demand in manpower, around 70 000 engineers, 21 000 scientists, 26 000 agriculturists, 11 000 accountants, 16 000 economists and 337 000 administrators and managers will be needed by 1990. In the energy sector only more than 5 000 engineers, scientists and technicians will be needed by 1985.

To cope with this problem the Government of Indonesia has an extensive programme to produce university graduates, postgraduates and technicians, together with vocational schools, and polytechnical institutes. A centre for human resources development has been founded recently. However, this remains one of the most serious problems faced by Indonesia in anticipating its industrial take off in the Fourth Five Year Development Plan.

On the social level, the problems of meeting basic human needs and maintaining equity loom large. These can only be alleviated by accelerated growth accompanied by employment creation in the industrial and agricultural sector, as well in the service sector.

4.3 OBJECTIVES AND PRIORITIES

Development of science and technology is an integral part of national development. Activities of science and technology are directed towards the following objectives:

i. Short-Term Objectives:

To develop the national capability in research and development;

To promote the transfer of technology.

ii. Intermediate Objectives:

To increase value added processes to natural resources development;

To increase employment.

iii. Long Term Objectives:

A higher degree of self-support in science and technology;

To increase national resilience.

The priorities in research and development in Indonesia are stipulated in the national science and technology matrix. The matrix identifies five priority problem areas, i. e.

Research and development to meet basic human needs

Research and development to develop natural and energy resources

Research and development to support industrialization

Research and development for the defence system

Research and development in social, cultural, economic and philosophic studies.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

In pursuance of its national goals of development, Indonesia participates in international cooperation through bilateral as well as multilateral cooperation.

In the field of multilateral and regional cooperation, Indonesia is participating in the activities of the United Nations agencies, i. e. UNDP, Unesco, Escap, Unido, WHO, ILO, etc; ASEAN, IDRC, EEC countries, and various financing institutions such as IBRD, ADB, etc.

Activities for promoting R&D have actively been pursued through bilateral cooperation. In line with the extent and volume of its economic activities and cooperation, Indonesia recently signed Science and Technology Agreements with the USA, the Federal Republic of Germany, the Republic of France, Japan, India, Saudi Arabia, etc.

Though no specific agreement on science and technology has been made, cooperation in science and technology has also been undertaken with other countries like Australia, New Zealand, the Netherlands, United Kingdom, Brazil, and many others.

International, inter-regional, regional and sub-regional types of cooperation have been developed not only to increase needed capital investment and transfer of know-how and technology but, indirectly, also to enlarge the export potential and increase the socio-economic benefit.

PART 5.

Select Bibliography

1. Ministry of Information of the Republic of Indonesia, *"The Guidelines of State Policy of the Republic of Indonesia"*, Jakarta,1973.

2. Ministry of Information of the Republic of Indonesia,*"The Guidelines of State Policy of the Republic of Indonesia"*, Jakarta, 1978.

3. Ministry of Information of the Republic of Indonesia,*"The First Five Year Development Plan (1969/1970-1973/1974)"*, Jakarta, 1969.

4. Ministry of Information of the Republic of Indonesia,*"The Second Five Year Development Plan (1974/1975-1978/1979)"*, Jakarta, 1974.

5. Ministry of Information of the Republic of Indonesia,*"The Third Five Year Development Plan (1979/1980-1983/1984)"*, Jakarta, 1979.

6. Secretariat of the Minister of State for Research and Technology,*"Policy and Main Programmes of Research and Technology"*, Jakarta, 1980.

7. Secretariat of the Minister of State for Research and Technology, *"Collection of Speeches by the Minister of State for Research and Technology"*, Jakarta, 1980.

8. Country Report, *"Indonesian National Paper for the United Nations Conference on Science and Technology for Development"*, Jakarta, 1979.

9. Central Bureau of Statistics, *"Statistical Pocketbook of Indonesia, 1978/1979"*, Jakarta, 1979.

10. Central Bureau of Statistics, *"Statistical Pocketbook of Indonesia 1979/1980,"* Jakarta, 1980.

11. Central Bureau of Statistics, *"National Income of Indonesia 1975-1980"*, ISSN 0126-4796, Jakarta, 1980.

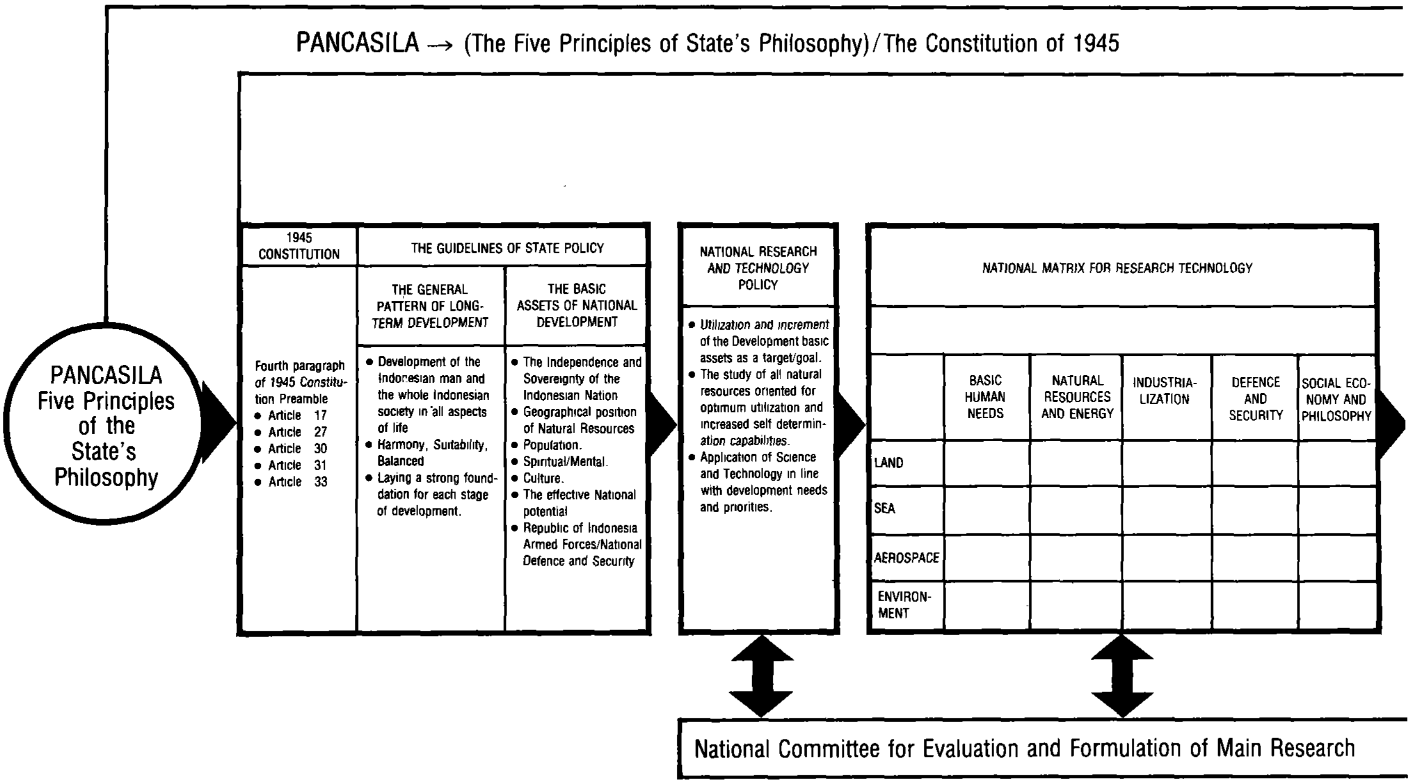
12. Central Bureau of Statistics, *"Indonesian Population 1980"*, Jakarta, 1980.

13. Bureau of Coordination and Science Policy - Indonesian Insitute of Sciences, *"Directory of Institutions Working in Research and Development in Indonesia"*, 1977.

14. Bureau of Coordination and Science Policy – Indonesian Institute of Sciences, *"Directory of Science and Technology Activities in Indonesia"*, 1977.

15. Bureau of Coordination and Science Policy – Indonesian Institute of Sciences, *"Directory of Research within Governmental Institutions and State Enterprises Involved in Research and Development Activities"*, 1979.

The General Pattern of National Research and Technology



PANCASILA → (The Five Principles of State's Philosophy)/The Constitution of 1945

PANCASILA Five Principles of the State's Philosophy

1945 CONSTITUTION

Fourth paragraph of 1945 Constitution Preamble
- Article 17
- Article 27
- Article 30
- Article 31
- Article 33

THE GUIDELINES OF STATE POLICY

THE GENERAL PATTERN OF LONG-TERM DEVELOPMENT

- Development of the Indonesian man and the whole Indonesian society in all aspects of life
- Harmony, Suitability, Balanced
- Laying a strong foundation for each stage of development.

THE BASIC ASSETS OF NATIONAL DEVELOPMENT

- The Independence and Sovereignty of the Indonesian Nation
- Geographical position of Natural Resources
- Population.
- Spiritual/Mental.
- Culture.
- The effective National potential
- Republic of Indonesia Armed Forces/National Defence and Security

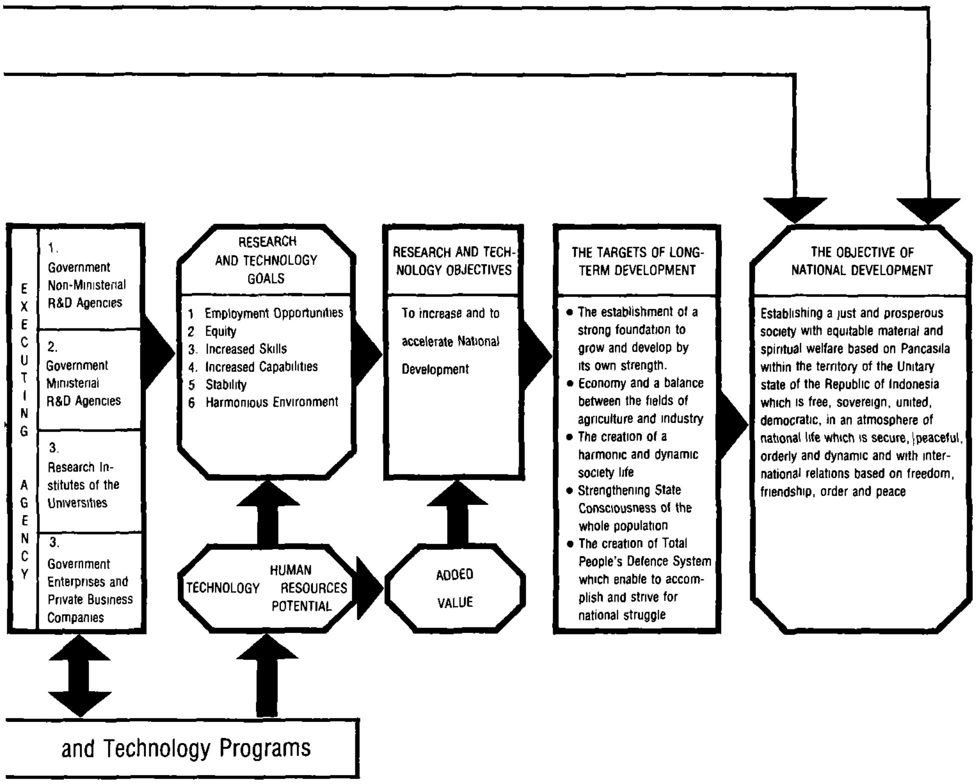
NATIONAL RESEARCH AND TECHNOLOGY POLICY

- Utilization and increment of the Development basic assets as a target/goal.
- The study of all natural resources oriented for optimum utilization and increased self determination capabilities.
- Application of Science and Technology in line with development needs and priorities.

NATIONAL MATRIX FOR RESEARCH TECHNOLOGY

	BASIC HUMAN NEEDS	NATURAL RESOURCES AND ENERGY	INDUSTRIALIZATION	DEFENCE AND SECURITY	SOCIAL ECONOMY AND PHILOSOPHY
LAND					
SEA					
AEROSPACE					
ENVIRONMENT					

National Committee for Evaluation and Formulation of Main Research


EXECUTING AGENCY
1. Government Non-Ministerial R&D Agencies
2. Government Ministerial R&D Agencies
3. Research Institutes of the Universities
3. Government Enterprises and Private Business Companies
RESEARCH AND TECHNOLOGY GOALS
1 Employment Opportunities
2 Equity
3. Increased Skills
4. Increased Capabilities
5 Stability
6 Harmonious Environment
TECHNOLOGY
HUMAN RESOURCES POTENTIAL
RESEARCH AND TECHNOLOGY OBJECTIVES
To increase and to accelerate National Development
ADDED VALUE
THE TARGETS OF LONG-TERM DEVELOPMENT
• The establishment of a strong foundation to grow and develop by its own strength.
• Economy and a balance between the fields of agriculture and industry
• The creation of a harmonic and dynamic society life
• Strengthening State Consciousness of the whole population
• The creation of Total People's Defence System which enable to accomplish and strive for national struggle
THE OBJECTIVE OF NATIONAL DEVELOPMENT
Establishing a just and prosperous society with equitable material and spiritual welfare based on Pancasila within the territory of the Unitary state of the Republic of Indonesia which is free, sovereign, united, democratic, in an atmosphere of national life which is secure, peaceful, orderly and dynamic and with international relations based on freedom, friendship, order and peace
and Technology Programs

JAPAN

Table of Contents

JAPAN

GEOGRAPHY

Capital city: Tokyo
Main ports: Kobe, Yokohama, Chiba
Land surface area: 372,313 sq km

POPULATION (1978)

Total	114.9 million
Density (per sq km)	309
Urban/rural ratio (1975)	3.1
Average rate of growth (1970-78)	1.2% p.a.

By age group:	0-14	15-19	20-24	25-29	60 and above	Total
	23.8	7.0	7.3	49.6	12.3	100%

SOCIO-ECONOMIC

Labour force (1978)	
Total	55.3 million
Percentage in agriculture	11.4%
Gross national product (1978)	
GNP at market prices	US $884,500 million
GNP per capita	US $7,700
Real growth rate of GNP per capita (1970-78)	7.8%
Gross domestic product (1976)	
Total (in current producers' values)	US $563,687 million
Percentage by origin	
Agriculture	5%
Manufacturing, mining & quarrying, electricity gas & water, construction	40%
Government finance	
National budget (1978)	US $70,656 million
As percentage of GNP	7.2%
External assistance (official, net; 1976)	...
As percentage of GNP	...
Exports (1978)	
Total exports of goods	US $97,501 million
Average annual growth rate (1970-78)	9.7%
External debt (1978)	
Total public, outstanding + disbursed	...
Debt service ratio (% GNP)	...
(% Exports of goods and non-factor services)	...

Exchange rate (1978): US $1 = 208.33 Yen

EDUCATION

Primary and secondary education (1978)	
Enrolment, first level	11,065,096
As % of (6-11 years)	99%
Enrolment, second level	9,090,491
As % of (12-17 years)	91%
Combined enrolment ratio (6-17 years)	96%
Average annual enrolment increase (1970-1978)	1.3%

Higher education (third level) (1978)

Teaching staff, total	206,131	
Students and graduates by broad fields of study		
	Enrolment[1]	Graduates (1977)
Social sciences and humanities	1,599,841	388,505
Natural sciences	61,040	12,682
Engineering	413,837	96,402
Medical sciences	128,226	22,421
Agriculture	62,479	15,344
Other and not specified	166,629	13,845
Total	**2,432,052**	**549,199**
Number of students studying abroad:	14,399	

Education public expenditure(1978)

Total (millions of Yen)	11,692,710
As % of GNP	5.7%
Current, as % of total	67.8%[2]
Current expenditure for third level education, As % of total current expenditure	11.0%

---

1. Including correspondence courses.
2. Data do not include public subsidies to private education.

Table 1 - Nomenclature and networking of S&T organizations

I - First level - POLICY-MAKING

Organ	Function	Linkages		
		Upstream	Downstream	Major collateral
A. GOVERNMENNT MINISTRIES & AGENCIES		(report to)	(advised by)	(consult with)
Prime Minister's Office	planning, administration & co-ordination		councils	national & local administrative bodies, research institutions, academic organizations, professional organizations, industry groups, public corporations, interest groups
Science & Technology Agency				
Environment Agency				
Ministry of Education, Science & Culture				
Ministry of International Trade & Industry				
Ministry of Agriculture, Forestry & Fisheries				
Ministry of Health & Welfare				
Ministry of Transport				
Ministry of Posts & Telecommunications				
Ministry of Construction				
B. COUNCILS				
Science Council of Japan	advisory	Prime Minister		
Council for Science & Technology				
Atomic Energy Commission				
Nuclear Safety Council				
Space Activity Commission				
Radiation Council				
Council for Ocean Development				
Council for Aeronautics, Electronics & other Advanced Technologies		Director-General, Science & Technology Agency		
Science Council		Minister of Education, Science & Culture		
Geodesy Council				
Agriculture, Forestry & Fisheries Research Council		Minister of Agriculture, Forestry & Fisheries		
Industrial Structure Council		Minister of International Trade & Industry		
Industrial Technology Council				
Council of Transport Technics		Minister of Transport		
Radio Technical Council		Minister of Posts & Telecommunications		

II - Second level - PROMOTION & FINANCING

Organ	Linkages		
	Upstream	Downstream	Other linkages
A. GOVERNMENT MINISTRIES & AGENCIES	(report to)	(performed by)	
Science & Technology Agency		local governments, universities, research institutions & companies	
Environment Agency			
Ministry of Education, Science & Culture			
Ministry of International Trade & Industry			
Ministry of Agriculture, Forestry & Fisheries			
Ministry of Health & Welfare			
Ministry of Transport			
Ministry of Construction			
B. SPECIAL QUASI-GOVERNMENTAL BODIES			
Japan Development Bank	Minister of Finance Minister of International Trade & Industry	companies	
Small Business Finance Corporation			
Japan Science Academy	Minister of Education, Science & Culture	universities & research institutions	academies, universities & research institutions in other countries
Japan Society for Promotion of Science			
Japan Foundation for Promotion of Private School Education			
Japan International Co-operation Agency	Ministers of Foreign Affairs, of Agriculture, Forestry & Fisheries, of International Trade and Industry	national & local governments, public corporations, universities & research institutions	governments, universities & research institutions in developing countries

Note:
In addition to those listed above, there exists a number of special quasi-governmental research institutes of government ministries, agencies, and foundations.

Organ	Linkages		
	Upstream	Downstream	Other linkages
C. *PRIVATE FOUNDATION*			
EXPO Memorial Association		universities & research institutions	
Kajima Institute of International Peace			
Mitsubishi Foundation			
Naito Memorial Foundation for Promotion Science			
Nissan Foundation for *Promotion of Science*			
Tohre Foundation			
Toyota Foundation			
Yamada Foundation for Promotion of Science			
Yoshida Foundation for Promotion of Science			

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages	
		Upstream	Other major
A. RESEARCH INSTITUTIONS			
1. Government organizations (100)			
National Aerospace Laboratory	R&D	Director-General, S&T Agency	
National Institute for Environmental Studies	R&D,STS	Director-General, Environment Agency	
National Institute of Genetics	R&D	Minister of Education, *Science & Culture*	
National Institute of Health	R&D	Minister of Health & Welfare	
Forestry & Forest Products Research Institute	R&D	Minister of Agriculture, Forestry & Fisheries	
Electrotechnical Laboratory	R&D	Minister of International Trade & Industry	
Ship Research Institute	R&D	*Minister of Transport*	
Radio Research Laboratory	R&D	Minister of Post & Telecommunications	
2. Local government organizations (600)	R&D, STS	local governor	
3. Quasi-governmental Research Institutes (10)			
Institute of Physical & Chemical Research	R&D	Director-General, S&T Agency	
Japan Atomic Energy Research Institute	R&D		
Japan Nuclear Ship Research & Development Agency	R&D		
Power Reactor & Nuclear Fuel Development Corporation	R&D		
National Space Development Agency of Japan	*R&D*		
Japan Marine Science & Technology Center	R&D		
Institute of Agricultural Machinery	R&D	Minister of Agriculture, Forestry & Fisheries	
4. Non-profit private organizations (350)	R&D		
B. UNIVERSITIES			
University faculties (1,000)	R&D, STET	Minister of Education, Science & Culture	
University research institutes (700)	R&D, STET		
National inter-university research institutes (7)	R&D, STET		
C. COMPANIES (15,000)	R&D		
D. INSTITUTIONS ON S&T INFORMATION & TECHNICAL TRANSFER			
Patent Office	STS	Minister of International *Trade & Industry*	
Small & Medium Enterprise Agency	*STS*		
Agency of Industrial Science & Technology	STS		
National Diet Library	STS		public & university libraries, research institutes
Public libraries (1,250)	STS	local governor	
University libraries (900)	STS	Minister of Education, Science & Culture	
National university data processing centers (7)	STS		
Japan Information Center of Science & Technology	STS	Director-General, S&T Agency	national & local government research institutions
Japan Patent Information Center	STS	Director-General, Patent Office	
Japan Science foundation	STS	*Director-General, S&T Agency*	
Research Development Corporation of Japan	STS		
Small Business Promotion Corporation	STS	Director-General, Small & Medium Enterprise Agency	

Table 2 - Scientific and technological manpower

Country: Japan

Year	Population (millions)	Scientists and engineers								Technicians*	
		Total stock (thousands) (A+B)	of which working in R&D							Total stock (thousands) (B)	Assistant research workers
			Total number (thousand) (A)	Breakdown by field of educational training							
				Natural Sciences					Social science and humanities		
				Science	Engineering & technology	Agricultural sciences	Medical sciences	others			
1965	98	351	149	43	41	13	21	3	28	202	79
1970	104	459	218	58	68	17	27	4	34	241	81
1975	112	570	310	78	107	20	47	6	52	260	86
1979	116	575	341	73	124	25	59	6	54	234	83
1985	122										
1990	126										

Source: 'Japan's Future Population Projections' published by the Population Problem Research Institute, Ministry of Health & Welfare. The projections were made based upon the population as of November 1976.

* 'Technician here includes assistant research workers, skilled workers, clerical or administrative personnels.

Source: 'The Report on the Findings of Survey on Scientific & Technological Research' published by the Statistical Bureau, the Prime Minister's Office.
'Educational Statistics of Japan' published by the Ministry of Education, Science & Culture.
'Statistical Yearbook of Japan' published by the Statistics Bureau, the Prime Minister's Office.

Table 3 - R&D expenditures

Country: Japan
Currency: Yen (¥)

Table 3a Breakdown by source and sector of performance

Year: 1979

Unit: billion yen

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive	37	2,626	2	2,665
Education Higher	758	525	—	1,283
General Service	578	82	1	661
Total	1,373	3,233	3	4,609

Table 3b: Trends

Year	Population (millions)	GNP (in: *billion yen*)	Total R&D expenditures (in: billion yen)	Exchange rate US $1 =
1965	98	32,982	486	360
1970	104	75,524	1,356	360
1975	112	153,126	2,975	308
1979	116	224,867	4,608	206
1985	122		2.5% of GNP for the time being (3% in the long-term perspective)	
1990	126			

Source: 'The Report on the Findings of Survey on Scientific & Technological Research' published by the Statistics Bureau, the Prime Minister's Office.
'Educational Statistics of Japan' published by the Ministry of Education, Science and Culture.

Introduction

A second Ministerial Conference for the Asia and Pacific region (CASTASIA II) aims primarily at discussing, on the basis of the outcome of the United Nations Conference on Scientific and Technological Development (UNCSTD) and within the framework of Unesco's programmes, the ways of promoting, in a more effective manner, scientific and technological cooperation between countries in the Asia and Pacific region. Since CASTASIA I in 1968, Japan has been extending its cooperation, with the stress on practical aspects, toward development of science and agricultural education through such programmes as Unesco's Asian Programme of Educational Innovation for Development (APEID), training of personnel through such training programmes as the international postgraduate courses, and development of regional cooperation through the Programme of Regional Cooperation in Basic Sciences in Southeast Asia. It is expected that, in future, Japan will continue to spare no effort to further the advancement of regional programmes paying due respect to the interdependency among the countries in the region.

It goes without saying that science and technology play an important part in national development. However, transfer of science and technology from one country to another will not automatically ensure the development of the recipient country.

Today, whether it is in the developed countries or in the developing countries, it is not possible to treat science and technology as matters of "autonomous" policy. To find for science and technology a correct place in the society of respective countries within the whole context of its cultural and economic development has increasingly become an important task. Some countries in the region need science and technology in order to solve problems of agriculture and water or health and medical treatment. For the region as a whole, great possibilities can be foreseen in such fields as the development of edible plants and medicines through utilization of abundant natural resources, and the biomass conversion in fermentation technology. It should be said that, in any case, the decision as to which of the fields of science and technology should be given a higher priority must be left solely to the judgement of respective countries.

In this connection, we value highly the fact that some countries in the region have attached greater importance to basic sciences in their science policy. For we believe that popularization of general education, the promotion of research in basic sciences, and the intensification of training of personnel are prerequisites for the development and application of science and technology.

The countries in the region, including Japan, have preserved their own culture over the centuries, with artisans engaged in the craftwork and other types of activities peculiar to their countries. The combining of such traditional culture with science and technology has great significance for endogenous development of individual countries. Scientific findings are the common property of mankind and the technology which results from their application is universal and can be used by any country; nevertheless, care must be taken in adapting science and technology to a region so that they will not result in the disruption of the region's cultural and natural environment (including scenic beauty).

In accordance with the views outlined above, Japan hopes to further strengthen the ties of mutual cooperation in science and technology among the countries in the region, with due respect to the cultural and geographical identity of each country.

It may be added that, in order to be effective, regional cooperation must be promoted from an overall point of view, with due regard to connections between Unesco's multilateral cooperation programmes and other multilateral or bilateral cooperation programmes.

The present report prepared for submission to CASTASIA II describes how science and technology have been developed, socially applied, and are presently being promoted in Japan. It is our earnest hope that the report might assist in the promotion of cooperation in science and technology among the countries in the region.

PART 1.

General Features

1.1 GEOPOLITICAL SETTING

Geographical features

Japan, an archipelago lying north-east of the Asian continent, consists of about 4 000 islands, Hokkaido, Honshu (mainland), Shikoku and Kyushu being the four main islands, and stretches over 3 800 kilometres from north to south. The total land area is some 378 000 square kilometres, of which mountainous land accounts for 72% and flat land only 28%. On that limited flat land, 117 million people (as of October 1980) live. The population density is thus 312 persons per square kilometre. Forty-five per cent of the Japanese people live in the large cities: Tokyo, Osaka, Nagoya and others. Tokyo, the capital of Japan, has a population of about 11.6 million (as of October 1980) and the population density there is 5 405 persons per square kilometre. Of the cities of Japan ten have populations of more than 2 million persons.

The islands of Japan lie in the temperate zone and the monsoon area and the climate is generally mild with four clearly distinct seasons. Being a long archipelago stretching from north to south, Japan has a complicated topography and its climate varies widely from one place to another. It has an abundant rainfall, ranging from 1 000 to 2 500 mm annually, which makes the country rich in forests and hydropower.

Because of the limited arable land efforts are made to adopt intensive and mechanized farming with a view to increasing productivity. Japan is also rich in marine resources due to its topographical feature of being surrounded by sea, and its fishing catch represents 15% of the world's fishing haul. Further, forests cover 66% of the total land area and the raw materials for timbers and pulp for paper production are abundant, yet, in terms of the demand, 60% of the total paper consumed is met by import. This gives rise to a growing awareness of the need for management of forestry resources. In regard to the mineral resources, Japan is poorly endowed with such basic materials as oil, iron ore, coke and non-ferrous metals. In particular, oil consumption, which accounts for three-quarters of total energy consumed in Japan, depends heavily on imports which represent 99.8% of the total oil consumed.

Political system

As the symbol of the state of Japan, the Emperor performs those Acts of State that are stipulated in the Constitution. These are to convene the Diet, to appoint the Prime Minister and the Chief Judge of the Supreme Court, to receive foreign ambassadors and so forth. The Emperor performs these tasks with the advice and approval of the Cabinet, but he has no power relating to government. The Diet is the highest organ of state power and the sole law-making organ of the state. It has two Houses, the House of Representatives and the House of Councillors, both of which are composed of Diet members who are representatives of the nation and elected by the people. The executive power is vested in the Cabinet. In Japan, the parliamentary Cabinet system has been adopted, and the Cabinet consists of the Prime Minister, designated from among the Diet members by a resolution of the Diet, and the state ministers appointed by the Prime Minister.The Cabinet members are collectively responsible to the Diet for the performance of executive power. All judicial power is vested in the Supreme Court and its inferior courts. The Chief Judge, as the head of the Supreme Court, is designated by the Cabinet. No extraordinary court can be established. (See Figure 1)

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

Socio-cultural features

The Japanese society is essentially homogeneous in the sense that it is composed largely of a single race speaking the same language and sharing the same customs, habits, and culture. It is characterized also by a homogeneity in terms of the people's intellectual level which is the result of a remarkable popularization of education over a long period of time as well as the recent development of the information media. Japan has social institutions based on liberalism, where the people's rights in respects of speech and publication, freedom of religion, and freedom of job selection are guaranteed. These conditions could be considered as significant factors in the substantial development of science and technology which are closely tied with the quest for truth and the elevation of the people's standard of living.

Economic features

i. Major sectors of economic activities

Japan has made efforts in increasing productivity through technical innovation and the concentration of capital investment on heavy and chemical industries. As a result, Japan's industrial structure underwent a drastic change after World War II. In 1979, the primary industries represented 4.5% of the Gross National Product (GNP), with 38% for the secondary and 57.5% for the tertiary industries. While the number of employees in the primary industries sector continued to decrease, the number of the employees in the tertiary sector surpassed 50% in 1974 and continued to increase further.

ii. Major export commodities and balance of trade

Manufactured goods account for 97% of total exports, and Japan leads the world in the export of television sets, calcultating and accounting machines, cars and ships. The balance of trade for the fiscal year of 1978* showed a record surplus, but, in the fiscal year of 1979 it moved a deficit, reflecting the fluctuation of exchange rates and market prices of international commodities, particularly crude oil.

1.3 DEVELOPMENT SCENE

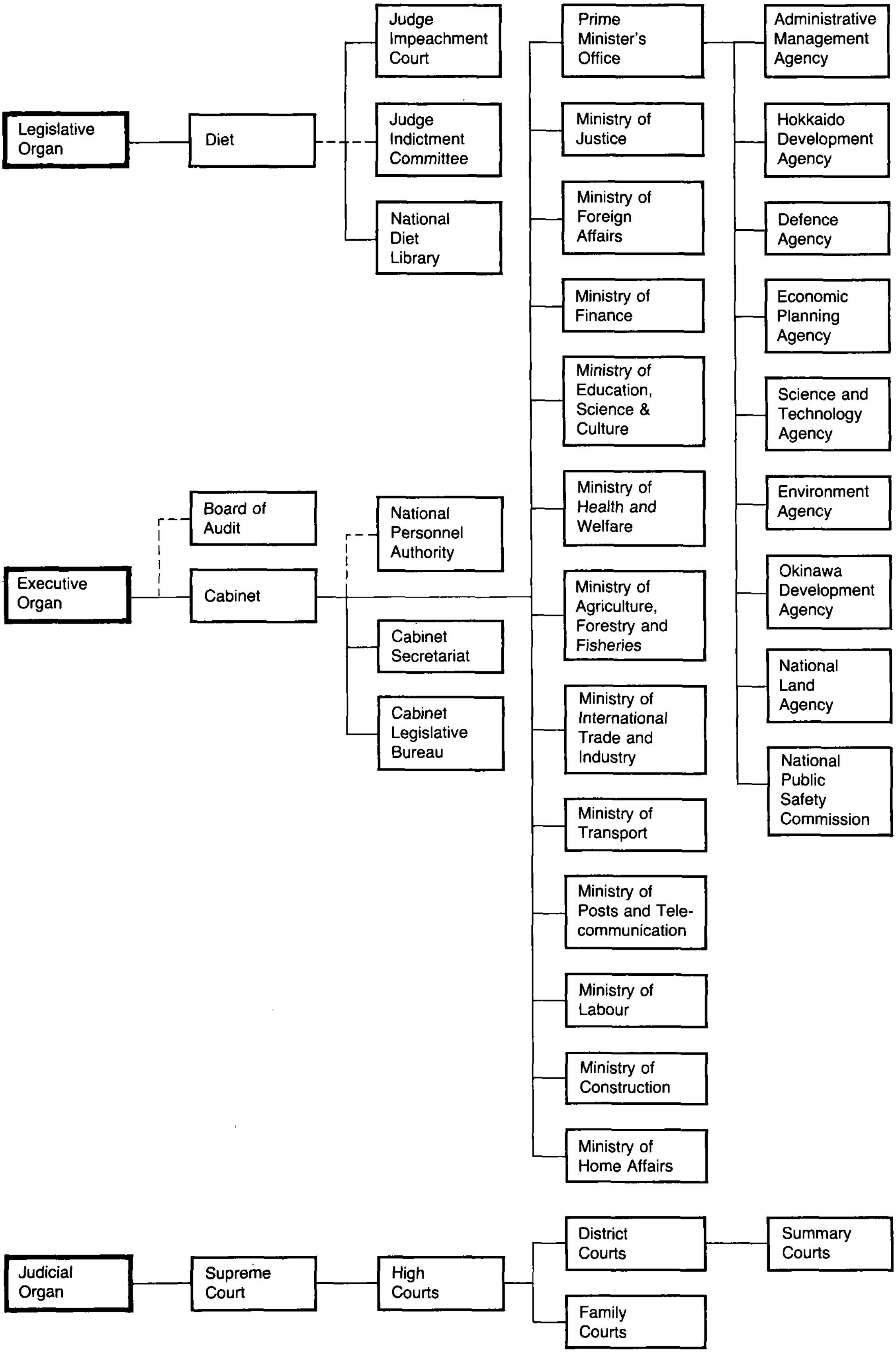
It is generally considered that Japan's modernization made its great advancement around 1868, the year of the Meiji Restoration. Since then, the science and technology of the Western advanced countries were introduced into Japan with great zeal.

---

*The Japanese Government's fiscal year begins on 1 April and ends on 31 March of the following year.

Figure 1

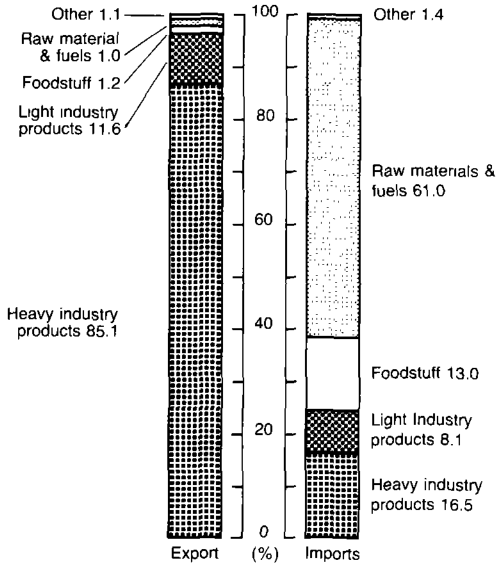
Government Organization



Source: 'Statistical Handbook of Japan 1980' published by Statistical Bureau, Prime Minister's Office

Figure 2

Foreign Trade by Commodity Group (1979)



Source. ''80 Japan' published by Statistics Bureau, the Prime Miniser's Office

In order to build a modern state, a nationwide effort was made to establish modern political institutions and lay the foundation for modern industrialization. As a result, Japan's national strength increased to the point where it could be ranked with the leading Western advanced countries a few decades after the Meiji Restoration. That achievement turned to ashes following Japan's defeat in World War II. Though its whole territory was impoverished, Japan soon recovered from its war-devastated state and showed a remarkable economic growth in the 1960s. With technical innovation and enormous capital investment in the heavy and chemical industries Japan grew, by 1969, to be a world power next to the United States and U.S.S.R., and the third power of the world in terms of the volume of its Gross National Products (GNP). While the process of development brought about change in Japan's industrial structure and in the concentration of industries and population in urban areas, it also promised a great increase in the people's standard of living.

In the 1970s, when Japan faced a difficult international economic environment. pressure for internationalization, and a new problem of environmental pollution as the reverse side of development, there appeared a change in people's perception of development.

Under the severe conditions peculiar to Japan, such as limited land and a scarcity of natural resources, Japan is now facing the challenging task of developing a knowledge-intensive industry in order to realize an affluent and harmonious society, rather than continuing to rely on the growth of natural resource-consuming industries.

As regards the factors which have contributed to the achievement of Japan's modernization, the following points can be highlighted. Firstly, the fact that education had already been popularized throughout the country in the days of Meiji Restoration made it possible for Japan to absorb successfully Western science and technology within a very short period of time. The nation's rate of illiteracy was then very low and most of its people had a basic knowledge of arithmetics and mathematics. It should also be noted that, since the early days of the Meiji Era, Western science had been studied at Japanese universities without regard to its application to daily life. At that time a greater importance was attached to the introduction of fundamental science as part of the cultural life of the nation. This was all assisted by the fact that the Japanese people speak the same language and share the same culture. Such unique homogeneity freed Japan from the task of spending a great amount of effort on the formation of a nation state, and thus enabled it to concentrate its energy on the carrying out of its policy of industrial development.

Secondly, when Japan started its efforts for the introduction of Western science and technology, not many years had passed since the United Kingdom and the United States had gone through the first industrial revolution. This assisted Japan to catch up with the Western countries technically, and created a favourable condition for Japan to build up the national strength to keep abreast with these advanced countries.

Thirdly, the geographical position of Japan, lying far away from the Western countries, worked in its favour. In other words, under such circumstances, Japan could introduce the advanced technology of the Western countries without losing its own identity and, in so doing, Japan also succeeded in adding some originality to the process based on its own culture which made the imported technology even more efficient.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

In recent years, the economic and social circumstances surrounding Japan have changed rapidly. The people's expectations and calls for administrative measures have become diversified in terms of quality as well as quantity. At the same time, other nations, particularly those in the Pacific and Southeast Asia, have become increasingly interested in exchange and cooperation programmes with Japan.

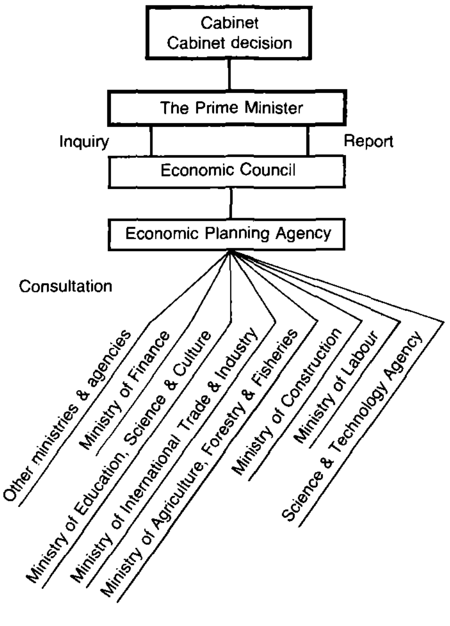
Under these circumstances, Japan formulated a New 7-Year (1979-1985) Plan of Economic and Social Development as a guideline for medium-term economic and social development programmes. It aims at the advancement of the people's quality of life and, at the same time, at making a positive contribution to the development of the international economic community.

The Prime Minister asked the Economic Council to formulate the Plan, and the Council conducted surveys and held debates on the matter and submitted a report to the Prime Minister, who presented the report to a Cabinet meeting for adoption as a government plan. The preliminary draft to be studied by the Council was prepared by the Economic Planning Agency in consultation with other governmental organizations concerned, that is, the Ministries of Finance, Education, Science and Culture, International Trade and Industry, Agriculture, Forestry and Fisheries, Construction, and Labour, and the Science and Technology Agency. An illustration of the process of formulating a plan follows:

However, Japan has as its foundation a market economy based on free competition, and the plan has no binding power over social and economic development activities. Thus the measures suggested under the pl in must be implemented not only by the hand of government, but also by the spontaneous cooperation and efforts on the part of individuals, families and enterprises.

The fundamental objectives of the plan and an outline of major policies to be undertaken by the plan are as follows:

Figure 3



(1) Realization of full employment and stabilization of prices

i. Stabilization and assurance of full employment in the changing structure of demand and supply of labour forces by advancing the training of personnel, improving working conditions and consolidating necessary conditions contributing to industrial development so that employment might be increased in such sectors as knowledge-intensive industry, leisure-oriented industry or other service industries in the fields of education, health and welfare; by enhancing technical capability and management infrastructure of small and medium-size industries; by improving working conditions and employment opportunity in local districts; and by preventing unemployment by use of an employment stabilization fund, and promoting re-employment through vocational training and placement services.

ii. The development of job competence corresponding to economic and social needs by establishing a comprehensive vocational education and training system in both public and private sectors and, in so doing, paying attention to the promotion of aid measures to employers, strengthening private advisory organizations and popularizing a paid-leave system for receiving education and training; and by identifying promising jobs, collecting systematically information regarding job description, job qualifications and requirements, and establishing a system there under to supply the information.

iii. Reception of trainees from abroad and the promotion of international cooperation, including aid to vocational training, centres in foreign countries.

(2) Stabilization and enrichment of national life

i. To improve education and to promote science and culture by improving primary and secondary school education with better educational content and teaching methods with a view to making school life freer and more comfortable, without lowering the standard of education, while attaching a greater importance to the teaching of the fundamentals, providing schools with the facilities required, and improving the teacher's quality and teaching ability; by improving and enhancing higher education and expanding the fields in which well-defined personnel training programmes are required, developing a well-balanced distribution of specialized fields among the local district and increasing their capacity, diversifying the opportunities for post-secondary education by providing a university of the air and a special training college, and improving the methods used for university entrance; by promoting social education, physical education and sports and improving facilities, training leaders and encouraging sports clubs and volunteer activities; by promoting culture to encourage the protection of cultural property and providing and improving facilities and requirement with a view to promoting the arts and cultural activities; by promoting science and research to encourage creative and pioneering scientific research, promoting science and research contributing to the solution of major problems including the development of new energy sources, space and marine resources, the promotion of technology for forecasting earthquake and volcanic activity and for medical treatment of diseases which are difficult to cure, and improving research institutes and training researchers to ensure their supply; by cooperation with other countries to make a contribution to the international community by increased exchange of students, educational personnel and researchers, by promoting scientific exchange with the developing countries, and also exchange with other countries in sports and culture.

ii. To increase social capital by improving facilities necessary for the safeguard of the living environment by promoting the betterment of housing, drainage, and facilities for the disposal of wastes, providing city parks, and helping to improve facilities for social welfare and education; and by helping improve facilities for traffic and communication and for protection and preservation of national land and agriculture. The target amount of investment by which to increase social capital under the 7-year plan (fiscal years 1979-1985) is approximately 190 000 billion yens (estimated on the basis of fiscal year 1978), with the amount of investment for each year to be decided in a flexible manner. With regard to the ways of increasing social capital in Japan, there was a Third Overall National Land Development Plan which preceded the 7-year plan and was formulated in November 1977. It outlined a national land development programme from a long-term viewpoint and set a target of providing and improving facilities in the course of a period of about ten years. The 7-year plan was formulated with due consideration for the contents of the National Land Development Plan.

(3) Adapting and contributing towards the economic and social development of the international community

i. By the expansion of economic cooperation in order to increase to the greatest extent the government aid to development and to promote an overall arrangement so that government aid can be supplemented by a programme of cooperation with the private sector which seeks to pay greater attention to cooperation in "manpower" development; to expand technical cooperation; and to increase understanding about the actual conditions and needs of the developing countries.

ii. By further promotion of international exchange in order to encourage the exchange of persons and the collection and distribution of information in the fields of industry, culture, education, science, labour and welfare.

(4) Ensuring economic stability and the creation and solidification of the developmental base

i. By developing and utilizing the private sector's ability to develop technology.

ii. By enhancing fundamental research to improve the research environment of national and local public experimental research institutes, universities and their research institutes, and to encourage research and development under a priority system and to provide a wider flow of scientific and technological information.

iii. By ensuring financial resources for research and development in order to provide greater incentives for the private sector and to increase investment in government-based research and development (the national target of investment for the planned period represents 3% of the national income).

iv. By developing and training personnel through providing education for the purpose of encouraging those who are rich in creativity and synthesizing ability, training researchers and technologists, and facilitating exchanges between the public, academic and private sectors.

v. By promoting international cooperation and encouraging international research cooperation in regard to large-scale research and development and furthering closer technical cooperation with the developing countries, including cooperation in the training of personnel.

vi. By reconstructing public finance and developing a new approach to financing.

(5) Finance rehabilitation and an effective monetary policy

i. To rationalize public finance and administration;

ii. To establish the appropiate share in reponsibility for meeting the demand of a higher priority for public finance, realizing the appropriate tax responsibility in order to effect the reconstruction of public finance, and ensure appropriate operation of the beneficiaries' and causers' liability system;

iii. To conduct appropriate management of public bonds;

iv. To establish a healthier local public finance.

2.2 DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

The new 7-year Plan of Economic and Social Development, which is a basic plan for the social and economic development of Japan, contains, as referred to in (2) and (4) of 2.1 above, a fundamental policy regarding the scientific and technological development of the country. It thus ensures that the scientific and technological development policy is integrated in the overall economic development policy. On the other hand, Japan's overall scientific and technological policy is formulated in the first place by the Council for Science and Technology, which is an advisory body to the Prime Minister. The Council prepared its reports in 1977, "On the Basic Principles of the overall Scientific and Technological Policy in the Long-Term Perspective". A draft of a report for adoption by the Council is prepared by the Science and Technology Agency in consultation with other related government ministries and agencies. Since the same ministries and agencies also participate in the formulation of economic and social policy, coordination is ensured between social and economic policy and scientific and technological policy.

As regards the specific policy concerning scientific and technological research activities at universities, it is the Minister of Education, Science and Culture who decides the policy, after having conferred with the Science Council (an advisory body to the Minister), and in accordance with the scientific and technological policy formulated by the Council for Science and Technology. The Science Council in 1973, in its reply to an inquiry made by the Minister, submitted a report, "On the Basic Measures for Promotion of Science of Today". The report was given serious consideration by the Ministry of Education, Science and Culture as the guideline for its science policy.

Aiming to put into effect the measures proposed by the social and economic policy, the government ministries and agencies secured budgetary appropriation for their implementation within their respective areas of competence.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

Governmental organizations concerned with the formulation of Japan's science and technology policy include administrative bodies such as the Science and Technology Agency, the Ministry of Education, Science and Culture, and the Ministry of International Trade and Industry, and advisory organs such as the Council for Science and Technology, the Science Council, and the Science Council of Japan. Each of these organizations, while attending to its proper functions, also maintains close contact with other organizations in order to secure the integrity of government policy.

The purpose and the functions of the major organizations concerned are outlined below:

Science and Technology Agency

The Agency was established in 1956 as an organization responsible for overall administration in science and technology. Matters concerning social sciences, humanities and university research are, however, outside the ambit of its functions.

It performs planning and promotion of fundamental policy on science and technology, as well as coordination of various administrative bodies as regards their policies on science and technology. It also serves, together with the Ministry of Education, Science and Culture, as the secretariat of the Council for Science and Technology.

Ministry of Education, Science and Culture

The ministry, which was established in 1871, is responsible for the promotion and popularization of school education, social education, science and culture, and also for administrative matters concerning religion.

The term "science" as it is used here, and which falls under the jurisdiction of the Ministry, includes humanities and social sciences as well as natural sciences and the applied research thereof.

The Ministry mainly formulates the science policy for the promotion of science at universities, after asking for advice from the Science Council and other advisory organs composed of experts in various fields of science, and after taking into consideration their reports, recommendations, requests and advice.

Council for Science and Technology

The Council was established in 1959 as an advisory organ to the Prime Minister in the formulation of the government 's science and technology policy. Being presided over by the Prime Minister, it is composed of Ministers of Finance and Education, Science and Culture, and the Director-Generals (Ministers of State) of the Economic Planning Agency and of the Science and Technology Agency, and the President of the Science Council of Japan, as well as other individual scientists.

In its reply to a request from the Prime Minister, the Council submits its report to the concerned minister as the necessity occurs for general coordination of administrative bodies on a fundamental and comprehensive science and technology policy for long-term and overall research objectives. It may advance its views to the Minister on matters in question even after having submitted its report to the Prime Minister. The Prime Minister must take into careful consideration the report and the views presented by the Council.

Science Council

The Council, and advisory organ to the Minister of Education, Science and Culture, conducts surveys and deliberates on major issues concerning science in reply to the Minister's inquiry, and submits its report to the Minister on such matters as deemed necessary.

The Council is composed of not more than 30 leading scientists and researchers and contributes to the formation of basic policy on science and technology on the basis of a purely scientific consideration and not from an administrative point of view.

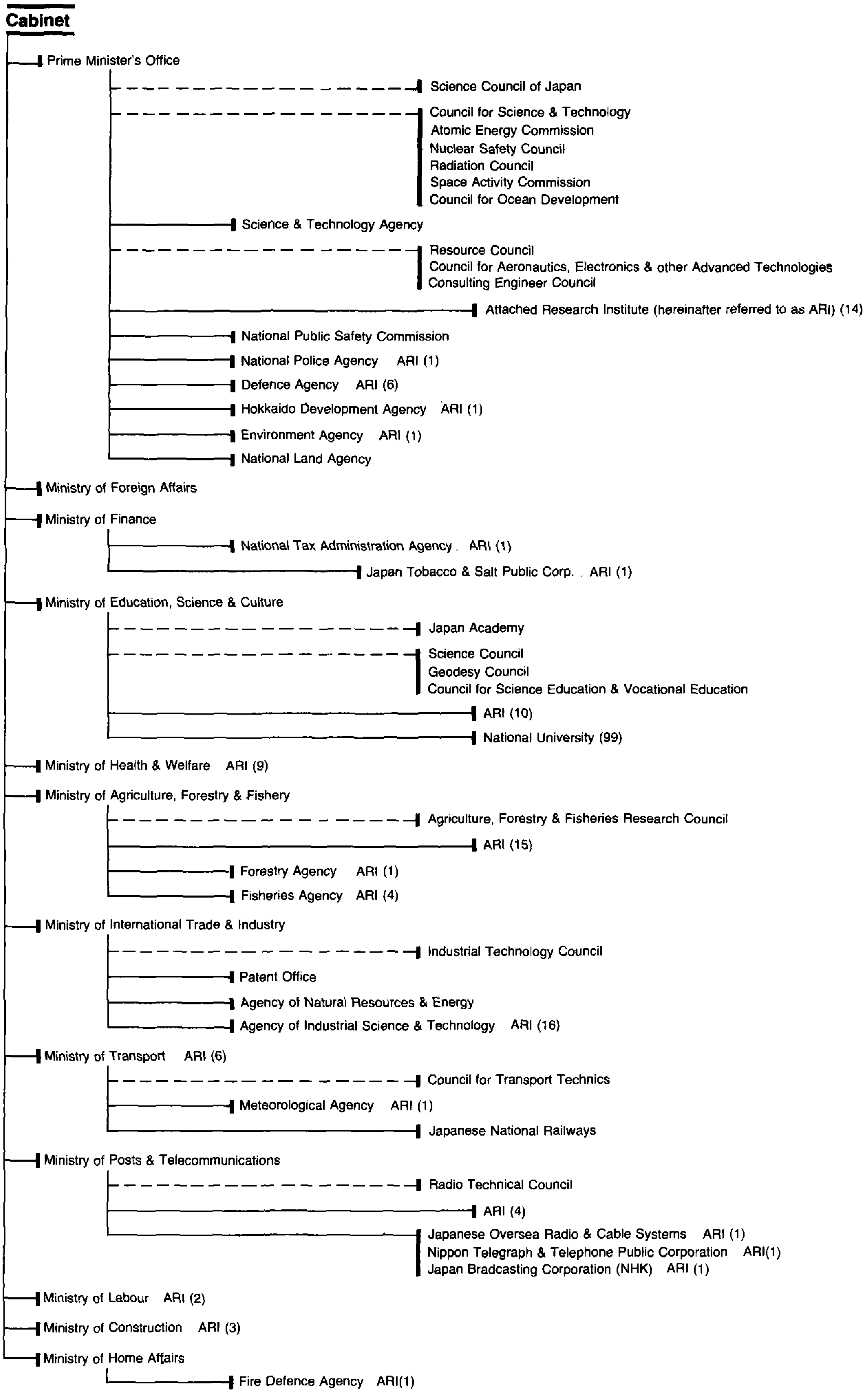
Science Council of Japan

The Science Council of Japan was established under the Prime Minister's Office in 1949 as a representative organization of scientific researchers.

It is composed of 210 researchers form every discipline who are elected from qualified scientists. It collects and analyses scientists' views on policies for promoting and developing science and technology, and makes recommendations to the government thereon through resolutions by its general assembly.

Figure 4

Organization of Japan's Scientific & Technological Administration



PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

In Japan, scientific and technological activities are carried out by various bodies of the government, the private sector, universities and research institutes, each of them producing results expected according to their role and function.

Government

The goverment decides and implements Japan's scientific and technological policy and, at the same time, undertakes research and development required from a national viewpoint. Major government organs responsible for general policy concerning science and technology are the Science and Technology Agency and the Ministry of Education, Science and Culture. The Agency, maintaining an overall coordination among relevant administrative bodies, is responsible for the overall promotion of administration in science and technology (other than administration concerning humanities and social sciences and scientific research at universities). The Ministry of Education, Science and Culture is responsible for the promotion of education and research in the humanities, the social sciences and the natural sciences (as well as the applied research thereof) at universities. Besides, the Ministry of International Trade and Industry plays an important role in research and development activities in the field of industrial technology. It conducts large-scale research and development projects and, in addition, assumes responsibility for encouraging technological development in the private sector. Other ministries and agencies conduct research and development at their own experimental research institutes and at the autonomous research organs falling under their jurisdiction, in order to meet public needs or the requirements of the national policy, as well as to extend assistance to research and development in the private sector.

The research and development projects include those large-scale projects related to space, nuclear power, ocean and new energy research, and those aimed at improving health and medical treatment to raise the quality of national life, and those concerned with disaster prevention.

In addition, local governments are promoting research and development activities in ways that reflect the particular needs of their areas. Such activities are being carried out through their affiliated research institutions, and with the cooperation of the central government.

Private sector

Private enterprise has been playing the larger role, with research and development in agricultural and industrial technology in Japan. It has really supported, particularly, Japan's research and development activities and its post-wars high rate of economic growth. As an example, the share of the government and the private sector in total research expenditure has stood at a 7 to 3 ratio over the past ten years. This means that a larger part of Japan's research and development has relied upon the free and independent activities of private enterprise and has been sustained by its rich creativity.

Private enterprise tried hard to achieve technical innovation in every field after the end of World War II in order to greatly increase productivity and to continue renewal of productive equipment and apparatus. In that effort, many enterprises established central research institutes to conduct research and development activities and invested increasingly large amounts on research and development. The number of enterprises conducting research activities (among enterprises with a capital of over 3 million yen) was about 15 000 in April 1979. Of those with capital of over 10 billion yen, approximately 90% conduct research and development, and of the small-and medium-sized enterprises whose capital stands between 100 million and 1 billion yen, about 50% carry out research and development in one way or another. In their research and development, stress is placed on the development of new products, new production methods, and the improvement of production techniques.

The enterprises conducting research are larger in number in the field of manufacturing industry, and vigorous research activities are carried out particularly in the chemical industry, the oil and coal products manufacturing industry, the precision, electrical and transportation machinery industry, and in the non-ferrous metals industry.

Universities

Universities play an important role in scientific research, including research in the natural sciences and the application thereof, as well as the training of scientific and technological personnel. The number of researchers at universities is about 162 000 at present, of whom 66% are in the field of natural science. They are engaged mainly in research activities in the field of basic science and technology, and also in education and training of future research workers and technologists. They play an important part in laying a solid foundation to develop Japan's science and technology. Further, universities undertake exchange programmes for research workers with national experimental research institutes or industrial firms, and conduct joint studies in compliance with the demands of government and industry.

National and local experimental research institutes

These institutes conduct research activities such as pioneering and large-scale projects aimed at nuclear power development and space development, research beneficial to agricultural and fishery industries of other small and medium-sized enterprises incapable of conducting research by themselves, and research in fields of concern to local industries which support the local economy. The number of such institutes is about 700, of which those in agricultural research represent the highest number, standing at 40%, followed by those in engineering research representing 25%, and those in health and science in that order.

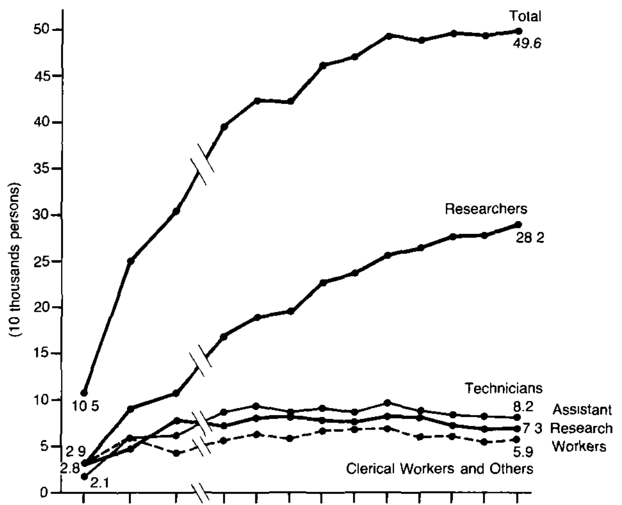
3.2 HUMAN RESOURCES

Scientific and technological personnel

The number of those who are engaged in research and development activities was about 575 000 in April 1979. They work in universities, industrial firms and research institutes. Those who specialize in natural sciences number 496 000. Changes in the number of researchers by the type of job classification are given in Figure 5.

Figure 5

Changes in the number of those engaged in research and development



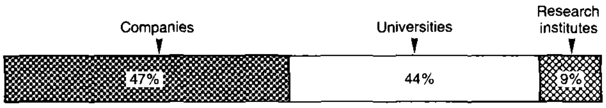
Source Scientific and Technological White Paper (1980)' published by the Science and Technology Agency

Of those who are engaged in research work, the regular researchers number about 340 000. The breakdown of researchers by sector is given in Figure 6.

Scientific and technological personnel other than regular researchers are assistant researchers, technicians, clerical workers and others. Their breakdown is shown in Figure 7.

Figure 6

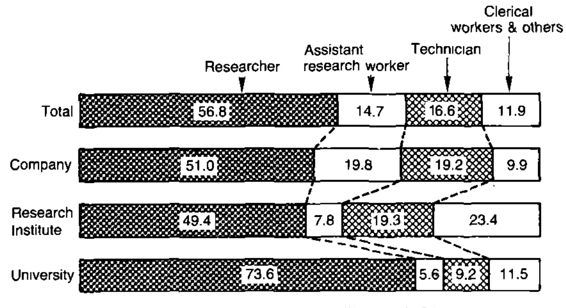
Sectoral Breakdown of Regular Researchers



Source The Report on the Findings of Survey on Scientific and Technological Research (1979)' published by the Statistics Bureau

Figure 7

Ratio of those engaged in Research & Development by Sector (1979)



Source Scientific & Technological White Paper (1980)' issued by the Science & Technology Agency

The distribution of researchers by specialized fields is as follows: in the enterprise sector, the researchers in engineering are the largest in number, representing about 60% of the total number of researchers, which is followed by the researchers in science, amounting to 30%. In particular, the number of those involved in the fields of machinery, ship-building and aviation, electricity, communication, and chemistry constitutes three-fourths of the total researchers. At universities, one half of the total researchers are in health services (medicine, dentistry, pharmacy, nursing) and engineering, representing 75% of all the researchers in the natural sciences. In the research institute sector, researchers in agriculture and engineering account for 70% and those in science and health service (medicine, dentistry, pharmacy, nursing) stand at 30% of all researchers.

Training of scientific and technological personnel

Scientific and technological progress largely depends on the ability and quality of scientists and technologists. In this respect, education and training of scientific and technological personnel, and improvement of their quality, are matters of crucial importance. The following are some examples of thng of those personnel.

i. Upper secondary school

The 9-year compulsory education system consists of a 6-year elementary school education and a 3-year lower secondary school education. The enrolment rate in compulsory school education is nearly 100%, and 94% of those who finish compulsory school education proceed to upper secondary schools. The 3-year vocational upper secondary schools are institutions for training technicians, and the students in agriculture, engineering and fishery courses account for about 15% of the total enrolment at upper secondary schools, namely 4 500 000 in May 1979.

ii. Institutions of higher education (other than graduate schools)

For those who have finished upper secondary school education, there exists junior college (a 2-year course), technical college (a 5-year course of education for those who have finished lower secondary school education), or the university (a 4-year course). The number of students in the science and technology courses of those institutions was about 660 000 in May 1979, which was about 30% of the total number of students enrolled at those institutions. The percentage has not changed in recent years.

iii. Graduate school

For those who have graduated from universities and wish to obtain specialized knowledge at a higher level, there are graduate schools for the master's and doctor's degrees. The total number of students in those courses was approximately 53 000 in May 1979. Of this total, about 34 000 students, or 64%, were in science and technology. The proportion of students specializing in science and technology in the total student body increases according to the advancement of the level of education, from upper secondary school to university, and from university to graduate school.

iv. Consultant engineer and others

A state registration system exists to grant authorization upon examination to those who possess advanced practical knowledge and ability. Under this system, about 14 000 technicians are presently registered in 17 fields. In addition, in the field of nuclear energy, a national examination system has been set up for authorizing qualified technicians.

Besides, a large number of technicians receive in-service training at training institutions within each industry, at special training schools, at miscellaneous schools and in scientific and technical foundations founded by the private sector.

3.3 FINANCIAL RESOURCES

The research expenditure of government, industrial firms, universities and research institutes is an important indicator of the level of scientific and technological development of a country. The total amount of Japan's research expenditure for the fiscal year 1979 was approximately 4 600 billion yens (20.4 billion US dollars), representing 2.05% of the National Income (the research expenditure in the natural sciences accounts for 88.5% of the total amount of research expenditure). The Council for Science and Technology made a recommendation in May 1977 that the rate should be raised to a target of 2.5% in the short-term and, in the long-term, up to 3.0%.

Research and development expenditure by sectors

Looking into the research expenditure by sectors, it is clear that a larger proportion of the expenditure is spent by industrial firms, standing at 58% of the total amount for the fiscal year 1979, with 28% by universities, and 14% by research institutes. As regards the source of the expenditure, government funds cover 30% and private funds 70% of the whole expenditure. The private share in the financial resources for research and development is thus relatively high. A larger part of the government funds flows into universities, national and local public research institutes, and quasi-governmental institutes under the jurisdiction of various ministries.

Research and development expenditure by type of activity

The structure of research expenditure by type of activity indicates that basic research expenditure accounted for 18%, while applied research expenditure was 25%, and developmental research expenditure represented 57% of the total amount of expenditure for the fiscal year 1979, thus making the proportion of expenditure similar to that of the major industrialized nations.

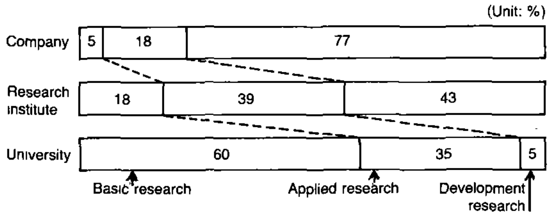
Research and development expenditure by field and specific theme

With regard to research expenditures for the five themes of nuclear energy development, space development, ocean development, data processing and the protection of environment, the total expenditure for the fiscal year 1978 was 550 billion yens (2.82 billion US dollars). It represents 16% of the total amount of research expenditure in the fields of natural science, of which the largest part had been spent on the energy research including nuclear energy development, amounting to 280 billion yens (1.436 billion US dollars). Of that expenditure, 66% was spent for nuclear energy research, 7% for energy-saving research, 7% for fossil energy research, and 4% for natural energy research respectively.

The following figures give a breakdown of research and development expenditure on energy.

Figure 8

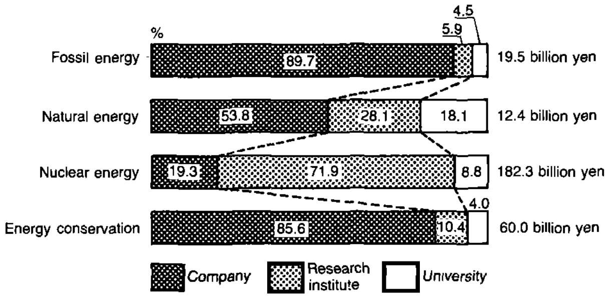
Ratio of Research and Development Expenditure by Type of Activity (Fiscal Year 1979)



Source: Based on 'The Report on the Finding of Survey on Scientific & Technological Research (1979)' published by the Statistics Bureau, the Prime Minister's Office

Figure 9

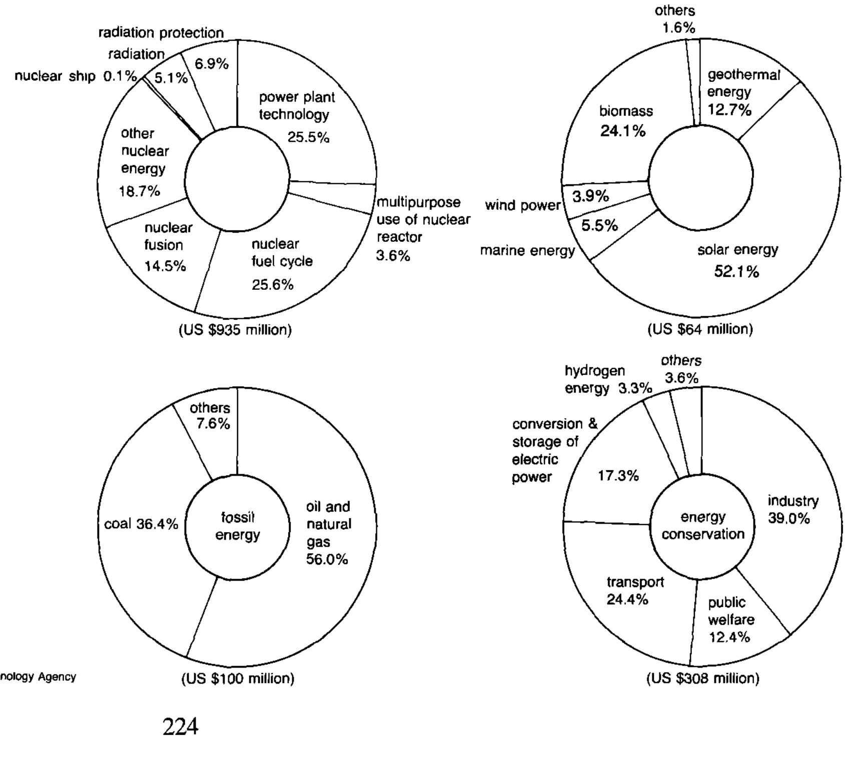
Breakdown of Research and Development Expenditure (on Energy by User (Fiscal Year 1978)



Source: Scientific and Technological White Paper (1980)' published by the Science and Technology Agency

Figure 10

Breakdown of Research and Development Expenditure on Energy by Field (Fiscal Year 1978)



Source: 'Scientific and Technological White Paper (1980)' published by the Science and Technology Agency

3.4 SURVEYING OF S&T POTENTIAL

In Japan, the Statistics Bureau of the Prime Minister's Office conducts the national census and other statistical surveys on basic data related to such national capabilities that do not fall under the jurisdiction of other government ministries and agencies.

The Bureau has been well furnished with the equipment and apparatus for data collection, data analysis and tabulation. It conducts the collection and analysis of survey findings upon request from other government ministries and agencies, and from the local public bodies as well.

Statistical surveys on the research expenditure and the number of researchers, which serve as important indicators of Japan's scientific and technological research activities, have been conducted annually by the Bureau since 1953. The result of each survey is published under the title of "The Report on the Survey on Scientific and Technological Research". The statistical survey aims at supplying the basic data required for the promotion of Japan's science and technology. The contents of the survey cover the research expenditure and the personnel engaged in research and development, and is classified by either sector (namely university, research institute and company), or by type of activity (namely basic research, applied research and development research), or by industry.

Apart from this, the collection of various data concerning scientific and technological potential is conducted, respectively, by the Ministry of Education, Science and Culture and the Science and Technology Agency on matters falling under their individual jurisdiction.

The Ministry of Education, Science and Culture has been conducting a survey every year since 1948 on "School Basic Statistics". As for statistics on universities, this covers such items as the number of students, teachers and other educational personnel, the number of faculties by specialized course, the number of school facilities, school expenses, and the number of new graduates entering employment by industry and occupation. It has also been conducting every three years a "Social Education Survey" in relation to the actual position regarding the "public citizens' hall" library and museum since 1955.

The Science and Technology Agency publishes every year a "White Paper on Science and Technology" and a "White Paper on Nuclear Power", and also prepares "the State's Plan of Experimental Research" on the basis of the findings of the survey on national experimental research institutes and the quasi-government research institutes under the jurisdiction of various ministries of the government. It has also been conducting every year since 1979 a "Survey on Scientific and Technological Trends" which is related to research activities by industrial firms, the aim of which is to assess the performance of post-war research and development and give a perspective on research and development in the 1980s.

PART 4.

Policy Issues in Scientific and Technological Development

4.1 MAJOR DEVELOPMENTS

The 1970s were a crucial turning point for Japanese society and economy, with the emergence of a worldwide awareness of limited energy and natural resources, coupled with concern over complex issues of environment protection and the decline in economic growth. The following are major changes Japan experienced during this period.

Natural resources

The contemporary world is characterized by its widespread consumption of various natural resources including energy, food, minerals, water and timber. It is expected that the demand for natural resources will continue to grow further on a global scale with economic development and further rises in the peoples' standard of living. In this context, the world experienced a steep rise in the price of grains in 1972, and an upsurge of resource nationalism as witnessed in the oil crises in 1973 and 1978, and in the introduction of 200-mile sea zones. As Japan relies heavily upon imported resources, it will thus have to double its efforts in research and development with a view to developing alternative resources, increasing domestic productivity, and achieving rational use of natural resources in the face of changes in international circumstances with respect to natural resources.

Land and environment

During the period of high economic growth from the end of World War II to the beginning of the 1970s, Japan experienced a great concentrating of its population in big cities. It is believed that this trend will continue in the future as the population increases. In the past few years pollution prevention technology has advanced remarkably and environmental pollution has been alleviated, but it is anticipated that the problems of overpopulated areas, increasingly less populated areas, urban traffic and transportation problems, the vulnerability of cities to natural and man-made disasters, and the problem of disposal of wastes, will all become more serious. In order to ensure a safer and healthier land and environment, it will be necessary to protect the natural environment, to prevent environmental pollution, to take preventive measures against various natural hazards, to appropriately re-allocate industry and the population; thus making an overall and well-balanced use of national land.

National life

i. The number of aged people has increased rapidly in Japan in recent years. It is foreseen that, in the 21st century, the number of those who are aged 65 years and over will be about one-seventh of the total population. With this change in the population structure there will, no doubt, be a rising demand for better public health and a satisfactory level of medical treatment and welfare.

ii. In Japan, industry has developed and urbanization has progressed very rapidly without a sufficient level of social capital investment to improve national life. As a result, the nation's living environment, such as housing, parks, green belt and drainage, has been left underdeveloped. In the national life of tomorrow, greater attention will be paid to a better quality of life and, eventually, to the enhancement of the social capital investment required to ensure a more comfortable living environment.

iii. With the expansion and diversification of living and production areas, the way such man-made accidents as fire, disaster and explosion occur, becomes complicated and varied, and the damage caused by them tends to be greater in scale. Further, as various kinds of consumer goods, such as foods, home appliances and medicines, have increased and diversified in recent years, their undesirable effects upon health and safety cannot be ignored. In the face of those developments, there will be a great demand in the future for the ensurance of safety in the national life.

4.2 ACHIEVEMENTS AND PROBLEMS

i. There is no doubt that scientific and technological progress have given birth to the present civilization and enriched man's life. But it must be admitted at the same time, that science and technology have accelerated the shortage of natural resources, the pollution of environment, the occurence of various kinds of disasters, and the destruction of nature in the course of adapting science and technology to society. In addition, the recent rapid progress in biology has made it possible to control genes artificially and to make experimental recombination. As a result, it is now considered necessary to make a general assessment of the human and social implications of science and technology.

On the other hand, science and technology are essentially the activities of human beings and a driving force which is indispensable for overcoming difficulties and opening the way to a prosperous society. Therefore, it is necessary in the future to develop and apply science and technology while always paying attention to identifying a proper place for them in the society.

ii. The development of Japan's science and technology during the thirty years since the end of the war has been remarkable. It appears that the level of Japan's technology reached almost as high as that of the advanced countries of the West. On the other hand, technical innovation in the world, generally speaking, is tending towards stagnation as a result of economic difficulties, and it is becoming increasingly difficult for Japan to import technological know-how from other countries.

In order to achieve a drastic innovation in science and technology under these circumstances, it will be more advisable for Japan to promote the basic sciences to enhance the training of personnel with a view to laying a more solid foundation of scientific and technological development, and to encourage pioneering basic research and development in science and technology which aims at establishing the state on the basis of its science and technology capacity.

Japan will thus be expected to actively develop independent technology and to offer its results for the benefit of the international community.

iii. With social and economic advancement and the rise in the standard of living, the people's values, life styles and needs have become complicated and diversified. And the issue of meeting those needs that are small in size, individualistic in nature, and which reflect the specific requirements of varied regions has become a challenging task. Measures will have to be taken to respond to such new problems in the development and application of science and technology.

4.3 OBJECTIVES AND PRIORITIES

The overall science and technology policy of Japan is, as stated in Part 2 of this report, formulated by the Council for Science and Technology (an advisory organ to the Prime Minister), and as regards the science policy related in particular to the research activities at universities, the Minister of Education, Science and Culture decides the policy after making an inquiry to the Science Council (an advisory organ to the Minister).

The Council for Science and Technology submitted in 1977 a report entitled "On the Basic Principles of the Overall Scientific and Technological Policy in the Long-Term Perspective" in its reply to the request made by the Prime Minister to the Council. In the report, the Council, being aware of the severe social and economic circumstances surrounding Japan, and trying to give a future perspective for the 21st century, clarified the basic principles to be followed in the formulation of a science and technology policy in the future and further proposed an outline of the measures to be taken in the implementation of the policy.

In the report, the following items are enumerated as the bases for the implementation of the policy:

i. To pay more attention to the harmonious relations between science, technology and society in the development and application of science and technology;

ii. To respond in a flexible manner to rapid social and economic change, and to unexpected changes in the state of affairs;

iii. To take full advantage of knowledge and experience in the humanities and social sciences in an effort to find a comprehensive approach to development and the application of science and technology which responds to increasingly complex social and economic needs;

iv. To implement the policy on a priority basis;

v. To be based on a global and long-term point of view.

On this basis the Report elaborates, as follows, the specific targets to be pursued in the implementation of a science and technology policy:

i. To ensure the stable supply of natural resources and to encourage natural resource saving;

ii. To provide a desirable living environment through, for example, the solution of environmental and safety problems;

iii. To maintain and promote public health or medical treatment;

iv. To promote pioneering and basic science and technology;

v. To develop a technological strength capable of contributing to international cooperation and ensuring Japan is a competitive international power;

vi. To promote basic sciences.

To achieve the above targets, the following are proposed in the Report as the principal measures that ought to be taken:

i. To formulate a basic plan in each of the major fields and to strengthen coordinating functions among the authorities concerned;

ii. To strengthen an effective linkage among government, university and industry in research and development;

iii. To replenish the fund for research and development;

iv. To train personnel and to ensure their supply;

v. To promote basic sciences mainly at the university;

vi. To promote public understanding and cooperation;

vii. To encourage scientific and technological activities at the local level;

viii. To effect the distribution of scientific and technological information (by establishing a nation-wide information network and participating in the international information system);

ix. To strengthen international scientific and technological activities.

As for basic guidelines for the promotion of research activities mainly at universities, the Science Council submitted a report in 1973 in its reply to an inquiry made to the Council by the Minister of Education, Science and Culture. In the report, the following eight items are proposed as the basic principles for the promotion of sciences:

i. To attach importance to creative and pioneering research;

ii. To encourage flexibility in research organization;

iii. To improve and expand the research functions of universities through an appropriate organization and operation bearing in mind the trend towards the popularization of university education;

iv. To establish a method of research evaluation;

v. To develop and consolidate the foundations of research and, at the same time, to increase research investment on the basis of the priority accorded to respective research problems;

vi. To train future scientists and technologists, and to strengthen the research-supporting organizations;

vii. To make universities open to the international community;

viii. To establish an appropriate system for obtaining and supplying scientific information.

The report further proposed five items as the basic measures to be taken, an outline of which is given below:

i. Improvement and renovation or research organizational structure by re-arranging the faculties and departments through separation of the research staff organization from student education organization; by improving the institutions jointly used by universities; and by establishing a method of research evaluation;

ii. An increase in research investment by increasing the current expenditure for research, increasing the research investment on a selective and priority basis, improving research equipment and apparatus, and extending aid to private organizations in scientific research;

iii. Promotion of training of researchers and research supporting organizations by reforming and improving the doctor's and master's degree courses of graduate schools, establishing and increasing post-doctoral fellowships and research fellow schemes, and encouraging research supporting organizations in those fields of experimentation, data collection and analysis, and production and operation of related equipment;

iv. Establishment of research organizations open to the international community and the promotion of international exchange by strengthening and improving the organization and operation of universities and improving and promoting exchange programmes for researchers, joint studies, and international study meetings, with particular emphasis on the developing countries;

v. Improvement of the system for the exchange of information by identifying and ensuring sources of primary and secondary information, improving the information exchange system and training experts in data processing.

Since this report in 1973, the Science Council has made many recommendations and proposals for promoting research activities in various fields: space science, nuclear fusion, life science, scientific exchange with the developing countries, oceanographic research, the scientific information system, and energy development. In November 1980, the Minister of Education, Science and Culture made a request to the Council "On the Basic Measures for Improvement of the Scientific Research System", with a view to promoting an overall and effective scientific research programme to meet the social and research needs on, for example, the energy issues. The Council is now making studies on the subject.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

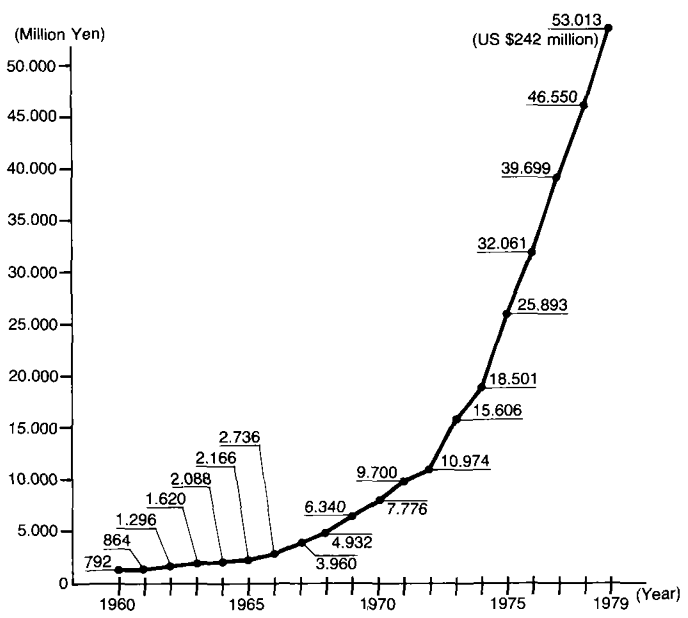
International cooperation in science and technology is becoming more and more important as an effective means of helping to solve global issues concerning natural resources, energy, environment, food and population.

As a country lacking in natural resources, and aiming at establishing a state on the basis of science and technology, Japan is well aware of the necessity for interdependency of the nations of the world and has been making positive efforts to advance and strengthen its scientific and technological cooperation with other countries, both developed and developing, under bilateral or multilateral arrangements. Cooperative programmes with developing countries cover various fields, such as education, research, and technical assistance. Financial support is given to relevant organizations with a view to enabling those countries to lay a solid foundation for their development and in particular to develop "manpower", which is one of the prerequisites for building a nation.

Looking into the performance of Japan's cooperation in terms of funding, the total amount of bilateral scientific and technological cooperation with the developing countries in 1979 was valued at about US$242 million (about 53 billion yen), and it has shown a steady increase year after year.[*] By expanding technical cooperation in terms of quantity as well as quality, Japan is being called upon to strengthen its effort to make a positive contribution to the economic and social development of the developing countries.

Figure 11

Growth of bilateral co-operation in science and technology between the developing countries and Japan



Source: based on 'The Japan's Diplomacy of Today (1980)' published by the Ministry of Foreign Affairs

The following are Japan's major cooperative activities in science and technology with developing countries. The description is confined to a brief account of the activities which are carried out on a governmental basis, and have been selected as appropriate for the purposes and objectives of CASTASIA II.

Bilateral cooperation

i. Reception of foreign students

The number of foreign students enrolled in under-graduate courses at universities, at graduate schools, or at research institutes attached to universities was 5 933 in May 1979 (4 614 being from the Asian and Pacific region). Of those foreign students, 1 183 (619 from the Asian and Pacific region) were on the government scholarship programme offered by the Ministry of Education, Science and Culture. Of the total number of foreign students, 40% were enrolled in graduate schools.

In addition, in the fiscal year 1980 Japan started a new programme for receiving teachers of elementary and secondary schools from Asian countries for their training and study at Japanese universities.

ii. Scientific exchange by the core-university system

Since the fiscal year 1978 the Ministry of Education, Science and Culture has been carrying out scientific exchange programmes between the Sout-East Asian countries and Japan under the core-university system, with the Japan Society for the Promotion of Science as the executing agency. Under this programme, interested universities in Japan are formed into several groups and within each group a core-university is designated. The same arrangement is made in other countries. With the core-universities playing a central role, systematic, continuous and organic exchanges of researchers and the organization of joint studies and seminars are carried out between the Japanese universities and their counterparts.

The scientific exchange mechanisms, and the performance of exchange cooperation, are given in Figure 12.

iii. Technical cooperation

Japan's technical cooperation at a governmental level started in 1954 when Japan joined the Colombo Plan. Such cooperation is at present being carried out primarily by the Japan International Cooperation Agency (established in 1974, succeeding the former body, the Overseas Technical Cooperation Agency which was established in 1962) in order to meet the growing needs of the developing countries. The Agency's programmes for technical cooperation are: reception of trainees (3 100 trainees in the fiscal year 1979); dispatch of experts (3 700 experts in the fiscal year 1979); supply of machines and tools; conduct of development surveys, cooperation through technical training centres of the developing countries, and medical, agricultural, forestry or industrial development cooperation. In 1979, a total of 35.27 billion yen (approximately US$160 million) was expended on technical cooperation by the Agency, which represents 66% of the total amount in real terms of Japan's cooperation with developing countries under bilateral arrangements (see Figure 12 above).

iv. Other programmes of scientific and technological *cooperation*

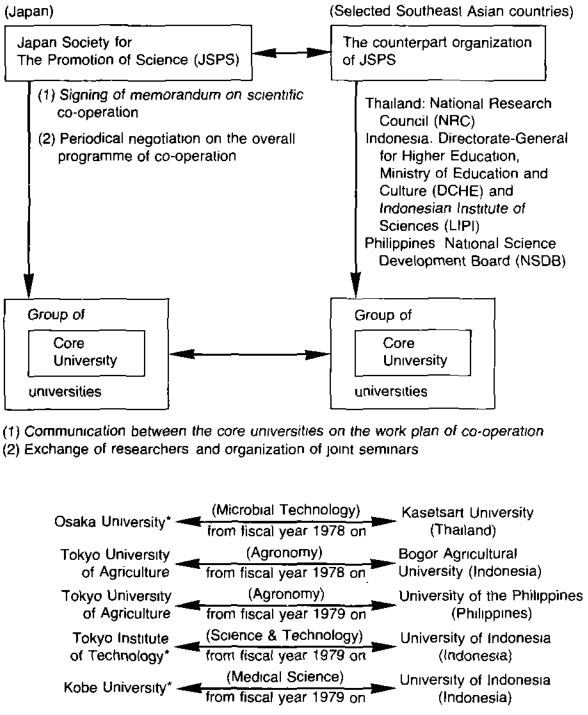
In addition to those stated above, Japan conducts various cooperative programmes with developing countries, mainly with Asian countries. Those programmes are carried out by the Science and Technology Agency, and the Ministries of Health and Welfare, Agriculture, Forestry and Fisheries, International Trade and Industry, Construction and other ministries and

---

[*] In this amount, the expenditure by the Japan Society for the Promotion of Science on the core-university system was not included.

agencies, with a view to increasing the research and development capability, developing technology to meet particular conditions and needs, or helping promote research and development in the respective developing countries. The details of the wide-ranging research cooperation are not given here in view of the limited space available.

Figure 12



* At Osaka University, Tokyo Institute of Technology, and at Kobe University, there has been established respective international exchange centres which would provide a place for the exchange of researchers and joint studies programmes

Multilateral cooperation

i. Participation and cooperation in Unesco programme activities

(a) Cooperation in the Asian Programme of Educational Innovation for Development (APEID)

Participating in the programme, Japan has so far organized training seminars in each of these fields: educational technology, vocational and technical education, curriculum development and science education, and also sent overseas mobile team missions in those fields. A total expenditure of some 101.5 million yen (approximately US$450 000) was budgeted for the fiscal year 1980. Apart form this, Japan makes a financial contribution to APEID every year amounting to US$150 000.

(b) Regional cooperation programme in basic sciences in South-East Asia

Under the programme Japan has, since 1975, been making a financial contribution (amounting to US$100 000) every year to work in the fields of microbiology and chemistry and, in addition, providing experts to give training courses and workshops at home and abroad.

(c) Participation and cooperation in the Intergovernmental Oceanographic Commission (IOC)

Japan has been participating actively in Unesco's programme of oceanographic studies since IOC started its activities. In this connection, Japan attaches great importance to the regional cooperation programmes and participated in the Cooperative Study of the Kuroshio and Adjacent Regions (CSK) which ended successfully, and is now participating in the newly started Cooperative Study of the Western Pacific (WESTPAC) by way of organization of various preparatory meetings. In the fiscal year 1981, Japan is making a financial contribution of US$30 000 for WESTPAC activities in the form of a trust fund.

(d) Establishment of International Postgraduate Courses

In cooperation with Unesco, Japan has been organizing since 1964 annual training courses in the fields of chemistry (and chemical engineering) and microbiology at Tokyo Institute of Technology and Osaka University. The courses offered are for junior teaching staff and researchers of universities of the developing countries, mainly in the Asian region (14 teachers and researchers are accepted every year for each course). In the fiscal year 1981, the appropriation for the courses has been budgeted at 103.40 million yens (approximately US$470 000).

(e) Establishment of International Training Course in Geothermal Energy

The Japan International Cooperation Agency and Kyushu University have been organizing, in cooperation with Unesco, a training course on geothermal energy every year since 1970. The course is designed for the training of junior researchers of the developing countries mainly in the Asian region (approximately 13 researchers for ten weeks). The expenses required for the course were borne by the Japan International Cooperation Agency and amounted to 18.4 million yen (approximately US$7 600) for the fiscal year 1980.

ii. Cooperation in the United Nations University

Japan has so far made a financial contribution of US$90 million to the endowment fund for the United Nations University (the total endowment made by voluntary contributions from governments of the Members States of the United Nations, foundations and indivuduals is US$109.6 million). In addition, Japan has provided the facilities and equipment for the United Nations University Headquarters, and Japanese research institutes and universities have been cooperating with the United Nations University in its study programmes and receiving trainees from abroad.

iii. Cooperation in the programmes of other United Nations organizations

(a) Japan attaches importance to the programmes of the Economic and Social Commission for Asia and the Pacific (ESCAP) under the United Nations Economic and Social Council, and has been actively cooperating in natural resource surveys, disaster prevention, meteorological studies and exchange and transfer of technology and information.

(b) In cooperation with the Association for Science Cooperation in Asia (ASCA), Japan conducts its research cooperation with the countries in the Member States of ASCA region.

(c) In addition to those mentioned above, Japan has been participating in various cooperative programmes of the United Nations Industrial Development Organization (UNIDO), the United Nations Food and Agriculture Organization (FAO) and International Atomic Energy Agency (IAEA), paying particular attention to the promotion of programmes relevant to the Asian region.

PART 5.

Bibliography

Statistical Handbook of Japan 1980, Statistics Bureau, Prime Minister's Office, March 1980.

'80 Japan, Statistics Bureau, Prime Minister's Office, 1980.

The Japan of Today, Ministry of Foreign Affairs, 1980.

The New 7-Year Plan of Economic and Social Development, Report of the Economic Council, June 1979.

"On the Basic Principles of the Overall Scientific and Technological Policy in the Long-Term Perspective", Report No. 6 of the Council for Science and Technology, May 1977.

"On the Basic Measures for Promotion of Science of Today", Report No. 3 of the Science Council, October 1973.

"The Third National Overall Development Plan", Report of the Overall Development Council, November 1977.

National Paper for the United Nations Conference on Science & Technology for Development, National Committee on Preparation of National Paper, March 1978.

White Paper on Science and Technology, Science and Technology Agency, August 1980.

The Report on the School Basic Survey (1979), Ministry of Education, Science and Culture, December 1979.

Indicators of Science and Technology 1980, Planning Bureau, Science and Technology Agency, June 1980

The Report on the Survey on Scientific and Technological Research, Statistics Bureau, the Prime Minister's Office (1965, 1970, 1975 and 1979 editions)

The Summary Report on the Survey on Scientific and Technological Research 1980, Statistics Bureau, Prime Minister's Office, December 1980

Statistical Abstract of Education, Science & Culture 1980 Ministry of Education, Science and Culture, June 1980

Statistical System and Statistical Survey, Administrative Management Agency, March 1977.

The 24th Annual Report of the Science and Technology Agency, Science and Technology Agency, November 1980.

The Japan's Diplomacy of Today 1980 Edition, Ministry of Foreign Affairs.

White Paper on Public Health & Welfare, 1978 Edition, Ministry of Health & Welfare, December 1978.

"On the Promotion of Cooperation in Training of Personnel in the Developing Countries and on the training of the Japanese Personnel engaged in the Cooperation" (The Recommendations of the Council of Foreign Economic Cooperation), December 1979.

"On What Future Economic Cooperation Should be like" (The Recommendations of the Council of Foreign Economic Cooperation), November 1980.

KAMPUCHEA DEMOCRATIQUE

Table des matières/Table of Contents

KAMPUCHEA DEMOCRATIQUE

GEOGRAPHY

Capital city: Phnom-Penh
Main ports: Phnom-Penh, Kampong-Som Ville
Land surface area: 181,035 sq km

POPULATION (1978)

Total	8.6 million
Density (per sq km)	47
Urban/rural ratio	...
Average rate of growth (1970-78)	2.5% p.a.

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	38.6	11.4	9.8	35.5	4.7	100%

SOCIO-ECONOMIC

Labour force (1962)	
Total	2.5 million
Percentage in agriculture	...
Gross national product	
GNP at market prices	...
GNP per capita	...
Real growth rate of GNP per capita (1970-78)	...
Gross domestic product	
Total (in current producers' values)	...
Percentage by origin	
Agriculture	...
Manufacturing, mining & quarrying, electricity, gas & water, construction	...
Government finance	
National budget	...
As percentage of GNP	...
External assistance (official, net; 1976)	...
As percentage of GNP	...
Exports	
Total exports of goods (1978)	...
Average annual growth rate (1970-78)	...
External debt (1978)	
Total public, outstanding + disbursed	...
Debt service ratio (% GNP)	...
(% Exports of goods and non-factor services)	...

Exchange rate (1974): US $1 = 518.13 Riels

EDUCATION

Primary and secondary education (1972)	
Enrolment, first level	479,616
As % of (6-11 years)	38%
Enrolment, second level	103 419[1]
As % of (12-18 years)	9%
Combined enrolment ratio (6-18 years)	24%
Average annual enrolment increase (1970-1972)	17.3%[1]

[1] Not including teaching training at the second level.

Higher education (third level) (1972)

Teaching staff, total	...

Students and graduates by broad fields of study:

	Enrolment	Graduates
Social sciences and humanities	5,576	419
Natural sciences	1,065	53
Engineering	1,057	172
Medical sciences	2,169	115
Agriculture	121	31
Other and not specified	...	...
Total	**9,988**	**790**
Number of students studying abroad	1,121	

Education public expenditure (1972)

Total (millions of Riels)	...
As % of GNP	...
Current, as % of total	...
Current expenditure for third level education, as % of total current expenditure	...

Table 1. Nomenclature and Networking of S&T Organizations

(Data unavailable at time of publication)

I - First level - POLICY-MAKING

Country: Democratic Kampuchea

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
....	....	....	....	....

II - Second level - PROMOTION & FINANCING

Organization	Linkages		
	Upstream	Downstream	Others
....	....	....	....

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages	
		Upstream	Others
....	....	....	....

Table 2 - Scientific and Technological Manpower

(Data unavailable at time of publication)

Country: Democratic Kampuchea

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (*thousands*)	of which working in R&D						Total Stock (thousands)	of which working in R&D
			Total number (in units)	Breakdown by field of educational training (*in units*)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965										
1970										
1975										
1979										
1985										
1990										

Table 3 - R&D expenditures

(Data unavailable at time of publication)

Country: Democratic Kampuchea
Currency:

Table 3a: Breakdown by source and sector of performance

Year: Unit:

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive				
Higher Education				
General Service				
Total				

Table 3b: Trends

Year	Population (millions)	GNP (in)	Total R&D expenditures (in)	Exchange rate US $1 =
1965				
1970				
1975				
1979				
1985				
1990				

PARTIE 1.

Considérations d'ordre général

1.1 CADRE GEOPOLITIQUE, SOCIO-CULTUREL ET ECONOMIQUE

Géographie

Situé dans l'Asie du Sud Est, limité au Nord par le Laos, à l'Ouest par le Royaume de Thaïlande, au Sud Ouest et au Sud par le Golfe de Thaïlande, au Sud Est et à l'Est par le Vietnam, le Kampuchéa Démocratique a une superficie de 181 035 km^2. La partie continentale est entièrement inscrite dans le rectangle : 10°-15° de latitude Nord et 102°-108° de longitude Est. Ses dimensions maximales sont de 450 km Nord-Sud et 550 km Est-Ouest. Il a la forme d'une cuvette largement ouverte au Sud Est sur le delta du Mékong qui se jette dans la Mer de Chine Méridionale. Cette cuvette est bordée au Nord Est par les plateaux de Ratanakiri et de Mondulkiri, au Nord par la chaîne des monts de Dangrêk, à l'Ouest et au Sud Ouest par la chaîne des Cardamones, et la chaîne de l'Eléphant. Le point culminant est le Mont Aural (1 813 m) à environ 100 km au Nord-Ouest de Phnom Penh.

Population

Plus de 90% de la population est d'origine khmère, c'est-à-dire des descendants directs de ceux qui ont bâti la civilisation de bronze de Samrong Sen 12 siècles avant notre ère, puis la civilisation dont l'apogée fut celle d'Angkor. Le reste représente plus d'une dizaine de minorités nationales dont la plupart vivent sur les plateaux du Nord Est.

La population était de l'ordre de 7 millions en 1970. Elle a peu progressé jusqu'en 1975 à cause de la guerre. En 1977 elle était seulement de l'ordre de 7,5 millions pour dépasser les 8 millions fin 1978. Mais depuis décembre 1978, à cause de la guerre d'annexion et d'extermination qui nous est imposée, beaucoup sont morts par les armes classiques, par les armes chimiques, par les empoisonnements systématiquement organisés et surtout par l'arme de la famine. Actuellement la population est de l'ordre de 6 millions à 0,5 million près. D'autre part, l'âge moyen de la population est assez bas : plus de la moitié a moins de 20 ans.

Climat

Le Kampuchéa est soumis au régime des moussons : la mousson d'été qui débute en mai, est pluvieuse. La quantité totale annuelle d'eau tombée est en général suffisante pour l'agriculture et plus particulièrement pour la riziculture, mais ces pluies sont en général irrégulières sauf sur les côtes. Pendant cette période, le Mékong grossi des fontes de neige du Tibet déborde son lit et une partie de son eau vient remplir le Grand Lac Tonlé Sap. Ce dernier voit son niveau augmenté de plus de 14 mètres en moyenne et sa surface passe de 3 000 à 10 000 km^2. Ainsi le Grand Lac Tonlé Sap est un véritable régulateur naturel du Mékong. La mousson d'hiver est sèche et commence en octobre. Un peu avant cette date, l'eau du Grand Lac Tonlé Sap commence à refluer vers le Mékong qui lui-même amorce la décrue. Ainsi toute la vie économique et par suite socio-culturelle est rythmée par ces variations saisonnières périodiques. Précipitations annuelles : 4 500 à 5 000 mm de pluie en moyenne sur les côtes (5 470 mm en moyenne au Bokor et 7 900 mm en 1923) ; 1 500 mm en moyenne à Phnom Penh. Température moyenne à Phnom Penh : 27°C avec un minimum en décembre-janvier de 18° et un maximum en avril de 35°. Sur les hauteurs des régions périphériques les températures sont plus basses.

Ressources en terres cultivables

78% du pays sont couverts par la forêt et par des régions accidentées, 17% représentent les terres arables soit 30 750 km^2 dont près de 200 km^2 de rizières. En général les terres sont mal irriguées et peu productives sauf celles des berges des fleuves et celles qui bordent le Grand Lac Tonlé Sap qui de plus reçoivent annuellement des sédiments fertiles lors de leur inondation. Le reste demande des grands travaux d'irrigation, l'installation de grandes stations de pompage, la construction de grands réservoirs pour régulariser les eaux de pluies. Les 9% restant représentent les surfaces occupées par le Grand Lac Tonlé Sap, les fleuves, les rivières et les terres à pâturage.

Ressources en eau

Le bassin du Mékong à la traversée du Kampuchéa comprend en outre le Grand Lac Tonlé Sap et les nombreuses rivières qui se jettent dans le Mékong et le Grand Lac Tonlé Sap. Les crues du Mékong sont très importantes : 50 000 m^3/s et son niveau à Phnom Penh varie en moyenne de 14 mètres. Avec les pluies de la mousson d'été le pays est dans l'ensemble suffisamment pourvu en eau. Mais à cause des irrégularités des pluies, les habitants depuis près de deux millénaires ont dû entreprendre des travaux d'irrigation très inportants soit pour assécher des marécages, soit pour creuser des réseaux de canaux pour rendre cultivables les terres entre le Mékong et le Golfe de Thaïlande ou construire de grands réservoirs artificiels pour irriguer des rizières au nord du Grand Lac Tongé Sap. Les ressources en eau souterraine sont encore très peu exploitées.

Ressources énergétiques

Jusqu'à présent on n'a pas encore trouvé au Kampuchéa des sources d'énergie fossile, quoique avant 1975 des forages sur le plateau continental au Sud de l'Ile de Way aient donné des espoirs de pétrole. Des mines de charbon d'assez mauvaise qualité existent mais ne sont pas exploitables à cause des inondations. Mais le pays est assez bien pourvu en possibilités d'énergie renouvelable.

Energie hydraulique : deux barrages sur le Mékong peuvent donner des puissances de plusieurs centaines de milliers de kilowatts. Des barrages sur des torrents qui descendent de la chaîne des Cardamomes et de celle de l'Eléphant peuvent alimenter des centrales de l'ordre de dizaines de milliers de kilowatts. Une centrale de dix mille kilowatts était en exploitation à Kirirom fin 1978 après réparation.

Les énergies d'origine solaire, éolienne ou l'énergie de la biomasse ne sont pas encore exploitées. Elles sont pourtant abondantes.

Ressources minérales

Elles sont peu explorées et peu exploitées. Des minerais de fer dans les provinces de Battambang, de Kampot et de Preah

Vihear. Celui de Phnom Dek et ses environs est extrêmement pur (jusqu'à 65 % de fer). Il est exploité depuis plus de deux millénaires. L'acier était extrait directement par la technique des bas fourneaux dits Catalans utilisant comme source de chaleur et comme réducteur le charbon de bois. Malheureusement les réserves de Phnom Dek et de ses environs sont faibles (moins de 10 millions de tonnes). Des carbonates de calcium assez purs pour alimenter des usines de ciment.

Des phosphates dans les provinces de Kampot et de Battambang. Des argiles réfractaires. Des minerais pour la fabrication des objets en porcelaine et en faïence. Des possibilités de bauxite, d'étain, de fluorite, de cuivre.

Des minerais d'or sont assez peu productifs et peu exploités. Des minerais de pierres précieuses très connues dans le monde.

D'autre part le climat et la configuration des côtes permettent une production très importante de sel marin, source possible de diverses industries chimiques.

Ressources forestières

Les forêts du Kampuchéa sont encore assez importantes surtout les ressources en bois précieux et de luxe. Mais le pays a besoin d'une politique cohérente de reboisement et d'exploitation rationnelle pour préserver et renouveler ces richesses naturelles. Cette politique est aussi nécessaire pour éviter les phénomènes d'érosion désastreuse.

Pêche

Les possibilités de pêche sont très importantes aussi bien en eau douce que dans la mer. Le Grand Lac Tonlé Sap, du fait de ses forêts annuellement inondées est un véritable réservoir à poissons; avec des moyens assez rudimentaires, la production annuelle dépasse les 150 000 tonnes. Les côtes du Kampuchéa, à cause de la baie de Konpong Som, riche en matière organique, sont aussi très poissonneuses. Mais jusqu'à présent les capacités d'exploitation et de production sont encore très loin d'atteindre les possibilités optimales de capture (de l'ordre de 100 000 tonnes par an). La population du Kampuchéa est grande consommatrice de produits de pêche. Une organisation scientifique et rationnelle de la pêche ainsi que celle de conservation de ses produits peut apporter une très grande contribution à l'amélioration de l'alimentation de la population.

Centres urbains

Chacune des 19 provinces possède son chef-lieu qui est en général la ville la plus importante de la province. Cependant les plus grandes villes sont : Phnom Penh, la capitale, Battambang, Kompong Cham et le port de Kompong Som. Les centres industriels les plus importants sont Phnom Penh, Kompong Som, Battambang et Kompong Cham. Cependant la population totale de ces grandes villes ne dépasse pas les 15 % de la population totale.

Transports

Le réseau routier comprend plus de 6 500 km de routes dont 3 500 asphaltées. Le Mékong est navigable pour des chalands toute l'année de la frontière avec le Vietnam jusqu'à Sambor au Nord de Kratié, ainsi que la partie du bras du Tonlé Sap qui lie le Grand Lac Tonlé Sap au Mékong. Le Grand Lac lui-même et la plupart des rivières ne sont navigables pour les transports que huit mois par an pendant la période des hautes eaux.

Une voie de chemin de fer à voie unique et étroite relie le port de Kompong Som – Kampot – Takeo – Phnom Penh – Battambang – Poipet à la frontière avec la Thaïlande (660 km). Une nouvelle ligne directe, répondant aux normes internationales reliant Kompong Som à Phnom Penh, en suivant à peu près la route nationale N°4, était en voie de réalisation. Elle devait entrer en fonctionnement entre Phnom Penh et Kompong Speu fin 1979 et être terminée entièrement fin 1982. Elle était prévue pour être doublée après quelques années de service.

Le port de Kompong Som est agrandi et est accessible en même temps à 8 bateaux de 10 000 tonnes.

Deux aéroports de normes internationales sont en fonctionnement : ceux de Phnom Penh et de Siemreap.

1.2 CADRE SOCIO-CULTUREL ET ÉCONOMIQUE : SITUATION DU DÉVELOPPEMENT

Cadre socio-culturel

Le Kampuchéa est une terre de vieille civilisation. Des recherches entreprises principalement dans les années 60 ont permis de trouver de nombreux sites préhistoriques datés d'une dizaine de milliers d'années avant notre ère, habités par des hommes de la civilisation de la pierre polie. Puis au 12ème siècle avant notre ère est apparue, au Nord et à l'Ouest du Grand Lac Tonlé Sap, à Samrong Sen et à Melou Prey en particulier, une civilisation pratiquant la métallurgie du bronze puis quelques siécles plus tard la métallurgie du fer. Puis après une lente évolution, leurs descendants ont amorcé la civilisation qui consistait à construire des bassins de retenue d'eau qui permettaient sa régularisation et son utilisation rationnelle durant toute l'année. Le prototype le plus important connu est le système d'irrigation de Sambaur Prey Kuk au début du 7ème siècle de notre ère. Puis le système a été généralisé à toutes les rivières entre les monts Koulène et le Grand Lac Tonlé Sap. Ainsi toutes les terres situées dans cette région et même à l'Ouest des monts Koulène ont été scientifiquement et systématiquement irriguées et utilisées au maximum de leur rendement. La combinaison de ces irrigations avec l'utilisation des instruments aratoires en fer avait permis une très importante production agricole qui à son tour avait permis le développement de la civilisation d'Angkor bien connue. Nous tenons a rappeler que nos ancêtres avaient à la même époque développé un art monumental de bronze extrêmement original et raffiné : toutes les méthodes de moulage ont été utilisées.

Ainsi le peuple du Kampuchéa possède par tradition une très grande habileté dans la fabrication des produits artisanaux. Il sait combiner l'efficacité à l'harmonie des formes dans la fabrication de ses outils. C'est pourquoi depuis l'acquisition de l'Indépendance confirmée par les Accords de Genève de 1954, les étudiants Khmers ont pu accéder à toutes les universités et grandes écoles de France, des États Unis d'Amérique et d'autres pays. Et les ouvriers et techniciens Khmers ont pu acquérir très rapidement les connaissances suffisantes pour faire fonctionner toutes sortes d'industries.

Religion

La grande majorité des habitants du Kampuchéa pratique le Bouddhisme Theravada. Mais une petite minorité pratique les religions musulmane, Brahmanique et chrétienne.

Economie

Répartition de la population économiquement active en 1978 (évaluation approximative) :

employés dans les industries, dans les ports de Kompong Som et de Phnom Penh ; dans les transports terrestres et fluviaux, dans les pêcheries, dans les plantations de caoutchouc et les plantations de coton, de canne à sucre et autres plantes industrielles, dans les marais salants, dans les constructions diverses : usines, routes, chemins de fer, barrages, etc ... : *250 000;*

employés dans les ateliers artisanaux des villes et villages, forgerons, réparateurs de machines agricoles , etc..: *100 000;*

personnes utilisées dans la production agricole : *2 900 000*

Total des personnes économiquement actives : *3 250 00*

La balance commerciale du Kampuchéa en 1978 était à peu près équilibrée. Le Kampuchéa exportait du caoutchouc, du bois d'oeuvre, du poisson, du riz, des plantes médicinales, du kapok, des huiles végétales, etc... Il importait des matières premières pour ses usines, des machines outils, des moteurs, des tracteurs, des usines, des produits pharmaceutiques etc. . . Il avait des relations commerciales avec la Chine, la République Populaire Démocratique de Corée, Hong Kong, le Japon, la Thailande, la Yougoslavie, Singapour, Madagascar, la Suède entre autres.

Mais actuellement toutes les infrastructures et les usines sont détruites. Après la libération, le Kampuchéa aura besoin massivement de capitaux et d'aides matérielles et techniques pendant une assez longue période. Son revenu national actuellement est parmi les plus bas du monde. Son peuple n'aspire qu'à la paix. Mais il ne saurait accepter de vivre dans l'esclavage ni de perdre son identité nationale.

PARTIE 2.

Cadre des poliques scientifiques et technologiques

2.1 CADRE DES POLITIQUES DE DEVELOPPEMENT

Principes fondamentaux de développement avant fin 1978

Au départ, l'agriculture doit être la base du développement, car le Kampuchéa, étant un pays arriéré et venant de sortir d'une guerre très meurtrière, l'objectif primordial est de nourrir convenablement la population et d'améliorer ses conditions de vie.

Donc l'agriculture doit :

fournir la nourriture en quantité suffisante à toute la population y compris les travailleurs non agricoles et les autres catégories de la population :

fournir un surplus exportable pour financer les achats des matières premières pour l'industrie, des machines outils pour pouvoir produire des outillages de plus en plus complexes, des produits manufacturés tels que des tracteurs et autres, des usines complètes, etc...

En retour l'industrie doit fournir en priorité :

des instruments agricoles de plus en plus mécanisés et automatiques tels que des batteuses mécaniques semi-automatiques et automatiques de petites et grandes dimensions, des machines pour fabriquer des engrais phosphatés à partir des minerais, des motopompes de tous calibres etc...

des produits de première nécessité pour améliorer la vie de la population : tissus pour la confection des vêtements, de mousseline pour moustiquaire, des couvertures, clous et boulons pour la construction des maisons, scies mécaniques horizontales et verticales pour débiter des grumes de bois en planches, des filets de toutes tailles pour la pêche en eau douce et en mer etc...

des médicaments à partir des plantes médicinales et à partir des produits en vrac importés tels que antibiotiques, sulfamides, aspirines etc...

des outils d'utilisation courante : clefs de toutes sortes, marteaux, tenailles, étaux, etc..., des pelles, pioches, couteaux, machettes etc... des petites machines outils (petits tours mécaniques horizontaux et verticaux, fraiseuses, raboteuses à bois etc...)

Ainsi les principales usines en fonctionnement en 1978 étaient :

3 filatures

11 usines textiles de 100 à 500 métiers à tisser mécaniques dont une à Kompong Cham et une autre à Battambang ;

2 usines pour la réparation et la fabrication des pièces détachées des métiers mécaniques ;

1 usine de couvertures en coton produisant 400 000 couvertures par an. Cette usine était en cours d'agrandissement pour pouvoir produire plus d'un million de couvertures par an à partir de 1982 ;

1 usine de tissage de sacs de jute;

1 usine de tissage de filets de pêche en nylon de toutes dimensions;

3 usines de séchage de caoutchouc;

1 usine de fabrication de pneus et de chambres à air pour voitures et camions et d'autres produits à base de caoutchouc ;

1 usine de rechappage de pneus usagés ;

2 usines de fabrication de pneus et de chambres à air pour bicyclettes ;

3 usines de fabrication de souliers en caoutchouc ;

1 usine de fabrication de tuyaux de caoutchouc à armature métallique jusqu'à 30 cm de diamètre ;

2 usines de fabrication de bicyclettes ;

1 usine de produits divers en plastique : peignes, bols, verres, bouteilles, gobelets, assiettes, toile en plastique, sacs, tuyaux de faible diamètre, bassines, etc...

2 usines pour la fabrication du savon ;

1 usine pour la fabrication de pâte dentifrice ;

1 usine pour la fabrication des objets en aluminium dont des ustensiles de cuisine : casseroles jusqu'à 80 cm de diamètre, assiettes, couverts, gobelets, etc...

1 usine pour la fabrication des assiettes et bols en faience ainsi que des porcelaines pour des appareillages électriques et des briques réfractaires ;

1 verrerie qui fabriquait aussi des verres neutres utilisés en médecine, en pharmacologie et dans des laboratoires de chimie et de biologie ainsi que des verres résistant au feu du genre pyrex ;

1 usine pour la production de l'oxygène, de l'azote, de l'acétylène et du gaz carbonique ;

1 usine pour la production de l'acool éthylique, du vinaigre d'alcool, des vins et des alcools comestibles ;

1 usine pour l'extraction d'huile du son de riz ;

2 usines pour la fabrication de clous, de boulons, de vis et les tiges de fer utilisés comme âmes pour électrodes pour la soudure à l'arc électrique (chaque usine ou atelier fabrique lui-même ces électrodes en question pour les soudures ordinaires);

1 usine pour la fabrication du papier à partir de vieux papiers mélangés avec de la pâte à papier ;

2 usines pour la fabrication des engrais phosphatés, les appareillages de ces usines étaient fabriqués au Kampuchéa ;

1 usine de ciment ;

1 usine de contreplaqués;

plus d'une trentaine de fonderies de plus d'une tonne de capacité dont 19 attenantes à des usines mécaniques comportant entre 100 à 250 tours mécaniques dont certains récemment importés peuvent usiner des pièces de 4 mètres de long et d'autres des pièces de plus de 2 mètres de diamètre. Ces usines fabriquaient des batteuses rotatives ; des batteuses mécaniques automatiques de moyenne et grande dimensions ; des égraineuses de kapok et de coton ; des pompes rotatives jusqu'à 30 cm de diamètre ; des tuyaux en fer soudé et en fonte ; des machines outils de faibles dimensions (tours mécaniques, fraiseuses verticales, raboteuses à bois) ; des motoculteurs de 12 CV (le moteur était *importé*) ; scieries mécaniques horizontales et verticales ; des prototypes de métiers à tisser mécanique et des métiers à tisser de sacs de jute; des outils de toutes sortes : pelles, pioches, marteaux, clefs plates, clefs à pipe mâle et femelle, tenailles, étaux, clefs à molette, etc. . .

fabrication des pièces détachées des machines ;

deux fabriques de cigarettes ;

2 chantiers de fabrication de bateaux en bois et en fer de 500 tonnes l'un à Phnom Penh pour les transports fluviaux, l'autre à Srè Ambel pour la pêche côtière maritime et le cabotage ;

3 usines de conditionnement des médicaments occidentaux dont deux automatisées ;

1 usine de fabrication des compresses, des bandes de pansements et du coton médical ;

l'Institut Pasteur préparait des vaccins anticholérique, antivariolique, antitétanique, antityphoïdique, contre le choléra aviaire, et était en voie de produire le vaccin BCG et DT polio ;

les ateliers attenants à la gare de Phnom Penh étaient transformés en véritables usines pour la réparation des locomotives et des wagons et pour la construction des wagons de marchandises et des wagons citernes ;

plusieurs usines de produits alimentaires comme les sauces de soja, les jus de poisson salé, les conserves de soja, les divers jus de fruit. la bière, etc. . .

une multitude de fours pour la fabrication des briques, des tuiles, des jarres en terre cuite, un peu partout dans le pays ;

toutes les centrales électriques étaient en fonctionnement. La centrale hydroélectrique de Kirirom était réparée et commençait à fonctionner.

Usines en construction

une usine pour la fabrication de moteurs diesel de 12 CV, commencement de fonctionnement en 1982. Sa capacité finale sera de 40 000 moteurs par an ;

une très grande usine pour la fabrication des vis, boulons de toutes dimensions pour satisfaire toutes les usines en particulier celle de moteurs diesel ci-dessus ;

deux centrales thermiques de 25 000 kw chaque, l'une + Phnom Penh, l'autre à Kompong Som ;

une briquetterie à cuisson continue et semi automatisée de grande capacité ;

une raffinerie de pétrole de 600 000 T de capacité annuelle de traitement ; elle peut être plus tard portée à 1 000 000 de tonnes ;

un chantier de construction de bateaux de 500 à 1 000 tonnes près de Prek Phneu au nord de Phnom Penh ;

trois usines de séchage de caoutchouc ;

une usine pour l'extraction de l'acide acétique à 60 % à partir du vinaigre ;

un petit haut fourneau de 4 tonnes de capacité :

Usines dont la construction devait commencer en 1979

une usine pour la fabrication de la pénicilline ;

une usine pour la fabrication des tuyaux en caoutchouc à armature de nylon, des courroies de transmission en caoutchouc ;

une usine pour la fabrication des moteurs électriques et des générateurs jusqu'à 5kw ;

une usine d'électrolyse du sel pour la fabrication de la soude concentrée, du chlore et des produits chlorés ;

une usine d'ammoniaque et d'engrais azotés ;

une nouvelle cimenterie ;

un four électrique à induction de 5 tonnes pour la fabrication de l'acier suivi d'un laminoir ;

Avec la Roumanie organiser la pêche maritime à l'échelle industrielle y compris la fabrication des conserves de poisson en boîtes ;

une grande usine à papier pour satisfaire tous les besoins du pays à partir des matières premières locales.

2.2 POLITIQUES DE DÉVELOPPEMENT ET POLITIQUE DE DÉVELOPPEMENT DES SCIENCES ET TECHNOLOGIES

Dans le monde actuel, il n'est pas pensable de développer un pays sans un développement parallèle des connaissances des sciences et des technologies. Au Kampuchéa les deux développements sont étroitements liés et interdépendants.

Tout d'abord du fait que la majorité de nos citoyens vivent à la campagne, nous estimons que le monde rural de notre pays possède un énorme potentiel d'énergie, d'intelligence et d'expériences plurimillénaires. C'est donc un immense capital que nous désirons faire fructifier par le développement de l'enseignement, de l'expérimentation scientifique, de l'expérience pratique et des activites productives dans un développement rural intégré.

Parallèlement dans les villes, le développement de l'enseignement des sciences et techniques est étroitement lié au développement industriel et à l'amélioration constante de la technologie, en collaboration étroite avec les centres et laboratoires de recherche.

D'autre part, le système et les méthodes d'enseignement des sciences et des technologies au Kampuchéa sont spécifiques. Ils s'inspirent essentiellement de nos traditions culturelles plurimillénaires, de nos propres expériences et des résultats des expériences des autres peuples. Ils se construisent pas à pas en s'adaptant avec souplesse, à chaque étape, aux conditions concrètes à l'échelle nationale et même à l'échelle locale.

Ainsi notre objectif fondamental est de stimuler un développement des connaissances scientifiques et technologiques de masse tout en permettant aux plus doués et aux plus aptes à poursuivre les études les plus approfondies et à utiliser au mieux leurs capacités créatrices.

Nous incluons les sciences humaines, l'archéologie et la recherche historique dans le développement scientifique. Car dans la lutte actuelle pour la survie nationale, la préservation de l'identité nationale et l'enseignement et le développement de la culture nationale sont des stimulants pour encourager nos jeunes comme nos enseignants dans leurs études, leurs recherches pour élever leurs connaissances scientifiques et technologiques.

Notre principe fondamental est que tout enseignant en sciences et technologies doit avoir un poste de responsabilité dans une usine ou dans un centre ou laboratoire de recherche. Et à partir d'un certain niveau, dès les classes secondaires ou à partir de 12 à 13 ans, les jeunes font des stages dans les usines, les centres et laboratoires de recherche correspondant à leur niveau et conformément à leurs aspirations. Ce qui explique notre objectif de développer très rapidement l'agriculture, les industries et les centres et laboratoires de recherche. Il n'est pas encore question de recherches fondamentales.

2.3 MECANISME DE DECISION EN MATIÈRE DE SCIENCE ET TECHNOLOGIE

Organismes participant au développement des sciences et technologie :

- Ministère de l'Économie
- Ministère de l'Industrie
- Ministère de l'Agriculture
- Ministère des Transports et des Communications
- Ministère de la Santé
- Ministère de la Défense Nationale
- Institut National de Recherche des Sciences et Technologies
- Ministère de l'Education Nationale et de la culture.

Mécanisme de l'élaboration des décisions concernant le développement des sciences et technologies, tous ces ministères et organismes coopèrent et établissent un plan de développement assez précis de trois ans mais établissent aussi des objectifs à long terme de 10 ou 20 ans. Alors l'Institut National de Recherche des Sciences et Technologies en collaboration avec le ministère de l'Education Nationale et de la Culture et avec les autres ministères organisent les centres et laboratoires de recherche.

2.4 REMARQUE GÉNÉRALE

Mais depuis le 25 décembre 1978, le Kampuchéa Démocratique est envahi, et son peuple est en train de mener une guerre populaire principalement basée sur la guerrilla contre la guerre extrêmement barbare de conquête et d'extermination. Toutes les infrastructures agricoles, barrages et canaux d'irrigation sont détruits, le parc des tracteurs est réduit à néant. La population rurale est réduite à une production de subsistance souvent pillée par les envahisseurs. En ville, les usines, les centres et laboratoires de recherche sont pillés et détruits, ainsi que les ateliers artisanaux. Les usines isolées telles que la cimenterie, l'usine de contre-plaqués entre autres sont également pillées et détruites.

Une fois libéré, le Kampuchéa aura besoin d'assistances massives, et de longue durée de la part des pays amis. D'après le nouveau programme politique appliqué par le Gouvernement du Kampuchéa Démocratique, il n'y aura plus de monopole d'État ni en économie ni en éducation. Mais dans les grandes lignes, la politique, en ce qui concerne le développement des sciences et des technologies, reste toujours basée sur la liaison étroite entre la théorie et la pratique, entre le développement des productions agricoles et industrielles et les recherches scientifiques et technologiques, entre le métier d'enseignants et les postes de responsabilite dans les centres et les laboratoires de recherche. Notre pays aura donc un grand besoin de la coopération régionale et internationale ; car notre pays est actuellement un des plus pauvres et des plus démunis du monde, sinon le plus pauvre et le plus démuni.

PARTIE 3.

Potentiel scientifique et technologique

3.1 RÉSEAU INSTITUTIONNEL

Avant fin 1978

Beaucoup d'usines avaient leur laboratoire de contrôle des produits lequel était en train de se transformer en laboratoire de recherche. C'était le cas pour les usines de ciment, de contreplaqués, de pneus pour voitures et camions, la verrerie, les usines de caoutchouc etc...

Il existe également des centres de recherche :

Centre de recherche agricole pour la sélection des semences, en particulier celles du paddy ;

Centre d'études des sols pour adapter les cultures et une meilleure utilisation des engrais ;

Centre d'analyse des minerais (cristallographie, spectogramme à flamme et à arc, analyse chimique qualitative et quantitative etc...)

Centre de recherche biologique à l'Institut Pasteur.

L'ancien Institut technologique et l'ancienne École Normale Supérieure étaient ouverts en octobre 1978. l'École de Médecine était sur le point d'ouvrir ses portes.

D'autres centres et laboratoires de recherche étaient en préparation comme le laboratoire pour tester la résistance des matériaux, le laboratoire pour contrôler la qualité et les normes des produits importés et exportés etc...

l'Institut National de recherche des sciences et technologies et le Ministère de l'Education Nationale et de la Culture coordonnent leurs efforts pour développer et orienter ces centres et laboratoires de recherche.

3.2 RESSOURCES HUMAINES

Le peuple du Kampuchéa a une très longue tradition de connaissances technologiques et scientifiques. Dès le 12ème siècle avant notre ère il connaissait la métallurgie du bronze, puis quelques siècles après, la métallurgie du fer dont la pratique n'avait cessé que dans les années 30 du 20ème siècle.

Au début de notre ère, il a construit les réseaux d'irrigation de la civilisation du Founan. A cette époque l'université bouddhique du Kampuchéa avait une très grande renommée. Deux moines bouddhiques étaient même allés en Chine pour enseigner dans des universités chinoises la philosophie bouddhique.

A partir du début du 7ème siècle, il a construit un système de bassin d'eau et de système d'irrigation qui a permis la civilisation d'Angkor. D'après les analyses minutieuses, des relevés topographiques des régions au sud et à l'ouest des monts Koulène, effectués par satellite, des spécialistes ont pu montrer qu'avec nos connaissances actuelles, on ne peut faire mieux. Nos ancêtres savaient, vu la configuration du terrain, construire les bassins permettant de retenir le volume optimum d'eau pour un volume minimal de remblai. Les canaux et les digues qui permettaient de relier les divers cours d'eaux qui coulent des monts Koulène, étaient construits de la manière la plus rationnelle possible. La construction des centaines de monuments gigantesques atteste également la maîtrise dans l'art de construire. Il y avait à cette époque des dizaines de milliers d'artisans, de techniciens, d'ingénieurs, de savants, de philosophes, de mathématiciens, etc... derrière ces constructions. A tel point qu'un historien anglais assez récemment a pensé faire un parallèle entre la civilisation Khmère et celle de Rome.

Actuellement on commence à comprendre d'une manière plus approfondie les raisons qui avaient amené la population à émigrer de la région d'Angkor vers d'autres régions.

Mais pendant le 19ème siècle et au 20ème siècle jusqu'à la 2ème guerre mondiale, rien que pour pouvoir poursuivre les études secondaires, les Khmers avaient dû s'expatrier et en 1946, le nombre des étudiants qui avaient fini leurs études supérieures se comptaient sur les doigts d'une seule main. Mais à partir de cette date et surtout aprés l'indépendance, c'était une explosion. Car le peuple du Kampuchéa a un très grand respect pour le savoir, la science, les techniques, les mathématiques et les spéculations philosophiques. Il a une très grande soif du savoir et son héritage culturel lui permet de s'adapter très rapidement aux sciences et technologies modernes. Il suffit de voir avec quelle rapidité les Khmers avaient rattrapé le temps perdu. Ainsi dans les années 70, il y avait environ 1 500 étudiants Khmers à l'étranger. Avant l'invasion étrangère des milliers de techniciens, d'ingénieurs et de médecins et autres faisaient fonctionner les usines, les centres et laboratoires de recherche et de contrôle et les hôpitaux du pays.

Actuellement, par manque de statistiques précises, nous estimons qu'entre 3 à 5000 citoyens originaires du Kampuchéa dans le monde ont fini leurs études du 3ème degré. la très grande majorité d'entre eux vivent actuellement à l'étranger. Ils travaillent dans des usines, des laboratoires et centres de recherche. Certains sont enseignants dans des universités. Ils travaillent dans presque toutes les branches des sciences et technologies et même dans des recherches fondamentales et des technologies de pointe comme les microprocesseurs, la physique théorique et les mathématiques. La très grande majorité d'entre eux vivent et travaillent en France, aux USA, au Canada, d'autres moins nombreux vivent et travaillent au Japon, en Australie, en Allemagne Fédérale, en Suisse, en Belgique, en Nouvelle Zélande etc. . .

Un peu moins d'une centaine vivent et travaillent dans les zones sous contrôle du Gouvernement du Kampuchéa Démocratique où les conditions de vie sont assez difficiles. Mais des milliers de techniciens du second degré y vivent et travaillent aussi dans les mêmes conditions. Certains vont recevoir des enseignements théoriques pour pouvoir plus tard s'engager dans les études du troisième degré.

Plusieurs centaines vivent dans les zones de guérilla, camouflés en paysans et ouvriers. La plupart participent activement à la lutte contre les envahisseurs sous la forme qui leur convient.

Plusieurs autres centaines sont dans les prisons de Phnom Penh ou emmenés de force dans le pays des occupants. Beaucoup sont morts sous la torture ou les mauvais traitements infligés par l'ennemi.

3.3 RESSOURCES FINANCIÈRES

Avant 1978, nous pouvons estimer les dépenses pour le développement des sciences et technologies à environ 3 % de celles effectuées pour le développement du pays.

3.4 INVENTAIRE DU POTENTIEL SCIENTIFIQUE ET TECHNOLOGIQUE

Un tel inventaire n'a jamais été fait et nous pensons que dans un avenir prévisible, il ne nous est pas possible d'envisager d'effectuer ce travail. Car notre pays est actuellement en guerre et tout de suite après le retrait des troupes étrangères, pendant une certaine période, nous serons occupés à reconstruire notre économie. Mais avec l'aide des organisations internationales spécialisées, il sera probablement alors possible de charger un organisme spécial d'effectuer le travail.

PARTIE 4.

Politiques du développement scientifique et technique - questions majeures

4.1 PRINCIPAUX DÉVELOPPEMENTS

Nous avons vu les développements agricoles et industriels avant l'invasion étrangère. Depuis, les données du problème ont complètement changé. D'une part, maintenant le pays est en grande partie occupé et détruit avec une population clairsemée. D'autre part, devant cette nouvelle situation, le Gouvernement du Kampuchéa Démocratique, remanié fin 1979, a adopté un nouveau programme où sera institué dès que possible un régime de démocratie parlementaire. La propriété privée est respectée et une économie de marché est instaurée. Il y aura donc des usines, des centres et laboratoires de recherche privés appartenant à des Khmers ou à des étrangers, semi-privés semi-étatiques, ou entièrement étatiques.

Ainsi, depuis fin 1978, il y a une rétrogradation très importante à l'intérieur du pays concernant le développement des sciences et techniques. Mais jusqu'à présent, il n'existe pas encore d'organismes pour identifier, fixer et coordonner d'une manière cohérente les besoins et les objectifs fondamentaux en ce qui concerne le développement des sciences et technologies. Dans les conditions actuelles, un tel organisme est encore moins pensable. Mais cela ne signifie pas que dans l'avenir, un tel organisme n'est pas nécessaire. Mais actuellement l'objectif fondamental est de fournir le maximum d'efforts à la lutte contre les envahisseurs et de préparer les jeunes à assumer leurs pleines responsabilités dans le domaine du développement des Sciences et Techniques une fois le pays libéré.

4.2 RÉALISATIONS ET PROBLÈMES

Dans les zones sous le contrôle du Gouvernement du Kampuchéa Démocratique, partout où la situation est stabilisée, nous sommes en train de mettre sur pied progressivement un enseignement intégré des mathématiques, des sciences et des technologies même dans les classes primaires parce que dans l'état actuel, beaucoup d'enfants scolarisés dans les classes primaires ont plus de 12 ans. Le principe de l'enseignement intégré est encore plus accentué dans le secondaire.

D'autre part pour ceux qui travaillent dans les ateliers de fabrication des outillages nécessaires à l'agriculture, ou dans les ateliers dépendant de l'armée, ou dans les hôpitaux ou laboratoires d'analyse, nous organisons des cours théoriques pour leur permettre de relever leur niveau de connaissances. Ils apprennent en outre une langue étrangère pour pouvoir faire des stages dans des pays amis.

Problèmes

a) Comme nous venons de voir, les jeunes Khmers n'avaient les possiblités d'accéder avec certaines facilités pratiques aux études supérieures que depuis une trentaine d'années. La langue Khmère a une certaine aptitude à exprimer des concepts philosophiques à cause de la pratique de la religion bouddhique dont les bases fondamentales sont d'ordre philosophique. Mais malgré des efforts louables, notre langue n'est pas encore en mesure d'exprimer clairement et correctement les concepts de la Science et de la Technologie modernes ainsi que beaucoup de concepts de la Philosophie moderne en particulier en Psychologie. La tendance dominante actuellement est de Khmériser la prononciation des mots couramment utilisés ou internationalement adoptés dans des congrès scientifiques internationaux.

D'autre part, il est très difficile d'élaborer les livres pour l'enseignement supérieur et de les publier en langue Khmère, cela représente une grande perte, alors qu'après la libération, le maximum de nos efforts doit être porté sur la reconstruction avec nécessairement des aides très importantes des pays étrangers amis ainsi que des organisations internationales.

Ceci explique la nécessité d'enseigner une langue étrangère dès la deuxième partie de notre enseignement primaire. Pour l'instant nous enseignons l'anglais ou le français.

b) Actuellement les conditions de vie de la population du Kampuchéa sont encore très difficiles. Par ailleurs, la lutte contre l'agression étrangère absorbe une très grande partie de nos efforts. Ainsi nous nous trouvons devant un des problèmes cruciaux qui est le financement et l'obtention des matériels pour l'enseignement des Sciences et Technologies. Par exemple nous avons beaucoup de difficultés pour monter les centres d'expérimentation scientifique par exemple en électricité, des laboratoires d'analyse médicale et des laboratoires d'autres spécialités.

c) Maintenant que l'ennemi ne peut plus nous vaincre militairement, les réfugiés Khmers à l'étranger ont maintenant la conviciton que la nation du Kampuchéa vivra et pourra exister en tant que pays indépendant et souverain dans son intégrité territoriale. D'autre part, ils savent qu'une fois indépendant, le Kampuchéa aura besoin des aides très importantes des pays ou ils résident. C'est pourquoi ils sont de plus en plus nombreux à se demander quels métiers choisir pour mieux servir la reconstruction de la nation. Les jeunes et les intellectuels se demandent dans quelles branches de la Science et Technologie s'orienter. Le problème qui se pose à nous est de définir certains objectifs et priorités pour les conseiller et au besoin chercher des bourses pour leurs études.

4.3 OBJECTIFS ET PRIORITÉS

a) Le Kampuchéa doit faire face maintenant à une guerre d'agression et d'extermination qui risque de détruire à jamais son entité et son identité nationale. Or sans nation il n'est plus question de développement scientifique et technique. C'est pourquoi nous mettons en valeur notre culture nationale et plurimillénaire et notre langue maternelle nationale.

Nous favorisons les recherches historiques et archéologiques car notre histoire nationale est parfois systématiquement et intentionnellement déformée par certains auteurs étrangers aussi bien dans les conceptions fondamentales que dans l'interprétation des faits et dans les faits mêmes. Ainsi notre histoire doit-elle être écrite à la lumière des faits soigneusement vérifiés, en tenant compte de ceux jusqu'à présent omis. Elle doit être écrite dans le but de contribuer à renforcer notre unité nationale et à servir de base au renforcement de la conscience nationale des citoyens du Kampuchéa, et pour que ceux-ci soient profondément imprégnés de leur culture nationale, de leur identité et de leur personnalité propre, tout en étant respectueux de l'apport enrichissant des autres cultures et civilisations. Ainsi, chaque citoyen du Kampuchéa est et sera davantage en mesure de s'entraider, de s'unir étroitement pour défendre et préserver l'indépendance, la Souveraineté, l'Intégrité territoriale et l'Identité Nationale en toutes circonstances, ainsi que pour être en mesure de promouvoir la coopération et la compréhension internationale.

b) Nos compatriotes sont maintenant dispersés dans le monde. D'autres dans le pays, tout en menant la lutte, préparent les enseignants et les élèves pour pouvoir, après la libération, apprendre et assimiler rapidement les connaissances scientifiques et techniques. Il faut donc préparer les esprits et élaborer une structure d'organisation pour qu'après la libération, nous puissions recevoir tous nos compatriotes qui actuellement reçoivent des formations et acquièrent des expériences très diverses, pour que cette diversité soit une source de créativité et non une source de contradictions.

c) Nous développons en priorité les études des Sciences et Technologies qui contribuent à améliorer la santé de la population et la reconstruction rapide de notre économie nationale après la libération. Actuellement, dans les zones sous le contrôle du Gouvernement du Kampuchéa Démocratique, nous développons en priorité l'enseignement des sciences médicales.

d) Nous orientons nos recherches vers l'exploitation systématique des énergies renouvelables. D'abord l'utilisation des technologies les plus simples et les plus accessibles comme le biométhane, des petites turbines hydrauliques de 10 a 20 kw pour les besoins des villages, l'extraction des alcools à partir des plantes, la recherche des économies de combustibles comme par exemple la recherche des formes les plus rationnelles des fourneaux familiaux en terre ou en terre cuite à bois ou à charbon qui diminuent les pertes calorifiques. Mais nous n'excluons pas l'utilisation en grand de nos ressources hydrauliques ainsi que l'utilisation des énergies éoliennes et solaires quand leurs techniques seront plus au point et plus rentables.

4.4 COOPÉRATION SCIENTIFIQUE ET TECHNOLOGIQUE

Le Kampuchéa est un pays pauvre et arriéré, avec une population clairsemée. Il connait actuellement une dévastation incalculable à cause de la guerre d'annexion et d'extermination qui nous est imposée. C'est pourquoi actuellement et encore plus après la libération, le Kampuchéa Démocratique a et aura besoin pour sa survie même de très importantes aides matérielles et coopérations scientifiques et technologiques de tous les pays du monde et principalement de ses voisins, les pays de la région.

Déjà actuellement, nous recevons des aides et nous coopérons avec certains pays de la région et certaines organisations inter-régionales et organisations de masse.

Mais la plus importante contribution est et sera représentée par nos intellectuels et réfugiés qui vivent et travaillent actuellement à l'étranger. Ils seront les traits d'union pour l'établissement des formes de coopération entre le Kampuchéa et ces pays hôtes.

PARTIE 5.

Bibliographie

a) Revue illustrée Kampuchéa publiée par le Gouvernement du Kampuchéa Démocratique jusqu'à fin 1978

b) Sarin Chhak *"les frontières du cambodge"* Tome I, Paris, Dalloz 1966.

c) Les Œuvres récentes de Bernard Philippe Groslier ***"Bulletin** de l'Ecole Française d'Extrême Orient"* Paris 1979.

d) Rapport National du Kampuchéa Démocratique pour la 38ème session de la Conférence Internationale sur l'Éducation Genève, Novembre 1981 ;

DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

Table of Contents

COUNTRY DATA

DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

GEOGRAPHY

Capital city: Pyongyang
Main ports:
Land surface area: 120,538 sq km

POPULATION (1978)

Total	17.1 million
Density (per sq km)	142
Urban/rural ratio	...
Average rate of growth (1970-78)	2.6% p.a.

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	40.6	11.2	9.9	32.6	5.7	100%

SOCIO-ECONOMIC

Labour force

Total	...
Percentage in agriculture	...

Gross national product (1978)

GNP at market prices	US $17,040 million
GNP per capita	US $1,000
Real growth rate of GNP per capita (1970-78)	3.8%

Gross domestic product

Total (in current producers' values)	...
Percentage by origin	
Agriculture	...
Manufacturing, mining & quarrying, electricity, gas & water, construction	...

Government finance

National budget (1978)	...
As percentage of GNP	...
External assistance (official, net; 1976)	...
As percentage of GNP	...

Exports

Total exports of goods (1978)	...
Average annual growth rate (1970-78)	...

External debt

Total public, outstanding + disbursed	...
Debt service ratio (% GNP)	...
(% Exports of goods and non-factor services)	...

Exchange rate (1978): US $ 1 = ...

EDUCATION

Primary and secondary education (1976)

Enrolment, first level	2,561,674
*As % of (5-9 years)	113%
Enrolment, second level	...
As % of (10-15 years)	...
Combined enrolment ratio (5-15 years)	...
Average annual enrolment increase (—)	...

* The enrolment ratio is the relationship between the number of all pupils enrolled (regardless of their age) and the number of the population of the relevant official ages.

Higher education (third level)

Teaching staff, total	...

Students and graduates by broad fields of study:

	Enrolment	Graduates
Social sciences and humanities	...	...
Natural sciences	...	...
Engineering	...	...
Medical sciences	...	...
Agriculture	...	...
Other and not specified	...	...
Total	...	...

Number of students studying abroad

Education public expenditure

Total	...
As % of GNP	...
Current, as % of total	...
Current expenditure for third level education, as % of total current expenditure	...

Table 1. Nomenclature and Networking of S&T Organizations

I - First level - POLICY-MAKING

Country: DPR Korea

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
The Committee of Science and Technology of the State	Administration of technology, control	The Administration Council	Department of the technological control	Committee or Ministry

Table 2 - Scientific and Technological Manpower

(Data unavailable at time of publication)

Country: DPR Korea

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total stock (thousands)	of which working in R&D
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965										
1970										
1975										
1979										
1985										
1990										

PART 1.

General features

1.1 GEOPOLITICAL FEATURES

Official name of the country: the Democratic People's Republic of Korea

its capital city : Pyongyang

geographical location: our country is located in the Far East of Asia

our adjacent countries : USSR, China and Japan

land surface : 220 000 in sq. km

population : about 50 000 000

climate characteristics: spring, summer, autumn and winter with seasonal clearness

land and water resources: land and water resources as follows about 70% of our land is mountain, land is fertile and abundant in water

other natural resources: abundant in iron ore, coal and various underground resources, and resources of sea and forest

major seaports: Nampo, Chongjin, Hungnam, Wonsam and Haiju

airport : Sunan

average traffic: electric railway

Brief description of the political system of the country:

supreme authority : the People's Central Committee of the Democratic People's Republic of Korea

executive and legislative body : the Administration Council of the Democratic People's Republic of Korea

administrative structure: the Provincial People's Committee
the County People's Committee
the Ri People's Committee

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

Composition of social groups : the League of Socialist Working Youth of the Democratic People's Republic of Korea

the General Federation of Trade Unions
the Union of Agricultural Working People

religious groups: the religion of Chondogyo
Buddhism

language: Korean

major economic sectors and their relative importance: the major branches of national economy such as machine, metal, chemistry, coal, electricity and so on are sectored in every province

major exports: machine tools, magnesia clinker, non ferrous metal minerals, cement and so on.

1.3 DEVELOPMENT SCENE

Major problems hindering the development process : no major problems hindering the development process.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

Planned for the coming 5-10 years:

In the near future we shall be turning out annually

100 000	million kwh of electricity,
120	million tons of coal,
15	million tons of steel,
1.5	million tons of nonferrous metals,
20	million tons of cement,
7	million tons of chemical fertilizers,
1 500	million metres of fabrics,
5	million tons of sea foods, and
15	million tons of grain, and reclaim
300 000	chongbo of tideland within the next ten years.

These are the ten long-term objectives of socialist economic construction we have to attain in the 1980's.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

Before liberation there was not even single research institute in our country and even our spoken and written language was deprived of by Japanese imperialism.

However, research institutes of various branches including industry, agriculture and medicine were established also under the difficult condition immediately after the liberation.

The great leader personally proposed to found the Academy of Sciences in 1952 when the whole land was enveloped in the sea of war flames and established the Academy of Sciences of the Democratic People's Republic of Korea, the highest grand palace of our Science, on December 1 that year.

Never before in the history of the world countries has been such a fact that an academy of sciences was founded for the future of the triumphant fatherland even when the flames of the fatherland liberation war were fiercely flaring up.

The great leader sent personnel to faraway foreign countries under the war circumstances so that they imported precious apparatuses, reagents and materials for experiments necessary for the scientific research work and built up a modern library with hundreds of thousands of scientific and technical books spending a large sum of money even in the difficult postwar period where the entire people were engrossed in the rehabilitation and reconstruction sparing even a penny and tightening their belts.

Under the condition that the ranks of scientists and technicians increased to scores of thousands, scientific research organs were newly set up and the scope of scientific research work was expanded, the Committee of the Science and Technology of the State to lead scientific research and technical administration was established in 1961, and branch organs for leading scientific research such as Academy of Agricultural Sciences and Academy of Medical Sciences were newly organized and their roles enhanced.

We have taken measures for widely establishing on-the-spot research bases such as research centres, medium pilot plants, testing grounds, observation posts, etc. so that scientists and technicians might penetrate into production realities and carry out their research work in combination with production in creative cooperation with the workers and peasants.

Thus, today in our country, several modern comprehensive scientific research bases and a number of on the spot research bases have been built in the capital Pyongyang, Hamheung, Chongjin, Pyongsong and many other localities.

3.2 HUMAN RESOURCES

We have built up a large army of scientists and technicians. At the time of liberation in our country there was neither even a single college nor an institute nor ranks of scientists and technicians owing to the aftermath of the feudalistic rule.

The great leader sought out scientists and technicians who were scattered in every nook and corner, personally met them one by one regarding them as precious as gold, entrusted them with important tasks at colleges, institutes, factories, enterprises and state organs, and looked after their work.

The great leader saw to it that many institutes of higher education and cadre training organs be established to bring up new scientists and technicians on a big scale.

Even under the difficult conditions immediately after the liberation in which everything was insufficient, the great leader set up the Kin Il Sung University, the first people's higher institute throughout the history of our country, in October 1946, and newly established the Kin Chaek Polytechnical Institute and many other colleges thereafter with the University as their core.

In 1948, initiated night and correspondence courses of studying while working in many colleges in order to train scientists and technicians more speedily and more greatly with a view to developing the science and technology of the country even under the arduous circumstances of the Fatherland Liberation War, the great leader led us to ceaselessly continue the work of cadre training and education.

The great leader called back youths fighting with rifles in their hands on the front and had them study at colleges or institutes. In April and June 1952 when he was so busy in commanding the front and the war, he personally visited many universities and colleges through the gun smoke, and instructed us one by one on the direction and methods of training cadres.

In anticipation of the demands for the technical personnel to be increased rapidly in our country in the post-war period, the great leader made colleges train over 70% of the total students into the technicians and specialists of engineering and natural sciences and newly set up research courses in various research centres of the Academy of Sciences for the purpose of training scientific cadres.

During the Five-Year Plan period for building the foundations of socialism, he set up factory colleges, a new form of education of studying while working, in the big factories and enterprises for meeting the increasing demands for the scientists and technicians in accordance with the over-all implementation of technical revolution. There was not even a single college before the liberation in our country, but thanks to the wise leadership of the great leader Comrade Kim Il Sung and the dear leader Comrade Kim Jong Il, 15 colleges were established by 1949 and today, the number of colleges has been increased up to 170.

And there were only a few engineers immediately after the liberation in our country, but more than 1 100 technicians and specialists who had been newly educated at our colleges by 1949 were standing among the ranks of the scientists and technicians, the number increased to about 50 thousands at the end of the First Seven-Year Plan period and now the ranks of specialists have grown to as many as over one million.

3.3 FINANCIAL RESOURCES

On the other hand, directing great efforts to enhancing the qualification of scientists and technicians, building scientific research bases and preferentially providing up-to-date experimental instruments, we saw to it that the funds necessary for the scientific research work were specially established in the state budget.

3.4 SURVEYING OF THE S&T POTENTIAL

There are the Centre of Information for Science and Technology and other institutions for the collection and analysis of the scientific and technological data and other information in our country.

The Centre of Information for Science and Technology exchanges necessary documents in accordance with a bilateral agreement with the institute of information of science and technology of some countries, and receives documents of science and technology through an international organization, informs index of titles, abstracts, copies and publications of translation to demanders.

PART 4.

Policy issues in scientific and technological development

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

The science and technology cooperation policy of our country is to cooperate, under bilateral agreements, with many countries of the world in various fields such as scientific and cultural exchanges and scientific and technical cooperation.

REPUBLIC OF KOREA

Table of Contents

REPUBLIC OF KOREA

GEOGRAPHY

Capital city: Seoul
Main ports: Ulsan, Pusan, Incheon
Land surface area: 98,484 sq km

POPULATION (1978)

Total	37.0 million
Density (per sq km)	376
Urban/rural ratio (1975)	0.9
Average rate of growth (1970-78)	1.7%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	35.2	12.3	10.5	35.9	6.1	100%

SOCIO-ECONOMIC

Labour force (1978)

Total	13.9 million
Percentage in agriculture	37.2%

Gross national product (1978)

GNP at market prices	US $48,000 million
GNP per capita	US $ 1,300
Real growth rate of GNP per capita (1970-78)	8.1%

Gross domestic product (1977)

Total (in current producers' values)	US $35,183 million
Percentage by origin	
Agriculture	21%
Manufacturing, mining & quarrying, electricity, gas & water, construction	36%

Government finance

National budget (1978)	US $8,626 million
As percentage of GNP	17.9%
External assistance (official, net; 1976)	US $768 million
As percentage of GNP	2.8%

Exports (1978)

Total exports of goods (1978)	US $12,711 million
Average annual growth rate (1970-78)	28.8%

External debt (1978)

Total public, outstanding + disbursed	US $11,992 million
Debt service ratio (% GNP)	3.9
(% Exports of goods and non-factor services)	10.5

Exchange rate (1978): US $1 = 476.19 Won

EDUCATION

Primary and secondary education (1978)

Enrolment, first level	5,604,365
*As % of (6-11 years)	111%
Enrolment, second level	3,692,809
As % of (12-17 years)	70%
Combined enrolment ratio (6-17 years)	90%
Average annual enrolment increase (1970-1978)	2.5%

* The enrolment ratio is the relationship between the number of all pupils enrolled (regardless of their age) and the number of the population of the relevant official ages.

Higher education (third level) (1978)

Teaching staff, total	16,876

Students and graduates by broad fields of study:

	Enrolment	Graduates
Social sciences and humanities	171,153	32,469
Natural sciences	18,750	3,294
Engineering	139,572	25,123
Medical sciences	37,401	8,267
Agriculture	34,054	8,089
Other and not specified	17,945	2,705
Total	**418,875**	**79,947**

Number of students studying abroad	6,438

Education public expenditure (1978)

Total (millions of Wons)	567,376
As % of GNP	2.5%
Current, as % of total	...
Current expenditure for third level education, as % of total current expenditure	...

Table 1. Nomenclature and Networking of S&T Organizations

Country: Republic of Korea

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
President	Control and co-ordination		all agencies	
State Council	Control and co-ordination	President	all agencies	Science and Technology Policy
Economic and Scientific Council	Advisory	President	all agencies	Science and Technology Policy
Prime Minister	Control and co-ordination	President	all agencies	Science and Technology Policy
National Council for Science and Technology	Co-ordination	Prime Minister	all agencies	Science and Technology Policy
Deputy Prime Minister Economic Planning Board	Control and co-ordination	Prime Minister	all agencies	R & D budget
Ministry of Science and Technology	Control and co-ordination, executive	Prime Minister	National Science Museum Central Meteorological Office National Astronomical Observatory Daeduk Science Town Research Institutes (9)	Science and Technology Policy
Ministry of Home Affairs (MHA)	Control and co-ordination, executive	Prime Minister	Research Institute (1)	Investigation
Office of Forestry	Executive	Minister of MHA	Research Institutes (3)	Forest Research
Ministry of Finance (MOF)	Control and co-ordination,	Prime Minister		
Office of Nat. Tax. Adm.	Executive	Minister of MOF	Research Institute (1)	Wine Research
Office of Monopoly	Executive	Minister of MOF	Research Institute (1)	Tobacco Research
Ministry of Education	Control and co-ordination	Prime Minister	Research Institute (1)	Education Research
			Universities and Colleges (108)	Basic Research
Ministry of Agriculture and Fisheries (MAF)	Control and co-ordination	Prime Minister	Research Institutes (5)	Agriculture Research
Office of Rural Devt.	Executive	Minister of MAF	Research Institutes (11)	Agriculture Research
Office of Fisheries	Executive	Minister of MAF	Research Institutes (2)	Fish Research
Ministry of Commerce and Industry (MCI)	Control and co-ordination, Executive	Prime Minister	Industries	Industrial Development Policy
Industrial Advancement Administration	Executive	Minister of MCI	Industries	Quality Control
Office of Patents	Executive	Minister of MCI	Industries	Patents
Ministry of Construction	Control and co-ordination	Prime Minister	Research Institute (1)	Construction Research
Ministry of Health and Social Affairs	Control and co-ordination	Prime Minister	Research Institutes (2)	Health Research
Ministry of Labour Affairs	Control and co-ordination	Prime Minister	Research Institute (1)	Vocational Training Research
Ministry of Transportation (MOT)	Control and co-ordination, executive	Prime Minister	Hydrographic Office	Hydrographic Research
Office of Railroads	Executive	Minister of MOT	Research Institute (1)	Railroad Technical Research
Ministry of Communications	Control and co-ordination, executive	Prime Minister	Research Institutes (2)	Radio and Telecom. Research
Local Government	Control and co-ordination, executive	Minister of MHA	Laboratories (27)	Test and Inspection

Table 2 - Scientific and Technological Manpower

Country: Republic of Korea

Year	Population (thousand persons)	Scientists and engineers							Technicians	
		Total number (thousand persons)	of which working in R&D						Total stock (thousands)	of which working in R&D (in persons)
			Total number (in persons)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1967	30,131	18.0	4,061	869	1,607	979	404	203	56.0	2,637
1970	32,241	24.8	5,628	513	2,334	1,659	632	490	57.9	2,637
1975	35,281	62.8	10,275	1,649	4,134	1,953	1,868	781	79.3	9,056
1979	37,605	91.8	15,711	2,957	7,411	2,675	2,216	452	123.6	7,682
1985		188.6							186.4	
1990		309.6							244.6	

Table 3 - R&D expenditures

Country: Republic of Korea
Currency: Won

Table 3a: Breakdown by source and sector of performance

Year: 1979

Unit: Million Wons

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive	37,943	68,879	3,128	109,950
Higher Education	6,006	10,365	165	16,536
General Service	47,372	4	176	47,552
Total	91,321	79,248	3,469	174,038

Table 3b: Trends

Year	Population (millions)	GNP (in billion Won)	Total R&D expenditures (in thousand Won)	Exchange rate US $1 = Won
1965	28,943	805.7	2,064,660	272.1
1970	32,241	2,684.0	10,547,753	316.7
1975	35,281	9,792.9	42,663,725	484.4
1979	37,605	29,072.1	174,038,000	484.0
1985	—	—	—	—
1990	—	—	—	—

PART 1.

General features

1.1 GEOPOLITICAL SETTING

The Republic of Korea occupies the southern half of the Korean peninsula which extends in a southerly direction from the northeast Asian mainland. It extends to Manchuria and the Soviet Union in the north, and is separated from the People's Republic of China on the west by the Yellow Sea and from Japan on the southeast by the Korean Straits. It covers an area of 98 955 square kilometres. Only about 23% of the land is arable; about 67% is forested mountain slopes, and the remaining 10% consists of urban areas, industrial estates, roads and such.

The population has increased steadily at an annual rate of 1.6% reaching a total of about 38 million in 1980. The capital city, Seoul, is inhabited by a little over 8 million people. There is a continental monsoon-type climate and four clearly defined seasons with heavy winds in March and April, and typhoons in July and August. The spring winds originate in the Yangtze valley, and bring abundant rainfall, which is important to farmers for rice cultivation.

Korea is relatively rich in water resources but has suffered from droughts and floods due to the concentrated rainfall from mid-June to September. The average annual precipitation totals approximately 114 billion tons, of which only 8.1 billion tons are actually used. The ability to make use of water resources is unbalanced among areas, but four major river basins, which represent about 64% of the national territory, have been developed by constructing multipurpose dams. Agricultural land is very limited, the total cultivated area accounting for around 2 million hectares. Korea is, however, endowed with abundant marine resources as it is surrounded on three sides by sea and has 17 600 kilometres of coastline. A 200-mile economic sea zone has been declared.

The Republic of Korea is very poorly endowed with mineral resources in both the variety and quantity of its reserves. All mineral resources, both processed or unprocessed, have had to be imported in the course of the nation's industrialization, with the exception of tungsten and limestone.

Four major urban centres have been developed: Seoul, Pusan-Taegu, Daejun and Kwangju in the southern half of the peninsula. Pusan, which plays the role of gateway for Korean trade, is the largest seaport and is located on the south-eastern tip of the peninsula. Incheon is the second largest port, and Mokpo and Jeju follow. There are three international airports:. Kimpo in Seoul, Kimbae near Pusan, and Jeju on Jeju Island.

The Republic of Korea, since its independence in 1945; has adopted a democratic-republic political system, in which the President is the Head of State and is elected by a Presidential Electoral College. He represents the state vis-a-vis foreign states. The National Assembly and the judiciary, respectively, exercise independent legislative and judicial powers. The State Council consists of the President, Prime Minister, Deputy Prime Minister, seventeen heads of ministries and three ministers without portfolio. The Prime Minister is appointed by the President with the consent of the National Assembly and supervises the administration of the executive ministers.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

Korea has been a unified country for more than 1 300 years. Its language belongs to the Ural-Altai language group. The country provides a natural geographic crossroad for cultural interchange, particularly between China and Japan, yet its isolation as a peninsula has guaranteed the preservation of its own cultural identity. Historically, in the very early period developments in China were transmitted to Korea and then quickly taken over and adapted. In certain cases, as for example printing, the Koreans adapted China's wood block techniques to produce the very first movable metal type in the world.

There are no strong regional or religious cleavages or entrenched caste structures. The Korean people are, however, free to choose their own religion. Buddhism is most widespread, having approximately 13 million followers. Christianity has about 6 million and Confucianism a little less than 5 million. There are virtually no traditional obstacles to the mobility and adaptability of labour nor to economic development in general.

Korean independence, after 36 years of Japanese occupation, was attained in 1945 with the Allied victory in the Pacific War, but this was almost immediately followed by the Korean War which brought major devastation to the country and resulted in a divided Korea. Only with the 1953 truce were the Korean people finally free to enter the modern age of nation-building, not to mention the application of modern science and technology. Koreans brought to this opportunity their own heritage of a respect for learning, their cultural adaptability, native ingenuity, and an enterprising spirit conducive to entrepreneurship. This social acceptance has been of great importance in building a free economy which depends on private and enterpreneural initiatives more than anything else.

Korea has undertaken four consecutive Five-Year Economic Development Plans since 1962 to focus its national efforts and resources on breaking through the inertia of its underdevelopment in many socio-economic areas, and on bringing about the establishment of a social infrastructure essential to socio-economic development. As a result, the traditional dependence for national production on primary industries has been shifted to the secondary and tertiary sectors. The contribution of agriculture, forestry and fisheries to the GNP was about 19% in 1980, whereas that of mining and manufacturing was 40% and social overhead capital and other services 41%. In the 19-year period from 1962 to 1980, the GNP increased 4.5 fold from $12.7 billion to $57.4 billion at 1980 prices. The smallness of Korea's domestic market, however, made it inevitable that its economic development policy would be directed toward export-led industrialization. The volume of the commodity exports increased from $50 million in 1962 to $17.2 billion in 1980 at current prices.

From the launching of the First-Year Economic Development Plan in 1962 until 1977, the economy as a whole maintained an average growth rate of about 10% per annum, while the real GNP increased more than three-fold between 1965 and 1977. Due to the second oil crisis and the worldwide recession, growth in 1980 was negative for the first time in recent history, but the economy is now gradually recovering. Per capita income, which was below $100 in 1961, rose to $1 506 at current prices in 1980, an impressive increase even in real terms for the period. This phenomenal performance transformed Korea, as the World Bank indicated, "from one of the poorest developing countries, with heavy dependence on agriculture and a weak balance of payments situation financed almost entirely by foreing grants, to a semi-industrialized , middle-income nation with an increasingly strong external payments position and prospects of eliminating the current account deficit in the next 5-10 years".

1.3 DEVELOPMENT SCENE

The division of the peninsula into two Koreas is not only geographic but also political. It has resulted in an unbalanced division of natural resources for the economic development of either part. Moreover, the Korean War, which broke out in 1950, demolished nearly all existing production plants. leaving Korea a perfect example of an underdeveloped country by the time of the truce in 1953. Worsening economic conditions continued in a vicious cycle until the early 1960s when the First Five-Year Economic Development Plan was launched. During the period from 1959 to 1961, the GNP growth rate averaged only 3.3% per annum while the population grew at an average rate of 2.9% and the ratio of domestic savings to GNP was 3%. About 65% of the total employment was in the primary sector whereas secondary industries employed a mere 6.9% of the total.

Hence, the First Five-Year Economic Development Plan (1962-66), which was for all practical purposes the first real industrialization effort, began with the development of highly labour-intensive industries, absorbing the abundant labour force from the primary sector. The First Plan focused on laying the foundation for future economic growth by correcting all manner of socio-economic ills besetting the national economy. Because of the weak domestic savings power the economy was, from the beginning of industrial development, an open economy vis-a-vis foreing countries to obtain the funding required for the increased import of foreign goods and services and also, to some extent, to increase exports to pay for the imports.

As it was also necessary to be outward-looking for both markets and technologies, Korea did not choose the "import substitution followed by exports" type of industrialization for its development, but instead the two were undertaken almost simultaneously. During the First Plan period, national efforts were made to build up energy industries such as coal, electric power and oil refineries, and such key technologies as those for the production of fertilizers and cement. and for chemical and textile production. As a result, the nation achieved an average 8.5% GNP growth rate during the period while the growth rate for secondary industry reached 15.3%

The apparent success of this bold approach can be attributed to several factors: the amenability to training, or the absorptive capacity, of the labour force in dealing with technologies which were relatively sophisticated, even during the Korean War period when over 15% of the total population was acquiring formal education as compared to only 6% before the liberation from Japan in 1945; close trade relations with the United States and Japan, both big markets; full exploitation of the technical advantage of being latecomers in industrialization, and the capacity to adapt to the international economic environment, which was actively supported by government via the creation of a favourable investment climate for foreigners.

Deficient social overhead capital (SOC) is the main constraint on rapid industrialization and Korea was no exception. The government, therefore, placed the greatest emphasis on building roads, ports, communications and other national development essentials and, particularly, it expended educational facilities for technical vocational training. About 50% of the total induced foreign capital was allocated to this SOC area as well as over 70% of the total public funds from overseas.

The Second Five-Year Economic Development Plan (1967-71) forged ahead with the modernization of the industrial structure through the build-up of petrochemical, steel, electronics and machinery industries. Efforts were also made to promote the development and expansion of export industries such as textiles and plywood. During this period, the GNP grew at an average annual rate of 10.5%, and the industrial sector at the high rate of 22.2%. What was attempted during the Second Plan period was, in essence, the initiation of a growth momentum through the development of lead sector industries. These industries, by their very nature, are highly capital-intensive and also require very large infrastructures which have to be supported by the government, not merely so that they develop sufficient linkage effects directly but because they are the essential foundation upon which the highly capital-intensive industries can be built.

The Third Five-Year Economic Plan (1972-76) followed in more or less the same direction for industrialization, with greater concentration on heavy and chemical industries of a capacity to enjoy an economy of scale, together with agricultural and social services to maximize the advantage of a latecomer by capitalizing on the experiences of the advanced countries and the improved capacity of the country itself. This orientation necessitated the introduction to industry of new, higher level, technologies on an order of magnitude never experienced before.

The harmonization of growth and stability was the important theme of this Third Plan. It also aimed at regional balance through innovative development of the rural economy. The "Saemaul" (New Community) Movement was instituted during the Third Plan period to promote the equitable distribution of Wealth accumulated as a result of the tremendous increase in exports and to contribute to further social development.

Social development was a basic objective throughout the period of the Fourth Economic Development Plan (1977-81). In addition, the Fourth Plan placed national emphasis on the renovation of the economic structure for self-sustained growth, as well as the technological innovation and improvement which were the keys to the country's continued economic growth. The outstanding process made by the Korean economy since the mid-sixties brought about many socio-economic changes, but still leaves a variety of tasks to be done to improve the balance of payments and strengthen the industrial structure, as well as to improve national welfare and the rural living environment.

Korea is now approaching the Fifth Plan period (1982-86) with great national aspirations for building a highly industrialized society and a welfare state. The general framework of the Fifth Five-Year Economic and Social Development Plan has been announced, and will be described briefly, later, in connection with science and technology development.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

The basic four goals to which all government policy is being directed in the 1980s are: establishing the foundation for democracy; building a welfare state; achieving social justice; and carrying out educational and cultural development . The Fifth-Year Economic and Social Development Plan for the period from 1982 through 1986 is designed to help the nation achieve these goals. According to the Plan, Korea aims to maintain an average annual economic growth rate of 7.6% and to hold inflation to a single-digit rate. The welfare investment ratio is expected to rise from 23.1% in 1977-81 to 28.6% over the next five years.

The Plan was formulated after about fifteen months of extensive work. Sectoral task force teams prepared a first draft covering twenty-seven policy issues of which science and technology development was one. These were then refined at discussion forums involving more than two hundred civilian participants and coordinated by the Korea Development Institute. The refined drafts were placed before the economic ministers' and vice ministers' meetings. Foreign experts and the World Bank also contributed to further refining of the Plan. It was finalized at an economic cabinet meeting in accordance with the President's directions and the majority party's recommendations after coordinating relevant ministries' opinions.

This Plan, which was formulated with the participation of more than 400 experts from outside the government, is different from previous ones in several respects. Unlike previous plans, it explicitly includes social development, and is no longer a commanding, but an indicative plan. The word "development" reflects a national consensus which leans toward stability, rather than to the growth of the economy, although it has often been misleadingly used as synonymous with "growth". Hence the main themes of this plan are stablility, efficiency and balance. On the basis of these themes, Korea aims during the plan period to accomplish five priority tasks:

i. to consolidate the foundation for economic stability and enhanced efficiency;

ii. to strengthen its outward payments position and attain economic security;

iii. to shift the industrial structure on the basis of comparative advantage;

iv. to develop the national land resources in a balanced fashion while conserving the natural environment: and

v. to expand social development.

When the plan has been successfully completed, the per capita GNP will have risen from $1 506 in 1980 to $2 170 in 1986 measured in 1980 prices, as shown in the accompanying table.

The wholesale price index is also to go down from 20.0% in 1980 to 9.0% in 1986. Employment will increase by 3.0% thus reducing the unemployment rate from 4.8% in the Fourth Plan period to 4.0%. Labour productivity will rise to 5.0% compared with 3.2% in 1977-81.

To achieve greater efficiency, the management of the economic system will rely heavily on private initiative and market competition. Freer competition will be encouraged by guaranteeing the enforcement of the newly introduced Antitrust and Fair Trade Act internally, and by inducing foreign competition externally, along with the modernizing of the financial market and the streamlining of the government support system. To this end, the import liberalization ratio will be pushed up to the level of advanced industrial countries by 1986, imports of foreign technology will be decontrolled and an increase in joint ventures with technology-equipped alien concerns will be sought.

General Plan Indicators

	Unit	1980	1986	Average Annual Rate of Increase (%) 1982-86
GNP(b)	Trillion Won	35.0	53.7	7.6
	US $ Billion	57.4	41.8	1.6
Population	Million persons	38.1	41.8	1.6
Per Capita GNP(b)	Thousand Won	919	1,283	5.9
	US $	1,506	2,170	5.9
Increase in GNP Deflator	%	27.7	9.5	10.8
Commodity Exports(c)	US $ Billion	17.2	53.0	11.4(a)
Commodity Imports(c)	US $ Billion	21.6	55.5	8.4(a)
Current Accounts(c)	US $ Billion	—5.3	—3.6	—

Note: (a) Rate of increase in real terms
(b) At 1980 prices
(c) At current prices

2.2 DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

During the past two decades Korea has had a quite high rate of economic growth, matched by parallel science and technology development to a degree which may make indigenous technical innovation a real possibility.

An indispensable factor in providing impetus for satisfactory development and the application of science and technology in the interest of overall national development in a developing country is that the political leaders and policy-makers of that country have a clear recognition of the importance of science and technology and that such recognition is translated into action in a resolute manner. As one of the major goals set forth for overall national development from the outset of the industrialization process, Korea perceived the importance of science and technology as an integral part of its economic development effort, and its science and technology development policy was systematically followed at the national level.

A prerequisite to the development of science and technology in a developing country in the face of built-in obstacles and frustrations is an efficient national science policy mechanism and the build-up of an institutional infrastructure for science and technology. In 1967, the Science and Technology Promotion Law was enacted to meet the requirements for national scientific and technological development and, during the same year, the Ministry of Science and

Technology (MOST) was set up as an arm of the government specifically to administer the development of science and technology. The Ministry was instrumental in developing effective science policies based on a long-range forecast of economic and social needs, and it then established the appropriate mechanisms and programmes for implementing that policy.

The establishment of the Korea Institute of Science and Technology (KIST) , now the Korea Advanced Institute of Science and Technology (KAIST), was one result of this policy, and was followed by the establishment of nine separate, special research institutes. This represents the establishment of an effective national R&D system, and a science town or research complex is under construction to centralize the various research institutes. Korea has been quite successful in forestalling the brain-drain as increasingly high-level scientists are repatriated to man industrial research organizations which continue to be set up as industry's need for such manpower increases.

Economic development has also produced a rapid increase in the demand for trained technical manpower. The Korea Advanced Institute of Science (KAIS), now merged into KAIST, was established to provide postgraduate education for engineers and scientists. It is contributing greatly to the develoment of technical manpower. Vocational school education and professional training are also being given strong support, and the national technical qualification system established professional criteria in 1975. Korea has an abundant reserve of potentially skilled, educated manpower, and the government has been working to develop and use this manpower effectively and strategically.

In view of Korea's limited natural resources, restricted size, and high population density, it was inevitable that it should place heavy emphasis on developing export industries to achieve economic development. Science policy was, therefore, also oriented toward developing industrial technologies. The proper choice of imported technology, its indigenization, and its appropriate application, have been major R&D considerations. Equally important was the development of research capabilities as a basis for the effective adaptation and improvement of imported technologies to meet particular domestic requirements. The concept of appropriate technology tended initially to apply only to labour-intensive, small-scale industries, but as the industrialization process proceeded the concept shifted toward technology transfer involving capital-intensive, high-level technologies.

Economic and technical assistance from industrialized countries cannot be overlooked in examining Korea's industrialization. The Korean technological community has been active in its exchange of technology and technical personnel with advanced countries, in working on jointly sponsored research projects, in introducing modern research equipment, and it is now also undertaking regional cooperation with developing countries based on its own accumulated technological expertise. Korea's experience in the course of economic and technological development in the past two decades may be a useful example for other countries aspiring to similar development, so Korea is prepared to share its experience with other developing countries.

The total science and technology effort has aimed at effecting a structural change in the economy by shifting it from a simple labour-intensive to a more viable technology intensive structure which is, in turn, to be followed by a knowledge-intensive structure. The role of science and technology will shift from supporting national economic development, to leading such development on the foundation of the technologically self-reliant economy planned for the early 1980s. Appropriate technologies may initially have been labour-intensive but as industrialization proceeds they are becoming highly advanced.

In view of Korea's poor resource endowment, increased productivity through technological innovation and improved efficiency is the key to a continuing high rate of economic growth. Catalyzing technological innovation requires increased indigeneous research and development and the accelerated introduction and adaptation of imported, often advanced, technologies from abroad as well. These two seemingly contradictory elements are the two main policy pillars so long as export-led economic growth remains the economic development strategy.

To this end, the Korean Government has already effected a set of measures designed to relax its screening functions for technology imports by enlarging what is called the automatic approval category and by reducing the period required for approval. This means that Korea has taken the first step with measures for technology import liberalization and is working toward broadening it gradually. The government will continue to promote foreign technology inducements and maintain those procedures which favour foreign technology licensors.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

The Korean Government, by establishing the Ministry of Science and Technology (MOST) in the first year of the Second Five-Year Economic Development Plan in 1967 and by formulating long-term plans and aims for scientific and technological development, formally committed itself to a bold, imaginative approach. To overcome in a short time the lack of experience and manpower in the scientific and technological field and the Korean populace's general lack of awareness concerning it, a rather strong, efficient, centralized government organization was very much needed. Accordingly, MOST was placed in charge of formulating basic policies and plans, implementing and coordinating them, and formulating budgets for plans concerned with scientific and technological development. The administration structure of the ministry is given in Figure 1.

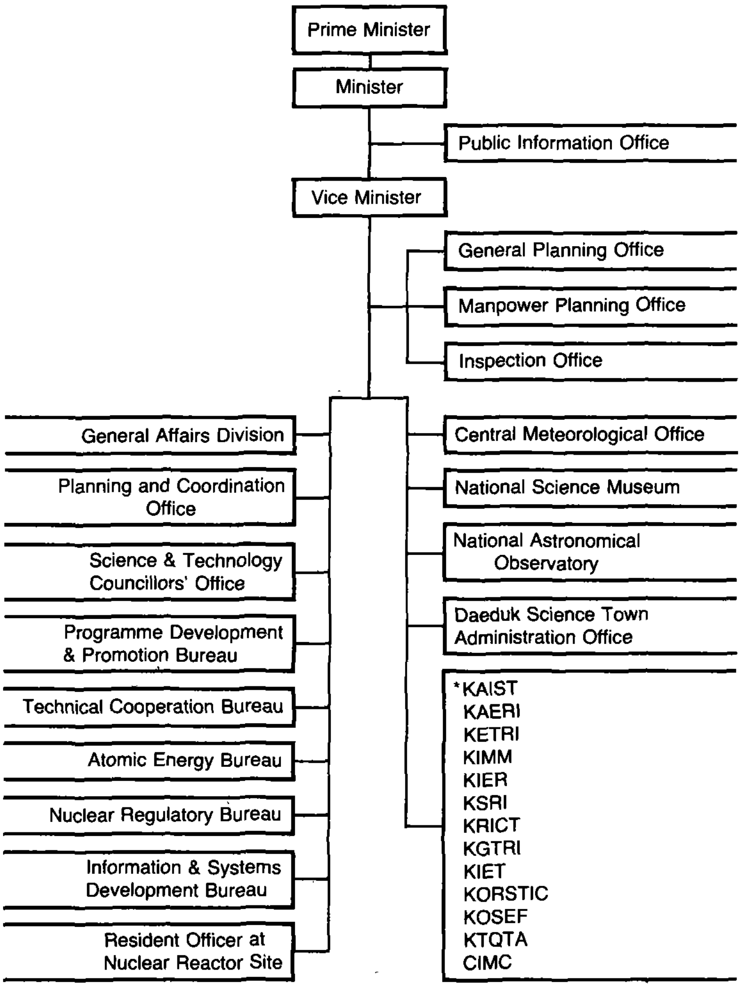
In addition to MOST, several other ministries are involved in these development efforts. Specific plans and problems related to a given field of science and technology are dealt with by appropriate ministries. The overall administrative structure for science and technology is shown in Figure 2. The National Council for Science and Technology was established in 1973 to deliberate on fundamental and overall policies concerned with scientific and technological fields which related to more than one ministry. It consists of the Prime Minister as chairman and the ministers of relevant ministries, and a few well-known scientists and engineers. Rather than formulating and implementing policies and plans directly, the council has been playing the role of approving and confirming those formulated by MOST. There are several advisory committees, such as the Committee for the Promotion of Science and Technology, the Committee for Technological Development, and the Deliberation Committee for Engineering Services, which come under the jurisdiction of MOST and which assist it in formulating and coordinating scientific and technological policies and plans.

The importance of the development of science and technology has been recognized as an indispensable moving force for industrialization and economic development processes from the very beginning of economic development planning. As a result, the setting up of policies for the development of science and technology, both explicit and implicit, has evolved in conjunction with or as an integral part of the consecutive Five-Year Economic Development Plans. Up till the Third Five-Year Plan, the predominant thrust was the building up of the infrastructure, involving a great variety of institutions and legal measures for the promotion of science and technology development. This ranged from the establishment of MOST to more recent measures to promote engineering companies.

To formulate and implement the national science and technology policy the Ministry of Science and Technology, for example, selects and coordinates technology development projects of national interest and with high spin-off effects. The selection process is the responsibility of the Science and Technology Councillor's Office, the staff of which has advanced degrees in various disciplines. It is assisted by a group of experts from public sector institutes and the academic community.

Figure 1

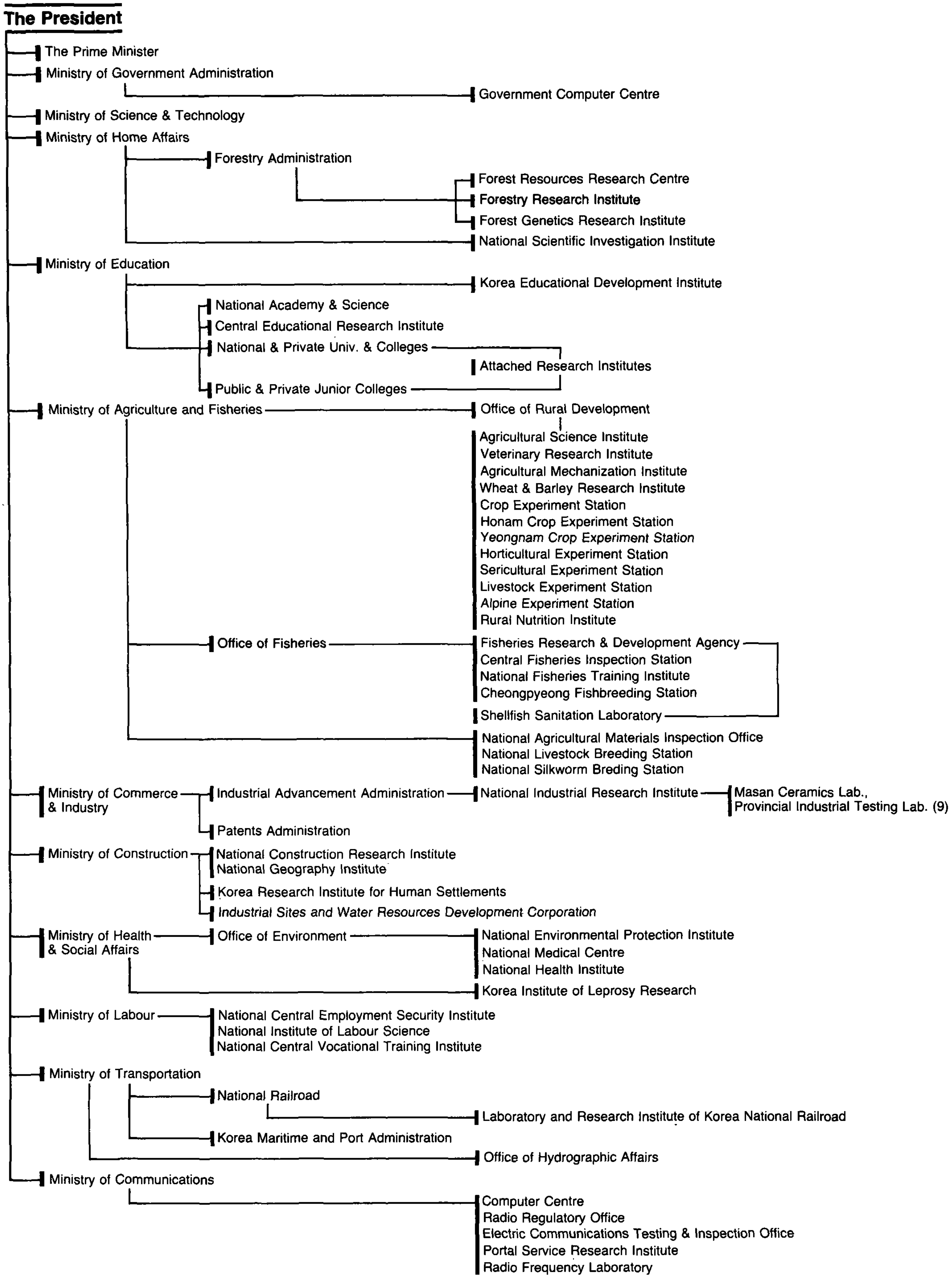
Organization of Ministry of Science and Technology (MOST)



*KAIST	Korea Advanced Institute of Science and Technology
KAERI	Korea Advanced Energy Research Institute
KETRI	Korea Electrotechnology and Telecommunications Research Institute
KIMM	Korea Institute of Machinery and Metals
KIER	Korea Institute of Energy and Resources
KSRI	Korea Standard Research Institute
KRICT	Korea Research Institute of Chemical Technology
KGTRI	Korea Ginseng and Tobacco Research Institute
KIET	Korea Institute of Electronics Technology
KORSTIC	Korea Scientific and Technological Information Centre
KOSEF	Korea Science and Engineering Foundation
KTQTA	Korea Technical Qualification Testing Agency
CIMC	Changwon Industrial Masters College

Figure 2

Administrative Structure for Science and Technology (January 1981)



The Ministry is also responsible through the Economic Planning Board for supplying the necessary budget which is estimated during selection procedures. The councillors perodically follow up the projects undertaken and executed by such public sector institutes as the Korea Advanced Institute of Science and Technology. The Programme Development and Promotion Bureau of the Ministry, among its other activities, is in charge of encouraging the private sector's R&D. The Technical Cooperation Bureau coordinates both bilateral and multilateral technical cooperation.

The Ministry's policy formulation is reviewed and assisted by an advisory committee which consists of about 100 experts representing both the academic and industrial communities. Policies are then presented to the cabinet and/or Economic Ministers' Meeting, or the National Council for Science and Technology chaired by the Prime Minister. The upward and downward linkages with relevant organizations and councils are shown in detail in Table 1.

Since advanced countries continue to be the source of technologies for Korea, the transfer of such technologies from abroad is so important that government agencies play a crucial role in the transfer. When the capability of Korean industries was too weak for them to be able to select appropriate technologies, the government adopted an approval system for technology importation. With the experience accumulated over the past two decades, however, Korean industry, particularly large-scale industry, is now capable of doing this for itself so that the Ministry is no longer intervening in the process of the private sector's importation of foreign technology. In adherence to a gradual liberalization policy, the consultation activities of the Technology Transfer Centre of KAIST will be strengthened, particularly for small-scale firms. The Centre, which is given government budgetary and financial support, has provided consultative services to the governemnt in reviewing applications for approval. The Centre's activities have now, however, been reoriented toward assisting firms.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

In the early stages of industrialization, the Korean Government focused on institution building, as demonstrated by the establishment of the Korea Institute of Science and Technology (KIST) in 1966, to provide an R&D infrastructure.

In view of the fact that industries were hardly capable of selecting appropriate technologies and absorbing them, KIST, at the time of its establishment, assumed the role of intermediary agency in introducing advanced foreign technology. To induce contract participation by industry, KIST carried out industrial technology projects, and each such project was managed under an independent accounting system so that each research laboratory became a profit centre for the institute. This type of contract research and the independent accounting concept was very new to Korea, and it took some time for it to be accepted because such services and knowledge were not considered items to be sold. As a result, the success of the KIST operation contributed not only to technology development but also to the establishment of Korea's industrialized society.

As industrialization proceeded, the social needs of technology development increased in volume and became diversified in nature. Many specialized institutes have been established to help industry solve its current problems, and to undertake research projects of a public nature such as those related to energy and standards.

These institutes include the:
- Korea Shipbuilding Research Institute;
- Korea Standards Research Institute;
- Korea Chemical Technology Research Institute;
- Korea Energy Research Institute;
- Korea Nuclar Fuel Development Institute;
- Korea Telecommunications Research Institute;
- Korea Electronics Research Institute;
- Korea Institute of Machinery Metals;
- Korea Heavy Electrical Equipment Testing Institute;
- Korea Ocean Research and Development Institute.

The Korea Advanced Institute of Science (KAIS) was established in 1970 as a postgraduate school to supply highlevel technical manpower. Until recently, most Korean universities and colleges emphasized undergraduate-level education. KAIS students have been encouraged to solve practical industrial problems as part of their education.

Private companies have also been encouraged to establish R&D institutes so that they can participate in the technology-intensive heavy and chemical industries, since international competition is constantly increasing. Government encouragement took the form of tax incentives and financial support. There are now 36 such research institutes and seven more are planned or under construction. As of 1979, there were 641 R&D related institutions which included 125 public research institutes, 211 at universities, colleges and junior colleges, and 305 R&D departments belonging to private industries. R&D personnel totalled 15 711, 0.4 person per 1 000 population, and the total R&D investment was 174 billion won, or 0.6% of the GNP.

The comprehensive plans for the realization of a highly industrialized economy required a well conceived scientific and technological support base. A science town/research complex to increase economic efficiency and to promote the effective use of research facilities, personnel and information has been under construction in Daeduk County since 1974. The town, with an area of 28 square kilometres, now contains seven research institutions and a university, and when completed in 1983 will have a total of thirty R&D institutions.

Foreign countries are familiar with the establishment of such industrial research institutes with government support and their efforts along these lines have become a model for other developing countries. In Korea, these institutes collectively provided the essential infrastructure, and some played a successful role as intermediary agencies in introducing advanced technologies to Korean industry, since industry had no technological development capabilities until recently. Now that private industry has both the capability and experience to a certain degree, the institutes must assume roles other that those of intermediary agency and neutral infrastructure. In fact the private industry institutes are playing much the same role as was previously played by public sector institutes.

They are now expected to produce results, not as helpers but as problem-solvers. This requires a critical mass to form specialist cadres in various disciplines to solve industry's problems by complementing private sector institutes. Due to both manpower and money limitations, some institutes were far below the critical technical manpower and facility scale and, as independent entities, wasted scarce technical manpower on management and wasted funds on administrative support. A lack of cooperation among institutes and inefficient coordination among sponsoring ministries made it difficult to manage big projects which had national priority. To eliminate these problems and to maximize the efficient use of resources, the government decided in 1980 to reorganize and merge 15 government-supported institutes into nine institutes:

i. the Korea Advanced Institute of Science (KAIS) and the Korea Institute of Science and Technology (KIST) were merged to become the Korea Advanced Institute of Science and Technology (KAIST);

ii. the Korea Atomic Energy Research Institute (KAERI) and the Korea Nuclear Fuel Development Institute (KNFDI) became the Korea Advanced Energy Research Institute (KAERI);

iii. the Korea Research Institute of Geoscience and Mineral Resources (KIGAM) and the Korea Energy Research Institute became the Korea Institute of Energy & Resources (KIER);

iv. the Korea Standards Research Institute (KSRI), the Korea Research Institute of Chemical Technology (KRICT) and the Korea Institute of Electronics Technology (KIET) have continued as they were;

v. the Korea Institute of Machinery and Metals (KIMM) and the Korea Research Institute of Ships (KRIS) became the Korea Institute of Machinery & Metals (KIMM);

vi. the Korea Electric Research and Testing Institute (KERTI) and the Korea Telecommunications Research Institute (KTRI) became the Korea Electrotechnology & Telecommunications Research Institute (KETRI);

vii. the Korea Ginseng Research Institute (KGRI) and the Korea Tobacco Research Institute (KTRI) became the Korea Ginseng & Tobacco Research Institute (KGTRI).

It is expected that this restructured national R & D system under the supervision of the Ministry of Science and Technology will achieve both horizontal and vertical integration to meet technological needs in the coming years. The consolidation was carried out taking into consideration the appropriate scale, and the research fields and functions involved. After the consolidation, there was also a redistribution of functions among research institutes to line them up according to current national goals so that they will be able to undertake big projects of national importance in a more comprehensive and cooperative manner. They will also adopt an incentive system so that the teams or institutes with outstanding performances can be suitably rewarded. This will in turn help to revitalize R&D.

3.2 HUMAN RESOURCES

The modern Korean education system, basically a 6-3-3-4 year structure, was founded in 1948, the year of the government's establishment and has continued with only minor changes. After six years of primary education (compulsory), students are offered three years of junior secondary education (middle school) which includes some prevocational elements but is basically of a general nature. In senior secondary education (high school) the main choice is between three years of general, technical, agricultural or commercial curricula. After high school, students may continue on to a four-year college course, or to a two-year junior vocational college, or to a primary teacher training college.

Korean education has expanded rapidly. Total enrollment increased by 217% from 4 715 000 in 1960 to 10 218 000 in 1979. Therefore, a highly educated manpower with great potential has resulted and made a great contribution to the rapid growth of the Korean economy. Due to traditional beliefs, however, vocational and natural science education were not well received by the Korean people in spite of the increasing social need for industrialization. To solve this problem and to meet the technical manpower requirements desperately needed for national modernization, the government has tried to induce more students into vocational and/or technical fields of education through the construction of better facilities, the offering of scholarships, and other incentives. In addition, vocational training programmes under the Vocational Training Law have been emphasized since 1967 in both the public and private sectors to meet the demand for skilled workers required by industrialization. During the Fifth Five-Year Plan, 113 vocational schools will be opened so that there will be a total of 990 by 1986.

The Korean Government, with international cooperation, is establishing many training centres and encouraging government agencies and public entities, such as military units and prisons, to set up training programmes for their personnel; inplant training has been particularly emphasized. Under the Vocational Training Law, enterprises over a specified size are required to run their own training centres or to send their employees to training institutes at company expense; or they must pay a fee to the government as provided by the law. The number of public training centres will be increased to 29 in 1986.

Up to the 1960s when Korea's industrial technology level was very low the economy was able to rely mainly on such skilled labour. However, as economic development succeeded under the economic development plans, technology-intensive industries such as machinery, metal and electronics were emphasized, and this new scheme of industrialization required a large number of highly qualified technical personnel. According to a manpower projection, this technical manpower including scientists; engineers and craftsmen is expected to increase from 736 000 in 1981 to 1 402 000 in 1991. The statistics for scientific and technological manpower are given in Table 2. Accordingly, parallel with the strengthening of vocational education and training, the government has taken every possible measure to train high-level technological personnel to act as the leaders of science and technology development.

First, the graduate school programme of the Korea Advanced Institute of Science and Technology (KAIST), formerly KAIS, was established in 1970 under a special law to train leading scientists and engineers. So far it has produced 1 081 graduates, all of whom were employed by research institutes, colleges and industries immediately upon graduation. To meet the pressing demand for KAIST graduates, the government is planning to expand these training facilities.

Second, the government initiated overseas training programmes for 100 scientists and engineers in 1981 to study advanced technologies in industrial establishments, research institutes, and universities in advanced countries. There is a plan to extend this number to 750 during the Fifth Five-Year Plan (1982-86).

Third, Korean scientists and engineers working abroad have been repatriated with financial support from the government. Since the programme was initiated in 1968, a total of 550 Korean scientists and engineers in developed countries have been recruited by research institutes, colleges and industries. An active campaign is now underway to recruit more such scientists and engineers, and about 500 Korean scientists and engineers will be repatriated during the 1982-86 period.

Fourth, the government is strengthening graduate schools, and the number of students at the graduate school-level will be increased, and priority for faculty training facilities and scholarships will be given to graduate education.

3.3 FINANCIAL RESOURCES

In the early stages of science and technology development, the government played a most significant role in providing funds for research. However, as the industrial structure changed from labour-intensive light industries to more capital-and technology-intensive heavy and chemical industries in the second half of the 1970s, industry expanded its own research and development efforts in an attempt to strengthen its international competitiveness by developing and improving productivity and production processes.

Looking specifically at funding by the source, the absolute amount of public sector scientific and technical research funds have increased steadily from 7.5 billion won in 1970 to 95 billion won in 1979. The public sector's share, however, decreased significantly during this period from 70% to 54%. Industry's investment in research and development increased from 3 billion won in 1970 to 79 billion in 1979, increasing industry's share of R&D from 30% to 46%. Other sectors, including higher educational institutions, played a minimal role as generators of funds for scientific and technical research.

R&D Expenditures by Source and Performance

(unit: Million Won)

Source / Performance		Total		Govt. & Public		Private		Foreign	
		'79	'78	'79	'78	'79	'78	'79	'78
Research Institutes	Govt. & Public	47,552	35,446	47,372	35,338	4	4	176	54
	*Special Corps.	50,655	42,627	37,879	26,253	10,047	15,981	2,729	393
Universities & Colleges		16,536	20,543	6,006	11,922	10,365	8,429	165	192
Companies		59,295	53,802	64	159	58,832	53,557	399	86
Grand Total		174,038	152,418	92,321	73,722	79,248	77,971	3.469	725

* Note: Special Juridical Bodies

When reviewing performance, it is the public sector that did most scientific and technical research in the 1970s. For example, the public sector accounted for 83.9% of the funds allocated for research, while industry and higher educational institutions accounted for 12.6% and 3.5% respectively. Industry's share, however, increased from a mere 12.6% in 1970 to 34% in 1979, while research at higher educational institutions increased from 3.5% to 9.5% during the same period. These changes in the origin and allocation of funds indicate the structural changes in industry, and the gradual shift of the foundation for competitiveness in industry from a cheap labour force to high-level technology.

3.4 SURVEYING OF S&T POTENTIAL

Scientific and technological activity statistics including R&D statistics are collected by the Ministry of Science and Technology, which regularly publishes statistical reports in the Science and Technology Annual. These repors include the number of researchers, technicians and auxiliary personnel as well as R&D expenditure. The surveys have been carried out by mail.

Science and technology statistics have been processed manually, but will be computerized from 1981. A study of the guidelines for the collection of statistics on science and technology and the development of science and technology indicators was carried out by KAIST in 1980. Such statistics and science and technology indicators will be developed continuously.

PART 4.

Policy Issues in Scientific and Technological Development

4.1 MAJOR DEVELOPMENTS

As explained in Part 1, the Korean economy has grown at a high rate since the First Five-Year Economic Development Plan was launched. Through the successful implementation of two consecutive Five-Year Plans in the 1960s, it built up the infrastructure for continuous economic growth in the 1970s. Korean export products and markets were widely diversified, and the domestic infrastructure also significantly expanded, so that there were many and varied socio-economic changes, which in turn affected science and technology development policy.

For a country like Korea which is poorly endowed with natural resources but has an abundant labour force of relatively high quality, technology must be an important, if not the most inportant, element in economic development. While maintaining its export-oriented policy, the government encouraged the private sector to introduce foreign technology and also expanded the infrastructure necessary for R&D. The Foreign Capital Inducement Act has provided a variety of tax and financial incentives for both domestic and foreign concerns. This accelerated the inflow of machine-embodied technologies from the developed countries. Efforts to broaden the infrastructure by way of government initiatives through MOST have continued since the establishment of KIST in 1966, and were in line with the structural shift from light to heavy and chemical industries. A series of special laws to promote heavy and chemical industries was enacted to support such industries as petrochemicals and electronics, and gave explicit recognition to the importance of technology development.

MOST, inaugurated in 1967, realigned policy-making mechanisms and assumed a central coordinating role for science and technology development. The Science and Technology Promotion Law provided the government's basic commitment to the support of science and technology and to providing policy leadership. In addition, a series of fundamental laws were enacted to support the implementation of technological development:

i. the Technical Development Encouragement Law which supports private and public corporate enterprises through tax privileges and other incentives;

ii. the Engineering Services Promotion Law which ensures the opportunity for, and quality performance of, professional engineers; and

iii. the National Technical Qualification Law which, through a system of examinations and certifications, regularizes the professional status of engineers and technicians.

The government established special funds at national development banks to help industry meet the increasing financial requirements of technological development. The Korea Development Bank established and operated the Technology Development Fund from 1975, and the Small and Medium Industry Bank handled the Commercialization Fund for New Technologies from 1978. In addition to these special funds to provide direct loans for technology development projects to the private sector, there are other indirect financial support mechanisms using the National Investment Fund of the Bank of Korea to create a market for the first domestically manufactured machinery by supplying long-term, low-interest procurement loans. The Small and Medium Industry Promotion Corporation, a public organization, has since 1980 operated a long-term loan fund for small and medium-scale business R&D. A most important financial support mechanism is the Korea Technology Development Corporation which went into operation in 1981 with a total capital of about $100 million. It is a privately operated, government invested finance corporation subject to a special law, and it provides loans and venture capital investment to private industry for technology development including intangible software projects. This corporation may be the first of its kind of this size.

Now that many Korean firms are experienced and capable of selecting and absorbing appropriate technologies, the government has changed its policy for technology import from an approval to a report system. It is now just a step to the complete liberalization of technology importation.

Another important responsibility assumed by the government and the public sector is the training of technical manpower. Science and engineering education has been significantly strengthened both in quantity and quality through, for instance, the steadily increasing enrollments at KAIS over the years and the diversification of its postgraduate education disciplines. KAIS students have been exempted from military duty and awarded full scholarships as well as having their living costs borne by the government. Technical education both at the postgraduate and vocational levels has been greatly expanded to meet the growing demand for technical manpower.

4.2 ACHIEVEMENTS AND PROBLEMS

The Republic of Korea's science and technology policy in the 1970s can best be summarized as a broadening of the infrastructure and the creation of a suitable environment for technological research and development.

The government played a leading role in establishing industrial research organizations and inducing the private sector to participate actively with them. These public sector institutes have made both direct and indirect contributions to advancing industry's technological capabilities. They helped industry to solve current problems related to imported technology, such as adjusting it to local conditions and improving it. The institutes' research projects on high-level technologies upgraded private enterprises' power in bargaining for technology transfer contracts. In addition to industrial technology, their contributions to the development of technical manpower and to projects of a public nature, such as those related to alternative energy sources and environmental protection, cannot be ignored. An ambitious plan to construct a Science Town in Daeduk as a research complex should also be noted since, on completion in 1983, the Town will serve the entire country as the centre for its R&D through its institutes and facilities, both public and private.

The expanded educational and vocational system has contributed to Korean development and will continue to be improved to meet society's changing needs. Concerning manpower, Korea has been quite successful in repatriating scientists and engineers trained abroad, who after returning have contributed notably to the modernization process.

The government's original efforts to encourage the active participation of private corporations through publicly sponsored industrial technology development institutions gradually shifted toward encouraging them to build their own R&D institutes. As described earlier, there are now many such private sector institutes engaged in R&D and more are being constructed or are planned. The government supported institutes must, therefore, assume roles other than those of helping industry introduce foreign technologies. Consequently they have recently been reorganized to undertake research projects of national importance, and of high risk and greater externality.

In spite of a comparative success in infrastructure building, the investment in R&D, which remained well below 1.0% of the GNP in the past, was not sufficient to cover the cost of research itself, since much of the national R&D expenditure had gone into infrastructure building. As a consequence, public sector institutes were hardly able to extend their work into the costly stage of mass-production technology development for commercialization. The private sector, on the other hand, was interested mostly in the immediate commercial application of proven technologies. Private industry seeks short-term profit, particularly in the presence of high inflation, so public sector institutes and private industry were not able to establish as close a partnership as desired until the role of the institutes was changed. There are many reasons for this but basically it is because science and technology development has not been treated as an integral part of industrial or economic development policy.

The investment in science and technology has been fairly small compared with industrial investment, and a large portion of industrial investment went into the capital expansion of private industry based on plants imported on a turn-key basis. Technologies embodied in machinery were dependent on foreign sources, and industry was satisfied with securing operational technologies. Now that Korean industry faces difficulties in importing foreign technology, it becomes urgently necessary to upgrade technical capabilities to maintain the international competitiveness of Korean exports.

The problem is, therefore, to increase efficiency in the use of the limited national financial resources by investing more in R&D; another problem is to shift the role of science and technology from supporting industrial development to leading it. This new role for scientific and basic research should be emphasized in the years to come.

4.3 OBJECTIVES AND PRIORITIES

Korea's Fifth Five-Year Economic and Social Development Plan covering the period 1982 through 1986 is about to go into effect. Compared with previous Five-Year Plans which resulted in the Korean economy's phenomenal growth record, the Fifth Plan emphasizes the enhancing of efficiency and effectiveness. Hence it recognizes the importance of the role of science and technology more than ever. In other words, Korea is now entering into a new era in achieving its national goal of becoming an industrially advanced society on the basis of an expanded economy by increasing its economic efficiency and upgrading its social development.

Science and technology policy for the Plan period will, therefore, follow three major routes: first, securing a comparatively advantageous position in the skill-intensive light industries to deal with the import regulations of advanced countries and the growing competition with other developing countries; second, building up a comparative advantage in the international division of labour in technology intensive, heavy industries; and third, developing selected strategic areas of frontier technology in which international competition is increasing.

Consequently, the Republic of Korea has the following goals for its science and technology development:

i. training and maintaining high-level technical manpower;
ii. promoting the productivity of R&D; and
iii. developing and introducing comparatively advantageous advanced technologies.

It is estimated that the supply of technical manpower will be about 30 000 scientists and 120 000 technicians and skilled personnel short of the demand by 1991 while there will be an oversupply of 44 000 engineers. In addition to expanding graduate school education in science and engineering, public sector institutes such as KAIST will participate in training high-level technical manpower to produce 1 060 Ph.D. and 2 250 master degree-holders during the Plan period.

The repatriation programme for Koreans working abroad will also be actively pursued with the aim of repatriating 750 scientists and engineers on a permanent basis and 1 500 on temporary visits, while about 1 800 trainees will be sent to advanced countries at government expense during the Plan period. The fields of specialization will be carefully selected taking into consideration social needs and the duration of training; three to five years for researchers at institutes and one year for industrial technologists and doctorate-holders.

To promote productive R&D, the government has already reorganized the public sector R&D institute system as mentioned earlier to form centres of excellence for the technological areas of national importance. Each institute will become the centre for carrying out large-scale R&D projects of national interest: the Korea Institute of Electronics Technology for semiconductor and computer related technology; the Korea Research Institute of Chemical Technology for fine chemical research; and the Korea Institute of Machinery and Metals for the advancement of mechanical engineering. KAIST, in active collaboration with academia, will emphasize its future oriented mission in such basic research areas as solid state physics, metallurgy and genetic engineering. In addition, the independent and autonomous management of these institutes will be assured to increase research productivity and responsibility, while the fringe benefits for their researchers will be expanded to boost motivation and morale. In addition a bold approach will be adopted to overcome the limitations of the domestic R&D capability and to accelerate the accumulation of frontier technology. To this end, Korean R&D organizations will actively seek opportunities for carrying out joint research with renowned institutions in advanced countries and industry will be encouraged to introduce foreign technologies in the early stages of the R&D process. Moreover the investment of venture capital in foreign overseas high technology projects will be promoted and a comprehensive system of collecting, processing and disseminating technological information will be established with the Korea Institute of Industrial Economics and Technology which will begin operations in 1982.

Finally, Korea will develop national projects with high externality which cannot be pursued by industry alone. The criteria for selecting such projects will include knowledge concentration, the conservation of energy and resources, the contribution to exports, growth probability under domestic conditions, and comparative advantage. Projects of this nature related to the fine chemical industry, semi-conductors and computers, and the advancement of the mechanical engineering industry, will be undertaken with the joint efforts of industry, public sector institutes, and the government. Cooperation in the form of both joint research and technology transfer with industrially advanced countries will be actively sought after.

In addition to national efforts to achieve these three goals, industrial technology development by the private sector will be promoted and encouraged by increasing incentive measures and support from public sector institutes. A system will be established for the industry led development of industrial technology by inducing each large-scale firm to establish one institute, and small-scale firms to form consortiums. These institutes and R&D consortiums will receive much the same privileges from the government as the public sector institutes, including endowment funds and exemption from military duty for their research personnel. Among the expanded financial and tax incentive measures for industry and worthwhile noting are, tax credits of 10% of the R&D investment, the application of a preferential special tax rate for high technology products, as well as financial support for the Korea Technology Development Corporation, a private R&D financing organization. Public sector institutes are expected to form more active ties with industry not only in undertaking national projects with industry but also to solve or help solve small and medium industry technological problems.

Basic research and the development of technologies in the public interest will also be fostered. More than 10% of total R&D investment will be spent to foster basic research in such areas as solid state physics, applied mathematics and genetic engineering, as well as to expand the Korea Science and Engineering Foundation endowment fund to support basic research. Increased technology development in the public interest includes matters related to energy and resource development, the securing of nuclear power generation safety and the modernization of meteorological services. The investment in science and technology to achieve all these ambitious goals will be increased to up to 2.0% of GNP, of which 55% is expected to come from the private sector. Scientific and technological manpower will be increased form 736 000 persons in 1981 to 1 044 000.

To give strong recognition to the important role of science and technology for the continued stable growth of the Korea economy, a (quarterly) Meeting for the Promotion of Science and Technology will be inaugurated from 1982 with the President as its chairman. This meeting is in recognition of the very high priority the Fifth Republic's national policy gives to science and technology. It will be attended by cabinet ministers and representatives from institutes and industry.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

In accordance with its open and outward oriented policy direction of science and technology development, Korea will seek active international technical cooperation so that it can absorb the advanced technologies of developed countries and share its experience with other developing countries.

Before describing plans for international technical cooperation, it is appropriate to summarize briefly the technical assistance which Korea has received. It received a total of US$288 million in outside technical assistance between 1951 and 1980, and sent 17 000 trainees overseas, invited 3 900 experts to Korea, and acquired facilities and equipment worth US$158 million. This financial support came from UN organizations, USAID, Colombo Plan member countries and other advanced countries.

It is true that technical cooperation programmes have made a valuable contribution to our scientific and technological development during the last two decades. Technical assistance from outside, however, has been decreasing. USAID programmes in Korea and technical cooperation from Great Britain were terminated in 1976 and 1979 respectively. and other technical cooperation resources are expected to be reduced. In addition, advanced countries are reluctant to provide advanced industrial technology which is very much needed for our industrial development. To meet this new technical cooperation situation, the Korean Government has set up new directions for strengthening international technical cooperation.

First, technical cooperation with advanced countries will be developed not on a concessional, but on a reciprocal, basis so that we can acquire the new advanced technologies needed for our industrialization. In this context, the Korean Government has exchanged technical cooperation agreements and promoted institutional cooperation with nineteen countries. The government has also formulated overseas training programmes for technological personnel at government expense.

Second, we are interested in participating in international cooperative programmes initiated by U.N. organizations in which we can exchange our development ideas and new technologies on a multilateral basis through the increased contribution of expert services and technical training.

Third, based on the spirit and principles of technical cooperation among developing countries which aim at establishing a new international economic order through collective self-reliance among developing countries, the Korean Government wishes to increase its technical assistance to developing areas and share its development experiences and technologies for the common prosperity. Korea's first experience with providing technical training for participants from developing countries was in 1963 under USAID's third country programme, and later, in 1967, under the U.N. fellowship programme. In 1965, the Korean Government started a training programme with its own funds, and in the 1970s it expanded cooperation programmes in the spirit of technical cooperation among developing countries (TCDC).

Since 1963, a total of 2 595 trainees from about 60 countries of Asia, the Middle East, Africa and Latin America have been brought to Korea. Parallel with this training, Korean expert services were provided to developing countries, mainly in the fields of agriculture and fisheries. About 3 300 persons will be trained in Korea and 130 Korean experts will be dispatched during the Fifth Five–Year Plan.

It is important to take note of the plan for technical cooperation with Asian and Pacific countries. The principle underlying this cooperation is the realization of long-term mutual benefits from combining in a complementary way Korea's development experience with other countries' rich resources and labour forces. On the basis of this principle, Korea plans to train technical manpower from Asian and Pacific countries, to transfer technologies to these countries, to expand institutional cooperation and to cooperate in developing energy sources and other resources. The technical training programme will be expanded, not only for the Asian and Pacific countries, but also for other developing countries.

Tripartite cooperation programmes, in which advanced countries provide funds and newly industrializing countries share experience, are desirable to make cooperation programmes more effective and efficient.

REPUBLIQUE DEMOCRATIQUE POPULAIRE LAO

Table des matières/Table of Contents

RÉPUBLIQUE DÉMOCRATIQUE POPULAIRE LAO

GEOGRAPHY

Capital city: Vientiane
Main ports:
Land surface area: 236,800 sq km

POPULATION (1978)

Total	3.5 million
Density (per sq km)	15
Urban/rural ratio (1973)	*0.2
Average rate of growth (1970-78)	2.3% p.a.

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	42.3	10.1	8.7	34.2	4.7	100%

SOCIO-ECONOMIC

Labour force	
Total	...
Percentage in agriculture	...
Gross national product (1978)	
GNP at market prices	...
GNP per capita	...
Real growth rate of GNP per capita (1970-78)	...
Gross domestic product	
Total (in current producers' values)	...
Percentage by origin	
Agriculture	...
Manufacturing, mining & quarrying, electricity, gas & water, construction	...
Government finance	
National budget	...
As percentage of GNP	...
External assistance (official, net; 1976)	...
As percentage of GNP	...
Exports (1978)	
Total exports of goods (1978)	US $ 9 million
Average annual growth rate (1970-78)	...
External debt (1978)	
Total public, outstanding + disbursed	...
Debt service ratio (% GNP)	...
(% Exports of goods and non-factor services)	...

Exchange rate (1977): US $1 = 200.00 Kips

EDUCATION

Primary and secondary education (1978)

Enrolment, first level	441,010
*As % of (6-10 years)	93%
Enrolment, second level	76,613
As % of (11-16 years)	16%
Combined enrolment ratio (6-16 years)	54%
Average annual enrolment increase (1970-1978)	9.0%

Higher education (third level) (1974)

Teaching staff, total	152	
Students and graduates by broad fields of study:		
	Enrolment	Graduates
Social sciences and humanities	489	119
Natural sciences	—	—
Engineering	—	—
Medical sciences	339	35
Agriculture	—	—
Other and not specified	—	—
Total	**828**	**154**
Number of students studying abroad	2,073	

Education public expenditure

Total	...
As % of GNP	...
Current, as % of total	...
Current expenditure for third level education, as % of total current expenditure	...

Table 1. Nomenclature and Networking of S&T Organizations

I - First level - POLICY-MAKING

Country: LAO PDR

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
State Committee for Science and Technology	Co-ordination and Consultation			

II - Second level - PROMOTION & FINANCING

(Data unavailable at time of publication)

Organization	Linkages		
	Upstream	Downstream	Others
....	....	....	....

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

(Data unavailable at time of publication)

Establishment	Function	Linkages	
		Upstream	Others
....	....	....	....

Table 2 - Scientific and Technological Manpower

Country: LAO PDR

Year	Population (millions)	Scientists and engineers						
		Total stock (in units)	Breakdown by field of educational training (in units)					Total stock (in units)
			Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences	
1968		174						
1970								
1975								
1980	3.75	630	74	94	82	113	267	3,760 (a)
1985								
1990								

(a) Excluding those in the provinces

Table 3 - R&D expenditures

Country: LAO PDR
Currency: Kip

Table 3a: Breakdown by source and sector of performance

Year:

(Data unavailable at time of publication)

Unit:

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive				
Higher Education				
General Service				
Total				

Table 3b: Trends

Year	Population (millions)	GDP (in US$ million)	Total R&D expenditures (in)	Exchange rate US $1 =
1968				
1970				
1977		290		
1979-80	3.75			10 Kip
1985				
1990				

Introduction

ÉTAT ACTUEL DE L'APPLICATION DE LA SCIENCE ET DE LA TECHNIQUE AU DÉVELOPPEMENT AU LAOS

En République démocratique populaire lao, jusqu'à 1980, il n'existe pas d'infrastructure pour la politique ou la planification scientifiques. Les recherches ont seulement été opérées sous forme sectorielle dans les différents bureaux d'études et centre d'expérimentation. Au début de l'année 1980, un pas important a été franchi avec la création du Comité d'État pour la Science et la Technique. Il est l'organe consultatif et coordinateur du gouvernement pour les problèmes relatifs au domaine de la science et la technique.

L'enseignement supérieur est dispensé par deux universités. On estime qu'en 1980, environ 250 étudiants en sont sortis diplômés et 800 autres ont été envoyés pour la formation dans les différentes disciplines à l'étranger. Par ailleurs, il existe encore 24 écoles socio-professionnelles destinées à former des techniciens, pour l'année 1980, un peu plus de 2 100 techniciens sont sortis de ces écoles.

D'après les premiers recencements, en 1980 l'effectif total des scientifiques et ingénieurs (sans distinction entre ceux qui se consacrent uniquement ou partiellement à la recherche) est évalué à 630 personnes (*) soit un rapport de 0,17 (**) pour mille habitants ou 168 scientifiques et ingénieurs pour 1 million d'habitants. La répartition par discipline serait approximativement la suivante :

sciences exactes et naturelles :	12%
sciences de l'ingénieur :	15%
sciences médicales :	18%
sciences agricoles :	13%
sciences sociales :	42%

D'autre part, le nombre des techniciens relevant de l'administration centrale s'élève à environ 3 700 personnes (les données relatives aux provinces ne sont pas encore disponibles).

Les activités de recherche ne sont qu'aux premiers stades de développement et sont surtout orientées vers les domaines agricoles.

En RDPL, il n'est pas possible de séparer nettement les dépenses afférentes aux recherches et celles qui concernent le développement. Toutefois, le gouvernement a fait un effort considérable pour la recherche et le développement. Ces activités sont financées à la fois par les fonds propres du gouvernement par le biais du budget national, et par les fonds provenant de l'aide extérieure.

Données de base sur la République démocratique populaire lao

1. Superficie	236 800 km^2
2. Population (1980)	3,75 millions
a) Densité (1980)	16/km^2
b) Accroissement annuel moyen	2,4
c) Taux de naissance (par 1 000)	45
d) Taux de mortalité (par 1 000)	23
e) Taux de mortalité infantile (par 1 000)	200
3. Capitale	Vientiane
4. État sans littoral	
5. Date de la création de la République	2 Décembre 1975
6. Population active	1,6 millions
7. PIB (1977)	290 millions $E.U.
8. PIB par habitant (1977)	90 $E.U.
9. Commerce extérieur :	
Exportations (1979)	19,2 millions $E.U.
Importations (1979)	20,3 millions $E.U.
10. Nombre d'habitants par médecin	30 800
11. Nombre d'habitants par lit d'hôpital	458
12. Taux de scolarisation	
primaire	85 %
secondaire	15 %
professionnel	3 %

Source : Mémoire de la R.D.P.L. Conférence des Nations Unies sur les pays les moins avancés, ONU, New York, 1981.

---

* en 1968 il y en avait 174

** en 1968 le rapport était de 0,06 pour mille habitants.

PARTIE 1.

Considérations d'ordre général

1.1 CADRE GÉOPOLITIQUE, SOCIO-CULTUREL ET ÉCONOMIQUE

La République démocratique populaire lao (RDPL) a une superficie de l'ordre de 236 800 km^2. Située dans la péninsule indochinoise, sans accès à la mer, elle jouit d'un climat tropical ou subtropical selon la latitude, ayant essentiellement un cycle régulier des moussons du nord et d'hiver, saison sèche de novembre à avril et du Sud et d'été, saison des pluies, de mai à octobre.

La population, estimée en 1980 à 3 750 000 habitants, est à 85 % rurale et se concentre dans les plaines centre-Ouest et Sud-Ouest le long du Mékong et ses affluents. Le taux de croissance est de 2,4 %. Il y a plus de 68 ethnies différentes qui peuvent être classées en trois grands groupes : les Lao Loum, les Lao Kang et les Lao Soung. Les Lao Loum constituent le groupe dominant, ils représentent environ la moitié de la population et vivent principalement dans les basses terres du Pays. Les deux autres groupes sont minoritaires. La densité est d'environ 16 habitants au kilomètre carré pour l'ensemble du pays. Il y a une dizaine de centres urbains dépassant 20 000 habitants; la capitale Vientiane a plus de 100 000 habitants.

L'administration du pays est décentralisée et organisée en quatre niveaux : central, provincial (Khouèng), district (Muong) et sous-district (Tassèng). Il y a 13 provinces ; l'unité de base, le sous-district, comprend 2 000 à 5 000 habitants selon le contexte géographique.

L'agriculture reste le secteur dominant de l'économie et constitue le fondement du développement du pays. La culture principale reste le riz qui occupe 75 % de la surface cultivée. Sur le total des terres cultivables près de la moitié sont des pâturages.

Le pays est riche en ressources naturelles. Naguère la forêt, en bois précieux et autres produits forestiers, occupait plus de 19 millions d'hectares ; elle couvre encore plus de la moitié de la superficie totale du pays.

Les réserves hydro-électriques et minérales sont importantes ; parmi ces dernières, seules les réserves de minerais d'étain et de gypse sont exploitées.

Le secteur industriel moderne est à son premier stade de développement.

1.2 SITUATION DE DÉVELOPPEMENT

Pendant de longues années, alors que les peuples du monde entier ont pu se consacrer aux efforts de développement, le Laos, pays essentiellement agricole arriéré, devait, quant à lui, subir le joug du féodalisme et du colonialisme. En même temps, la guerre a pendant plus de trente ans, ravagé tout le pays, ce qui a davantage disloqué et détruit radicalement son infrastructure tant sur le plan social qu'économique et physique.

La République démocratique populaire lao a été proclamée le 2 Décembre 1975. Le pays s'est engagé dans la voie du socialisme. Tout en subissant les séquelles de la guerre et des vestiges néfastes de l'ancien régime le pays a connu de profonds changements.

Très tôt, parallèlement aux tâches de renforcement de défense du pays, les programmes politiques du Parti et du gouvernement ont mis l'accent sur le développement de l'agriculture et de la sylviculture dans tous les aspects. Dans le domaine agricole, l'application de ces programmes a donné des résultats remarquables. Plus de 40 % des paysans se sont constitués en coopératives agricoles et le mode de vie collectif s'est étendu sur la moitié du nombre des Tassèng (sous-districts) de tout le pays.

En 1980, la dernière année du plan triennal 1978-80, la récolte dans tout le pays a atteint plus d'un million de tonnes de riz, chiffre qui constitue un record jamais atteint au Laos.

Parallèlement l'élevage a marqué de grands progrès : plus d'un million trois cent mille de buffles et de boeufs et une augmentation par rapport à 1976, de 32 % d'animaux domestiques.

La forêt constitue un des atouts économiques du pays ; le gouvernement a fixé des directives appropriées concernant sa préservation, son entretien et son exploitation ; le rabaissement des zones dévastées est une préoccupation majeure du gouvernement; la quantité des produits forestiers récoltés a augmenté chaque année d'environ 30 %.

Dans le domaine des activités industrielles étatiques, les industries consistant en agro-industries, industries de transformation du bois, des boissons, ont été restaurées et développées.

De son côté l'artisanat est encouragé et s'est développé favorablement.

Dans un autre domaine, les infrastructures de communication de transport et de magasinage, ont été restaurées et développées et font l'objet des préoccupations majeures du gouvernement. Également, l'organisation de l'habitation, des villages et des villes endommagés et détruits pendant la guerre a été restaurée.

Les réseaux de commerce étatique et collectif ont été élargis vers les bases régionales, jusque vers des régions de minorités ethniques les plus éloignées et reculées. Les marchés provinciaux et locaux se sont de plus en plus élargis, ce qui développe davantage la circulation des marchandises entre la campagne et les villes, créant les conditions de démantèlement d'une économie naturelle d'auto-suffisance et ouvrant la voie au développement de la production marchande.

Dans le domaine des finances et de la banque, le gouvernement a institué une réforme monétaire, ce qui a amené une gestion unitaire de la monnaie. En même temps il a institué un nouveau régime des salaires, ordonné certaines pratiques politiques indispensables telles que la politique des prix, des contributions, d'import-export, et s'est efforcé de transformer la distribution selon le régime administratif en celui de la gestion des entreprises.

Les activités dans le domaine de l'éducation, de la culture, de la santé publique se sont developpées rapidement. A présent, le nombre de ceux qui ont fait des études couvre le quart de la population totale, l'analphabétisme est éliminé fondamentalement dans dix des treize provinces. C'est là une chose inhabituelle dans l'histoire du Laos. Comparé à celui d'avant la libération, le nombre d'élèves dans le primaire, a doublé, celui du secondaire premier cycle a augmenté de 6 fois, celui du secondaire deuxième cycle plus de 10 fois. En outre, on compte par dizaines de milliers le nombre d'étudiants en cours d'études dans les universités et les écoles professionnelles tant dans le pays qu'à l'étranger. (Voir tableau (a)).

Tableau (a) – Effectifs des élèves dans l'enseignement général en 1980

1. *Effectif total :*	558 216
dont :	
niveau primaire	479 291
niveau secondaire (1er cycle)	63 982
niveau secondaire (2ème cycle)	14 943
2. *Effectif total en 1ère année*	
de niveau primaire	86 458
de niveau secondaire (1er cycle)	21 145
de niveau secondaire (2ème cycle)	5 908
3. *Effectif total des élèves ayant terminé*	
le niveau primaire	35 647
le niveau secondaire (1er cycle)	11 705
le niveau secondaire (2ème cycle)	2 813

La protection de la santé de la population fait l'objet d'une attention particulière du gouvernement. Nombre de maladies dangereuses sont en voie de diminution. La pratique des "trois principes de base de la propreté" fait partie du mouvement populaire. Jusqu'à ce jour il y a 26 hôpitaux centraux et provinciaux, 100 hôpitaux de Muong (district), près de 600 dispensaires de Tassèng (sous-districts).

L'économie de la RDPL est caractérisée, d'un côté, par la présence d'un potentiel en ressources naturelles considérables (cuivre, étain, manganèse, fer, charbon, potasse, énergie hydroélectrique, bois...) et d'un autre côté, des contraintes énormes (obstruction et sabotage de l'ennemi, enclavement et étendue du pays, densité de population faible, absence d'infrastructure, de main d'oeuvre qualifiée et de cadres techniques, etc.).

Les tâches de développement du pays s'avèrent extrêmement difficiles et nécessitent des investissements importants qui dépassent la capacité actuelle du pays. Néanmoins, avec la juste option pour la voie du socialisme et avec l'aide bienveillante de la communauté internationale, le peuple lao peut parvenir rapidement à un développement harmonieux de son pays.

PARTIE 2.

Cadre des politiques scientifiques et technologiques

2.1 CADRE DES POLITIQUES DE DÉVELOPPEMENT

Après la proclamation de la RDPL en Décembre 1975, le Parti Populaire Révolutionnaire Lao a défini les grandes lignes politiques visant la création d'une société socialiste au Laos. Les objectifs économiques sont de jeter les bases d'une économie nationale indépendante et d'améliorer les conditions de vie du peuple.

Pour atteindre ces objectifs il fallut mener de front les trois révolutions : révolution des rapports de production, révolution scientifique et technique, révolution culturelle et idéologique. La révolution des rapports de production ouvre la voie, la révolution scientifique et technique est la clé principale et la révolution culturelle et idéologique doit être d'un pas en avance sur les autres.

Concrètement il faut transformer les moyens de production en propriétés collectives et de l'État, développer l'agriculture, la sylviculture et l'industrie ; le développement de l'agriculture et de la sylviculture doit servir de base au développement de l'industrie pour progresser pas à pas vers la grande industrie. En d'autres termes, les ressources agricoles et sylvicoles doivent être développées en priorité pour permettre d'atteindre les objectifs aussi bien de résoudre l'auto-suffisance alimentaire que de servir de base au développement industriel.

Le bilan de la situation en 1980 se traduit par le revenu national (produits intérieurs bruts) atteignant 113,5 $E.U. par habitant, dont 83,7% provenant de l'agriculture et 6,8% de l'industrie (10 kip/$E.U.).

Pour la même année, les échanges et le commerce extérieur suivants ont été enregistrés :

Exportations : $E.U. 18, 11 millions;
Importations : $E.U. 41, 97 millions.

Les principaux programmes envisagés pour les cinq ans à venir (1er plan quinquennal, 8ème résolution du Comité central du Parti) sont :

- éliminer l'économie naturelle arriérée du pays ;
- accélérer le développement de la production ;
- poursuivre le changement social dans la voie du progrès et rehausser le niveau de vie du peuple ;
- assurer la capacité de défense du pays ;
- utiliser efficacement des moyens techniques, de la main d'œuvre et des moyens financiers ;
- élargir le fondement de la production des biens matériels.

Les objectifs visés doivent permettre d'atteindre la croissance suivante en 1985 (comparée au niveau de 1980) :

40% en PIB;
24% en production agricole;
200% en production industrielle;
40% en main d'œuvre qualifiée;

mais ils doivent avant tout permettre de régler les problèmes les plus urgents de l'existence quotidienne du peuple et de créer des bases pour l'industrialisation progressive du pays.

Procédure de planification

L'économie de la RDPL est de modèle socialiste. Elle doit être actionnée par une planification centralisée. L'élaboration du 1er Plan quinquennal (1981-1985) tient compte d'une part des besoins et exigences aux niveaux national et régional, et d'autre part des moyens et ressources disponibles et prévisibles tant intérieurs qu'extérieurs.

Le processus d'élaboration du plan a trois niveaux. Le district qui est le niveau le plus bas ayant un service du plan, établit les plans de développement à l'échelle locale où l'État (autorité locale) ne joue qu'un rôle d'assistance à la population et de contrôle. Au niveau régional, chaque province possède un service du plan chargé de centraliser les plans émanant des districts et formuler les plans de développement régional englobant aussi bien l'économie rurale que l'économie étatique, celle-ci relevant directement de la compétence des autorités provinciales.

Au niveau central, le comité national du plan centralise les plans de différentes régions et ministères, ces derniers étant responsables des grands domaines économiques du gouvernement central, et élabore le plan national de développement à soumettre à la décision du conseil des ministres.

2.2 POLITIQUE DE DÉVELOPPEMENT ET POLITIQUE SCIENTIFIQUE ET TECHNOLOGIQUE

Le programme de développement pour les cinq années à venir met implicitement l'accent sur la nécessité d'augmenter les moyens technologiques ainsi que la nécessité d'avoir la maîtrise technique de l'opération de ces moyens.

Au stade actuel de développement au Laos, cela signifie qu'il faille recourir aux technologies importées et s'organiser en conséquence pour en assurer la bonne utilisation. La politique scientifique et technologique de la RPDL est pour ainsi dire intimement liée aux buts et objectifs de développement. Les activités scientifiques et techniques sont organisées pour parvenir à ces buts et objectifs qui, à long terme, doivent conduire au renforcement du potentiel scientifique et technologique, à la maîtrise graduelle des sciences, des techniques et technologies, à l'indépendance nationale.

2.3 MÉCANISME D'ÉLABORATION DES POLITIQUES SCIENTIFIQUES ET TECHNOLOGIQUES

Les activités scientifiques et technologiques sont organisées pour parvenir aux buts et objectifs de développement. Cela suppose en premier lieu, que chaque unité de base, plus particulièrement unité de production, doive, sur le plan matériel, comporter des sections d'étude d'entretien des équipements et de développement de ses activités et, sur le plan humain, entreprendre une formation permanente de la qualification technique. En deuxième lieu cela suppose qu'au niveau régional et national des efforts soient entrepris pour la création des centres scientifiques et technologiques, de recherche et de formation.

Après cinq années d'existence la RPDL s'est efforcée de s'organiser dans ce sens et lorsque les conditions favorables sont réunies, des sections techniques, de grands ateliers, des centres scientifiques sont créés.

Les sections techniques, les centres de recherche nationaux et régionaux sont à la base du mécanisme d'élaboration des politiques scientifiques et technologiques. Les formulations des politiques émanant de la base sont centralisées aux ministères intéressés où les directions spécifiques se sont constituées en unités d'études et de recherches. Après ce stade d'élaboration, les politiques scientifiques s'intègrent dans le processus d'établissement même du plan national de développement.

Ce qui vient d'être décrit ses rapporte aux faits du passé. A partir de 1981, les activités scientifiques et technologiques auront des dimensions nouvelles. Un comité d'État des sciences et techniques vient d'être créé à cet effet. Il a pour mission de donner l'impulsion et gérer le développement scientifique et technologique. Ce comité fera la charnière entre la base, à savoir les différents centres scientifiques et ministères d'une part, et le Comité national du Plan d'autre part, de telle sorte que l'ensemble ainsi constitué formera un vaste système de recherches et d'actions scientifiques et technologiques du niveau central jusqu'à la base dont le Comité d'État des Sciences et Techniques sera le centre moteur.

Le Comité d'État des Sciences et Techniques aura en outre à développer et gérer un centre national de documentation scientifique et technique et aura des membres permanents et non permanents choisis parmi les scientifiques et les ingénieurs en poste dans différents départements.

PARTIE 3.

Potentiel scientifique et technique

3.1 RÉSEAU INSTITUTIONNEL

Les activités scientifiques et technologiques ont connu un appréciable développement pendant ces dernières années, sutout dans le secteur de l'agriculture et de la sylviculture.

Dans ce secteur, une dizaine de bases de recherche et d'expérimentation des espèces tant animales que végétales ont été installées, ainsi que des services scientifiques et techniques indispensables au développement de l'agriculture tels que les services d'analyse des sols de culture, d'étude des systèmes d'irrigation, d'inventaire et de prospection des forêts, de diagnostic vétérinaire etc... Des centres de formation technique agricole ont été créés et élargis un peu partout.

Dans le secteur de la santé publique, les activités de recherches médicales classiques, de médecine traditionnelle et d'épidémiologie se développent peu à peu.

Par ailleurs il existe des activités scientifiques et techniques relevant du Service national de géodésie et de cartographie, et du Laboratoire géologique de la Direction des mines. Il faut citer au Ministère de l'éducation, du sport et des cultes se rapportant aux recherches et élaboration des programmes, des manuels scolaires adaptés à l'éducation socialiste ainsi qu'aux nouvelles terminologies scientifiques en langue lao.

Dans le domaine de l'Enseignement et formation scientifique et technique, le Laos possède actuellement deux établissements d'enseignement supérieur :

- l'Université des sciences médicales comprenant les facultés de médecine, de pharmacie et dentaire ;
- l'Université des sciences et pédagogie comportant la faculté des science exactes et naturelles et la Faculté des sciences sociales avec une section de langues étrangères.

3.2 RESSOURCES HUMAINES

Pleinement conscient de la nécessité de créer l'homme nouveau, l'homme socialiste, l'État a fixé une nouvelle ligne politique éducative et a clairement déterminé les conceptions de base selon lesquelles l'organisation des écoles doit être systématique et complète, comportant à la fois les crèches, les écoles maternelles, les écoles d'enseignement général, les écoles professionnelles et les universités.

Conformément à cette politique, l'organisation des écoles techniques et professionnelles (pour ne parler que du secteur prioritaire) et les programmes et plans d'études ont été renforcés et améliorés graduellement, un équilibre entre les cours généraux, des cours techniques généraux et les travaux pratiques en atelier ou sur le terrain a été recherché et s'établit actuellement au niveau suivant :

Cours généraux : 20 % au 1er cycle ;
25 % au 2ème cycle.

Cours techniques généraux : 20 % au 1er cycle ;
40 % au 2ème cycle.

Travaux pratiques : 60 % au 1er cycle ;
35 % au 2ème cycle.

Sur le plan quantitatif, le nombre d'élèves des écoles professionnelles et techniques à l'intérieur du pays est passé à 11 500 en 1980, soit une augmentation de 42 % par rapport à 1978. Pour cette même période, le nombre de jeunes Lao inscrits dans les écoles techniques et professionnelles des pays socialistes a progressé de 550 (150 dans les écoles professionnelles et 400 dans les technicums) à 2 160 dont 1 040 dans les écoles professionnelles et 1 120 dans les technicums. Actuellement le Laos possède 20 écoles techniques et professionnelles de 2ème cycle et 24 écoles techniques et professionnelles de 1er cycle.

Tableau (b) – La Formation des Cadres en 1980

1. *Enseignement supérieur :*	
nombre d'instituts	2
effectif total d'étudiants en 1ère année	715
effectif total d'étudiants ayant terminé leurs études	246
effectif d'étudiants en début d'année	1 860
2. *Enseignement socio-professionnel :*	
nombre d'écoles	24
effectif total des inscrits en 1ère année	3 521
effectif des élèves ayant terminé leurs études	2 154
effectif des élèves en début d'année	7 809
3. *Formation d'ouvriers qualifiés :*	
nombre d'écoles	40
effectif total des inscrits en 1ère année	2 788
effectif total des élèves ayant terminé leurs études	2 044
effectif des élèves en début d'année	6 103
4. *Formation des cadres à l'étranger :*	
effectif total :	1 771
dont :	
pour la recherche :	7
dans les instituts :	780
cadres moyens :	567
ouvriers qualifiés :	417

Pour les années à venir, la politique des trois révolutions doit être menée avec les ardeurs encore plus grandes et sur le plan de la préparation des ressources humaines, de l'éducation nationale, en général, les objectifs du 1er Plan quinquennal 1981-1985 doivent permettre d'atteindre en 1985 les augmentations suivantes, par rapport à 1980.

- nombre d'employés et ouvriers spécialisés pour la production, 40 à 45 % ;
- nombre d'élèves inscrits dans l'enseignement général, 40,3 % (592 650 en 1980) ;
- nombre d'étudiants dans l'enseignement supérieur, 26,3 % (620 en 1980, à l'intérieur du pays) ;
- nombre d'élèves inscrits dans les établissements professionnels et techniques 1er cycle, 59,4 % (5 640 en 1980) ;
- nombre d'élèves inscrits dans les établissements professionnels et techniques, 2ème cycle, 74,3 % (5 520 en 1980) ;
- nombre d'enfants inscrits dans les écoles maternelles, 400 % (5 190 en 1980) ;
- nombre d'élèves envoyés à l'étranger, 20 % (2 160 en 1980).

3.3 RESSOURCES FINANCIÈRES

Les activités scientifiques et techniques en RPDL s'intégrent dans l'ensemble des activités économiques et sociales du pays et il existe un lien étroit entre les projets de développement scientifique et technique des ministères et des entreprises qui ressortent dans le plan d'État.

C'est pourquoi, d'une manière générale, les dépenses consacrées aux activités scientifiques et techniques sont financées par le budget de l'État. Cependant, les grandes entreprises de production étatique ou collective, de par leur statut, sont autogérées et peuvent prélever une part importante de fonds pour leur recherche-dévelopement.

Les sources du budget de l'État sont doubles, intérieures et extérieures. Dans la situation actuelle du Laos, les sources extérieures sont les plus importantes car elles concernent le financement des infrastructures et des équipements technologiques apportés.

Pour les années à venir (objectifs du 1er Plan quinquennal), un certain nombre de mesures ont été prises pour élever l'efficacité de la politique de mobilisation de ressources nationales, à savoir : établissement des régimes de taxes équitables, extension du réseau des établissements d'épargne pour faciliter l'accès du large public, formation intensive de cadres pour les établissements financiers.

En ce qui concerne les activités scientifiques et technologiques, l'ultime objectif financier des prochaines années est de renforcer les dépenses y afférentes et de doter un Fonds spécial de recherche et de développement qui sera géré par le Comité d'État des Sciences et des Techniques.

Malgré toutes ces mesures, la RDPL aura besoin pour les raisons que l'on sait, de l'assistance extérieure plus importante.

PARTIE 4.

Politiques du développement scientifique et technique

L'émergence de la RDPL comme État banni du colonialisme, néocolonialisme et du régime bourgeois féodal est un évènement historique pour le Laos. Elle lui ouvre une ère nouvelle d'édification nationale harmonieuse fondée sur l'équité sociale, l'utilisation rationnelle des ressources matérielles du pays afin d'améliorer les conditions de vie du peuple dans son ensemble, d'acquérir une base scientifique, technique et technologique pour promouvoir un développement autonome, acquérir une indépendance nationale et sauvegarder son identité culturelle et sa souveraineté. Pour parvenir aux buts fixés, l'objectif de la politique vise avant tout la productivité du travail.

Dans le cas d'un pays sous-développé, comme la RDPL et parallèlement aux efforts à consacrer au développement de l'éducation idéologique et culturelle scientifique et technologique et de la santé publique, les tâches primordiales du programme politique scientifique et technique consistent à appliquer judicieusement les sciences et techniques, les technologies importées.

Il s'agit là des problèmes qui sont au centre même de la politique économique et sociale du gouvernement de la RDPL fondée sur les principes qui permettent le développement sur la base de la mobilisation des ressources nationales et de la relation internationale basée sur la non-ingérence dans les affaires intérieures, le respect de l'indépendance nationale, les relations de bonne amitié et du respect des intérêts réciproques avec tous les pays sans distinction de systèmes politiques et idéologiques différents.

Dans le cadre de cette politique de coopération avec l'étranger, la RDPL a l'avantage d'avoir à pratiquer la politique de concertation et de coopération avec la R.S. du Viet Nam et la R.P. du Kampuchéa, de recevoir l'aide et la coopération bilatérale des pays socialistes plus particulièrement de l'URSS. D'autres pays amis ainsi que des organisations internationales lui ont apporté une très appréciable assistance.

La RDPL aura besoin, pour diverses raisons de la coopération internationale plus importante. L'établissement du 1er Plan quinquennal 1981-1985 mise en effet sur un apport accru des ressources extérieures dont elle espère bénéficier.

MALAYSIA

Table of Contents

MALAYSIA

GEOGRAPHY

Capital city: Kuala Lumpur
Main ports: Sandakan, Miri, Port of Klang
Land surface area: 329, 749 sq km

POPULATION (1978)

Total	13.0 million
Density (per sq km)	39
Urban/rural ratio (1970)	0.4
Average rate of growth (1970-78)	2.8% p.a.

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	41.2	11.7	9.8	31.7	5.5	100%

SOCIO-ECONOMIC

Labour force (1975)	
Total	3.8 million[1]
Percentage in agriculture (1970)	42.7%
Gross national product (1978)	
GNP at market prices	US $15,270 million
GNP per capita	US $ 1,180
Real growth rate of GNP per capita (1970-78)	4.8%
Gross domestic product (1977)	
Total (in current producers' values)	US $13,112 million
Percentage by origin	
Agriculture	...
Manufacturing, mining & quarrying, electricity, gas & water, construction	...
Government finance	
National budget (1978)	US $3,822 million
As percentage of GNP	25.2%
External assistance (official, net; 1976)	US $155 million
As percentage of GNP	1.5%
Exports (1978)	
Total exports of goods	US $7,413 million
Average annual growth rate (1970-78)	5.2%
External debt (1978)	
Total public, outstanding + disbursed	US $2,671 million
Debt service ratio (% GNP)	4.6
(% Exports of goods and non-factor services)	8.8

Exchange rate (1978): US $1 = 2.31 Ringgit

EDUCATION

Primary and secondary education (1978)[1]	
Enrolment, first level	1,637,143
As % of (6-11 years)	94%
Enrolment, second level	905,234
As % of (12-18 years)	51%
Combined enrolment ratio (6-18 years)	72%
Average annual enrolment increase (1970-1978)	3.2%

---

[1] Data refer to Peninsular Malaysia

Higher education (third level) (1978)[1]

Teaching staff, total 3,960

Students and graduates by broad fields of study:

	Enrolment	Graduates
Social sciences and humanities	17,148	8,118
Natural sciences	9,550	298
Engineering	7,780	1,065
Medical sciences	1,835	185
Agriculture	1,736	1,323
Other and not specified	313	21
Total	**37,862**	**11,010**

Number of students studying abroad .... 22,324[2]

Education public expenditure (1977)[1]

Total (thousands of Ringgit)	1,742,489
As % of GNP	...
Current, as % of total	90.2%
Current expenditure for third level education, as % of total current expenditure	15.8%

---

[1] Data refer to Peninsular Malaysia

[2] Data refer to Malaysia

Table 1. Nomenclature and Networking of S&T Organizations

(Data unavailable at time of publication)

I - First level - POLICY-MAKING

Country: Malaysia

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
....	....	....	....	....

II - Second level - PROMOTION & FINANCING

Organization	Linkages		
	Upstream	Downstream	Others
....	....	....	....

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages	
		Upstream	Others
....	....	....	....

Table 2 - Scientific and Technological Manpower

Country: Malaysia

Year	Population (millions)	Scientists and engineers							Technicians	
		Total number (in units)	Breakdown by field of educational training (in units)						Total stock (in units)	of which working in R&D
			Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences			
1965										
1970										
1973	11,455 (a)	217,041	8,214	25,156	1,429	24,945	157,297		505.0	
1980	14,261 (b)	340,520	13,980	40,720	2,530	40,390	242,900		935.5	
1985	16,180	419,130	18,150	53,570	3,050	49,120	295,240		1,227.1	
1990	18,143	522,774	23,656	70,989	3,680	66,049	358,400		1,582.4	

(a) The 1973 population figure was estimated as at December, 1973.
Its source is from the 'Vital Statistics' - Peninsular Malaysia, Sabah and Sarawak, 1976.

(b) The source for the 1980, 1985 and 1990 population figures is the Fourth Malaysia Plan, 1981-85, p. 218.

Table 3 - R&D expenditures

(Data unavailable at time of publication)

Country: Malaysia
Currency:

Table 3a: Breakdown by source and sector of performance

Year:

Unit:

Source Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive				
Higher Education				
General Service				
Total				

Table 3b: Trends

Year	Population (millions)	GNP (in)	Total R&D expenditures (in)	Exchange rate US $1 =
1965				
1970				
1975				
1979				
1985				
1990				

PART 1.

General features

1.1 GEOPOLITICAL SETTING

Geography

Malaysia comprises thirteen States which formed the Federation of Malaysia namely Perlis, Kedah, Kelantan, Trengganu, Pulau Pinang, Perak, Pahang, Selangor, Negeri Sembilan, Melaka, Johore, Sabah and Sarawak. It lies within the tropics between latitude 7.5° and 7° north, extending from longitude 100° to 119.5° east. Peninsular Malaysia, consisting of 11 states is bordered on the north by Thailand, and on the south accross the Straits of Johore by Singapore. To the west, across the narrow Straits of Melaka, is Sumatra and to the east is the South China Sea. The States of Sabah and Sarawak have a common border with Indonesia's Kalimantan. The capital city, which is also the main city, is Kuala Lumpur which was declared a federal territory in 1974.

The total area of Malaysia is approximately 332 952 square kilometres with Peninsular Malaysia covering an area of 131 870 square kilometres, Sarawak 124 968 square kilometres, and Sabah 76 115 square kilometres. Peninsular Malaysia extends 740 kilometres in length from the northern tip of the State of Perlis to the southern Straits of Johore, while the greatest length of Sabah and Sarawak from Tanjong Datu in Sarawak to Hog point on Dent Peninsular in Sabah is 1 207 kilometres. The maximum width, on the other hand, is 483 kilometres in Peninsular Malaysia (the distance between Dinding in West Perak to Tanjung Penunjok in East Trengganu). In Sabah and Sarawak the maximum width is about 257 kilometres.

Population

Malaysia is a multi-racial country with a population of 13 435 588 in 1980. On this total about 11 138 227 were in Peninsular Malaysia, 1 002 608 in Sabah, and 1 294 753 in Sarawak. The population density is about 40 persons per square kilometre, and the rate rf population growth is 3% per annum. About 39%, of the total population live in towns of 1 000 inhabitants or more. On account of the good existing infrastructure of public roads, railways and communications there is easy access between the rural and urban areas.

Climate

Proximity to the equator has given Malaysia a climate of high humidity and uniformly high temperatures with copious rainfall. The equatorial climate is modified by the region's insularity and its exposure to monsoonal wind systems that originate from the Indian Ocean and the South China Sea. The climate on the whole is pleasant and equable with bearable humidity.

The Malaysian seasons of heavy rainfall are caused by the North-East Monsoon which is from May to August. These seasons occur slightly earlier in Peninsular Malaysia than in Sabah and Sarawak. Two inter-monsoon periods, each of about eight weeks' duration, are distinguishable. There are no prevailing winds during the intermediate seasons but daily conventional rain.

The average annual rainfall is about 250 cm but this varies from place to place. The East Coast of Peninsular Malaysia has an average annual rainfall of 305 cm whereas Maxwell Hill (a popular tourist resort near Taiping) receives an annual rainfall of 510 cm. Jelebu district, Malaysia's driest region receives only about 165 cm of rainfall per year. A large area of Sarawak has an average annual rainfall of 305 cm to 406 cm whereas, in Sabah, the average annual rainfall is between 152 cm and 406 cm.

Temperatures are fairly constant throughout the year, ranging from a mean daytime maximum temperature of 29.15°C to 32.9°C and a mean minimum temperature of 22°C to 23.7°C at night. The average monthly temperature varies around 2.2°C. However the daily temperatures show great variation (daily range at coastal locations being 5.5°C to 8.3°C). In Sabah and Sarawak night temperatures in interior highlands of over 610 metres may drop as low as 12.7°C. Malaysia as a whole has an average daily temperature that varies from 20.9°C in the highland areas to 31.9°C in the lowland and coastal areas.

Vegetation

The vegetation is tropical rainforest in a number of forms, depending upon such factors as elevation, soil, moisture and drainage. These factors give rise to three general groups of forest communities. The first includes those conditioned and perhaps controlled by edaphic features. These comprise vegetation on the beaches, in mangrove and peat swamps, in semi-swamps and in riverine-fringing forest, as well as forest and swamp vegetation of limestone and quarzite outcrops. The second group consists of the vegetation communities of the lowland, hill and montane regions including lowland, hill and upper depterocarp forest, the montane oak forest, and the montane ericaceous communities. The first category of this second group extensively comprises the forests of the plains and foothills up to a height of 305 metres. It is dominated by immense trees, the largest of which are 46 metres to 61 metres or more in height with large cylindrical trunks of 3 metres or more circumference and massive crowns at the top forming an evergreen canopy. These trees yield the bulk of the commercial timber. Some of these species of trees found in Malaysia's forest are meranti, keruing, kempas, merbau, kapur, jelutong and nyatoh. About 94% of the total timber exported from Malaysia is from such species of timber.

The hill and upper dipterocarp forests lie between a height of 305 feet to 1 220 feet. The montane oak forests lying between a height of 1 220 feet to 10 524 feet are of little commercial value, while the montane ericaceous communities of over 10 524 feet have only protective and aesthetic value. Parasitical vegetation is also to be found within the Malaysian forests, though not in the abundance that is usually assumed. The few species that are to be found include members of the mistletoe family and a species of rafflesia in Sarawak which produces the largest flowers in the world and may measure up to a metre across.

Water Resources

Due to the abundant rainfall throughout the year the Malaysian rivers are well filled and are a potential source of energy. In Peninsular Malaysia the main mountain range lies approximately parallel to the west coast forming a continuous watershed from the border of Thailand to Melaka. Most of the rivers to the west of the watershed thus have comparatively short courses. Gradients in the upper reaches of the rivers are steep and with the abundant rainfall these serve as excellent sources of energy.

Fisheries

Malaysia's fishing potential from its 1 122 300 square kilometres of coastal waters is currently estimated at between 1 060 000 to 1 118 000 tonnes per annum. In 1977, there were 75 645 fishermen in Peninsular Malaysia operating a total of 24 080 fishing boats. Malaysian fishermen employ a variety of fishing techniques, ranging from efficient gear-like purse seines and trawler nets to simple traditional fishing techniques. The majority of fishermen still confine their fishing activity to the shallower waters near the coast. The bulk of fish landed in Malaysia is marketed in a wet form without dressing and is for local consumption. The balance is processed into products such as salted fish, dried prawns, budu (fermented anchovy), cincalok (fermented shrimp), belacan (shrimp paste), keropok (craker) and fish meal. A frozen seafood industry has been established in Malaysia and one of the main exports is frozen shrimp. The establishment of aquaculture projects has become increasingly important in providing a much needed protein diet for the nation. It is estimated that some 30 000 tonnes of fish are obtained annually from inland waters and aquaculture in Peninsular Malaysia.

Mineral Resources

The major minerals mined in Malaysia are tin, bauxite, iron ore and copper concentrates. Of less importance are china clay, gold, wolfram, manganese, ferro manganese, barite as well as by-product minerals such as ilmenite, monazite, zircon and thorium.

Malaysia is the largest producer of tin in the world and currently 80 500 persons are being employed in this industry. Gravel pump mining accounted for about 54%, and dredging 32% of the total production, while other methods such as panning (dulang washing) accounted for the balance. The major tin fields are found in the states of Perak and Selangor, lying close to the western limit of the main Range. Smaller tin fields are found in Perlis, Kedah, Negeri Sembilan, Melaka, Johore, Pahang and Trengganu. The major lode deposit being mined is at Sungei Lembing, Pahang. Offshore tin deposits are attracting interest and the National Corporation (Pte) Limited is currently prospecting for tin in the Melaka Straits.

The most notable development in the natural resources industry is the tremendous increase in petroleum production in Sabah and Sarawak. Prospects for the petroleum industry appear to be very encouraging as several oil companies have commited sizeable funds for oil exploration activities off the coasts of Sabah and Sarawak. Similar explorations off the east coast of Peninsular Malaysia have also been started. Another promising mineral in production is copper. The Mamut Copper Mine in Sabah commenced production in May 1975.

Transport

The main trunk road in Malaysia runs from the border of Thailand in the North to Singapore in the South. Another main road links the west to the east coast of Peninsular Malaysia. A new east-west highway project linking Kota Bahru in East Peninsular Malaysia to Pulau Pinang in the west is nearing completion and is expected to facilitate more effective and efficient communication across the northern part of Peninsular Malaysia. In Sabah and Sarawak there is an estimated 4 500 kilometres of metal-surfaced road, of which 2 834 kilometres in Sabah and 1 666 kilometres in Sarawak. The basic infrastructure consists of roads providing linkages between major population centres along the coast. In Sarawak the major trunk road links the towns of Kuching and Sibu.

The Malayan Railway comprises approximately 2 155 kilometres of railway track of which 1 666 is route kilometres. The main railway line links Kuala Lumpur, the capital of Malaysia, to the Republic of Singapore in the south (398 kilometres). It also serves the Port of Singapore and Jurong. From Kuala Lumpur the railway runs north to Butterworth and Prai a distance of about 393 kilometres. Butterworth and Prai are ports on the mainland opposite the Island of Pulang Pinang and the railway serves the wharves and port facilities there. To the east there is a branch of the railway line running from Gemas which is 178 miles from Kuala Lumpur towards the east coast town of Aumpat which is 528 kilometres away. There are also three other branch lines from the main line, which connect the three ports of Port Kelang, Port Dickson and Telok Anson.

There are three main ports in Peninsular Malaysia. Pulau Pinang is located in the north, Port Kelang is centrally located, and Johore Port is located at the southern tip of the peninsular, northwest of Singapore Island. Another port which is located on the east coast, called the Kuantan Port, has been completed but has yet to be commissioned.

Kuala Lumpur International Airport and the expanding Pulau Pinang Airport are gateways for travellers on international flights. At present 20 international airlines operate through Kuala Lumpur providing connections to various points in the world. Most towns have their own domestic airports which are linked to the Federal Capital.

Federal Government

The Malaysian Parliamentary system consists of the Head of State (Yang Di Pertuan Agong), and two Houses of Parliament known as the Senate (Dewan Negara) and the House of Representatives (Dewan Rakyat).

The Yang Di Partuan Agong is elected to hold office for a period of five years from among the nine hereditary Malay Rulers of nine States: Perlis, Kedah, Kelantan, Trengganu, Perak, Selangor, Pahang, Negeri Sembilan and Johore. The Timbalan Yang Di Pertuan Agong (Deputy Supreme Head of State) is also elected in a similar manner. The Senate consists of 58 members, of whom two are elected by the Legislative Assembly of each State, and 32 appointed by the Yang Di Pertuan Agong. The term of office of members of the Senate is six years and this is not affected by the dissolution of Parliament. The House of Representatives consists of 154 members of whom 114 are from the Peninsula of Malaysia, 16 from Sabah and 24 from Sarawak. The members from Peninsular Malaysia are directly elected by the people while those from Sabah and Sarawak are elected indirectly by Legislative Assemblies of the States though, ultimately, they will also be directly elected. The maximum term in the House of Representatives is five years. In the process of legislation, bills have to be passed by both Houses and assented to by the Wang Di Pertuan Agong.

The Yang Di Pertuan Agong appoints as Prime Minister a members of that House. On the advice of the Prime Minister, he ment, is likely to command the confidence of a majority of the members of that House. On the advice of the Prime Yinister, he also appoints other Ministers from among the other members of either House of Parliament. Every member of the cabinet has the right to take part in the proceedings of either House of Parliament but may not vote in the House of wich he is not a member.

Governments of the States

Each state has its own constitution which must be compatible with the constitution of the Federal Government. The constitutions of all the states are similar, except for Sabah and Sarawak. There are certain differences in nomenclature of these two states and these are mentioned in the articles of their constitutions.

There is a Head of State in each state. In nine of the states of Malaysia, the Head of State is a Malay Ruler. In the other states the Head of State is appointed by the Yang Di Pertuan Agong and is known as Yang Di Pertua Negeri. The executive authority in a state is vested in the Head of State and he is advised by an Executive Council (cabinet in Sabah and Supreme Council in Sarawak) in the exercise of his functions: The Executive Council is headed by a Chief Minister (Menteri Besar) who is a member of the State Legislative Assembly and who is likely also to command the confidence of a majority of the members of the Assembly.

1.2 ECONOMIC SETTING

Malaysia has shown an impressive economic growth since its formation in 1963. For the last ten years, from 1971 to 1980, the Malaysian economy recorded a growth rate of 7.8% per annum. This resulted in an increase in per capita Gross National Product (GNP) from M$3 200 in 1979 to M$3 600 in 1980. This also resulted in a decline in the unemployment rate from 7.8% in 1979 to only 5.3% in 1980.

This overall growth resulted in major structural changes in the various sectors in the economy. Basically the four main sectors that contribute to the GNP are the agriculture sector, the mining sector, the manufacturing sector and the service sector. The relatively faster rates of growth of the non-agricultural sectors led to a decline in the share of the agricultural sector in total GDP from 30.8% in 1970 to 22.2% in 1980, though its contribution to total export earnings in that same year was 44%. A major part of this agricultural export earnings was from rubber which accounted for 16.6%, palm oil 9.3%, sawn logs 9.2% and sawn timber 4.8%. The remaining 5.1% comprised earnings from palm kernel oil, fish, pepper, coconut oil, cocoa and others. In terms of employment, this sector accounts for 40.6% of total employment.

The mining sector is another important sector in the economy, even though its contribution to the total GDP has been declining lately. However during the last decade there were significant developments in this sector due to the emergence of petroleum as a major export commodity. The increase in crude oil production, coupled with rising prices, has pushed up the share of crude oil in this sector which increased from 29% in 1970 to about 63% in 1980.

The manufacturing sector is the leading sector in the economy. It provides the main stimulus to modern sectoral growth which, in turn, plays an important role in the achievement of the two-pronged objective of the New Economic Policy (NEP), as elaborated in Part 2. The overal manufacturing output has been growing at a rate of 12.5% annually during 1979 and 1980. Exports of manufactured goods in 1980 amounted to M$5 935 million or 21.1% of the total export earnings. The most important manufacturing industry, the electrical machinery and appliances industry, contributed 47.0% of the total export earnings of this sector in 1980. In addition to this, the resource-based industries and intermediate goods industries have grown in importance.

The nature of goods imported into Malaysia indicates the emphasis given to developing manufacturing industries and modernising the agriculture sector. In 1980, for instance, 27.6% of the total imports were intermediate goods while 10.3% were machinery. However looking at classification by end use, intermediate goods form the bulk of Malaysia's overall imports, while in 1980 they formed 48.2% compared to 30.5% for investment goods and 19.6% for consumption goods. About 70% of our total imports are from Japan, the United States, the European Economic Community (EEC) and the Association of South East Asian Nations (ASEAN).

A good export performance, in terms of volume as well as prices, during the 1971 to 1980 period resulted in a trade surplus of M$ 26 042 million. This, however, was offset by the deficit in the services account due mainly to the repatriation of investment income and due, also, to the increase in freight and insurance charges. With the maintenance of a favourable investment climate in Malaysia there is an increasing inflow of foreign investment, resulting in an overall balance of M$ 7 343 million and an accumulation of external reserves of M$ 10 304 million at the end of 1980.

1.3 DEVELOPMENT SCENE

Political stability is an essential ingredient for the continual growth of the Malaysian economy. This stability provides a necessary foundation for the acceleration of investment and for economic activities. In addition to this, the Malaysian Government is committed to maintaining a favourable investment climate to encourage local and foreign investment that is consistent with national objectives. Presently, private sector investment accounts for about 60% of total investment in the economy. In addition to this, institutional information networks and forums have been established to provide the necessary feedback information from the people so that they can participate in the national development process. There is also strong cooperation between public and private sectors and frequent consultations are held with the private sector on matters affecting private sector investment. The government, in addition to expanding the productive capacity of the economy, has also placed considerable emphasis on improving the general well-being and quality of life of the people, such as by the improvement of the environment, by providing better housing facilities to the low income-earners, as well as by improvements in health and educational facilities.

Achievement of the objectives of the New Economic Policy (NEP) is expected to derive from the rapid growth of the economy. Investment, especially from the private sector, is encouraged through fiscal and monetary policies, improved infrastructural facilities, and various administrative measures. Development efforts in Malaysia also include social development which is geared toward the improvement of the quality of life of the people. During the implementation of the Fourth Malaysia Plan period, about 16.2% of the Federal Development Expenditure will be spent on improvement of, and development of, educational, health, cultural and social programmes.

The success of the development efforts outlined above depends on how well the country can implement the plans and reduce the effect of recessionary tendencies in the major industrial countries. One of several factors that will give rise to implementation problems will be the lack of trained manpower, especially in science and technology. Furthermore, the uncertainty in the world economy has resulted in fluctuating commodity prices and protectionist attitudes by the Western markets. These, together with the worsening of the inflationary situation, will be among the problems faced by the country in achieving the two-pronged objectives of the New Economic Policy.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

Malaysia's socio-economic development is based on the New Economic Policy (NEP). The overriding objective of the NEP, adopted in 1971, is to achieve national unity through a two-pronged development strategy of first, reducing and eventually eradicating poverty by increasing the level of income and employment opportunities for all Malaysian irrespective of race, and, second, of accelerating the process of restructuring society to correct economic imbalances so as to reduce and eventually eliminate the identification of race with economic functions.

The NEP represents a new approach in dealing with economic and social problems by emphasizing the importance of achieving a better distribution of income, wealth and employment among the various ethnic groups and regions in the country within the context of an expanding economy. In 1970, about 49.3% of the households were poor. The incidence of poverty was higher in the rural areas and the problem was predominantly that of the Malays and other indigenous people. Also, there were wide imbalances in income among the races, mainly due to differences in the degree of participation in the productive sectors of the economy, in employment, and ownership of assets.

The thrust of development policy in Malaysia that underlies all development plans is to narrow the socio-economic differences so that the benefits of development are shared equitably by all groups in society and, through this process, attain national unity. In the attainment of the NEP, a major role is expected from the private sector, and investment by this sector which is consistent with the national goals is given encouragement through appropriate fiscal and monetary policies.

The NEP objectives are to be achieved within a span of two decades, i. e. 1971-1990, and for this purpose an Outline Perspective Plan (OPP) was formulated. The period 1981-1990 constitutes the second decade in the implementation of the NEP. The long-term targets of the OPP are as follows:

i. a rate of growth of the economy in real terms of at least 8% per annum to enable the achievement of the various socio-economic objectives, with a growth rate of 12% per annum for the manufacturing sector;

ii. full employment of the labour force from the generation of 1.9 million jobs by 1990;

iii. reduction in the incidence of poverty to 15% of total households by 1990;

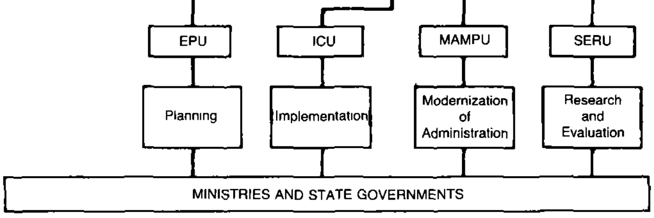
iv. employment in the various sectors of the economy and at all occupational levels should reflect the racial composition of the country by 1990; and

v. the pattern of ownership of share capital in the corporate sector should be restructured so that, by 1990, Malaysians own and manage 70%, with Malays and other indigenous people owning and operating at least 30%, and foreigners 30%.

During the first decade of the implementation of the NEP, major progress was made in the attack on poverty. Overall, the incidence of poverty declined from 49.3% of total households in 1970 to 29.2% in 1980. Progress was also made in restructuring the pattern of equity ownership and in the development of the less developed states and regions of the country.

In order to ensure that the policies and programmes for the second decade 1981-90 will be successfully carried out, planning and implementation capacities will be enhanced and further initiatives taken to organize the machinery of the government to deal with the challenges ahead. The need for effective organization of the development effort has become more critical in the light of the less favourable outlook of the world economic situation, the need to ensure the attainment of the targets of the NEP, the challenges posed by advances in science and technology and the need to fully harness the nation's manpower resources for full participation in the development process.

The machinery for the planning, evaluation and coordination of development efforts is shown in the chart. The Economic Planning Unit of the Prime Minister's Department serve as the secretariat to the National Development Planning Committee (NDPC) which has the overall responsibility for planning and development matters. The NDPC consists of heads of all major ministries dealing with development and is chaired by the Chief Secretary to the Government. The NDPC in turn reports to the National Council (NEC), a committee of senior cabinet ministers under the chairmanship of the Prime Minister. The EPU coordinates the presentation of issues and policies for the consideration of the NDPC and NEC. This process, whereby fundamental issues are fully considered at the highest levels of government, ensures that Malaysia's development policies and programmes meet the needs of the people in terms of the underlying concepts and strategies of the development plan. At the state level, the State Economic Planning Units and State Development Offices are responsible for formulating state development strategies and coordinating the preparation of state development projects and programmes. In addition, planning cells have been established in ministries and departments to plan the departmental programmes and policies.



Note NEC = National Economic Council
NAC = National Action Council
NSC = National Security Council
MAMPU = Modern Administrative and Manpower Planning Unit
NDPC = National Development and Planning Council
IAPG = Inter-Agency Planning Group
EPU = Economic Planning Unit
ICU = Implementation and Coordination Unit
SERU = Socio-economic Research Unit

Implementation is the responsibility of executive ministries, departments and agencies at the federal, state and regional levels. To ensure the effective implementation at the national and inter-departmental levels, the Implementation and Coordination Unit (ICU) was established under the Prime Minister's Department. The ICU serves as a secretariat to the National Action Council which is chaired by the Prime Minister and serves as a forum to resolve implementation bottlenecks as well as to ensure that the implementation of projects meets with the national objectives.

2.2 SCIENCE AND TECHNOLOGY AND THE ROLE OF DEVELOPMENT POLICY

Social and economic development through the application of science and technology is one of the concepts enshrined in the National Ideology called the Rukun Negara. This ideology is used by the Government of Malaysia as a guide for most policies relating to social and economic development. It is also within the context of the New Economic Policy that science and technology should be harnessed for the development of the country.

Although science and technology is important for development of the nation, socio-economic development must be consistent with scientific and technological development. During the last decade, emphasis was given to the development and transfer of appropriate technology covering the major areas of activity involving agriculture, mining, manufacturing, energy, medical and health infrastructure. In this case, appropriate technology means technology that utilizes natural resources, uses local skills, is in line with the current energy situation, and also helps to promote exports. Therefore, any application of science and technology should be geared towards the achievements of socio-economic goals set out in the national development plan. To this end, technology transfer is being promoted to accelerate rural development in view of the fact that this sector comprises the bulk of the poor people. However, there are several factors that must be considered when adopting foreign technology for local consumption. It is relevant to review and analyse the appropriate scale of the technology needed, the cost, the complexity of operation and maintenance, and also to see that this technology does not aggravate any existing problems of unemployment or under-employment, under-utilization of equipment, nor gives rise to pollution of the environment.

Many years of effort in applying science and technology for research purposes have contributed towards making Malaysia a leading producer of rubber, palm oil, and pepper. Production of these commodities improved, both in quality as well as quantity, due to the development of a variety of seeds and clones that gave a high yield per acre. Research using science and technology also contributed to various breakthroughs in the processing of both rubber and palm oil. These improvements in processing led to the production of a superior grade of processed rubber known as the Standard Malaysian Rubber (SMR). Research efforts are also focused upon the re-utilization of waste products from palm oil and rubber effluents. Concentrated research efforts are also geared towards rice cultivation, resulting in near self-sufficiency in rice production. Through the application of science and technology in the agricultural sector an increased production is being realized with an increase in income, thereby promoting rural development and contributing towards the achievement of the New Economic Policy.

In the manufacturing sector, development in science and technology is aimed at the greater utilization and reprocessing of natural resources to stimulate the production of manufactured and intermediate goods. Application of science and technology in the mining sector is aimed at reducing the operating costs to enable economical exploitation of the deposits.

The growing trend in the Malaysian economy is the encouragement of the application of science and technology to further the establishment of resource-based and agro-based industries in the manufacturing sector which make extensive use of local resources. To meet with the increasing demand for energy in the expanding manufacturing sector, concentrated efforts are being made to exploit locally available sources of energy such as the building of hydro-electric power stations, mini-hydros, waterworks, and natural gases. Research and development is also underway to seek out and harness cheaper alternative sources of energy such as solar energy, energy from biogas and nuclear energy.

Studies constantly being conducted in the field of medical science, health, and family planning programmes have contributed to the improved health standards of the people. Research efforts on various fields and subjects are being carried out by both the public and the private sectors in the country. Research institutes established by the Malaysian Government, such as the Malaysian Agricultural Research and Development Institute (MARDI), Rubber Research Institute (RRI), Palm Oil Research Institute of Malaysia (PORIM), Forest Research Institute, Mines Research Institute, Institute of Medical Research (IMR), are a few of the research institutes that contributed greatly to the implementation and achievement of national policies and objectives on the advancement of science and technology for development.

Apart from these institutes, the Standards and Industrial Research Institute of Malaysia was also established to undertake research in the transfer of appropriate technology, and to ensure acceptable standards for manufactured goods. The Tun Dr. Ismail Atomic Research Centre (PUSPATI) was established in 1975 and is expected to be fully operational by 1982 to undertake training and research in the application of nuclear technology for agriculture, industry, and medicine.

Besides sources of information from internal research and conducted studies, Malaysia also has close liaison with various international scientific organizations and is actively involved in international agencies, thus gaining from the exchange and dissemination of information on research projects undertaken by the developed countries.

Realization of the importance of science and technology's role in the developmental process has led to a review of the educational policies of the country. Greater emphasis is being placed on educating and training capable personnel to cater for the increased demand for scientists and technicians. Opportunities are being increased in institutions of higher learning by the expansion of existing facilities. The intake into science courses in the various universities and colleges is being expanded to achieve a target of 60% science graduates.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

The Ministry of Science, Technology and Environment has been given the role of planning, coordinating and developing all activities relating to science and technology. It is also entrusted with the design and development of national science and technology policies. It is assisted in this task by the National Council for Scientific Research and Development and the Coordinating Council for Industrial Technology Transfer. In addition the various research and development institutions have their own respective councils that provide direction on policies.

Essentially, the objectives of this Ministry are:

i. to develop and to promote the expansion of science and technology with the aim of improving the quality of life;

ii. to formulate, research, plan and determine the extensive application of science and technology so that they do not give rise to adverse effects and in order to sustain a prosperous and peaceful nation;

iii. to ensure that material development through science and technology does not pollute the environment and destroy wild life and plants;

iv. to integrate physical development through science and technology with human and individual development, in order to reduce undesirable conflict and stress that may arise from environmental and technological changes.

Implementation of the national science and technological policies and objectives is carried out by various institutions and departments which are directly under the charge of the Ministry of Science, Technology and Environment. These departments or institutions are outlined below.

i. Environment Division

The activities of the division are governed by the Environmental Quality Act of 1974. Its main function is to ensure that the economic and industrial progress of the nation would not be pursued at the expense of the environment. Among its main activities are, research on and monitoring of discharge of wastes, survey and investigation activities into the causes of and remedies for air pollution, setting up of standards and criteria for the maintenance of the quality of the environment and also the enforcement of provisions in the Environmental Quality Act of 1974.

ii. Tun Ismail Atomic Research Centre (PUSPATI)

PUSPATI was established in 1972 as an atomic research centre. The main objective of this centre is to introduce and extend the application of nuclear science and technology in a peaceful manner in various fields such as medicine, agriculture, industry and other areas for the national development effort. Also to ensure that public security and environmental cleanliness is not impeded by the use of this new technology.

iii. Standards and Industrial Research Institute of Malaysia

To improve the status of local industries, to expand technological development through industrial research development standards, and to transfer technology in line with the New Economic Policy.

iv. Chemistry Department

To provide analytical, investigative and advisory services to all government agencies, municipalities and statutory bodies.

v. Department of Wildlife and National Parks

This department is given the responsibility of safeguarding and preserving the wild life of the country so that extinction does not occur due to hunting and environmental changes. This department administers the Wildlife Conservation and National Park Act of 1976/1972 and also the National Park Act of 1980. Among its main activities are the enforcement of the above acts, and the management of wildlife and national parks.

2.4 NATIONAL COUNCIL FOR SCIENTIFIC RESEARCH AND DEVELOPMENT

The National Council for Scientific Research and Development (NCSRD) was established in 1975 with the primary objective of monitoring, evaluating and coordinating scientific research and development in support of national development. The NCSRD advises the government on all scientific and technological matters. The Council also has the responsibility of ensuring a maximum utilization of resources such as manpower and physical facilities. It also provides linkages between research and scientific institutions within and outside the country.

The membership of the Council is drawn from senior scientists of various disciplines and the Chairman of the Council is the Chief Secretary to the Government of Malaysia. The Council has established four main Committees to provide coverage of scientific and technological development namely the:

i. Agricultural Sciences Committee;
ii. Industrial Sciences and Technology Committee;
iii. Marine Sciences Committee;
iv. Medical Sciences Committee.

In addition, the evaluation of socio-economic aspects of the above activities is also incorporated so as to ensure a balanced approach in the contribution of science and technology in national development. The government has also established a Trust Fund to finance scientific research in areas that are not already covered by existing research programmes and which have serious implications for, and some usefulness to, the country.

2.5 NATIONAL INSTITUTION ESTABLISHED TO PROVIDE SERVICES RELATED TO TECHNOLOGICAL TRANSFER

In 1977, the Coordinating Council for Industrial Technology Transfer was formed with the main intention of accelerating industrialization and coordinating various agencies which have been entrusted to perform activities relating to technology transfer. Membership in the Council includes representation from both public and private sectors. The government departments and private agencies involved are: the Ministry of Trade and Industry; Ministry of Science, Technology and the Environment; the Economic Planning Unit of the Prime Minister's Department; the Industrial Development Authority (MIDA); the National Productivity Centre (NPC); the National Council for Scientific Research and Development (NCSRD); the Malaysian Industrial Development Finance (MIDF); the Malaysian Industrial Development, Finance and Industrial Consultants (MIDFIC); the Federation of Malaysian Manufacturers (FMM); and the Standards and Industrial Research Institute of Malaysia (SIRIM).

The main task of this Council is to identify the priority sectors for development and to formulate technology transfer plans and policies, as well as to monitor the technology developments of the country, in order to ensure the more effective growth of industrial and economic development in Malaysia. It carries out public relations activities while coordinating and harmonizing relationship between the donor and recipients involved in the transfer of technology. It also cooperates with comparable organizations in other countries in the furtherance of technology transfer. In addition, a technology information centre has been established at SIRIM for storing technical information on computer.

2.6 ROLE OF NON-GOVERNMENT AND SEMI-GOVERNMENT BODIES IN POLICY-MAKING

Non-government and semi-government establishments and organizations, especially universities, research institutions and professional bodies, play a very important role in the innovations in science and technology. The universities have their own research budgets, apart from grants from various sources, to promote and undertake research in science and technology. Research conducted by the private sector is mostly on the agricultural sciences.

The recent establishement of COSTAM (Confederation of Scientific and Technological Associations in Malaysia), an umbrella organization covering the major scientific and technological associations in the country, is to present to the government a unified stand on issues relating to science and technology.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

In Malaysia, most of the institutions active in science and technology activities are government agencies such as the Malaysian Agricultural Research and Development Institute (MARDI), the Rubber Research Institute Malaysia (RRIM), the Palm Oil Research Institute of Malaysia (PORIM), the Forest Research Institute (FRI), the Mines Research Institute of Malaysia, the Institute of Medical Research (IMR), the Tun Ismail Atomic Research Centre (PUSPATI), and institutions of higher learning. The private sector has also undertaken a considerable number of research activities. The major institutions performing scientific and technological activities are described below.

Institute of Medical Research (IMR)

The Institute of Medical Research was established in 1901 and is primarily entrusted with the task of carrying out research on the cause, treatment, and prevention of beri-beri and all forms of malarial fever. In a span of eighty years this institute has become the main medical research institute in the country and is presently conducting research on over a hundred projects per year. Its main activities involve research, training, vaccine production, and referral diagnostic laboratory services. The main thrust of IMR research is directed at:

i. investigating rural health problems;

ii. research into the causes of, and treatment of, insect-borne diseases, especially dengue, scrub typhus, leptospirosis, parasitology, chemotherapy, malaria, and particularly filarasis;

iii. community nutritional status, for instance, nutritional biochemistry and nutritional disorders;

iv. abnormal haemoglobinopathies, G^6PD deficiency and genetic disorders;

v. the newer biochemical and radiochemical methodologies in relation to hormone disorders, chemical enzymology and toxicology;

vi. the frequency, distribution, etiology and epidemiology of Malaysian cancers with particular reference to oral cervical cancer.

The Hooper foundation of the University of California International Centre for Medical Research has had close collaboration with Malaysia since 1960 in the study of parasitic diseases, the study of genetic factors in blood disorders, and research on the social, cultural and behavioural factors affecting health. Among the most recent achievement of the IMR was the setting up of a snake farm in Kangar (Perlis) for the production of, and research into, antivenin specifically for cobra, pit viper and seasnake bites.

Standards and Industrial Research Institute (SIRIM)

SIRIM was established as a Federal Statutory Body in 1975 under the SIRIM Act of 1975 which is administered by the Ministry of Science, Technology and Environment. It is governed by a 24-member council and assisted by three committees, namely, the Executive Committee, the Standards Committee and the Research Committee.

The essential tasks of this institute are outlined below.

i. To promote and conduct industrial research with the aim of improving procedures and processes, innovating procedures for new processes and techniques, promoting the consumption of Malaysian products, and using and adapting foreign technologies.

ii. To promote, develop and promulgate standards for commerce and industry and for goods produced in or imported into Malaysia by conducting tests on products and encouraging various industries to set up their own quality control, and by giving certifications for the control of quality.

iii. To promote industrial efficiency and development.

iv. To promote public and industrial welfare, health and safety.

v. To promote industrial extension in meeting standards.

vi. To improve production processes and techniques.

The main activities of SIRIM can be classified into four categories:

i. Industrial Research
Activities included are research and research development, engineering research, scientific analysis, industrial design and fabrication.

ii. Standards and Establishment of Standards
This involves development of standards, uses and implementation of standards, and determination of quality and also metrology.

iii. Industrial Consultancy Services
This activity involves industrial consultation and guidance, industrial relations, technical clarification, and technical publications.

iv. Administrative
This section of the institute is in charge of all financial and administrative matters of the institute.

The annual budget for SIRIM in 1981 was M$34.6 million of which M$8 million was to be spent on equipment for the laboratory. New projects implemented include the setting up of a Metal Industry Technology Centre and a Metal Industry Research and Development Centre. These two centres are being set up to improve the metal technologies of the country. Apart from this, new branches of SIRIM will be set up in Sarawak, Kota Bharu, Seberang Prai and Johore Bharu to provide consultation and testing facilities. These branch laboratories will be able to provide engineering testing and chemical analysis facilities.

Agricultural Research and Development Institute (MARDI)

Malaysia Agricultural Research and Development Institute (MARDI) was established by the MARDI Act which was passed by Parliament on 14th February, 1969. This research institute, which is under the Ministry of Agriculture, is governed by a Governing Board and a Scientific Council. Up to date, MARDI has established Research Stations covering 6 810 hectares of land and located in different parts of Peninsular Malaysia.

The overall objective of MARDI is generally to intensify its research activities according to the identified research priorities and to develop new technologies which can be easily adapted by farmers, thereby increasing their income in consonance with the government's New Economic Policy of eliminating poverty. Included among the activities of MARDI is research in food processing and preservation, maximum utilization of agricultural products, and the reduction of wastage in food and non-food production in processing, handling and transportation. It also acts as an information centre by publishing and distributing information on research to farmers' associations, and relevant agencies.

Some of the achievements of MARDI are in the research into high-yielding varieties of rice such as SRI Malaysia I and II and shorter maturing varieties such as MR 7 and MR 10. Significant progress has also been achieved in the development of vegetative methods for propagation of cocoa. Under its livestock programmes, the main thrust was toward improving the supply of feedstuffs and studies on spawning and rearing techniques in the breeding and reproduction of fresh-water fish.

Rubber Research Institute (RRIM)

The RRIM was established on 29th of June, 1925. It is primarily concerned with research into all aspects of natural rubber cultivation and latex production, the development of new forms of rubber and rubber consumption as well as technological and end-uses research in the processing and manufacture of natural rubber products. It also extends its advisory and information services to all sectors of the industry.

In 1972, several natural rubber bills were passed to streamline the activities of various natural rubber bodies in the country. These bills enable the RRIM to encompass natural rubber research for the whole of Malaysia inclusive of Sabah and Sarawak. It also enables the institute to conduct end-use research and development of new rubbers to complement its main focus on production research. Apart from this research, RRIM also carries on adaptive research on strategic and selected smallholders' problems.

In anticipation of a higher demand for natural rubber in the next decade, RRIM will emphasize the implementation of the Dynamic Production Policy of Natural Rubber. Efforts will be aimed toward increasing productivity through agronomic practices and labour utilization, optimum use of fertilizers and effective disease control. It will intensify the use of natural rubber through development of new forms of rubber and promote the growth of the rubber-based manufacturing industry.

Chemistry Department

The Chemistry Department with its seven branches throughout the country, is directly under the administration of the Ministry of Science, Technology and the Environment. Its functions include providing analytical, investigatory and advisory services to several government agencies. Among the major agencies to which these services are provided are the Ministries of Health, Defence, Trade and Industry and departments like the Royal Malaysian Police and Royal Malaysian Customs and Excise, Central Narcotics Bureau, National Bureau of Investigation, Stores and Contracts Division of the Treasury, Public Works Department and the Environment Division of the Ministry of Science, Technology and the Environment. Most of the services provided are to enable due enforcement of legislation such as the Sale of Food and Drugs Ordinance 1952, Poisons Ordinance 1952, Customs Ordinance 1967, Excise Act 1961, Criminal Procedure Code, Explosives Ordinance 1957, Dangerous Drugs Act 1952, Environmental Quality Act 1974, Trade Description Act 1972 and Petroleum Ordinance 1949.

This department also provides services to ensure that the supply of materials is in accordance with specifications such as food and uniform materials for the army, police, prisons, and hospitals etc. It also ensures that the country's public water supplies are adequately treated as to be potable and do not contain microorganisms capable of transmitting water-borne diseases such as dysentery, cholera, and typhoid.

Forest Research Institute

The Forest Research Institute, which is an agency of the Ministry of Primary Industry, was established to be solely responsible for planning and implementing forest conservation and utilization schemes. This institute undertakes research into the feasibility of implementing reforestation schemes in areas where natural resources are depleted. It also conducts research into the viability of large-scale agro-forestry or forestry farming in those areas, with the aim of introducing new species of trees which will ensure a continuous supply of raw materials for pulp and paper processing. This institute is also closely monitoring the effects of forest utilization on the stability and quality of the surrounding environment.

Forest research is mainly focused on the development of forest regeneration techniques and timber utilization. Considerable efforts are being directed by FRI to silviculture of regenerated forests and forest hydrology. Progress has been made in determining preservation and seasoning schedules of various local timber species, pulping properties of certain species, wider utilization of quick-growing species and rubber wood, and the working properties of locally grown teak wood.

Mines Research Institute

The Mines Research Institute which is placed under the Ministry of Primary Industries was established with the objective of carrying out research and investigation into various aspects of mining and mineral processing, such as looking into the problems of mining capacity, mining technology and mineral processing. This institute has the facility of a geotechnic laboratory which carries out research on problems relating to mine safety. It will also establish a Mining Technology Testing Centre to undertake various tests on modern techniques of tin mining to ensure high productivity. A programme for manpower training in mineral resource industries will also be initiated by this institute.

Other Major Research Agencies

Other major government research agencies include the Veterinary Research Institute, the Palm Oil Research Institute Malaysia (PORIM), the Fisheries Research Institute, the Tun Ismail Atomic Research Institute and the Defense Research Institute.

The main activities of the Veterinary Research Institute are diagnostic services and the production of vaccines for specific animal diseases. From 1971-80 the institute has established six regional diagnostic laboratories which provide a much improved veterinary health coverage to farmers in the prevention of disease outbreaks.

PORIM was established as a Statutory Body on 15th May 1979. The activities of PORIM are research into the expanding uses of palm oil, formulating new uses, improving agronomic practices, and minimizing the costs of operation. Priority will be accorded to biological as well as technical research aimed at increasing the proportion and performance of palm oil in edible and non-edible uses. In addition, techno-economic studies will be carried out on palm oil and other oils and fats. Research on effluent treatment and disposal will also be undertaken.

The Fisheries Research Institute under the Ministry of Agriculture is responsible for carrying out surveys on demersal and pelagic fish resources and conducting research to improve the techniques of fishing. Several studies were carried out on biological aspects of marine fishes. Further financial allocations for research were given to this institute to develop aquaculture in brackish water, and also inland aquaculture and cage or pen culture to supplement sources of protein and create employment opportunities for the rural people.

The Tun Ismail Atomic Research Centre was established in 1975 with the main aim of providing training and research and also to produce isotopes to supply to hospitals, research institutions and industrial organizations.

The Defense Research Institute is responsible for carrying out research activities on defense requirements of the country such as the supply, storage and usage of defense equipment.

Apart from these government research institutions and departments, academic institutions also have their own research capabilities. There are five universities in Malaysia. The University of Malaya (established in 1949 in Singapore but later transferred to Kuala Lumpur in 1959); the University of Science Malaysia; the University of Agriculture; the University of Technology; and the National University. The University of Malaya provides courses in economics. engineering, dentistry, medicine, arts, social sciences and law. The University of Science, on the other hand, emphasizes pure sciences, applied science, pharmacy, housing, building, planning, and other related areas. The University of Agriculture provides courses in agriculture, forestry technology, social sciences and humanities. The University of Technology offers courses in engineering and technology, and the National University provides courses in business management, economics, medicine, and others. Universities in Malaysia are entirely financed by government funds and are administered by the Ministry of Education.

Private organizations, as well as multinational companies, also make contributions to research efforts in science and technology, though they are motivated by profit. Some of the active agencies are the Harrison and Crosfields Research and Advisory Services, the Dunlop Research Centre, and ICI (Malaysia) Limited Company. These centres deal mainly in agricultural research.

3.2 HUMAN RESOURCES

In response to employment creation and demand trends over the past decade, emphasis has been placed on expansion of the supply of manpower in the scientific and technical fields in Malaysia. Such a trend is expected to intensify in the present decade with an accelerated growth of the industrial sector and a trend towards modernization of the primary sectors.

Enrolment Trends

The proportion of students enrolled in arts courses at the university level has declined from 63.5% in 1970 to 47.8% in 1980, while science and technical courses enrolments have increased from 36.5% to 52.2% between 1979 and 1980. This has resulted in an increased output of science and technological qualified personnel from 35% in 1970 to 39% in 1980. Early in the 1970s there was a rapid development of a Science University in Pulau Pinang, which now has a total enrolment of 7 500 students distributed among pharmacy, science, social science, humanities, and computer science courses. The College of Agriculture was upgraded to an Agriculture University and the Technical College was upgraded to the University of Technology.

3.3 FINANCIAL RESOURCES

Without the benefit of careful research on the subject, it is difficult to assess Malaysia's current and annual commitment on R&D. Suffice to say, however, that current R&D expenditure is mainly financed by the government by way of annual budgetary grants to the various research bodies. Added to this, of course, are the various R&D projects undertaken by the private sector institutions, especially in the plantation sector, and also product research undertaken by large industrial and commercial firms. One other important area in which the government indirectly finances research is in the form of contributions to organizations linked to primary commodity research, for example, tin. To arrive at an exact and an absolute estimate would be difficult.

3.4 SURVEYING OF THE SCIENTIFIC AND TECHNOLOGICAL POTENTIAL

The National Council for Scientific Research and Development (NCSRD), in the Ministry of Science, Technology and the Environment is responsible for the collection and dissemination of data and information on national science and technological development. The Council has presently embarked on the compilation and registration of all past and current research efforts, a manual of scientific equipment valued at M$50 000 and above, and also a directory of scientific research organizations established in the country. Apart from this, the Council will be undertaking a nation-wide survey with the Malaysian Administrative Modernization and Manpower Planning Unit (MAMPU) and the Economic Planning Unit (EPU) on the current and future scientific and technological manpower needs. With such information and data the Council will be able to determine the present and future manpower potential of this country for the development of science and technology policies and plans.

PART 4.

Policy issues on scientific and technological development

4.1 MAJOR DEVELOPMENTS

The major development that has occured in Malaysia in the last decade was the increasing emphasis placed by the government on the application of science and technology for the achievement of the socio-economic objectives of the national plan. Policies on science and technology are directed towards encouraging research in the various types of innovations that will suit the local environment and requirements of the country. There is continuing effort being made by the government to formulate policies that will coordinate and harmonize all scientific research and technological innovations into a single unified plan of action. To this end, the National Council for Science Research and Development was established in 1975. It is essentially an advisory body to the government, ensuring that all policy formulation relating to the application of science and technology is geared towards the achievement of national objectives. It also functions as a central coordinating body for all scientific research activities. Coordinating efforts made by this Council since its establishment can be divided into four main categories:

i, coordination in the agriculture sector;

ii. coordination in the industrial and technological sector;

iii. coordination in the medical fields;

iv. coordination in marine science.

The Malaysian Standards and Industrial Research Institute (SIRIM) was established in 1975 and it is entrusted with the task of promoting the transfer and development of technology and assisting the nation in its efforts towards industrial development. Its diverse activities include research into alternative source of energy, re-utilization of industrial wastes, design and fabrication of industrial technologies and the testing of local products to ensure that Malaysian products remain competitive in the world market.

Recent developments in the palm oil industry, and the increasingly important role that palm oil is playing in its contribution to the country's export earnings, led to the establishment of the Palm Oil Research Institute in Malaysia (PORIM) on the 15th May 1979. It is given the task of conducting research on production, extraction, processing, storage, transportation, marketing, consumption and end-use of palm oil and oil palm products.

The Tun Ismail Atomic Research Centre (PUSPATI) established in 1975 is Malaysia's first venture into the research and development of nuclear science and technology. When fully operational, this centre is expected to produce and supply short-life radioisotopes to hospitals, research institutions and industrial organizations. It is also entrusted with the primary function of training and improving the expertise of local scientists in nuclear science and technology.

4.2 ACHIEVEMENTS AND PROBLEMS

Malaysia has made significant progress during the last decade in building up the scientific and technological infrastructure such as the establishment and strengthening of more higher education and research institutions as well as technical services organizations.

The main problem that hinders the expansion of a science and technology capacity in the country is the acute shortage of skilled manpower, especially in scientific and technical fields. However, efforts are being made to expand educational opportunities, especially at college and university levels. To overcome the acute shortage of skilled technical workers, new vocational institutions are rapidly being set up and it is expected that this measure will ensure an increased enrolment of pupils in vocational schools from the 4.6% of the total enrolment at upper secondary levels in 1980, to 6.3% in 1985.

However, such problems, as developing improved methods of teaching science and technology exist, and solutions for these, as well as to other problems such as staff development, improving the teaching cum research capacity, and development of appropriate scientific and technological programmes, have to be found.

Malaysia's economic growth has been predominantly dependent on the growth of export-oriented primary industries which involve major agricultural commodities such as rubber, palm oil, coconut, timber, pepper, cocoa and coffee and, to an increasing extent, mineral resources such as tin, copper, oil and gas. The future growth of the Malaysian economy will depend heavily on the expansion of research capacities to improve the quality and quantity of commodities production. The expansion of Malaysia's research capacity in post-harvest technology and utilization is therefore of extreme importance. Emphasis is also placed on research efforts in the processing areas of these commodities, leading to the establishment of more resource-based industries.

The Fourth Malaysia Plan outlined two areas for research and development and these are first, agricultural research, for which M$93 million has been earmarked for supporting activities at MARDI, PORIM and the Department of Agriculture in the states of Sabah and Sarawak and, second, energy and industrial research, accounting for M$77 million. In addition, there are provisions for investment into research activities for forestry, mineral resources, fisheries, livestock, and other sectors.

A problem that arises is the lack of R&D activities in private sector, and hence the government's investment in R&D assumes greater importance. The information service for science and technology is one of the missing links in the scientific and technological infrastructure in Malaysia. The need for such a mechanism is acute in Malaysia. What is needed most urgently is an industrial information service which can reach and develop a new breed of clientele for such information services. Efforts are being made to study the feasibility of setting up such a centre.

4.3 OBJECTIVES AND PRIORITIES

The Government of Malaysia recognizes that science and technology is an important instrument of economic and social development. The objective of the New Economic Policy (NEP) is to achieve a socio-economic environment in which individual Malaysians can achieve self-fulfillment within a system which provides for proportional participation in and control over the economic life of the nation. It is within the context of the NEP that science and technology is harnessed for the development of the country. Any application of science should have a bearing on the attainment of the objectives set down for national development.

Though the country, at the present moment, does not possess any explicit science ant technology policies and plans they are, however, implicitly integrated into the National Development Plan. Nevertheless, efforts are being made to formulate an explicit national science and technology policy to overcome problems of planning and implementation. This is the main priority of the Ministry of Science, Technology and the Environment. Of major concern to the government is the formulation of policies and guidelines for the transfer of technology, especially technology transfer promoted to accelerated rural development because this sector comprises the bulk of poorer people. Even with rapid advances in science and technology their beneficial impact on the poorer sections of the population is, at best, marginal.

With the emphasis on the diversification of the economy, industrialization of the country through the development of resource-based industry leads to an increasing need for the policy-makers to formulate a technological plan. Such a plan must maximize the use of our natural resources through the application and adaptation of foreign technologies, and the improvement of indigenous technologies. To this end, several priority areas are identified such as quality control of products, alternative sources of energy, uses of radioisotopes, conservation of resources, and technical education.

There is a great potential for improving the scientific and technological capacities of the country, but obstacles and constraints such as the lack of coordination among research institutions, financial constraints, and the lack of skilled manpower, must first be solved. Progress have been made through the efforts of the National Council for Scientific Research and Development on coordination aspects and studies are being carried out to determine financial and manpower requirements in the future with a view of coming out with a National Science and Technological Plan. The main concern of such a plan will be the achievement of the national development objectives through the application of science and technology. However, safeguards must be incorporated into the plan to ensure that the quality of life, health and the environment will not be adversely affected through material progress.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

Malaysia is a developing country and its advancement of science and technology depends largely on the extent of international cooperation it carries out with the other countries of the world. This cooperation which is mainly on the exchange of scientific and technological information and expertise is carried out in three main areas:

i. Scientific and Technical or Cultural Cooperation between Malaysia and individual countries through bilateral agreements;

ii. Scientific and Technological Cooperation between ASEAN Countries;

iii. Scientific and Technological Cooperation in International Scientific or Technological Organizations, e. g. through participation in United Nations bodies or agencies.

Scientific and technical or cultural cooperation between Malaysia and individual countries through bilateral agreement can be viewed in terms of bilateral agreements for scientific and technological cooperation, and bilateral economic, technical and cultural agreements containing provisions for scientific and technological cooperation. Countries with which Malaysia has established agreements are the Kingdom of Belgium in 1966, The Federal Republic of Germany in 1968, the Republic of France in 1972, the Socialist Republic of Romania in 1970, the People's Republic of Bulgaria in 1971, the Polish People's Republic in 1972, the USSR in 1972, the Socialist Republic of Yugoslavia in 1972, the Republic of Indonesia in 1973, India in 1979, the People's Republic of Bangladesh in 1979, the United Arab Emirates in 1975, the Socialist People's Libyan Arab Jamahiriyah in 1977, the Republic of Iraq in 1977, the Republic of Turkey in 1977, the Kingdom of Saudi Arabia in 1975, the State of Kuwait in 1975 and the Arab Republic of Egypt in 1977.

Of the agreements signed, the cooperation agreements with the Kingdom of Belgium and the Socialist People's Libyan Arab Jamahiriyah are specific agreements on scientific and technical cooperation. The other agreements are on economic, technical, and cultural cooperation containing provisions for scientific and technological cooperation.

At the ASEAN level, efforts towards the development of scientific and technological cooperation have been intensified. Various programmes on science research and technology are being carried out and these programmes address themselves to science and technology problems such as the need for cheap but nutritious food formulations from indigenous materials, management and utilization of food wastes, development of non-conventional sources of energy, and management of marine resources. At present, Malaysia is involved in a number of scientific and technological programmes at the ASEAN level. The cooperation programmes are outlined below.

i. Sub-Committee on Protein

This Sub-Committee is responsible for implementation of the ASEAN Protein Project which is funded solely by the Australian Government. The objectives of the project are to undertake development and produciton of low-cost high-protein foods, and to undertake activities supporting the development and production of low-cost high protein food by training research scientists and workers, the dissemination of information, and organizing of seminars and technical meetings to upgrade the skills of personnel involved in the project. These activities are carried out by various agencies in each ASEAN member country and these include research, organizing workshops and participation in international symposia.

ii. Working Group on Food Waste Materials

Like the ASEAN Protein Project, this project is also funded solely by the Australian Government. This project is carried out to meet the dual objective of decreasing or eliminating sources of pollution and to convert these pollutants, using appropriate technology, into useful products. At the moment, research is being carried out in the following area of fermentation processes, membrane processes, the utilization of food waste materials for feed formulation and production, and miscellaneous processes for food waste materials utilization.

iii. Working Group on Non-Conventional Energy Research

The main task of this Working Group is to draw up an integrated ASEAN programme on non-conventional energy research to meet the following objectives, namely, to enhance capabilities on non-conventional energy development in the ASEAN countries, to develop non-conventional energy technology, and to apply these technologies in the most efficient and economic manner so as to reduce the over-reliance on fossil fuels. The research areas identified as having potential for development into sources of energy are: solar refrigeration and air-conditioning, solar electric power systems, solar drying, solar pumping, bio-energy conversion, coal technology, wind energy, geothermal energy, and micro-hydro energy.

iv. Sub-Committee on Climatology

The ASEAN countries have embarked on an ASEAN Climatic Atlas and Compendium of Climatic Statistics Project to process and analyse climatic data of the five countries and compile the findings into a climatic atlas and compendium of climatic statistics. This project is supervised by the ASEAN Sub-Committee on Climatology under the Chairmanship of the Director-General of the Malaysian Meteorological Service. The project centre is located in Kuala Lumpur, Malaysia. The activities of this sub-committee include organizing workshops and expert group meeting on climatology. The committee has almost completed its work and has prepared an ASEAN Climatic Atlas and Compendium of Climatic Statistics and a map of ASEAN and climatic maps. In addition, the sub-committee intends to undertake additional tasks related to the meteorological sciences such as the weather modification programme and assessment of solar/wind energy.

v. Working Group on Environment

The Working Group on Environment has been charged with the responsiblity for formulation, adoption and implementation of an ASEAN environment programme and for intensifying the exchange of environmental information. To meet these objectives, the group is actively involved in the following programmes for the formulation of a Draft Action Plan in Nature Conservation, a UNEP Regional Seas Programme, Environment Impact Assessment Workshop, Urban Air and Water Quality Monitoring in ASEAN cities, and the ASEAN Environment Programme (ASEP).

vi. Other ASEAN projects

In order to foster cooperation and pool its technological capabilities to solve problems of mutual interest the other project proposals include ASEAN Research in Food Technology Project, an ASEAN Cooperative Programme on Marine Science, ASEAN Cooperation in Material Processing, ASEAN Cooperation in the field of Corrosion, and ASEAN Cooperation in Space and Space-related Activities.

vii. Ad-hoc Committee Meeting in the Formulation of the ASEAN Plan of Action on Science and Technology for Development

The Plan of Action seeks to focus those diverse activities within the objectives and terms of reference of the Committee on Science and Technology and to evolve clear-cut policies, identify priorities, improve coordination and intensify concerted action.

In order to keep abreast with the advancement of science and technology, Malaysia maintains close liaison with various international scientific organizations and is actively involved in international agencies such as the International Council of Scientific Unions (ICSU), Commonwealth Science Council (CSC), International Atomic Energy Agency (IAEA), Pacific Science Association (PSA), International Foundation of Science (IFS), Inter-Governmental Oceanographic Commission (IOC) and the Association for Science Cooperation in Asia (ASCA).

International cooperation in science and technology reflects the growing importance of science and technology in both developed and developing countries and the recognition that the scientific and technological strength of individual countries can contribute to the improvement of international relations. Presently, Malaysia is looking into training, collaborative research, and exchange of information and experts programmes with other friendly nations with the hope that through this concerted effort mutual benefits will arise which will facilitate the achievement of national objective and bring about an improvement in the socio-economic wellbeing of the country.

PART 5.

Bibliography

Fourth Malaysia Plan 1981-1985.

Economic Report 1979-80, Ministry of Finance, Malaysia.

Basic Guidebook for Potential Investors in Malaysia.

Malaysia Meteorological Service Summary of Observations

Report of the National Council for Scientific Research and development 1975-77.

Report of the National Council for Scientific Research and Development 1978-1979.

Malaysia Year Book 1979.

1980 Population and Housing Census of Malaysia.

Background paper or reorganization of Ministry of Science, Technology and the Environment.

Seventy-five Years of Medical Research in Malaysia.

Malaysian National Paper for the United Nations Conference on Science and Technology for Development, Vienna, August, 1979.

Report of the Working Group on Shallow and Deep Water Production, Sub-Committee on Marine Resources/Fisheries Research of the National Science Council for Research and Development, 1980.

The Constitutions of Malaysia.

Planters and Speculators, University of Malaya Press. 1968.

Prawn, Otter and Trawl Fishery in Sabah, Malaysia, Jesselton Fisheries Branch, Department of Agriculture, SABAH, 1967.

Rice Cultivation in Malaysia, Singapore, D. Moore, 1961.

The Oil Palm Industry of Malaysia, Penerbitan University Malaya, 1976.

Padi Farming in West Malaysia, Ministry of Agriculture and fisheries, Malaysia, 1972.

MONGOLIA

Table of Contents

MONGOLIA

GEOGRAPHY

Capital city: Ulan Bator
Main ports: —
Land surface area: 1,565,000 sq km

POPULATION (1978)

Total	1.6 million
Density (per sq km)	1
Urban/rural ratio (1973)	0.9
Average rate of growth (1970-78)	2.9%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	43.6	10.3	8.4	32.7	5.0	100%

SOCIO-ECONOMIC

Labour force

Total	...
Percentage in agriculture	...

Gross national product (1978)

GNP at market prices	US $1,100 million
GNP per capita	US $ 700
Real growth rate of GNP per capita (1970-78)	3.1%

Gross domestic product

Total (in current producers' values)	...
Percentage by origin	
Agriculture	...
Manufacturing, mining & quarrying, electricity, gas & water, construction	...

Government finance

National budget	...
As percentage of GNP	...
External assistance (official, net; 1976)	...
As percentage of GNP	...

Exports

Total exports of goods (1978)	US $281 million
Average annual growth rate (1970-78)	...

External debt (1978)

Total public, outstanding + disbursed	...
Debt service ratio (% GNP)	...
(% Exports of goods and non-factor services)	...

Exchange rate (1978): US $1 = 3.00 Tugriks

EDUCATION

Primary and secondary education (1975)[1]

Enrolment, first level	*129,802
As % of (8-10 years)	108%
Enrolment, second level	184,688
As % of (11-17 years)	81%
Combined enrolment ratio (6-17 years)	90%
Average annual enrolment increase (1970-1975)	5.3%

* The enrolment ratio is the relationship between the number of all pupils enrolled (regardless of their age) and the number of the population of the relevant official ages.

Higher education (third level) (1979)

Teaching staff, total	1,033	
Students and graduates by broad fields of study:		
	Enrolment	Graduates
Social sciences and humanities	2,930	875
Natural sciences	625	—
Engineering	2,790	369
Medical sciences	1,677	296
Agriculture	1,569	197
Other and not specified	2,235	170
Total	**11,826**	**1,907**
Number of students studying abroad	...	

Education public expenditure (1970)

Total (thousands of Tugriks)	298,737
As % of GNP	...
Current, as % of total	92.7%
Current expenditure for third level education, as % of total current expenditure	...

Table 1. Nomenclature and Networking of S&T Organizations

I - First level - POLICY-MAKING

Country: Mongolia

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
State Committee on Science and Technology of the Council of Ministers of the Mongolian People's Republic	Monitoring, co-ordination and administration	Council of Ministers of the MPR	Ministries and and departments	Academy of Sciences of the MPR

II - Second level - ASSISTANCE & FINANCING

Organization	Linkages		
	Upstream	Downstream	Others
Academy of Sciences, ministries and departments	State Committee of the Council of Ministers on Science and Technology	Ministries, departments and scientific organizations	Learned Councils of scientific organizations

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages	
		Upstream	Others
Academic and sectoral institutes, higher educational establishments	Research, design, experimentation, education	Academy of Sciences of the MPR, ministries and departments	Councils of scientific organizations to deal with specific problems

Table 2 - Scientific and Technological Manpower

(Data unavailable at time of publication)

Country: Mongolia

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total stock (thousands)	of which working in R&D
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965										
1970										
1975										
1979										
1985										
1990										

Table 3 - R&D expenditures

Country: Mongolia
Currency: Tugrik

Table 3a: Breakdown by source and sector of performance

Year: 1980

Unit: million

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive	1.3	2.4	.3	4.0
Higher Education	.04			.04
General Service	1.3			1.3
Total	2.64	2.4	.3	5.34

Table 3b: Trends

Year	Population (millions)	GNP (in million)	Total R&D expenditures (in million)	Exchange rate US $1 = Tugrik
1965	1.1		.7	
1970	1.2		1.1	
1975	1.4		3.1	
1979	1.6		5.2	3.205
1985	1.8		6.2	
1990	2.0		7.4	

PART 1.

General features

1.1 GEOPOLITICAL SETTING

The Mongolian People's Republic is a Central Asian state, 1 565 000 square kilometres in area, bordering on the USSR and the People 's Republic of China. The capital is the city of Ulan Bator.

Relief

A large part of the country lies at altitudes of 1 000 to 2 000 metres; mountains and high plateaux predominate. The most important ranges are the Mongolian Altai, which reaches a height of 4 362 metres, the Gobi Altai, the Khangai and the Khentei. In the south and south-east the Gobi Desert, one of the largest in the world, juts into Mongolia. In the north and north-west there are several extensive and relatively deep intermontane basins and valleys, the biggest being the Great Lakes region. The eastern part of the country is made up of plains. In the south and south-east and in the Great Lakes depression, areas totalling some 30 000 square kilometres are taken up by sandy deserts.

Mineral Resources

The country has major reserves of hard coal, copper fluorspar, tungsten, etc. The tungsten, copper and mobybdenum ores and fluorite deposits are largely products of the Mesozoic metallogenic era. Large phosphorite deposits have been discovered in the vicinity of Lake Hovsgol and there are reserves of gold, *tin, zinc, asbestos, granite and other minerals. Mongolia* is also provided with Glauber's salt, common salt, soda, graphite, silica sand, mica, sulphur, phosphorite, rock crystal, cairngorm, precious stones, substantial reserves of building materials- marble, gypsum, limestone, dyestones, etc, and hundreds of mineral springs.

The Climate

The climate is dry, markedly continental and temperate, with wide seasonal and daily fluctuations in air temperature. The winter is cold but sunny, with little snowfall, and the summer is hot but short. The annual mean temperatures ranges from -4 to +4° Centigrade. The rainfall is 200-300 mm in the north, less than 200 mm in the south-west and up to 500 mm in the mountains. In the north of the country there are areas of permafrost, mainly in isolated patches.

Lakes and Rivers

The largest rivers are the Selenga, Kobdo, Dzavhan, Kerulen and Onon. The aggregate length of Mongolia's rivers is 36 000 km, and their total annual discharge about 300 cubic kilometres. There are fairly large stocks of water in the lakes, which number about 3 500. The largest lakes are the Uvs (3 260, square kilometres) and Hyargas, which are closed and the Hovsgol (2 620 square kilometres, up to 238 metres deep) and Har Us, which are river-fed, river-drained and fresh.

Flora and Fauna

Chestnut soils cover more than 60% of the terrain, and brown soils are also common. There is black earth in the mountains. Mongolia has over 2 000 plant species. Steppes bearing cereals and various grasses predominate in the plains. In the widespread semi-deserts of the south and south-east, rhizome onions, brambles, saltwort, saxaul, etc. , are prevalent. Steppe and forest-steppe scenery is characteristic of the mountain regions. Forests occupy some 10% of Mogolian territory.

The country has over 100 species of mammals, more than 300 species of birds and 70 species of fish. There are large nature reserves in the Khentei, in the surroundings of Ulan Bator and is the Trans-Altaic deserts, while the Gobi is host to some extremely rare species including the wild camel, the Gobi bear, wild sheep and mountain goats.

Political Data

The Mongolian People's Republic is a sovereign socialist state. In 1921 the Mongolian people carried out an antifeudal and anti-imperialist people's democratic revolution. The victory of the People's Revolution was proclaimed the same year. On 26 November 1924 Mongolia was proclaimed a People's Republic, and the first Constitution of the Mongolian People's Republic was adopted. The present Constitution, adopted on 6 July 1960, provides that all power in the Republic belongs to the working people. The economic foundations of the social structure are socialist ownership of the means of production and *the socialist system of production.*

The political system is based on the Khurals of People's Deputies, which are elected on the basis of universal, equal and direct suffrage exercised by secret ballot. All citizens aged 18 or over have the vote.

Mongolian society comprises two fraternal classes, the working class and the working *arats* (farmers and herdsmen), and over the years of people's rule a national intelligentsia has come into being. Mongolian women - the most backward section of society before the revolution - now play a great part in public affairs and political life.

The supreme organ of state authority and sole legislative organ is the Great People's Khural, which is elected by the citizens for a five-year term on the basis of universal, equal and direct suffrage exercised by secret ballot. The Great People's Khural confirms and amends the Constitution, lays down the basic principles of domestic and foreign policy, confirms the national economic plan, the state budget and the report on its execution, and so on. In the periods between sessions of the Great People's Khural, the supreme organ of state authority is its Presidium.

The supreme executive and distributive organ of state administration is the Council of Ministers, which is formed by the Great People's Khural. At *aymag* (province), *somon* (district), town and urban district level, the local organs of state authority are the Khurals of Deputies, which are elected for a three-year term. The Khurals elect executive boards from among their members.

The leading role in the country's social, political and economic life is played by the Mongolian People's Revolution Party (MPRP), which was established on 1 March 1921. The public organizations with the largest membership are the Mongolian trade unions, the Mongolian Revolutionary Youth League and the Committee of Mongolian Women. For administrative purposes the country is divided into 18 *aymags* and about 300 *somons*, while the towns of Ular Bator, Darham and Krdene are divided into separate administrative units.

1.2 SOCIO-CULTURAL AND ECONOMIC SITUATION

Until the People's Revolution of 1921, Mongolia was a feudal theocratic state. The people were doubly oppressed; on the one hand by the local feudal lords both secular and clerical, and on the other by foreign commercial and usurious capital. At that time the country has no scientific, cultural or medical establishments of its own, and no more than 0.5% of the population were literate. Mortality was very high, and the nation was virtually on the brink of physical extinction.

After the triumph of the People's Revolution, our people opted for a gradual transition from feudalism to socialism, omitting the capitalist stage of development. During the general democratic phase of the revolution (1921-1940), the Mongolian people overcame the fierce resistance of domestic reaction, defeated the plots of the imperialist aggressors, swept away, with the support of the USSR, the political and economic foundations of feudalism and the outposts of foreign capital and brougth democracy into all spheres of community life.

In the 1940s, Mongolia set about laying the foundations of socialism. In those years, with Soviet aid, Mongolia transformed itself from an agrarian into an agro-industrial country. By 1960 all the one-man *arat* holdings had been brought into the cooperative system, and a unified socialist system of ownership had taken hold. In the early 1960s the country embarked upon a period of more extensive building of socialism.

The Fifteenth Congress of the Mongolian People's Revolutionary Party (MPRP) in 1966 adopted a fourth new programme for the party. This new programme laid down the objectives, purposes and chief guidelines for the country's further development towards the complete triumph of socialism in Mongolia. The programme recorded the fact that in the Mongolian People's Republic socialism had become a reality.

Population

According to the 1978 figures, the population of Mongolia exceeds 1.5 million. The official language is Mongolian. The natural increase in population is high, the rate being almost 3%. Characteristically the younger age-groups predominate. about 60% of the entire population is aged 30 or less.

The Economy

For the Mongolian people, the 1921 revolution ushered in a period of social and economic rebirth and created favourable conditions for all-round development of the economy. Since the people have been in power, Mongolia has not only overcome its age-old backwardness, but become a fast-developing socialist agro-industrial state. As a result of the consistent policy of the MPRP and the Mongolian Government in pursuing comprehensive development of the economy, the country's economic potential is growing steadily. In 1979 the gross social product of the Mongolian People's Republic was 5.4 times that of 1960.

The economic development of Mongolia is conspicuous for the high and stable growth rates of social production; the national income in 1978 was 2.1 times that of 1960. The mean annual growth rate of the national income was 1.1% in 1961-1965, 4.3% in 1966-1970, 6.7% in 1971-1975 and 5.7% in 1976-1979. Since the people came to power, both quantitative and qualitative changes have been made in the structure of the economy. The industrial sectors of the economy now produce more than 60% of the social product and 40% of the national income. Industrial sectors are increasingly one of the main factors determining the pace of development of social production in Mongolia.

Industry

The following industries are now present in the Republic: fuel, power generation, ore-mining, metalworking, building materials, forestry and wood-working, leather and footwear, textiles, knitwear, fulling and felting, clothing, printing, food, soap-making and others. Gross industrial output was multiplied by 5.6 between 1960 and 1978, and the average annual growth rate of gross output for the period since 1950 is about 10%. Despite the high rate of growth in gross output, heavy industry of the Mongolian People's Republic does not yet hold a dominant position in the economy. It now provides some 38% of the aggregate social product and 25% of the national income.

The development of ore-mining began in 1946. The industry is dominated by enterprises that mine and concentrate fluorspar, tungsten, gold and other rare non-ferrous metals as well as non-metallic minerals. Most of the output of the ore-mining industry is exported.

The building industry is composed mainly of construction combines, combines producing building materials, brick, and cement works, and integrated bases each comprising a factory prefabricating reinforced concrete items, an assembly shop, and a woodworking shop.

Before the revolution Mongolia used to import many food products, especially flour, barley, confectionery, sausages, etc. Factory production of foodstuffs within the country did not begin until 1940. Now the Mongolian food industry comprises more than 2 000 enterprises accounting for some 25% of all industrial output. They include large mechanized meat-packing combines, flour mills, industrial confectionaries and bakeries creameries and a brewery/distillery.

Light manufacturing accounts for some 30% of gross industrial output. Enterprises in this sector are engaged mainly in processing sheepskins, leather and wool, and in clothing manufacture. Over the years of the people's rule, with the unfailing and selfless assistance of the USSR and other countries of the socialist community-especially the countries members of CMEA – a modern national industry has been built up in Mongolia completely from scratch, and has radically changed the structure of the national economy.

Agriculture

In pre-revolutionary Mongolia all the land and almost half the livestock were owned by the secular and clerical feudal lords. The principal, and virtually the sole, sector of the economy was extensive nomadic stock-raising. Since the people took power, drastic changes have been made in Mongolian agriculture. From the social standpoint, the cooperative movement has triumphed everywhere. From the economic standpoint, agriculture has been diversified from one branch to many. The socialist sector has been substantially developed and strengthened and it is now represented by two forms of ownership: state ownership, in the form of state farms; and cooperative ownership in the form of agricultural associations.

Since the people took power, the material and technological bases of agriculture have been greatly strengthened. For the development of animal husbandry, the creation of a reliable fodder supply was crucial. In recent years dozens of mechanized teams or units have been set up, sharply increasing the degree of mechanization applied to haymaking. With the assistance of the USSR, a number of concentrates factories have been built in Mongolia. The combined effect of all these measures has been to secure the steady development of animal husbandry as a whole over the past two years. By 1977 the livestock population has grown 2.4 times, and the volume of agricultural output 4.7 times, what it had been in 1918. The Republic is now the foremost socialist country for both livestock population and per capita output of animal produce, and among the world's leaders for number of live-stock per head of the human population.

The reclamation of vast tracts of virgin land fosters the rapid growth of arable farming, which now provides almost a quarter of all agricultural output. Mongolia now meets the domestic for grain entirely out of its own productive resources.

Despite the enormous changes that have taken place in the structure of the economy, including that of industry, agriculture is still the basis of the economy in Mongolia. It is paramount in the generation of national income, and its output provides almost 90% of Mongolian exports.

1.3 DEVELOPMENT

In pre-revolutionary Mongolia, the economy was based solely on nomadic stock-rearing. The country has no industry apart from some small individual workshops which processed raw materials of animal origin and most of which were owned by foreign merchants. Feudal production relationships and the dominance of foreign capital stunted the growth not merely of the domestic market but the economy as a whole. The development of a productive capacity was hampered by the total illiteracy of the population, who were completely under the influence of the lamas. Mongolia had almost no domestic sources of capital formation for economic growth, and no monetary or financial system of its own.

With the victory of the People's Revolution in 1921, Mongolia began a transition from feudal backwardness to socialist progress, bypassing the stage of capitalism, and took the path of social and political transformation of society. During the general democratic phase of our revolution (1921-1940), the class of feudal lords was liquidated and the sway of foreign capital brought to an end. Directly after the victory of the revolution, state and cooperative enterprises began to be established, first in the sphere of commerce and then in that of the production of goods. The monetary and financial systems were brought under state control. Effective economic levers came into the hands of the people, and the state began to use them to discharge its economic functions with the aim of consolidating the gains of the revolution.

The deciding factor in the struggle to secure political and economic independence and to create a socialist economic system in those difficult years and thereafter was the unshakable alliance and all-round cooperation between the Mongolian People's Republic and the Soviet Union.

Between 1921 and 1940 the foundations of national industry were laid and new modes of transport and communications were developed. In agriculture the first rudiments of a state sector and a cooperative sector emerged. By 1940 industry had already become an independent branch of the Mongolian economy. The first nuclei of the Mongolian working class and of Mongolian engineers and technicians were appearing. As the country moved towards socialism, the MPRP and the Government of the Republic paid great attention to the pursuit of a genuine cultural revolution. Steps were taken to eradicate illiteracy, foundations were laid for the national education and public health systems, and a basis for modern art, culture and science was created. Since the early years of the people's rule, the state and party have made the emancipation of women, and the active involvement of women in public life and politics, their particular concern.

During the socialist phase of the revolution (1940-1960) Mongolia laid the foundations of socialism. Radical changes were made in the class structure of society, while state management of the economy began to be instituted on the basis of national economic planning. During that period, the state's activities in the fields of economic organization, culture and education were directed towards the planned administration of components of the socialist sector in the economy. By the end of the 1950s, the voluntary grouping of the *arat* holdings into agricultural cooperatives was completed. This marked the triumph of socialist production relationships in the Republic.

By 1960, by dint of sustained development of industry, Mongolia had become an agro-industrial country. The Republic entered a new phase in its development - that of completing the process of laying the material and technological basis for socialism through further industrialization of the country, by mechanizing agricultural production, and by raising the technological level in all sectors of the national economy.

The Mongolian People's Republic has passed through several phases in the revolutionary transformation of society. History has proved the MPRP right in having opted for non-capitalist development along Leninist lines. In the specific historical circumstances of the Mongolian People's Republic, it has been graphically demonstrated in practice that a transition to socialism that bypasses capitalism - something held out as a theoretical possibility by Marxism- Leninism - is an objectively feasible phenomenon. The path traversed by the Mongolian people over the past 60 years can serve as an example for peoples who have opted for economic independence, for the creation and development of their own self-reliant economy.

The Mongolian People's Republic is in the forefront among Asian countries in the level of well-being and culture of the people. In 1971-1975 real per capita income increased by 17%. In such figures as number of schoolchildren (2 357), students (125), doctors (21) and hospital beds (103) per 10 000 inhabitants, Mongolia in several cases outdoes some advanced capitalist countries. The state meets several requirements of the population directly out of public funds, in the form of free education, medical care and other services. Over the past 10 years the amount of national income spent on each inhabitant has increased by almost 5%, the social consumption fund by 130%, and pensions and benefits by 50%. Real per capita incomes are now double what they were in 1960.

PART 2.

Science and technology policy framework

2.1 THE STATE POLITICAL SYSTEM

In 1921 the Mongolian nation made an anti-feudal people's revolution. As a result, an independent sovereign state - the Mongolian People's Republic - was proclaimed in 1924. The Republic took its rightful place in the United Nations in 1961 and has been a member of CMEA since 1962.

For administrative purposes the territory of the Republic is divided into *aymags* (provinces) and towns; the *aymags* are subdivided into *somons* (districts), and the towns into districts. The organs of state authority in the *aymags*, *somons* and towns are the Khurals of People's Deputies, elected by the population for terms of two to three years. The supreme legislative organ of state authority in the Mongolian People's Republic is the Great People's Khural, which is elected by universal suffrage and secret ballot for a term of five years. In the intervals between regular sessions of the Great People's Khural, the supreme organ of state authority is its Presidium.

The supreme executive and administrative organ of state authority in the Mongolian People's Republic is the Council of Ministers, formed by the Great People's Khural. The guiding and directing force of the Mongolian people, the vanguard and leader of all statal and other mass organizations of working people, is the Mongolian People's Revolutionary Party. The largest public organizations are the trade unions, the Mongolian Revolutionary Youth League and the union of Agricultural Associations of the Mongolian People's Republic.

Mongolia maintains diplomatic relations with 90 states, and has economic and cultural links with 57 countries. The Party and the Government consistently pursue a peace-loving foreign policy, and the international authority of the Mongolian People's Republic is increasing from year to year.

2.2 THE STRUCTURE OF DEVELOPMENT POLICY

The chief objectives set for the final phase in the building of socialism in Mongolia are a further improvement of the material well-being of the people, a further rise in their cultural level, all-round development of productive capacity, the attainment of high rates of growth of the country's economic strength, and a further improvement in socialist relationships in society. These objectives can be attained only on the basis of the achievements of modern scientific and technological progress in close, organic combination with the advantages of a socialist economic system. For science, the main objective is to satisfy society's growing needs to the fullest possible extent and to help in every way to raise the material and cultural level of the population.

Scientific and technological policy is an integral part of the country's social and economic policy. Its basic elements find practical expression in the Party's programme and the decisions of its Congresses; they are implemented on the basis of five-year and annual plans for the development of the national economy, including science and technology.

Since the early days of the people's rule, science has been treated as an affair of state and set to serve the people. The Republic's first scientific institution was the "Book Hall" organized in 1921 to collect archives, manuscripts, historical monuments, local lore, literary translations, etc. , in summary to create a body of popular scientific literature. In the 1930s this was transformed into a learned committee, and sections directly concerned with the building of the economy were established under it. In this way the Committee of Sciences was enabled to pursue research in the interests of Mongolia's economic development. In 1961 the Academy of Sciences of the Mongolian People's Republic was founded as a major scientific centre to coordinate fundamental research in our country. In 1971 a State Committee on Science and Technology was established under the Council of Ministers as a state organ with instructions to formulate and implement a unified policy for the development of science and technology and to accelerate scientific and technological progress in Mongolia.

A decisive role in the birth and development of science and technology in the Mongolian People's Republic has been played by scientific and technological cooperation with the Soviet Union. The USSR has rendered the Mongolian people invaluable assistance in training scientists, organizing scientific research centres and making a comprehensive survey of the country. The help of the Soviet Union has been the main factor in establishing a national educational and scientific potential in Mongolia within a brief period of history.

If socialism is to be built in our country, science must be developed further and its achievements applied to the economy. Late last year the Party Central Committee adopted a detailed resolution "On the condition of scientific research work in the country and measures to improve it", which contained a thorough analysis of the current state of development of science in Mongolia and laid down the main guidelines for the development of science as a whole.

Scientific and technological activity in the Mongolian People's Republic is based on a unified (five-year and annual) state–wide plan and on correlating work on the key problems of scientific and technological development with the requirements of the main economic sectors. The State Planning Committee of the Mongolian People's Republic, the State Committee on Science and Technology, the Academy of Sciences, the State Committee on Prices and Standards and the competent ministries and departments all participate in laying down the main guidelines for such development.

The five-year plan for the development of science and technology is drawn up on the basis of the main guidelines laid down at ministerial and departmental level and of other future-oriented documents, and forms a separate but integral part of the five-year plan for the development of the economy and culture. The five-year plan is the fundamental form of planning for the development of science and technology.

The State Committee on Science and Technology and the State Planning Committee decide which major scientific and technological problems and applications are to be included in the five-year plan for the development of science and technology, and which ministries and departments are to be responsible for dealing with them. In their turn, the ministries and departments decide which scientific organization is to deal with each specific problem. The State Committee on Prices and Standards is responsible for drawing up the plan on standardization and product quality, and for ensuring that it is carried out.

To deal with each major scientific or technological problem, a coordination plan is drawing up specifying the phases, the starting and completion dates, the executor and co-executor, the expenditure required and the expected results. The coordination plan serves as a basis for drawing up the annual plans of research institutions.

The five-year plan for the development of science and technology is discussed at a session of the Great People's Khural of the Mongolian People's Republic. A coordination plan is drawn up consistent with the five-year plan, which is submitted to the Council of Ministers of the Mongolian People's Republic and thereafter confirmed by the State Committee on Science and Technology, which also monitors its implementation. In the light of the main provisions of last year's resolution of the MRPR Central Committee, Mongolia is changing over in the course of the period 1981-1985 to a more refined system for planning scientific and technological development. The essence of this system lies in the preparation of a unified plan comprising the optimum number of single-purpose programmes.

2.3 THE STRUCTURE OF SCIENTIFIC AND TECHNOLOGICAL POLICY-MAKING

At the end of the 1960s and the beginning of the 1970s, substantial changes were made in the national scientific and technological policy. Some changes were strategic, others tactical.

The Party's strategic course for the further development of science and technology during the period for laying the material and technological basis for socialism in the Mongolian People's Republic was formulated as follows in the MPRP's new programme: "comprehensive development of the various branches of science, especially the natural, technological, and social sciences; consolidation of the network of scientific institutions; extensive training of scientific staff in accordance with the requirements and foreseeable development of the economy and culture ; and comprehensive strengthening of the link between science and production".

As the Party and Government pursue this course, the scientific research base in the leading industries and agriculture is being further strengthened and active measures are being taken to expand and intensify bilateral and multilateral cooperation in science and technology with CMEA countries, especially the USSR. As a result, the network of sectoral research institutes has been expanded and strengthened considerably in recent years, while research and development have increased in scale. Over the past 10 years, for instance, a score of scientific institutions have been founded. Improved methods of financing research are being introduced, and wider use is being made of research and development work under contract. The intention here is to concentrate the main efforts on the direct application of final research results to production and on making more efficient use of new hardware and technology.

In addition, however, both the strategy and the consequent tactics of Mongolia's science policy have been directed towards improving the organizational structure for administering scientific and technological development. For example, the Academy of Sciences of the Mongolian People's Republic has been strengthened and a Research Coordination Council was established in 1966 under the Council of Ministers to provide state management of scientific and technological development and to improve the planning and coordination of research. In 1971 this Council was reorganized as the State Committee of the Council of Ministers on Science and Technology. Both the State Committee and the Academy plan an important part in the formulation and implementation of state policy on scientific and technological development. The State Committee monitors plan fulfilment, pursues a unified policy on the development of science and technology and is responsible for the application of results, while the Academy of Sciences lays down and coordinates the main guidelines for the development of theoretical and fundamental research. The science management functions of the competent ministries and departments are to decide upon the topics for research and development, to provide the necessary finance, materials and equipment, and to staff the research organizations. Thus the state system of science organization consists of interrelated subsystems which are relatively autonomous but which function as a unified whole.

PART 3.

Scientific and technological potential

3.1 ORGANIZATIONAL STRUCTURE

Comprehensive utilization of the achievements of science and technology is of decisive importance in laying the material and technological basis of socialism in the Mongolian People's Republic. Complete electrification of the country : the application of new hardware and technology; improvements of the organization of production and the comprehensive mechanization of production processes; extensive application of the achievements of physics, chemistry and biology to the national economy; the establishment and development of efficient new sectors of production; the comprehensive and rational use of human, material, labour and natural resources; and a close partnership between science and production: all these objectives call for systematic development of the country's scientific and technological potential.

We include in the country's scientific research potential research institutes, testing and experimental stations, ancillary stations, production research centres, and the "problem-solving" laboratories at higher educational establishments performing systematic research. By way of a qualitative and quantitative estimate of that potential, we shall consider its skilled-manpower material, equipment and financial components in more detail and assess the relative importance of pure research in the "research-production" system, together with scientific capacity which is expressed both as the proportion of R&D personnel to the total work force of the national economy and as the ratio of expenditure on science to total national income, and other indicators.

The Mongolian Academy of Sciences runs 13 research institutes which investigate and endeavour to solve major theoretical and practical problems of great importance to the economy. The work of the Academy is directed and coordinated by its Presidium, which comprises the President, Vice-Presidents, Scientific Secretary and Members elected at the General Assemblies of the Academy.

A significant contribution to the development of fundamenal and applied research in the social, natural, technological and agricultural sciences is being made by the sectoral research institutes, of which there are 31 in Mongolia. In recent years their experimental and pilot production facilities have been strengthened considerably and the scope of their research into topical problems of Mongolia's economic and cultural development has been widened. There are eight testing and experimental stations in the country.

Scientific research in the Mongolian People's Republic is organized on the basis of the guidelines for the development of science and technology and the state five-year plan for the development of the national economy and culture. Projects for the planned development of science and technology are drawn up by research institutions, the Academy of Sciences, ministries and departments under the methodological guidance of the State Committee on Science and Technology. This Committee works in conjunction with the State Planning Committee to correlate the scientific and technological development plan with the other sections of the national economic plan, and in particular with the economic objectives, financial resources, material inputs and personnel training plans for the country as a whole. In the plans for the development of science and technology, special emphasis is placed on the application of the latest achievements of Mongolian and foreign science and technology to production, on appropriations for R&D, on training highly qualified scientific manpower, and on optimizing the state network of scientific institutions.

The annual and five-year plans for the development of science and technology are based on the main guidelines for such development. These plans make provision for the quickest possible solution of scientific and technological problems that are especially important in connection with the further development of sectors of the economy and with speeding up the application of the achievements of domestic and foreign science and technology to production. Over the past quinquennium (1976-1980), the scientific organizations of the sectoral ministries and departments have concentrated on solving 28 fundamental scientific and technological problems, including the most pressing questions relating to the development of their sectors. One organization is placed in charge of the work on each problem, and a council is set up to deal with it.

3.2 HUMAN RESOURCES

Human ressources are one of the basic factors in the development of science and technology.

The process of staffing the country with scientific and technological personnel began with extensive cultural construction, the provision of universal education, measures to raise the cultural and technological level of the working people and the institution of scientific and technological cooperation with the Soviet Union. Systematic measures were taken in the Mongolian People's Republic to organize networks of general, specialized, secondary and higher educational establishments to train professional staff. Soviet educationists helped to organize the first schools in the country and trained its first teachers. Special teaching establishments were opened in the Soviet Union to educate young Mongolians of both sexes. An extensive network of general schools, vocational and technical training centres, specialized secondary schools, higher educational establishments and scientific research institutions has now been set up in Mongolia. The first higher educational establishment was founded in 1942, while the system of vocational and technical training centres dates from 1964. The introduction of free tuition at all educational establishments in Mongolia, the provision of grants for pupils and students at vocational and technical training centres, specialized secondary schools and higher educational establishments, and the institution of a system of day-time, evening and correspondence courses have created optimum educational opportunities for the broad masses of the working people.

The number of specialists with higher or secondary qualifications employed in science and technology is rising yearly. According to the 1980 figures, scientific institutions and organizations employed a total of more than 4 500 people, including 1 700 scientific officers, 700 auxiliary staff and more than 1 000 engineers and technicians. Over the past five years the total numbers have increased by 1 500; there are 19.2% more scientific officers and 26.6% more auxiliary workers. Over the same period more than 20 Doctors of Science and more than 300 Candidates in Science have been trained. The country now has more than 70 Doctors of Science and some 900 Candidates in Science, of whom 22% work at the Academy of Sciences, 19% in sectoral institutes, 31% in higher educational establishments and 28% in other sectors of the economy.

Mongolia is among those countries which have a high proportion of women working in science and technology. Between 1975 and 1980 the proportion of women among workers in those fields increased from 33.8 to 45.1%

The CMEA countries give Mongolia assistance free of charge in training scientists and specialists. In addition, the USSR and other fraternal countries send highly qualified specialists to research and development institutes in the Mongolian People's Republic to assist in research into key problems of scientific and technological development. Mongolian scholars and scientists participate actively in international courses, special seminars and schools. As a result of cooperation with the Soviet Union and other countries of the socialist community, the Mongolian People's Republic now meets all its own requirements for scientific staff.

The training of scientific personnel, the association of scientific specialists with the research carried on in the Republic and the opening there of new scientific institutions and higher educational establishments where new scientific knowledge and advanced scientific and technological thinking are daily and intensively pursued, impart a vigorous thrust to the development of modern science in our country. A socialist society provides genuine opportunities for the comprehensive development of the individual and for his spiritual and material well-being; hence the factors making for a brain drain have been totally eliminated in our country. Every member of our society has a stake in working for the good of the homeland.

3.3 FINANCIAL RESOURCES

The state provides the funds needed to strengthen and intensify scientific and technological potential and to make it more efficient. In 1976-1980 capital investment in scientific and technological development was 110% greater than in 1971-1975, and the fixed assets of scientific institutions increased by 190% between the two periods.

The sources of research finance in Mongolia are state budget appropriations and the scientific organizations' own resources. The first priority for state budgetary resources is to meet the entire financial requirements of the institutes of the Academy of Sciences engaged in fundamental research; appropriations are also made for research projects carried out at higher educational establishments, and in some cases for sectoral research organizations. The proportion of expenditure on science financed by budgetary appropriations is gradually decreasing for, whereas more than 80% of such expenditure was covered by the budget in 1970, the corresponding figure for 1980 was about 60%.

The sectoral research organizations' own resources derive from earnings from the application of their results to production, research work done under contract, the preparation of project documentation, the production of various articles at scientific establishments, and so on. The income of sectoral research institutions is gradually increasing. In 1971 they covered 34.3% and in 1980 53.6% of their expenditure out of earnings.

In order to finance particularly important work of decisive importance in speeding up the country's scientific and technological progress, 2% of all funds allocated to research in the planning year go to constitute a special reserve fund administered by the State Committee on Science and Technology of the Council of Ministers of the Mongolian People's Republic.

Some research organizations establish their own research development fund in order to foster managerial initiative in the conduct of highly effective research work and to strengthen their material and technical base. This fund is intended to finance additional capital investment, top cover the purchase of scientific equipment, instruments and materials, and so on.

The intention for the future is that all sectoral research organizations run by industrial ministries should gradually become completely self-financing. It is also planned to establish, at those ministries, funds for scientific and technological development and funds to finance the acquisition and introduction of new hardware and technology. Budgetary financing will be retained chiefly for theoretical research and for work of nationwide importance.

PART 4.

Policy issues of scientific and technological development

4.1 MAJOR ACHIEVEMENTS

Over the past 10 years Mongolia has made significant advance in the development of science and technology. The material and technological base of scientific institutions has been strengthened, the numbers of qualified staff have increased, the scope of research has been broadened and its effectiveness enhanced, the scientific organization of labour and the planning of scientific and technological work have been improved, and scientific and technological cooperation with the Soviet Union and other socialist countries has been expanded. This makes for the attainment of a proper standard in research, and an increase in the dividends that production reaps from science.

A second organizational structure has emerged in Mongolia for the administration of science at the national level. In the last quinquennium (1976-1980) the scientific and technological development plan became an integral part of the five-year plan for the development of the economy and culture.

In 1972 a National Centre for Scientific and Technological Information was set up in the Mongolian People's Republic as the core of a national information system. This Centre is in regular contact with scientific and technological information centres in the Soviet Union, with the corresponding institutions in other socialist countries, and with the International Centre for the Scientific and Technical Information of the CMEA countries. In recent years, sectoral information sevices have made their appearance in certain ministries, departments, institutes and large-scale enterprises.

4.2 ACHIEVEMENTS AND PROBLEMS

Scientific organizations and sectoral ministries and departments have concentrated on endeavouring to solve such important problems of economic development as the location of productive capacity, the supply of energy and heat, the study of natural resources, the rational use of surface and ground-waters, scientific principles for stabilizing the fodder supply to animal husbandry and efficient use of pastures and hay crops, improved techniques for processing raw leather and wool, the use of local materials in building, and so on.

Mongolian scientists take an active part in the "Intercosmos" programme run by the CMEA countries. The physicotechnical, technological and medico-biological experiments successfully completed during the Soviet-Mongolian space flight are an example of their modest contribution to cooperation among the fraternal countries.

Joint geological prospecting of Mongolian territory by scientists and specialists from CMEA countries has brought to light large deposits of coal, phosphorites, copper, molybdenum and other minerals, on the basis of which such sectors of the economy as mining, power generation and the building materials industry are being developed. The data from such geological surveys have been used to compile geological, tectonic and hydrogeological maps of Mongolia, and a map showing its mineral resources. A number of fundamental scientific treatises have been published dealing with highly topical questions relating to the geology of the Republic.

Mongolian biologists, in collaboration with scientists fraternal socialist countries, have done a great deal of work on the discovery and inventory of the country's biological resources. They have divided its territory into botanical and zoological regions and investigated its commercially exploitable stocks of wildlife and vegetation. Agricultural research has led to the breeding of new strains of sheep, goats and pedigree pigs and new varieties of cereal and vegetable crops suited to natural and climatic conditions in Mongolia.

The scientific teams of sectoral research and design institutes are making a significant contribution to the cause of faster scientific and technological progress. In recent years the have systematically brought dozens of new articles into production and applied advanced technologies, automation and mechanization to production processes. Techniques for the application of new technology are improving yearly, as are the links between science and production; capital formation resulting from the application of scientific and technological achievements to production is increasing significantly.

A special role is assigned to the social sciences, which distil the experience gained at successive stages of socialist development, identify the objective laws governing the historical process of development of the state and formulate the country's short-term and long-term policies for economics, science and technology. A large and valuable contribution to scientific research, and to the issue of practical recommendations, is made by the professors and teachers at higher educational establishments in the Republic.

In spite of all this, the development of science remains a pressing problem for us. Scientific research has not yet attained the desired level of effectiveness. More must be done to strengthen the material and technological base for research and the testing and experimental facilities for scientific institutions and higher educational establishments.

4.3 PURPOSE AND OBJECTIVES

Mongolia is highly appreciative of the role played by science and technology as a powerful driving force and an essential instrument of social and economic progress. This attitude is based on the historical teachings of Marxism-Leninism, which identify the basic laws of scientific and technological development and its role in enhancing the well-being of society.

The fundamental purpose of a socialist state is to satisfy the population's growing material and spiritual needs as fully as possible by ensuring their comprehensive development. The political and economic prerequisites for fulfilling that purpose are guaranteed by the Constitution of the Mongolian People's Republic: ownership of the land, subsoil and means of production by the people; no exploitation of man by man; social equality and freedom.

The subordination of scientific and technological progress to social and economic purposes entails keeping its consequences under continuous review. In the Mongolian People's Republic, therefore, the results of the application of science and technology to the well-being of the working people, to the improvement of working conditions, to the conservation and rational use of the natural environment and to raising the cultural level of the people are continuously monitored and adjusted. Such adverse effects as unemployment, the spread of crime, environmental pollution and so on are completely ruled out in Mongolia.

By a decision adopted at the Seventeenth Congress of the MPRP, new social and economic objectives were set for 1976-

1980: a further rise in social production, an increase in its efficiency, an improvement in the quality of work in all sectors of the economy and culture, and a rise in the level of living of the country's working people. In pursuit of those objectives it has proved essential to increase the effectiveness of scientific research and to improve the quality of its results. One way of meeting the new requirement might be, in particular, to expand scientific research and apply the results of scientific and technological development work, new equipment and new technology to the economy, to strengthen the links between science and production; to improve the planning of scientific research and the management of scientific institutions; and to expand scientific and technological cooperation with the Soviet Union and other socialist countries.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

The Mongolian Government's fundamental policy for foreign economic affairs is to broaden and intensify economic, scientific and technological cooperation with the Soviet Union and other CMEA countries, to secure for the Republic an active part in the international socialist division of labour and to increase still further the part played by foreign economic, scientific and technological relations in the attainment of Mongolia's social and economic objectives.

Mongolia's bilateral and multilateral cooperation with CMEA Countries in science and technology has been expanding vigorously in recent years, because it has become an important factor in speeding up the scientific and technological progress of the Republic. In the history of our country's bilateral scientific and technological cooperation, that between Mongolia and the USSR has an important place; it affords a convincing example of the new type of inter-state relations based on the principles of proletarian internationalism. In addition to the traditional forms of scientific and technological cooperation, such new forms as consultations on matters of scientific and technological policy, joint forecasting and planning of scientific development and joint research into agreed topics are now widely practised between our countries.

Mongolia has now been practising scientific and technological cooperation with other socialist countries for 18 years. The characteristic feature of the development of bilateral scientific and technological relations with socialist countries, including the CMEA countries, in recent years has been the fact that they are based on intergovernmental agreements, protocols and general specifications for the practice of scientific and technological cooperation with each individual party, and have thus required a stable legal and organizational basis; a guarantee that the cooperation will be effective and long-lasting.

Amid the scientific and technological revolution taking place today, international cooperation in science and technology takes on a new character; for it often happens that the conduct of R&D and the application of the results to many scientific and technological problems exceeds the capabilities of individual countries, even those that are economically, scientifically and technologically advanced. In such cases, international scientific and technological cooperation is the most practical, and sometimes the only possible, means of carrying out large-scale scientific and technological projects requiring heavy inputs of money, materials and manpower.

Consequently multilateral scientific and technological cooperation between the Mongolian People's Republic and the CMEA countries has been, is being, and will be, developed further. Moreover, such cooperation is a tremendous factor in the growth of Mongolias's scientific and technological potential, and is also of importance in speeding up the process of bringing our countries' levels of scientific and technological development closer and closer to equality. A milestone in the development of scientific and technological cooperation between the CMEA countries was the adoption by CMEA, at its twenty-fifth session, of a comprehensive programme for the socialist integration of our countries. As a result of the sustained implementation of that programme, cooperation between our countries in science and technology is being intensified, direct contacts between ministries, enterprises and scientific institutions are being more and more widely developed, and it is a steadily expanding practice to conduct joint R&D projects based on contracts and carried out by mixed working groups, scientific teams and the like.

A new step forward in developing and intensifying scientific and technological cooperation between the Mongolian People's Republic and the CMEA countries was the adoption by CMEA, as a matter of priority at the thirty-second session, of long-term single-purpose programmes of cooperation. The implementation of these programmes will play an important part in laying the material and technological foundations for socialism in Mongolia, in developing the country's industry and in accelerating its economic growth. A striking example of the great significance of combining the efforts of fraternal countries is the construction of the joint Mongolian-Soviet "Erdene" ore concentration combine to work a large deposit of copper and molybdenum. In collaboration with Bulgaria, Czechoslovakia and the German Democratic Republic, Mongolia is prospecting in its territory for various minerals with a view to their joint exploitation. Under a long-term single-purpose programme of cooperation, steps are in preparation to intensify animal husbandry and cereal cultivation through the comprehensive reclamation of large areas of farmland in Mongolia. In pursuit of these objectives, further development of multilateral scientific and technological cooperation is also planned.

Experience has confirmed that all advances in the realm of science and technology stem from Mongolia's cooperation with the fraternal socialist countries. The further expansion and intensification of scientific and technological cooperation with the CMEA countries is consequently an integral part of Mongolia's policy for the development of science and technology.

The main directions in which scientific and technological cooperation is likely to be pursued at the regional and international level over the next 10-15 years are:

- power generation and electrification;
- agriculture and food;
- natural resources (prospecting, extraction and processing);
- new materials;
- computer and laser technology;
- water resources;
- transport;
- medicine;
- protection of nature and the environment.

On the basis of the foregoing, the essential priorities for the developing countries in the development of science and technology are:

- agriculture and food;
- natural resources; and
- industry, as the specific circumstances in each country dictate.

For the developing countries, the successful development of scientific and technological cooperation in these main areas depends on a number of political, economic, scientific and technological factors. The strengthening of peace throughout the world, the deepening of international *detente*, and restriction of the arms race, are essential conditions for the development of international cooperation in science and technology and for the productive application of modern scientific and technological achievements for development purposes. Mongolia's position is based on the complete conviction that the efforts of United Nations organs and of the governments of countries will be crowned with success only if states and nations are able to develop in peace.

NEPAL

Table of Contents

NEPAL

GEOGRAPHY

Capital city: Kathmandu
Main ports: —
Land surface area: 140,797 sq km

POPULATION (1978)

Total	13.4 million
Density (per sq km)	95
Urban/rural ratio (1971)	0.04
Average rate of growth (1970-78)	2.0%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	42.5	10.2	8.5	33.7	5.0	100%

SOCIO-ECONOMIC

Labour force (1971)	
Total	4.9 million
Percentage in agriculture	94.4%
Gross national product (1978)	
GNP at market prices	US $1,580 million
GNP per capita	US $ 120
Real growth rate of GNP per capita (1970-78)	0.3%
Gross domestic product (1975)	
Total (in current producers' values)	US $ 1,347 million
Percentage by origin	
Agriculture	67%
Manufacturing, mining & quarrying, electricity, gas & water, construction	11%
Government finance	
National budget (1978)	US $ 129 million
As percentage of GNP	7.8%
External assistance (official, net; 1976)	...
As percentage of GNP	...
Exports (1978)	
Total exports of goods	US $87 million
Average annual growth rate (1970-78)	...
External debt (1978)	
Total public, outstanding + disbursed	US $ 88 million
Debt service ratio (% GNP)	0.2%
(% Exports of goods and non-factor services)	1.4%

Exchange rate (1978): US $1 = 12.08 Rupees

EDUCATION

Primary and secondary education (1978)	
Enrolment, first level	875,494
As % of (6-8 years)	77%
Enrolment, second level	370,231
As % of (9-15 years)	16%
Combined enrolment ratio (6-15 years)	36%
Average annual enrolment increase (1972-1978)	12.4%

Higher education (third level) (1978)

Teaching staff, total	2,311	

Students and graduates by broad fields of study:

	Enrolment	Graduates
Social sciences and humanities	24,606	7,948
Natural sciences	2,786	879
Engineering	1,673	255
Medical sciences	1,717	671
Agriculture	1,160	624
Other and not specified	—	—
Total	**31,942**	**10,377**
Number of students studying abroad	1,452	

Education public expenditure (1978)

Total (thousands of Rupees)	322,705
As % of GNP	1.6%
Current, as % of total	94.0%
Current expenditure for third level education, as % of total current expenditure	32.4%

Table 1. Nomenclature and Networking of S&T Organizations

I - First level - POLICY-MAKING

Country: Nepal

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
1. National Council for Science and Technology	(a) To formulate the national policy on science and technology; (b) To establish co-ordination in the research programmes of His Majesty's Government (HMG) and Tribhuvan University (TU); (c) To advise HMG on policy matters related to science and technology.	National Planning Commission	(a) Library Sub-Committee (b) Mapping Sub-Committee (c) Scientific and Technological Publication Sub-Committee	Ministry of Education, Royal Nepal Academy, Tribhuvan University, Departments of Health Services, Irrigation, Hydrology and Meteorology, Mines and Geology, Agriculture, National Parks and Wildlife Conservation, Medicinal Plants.
2. National	To formulate necessary policies and issue directives on education including science and technology education at school and college levels			National Planning Commission, Ministry of Education and Culture, Tribhuvan University
3. Water and Energy Commission	(a) To co-ordinate various programmes related to survey and feasibility studies as well as research works in the energy sector;			National Planning Commission, Ministries of Food and Agriculture, Forest, Finance, Foreign Affairs, Industry and Commerce, Water Resources, Land and Justice
4. Ministries of Industry and Commerce; Works and Transport, Food and Agriculture, Communication, Health, Water Resources, Forests	(a) To formulate short and long term plans and policies on research and development in this sector; (b) To define R&D needs in their related sectors.	Cabinet Secretariat	Different departments under the related ministry	

II - Second level - PROMOTION & FINANCING

Organization	Linkages		
	Upstream	Downstream	Others
A. *Royal Nepal Academy*	Ministry of Education and Culture	Scientific Associations	National Planning Commission, Ministry of Education and Culture, and Tribhuvan University
B. *Scientific Association & Societies** 1. Nepal Agriculture's Association 2. Nepal Engineers' Association 3. Nepal Medical Association 4. Nepal Pharmaceutical Association 5. Nepal Veterinary Association 6. Nepal Chemical Society 7. Nepal Geological Society 8. Nepal Nature Conservation Society 9. Nepal Forestry Association	Ministry of Education and Culture, National Council for Science and Technology and Royal Nepal Academy		Related departments of the government and institutes of the Tribhuvan University
C. *Research Division, Tribhuvan University*	Rector's Office	Institute of Science and Technology, Humanities	
D. *Ministry of Forests*		Forestry Association, Forest Research Offices	Ministry of Forests, Tribhuvan University, Travel Association (NATA, PATA)

---

* These are registered professional organizations, whose corporate powers are vested in the Executive Council/Committee formed of the elected members of the general body.

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages	
		Upstream	Others
A. *Institutes of the Tribhuvan University* 1. Institutes of Science and Technology, Engineering, Medicine, Agricultural Science and Animal Husbandry, Forestry	(a) To train manpower at various levels (undergraduate, graduate, research) in their respective fields of science and technology (b) To conduct scientific research, basic as well applied, in their respective areas	Central Office of the Tribhuvan University	National Council for Science and Technology, all the concerned ministries and departments of the government and related institutions of Tribhuvan University
B. *Research and Development Agencies* 1. Research Centre for Applied Science and Technology (Tribhuvan University)	(a) To undertake research and experimental development activities in different areas of applied science and technology (b) To collect and disseminate knowledge and information on appropriate technologies (c) To undertake feasibility and experimental development studies on technologies used for the utilization of natural products and harnessing natural resources (d) To promote consultancy services on the application and dissemination of suitable technologies		National Council for Science and Technology, Institutes of Tribhuvan University
2. Energy Research and Development Group (Tribhuvan University)	(a) To survey the country's energy resource and energy demand (b) To develop methods of increasing efficiency of energy utilization, energy conservation and environmental protection (c) To conduct seminars on energy resources, development, management and utilization	Institute of Science and Technology	Research Centre for Applied Science and Technology and Institute of Engineering of Tribhuvan University
3. Department of Medicinal Plants	(a) To undertake scientific and technological research related to the development and utilization of medicinal and aromatic plants (b) To undertake development and quality control of drugs and allied materials and to render analytical services to various agencies (c) To undertake extension programmes for the cultivation of economically important medicial and aromatic plants (d) To conduct study on the vegetation and plant ecology and publication of Nepal's flora and to establish germ plasm centre	Ministry of Forests	Department of Forests, Department of Drugs Administration, Royal Drugs Limited and National Council for Science and Technology
4. Department of Agriculture	(a) To carry out the basic and applied researches on technologies for different agroclimatic regions and develop package of practices for different levels (b) To disseminate suitable agricultural technologies among farmers and provide them technical services	Ministry of Agriculture	Department of Livestock Development and Animal Health, and National Council for Science and Technology
5. Department of Irrigation, Hydrology and Meteorology	(a) To investigate, plan, design and execute irrigation projects (b) To investigate and develop ground water resources	Ministry of Water Resources	Departments of Local Development, Water Supply and Sewerage, Agriculture, Survey
6. Department of Mines and Geology	(a) To investigate, explore, evaluate and undertake production feasibility of mineral deposits (b) To conduct engineering geological works, seismological studies and geological surveys (c) To regulate development of mines and minerals	Ministry of Industry and Mines	Institute of Science and Technology (Tribhuvan University), National Council for Science and Technology
7. Central Food Research Laboratory	(a) To conduct research on food grain preservation, fruit preservation and nutrition	Department of Food and Agricultural Marketing Services	
C. *STS Agencies* 1. Department of Building, Housing and Physical Planning	(a) To prepare physical planning schemes and low-cost housing plans (b) To expand and improve production of building materials from local resources, constructing the government buildings	Ministry of Works and Transport	Departments of Survey, Electricity, Roads

(III - Third level)

Establishment	Function	Linkages	
		Upstream	Others
2. Nepal Institutes of Standards	(a) To set-up and prepare standards for the items manufactured and produced within the country or exported from or imported to the country (b) To make provision for checking and inspection in order to ensure the production, distribution, import and export of commodities (c) To grant licenses and affix quality certification on the products		Departments of Mines and Geology, Mint, Electricity, Building, Housing and Physical Planning, Food and Agriculture Marketing Services
3. Departments of Surveys	(a) To provide topographical and other maps as required for (i) revenue purposes, (ii) development projects, and (iii) engineering survey works. (b) To provide training for medium and lower level survey technicians	Ministry of Land Reforms	
4. Department of Civil Aviation	(a) To provide training for medium technicians in aviation and communication fields	Ministry of Works	Royal Nepal Airlines Corporation
5. Natural History Museum (Tribhuvan University)	(a) To collect and preserve specimens of Nepalese flora, fauna, rocks and minerals and to study the different aspects of natural history and ecology of Nepal (b) To educate the common people on the natural wealth and environment of Nepal (c) To document literature and specimens of Nepalese Natural History	Institute of Science and Technology	
6. Central Library (Tribhuvan University)	(a) To provide, among others, scientific and technological books, periodicals and magazines on loans for students and teachers of the University (b) To arrange seminars and short-term training programmes on library management	Rector's Office	
7. National Computer Centre	(a) To provide computer services for government departments, corporations and private agencies		
8. Agricultural Projects Services Centre	(a) To conduct socio-economic studies for the agricultural development projects and evaluate agricultural or rural development projects		Ministries of Agriculture, Commerce and Supply
9. Industrial Services Centre	(a) To conduct techno-economic feasibility studies on industrial and subsidiary industries based on agriculture, forestry, mining and others (b) To advise and suggest methods for modernization, expansion and improvement in productive efficiency of industries		Nepal Industrial Development Corporation
10. Livestock Development Project Services Centre	(a) To carry out feasibility studies and provide advisory services on livestock development projects		

Table 2 - Scientific and Technological Manpower

Country: NEPAL

Year	Population	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total stock (thousands)	of which working in R&D (in units)
			Total number	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965										
1970	11.55[1]	1,927[1]	433*	208	95	52	78	N.A.	761[1]	
1975	12.7	1,964[2]	442*	212	97	53	80	N.A.	2,623[2]	
1979	15.0**	2,660[3]	599[4]	286	130	72	109	N.A.	4,522[3]	
1985	16.0	3,718							7,248	
1990										

1 Fourth Plan (1970-1975), National Planning Commission, HMG.
2 Fifth Plan (1975-1980), National Planning Commission, HMG.
3 Sixth Plan (1980-1985), National Planning Commission, HMG.
4 *Tribhuvan University (Statistical Data), 1979, August.*

* Estimated ** Preliminary results of 1981 Census.
N.A. denotes 'not available'.

Table 3 - R&D expenditures

Country: Nepal
Currency: Rupee

Table 3a: Breakdown by source and sector of performance

Year: 1979

Unit: thousands

Source* / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive[1]	49,229	—	—	49,229
Higher Education[2]	4,786	—	—	4,786
General Service[3]	2,306	—	—	2,306
Total	56,321	—	—	56,321

* Annual Budget Estimate for the year 1979/1980, published in 1979, National Planning Commission, HMG.

1 Includes budget allocated in the sectors of food, agriculture, irrigation, industry and mines for research, survey, feasibility studies, testing, mapping, exploration, etc.
2 Includes research budget of different institutes and research centres of Tribhuvan University. Amounts received under foreign aid have also been included.
3 Includes health, roads, drinking water, etc.

Table 3b: Trends

Year	Population (in millions)	GDP at (1976/77) constant prices in million Rs.		R&D expenditure in million Rs	Total Development Expenditure in million Rs.	Exchange rate vis-à-vis US $
		F. Year	GDP			
1971	11.6	1961/62				Rs. 10.1
1976	12.8*	1976/77	1,728		1,498	Rs. 12.45
1981	15.0	1980/81	1,887	56.321	2,346	Rs. 11.9
1985+	16.0					

* Estimated
\+ Provisional estimates of National Planning Commission Secretariat (1979/1980)

PART 1.

General Features

1.1 GEOPOLITICAL SETTING

Nepal is a mountainous country lying between the two most largely populated countries of the world – China on its north and India on its south. Its total area is 145 305 sq. km. and its population is about 15 millions according to the preliminary result of the 1981 census. Nepal occupies approximately 800 km. along the central sector of the Hindukush Himalayan chain extending from Afghanistan to the Yunan Province of the People's Republic of China; the country's breadth varies from 100 km. to 160 km. Nepal falls within an area enclosed by longitudes 80°3' to 88°15' East and latitudes 26°20' to 30°26' North.

Nepal is land-locked and bound on its three sides (western, southern and eastern) by India and by the autonomous Tibet region of China in the north. The nearest port (Calcutta) is about 500 km. from Nepal in the Bay of Bengal. It is separated by a land section of about 25 km. from Bangladesh at the eastern most end. The capital city is Kathmandu which lies on the undulating floor of an oval-shaped valley surrounded by land routes with India and China. It is linked by air with Bangladesh, Sri Lanka, India and Thailand.

The terrain and topography of Nepal has made it a country of many contrasts. Altitudinal variation, ranging from 55 m. to 8 848 m., has contributed to the occurence of tropical, temperate, alpine and arctic types of climate within the country. The rainfall in various parts of the country ranges from about 6 000 mm. per year to about 250 mm. per year depending upon the location. Nepal is essentially a monsoon country and over 80% of the total rainfall occurs during the three monsoon months of July, August and September.

Physically, three main geographical regions are identified in Nepal. On the north, the mountainous region occupies about 34 % of the total area. Most of this region lies above 3 000 m. and it is here that 8 of the 18 summits in the world exceeding 8 000 m. in altitude are concentrated. The southernmost part of the country constitutes low-lying hills and valleys with a belt of the Terai plain. It occupies nearly 21 percent of the total area with most of the region lying below 900 m. More than 60% of the agricultural output of Nepal is produced in this belt. The middle region lying between the northern mountainous region and the Terai plain is occupied by the hills and valleys ranging from 900 m. to 3 000 m. in altitude. It covers about 44% of the total land area and about 47.7% of the population lives in this region.

Nepal is a Sovereign Independent Hindu kingdom. His Majesty King Birendra Bir Bikram Shaha Dev, the eleventh ruler of the Shaha dynasty is the supreme head with sovereignty vested upon him. His Majesty is an enlightened monarch who has made strenuous efforts to eradicate illiteracy, poverty and hunger from the kingdom ever since His Majesty ascended to the throne in 1972. Nepal has adopted the partyless democratic system, the Panchayat System since 1960. This Panchayat System was given over-whelming support by the people in the referendum held in April 1980. Following this historic event some important changes have been made in the constitution by the Third Amendment of 1980, the embodiment of Nepal's desire to make it a Zone of Peace in the constitution itself, being one of these. Nepal's foreign policy is guided by the Charter of the United Nations and the principles of non-alignment. His Majesty the King is the supreme authority wherefrom all executive, legislative and judicial powers emanate. There are three separate branches of Government – the Council of Ministers (the executive), the Rastriya Panchayat (the national legislature), and the Supreme Court (the national judiciary). The Council of Ministers, which carries the day to day administration of the country and is responsible to the Rastriya Panchayat, is headed by the Prime Minister who is elected from among its members. The Rastriya Panchayat consists of 140 members, 112 elected from 75 districts on the basis of adult franchise and the remaining 28 members nominated by His Majesty the King. The legislative, executive and the judiciary are independent from each other and are coordinated by His Majesty the King.

The country is divided into 14 administrative zones, and further into 75 districts. The basic political unit is the Town or Village Panchayat. There are 23 Town Panchayats and 2 912 Village Panchayats in the country. For the purpose of development activity, the country is also divided into five development regions viz. Eastern, Central, Western, Mid-Western and Far-Western Development Regions. A national census carried out in the country in 1981 shows the population of Kathmandu, the capital city, to be 235 000. Urban population in Nepal accounts for about 6.4% of the total population. Roughly speaking, four types of settlement may be distinguished in the country: linear settlements, compact settlements, scattered settlements and ring settlements. Linear and compact settlements are typical of newly developed trade centres, industrial areas, highways and river banks whereas scattered and ring settlements are typical of mountain regions. Kathmandu, Bhaktapur and Patan are three ancient cities of the Kathmandu valley. Some other towns like Biratnagar, Bhairahawa, Nepalganj, and Pokhara are comparatively new.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

The ethnic features of the Nepalese people could be broadly traced to the Aryan and the Mongolian races. However, three major ethnic components from three different geographical regions may be distinguished, namely the Indian subcontinent, the Himalayan mountains and the Tibetan region. The majority of the people believe in Hinduism, while many others believe in Buddhism as well. Nepalese cultural heritage is, therefore, based on a syncretistic integration of Brahmanical and Buddhist practices that find their expression in the various socio-religious festivals and rites, as well as in the arts and architecture of Nepal.

Nepali language, which is spoken all over the country, is the national as well as the official language. Besides, there are more than 16 other prominent languages of which two, Newari and Maithili, have also developed their literature to a fair extent.

Literacy rate is estimated to be about 24.3%. Eighty percent of the primary school going children are enrolled in schools. Average life expectancy at birth is estimated to be 44.5 years for females and 47.5 years for males. The population to hospital bed and population to doctor ratios are estimated at 5 249 and 26 938 respectively.

Agriculture has remained as the mainstay of the Nepalese economy and this sector contributes over 60% of the country's GDP. A World Bank Survey conducted within the country in 1978 showed 93% of the total labour force employed by the agriculture sector while a meagre 2% and 5% have been absorbed by the industrial and services sectors respectively; 55% of the population was of working age. Planned industrialization began as late as the mid fifties. At present, agro-processing units and some consumption goods industries as well as a few construction materials production units exist in the country. There are several small scale industries and handicrafts operating in rural areas where local artisans are being used. In addition, several thousand non-formal self-employed vocations such as carpentry, blacksmithing, pottery, curio manufacture, shawls and garments-making are run within the country but theses units need immediate support for their modernization and growth.

About 80% of its total exports is made up of agricultural products like rice, jute, pulses and oil seeds. Other minor export commodities include forest products (timber and medicinal herbs), animal products (hides, skin, ghee and honey) and handicrafts. Tourism has played an important role in its foreign currency earnings and this industry has been expanding rapidly over the past few years.

The manufactured products constitute only about 4% of the total GDP of the country. During the Fiscal Year 1977/1978 and 1978/1979, the total exports was worth Rs. 1 046 and 1 297 millions against its total import of goods worth Rs. 2 469 and 2 885 millions respectively. The trade deficit amounted to Rs. 1 423 millions in 1977/1978 and Rs. 1 588 millions in 1978/1979. Major items exported from Nepal include jute and jute goods, rice, hides and skins, timber handicrafts and carpets while its imports comprise mainly textile goods, petroleum products, machinery and parts, drugs and medical equipment, and chemical fertilizers.

The technical hydropower potential of the Nepal's rivers is estimated to be about 83 000 Megawatt and indeed, it could be considered as the most important renewable resource for the development of the country. The next renewable resource, forests, occupy an area of less than 28 million hectares of land, about 20 percent of the total land area in Nepal.

The total growing forest stock is estimated at 158 million cubic metres of which 42% lies in the Terai (southern plain) region and 56% in the hills. Its annual yield is estimated as 7.2 million cubic metres of wood. But the increasing demand for fuelwood for domestic usage has led to an alarming rate of forest depletion in the country. However, fuelwood continues to be a source of energy for about 87% of the total population and 95% of the rural population. About 80% of the total energy consumption is met through the use of firewood alone. Thus, forest resources have been already over-exploited in the country.

1.3 DEVELOPMENT SCENE

After an experience of 25 years of planned economic development, and with the completion of five development plans, Nepal has launched the Sixth Five-Year Plan in 1980. In this period, the country has succeeded, by and large, in laying down the basic economic, social and administrative foundations for development. Despite many notable achievements gained during the period, particularly in roads, communication, education and health sectors the national income could not, however, be raised significantly. As, on the one hand, the major portion of public investment was made in building socio-economic infrastructure having long gestation period and while the population on the other hand grew at an alarming rate, the living standard of the people at large could not be improved as expected.

Although the agricultural sector received the highest priority in the previous plans and a large amount of development expenditure was made in this sector, no corresponding increase in agricultural production could be achieved. As a result, food grain production surplus is rapidly decreasing and if the present trend continues it is estimated that Nepal would have to import food by the year 2000.

There is wide incidence of unemployment and underemployment in the country. A survey undertaken by the National Planning Commission in 1976/1977 recorded an unemployment level of 5.62% of the total labour force and 63% of the total working days unutilized in the rural areas. The survey found 44.7% of the working days unutilized in the urban areas.

Nepal faces some serious problems in the process of development. The growth of gross domestic product (GDP) is much lower (2.2% during the Fifth Plan) than the population growth (2.6%) during 1971-1981 period. The agriculture sector still accounts for more than 60% of the GDP during the Fifth Plan period and 80% of the exports. Machinery oils and other development materials have to be imported to a large extent. The country is solely dependent on other countries for the research, development and application of science and technology for the development of the country.

However, prospects for the development of the country can be visualised in the proper utilization of the abundant water and human resources, particularly the surplus and unskilled labour force, on the basis of the experience gained and socio-economic infrastructure so far developed.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

The following major objectives have been laid down for the Sixth Five-Year Plan period (1980-1985):

(i) to increase the rate of national production;

(ii) to increase the opportunities of productive employment in the country; and

(iii) to meet the minimum basic needs of the people.

Accordingly, sectoral level objectives have been laid down to achieve these broad national goals. In the agricultural sector, more efforts are being made to ensure a higher production of food grains in the hilly regions, thus make those areas more self-sufficient in food as early as possible. To this end, special projects are being carried out to improve the existing irrigation facilities and create additional facilities in the hilly areas. While the supply of fertilizers and insecticides are being augmented, improved farming practices are being introduced and special attention is given to the cultivation of exportable agricultural commodities. Particular attention is being paid towards use of compost manure and organic fertilizers from waste products of the farms. Farmers are being encouraged to set up bio-gas units mainly for production of organic fertilizers. Special efforts will be made for production of nitrogen fertilizer from micro-power generation plants. Cultivation of fodder plants and pasture development will be promoted in the hills. In the Terai region, more emphasis will be placed on developing agricultural practices combined with livestock development. Under the land reform programme, tenancy rights will be granted to a larger section of the peasant population. In the process of agricultural development, proper attention will be paid to avoiding any possible effects on the ecological balance of the country.

In the industrial sector, priorities have been given to the cottage and small scale industries development. For this purpose, technical, financial and marketing facilities would be provided to the small private enterpreneurs in packaged form. During the plan period, except for those few industries which are of national interest, and thus call for such technology and level of investment as is not readily accessible to or feasible in the private sector, all the medium and the larger scale industries would be established in the private sector. Provisions have also been made for extending more relief and exemption to the new investors in the country. In order to encourage foreign investment in the country a separate "Foreign Investment Act" was recently enacted by His Majesty's Government. Industries that are specially designed to promote the export utilizing local products, as well as those concerned with important products such as textile and construction materials, would be promoted and expanded. Women labourers would be given more facilities for their employment in the cottage and small scale industries. Industrial cooperatives will be promoted and encouraged. More electricity will be made available for industrial purpose as well as irrigational uses. Additional micro-hydro plants will be commissioned within the country, mainly with a view to reducing the consumption of firewood and attempts will be made to manufacture nitrogen fertilizers using micro-hydro power. Research and development activities on cheaper alternative sources of energy will be undertaken.

In the transport and communications sector, modern public transport system will be developed in the country and it would be based on electricity as far as possible. Priority has been given to the task of providing transport facilities in the rural areas, such as construction of foot tracks, muletracks and suspension bridges. It is envisaged that the far-western segment of the East-West highway would be completed by the end of the plan period. International aviation facilities will be strengthened and possibilities for water transport will be explored.

In the educational sector, special attention has been given to expanding the general facilities for primary, adult and vocational-cum-technical education in the country. Science education will be promoted and directed towards bringing about a more efficient utilization of natural resources and manpower. People's participation will be encouraged in order to strengthen general education activities in the country. Special programmes will be carried out for the people living in the remote areas and emphasis will be given to the promotion of existing education facilities, the improvement of teaching standards, and the reduction of the number of school drop-outs.

During the Sixth Five-Year Plan period, it is aimed to provide basic health services, curative as well as preventive, for people throughout the kingdom, mainly through basic and integrated health programmes. The traditional ayurvedic practice will be integrated with the modern system of medicine and developed further. Family planning-cum-maternity and child health programmes will be carried out with the active and increased participation of the local panchayat workers. The supply of nutrient food and drinking water would be considered as an integral part of the health development programme.

2.2 DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

The need to integrate the national science and technology programme with the basic objectives of the Five-Year Plan has been duly recognised by His Majesty's Government of Nepal. For the first time, and duly recognising its role, a separate chapter on science and technology has been included in the Sixth Plan. The objectives of the science and technology programme in the Sixth Plan are:

(i) to assist in increasing production, raising employment opportunities and meeting basic minimum needs of the people by integrating science and technology development with the socio-economic development process in the country;

(ii) to increase science and technology capability by providing required scientific and technological manpower, executing research and development works, communication of science and technology knowledge and proper organization and management; and

(iii) to increase the application of appropriate science and technology by making the people aware of its usefulness.

Accordingly, the government has adopted the following policy strategies in the field of science and technology for the plan period (1980-1985).

(i) Such technologies that would be helpful in the mobilization of natural resources and the utilization of the existing labour, local materials or skills, will be developed and disseminated within the country.

(ii) Proper coordination will be established among the various agencies involved in the task of promoting natural scientific and technological capabilities.

(iii) All the governmental and non-governmental scientific R&D institutions will be further strengthened and new laboratories will be established, if necessary.

(iv) Necessary scientific and technological manpower for the national development activities of different sectors will be trained.

(v) Necessary scientific and technological informations will be made available to various concerned institutions in the country. A national science and technology information system, comprising the libraries of the training and research institutions in the field of science and technology, will be established.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

The National Development Council (NDC) under the chairmanship of His Majesty the King, is the highest policy making body, invested with power to direct and guide the National Planning Commission in its socio-economic plan and programme formulation.

Though some provisions were always made under various sectoral development programme for activities related to the application of science and technology for development, there was no single policy-making body for scientific and technological affairs at the national level in the past. Thus, policies related to science and technology were implicity incorporated in the sectoral programmes of various ministries and departments concerned. In appreciation of the role of science and technology in the development process, and realising the need of a national level body to formulate policies and programmes as well as to coordinate research programmes in the field of science and technology, the National Council for Science and Technology (NCST) was established as an apex body in 1976.

National bodies responsible for policy-making in the field of scientific research and development, science education and training, as well as the popularization of science and technology are as follows:

(1) National Council for Science and Technology (NCST)

(2) National Education Committee (NEC)

(3) Water and Energy Commission (WEC)

(1) National Council for Science and Technology

The Council is closely attached to the National Planning Commission. At present, the Vice-chairman of the National Planning Commission is serving also as the chairman of the Council. This body consists of 13 ex-officio members representing various related ministries and government departments, the Tribhuvan University and its institutes, and the Royal Nepal Academy. The present composition of the Council is given in Annex I. Thus, it has been possible for the Council to establish a closer coordination between His Majesty's Government and Tribhuvan University in research, as well as to formulate an integrated programme in the field of science and technology, more effectively.

The main objectives of the Council are as follows:

(a) To formulate the national science and technology policy;

(b) To promote scientific and technological research activities;

(c) To establish coordination between the research programmes of the departments of His Majesty's Government and the Tribhuvan University; and

(d) To disseminate and popularise scientific and technological knowledge among the masses through educational and communicational media.

(2) National Education Committee

The National Education Committee is a high level committee established in 1971 for the main purpose of implementing the National Education Plan in the country. The Committee works under the supervision of His Majesty the King, or a person nominated by His Majesty the King for the purpose. The Committee is chaired by the Minister of Education and Culture and its members include the Assistant Education and Culture Minister, the Vice-Chancellor of the Tribhuvan University, members of the National Planning Commission, the Chairman of the Social Service Committee of the National Panchayat, the Secretary to the Minister of Education and Culture, and two educationalists. The details of the membership are given in Annex II.

The National Education Committee formulates national policy as regards general education and manpower development and coordinates between Tribhuvan University, the Ministry of Education and Culture and other concerned ministries to fulfil the various objectives of the national education plan.

(3) Water and Energy Commission

The Water and Energy Commission is chaired by the Minister of Water Resources, and other members include the Assistant Minister of Water Resources, Vice-Chairman of the National Planning Commission and secretaries of seven HMG ministries (ex-officio). Annex III shows the details of its membership.

The Commission coordinates various programmes related to survey and feasibility studies, as well as research works in the energy sector, and prepares various long-term and short-term plans or projects related to energy. It has also provided a forum for discussion of various issues related to the definition and implementation of energy development strategies. The planning unit of the Commission works closely with the National Planning Commission in assessing the impact of alternative energy use programmes and supply sectors on the national economy.

Promotion and financing of research activities as well as science and technology services are being done by various bodies, mainly, for example, the Tribhuvan University, the National Council for Science and Technology, departments of Industry, Cottage and Rural Industry, Agriculture and Forests, and professional organizations in the country.

The Tribhuvan University was established under the Tribhuvan University Act 1959 by His Majesty's Government. His Majesty the King is the Chancellor of the Tribhuvan University. The Chancellor presides over the University Council meetings. The highest legislative body of the University is the University Council which consist of 46 members. The Council has the power to deliberate on the entire programme of the University. The Minister of Education and Culture of His Majesty's Government is the Pro-Chancellor of the University and the Vice-Chancellor is the Chief Administrative and Academic Executive of the University. The Vice-Chancellor is ex-officio head of the Executive Committee, the Technical Conference Body, the Research Centre Management Committee and the Planning Division. The Rector is responsible for all academic programmes of the University. Likewise, the Registrar is responsible for the general and fiscal administration, examinations, information and publication etc... There are ten academic institutes within the University and four Research Centres, each headed by a Dean or an Executive Director who is responsible for the academic and/or research programmes of the institute or centre. The various institutes of Tribhuvan University are expected to produce a total of 72 000 trained manpower during the Sixth Plan period.

Until the recent past there existed no national institution which provided services directly related to technology transfer. Some preliminary and broader aspects of this tasks were carried out by consultancy agencies like the Industrial Services Centre, Agricultural Project Services Centre, Research Centre for Applied Science and Technology in the selected areas of technology, mainly through performance of feasibility and assessment studies. But under the new Industrial Policy, a technology section has been recently opened in the Ministry of Industry to look into various policy affairs related to transfer of technology. The government is eager to facilitate transfer of technology through the operation of this new section.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

In Nepal, the various institutions that are presently engaged in different scientific and technological activities may be classified into the three following categories:

(1) Scientific research and development (R&D) institutions;

(2) Scientific and technological education and training (STET) institutions; and

(3) Scientific and technological services (STS).

i. Scientific Research and Development (R&D) Institutions

Institutions that carry out research and development activities in the various areas of natural sciences, engineering and technology, medical science and agricultural sciences in Nepal are briefly explained below:

Agricultural Research Laboratories

The Agricultural Research Laboratories complex at Khumal, Kathmandu, established in 1957 under the Department of Agriculture, is one of the well-equipped research institutions of the country. It has 17 major divisions each with its own laboratories and professional and supporting staffs. Each division carries out research of both an original and an adaptive nature, primarily with a view to the testing, trialing and propagating of new methods and materials. The Centre has well qualified staff numbering 140, of which 9 hold Ph.D. degrees, 80 M.Sc. degrees and 51 B.Sc. degrees (Agricultural graduates).

Department of Medicinal Plants

The Department of Medicinal Plants was set up in 1961. Besides being the prime organization responsible for the formulation and implementation of government policies in the matter of the utilization of medicinal plants, it is also involved in the cultivation, collection, processing and utilization of Nepalese medicinal, aromatic and other economic plants. The Department consists of four R&D institutions: (1) Royal Drug Research Laboratory (RDRL); (2) Royal Botanical Garden; (3) Botanical Survey and Herbarium; and (4) Herbal Farms.

The efforts of the Royal Drug Research Laboratory have been mostly directed towards general scientific and technological research activities related to development and utilization of medicinal and aromatic plants of Nepal. In the pilot plant simple pharmaceutical techniques are demonstrated with a view to encouraging private enterpreneurs in the establishment of pharmaceutical industries in Nepal. The improvement of traditional medicines is also included in its activities. The laboratory was instrumental in establishing the first modern pharmaceutical industry (i. e. Royal Drugs Ltd.) in the country. It has also been responsible for formulating the "Drug Control Act 1978" and for the establishment of the drug regulating agency – Department of Drug Administration – which administers the Drug Control Act. The Act has designated the RDRL as the official organ for carrying out testing, standardization and quality control of drugs and allied materials.

The Royal Botanical Garden essentially serves as a study centre for botanical research. The present activities include the study of plant improvement through various research methods such as genetics, tissue culture and other agro-techniques on medicinal and economic plants.

The Botanical Survey and Herbarium carries out mainly survey, collection and ecological studies of Nepalese flora. It maintains a herbarium of Nepalese plants. Over 100 000 plant specimens of more than 5 000 plant species collected from all over the country has been preserved in this Herbarium. The Herbal Farms unit is engaged in the experimental cultivation of varius useful medicinal and aromatic plants in different agro-climatic regions. The objectives of the project are to develop agro-technology for economic plants of high value.

The Central Food Research Laboratory

It is attached to the Ministry of Agriculture. The laboratory is concerned with research and development work as well as training and extension works on suitable food technologies. R&D activities include quality analysis of various cereals and other food commodities, as well as development of grains, and grain processing techniques. It has four units: a quality control and standarization unit, a food technology unit, a food grain testing unit and the nutrition research and development unit.

Forest Resources Survey and Research Office

The Forest Resources Survey and Research Office, established in 1963 in the Department of Forests, carries out studies on the prevalence of various fast growing indigenous and exotic trees, species regeneration, and the growth behaviour of Sal (*Shorea robusta*) forests of the country. It is also involved in research works on major forest products of Nepal.

Research Centre for Applied Science and Technology, Tribhuvan University

The Institute for Applied Science and Technology, established in 1973, was reorganized as the Research Centre for Applied Science and Technology (RECAST) in 1977. It is presently devoted to the task of developing appropriate technology with a view to improve the traditional technology and the generation of new technologies suitable for development and utilization of the indigenous natural resources. It is also engaged in the dissemination of socially acceptable and economically feasible technologies among people throughout the country.

The Centre has three main divisions: Research and Development (R&D), Technical Information and Technical Assistance Clearing House Service, and Administration and Planning. The R&D division consists of some major groups such as natural resources development, construction and building materials, and energy development.

The Centre is currently engaged in the implementation of a national project financed by the Interim Fund for Science and Technology for Development (IFSTD). It would cover the period 1981-1983.

Institutions which are involved in research work in the different areas of social sciences and education in Nepal are as follows:

(a) Research Centre for Economic Development and Administration (Tribhuvan University);

(b) Research Centre for Nepal and Asian Studies (Tribhuvan University);

(c) Research Centre for Educational Research, Innovation and Development (Tribhuvan University); and

(d) Institute of Humanities and Social Sciences (Tribhuvan University):

The National Council for Science and Technology has recently published a directory giving details about the scientific and technological organizations in Nepal.

ii. Scientific and Technological Education and Training (STET) Institutions

Since the launching of the New Education Plan in 1972 at University level, some measures have been taken to coordinate, expand and improve science and technological education and training in the country. A host of new institutions were established under Tribhuvan University with a view to promoting and developing technical education in the country. These efforts have resulted in reducing heavy dependence upon other countries for training middle-level technical manpower. In brief, the following institutions of Tribhuvan University provide, at present, education, training and research facilities in different fields of science and technology at various levels.

Institute of Science and Technology

Althoug higher education in science was started in the country in 1919, it was limited to the 2 years' intermediate level for several decades. In 1946, science teaching was upgraded to the Bachelor's degree level. Under the Tribhuvan University, a post-graduate College was established in 1965 to provide for teaching of science at Master's degree level, by the end of 1973, the number of science teaching institutions in the country rose to twelve. With the introduction of the New Education System Plan, the Institute of Science (now renamed as the Institute of Science and Technology) was established in 1973 and ten of these colleges (renamed as campuses) were attached to it: The Institute has, at present, eleven campuses, out of which two are of the post-graduate degree as well as research (Ph. D.) levels, three of the diploma (Bachelor's degree) level, and 6 of the certificate (Intermediate) level. The Institute of Science and Technology has one of the largest academic and professional staffs, employing two hundred forty one people.

Institute of Engineering

The Institute of Engineering was established in 1973 by amalgamating various technical institutes. It is the principal institute for preparing the various cadres of middle level manpower in engineering. The Institute has two campuses at present. It provides intermediate level engineering and technical education in the areas of civil engineering architecture, electrical engineering, radio and electronics, air conditioning and refrigeration, general mechanics and auto-mechanics. The Institute has started civil engineering classes at the bachelor's level since the academic year 1978/1979.

Institute of Medicine

In Nepal, the history of institutionalized training in Medicine can be traced back to a Ayurvedic School established in 1929 by the Department of Education. In 1972, when the Institute of Medicine came into being, the Ayurvedic School was upgraded to the campus level. Various other schools, such as Nursing, Assistant Nurse Midwife and Auxiliary Health Workers' Schools, were also upgraded into campuses under the Institute of Medicine in the same year (1972). The Institute offers certificate level courses in General Medicine, Nursing, Health, Laboratory, Radiography, Dispensing Pharmacy and Ayurveda. Besides, it runs a one-year community Medicine Auxilliary Nurse-Midwife programme.

The Institute offers two diploma courses, namely a post basic Medical Science Diploma in Nursing (3 semesters' Course) and Medical Diploma of Doctor of General and Community Medicine.

Institute of Agriculture and Animal Sciences

The Institute of Agriculture and Animal Sciences (IAAS) was established under the University in 1972. The History of agricultural education in Nepal goes back to 1959 when the School of Agriculture was started by the Department of Agriculture to train junior technicians for carrying out various agricultural development programmes in the country. The School was later upgraded into the College of Agriculture and renamed as the Institute of Agriculture and Animal Sciences (IAAS) of the Tribhuvan University after the introduction of the New Education System Plan.

The Institute is now engaged in operating agricultural classes at both the Certificate and Diploma levels. A two-year general agriculture and education course and three year course dealing both with agriculture, education and animal husbandary, are given by the Institute at the Diploma level. The former course is meant to produce professional teachers of agriculture for the secondary schools of the country, whereas the latter is meant to produce high level manpower in agriculture.

The Institute has seven campuses in different parts of the country.

Institute of Forestry, Tribhuvan University

Although forestry training in Nepal started in 1947 under the department of Forestry, a regular programme of training began only from the year 1957. The Institute of Forestry was established under the University in the year 1972 and there is presently only one campus. The Institute offers Certificate and Senior Certificate level programmes in forestry.

iii. Scientific and Technological Services (STS) Institutions

Various scientific and technological services (STS) that are provided in Nepal are: natural resources and environmental services (such as geological services, seismological observation, testing, standardization and quality control), and extension and advisory services for farmers as well as for industrialists. There are a few national libraries and museums, as well as a National History Museum in the country.

Some of the major institutions that provide various scientific and technological services in Nepal are briefly described below:

The Agricultural Projects Services Centre (APROSC) provides information and documentation, publications, feasibility studies, and consultancy services in the field of food and agriculture to all concerned, including farmers and industrialists.

The Industrial Service Centre (ISC) is mainly concerned with documentation, feasibility studies and publication, as well as consultancy services in industry. The Institute of Standards, established in the year 1976, is the national body for testing, standardization and quality control of market products.

The Department of Hydrology and Meteorology carries out meteorological studies in Nepal while the Department of Survey conducts topographical and cadastral survey works and fixes the geodetic control points required for all kinds of mapping, development projects and other engineering works. The Department of Mines and Geology undertakes the geological and mineral surveys of the kingdom, investigation and evaluation of mineral deposits, feasibility studies, the engineering of geological works and siesmological observation.

The Department of Agriculture has, several research centres and farms spread over various part of the country. These centres and farms provide technical services, relating to soil testing, use of improved seeds, fertilizers, crop production etc. , to the farmers on request. Moreover, the Department has a wide spread network of agricultural technicians (J.T. and J.T.A.'s) scattered over the whole country to provide technical advice to the farmers at their doorstep.

The Department of Cottage and Rural Industries Development makes surveys on various aspects of cottage industries and also prepares and distributes various schemes for cottage and rural industries. Short term training in weaving, knitting, woodwork, handicrafts, electricity etc. are also provided by the Department.

The Central Library of Tribhuvan University which is located at the Kirtipur Campus, Kathmandu, is one of the best equipped libraries of Nepal. Apart from its general reference and periodical collections, the library maintains a special section on Nepal where reports and other forms of documentation of various government agencies, dissertation, doctoral theses and publications are available. The Singh Collection, a personal donation of the late Lt. General Singh Shumsher J.B. Raña, was added in 1978. The library's total collection exceeds 100 000 volumes, 7 122 magazines and 550 periodicals. The library also provides various other facilities such as microfilm reading, bibliographical, reference, orientation programme, workshops, seminars and training.

The Natural History Museum, established in 1975 by the Institute of Science and Technology of the Tribhuvan University, has a rare and extensive collection of flora, fauna and geology of Nepal. Studies on the natural history and ecology of the country are also being carried out in the Museum. The Museum maintains a documentation unit for literature on different aspects of Nepales natural history.

The Research Centre for Economic Development and Administration (CEDA) of Tribhuvan University provides consultancy services on various aspects of economic development and administration to both the public and private enterpreneurs. The Research Centre for Nepal and Asian Studies is primarily concerned with the promotion of research on social and anthropological aspects of Nepal and other Asian countries. The Institute of Engineering of the Tribhuvan University also provides a consultancy service in the field of building design.

3.2 HUMAN RESOURCES

The growth of the national economy, the expansion of production activities in both industry and agriculture, the application of science and technology in different branches of the economy, and the trends in educational development are the main factors determining the demand of scientific and technological manpower in Nepal. The execution of more and more development projects has created a heavy demand for technical manpower. Employment opportunities for various categories of manpower, including scientific and technical, have also been increasing. The educational sector is both a creator and a major user of scientific manpower. A large proportion of the presently available scientific and technical manpower have been trained in India, the neighbouring countries, and overseas under the Colombo Plan. The table below shows the trend of scientific and technological students enrolment in the various campuses of the Tribhuvan University in the academic year 1979/1980.

In the Fith Plan (1975-1980) the total demand of technical manpower in the public sector was 24 868 but the supply side fell short by 4 893. The Sixth Five-Year Plan period (1980-1985) is expected to face a shortage of 3 304 technical manpower in the country. This will be one of the main constraints on Nepal's national development efforts. The long term nature of manpower planning and the limited enrolment capacity of the technical institutes in the country are some of the reasons for the continuing shortage of technical manpower. An additional demand of 3 381 high level manpower has been projected for this period against the stock of 3 217 in 1979/1980. This comprises scientific and technical, civil and other engineering, agricultural and forestry specialists, and medical doctors. Likewise, an additional 7 134 middle level manpower are required during this plan period as compared to a stock of 6 201 in 1979/1980. This assessment of the required manpower refers to the public sector only.

In 1977, the National Council for Science and Technology published a directory : "Scientists and Technologists of Nepal" listing the personnal engaged in various governmental and corporate organizations, including Tribhuvan University. The survey has shown a total number, of 2 378 high level manpower in the sectors of agriculture, engineering, forestry, medical science, natural science and other technological fields including pharmaceutical, dairying, food, beverages and textiles. The breakdown is given below:

Sector/Type	**Number**
Agriculturists	477
Engineers	119
Natural scientists	450
Forest technologists	155
Medical technologists	487
Other technologists	64
Other technicians	626
Total	2 378

The need for improvement in several aspects of technical education was stressed by the Full-Term Evaluation Report of the New Education System Plan (1979). The Evaluation Report pointed out that the current enrolment capacity of the technical institutes falls quite short of the demand. This is particularly

Institution	Level	No. of campuses	Student enrolment in 1979/1980	Budget in the year 1979/1980 (in rupees)	Size of the faculty
1 Institute of Science and Technology	a. Certificate b. Diploma c. Degree	6 3 2	2,406 716 345	12,611,550	288
2 Institute of Engineering	a. Certificate b. Diploma	1 1	1,538 46	12,032,500	117
3 Institute of Medicine	a. Certificate b. Diploma	2 1	806 71	12,746,700	109
4 Institute of Agriculture and Animal Sciences	a. Certificate b. Diploma	6 1	825 269	5,557,500	42
5 Institute of Forestry	a. Certificate b. Diploma	1 0	283	2,419,000	13

Source: Tribhuvan University (Statistical Data, 1979).

noticeable for technical courses, such as engineering and medicine. One difficulty, as has been pointed out in the Report, is with regard to tailoring training to the needs of the employing agencies and institutions in the public and the private sectors. Due to rapid expansion of higher education, difficulty is being experienced in the maintenance of standards. Science graduate in certain fiels often fail to secure employment while the middle level personnel of technical institutions are also unable to respond in a field situation. This means that they have to spend time and effort in the acquisition of new skills which they do not get in an academic or training institutions. This has been remedied to some extent through integration of field experience with class room instruction.

The available scientific and technical manpower is being utilized in a wide ranging number of institutions in the country. As regards applying science and technology, in the absence of access to a science and technology information system, the users cannot make use of the available technology. Scientists and technologists have still to acquire a status which their counterparts receive elsewhere. There is also the problem of creating the requisite socio-economic climate which would catalyse the scientists and technicans in Nepal in the process of undertaking R&D in the public and private sectors.

3.3 FINANCIAL RESOURCES

At present, research funds for most of the government laboratories are being allocated under the main budget heads of the concerned departments. In the case of the Department of Agriculture, budget allocations for research are specifically mentioned. The financial outlays are recommended by the National Planning Commission after discussions on the proposed budgets, with the departments concerned. The Ministry of Finance, ultimately, approves the annual budgets. In recent years, R&D expenditure has been growing in various productive and social sectors such as education and health.

PART 4.

Policy issue in scientific and technological development

4.1 MAJOR DEVELOPMENTS

In the past ten years, Nepal has taken some important steps which have had a major impact on the development of the scientific and technological capability of the country. A major step of this kind was the introduction of the New Education System Plan (NESP) at the school and university level in 1971. Greater emphasis has now been given to expansion and improvement of technical education and manpower training centres. Accordingly, various institutes of higher learning in the field of engineering, medicine, forestry, agriculture and animal science were established in Tribhuvan University. A good begining was made in developing a scientific research and development system in the country with the establishment of the Research Centre for Applied Science and Technology at the Tribhuvan University. The establishment of the National Council for Science and Technology (NCST) in 1976 was also an important step taken by his Majesty's Government in this matter.

Lastly, the current Sixth Plan of the country has duly recognised the role of science and technology by incorporating a separate chapter for science and technology. For the first time, specific policies and programmes have been spelled out in the sphere of science and technology.

4.2 ACHIEVEMENTS AND PROBLEMS

With the initiation of the NESP, and the establishment of NCST as the national policy making body, Nepal has sought to harness science and technology to bring about improvements in the daily lives of people through formulation of broad policies and programmes in this field. Moreover, through expansion of scientific and technological institutions, the need for trained manpower has been considerably fulfilled from indigenous sources,

Some constraints, however still exist in the country in the task of the generation and application of science and technology for development. First, the country has, at present, limited capability for undertaking the large scale application of science and technology. Second, there is a lack of sufficient awareness and information in the country. The role of science and technology in development has not been properly assessed. Third, scientists and technologists are yet to receive due recognition for their labour and adequate incentives for their R&D work. Fourth, the available manpower resources are not optimally utilized. Lastly, there is a lack of adequate resources for science and technology development activities within the country which has inhibited the process of strengthening the national scientific and technological capability.

Besides, some other obstacles also exist, such as the inadequacy of the scientific and technological services infrastructure, and the low capacity for diffusion and absorption of technologies within the country.

4.3 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

In the last twenty-five years or so, various socio-economic development programmes have been carried out in Nepal with the cooperation of other developing as well as developed, countries under bilateral and multilateral agreements. At present, several bilateral and multilateral assistance programmes in Nepal offer, among other things, technical cooperation. These programmes have contributed, directly or indirectly, to science and technology manpower development through incorporating training (short and long term) components in the funded project and programmes of development.

It is apparent that, for Nepal, multilateral or bilateral technical cooperation has to be geared in the future towards strengthening the existing institutions in the country to create more self-reliance in various aspects of science and technology for national development. For this, the immediate need lies in the generation of more trained manpower and the promotion of research and development on various problems related to achieving the targets of the national developmental plan. Creation of an effective and capable national capacity for the transfer of technology, the best utilization of local experts and consultancy firms, the promotion of S&T services and information networks, the increased application of science and technology in the national R&D institutions, and the linking these with the production units as well as with the user's needs, are some of the issues that need special consideration.

Nepal has still an inadequate base for application of science and technology in the proces of national development. For one thing, the country is still largely based upon agriculture which, though providing a base for industrialization, remains outmoded both in regard to technology and production. With a high rate of population growth, 2.66% per annum in the past decade. Nepal faces an unenviable challenge to maintain a balance between natural resources and population growth on the one hand, and maximize the use of the existing resource potential through the application of science and technology, on the other. Though some infrastructural development has taken place in regard to building R&D institutions – largely confined to the government sector and the higher educational institutions, yet there is a slow growth of their capability to absorb technology from outside. The launching of large scale projects such as the 60 MW Kulekhani Hydroelectric Project, though primarily executed by foreign collaboration, has nonetheless helped in raising the indigenous capability in this vital aspect of water resource use in Nepal.

There is the prospect of harnessing abundant water resources in Nepal for the benefit of not only her own people but neighbouring countries as well. A proposal to exploit the water resources of Nepal was for the first time put forth by His Majesty, King Birendra Bir Bikram Shaha Dev, at the time of the 26th Colombo Plan Consultative Meeting held in Kathmandu in 1976. Closer co-operation between the developed and developing countries of the world can accelerate the process of development of scientific and technological institutions in the Third World. The needs of the least developed countries have to be specially taken into consideration in accordance with the Substantial New Program of Action adopted at the Paris Conference of the least developed countries.

Therefore, strong support should be given to any programme which would develop collective self-reliance among the developing countries, as well as ensure the increased flow of technical and financial assistance from developed countries. It is gratifying that some steps have already been taken in this direction through identification of areas of regional cooperation. The Second Conference of Ministers responsible for the Application of Science and Technology to Development and those responsible for Economic Planning in Asia and Pacific can indeed be an occasion for broad identification of areas of cooperation, and for evolving a programme of action which would provide an effective and regular channel for exchange of information, knowledge and skill among the countries of the ESCAP region, as well as rest of the world. It would also, no doubt, identify the priority areas and mechanisms for ensuring such cooperation.

Annex I

Members of the National Council for Science and Technology

1. Vice-Chairman, National Planning Commission	Chairman
2. Rector Tribhuvan University	Vice-Chairman
3. Executive Director Research Centre for Applied Science & Technology	Member-Secretary
4. Joint Secretary Ministry of Education and Culture	Member
5. Director General, Department of Agriculture	Member
6. Director General, Department of Medicinal Plants	Member
7. Director General, Department of Health Services	Member
8. Director General, Department of Irrigation, Hydrology & Meteorology	Member
9. Director General, Department of National Parks and Wild-life Conservation	Member
10. Dean, Institute of Science and Technology	Member
11. Dean, Institute of Engineering	Member
12. Director General, Department of Mines and Geology	Member
13. Member, Royal Nepal Academy	Member

Annex II

Members of the National Education Committee

1. Minister of Education and Culture	Chairman
2. Assistant Minister of Education and Culture	Vice-Chairman
3. Vice-Chancellor, Tribhuvan University	Member
4. Member of the National Planning Commission	Member
5. Chairman of the Social Service Committee of the National Panchayat	Member
6. Secretary to the Ministry of Education & Culture	Member
7. Two experts	Members
8. His Majesty's nominee	Member-Secretary

Annex III

Members of the Water and Energy Commission

1. Minister of Water Resources	Chairman
2. Assistant Minister of Water Resources	Member
3. Vice-Chairman, National Planning Commission	Member
4. Secretary, Ministry of Law and Justice	Member
5. Secretary, Ministry of Foreign Affairs	Member
6. Secretary, Ministry of Food and Agriculture	Member
7. Secretary, Ministry of Finance	Member
8. Secretary, Ministry of Forests	Member
9. Secretary, Ministry of Industry & Commerce	Member
10. Secretary, Ministry of Water Resources	Member-Secretary

NEW ZEALAND

Table of Contents

NEW ZEALAND

GEOGRAPHY

Capital city: Wellington
Main ports: Auckland, Wellington, Whangarei
Land surface area: 268,676 sq km

POPULATION (1978)

Total	3.1 million
Density (per sq km)	12
Urban/rural ratio (1976)	4.9
Average rate of growth (1970-78)	1.2%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	28.2	9.9	8.8	40.2	12.9	100%

SOCIO-ECONOMIC

Labour force (1976)

Total	1.3 million[1]
Percentage in agriculture	10.1%

Gross national product (1978)

GNP at market prices	US $17,700 million
GNP per capita	US $ 5,700
Real growth rate of GNP per capita (1970-78)	0.9%

Gross domestic product (1976)

Total (in purchaser's values)	US $13,136 million
Percentage by origin	
Agriculture	...
Manufacturing, mining & quarrying, electricity, gas & water, construction	...

Government finance

National budget (1975)	US $4,181 million
As percentage of GNP	30.0%
External assistance (official, net; 1976)	...
As percentage of GNP	...

Exports (1978)

Total exports of goods	US $3,752 million
Average annual growth rate (1970-78)	2.4%

External debt (1978)

Total public, outstanding + disbursed	...
Debt service ratio (% GNP)	...
(% Exports of goods and non-factor services)	...

Exchange rate (1978): US $1 = 0.96 New-Zealand Dollar

EDUCATION

Primary and secondary education (1978)

Enrolment, first level	393,536
[2]As % of (5-10 years)	108%
Enrolment, second level	[3]368,811
As % of (11-17 years)	80%
Combined enrolment ratio (5-17 years)	93%
Average annual enrolment increase (1970-1978)	[3]0.8%

---

1 Relates to persons who have worked at least 20 hours per week.

2 The enrolment ratio is the relationship between the number of all pupils enrolled (regardless of their age) and the number of the population of the relevant official ages.

3 Second level education refers to general education only.

Higher education (third level) (1979)

Teaching staff, total	4,561

Students and graduates by broad fields of study:

	Enrolment	Graduates (1978)
Social sciences and humanities	43,506	7,092
Natural sciences	7,948	1,518
Engineering	7,435	92
Medical sciences	4,224	17
Agriculture	2,345	168
Other and not specified	19,617	1
Total	**85,075**	**8,888**
Number of students studying abroad	1,243	

Education public expenditure (1978)

Total (thousands of New Zealand Dollars)	936,671
As % of GNP	5.4%
Current, as % of total	86.2%
Current expenditure for third level education, as % of total current expenditure	23.5%

Table 1. Nomenclature and Networking of S&T Organizations

I - First level - POLICY-MAKING

Country: New Zealand

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
NRAC (National Research Advisory Council)	Advisory and co-ordinating	Minister of Science and Technology	All S&T organizations	Planning organizations such as Planning Council and Commission for Future

II - Second level - PROMOTION & FINANCING

Organization	Linkages		
	Upstream	Downstream	Others
Department of Scientific and Industrial Research (DSIR)	Minister of Science and Technology	Users	All science organizations
Medical Research Council	Minister of Health	All medical research units	Universities, Hospital Boards
NWASCA (National Water and Soil Conservation Authority	Minister of Works and Development	Local authorities, govt. departments and users generally	All science organizations
NZ Energy Advisory Committee	Minister of Energy	NZERDC, LFTB, Ministry of Energy	Planning organizations
Royal Society of NZ		Members	Member organizations & NRAC
National Commission UNESCO	Minister of Education & UNESCO		All science organizations
Professional associations		Members	All science organizations
University Grants Committee	Minister of Education	Universities	All science organizations

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages		
		Upstream		Others
Universities (7)	R&D and STET by contract	Contractor (e.g. govt. depts.)	Users generally	
	non-contract	Vice-Chancellor and UGC	Users generally	
Government Departments (16)	R&D and STS	Minister in Charge and Head of Department	Users generally	NRAC, other Depts., Research Advisory Coms.
Research Associations (13)	R&D and STS	Minister of Science and Technology and Board of Management	Members and Users generally	NRAC, DSIR
Quasi-government and independent institutes (4)	R&D and STS	Board of Management and contractor (e.g. govt. depts.)	Users generally	NRAC

Table 2 - Scientific and Technological Manpower(a)

Country: New Zealand

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total stock (thousands)	of which working in R&D (in units)
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965	2.629									
1970	2.816									
1975	3.089	21.67	3,653	1,100	981	1,117	338	117	19.98	2,517
1979	3.144	22.01	3,998	1,229	1,128	1,084	398	159	20.12	2,468
1985	3.245	22.72	4,158	1,278	1,173	1,127	414	165	20.77	2,567
1990	3.385	23.69	4,574	1,406	1,290	1,239	455	182	21.66	2,824

(a) All figures (apart from population) are estimated.

Table 3 - R&D expenditures

Country: New Zealand
Currency: NZ Dollar

Table 3a: Breakdown by source and sector of performance

Year: 1977

Unit: thousands

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive	82,420	17,203	—	99,623
Higher Education	22,629	1,340	—	23,959
General Service	1,437	739	—	2,176
Total	106,476	19,282	—	125,758

Table 3b: Trends

Year	Population (millions)	GNP (in million NZ$)	Total R&D expenditures (in million NZ$)	Exchange rate 1 US$ = NZ$
1965	2.629	3,589 } Not consistent	—	1.3859
1970	2.816	4,907 }	21.543	1.1219
1975	3.089	9,947	99.776	1.3478
1979	3.144	17,227	168.327(b)	1.0552
1985	3.245	27,550 (a)	283.967(b)	
1990	3.385	31,930 (a)	496.212(b)	

(a) In 1980 real prices assuming 3% p.a. real growth. Only GDP projections are made. (b) Estimated.

PART 1.

General Features

1.1 GEOPOLITICAL SETTING

Geography

The total area of New Zealand (including minor islands) is 269 057 sq kms.

The capital city, Wellington, is situated north of Cook Strait which separates the North and South Islands. The population is 327 300.

New Zealand extends from latitude 34°S to 47°S and lies athwart the meridians of longitude covering from 166° to 178°3' east.

Climate

The weather pattern from day to day is dominated by a succession of anti-cyclones, separated by troughs of low pressure, which pass more or less regularly from west to east across the Australia-Tasman Sea-New Zealand area and beyond. In this region there is no semi-permanent anti-cyclone such as those found in similar latitudes over the Indian Ocean and eastern Pacific Ocean respectively. The passage of the trough, with its associated cold front, is accompanied by a change to cold south-westerly or southerly winds and showery weather, occasionally with some hail and thunder. Winds moderate and fair weather prevails for a few days. as the next anti-cyclone moves across the country.

The chain of high mountains, which extends from south-west to north-east through the length of the country, raises a formidable barrier in the path of prevailing westerly winds. The effect is to produce much sharper climatic contrasts from west to east than in the north-south direction. In some inland areas of the South Island just east of the mountains the climate is distinctly continental in character, despite the fact that no part of New Zealand is more than 130 km from the sea. The distribution of rainfall is mainly controlled by mountain features; the mean annual rainfall ranging from as little as 300 mm to over 8 000 mm. The average for the whole country is high, but for the greater part lies between 600 mm and 1 500 mm. Thunderstorms are not numerous and hail is most frequent in the south-west.

Mean temperatures at sea level decrease steadily southwards from 15° C in the far north to 12° C about Cook Strait, then to 9°C in the south. January and February are the warmest months of the year, July is the coldest. Local frost variations are considerable, even within quite small areas. In inland areas light frosts occur frequently in the winter months. The majority of New Zealanders rarely see snow except on the mountains. The North Island has a small permanent snow field above 2 500 m on the central plateau, but the snow line rarely descends below 600 m even for brief periods in winter. In the South Island snow falls on a few days a year in eastern coastal districts, and in some years lie for a day or two even at sea level. The snow line of the Southern Alps is around 2 000 m in summer. In inland Canterbury and Otago, where there are considerable areas of grazing lands above 300 m, snowfalls are heavier and more persistent and have caused serious losses of sheep during severe winters in the past. However, only rarely does the winter snow line remain below 1 000 for extended periods. Humidity is commonly between 70 and 80 per cent in coastal areas and about 10 per cent lower inland. It varies inversely to the temperature, falling to a minimum in the early afternoon when temperature is highest and frequently lying between 90 and 100 per cent during clear nights. A large portion of the country is favoured with at least 2 000 hours of sunshine per year.

Land resources

With almost 27 million hectares of land and a population of just over 3 million, New Zealand has not in the past been conscious of the problems of resource utilization experienced in the more closely settled countries. An extensive coastline (approx. 15 000 kms), great variety of landscape and responsive soils and a generally favourable climate at lower altitudes are some of the assets which, because of the small population, have been utilized without any serious detrimental effects on the social and economic fabric. Between 1949 and 1964 urbanization claimed about 15 800 hectares of good farming land and expansion up to 1984 will require another 30 000 hectares of land. Considering that the total area of good farming land includes approximately 8 300 000 hectares of first class pastoral land and 500 000 hectares of first class cropping land and that agricultural production derives benefits from urbanization, this is not considered a serious problem on a national scale. In certain localities, however, unrestricted urban expansion could have serious limiting effects on agricultural production in the future. The problem is most acute around Auckland, the population of which is over 800 000.

Water resources

Since the combined length of the North and South Islands extends over 1 600 kms, and since the width of neither island exceeds 450 kms at its broadest point, New Zealand possesses a very lengthy coastline in proportion to its area. Of the numerous lakes to be found in New Zealand, seven have areas greater than 100 sq kms, the largest being Lake Taupo with an area of 606 sq kms. As reservoirs lakes of both islands are of vital importance for the maintenance of the rivers and streams draining them and as a means of flood prevention. More especially is this the case where hydro-electric schemes are involved. A series of narrow man-made lakes have been produced in connection with hydro-electric development along some of the rivers. In 1965 Lake Benmore, New Zealand's largest artificial lake, was created. It covers 79 sq kms in area. New Zealand rivers, owing to the high relief of the country, are mostly swift flowing and difficult to navigate. As sources of hydro-electric power the rivers are of considerable importance, since their rapid rate of flow and dependable volume of water make them eminently suitable for this purpose. Of the more important rivers, 38 have a length greater than 100 kms, the longest in the North Island being 425 kms and in the South Island 322 kms.

Other Natural Resources

Trees are among New Zealand's valuable assets with growth favoured by temperate climate and generally adequate rainfall and soil conditions. Today, apart from national parks, about 4 million hectares of land has been constituted State forest. The country's timber resources have been built up by afforestation with introduced species, mainly conifers which produce usable wood in 25 to 30 years; a much shorter time than the slower growing indigenous species. About three-quarters of the forest area is classed as unmerchantable. This is mainly Crown-owned indigenous forest which, because it covers much of the remote and mountainous high-rainfall country, has as its primary function soil protection and water regulation.

Of the 6.2 million hectares of indigenous forests that remain, only about a million hectares are merchantable by today's standards. Greatly increased use of exotic timber has enabled the rate of cutting in State indigenous forests to be reduced to 1 600 hectares a year. Greater emphasis is being placed on the management of indigenous forests for sustained wood yield or as reserved natural stands. A lower cutting level is also evident in privately-owned indigenous forests.

Merchantable forests also include almost all the planted (exotic) forests, about half of which were established and are owned privately or by local authorities. There are about 740 000 hectares of productive exotic forest, over half of which is in the Bay of Plenty – Taupo region. The output of timber from the exotic forests greatly surpasses that from the indigenous forests.

The exotic conifers, particularly radiata pine, have high growth rates, ease of establishment and ease of re-establishment on cut-over areas, and they produce wood that has many uses. Plantings of such trees are being extended and developed to provide for increasing domestic and export demand. The exotic species are also the basis of a flourishing pulp and paper industry, and an export trade in logs. Indigenous forest can be broadly grouped into podocarp, broadleaved forest (which includes kauri forest) and beech forest but there are also many sub-groups and transition zones. The principal podocarp is rimu, secondary ones are totara, matai and miro. Beech forests in which one or more of the southern species are dominant are the forests of the south, the mountains, and the lowlands. Introduced species of pine form the bulk of the large and valuable exotic estate and among these radiata pine is the supreme, all-purpose tree. Other major species are douglas fir, corsican pine and ponderosa pine. The largest of the exotic forests are in the centre of the North Island, medium and small plantations are distributed throughout the rest of the country. Radiata pine comprises about half the area of State plantations and about 90 per cent of private plantations.

Non-metallic minerals such as coal, clay, limestone and dolomite are both economically and industrially as important as metallic ones. Up to 1975 almost the total value of mineral production was represented by coal and limestone together with sand, rock and gravel for roads, ballast, building and construction. The position has changed over the last few years with the increased production of ironsand for export and the increasing output of gas and condensate from recently discovered natural gas fields. The Maui gas field extends over an area of 765 sq km placing it among the twenty largest gas fields in the world. The recoverable economic reserves of the field are estimated at 5 million million cubic feet of high quality methane gas which is used for electricity generation and premium fuel. Oil condensate from the field is likely to supply about 10-15% of the feedstock requirements for refining in New Zealand.

The value of sand and aggregate production has now exceeded that of coal and has therefore become the highest of any mineral in New Zealand. The quarrying industry produces about 26 million tonnes of aggregate and sand and 4 million tonnes of limestone annually, Substantial increases in mineral exports have taken place since 1972 with shipment to Japan of ironsand concentrates. Coal is mined inside specifically defined areas. The estimated recoverable reserves total 1 179 million tonnes. In 1977 the State operated 12 of the 37 underground mines and these produced 593 109 tonnes of coal. 13 of the 33 opencast mines were operated by the State and produced a further 1 094 459 tonnes. Titanomagnetite sands make up most of the black sands in the North Island but in the northern part of the North Island the beach deposits also contain ilmenite in varying proportions. In the South Island beach sands ilmenite is the chief iron bearing material. These beach sands have been estimated to contain some 800 million tonnes of titanomagnetite with a further 8.6 million tonnes of ilmenite in the North Island and 43 million tonnes in the South Island. Uranium bearing materials were found in 1955 but so far its production has not been an economic proposal. The more accessible alluvial gold deposits have been exhausted and production is now limited to one dredge.

The principal ore of tungsten in New Zealand is scheelite and scheelite bearing quartz veins are generally small and broken. Access and transport are difficult and production costs high. Deposits of copper have been mined but not in significant quantities and production has now ceased. Manganese deposits are generally small and shallow and capable of producing only limited tonnages of ore. Cinnabar, the principal ore of mercury, is widely distributed but only in a few localities is it found in quantities of economic importance. Lead, zinc and tin have been mined in small quantities. There are some large quantities of pure quartz (silica) sand and over 100 000 tonnes are used each year for glass manufacture. Propecting proved a 6 million tonne deposit of sulphur in the central North Island in 1968.

Chrysolite asbestos occurs at several localities in the South Island. Tests of the fibre indicate that it is of favourable economic quality. The more favourable sections of our phosphate deposits have been exhausted. Several deposits of serpentine, a magnesium-rich rock used as a fertiliser additive, are being mined. There are an estimated 4 000 hectares of moorland peat on the Chatham Islands with an average thickness of 4 metres. This peat contains a high proportion of peat wax and its commercial application is being investigated. Since 1952 salt has been produced by the solar evaporation of sea water and annual production between 1975 and 1977 averaged 45 000 tonnes.

Other Physical Features

The mountainous nature of New Zealand is one of the most striking physical characteristics, less than 25 per cent of the total land surface lying below the 200 m countour. In the North Island the higher mountains occupy about 1/10 of the surface, but with the exception of the four volcanic peaks, they do not exceed an altitude of 1800 m. Of these four volcanoes only one can be classed as dormant. Closely connected with the volcanic region are multitudinous hot pools and geysers. The mountain system of the North Island runs generally in a south-west direction parallel to the coast. The South Island is much more moutainous. Along almost the whole of the Island runs the massive chain known as the Southern Alps, which attains its greatest height in Mt Cook (3764m), while 19 named peaks exceed 3000 m. The south portion of the Southern Alps breaks up into a miscellany of ranges dominating the mountainous fiord and north-western Southland regions. There are at least 223 named peaks of 2300 m or more. New Zealand is distinctive in having a wide range of volcanic phenomena and associated thermal spas. In keeping with the dimensions of the mountain system, New Zealand possesses, in the South Island, a glacial system of some magnitude. In the North Island there are 7 relatively small glaciers compared with more than 360 in the Southern Alps.

Compared with some other parts of the Pacific margin, such as Japan, Chile, and the Philippines, the level of seismic activity in New Zealand is moderate. It may be roughly compared with that prevailing in California. A shock of Richter magnitude 6 of above occurs in the average about once a year, one of magnitude 7 or above once in ten years, and one of about magnitude 8 perhaps once a century. Other natural disasters and accidents are together responsible for more casualities than earthquakes. The last earthquake to cause deaths occurred in 1968, when 3 people died.

Transport

New Zealand's ports handle more than 35 million tonnes of cargo annually. Most goes through the main ports of Whangarei, Auckland, Tauranga, Napier, Wellington, Picton, Lyttelton, Port Chalmers and Bluff. International Airports are centred in Auckland, Wellington and Christchurch.

In 1978 domestic scheduled services flying scheduled routes flew 28 212 000 kilometres and carried 2 520 000 passengers, 61 000 tonnes of freight and 1 496 000 tone/kilometres of mail. International scheduled air services on scheduled routes carried 1 415 000 passengers, 49 209 tonnes of freight and 2 366 tonnes of mail.

Major Urban Centres

Population estimates of main urban areas in 1979 are as follows (Auckland and Wellington each consist of four combined urban areas):

Auckland	750 500	Nelson	42 800
Christchurch	296 600	New Plymouth	44 600
Dunedin	112 500	Palmerston North	64 800
Gisborne	32 000	Rotorua	47 400
Hamilton	97 500	Tauranga	49 000
Hastings	51 600	Timaru	30 100
Invercargill	53 800	Wanganui	39 800
Masterton	21 100	Wellington	327 300
Napier	51 000	Whangarei	39 600

Political System

New Zealand 's democratic process is based on that inherited from Britain. The basis of this framework comprises the Governor-General who represents Queen Elizabeth II, the Head of State, the Executive Council over which he presides, and the House of Representatives, which is elected by universal adult suffrage and secret ballot. There is no second chamber. The Cabinet consists of the Prime Minister and Ministers (totalling about twenty) and consists of the same membership as the Executive Council, less the Governor-General. Cabinet shapes the general policy of the State, takes the multitudinous decisions required in the day to day running of the country's affairs and discusses the Country's legislative programme to be brought before the House. The House of Representatives has 92 members, four of whom are elected directly by the Maori people. Members hold office for three years following a general election at which persons aged 18 and over are eligible to vote. Three political parties are at present represented in the New Zealand Parliament, Labour, National and Social Credit.

The House enacts laws, authorizes taxation and expenditure, hears the petitioning of grievances, exercises control over executive departments and interprets public opinion. Before becoming law, Bills passed by the House must receive the formal assent of the Governor-General who acts on the advice of the Executive Council. The Council, members of which are Ministers, gives legal effect to decisions of Government either by recommending to the Governor-General that he assents to Acts of Parliament or by resolution of the Council itself. This latter procedure is intended for use when swift action is necessary or when the House is not in session.

Government policy is implemented by some 40 ministries or departments each of which has a permanent head responsible to the Minister concerned. In addition to direct control through the departments on such policy matters as internal and foreign affairs, aspects of trade and industry, labour and defence and multitudinous interests that make up modern society there are other activities over which Government has some ultimate say although divorced in varying degrees from direct supervision. Through administratively self-contained corporations it operates an international airline, the main internal airline, television and most radio stations and some tourist hotels. In addition to central government functions there are more than 600 local authorities directed by elected citizens. These administer municipalities and counties and have considerable control over harbours, hospitals, roading, drainage and housing. The Government and local authorities employ about 1 person in 5 of the labour force.

The laws are administered by several courts. In the lower, or court of summary jurisdiction, a stipendary magistrate judges minor offences, settles some civil cases and with the consent of the accused who has the right to elect trial by jury in the higher court can deal with all the most serious charges. The high Court consisting of the Chief Justice and approximately 20 judges covers the broad spectrum from criminal cases to bankruptcy. It is also the Court of Appeal for decisions from the Magistrates Court. Higher still is the Court of Appeal at which appeals from the High Court are heard and as a final step cases may be referred to the Judicial Committee of the Privy Council in Britain. New Zealand, in 1962, followed the Swedish system and appointed an Ombudsman to act as a "watchdog" on central Government. The Ombudsman enquires into complaints by the public of alleged injustice by departments. Following an investigation he may report to the department and Minister concerned. If no action is taken, he may take the matter to Parliament.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

Social Groups

New Zealand's social groups are native-born New Zealanders of European origin, Maoris, Pacific Island Polynesians and immigrants not born in New Zealand. The following table which gives 1976 census figures displays the broad ethnic origins of the New Zealand population:

European		2 693 186
Maori*		270 035
Other origins – Pacific Island Polynesian		61 354
Samoan	27 876	
Cook Island Maori	18 610	
Niuean	5 688	
Tongan	3 980	
Tokelauan	1 737	
Other	3 463	
Other origins – Non-Polynesian		32 833
Chinese	14 860	
Indian	9 247	
Fijian	1 548	
Syrian, Lebanese and Arab	754	
Other ethnic groups	6 424	
Not specified		71 975
Total		3 129 383

The New Zealand life-style reflects the people's predominantly European origin. The increasing urbanization of the Maori population as younger Maoris seek better job opportunities in the cities and boroughs is a population trend of considerable sociological significance. Of the 270 035 Maoris

---

* "Maori" covers persons who specified themselves as half or more New Zealand Maori, plus those who indicated they were persons of the Maori race of New Zealand, but did not specify the degree of Maori origin.

at the 1976 census, 250 677 were in the North Island. The Maori population, which until recently was not greatly affected by external migration, is much younger population than the non-Maori. Inter-marriage between Maori and European is growing and the traditional Maori way of life is declining.

Although English is the language spoken universally in New Zealand, the Maori language is still spoken particularly by the North Island Maoris, but there are many Maoris who have never learnt to speak the language. Educators and the Maori people have become aware of this shortcoming, and the language is being incorporated into the curriculum of an increasing number of schools.

Religion

The principal Christian denominations are represented in New Zealand:

	% of total population
Anglican (Church of England)	29
Presbyterian	18
Roman Catholic	15
Methodist	6
Baptist	2
Other	30

In the 1976 census 3% of New Zealanders stated that they had no religion.

The New Zealand economy is based primarily on farm production. A country highly dependent on external trade, New Zealand is among the world's largest exporters of butter, meat and wool.

Primary Production	1978
Creamery butter	234 000 tonnes
Cheese	78 000 tonnes
Skim-milk powder	173 000 tonnes
Meat (bone-in weights, estimated)	
Beef	534 000 tonnes
Mutton	160 000 tonnes
Lamb	342 000 tonnes
Total all, meats	1 160 000 tonnes
Wool (greasy basis)	311 000 tonnes
Wood pulp	822 000 tonnes
Sawn timber	1 670 000 cu.m
Livestock Numbers	
Dairy cow in milk	2 053 000 heads
Total Cattle	9 129 000 heads
Breeding ewes	44 515 000 heads
Total sheep	62 163 000 heads
Total pigs	539 000 heads
Crop Yields	
Wheat	329 000 tonnes
Barley	259 000 tonnes
Maize	175 000 tonnes
Potatoes	237 000 tonnes

United Kingdom membership of the European Economic Community has led to the decline in trade with the United Kingdom and the subsequent diversification in New Zealand's overseas markets. New Zealand's principal exports were as follows in 1978:

Meat, fresh, chilled or frozen	(NZ$ million)
Beef and veal	313
Lamb	342
Mutton	47
Total	757
Dairy produce	
Skimmed milk powder	72
Butter	241
Cheese	77
Total	450
Hides, skins and fur skins	144
Wool	580
Forest products	186
Fruit and vegetables	77
Casein	61
Aluminium and Aluminium alloys	108

In 1978 the Gross Domestic Product was 15 316 million dollars.

New Zealand's total labour force was estimated in April 1978 to be 1.23 million persons. The distribution of the work force is as follows:

	%
Farming	10.1
Manufacturing	24.1
Electricity, gas and water	1.2
Construction	8.8
Wholesale and retail trade	17.0
Transport and communication	8.7
Finance, insurance, etc.	6.3
Community, social and personal services	20.7
Mining and quarrying	0.4
Other activities	2.7
	100%

The economy has been marked with a high level of employment moderate growth and a favourable balance of payments. However, recently there has been considerable inflation and unemployment.

1.3 DEVELOPMENT SCENE

Planning for economic development and growth is the concern of a wide range of sectors, including agriculture, manufacturing, transport, forestry, building, mineral development, and energy production. New Zealand is at present undergoing complex structural change with high resource costs and pressure on financial resources, and therefore a need for more careful selection of investment, even though demand has slackened. Within the urban areas themselves, competing demands for industrial, commercial, residential and recreational land have arisen as proponents of each particular use have sought their most suitable available location. Left unchecked, these conflicts of interest could lead unsatisfactory and uneconomic patterns of development. This has necessitated a planning framework within which competing demands can be resolved.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

From about the mid-1970's, the demand for housing and public capital investment in New Zealand began to level off, as the rate of family formation began to reflect the passing of the peak of the high birth rates of the post World War II period. At the same time, the country's balance of payments began to suffer from increases in oil prices, New Zealand being almost entirely dependent on imports for liquid fuels. Basic exports have declined in value relative to oil prices, and have also been facing market access problems.

As a consequence of the balance of payments situation, overall economic growth has slowed. Greatly increased costs of roading and other energy intensive activities have forced a reduction in programmes. Unemployment has become a significant issue for the first time in nearly forty years. Natural increase rates appear to have stabilised at around replacement level, while migration into the country has fallen considerably. At the same time migration from New Zealand, mainly to Australia, has risen, The result has been a substantial net migration loss and, over the last year or so, an overall population decline.

The response of the Government has been to promote a shift in the structure of the economy aimed at reducing vulnerability to price increases for imported liquid fuel, and seeking developments which will utilise New Zealand's basic resources, some of which have become increasingly competitive as world energy prices have risen. Several very large projects are now either under development or at an advanced stage of investigation. These include a methanol from natural gas plant, a synthetic gasoline from natural gas project, oil refinery extension to convert heavy residual fractions to automotive fuels, enlargements to an existing aluminium smelter and the establishment of a second smelter, further hydro-electric and coal fired power stations, major expansion of an existing steel works and the establishment of new pulp and paper mills and major extensions to existing ones.

Probable additional developments will be fishing (a tenfold increase based on one of the largest fishing zones in the world); horticulture (expanding the area currently cultivated for food crops from 2% to 20% of the suitable land); manufacturing and processing (aimed at export growth of some 90% over the next five years); and agriculture (realization of its potential for further increasing the value of production by 2/3 in the immediate future).

The Government has indicated its commitment to an expenditure strategy which includes:

- development of industries with export potential;
- reducing the demand for imports;
- promoting training or retraining programmes designed to correct any mismatch or potential shortfall of skills in the work force.

The main organizations involved in the formation of the development policies and strategy are:

Government

A number of Cabinet Committees have been set up consisting of ministers whose responsibilities are related to the subject matter covered by the committees. The main ones for the purposes of this paper are: Economic, Expenditure, State Services, Science and Technology and Works. Each committee has power, within its terms of reference, to make decisions and some are supported by inter-departmental groups of officials. The Members of Parliament of each party form parliamentary Caucuses, which in the case of the Government caucus can provide a sounding board for policy. Select Committees consisting of both Government and Opposition members cover such fields as Public Expenditure, Lands and Agriculture, Labour and Education, Health and Welfare, Commerce and Energy, etc. The national and local organisations of the political parties also contribute to policy development through their activities and their annual conferences.

Government Departments: Ministers have public service departments each with a permanent head, to administer their statutory responsibilities and carry out their executive decisions. The major Government Departments concerned with development policy in a general sense are the Treasury, the Ministry of Works and Development, the Prime Minister's Department, the Commission for the Environment and the Department of Trade and Industry.

The Treasury: This department controls the receipt, custody and payment of governmental finance as directed by statute and government decisions and keeps the government informed on the existing external and internal economic situation, the effects of existing policy and trends, and prospects for the future. It also advises the Government on the level and content of its expenditure and receipts; assesses the most effective allocations of limited resources among competing expenditure proposals; and advises on, and implements, various aspects of the government's financial and economic policies.

The Ministry of Works and Development: The Ministry's role includes the development of natural resources and the encouragement, investigation and coordination of proposals for regional planning, as well as the task of assembling information on the building and construction industries, and the programming of national capital formation including government works. The ministry also administers the Town and Country Planning Act; the National Roads Act; the Soil Conservation and Rivers purpose of encouraging investment in industry, and providing financial assistance and advisory services to industry. The share capital of the corporation is owned by the Crown and is vested in the Minister of Trade and Industry.

Planning: the NZ Planning Council was established in 1977, to advise the Government on national planning for social, economic and cultural development in New Zealand and on links with regional planning levels. The role of the Monetary and Economic Council in monitoring economic trends and policies was taken over by the Council but is also undertaken by an Economic Monitoring Group which work independently.

The Commission for the Future studies the longer-term possibilities for economic and social development and is required to give special attention to the long-term implications for New Zealand of new or prospective developments in science and technology, and to have regard to prospective trends, policies and events in New Zealand or overseas which could have important consequences for the country's future.

Sectoral development: There are a number of other bodies which assist with development planning and evaluation for particular sectors. These include:

National Research Advisory Council
Environmental Council
Nature Conservation Council
Industries Development Commission
Manufacturing Development Council
Advisory Committee on Heavy Engineering Industry
NZ Metal Casting Industry Association
National Electronics Development Association
Pacific Islands Industrial Development
NZ Export/Import Corporation
Land Use Advisory Council
Foresty Council
National Water and Soil Conservation Authority
National Roads Board

Local Government

The network of regional coordination bodies, the territorial local authorities, and the variety of special purpose authorities (such as harbour boards, catchment boards, electric power boards) contribute to the establishment and execution of development policy and priorities. All loan proposals of local authorities (except for money borrowed in anticipation of revenue) require the sanction of the local Authorities Loans Board. It is difficult to generalise about the processes and procedures used by the above organizations in development planning, evaluation and control. There are, however, three key pieces of legislation:

The Town and Country Planning Act 1977 provides a process by which the needs, opportunities and issues relating to land and water use can be identified and appropriate objectives and policies formulated. Measures can then be implemented and embodied in regional, district and maritime planning schemes. Every city, borough and country council or other authority responsible for the general administration of a district must provide and maintain a district scheme. There is similar provision for regional schemes. Provision is made for publication of the schemes and the hearing of objections and appeals from any body or person directly affected or representing some relevant aspect of the public interest. The process offers a means by which local government, representing district and regional communities and central government representing the national interest, can reach agreement on development and welfare policies and priorities for the allocation of resources.

The Water and Soil Conservation Act 1967 deals with the consumptive use of water and the Soil Conservation and Rivers Control Act 1941 with the protection of soils against flooding. Publications of water and soil resource management plans and water management (allocation plans) provide and opportunity for public comment and objection and the rationalisation of the rights of all known and potential water users.

National Development Act 1979

Under the Act, application can be made to the Minister of National Development for the status of national importance to be applied to a proposed work. The procedures which follow are initiated by order in Council which may be issued by the Governor–General if he considers that the work is major, likely to be in the national interest, and that it is essential that a decision be made promptly as to whether or not the consents sought should be granted. The Governor–General must also be satisfied that the work is essential to the development of New Zealand resources, or self–sufficiency in energy, or expansion of exports or import substitution, or development of significant employment opportunities. In such cases the Act provides for direct referral and report and the streamlining of the process of obtaining the necessary consents from a variety of organisations by dealing with it in one forum.

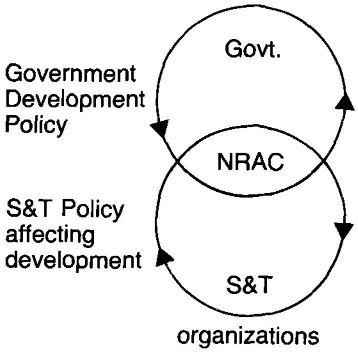
2.2 DEVELOPMENT POLICY AND SCIENCE/TECHNOLOGY POLICY

A single Minister of the Crown holds at present the separate portfolios of National Development and Science and Technology. The Minister of Science and Technology recently (on 10 October 1980) advised the National Research Advisory Council (NRAC) that he is firmly of the view that the Council cannot advise him effectively on research and development policy without a formal statement of government economic development objectives; and that he proposed, each March, to provide the Council with a statement of the government's economic development objectives and the criteria that should be used in formulating the Council's research and development policy and forward programme. The Council would then, in June, make recommendations to him regarding the broad research and development programmes required during the following 3 years in the various fields of application of science and technology and the relative priorities of such programmes. In July, the Cabinet Committee for Science and Technology would discuss and make decisions on the recommendations contained in the NRAC paper. In August, the Council would advise the government departments concerned with research and development of the Government's policy and priorities and would request information on their manpower requirements for the following year. These requests would be considered by the Council and a recommendation made to the Minister. Subject to his approval, the recommendation would be referred to the Cabinet Committee on State Services for consideration along with all other requests for additional government manpower.

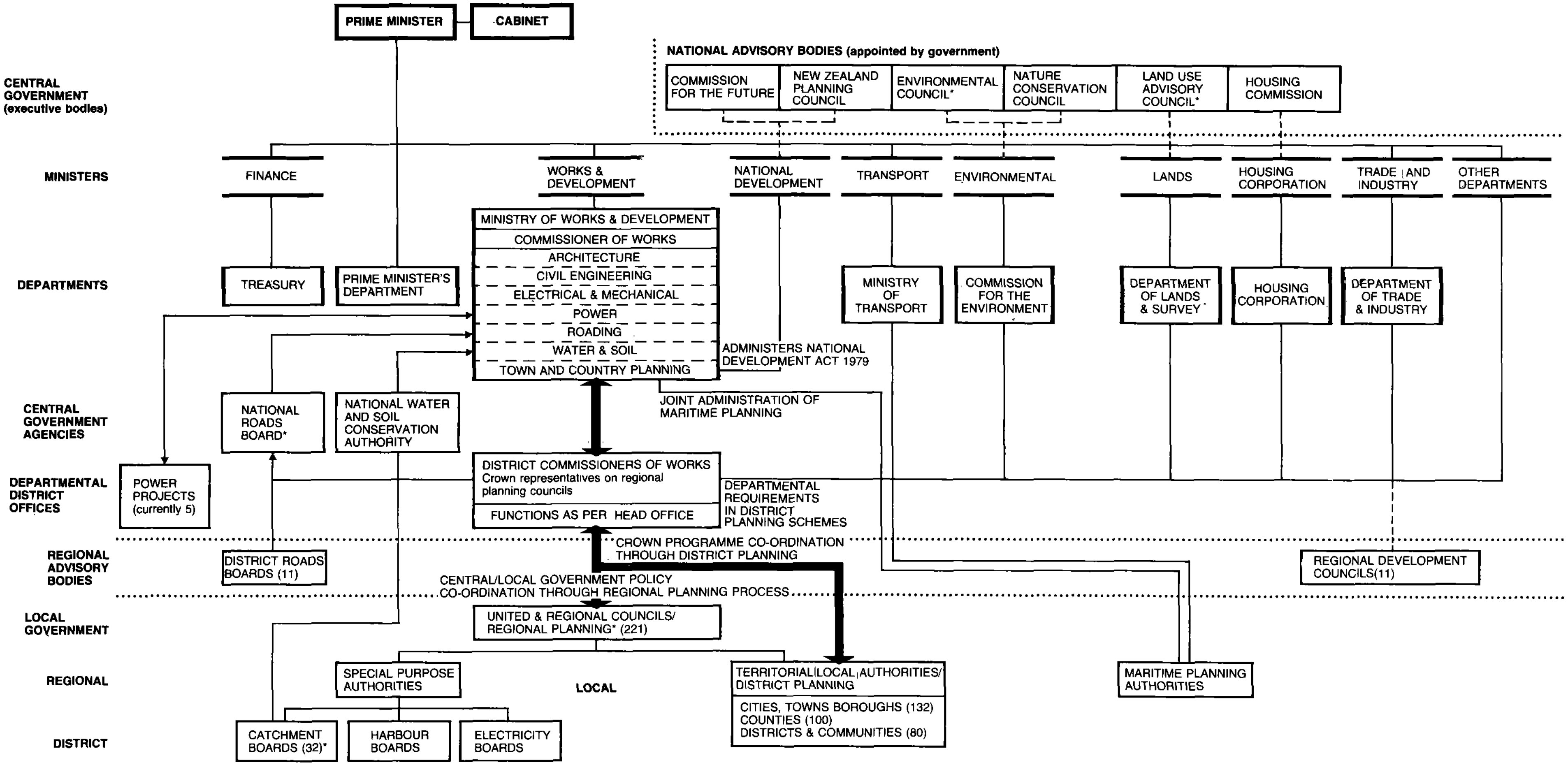
As about 80% of New Zealand expenditure on research and development is provided by the central government and over 70% is spent directly by the research units in government departments, the above procedure will provide a very close degree of inter–dependence between development policy, and science and technology policy. The balance of the government science and technology expenditure is largely administered by the governments departments in the form of grants to other agencies or research contracts mainly with the universities. Of the expenditure by business enterprises on science and technology about 13% is made through research associations, a partnership with the Government administered by joint boards of management.

In addition to this procedure which provides a downward flow of information from the government to the NRAC and upward in the form of comment on it from the NRAC to the government, the NRAC is in regular contact with all organizations involved in science and technology. Through a programme of visits and discussions, the Council provides a line of communication for these organizations to suggest developments arising from their science and technology work to the government. As these potential developments are identified, the Council frequently sets up a broadly representative working party to examine them and report to the Government in detail.

In summary the two processes form a two way information flow:



The Planning System, New Zealand



*MWD REPRESENTED

The NRAC is very conscious of its role in maintaining a balanced science and technology effort between long–term pure or "curiosity" research and short–term applied, development and demonstration research; between research and essential scientific servicing or data gathering; and between work directed towards economic goals and work related to the quality of the social and physical environment. The process described enables these factors to be given due weight in both development and science and technology policies. All of the development policies and priorities outlined in paragraph 2.1 are very clearly dependent, both in the setting and in the placing and timing of achievement, on science and technology input.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

National science and technology policy is made by the Minister of Science and Technology, subject to the approval of Cabinet and Parliament, mainly on the advice of the National Research Advisory Council (NRAC).

National Research Advisory Council

The objectives of the NRAC are :

to give the Minister of Science and Technology sound and timely advice on science and technology in New Zealand,

to ensure that scientific research in New Zealand is of the quality, quantity, and direction needed to contribute significantly to the advancement of knowledge;

to ensure that scientific research and service organisations in New Zealand undertake an appropriate share of this work and have no unnecessary gaps or overlaps, and that their work is appropriately used;

to ensure that priorities are established among the demands made on the Government for scientific research and servicing resources, in relation to the Government's objectives.

The NRAC was established by statute in 1963 and has, over the last 17 years, been developing its role withing the board framework of functions provided by the legislation. These functions are to advise the Minister of Science and Technology on:

the promotion and development of scientific research in New Zealand;

the planning and coordination of scientific research and services in New Zealand, including the determination of priorities among research activities of government departments, having regard to research done by other organisations; the provision of scholarships and fellowships, and the promotion of the training of research workers; the association of the Government with industry in the promotion of fundamental and applied research, including the promotion of research associations; and the collection and dissemination of scientific information including the publications of reports and journals;

the promotion of cooperation with the Governments of or organizations in other countries, of with international organizations, in scientific matters;

any other matters that are appropriate for the carrying out of any of the above–mentioned functions, or that are referred to it by the Minister of by any other enactment.

The NRAC has up to twelve members – nine appointed by the Governor–General on the recommendation of the Minister of Science and Technology and three ex–officio members (the permanent heads of the Ministry of Agriculture and Fisheries, the Department of Scientific and Industrial Research (DSIR), and the Treasury). In addition, the State Services Commission normally sends an observer to each Council meeting. The appointed members are chosen as individuals for their expertise in various fields and do not represent organisations. They are all part-time and include company directors, university professors and others involved with a wide variety of activities related to New Zealand's scientific effort. The Council has a one day meeting about seven times a year, in Wellington.

The NRAC is assisted by four permanent advisory committees of 8 to 10 members. These committees cover the fields of primary production, manufacturing, and processing the environment and energy , and social sciences. The 12 categories and 39 activities used by the Council in its classification of science have been allocated to the committees according to their major interests. A member of the Council acts as chairman of each committee. The committees make regular visits to scientific organizations. The committees from time to time set up ad hoc working parties to undertake detailed reviews of particular areas of science. These groups draw on a wide range of expertise as well as on Council and committee members. On completing their report they disband.

The NRAC operates through advice and persuasion, not through the direct allocations of funds. As referred to in Part 2.2 the greater part of science and technology expenditure is administered by 16 government departments. That paragraph also outlines the formal channels of interaction between the Government's development policies and NRAC. By Cabinet directive, all proposals initiated by government departments involving the establishment of new scientific activities or the major expansion, reduction of modification of existing activities, or proposals likely to make substantial demands on scientific manpower or other scientific resources, must be referred to the Council for evaluation.

Each year the estimates of expenditure and manpower for each government department for the following three years are given a detailed examination, firstly by a select committee of officials, and subsequently by the Cabinet Expenditure Committee. Expenditure and manpower related to science and technology and referred to the NRAC for a report. The NRAC considers the departments' estimates in relation to science and technology policy and the government's objectives, and makes recommendations on the level of science and technology activity and the priority order. The Government is then in a position to consider its science and technology effort as a whole. When approved the elements of the overall science and technology programme are administered by the various government departments.

The NRAC fellowships scheme is an example of this process. The NRAC obtains from departments a description of the fields in which they would like a fellow to work. These are collated by the NRAC and advertised internationally. Applications are received by the NRAC and referred to the appropriate departments for consideration. The NRAC then convenes a meeting and recommends to the Minister the allocation of fellowships between the departments. When approved the NRAC advises the departments, which then must ensure they have financial provision for fares, emolument, etc. and also take over the detailed administration, correspondence with the fellow, etc. The NRAC receives reports on progress and on occasions invites fellows to discuss their work with the Council and to comment ont the state of their field of research in New Zealand.

In addition to the task of advising on priorities between specific requests put forward by government departments, the NRAC and its committees work on a programme of regular (every 2 or 3 years) visits to science units to review their activities, and also from time to time undertake reviews of particular themes or subjects involving visits to the units involved. In undertaking all these activities, the NRAC is free to visit and discuss not only with government science units but with the whole range of organizations - quasi-government, university: and business enterprises.

The procedure adopted by the NRAC with its reports, particularly those dealing with a theme or subject (for example commercial fisheries research, employment research, etc.), is to refer the report in draft to the agencies who have an interest in the subject for comment. These comments are considered by the

NRAC and the report may be altered or additional material added before it is referred to the Minister and published in final form. This consultative process provides opportunity for input to science and technology policy from a wide range of organizations such as research units, planners, research users, etc.

Other Organizations with Ancillary Functions

Department of Scientific and Industrial Research (DSIR): Most of the Government science effort is applied, mission-oriented, research or scientific servicing. In general where a unit of viable size is required to support a government department's operation, it is located within that department. However a central government science department, DSIR, has been retained and undertakes a complementary programme of specialised work towards the basic research end of the range or of more general application. The Minister in charge of this department is the Minister of Science and Technology, and he uses the department for policy advice as well as an executive organization.

Medical Research Council (MRC): At the time of its establishment, there was discussion on whether the NRAC should deal with medical research in detail. The Medical Research Council Act of 1950 provided an appropriate organisation and the NRAC recommended that this should continue. The MRC administers the Medical Research Endowment Fund from which an annual expenditure of $4.3 million is spent on research contracts.

National Water and Soil Conservation Authority: The NWASCA is a statutory body with responsibility for guiding encouraging and carrying out research, surveys and investigations in matters relating to natural water and soil conservation. The authority is serviced by a division of the Ministry of Works and Development and its research and survey programme is coordinated by a broadly representative advisory committee. There is cross membership between the NWASCA and the NRAC.

NZ Energy Research and the Development Committee (NZERDC), the liquid Fuels Trust Board (LFTB), and the Energy Advisory Committee: These organizations were established (in 1974, and 1978 and 1980 respectively) to channel funds into urgent energy research and development. The NZERDC receives a government grant through the Ministry of Energy which it allocates by way of research contracts mainly with the universities. The Liquid Fuels Trust Board receives funds from a levy on the price of petrol and allocates them to liquid fuels research by way of research contracts. The Energy Advisory Committee was established by the Minister of energy to provide overall advice on energy policy from all the sectors involved. There is cross membership between all three organizations and the NRAC.

Other organisations Promoting or Funding Science and Technology

There are a number of organisations which play a role in science and technology policy-making. However their influence is generally in proportion to their size and to the funds they are able to commit to science and technology. As outlined earlier the major part of science and technology expenditure is provided by the Government through departments of State and therefore other influences on science and technology policy are relatively small.

The Royal Society of New Zealand: The Royal Society maintains contacts with major science academies throughout the world, and through its adherence to the Scientific Unions of the International Council of Scientific Unions, maintains contact with major non-governmental scientific organisations. It also maintains standards of scientific excellence and provides a source of disinterested advice or policy questions. Liaison with the NRAC operates as required and there are satisfactory informal channels of communication.

The National Commission for UNESCO: through its natural and social and human sciences sub-commissions in particular, the National Commission links international programmes to New Zealand science and technology and development. (For example the criteria put forward in 1977 as a basis for the coordination of social sciences in New Zealand.) Liaison between the NRAC and the National Commission is intermittent but adequate.

The Universities and the University Grants Committee (UGC): The universities have, until recently, played little part as organisations in influencing science and technology policy, although their staff have been active through the other agencies listed. The UGC advises the government of the needs of New Zealand for university education and research. It recommends the allocation of grants to the seven universities to meet the general running needs and through its statutory sub-committee, the Research Committee, is responsible for the distribution of a government grant for university research. This is allocated mainly to the purchase of major items of equipment.

Professional Associations: There are about 30 or so professional associations (such as the NZ Institute of Agricultural Science (Inc), the NZ Association of Scientists (Inc), the NZ Institute of Chemistry, etc.) whose membership frequently raises issues for consideration. These groups are invited by the NRAC from time to time to comment on the Council's reports.

Philanthropic Trusts and Lottery Funds: A small number of trusts and foundations provide funds, usually in the form of fellowships, for training or research. A proportion (NZ$ 350 000) of national lottery profits are distributed annually among research workers by a committee established for the purpose. At the present time neither of these contributions appear to be a significant factor in development.

Technology transfer

The Ministry of Agriculture and Fisheries provides advisory services to farmers, horticulturalists and fishermen, both on individual request and by means of demonstrations, "field days", workshops, and publications. A similar service to the manufacturing and processing industries is provided by the Department of Scientific and Industrial Research and the Department of Trade and Industry. In addition there are several quasi-government bodies which provide assistance:

The Standards Association of NZ (SANZ) which is responsible for the formulation of national standards for processes, goods and services;

The Industrial Design Council (IDC) which promotes and encourages good design;

The Testing Laboratory Registration Council of NZ which operates the national accreditation system which provides any testing laboratory with a formal mechanism whereby it can establish and maintain credibility, and at the same time offers users an authoritative statement of the competence of a registered laboratory.

Two other mechanisms which have a bearing on this field are the Research Associations, (see Part 3), and Research Advisory Committees. Both tend to bring the users of research into floser contact with research workers to help determine programmes and evaluate results.

Finally, mention must be included of libraries and the tertiary education system as a means of transmitting new technologies and importing them from overseas. In this connection the role of international companies should also be mentioned, as this appears to be a valuable source of overseas travel technology, and also fellowships and other provisions for overseas which are provided by a number of organizations.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

Scientific research in New Zealand is carried out by the research divisions of government departments, universities, joint governments/industry-funded research associations and private organisations which receive government assistance.

By far the greatest part of research undertaken in the national interest is provided by the government; particularly throughout the 21 divisions and branches of the Department of Scientific and Industrial research which accounts for 44% of government research expenditure.

Government Departments

The DSIR was formed with the purpose of coordinating and applying scientific research to foster the development of the primary and secondary industries. From its inception the department has sustained a philosophy of cooperation with other sectors of the community. Even within the DSIR itself the variety of scientific work required for projects of national importance necessitates inter-divisional collaboration. Staff at 31.3.80, total 2 163, comprised 936 science occupational class, 702 science technician occupational class and 525 supporting personnel. These are deployed as follows:

Agriculture – production	799
– processing	77
Energy	220
Manufacturing	282
Natural Environment	402
Other Activities	383
Total	2 163

In addition to its own research and development the DSIR makes grants to universities, research associations, and to overseas and New Zealand institutions.

The Ministry of Agriculture and Fisheries, together with the DSIR expend 70% of the government research allocation. MAF staff allocation under the science budget is 1 194. These are concentrated mainly in the area of agricultural production. The department's Advisory Services Division helps farmers and horticulturalists maximise the effect of their resources through adoption of proven management techniques and research developments. The Agricultural Research Division operates through 8 research stations or centres and also has scientists and technicians in every major farming district in the country. There are also divisions for Animal Health, Dairy, Economics, Fisheries Management, Fisheries Research and Meat.

The Ministry of Energy has been established for 2 years and brought together the former departments of Electricity, Mines and Energy Resources. The bulk of the funds allocated by the Government to energy research and development are spent by the Liquid Fuels Trust Board (LFTB) (42%), the DSIR (44%) and the New Zealand Energy Research and Development Committee (NZERDC) (11%). Responsibility for coordination of the programme lies with the Ministry of Energy. However the LFTB is directly responsible to the Minister of Energy, the DSIR is responsible to the Minister of Science and Technology and the NZERDC to Ministry of Energy officials. This situation is workable at present as one Minister holds the portfolios of Energy and Science and Technology and a number of principal individuals are established in all of the key committees. Coordination is thus less reliant on structural relationships.

The NZ Forest Service undertakes and coordinates its forestry and forest products research through the Forest Research Institute which has 3 divisions employing 139 scientists, 206 technicians and a large servicing staff. An advisory committee for each division of the Institute ensures the research programmes are relevant to the needs of the forestry and forest-based industries. The Ministry of Works and Development undertakes research and development through the various divisions - Civil Engineering Division, Electrical Engineering Division, Roading Division (Roading Research Unit), Town and Country Planning Division and Water and Soil Division. The Ministry of Transport undertakes research and development through the NZ Meteorological Service, the Economics Division and Traffic Research Section. Other government departments undertaking research and appearing in the science budget are Defence, Lands and Survey, Internal Affairs, Trade and Industry and the Social Science departments - Education, Justice, Social Welfare and Labour.

Quasi-Government Research Organisations

The NZ Council for Educational Research was set up in 1933 and supported by the Carnegie Corporation of New York for 10 years. Since 1945 the Council has been supported principally by State funds. It has remained under independent control as provided for in the NZCER Act 1945. In its research programme the Council has concentrated on New Zealand problems. The NZCER publish research reports, studies in education and other periodical publications. the Council employs its own permanent research staff as well as research fellows and assistants for particular projects.

The Carter Observatory is funded through the DSIR and is involved in a programme of observational and photographical work and in the design and calibration of new equipment.

The Cawthron Institute undertakes its own research programme in microbiology and the Cawthron Technical Group provides industry, local and central government with analytical and environmental consulting services.

The Testing Laboratory Registration Council of New Zealand operates the national accreditation system which provides any testing laboratory with a formal mechanism whereby it can establish and maintain credibility, and at the same time offer users an authoritative statement of the competence of a registered laboratory. At 31.12.79 there were 127 registered laboratories spread over 6 fields of testing, biological, chemical, electrical, mechanical, metrological and physical.

Research Associations

There are 12 Research Associations which receive 10.5% of the expenditure of the DSIR in the form of grant aid. The associations exist primarily to service an industry.

The Building Research Association of NZ (Inc) which promotes and conducts research and development in the building industry and provides a technical advisory service.

The Coal Research Association of NZ (Inc) which engages in work mainly related to the utilization of coal. In the past, activities have concentrated on chemical research and analysis, engineering research and development and the fuel technology extension service. A new major programme on the conversion of coal to liquid fuels has commenced. Staff at 31.3.79 was 29. Expenditure 1978/79 $500 000, financed by DSIR grant and a statutory levy on mined coal.

The Meat Industry research institute of NZ (Inc) which undertakes a wide range of research and development for the New Zealand meat industry. In these, engineering activities are progressively assuming greater significance. The Institute has a staff of 90 and expenditure of $ 3 million which is contributed to by the Meat Board and the Freezing Companies Association.

The NZ Concrete Research Association has engaged in the research and development of new materials and alternative uses for concrete. A small association, it employs a staff of 13 and its expenditure for the year ended 31.3.79 was $176 500. Funding is through DSIR and the cement industry.

The NZ Dairy Research Institute, the largest and longest-established of the Research Associations, is supported jointly by the government (through the DSIR) and the dairy industry. Applied and basic research are undertaken in the institute laboratories and close contact is maintained with the manufacturing dairy industry, the Dairy Division of the Ministry of Agriculture and Fisheries, the NZ Dairy Board and with equipment supply firms. The Institute also provides an extensive advisory service to the industry particularly in product and process development, equipment selection, building design and methods of improving the yield of products and efficiency of manufacture. The work of the Institute is augmented by research contracts with government departments and universities. The staff at 31.3.80 totalled 151 and the 1979/80 expenditure was $2.7 million.

The NZ Fertiliser Manufacturers' Research Association (Inc) which is financed jointly by the industry and the government grant through the DSIR. The management committe which controls policy and finances consists of representatives of the industry, the Ministers of Agriculture and Fisheries and Science and Technology. The primary function of the Association is to undertake research of importance to the economic operation and future planning of the fertiliser industry. Currently 70% of the research effort is devoted to fertiliser production and 30% to fertiliser use.

The NZ Heavy Engineering Research Association (Inc) commenced operation in 1979. The major activity of the association has been in the areas of surveying the capacity and capability of the industry, together with investigations of techniques of use in resource-workload matching.

The NZ Leather and Shoe Research Association was established in 1929. The present research and development programme, which has concentrated on the processing and preparation of leather, is to be expanded to match the present needs and potential of the fellmongering and tanning industries. The technical staff has been increased so that more emphasis can be placed on technology transfer. The staff totalled 14 at 31.3.79 and the expenditure was $300 000.

The NZ Logging Industry Research Association (Inc) undertakes research into all aspects of logging, from extraction from the forest to semi-processing and transport to the factory or dockside.

The NZ Pottery and Ceramics Research Association (Inc) is engaged in a varied programme of research related to the production and performance of porcelain, ceramics and pipes. This small association (staff 14, expenditure $300 000) is funded voluntarily by its industry.

The research Institute Textile Service (Inc) has members in the private and institutional laundry, drycleaning, textile importing and manufacturing, garment manufacturing and related industries. It also serves industrial textile users, suppliers to the trades and some retail outlets. There are 200 members of the Institute.

The Wool Research organization of NZ (Inc)'s research ranges from fundamental studies of wool growth and collaboration in breeding programmes, to operations of classing, selling, scouring and processing wool, to chemical finishing operations and the construction of end products. The organization has a staff of 92 and expenditure of $1.5 million. The NZ Wool Board contributes to the funding from a levy on producers.

An indication of the comparative magnitude of the operations of the Research Associations is given by the following table:

Grants paid in 1979-80 to Research Associations by DSIR

	NZ$
Building Research Association	413 600
Coal Research Association	241 900
Dairy Research Institute	1 054 900
Fertiliser Manufacturers Research Assn.	194 800
Research Institute Textile Service	54 500
Leather and Shoe Research Association	136 200
Logging Industry Research Association	94 500
Meat Industry Research Institute	719 700
Pottery and Ceramics Research Association	127 600
Wool Research Organisation	657 900
Heavy Engineering Research Association	21 100
Concrete Research Association	97 700

Universities

There are 6 separate universities and a university college of agriculture. The University Grants Committee (which functions under the Universities act of 1961) advises the government of the needs of New Zealand for university education and research. Its research committe distributes the government grant for research. In addition to this research grant for approved research, universities undertake contract research for government departments and the private sector. University staff can also work on secondment for government or industry.

Assistance to universities to further specific research in the form of continuing grants, short-term contracts and joint funding of instruments is provided by the DSIR.

Independent research organisations

The NZ Institute of Economic Research which is an independent non-profit making incorporated society administered by a board of trustees and funded by membership subscription. Its primary objective is to research economic problems affecting New Zealand especially in connection with econonmic growth. The Institute provides basic data on which private business and government may base their long-term plans. Contract work: is undertaken for public and private clients.

The Royal Society of New Zealand which receives government funding through the DSIR. It sponsors and guides international symposia, promotes science activities, publishes papers and administers the James Cook Fellowship which is awarded for research work in New Zealand or the south-west Pacific area. It administers various trust funds which support scientific workers in New Zealand by way of grants and prizes.

The Social Science Research Fund Committee is responsible for allocating an annual government grant (administered through the Department of Social Welfare) to approved projects in the field of social science research.

The Ross Dependency Research Committee is responsible for the formulation of the annual scientific programme in Antarctica and has the responsibility for the detailed planning and implementation of this programme.

3.2 HUMAN RESOURCES

Government policy in the present unfavourable economic climate is focusing on sustaining economic growth but within prescribed guidelines. These guidelines have been applied to science budget manpower increases where a growth rate of 1.5% p. a. is allowed overall. This rate is applied differentially across the 12 science budget activities. These activities are:

Agriculture – soil, pasture, crops, horticulture, meat, wool, dairy, and miscellaneous agriculture and associated processing;

Forestry – protection forestry, production forestry, and forest products;

Fisheries – fish production, fish processing, and sports fishing;

Minerals – mineral production and mineral processing;

Manufacturing;

Building and Construction;

Transport – transport, storage, and communications;

Natural Environment – atmospheric sciences, earth sciences, oceanography, biology, and Antarctica;

Social Sciences – economics, education, sociology, and other similar areas;

Human Health – principally food and drug investigations;

Energy – resources, generation and transmission, utilization and conservation;

Other Scientific Services – services not included elsewhere.

The rates of manpower expansion for 1980/81 have varied from 3.9% in the high priority areas of Manufacturing and Fisheries production to 0% in Building and Construction.

The manpower working for the government in research and development in 1977/78 possessed the following qualifications:

	Researchers	Technicians	Others	Total Manpower Working on R&D
Agriculture	607	855	480	1,942
Forestry	110	175	85	370
Fisheries	38	63	19	120
Minerals	18	10	9	37
Manufacturing	189	201	120	510
Building and Construction	40	45	18	103
Transport	49	24	14	87
Natural Environment	360	472	189	1,021
Human Health	101	61	42	204
Energy	113	81	39	233
Other Sciences Services	72	34	29	135
Social Sciences	55	2	12	69
Total	1,752	2,023	1,056	4,831

University Graduates Output

The birth rate in New Zealand has declined from a 1961 peak of 26.99 per thousand to 15.5 in 1980. This decline is now being reflected in the university attendance figures. The decline in the output of graduates commences in 1979 and should continue as the falling birthrate and changes in the study grants for students are reflected. The university output from 1970 to 1979 in science related areas is shown below:

Fluctuations in all areas are apparent. In the post graduate level the greatest output continues to be in the Natural Sciences. The new social sciences area is gradually increasing the output at higher levels while medical sciences are maintaining the same level. Another observable trend is the increasing proportion of women taking degrees in the natural and agricultural sciences.

	First Degree					
	1979	1978	1977	1976	1975	1970
Natural sciences	1,092	1,048	1,025	1,149	1,129	732
Engineering & Technology	417	519	445	440	456	320
Agricultural sciences	246	214	258	209	2420	138
Medical sciences	259	326	255	224	197	174
Social sciences	104	97	102	80	74	34
Total	2,118	2,204	2,085	2,102	2,096	1,398

	Post graduate					
	1979	1978	1977	1976	1975	1970
Natural sciences	252	263	238	249	227	187
Engineering and Technology	43	53	51	41	53	22
Agricultural sciences	42	40	16	31	37	25
Medical sciences	11	12	8	8	11	10
Social sciences	31	30	22	22	15	—
Total	379	398	335	351	343	244

In the past universities had not made any serious attempts to prepare students for work in industry. In order to meet this lack degree courses in technology are now available at two universities and increased emphasis is being placed on providing courses in management studies and computer science. A vocation orientation is being increasingly followed by the Technical Institutions which provide a wide variety of certificate courses for technicians. Technical education in New Zealand is still developing and expanding at a very rapid rate. It is being developed through national and regional institutes as well as smaller technical institutes or community colleges in provincial areas.

Not all social scientists undertaking research in government departments are at present accorded scientific status. A proposal is now under consideration whereby departments wishing to enhance their research effort and employ specialist research staff to engage on high level work may apply to have positions established in the science occupational class.

Research careers are available to women, however, where selection is based on qualifications, it is found that men usually possess the higher qualification and are therefore appointed. The latest salary survey carried out by the NZ Association of Scientists showed that of 2553 working scientists 2288 were men and 265 were women. The women tended to have lower qualifications and most were found in teaching positions in high-schools rather than participating in research and development departments of government. Women are 28% of science graduates but only 7% of working scientists. Marriage and child bearing usually mean that women scientists have to halt their career as there is little available childcare in New Zealand if a professional woman wishes to continue working. Some women scientists do return to part-time research positions after child bearing but these have low pay and low status.

Brain-drain Migration

The net population loss through migration has increased rapidly through the late 1970's. For the year ended 31 March 1980 the net outflow through long-term migration was 34 417. A recent survey of those leaving the country showed that a high proportion of the emigrants were professional/technical workers. Their reasons for leaving were that there were better job opportunities overseas for the highly qualified. The high tax and cost of living in New Zealand were also given as contributing factors. Some did indicate that subject to an improvement in economic climate and availability of work they may return in the future. An analysis of the migrants for the same year by occupation showed that the net loss of scientists and technicians for the period was 1077 (2766 out, 1689 in). This net outflow has been consistent over a three year period but is beginning to show some signs of decreasing. The inflow of scientists/technicians is predominantly from Britain and theses people are often recruited to fill specific positions where particular qualifications and training are required.

While the government is naturally concerned at the net outflow of professional and technical workers, the greater proportion of these are in the younger age group i. e. 25-35, and therefore likely to return in the future if conditions overseas worsen. In the latest year the inflow of New Zealand citizens with professional qualifications has increased.

Country: New Zealand

R&D Manpower by Occupation and by Sector of Employment
(in full-time equivalents)

		1972 Total	1975 Total	1977 Total
1	Business Sector	1,604	1,896	1,889
2	Government	3,930	4,717	4,831
3	Private Non-Profit	51	134	151
4	Higher Education	885	1,256	1,354
5	Total	6,470	8,003	8,225

Notes:
As the information is incomplete the differentiation between Scientists and Engineers, and Technicians has not been made.

3.3 FINANCIAL RESOURCES

A science budget is prepared annually to assist the National Research Advisory Council in advising the government on an appropriate allocation of resources to the various areas of scientific activity. Each department's work is classified according to the 12 science budget activities rather than by scientific disciplines (see Part 3.2).

The Council ascertains the work that is underway in each activity, the resources devoted to it, and the relevant cost. It also obtains forecasts of the resources needed to maintain existing levels of effort in each activity over a forward-planning period of three years. From this background information the Council recommends to the government what it considers should be the desirable growth rate in each acitivity, with an estimate of the likely cost. The government decision on an appropriate manpower growth rate becomes the approved framework for the scientific expenditure of each department undertaking research.

The figures on government expenditure (Table 3b) are not complete. They include expenditure on scientific, technical and support staff of the main science units within the Public Service, Science Budget Expenditure for Year Ended 31 March 1980 by Activity

Activity	Departmental expenditure NZ$'000	Grants and subsidies NZ$'000	Research Contracts NZ$'000	Total NZ$'000
Agriculture				
production	37,094	1,504	180	38,778
processing	2,117	3,027	51	5,195
Forestry				
production	7,367	161	29	7,557
processing	1,989	5	7	2,001
Fisheries				
production	4,184	10	10	4,202
processing	59	32	—	91
Minerals				
production	702	6	3	711
processing	295	2	2	299
Manufacturing	5,802	3,114	40	8,956
Building & construction	1,150	819	53	2,022
Transport	1,942	10	8	1,960
Natural environment	22,689	566	85	23,340
Social sciences	1,577	1,617	213	3,407
Human Health	1,615	53	5	1,673
Energy	8,361	1,244	340	9,945
Other scientific services	2,846	234	6	3,086
Total	99,789	12,404	1,032	113,225

grants by these departments to research associations and other agencies, and expenditure on the science building and equipment of these departments. They do not include expenditure on scientific research and servicing in the trading areas of the State Services such as the Railways, Post Office or by the Reserve Bank, nor in the Universities, the grants made to the non-government sector by the NZ Energy Research and Development Committee, the assistance to industry for research provided by the Development Finance Corporation, the allocation of Golden Kiwi lottery funds for scientific research, or the revenue foregone through taxation concessions to individuals' and companies' expenditure on research donations to research foundations.

The NZ Energy research and development budget for 1979 was NZ$8.26 million, which represents a 45% increase over the previous year in real terms. This is due to the new programme of the Liquid Fuels Trust Board in natural gas conversion. The expenditure on energy research and development is 7.4% of the total Government research and development budget. The funding of Research Associations (see Part 3.1) is more complex. The DSIR allocation of funds is reassessed annually by the Cabinet Economic Committee. The industry contribution matches this and is determined by statute or arrangement. In some cases constituent industries or procedures are levied as in the Wool Research Organisation of New Zealand where the wool growers pay a levy.

3.4 SURVEYING OF THE SCIENCE AND TECHNOLOGY POTENTIAL

At the present time the International Science Unit of the Department of Scientific and Industrial Research has the responsibility for the compilation, analysis and presentation of the data pertaining to the national scientific and technological effort. The sources of information are the Department of Statistics, the University Grants Committee, the National Research Advisory Council (NRAC) and Annual Reports of various government departments and organizations. Statistics are provided for UNESCO and OECD on a two and three year cycle. The compilation and presentation of data is in accordance with the definitions in the Frascati Manual.

The NRAC collects and processes returns from each government department for research expenditure (see Part 2.3). Other research organisations, e. g. the New Zealand Council for Educational Research, submit their budgets to NRAC for approval.

It has been proposed that NRAC should become the centralised service with responsibility for the compilation and analysis of all numerical data and other information and that this should be carried out on an annual basis in order that regular recording procedures could be instituted.

PART 4.

Policy issues in scientific and technological development

4.1 MAJOR DEVELOPMENTS

In the past decade significant changes have been the reviews of various scientific and technological activities, the development of more technical organisations and improved technical liaison with industry. In-depth reviews of the principal fields of activity – energy, processing, heavy industry, agricultural and horticultural production and the like identified those areas requiring above-average expansion in manufacturing and agricultural processing. The Energy Research and Development Committee (NZERDC) was established, which has provided guidance in this field, the Testing Laboratory Registration Council (TELARC) was set up (1972) to promote, develop and maintain good laboratory practice in testing. In 1973 the Development Finance Corporation (DFC) was established, to provide finance for industrial development and technological innovation and in 1976 the New Zealand Organisation for Quality Assurance (NZOQA) was founded.

New Research Associations, supported jointly by the Government and specific industry funds were established for the logging, heavy engineering and concrete industries and increased the number of Research Associations to thirteen. Meanwhile the Department of Scientific and Industrial Research developed two new divisions, the Industrial Processing Division, concerned mainly with minerals, metallurgy, chemical engineering and agricultural processing and waste recovery, and the Horticulture and Processing Division, with specific interests in food processing especially fruit and fish. Petrocorp, a government-owned corporation was initiated to develop specific fuels from petroleum reserves. More recently the Liquid Fuels Trust Board (LFTB) was established to study alternative fuels and their needs in the country. Commercial production of industrial grade alcohol based on whey has commenced and further developments in this field are expected. Two new geothermal energy fields have been evaluated and one is in the process of development. The iron and steel industry has expansion planned and recently DSIR undertook a firm by firm survey to evaluate the capability of the electronics industry and its export potential.

4.2 ACHIEVEMENTS AND PROBLEMS

Despite the expansion of science and technology support for manufacturing, processing, conservation of resources and energy development, the major restrictions to developing science and technology capacity are economic and social. Surveys of manufacturing indicate the small-scale nature of plants in New Zealand where 70% of manufacturers employ less than 20 people. Relatively little use is made of professional advisory services for perceived technical problems in industry. There is a need for better communication between technical advisers, in government service and elsewhere, with both management and shop floor workers. The rising problem of unemployment also presents problems of union and management resistance to change and redundancy. All these relationships are inhibited by economics.

Manufacturing industry is expected to pay for services, government departments are required to charge for services; neither group has money to spare to bridge the gap. Despite this, notable science and technology advances have been made, some indeed have been readily adopted, others not. Mechanization of processes in abattoirs (weighing, measurement of back fat depth, pelt removal, recovery of waste proteins); wool grease recovery from scouring works; control of tissue breakdown in storage (fruit); earthquake engineering; electronic medical aids (foetal heart beat); biological control of insect and plant pests; improved food and grain drying are but a few examples of quite recent advances.

4.3 OBJECTIVES AND PRIORITIES

Major objectives are to improve the communications between divisions of DSIR and Research Associations and between government institutions and industry. New collaborative groups such as the Foundry Industry Advisory Committee are being fostered, and the manufacturing industry is being encouraged to employ more technologists, or to designate key personnel to act as in-house contacts for the reception of technological information.

Another approach is the development of multi-disciplinary project teams for the exploitation of natural gas, industrial pollution, agricultural product processing and environmental studies. Priority is being accorded to research in energy, especially liquid fuels, to agricultural production of hill country and processing of farm and horticultural products. Other special interests are the use of naturally occurring minerals (lime, iron sands, coal), geothermal energy production, the application of foreign technology to local needs, and improving effectiveness of fertiliser application.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

Cooperation is strong especially in the South-West Pacific and Asian regions, both through international and regional organisations, and through bilateral association. In the Pacific emphasis has been on agricultural development, fisheries, oceanography, survey for plant pests and diseases, soil surveys, water supplies, off-shore mineral exploration including petroleum and food processing. Cooperation, with regional organisations like the South Pacific Commission in training courses, has been close. Similar aid and training programmes have taken place in the Asian regional area and in specific countries. Notable inputs from New Zealand include considerable transfer of technology in geothermal energy production, soil science, entomology, water analysis techniques and metrology.

Although the major contribution in technical assistance has been with developing countries in Asia and the Pacific, New Zealand has also assisted in Central and South America, East Africa and the Gulf States. Specific Scientific and Technological Cooperation Agreements are in operation between New Zealand and USA (1974), Singapore (1976), FRG (1978) and Romania (1979). Implementing agreements with the IEA have also been in force since 1977. Many less formal arrangements for scientific and technological cooperation are active under the aegis of such bodies as the Commonwealth Science Council (CSC), the Association for Science Cooperation in Asia (ASCA), the United Nations' Economic and Social Council for Asia and the Pacific (ESCAP) and UNESCO.

PART 5.

Bibliography

Statistics Department. *NZ Official Yearbook 1979 and 1980*

Growth Opportunities in New Zealand, Government Printer, 1980

Annual Reports, Government Departments

NRAC Annual Report, Government Printer

N.Z. Planning Council. *Migrants and Their Motives*, 1980

Statistics Department. Monthly Abstract of Statistics

Unesco Statistical Yearbook 1978-79

PAKISTAN

Table of Contents

PAKISTAN

GEOGRAPHY

Capital city: Islamabad
Main ports: Karachi
Land surface area: 803,943 sq km

POPULATION (1978)

Total	76.8 million [1]
Density (per sq km)	95
Urban/rural ratio (1972)	0.3
Average rate of growth (1970-78)	3.0% p.a.

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	45.2	10.9	9.3	29.9	4.7	100%

SOCIO-ECONOMIC

Labour force (1978)

Total	22.3 million [1]
Percentage in agriculture	53.9%

Gross national product (1978)

GNP at market prices	US $18,250 million
GNP per capita	US $ 240
Real growth rate of GNP per capita (1970-78)	1.5%

Gross domestic product (1976)

Total (in current producers' values)	US $ 14,509 million
Percentage by origin	
Agriculture	31%
Manufacturing, mining & quarrying, electricity, gas & water, construction	21%

Government finance

National budget (1978)	US $ 2,534 million
As percentage of GNP	13.8%
External assistance (official, net; 1976)	US $ 1,374 million
As percentage of GNP	10.2%

Exports

Total exports of goods (1978)	US $1,471 million
Average annual growth rate (1970-78)	—1.3%

External debt (1978)

Total public, outstanding + disbursed	US $ 7,568 million
Debt service ratio (% GNP)	2.1%
(% Exports of goods and non-factor services)	12.2%

Exchange rate (1978): US $1 = 9.93 Rupees

EDUCATION

Primary and secondary education (1978)

Enrolment, first level	*6,563,826
As % of (5-9 years)	56%
Enrolment, second level	*2,154,866
As % of (10-16 years)	16%
Combined enrolment ratio (5-16 years)	35%
Average annual enrolment increase (1970-1978)	6.0%

Higher education (third level) (1977)

Teaching staff, total	6,074[2]	
Students and graduates by broad fields of study:		
	Enrolment	Graduates
Social sciences and humanities	79,788	46,441
Natural sciences	20,992	6,448
Engineering	18,508	729
Medical sciences	22,291	840
Agriculture	6,658	654
Other and not specified	214	—
Total	**148,451**	**55,112**
Number of students studying abroad	4,458	

Education public expenditure (1978)

Total (thousands of Rupees)	3,875,946
As % of GNP	2.1%
Current, as % of total	72.5%
Current expenditure for third level education, as % of total current expenditure	*16.5%

---

1 Excluding Jammu and Kashmir (the final status of which has not yet been determined), Gilgit and Baltistan, Junagardh and Manavadar.

[2] Incomplete data. Teachers at the arts and sciences colleges are counted at the second level of education.

Table 1. Nomenclature and Networking of S&T Organizations

I - First level - POLICY-MAKING

Country: Pakistan

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
Ministry of Science and Technology	National S&T policy-making; promotion and co-ordination of R&D	President	National Science Council; Pakistan Science Foundation Research Councils; Ministries of: Industries; Commerce; Health, Social Welfare and Population; Food Agriculture and Co-operatives; Water and Power, Railways; Production; Petroleum and Natural Resources; Communication and Works; Education; and Defence.	

II - Second level - PROMOTION & FINANCING

Organization	Linkages		
	Upstream	Downstream	Others
Ministry of Science and Technology	President, Chief Martial Law Administration (MLA)	National Science Council; Pakistan Science Foundation; Pakistan Council of Scientific and Industrial Research Irrigation, Drainage and Flood Control Research Council; Council for Works and Housing Research; Pakistan Medical Research Council Appropriate Technology Development Orgaization	
Pakistan Atomic Energy Commission	President, CMLA	Research laboratories	
Cabinet Ministries	President, CMLA	Departmental research laboratories of respective ministries	
Pakistan Science Foundation (PSF)	Ministry of Science and Technology	Makistan Scientific and Technical Information Centre; professional associations	
Appropriate Technology Development Organization	Ministry of Science and Technology	Other scientific and technological organizations	
Pakistan Academy of Sciences	Ministry of Education and Ministry of Science and Technology (PSF)	Professional associations and scientific organizations	
University Grant Commission	Ministry of Education and Ministry of Science and Technology (PSF)	All the Universities of the country	

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Establishment	Function	Linkages	
		Upstream	Others
A. *Federal Government*			
Laboratories of Pakistan Council of Scientific and Industrial Research (6)	R&D; STS; STET	PCSIR	Ministry of Science and Technology
Laboratories of Pakistan Atomic Energy Commission (11)	R&D; STS	PAEC	President, Chief Martial Law Administrator (CMLA)
Laboratories of Ministry of Health, Social Welfare and Population (7)	R&D; STET; STS	Ministry	President, CMLA
Laboratories of Defence Science and Technology Organization (5)	R&D; STET; STS	DSTO, and Space and Upper Atmosphere Research Committee	Ministry of Defence
Building Research Laboratories (2)	R&D; STET; STS	Council for Works and Housing; Irrigation, Drainage and Flood Control Research Council	Ministry of Science and Technology
National Institute of Electronics (1)	R&D	Ministry of Science and Technology	
Fuel Testing Laboratories (3)	R&D	Hydrocarbon Development Institute of Pakistan	Ministry of Petroleum and Natural Resources
Mineral Evaluation Laboratories (2)	R&D; STS	Resource Development Corporation; Oil and Gas Development Corporation	Ministry of Petroleum and Natural Resources
Industrial Testing Laboratories (5)	STS; STET	Ministry of Industries	Ministry of Petroleum and Natural Resources
Agricultural Resezearch Laboratories (9)	R&D; STS	Pakistan Agricultural Research Council; Pakistan Central Cotton Committee; Dept. of Plant Protection	Ministry of Food and Agriculture
Natural Engineering Services of Pakistan	STS	Ministry of Planning	
Pakistan Environmental Planning and Architecture Consultants	STS	Ministry of Works and Housing	
Irrigation, Drainage and Flood Control Laboratory	R&D	Ministry of Water and Power	
Railway Research Centre	R&D	Railway Board	Ministry of Railways
National Universities and Colleges (3)	STA; STET	University Grants Commission	Ministry of Education
Marine Training Centres (2)	STS	University Grants Commission; and Ministry of Shipping	Ministry of Communication
Telecommunication Research Centre	R&D	University Grants Commission	Ministry of Communication
Appropriate Technology Development Organization	Technology Transfer	Ministry of Science and Technology	Rural and technical departments
Pakistan Scientific and Technical Information Centres (4)	STS	Pakistan Science Foundation	Ministry of Science and Techhnology
B. *Provincial Level Organization*			
1. *Punjab*			
Agricultural and Fisheries Research (6)	R&D	Respective provincial ministries	Ministry of Science and Technology
Building and Road Research (2)	R&D; STET	Respective provincial ministries	Ministry of Communication and Works
Universities (5) specialized colleges in engineering (2), veterinary science (1) health and medicine (8), and laboratories in hygiene (3) and irrigation (2)	R&D; STS; STET	Respective provincial ministries	Respective Federal Ministries and U.G.C.

Establishment	Function	Linkages	
		Upstream	Others
2. *Sind*			
Universities (5)	STS; STET	Respective provincial ministries	Respective Federal Ministries and U.G.C.
Institutes (2)	STS; STET	Respective provincial ministries	Respective Federal Ministries and U.G.C.
Medical colleges (5)	STET; STS	Respective provincial ministries	Respective Federal Ministries and U.G.C.
Agriculture and soil laboratories (8)	R&D; STS	Respective provincial ministries	Respective Federal Ministries and U.G.C.
3. *NWFP*			
Universities (2)	STS; STET	Respective provincial ministry	Respective federal ministry
Medical colleges (2)	STS; STET	Respective provincial ministry	Respective federal ministry
Engineering colleges (1)	STS; STET	Respective provincial ministry	Respective federal ministry
Agricultural colleges (2)	STS; STET	Respective provincial ministry	Respective federal ministry
Agricultural research institutes (2)	R&D	Respective provincial ministry	Respective federal ministry
4. *Baluehistan*			
University (1)	STS; STET	Respective provincial ministry	Respective federal ministry
Medical Colleges (2)	STS; STET	Respective provincial ministry	Respective federal ministry
Agricultural Institute (1)	R&D	Respective provincial ministry	Respective federal ministry
Soil Testing Laboratory	STS	Private	

Table 2 - Scientific and Technological Manpower

Country: Pakistan

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total stock (thousands)	of which working in R&D (in units)
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965	51.76									
1970	59.70		3,655							3,576
1974	69.21	111	4,164							4,626
1979	77.86		4,900							
1981[(a)]	82.60		5,000							
1983[(a)]	87.63	122	12,200							

(a) Estimated.

Table 3 - R&D expenditures

Country: Pakistan
Currency: Rupee

Table 3a: Breakdown by source and sector of performance

Year: 1973-74

Unit: million

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive	134.84		n.a.	134.84
Higher Education	7.94		n.a.	7.94
General Service	7.65		n.a.	7.65
Total	150.43		n.a.	150.43

Table 3b: Trends

Year	Population (millions)	GNP (in million)	Total R&D expenditures (in million)	Exchange rate US $1 = Rupee
1965	51.76	26,147		
1970	59.70	43,348	104.28	10.5
1974	69.21	105,787	150.43	15.2
1979	77.86	191,584		9.90
1981	82.60	275,000	400	
1986	92.96	464,000	1,330	

PART 1.

General features

1.1 GEOPOLITICAL SETTING

Pakistan came into being 33 years ago as the culmination of a popular struggle by a hundred million Muslims of the South Asian sub-continent for a homeland. The Islamic Republic of Pakistan came into existence on 14 August 1947. It embraces the northern and western parts of the former British India.

Pakistan lies in the northern hemisphere between latitudes 23° and 37° north, and longitudes 61° and 76° east. On its east and south-east lies India, on the north and north-west is Afghanistan, on the west is Iran and, in the south, the Arabian Sea. The country contains such physical features as the western offshoots of the Himalayas covering its northern and north-western parts, of which the highest peak, K-2, rises to 8 125 metres above sea level, the Baluchistan Plateau, the Potohar Plateau and the Salt Range, and the Indus Plain, the most fertile and densely-populated sector of the country. Its total area is 796 095 square kilometres. The total cultivated area is 19.12 million hectares, 13.05 million irrigated and 6.07 million unirrigated. The area under forest is 2.84 million hectares.

The 1972 census recorded Pakistan's total population as 65.30 million, with an urban population of 16.6 million. In January 1980 the population was estimated to be 80.2 million. With an annual population growth rate of 3%, the population will nearly double itself by the year 2000, reaching around 147.3 million.

Climatically, Pakistan enjoys a considerable measure of variety. North and north-western high mountain ranges are extremely cold in winter while the summer months from April to September are very pleasant. The vast plains of the Indus valley are extremely hot in summer and have cold and dry weather in winter. The coastal strip in the south has a temperate climate. There is a general deficiency in the rainfall. In the plains the annual average ranges from 13 cm in the northern parts of the Lower Indus plains, to 89 cm, in the Himalayan region. Rains are monsoonal in origin and fall late in summer. Due to the low rainfall and the high diurnal temperature range, humidity is comparatively low. Only the coastal strip has a high humidity.

The country has an agricultural economy with a network of canals irrigating a major part of its cultivated land. Wheat, cotton, rice, millet and sugarcane are the principal crops. Fruits such as mangoes, oranges, bananas and apples are grown in abundance in different parts of the country. The main natural resources are natural gas, coal, salt, and iron, The country has an expanding industry and cotton textiles, sugar, cement and chemicals play an important role in its economy.

Pakistan comprises the provinces of the Punjab, North-West Frontier Province (NWFP), Baluchistan and Sind. Most of the area in the Punjab and Sind is a plain formed by the river Indus and its tributaries. It is know for its excellent network of canals and rich agricultural land. The province of NWFP comprises both hilly areas and fertile valleys. Baluchistan is mainly an arid region, but with the promise of mineral wealth. Islamabad is the capital city of Pakistan and is situated in the north-east in Margala Hills. Islamabad has a population of over 125 000. The six largest cities of Pakistan are Karachi, Lahore, Faisalabad, Hyderabad, Rawalpindi and Multan.

Karachi, the gateway to Pakistan, is its most important port, being on the world's air and sea routes. With the establishment of Pakistan, the port of Karachi became the most vital point in the new country as it was the only port, and it was necessary to remodel and reconstruct its obsolete facilities. The four development phases for Karachi, with two phases already completed, will increase the port's dry cargohandling capacity to 6 million tons. (The present capacity is 5 million tons of cargo and 5 million tons of oil handling per annum).

Most cities and big towns of Pakistan are connected by air. The national carrier, Pakistan International Airlines (PIA), provides an efficient and dependable service on domestic and international routes. Pia is now operating in 43 stations on the international network and 22 stations on the domestic network. PIA continued to make steady progress, despite various adverse factors such as exceptional fuel price increases, currency fluctuations and the downturn in industrial production. In 1978-79, in terms of revenue, passenger traffic was 4 806 passenger kilometres and cargo traffic was 216 million freight tonne kilometres. The airline has shown a consistent increase in profit and has made a mark as an airline of international repute. In addition to meeting its own needs, the PIA training centre has so far provided training in various fields to over 2 000 personnel from 25 different airlines of friendly countries.

1.2 SOCIAL, CULTURAL AND ECONOMIC SETTING

Urdu is the national language and is used as a medium of understanding throughout the country. English is presently the official language and is widely spoken. Pakistan is currently divided into four bilingual provinces. Apart from Urdu, Punjabi is spoken in the Punjab, Sindhi in Sind, Pushto in the North Western Frontier Province and Baluchi in Baluchistan. The country was the centre of one of the great ancient civilizations of the world. Its historical sites, covering the period from the stone age ot the 20th Century AD, are a mirror of the life of its people who are by nature simple, hospitable and hard working. Taxila, Harappa and Moenjodaro speak of Pakistan's rich cultural heritage dating back to 3 000 BC. Kâghân, Swât, Chitral and Kalash valleys are places of scenic beauty and grandeur and are, among others, inhabited by the different primitive tribes of Pakistan.

Pakistan is an Islamic state and its minorities are those who profess religions other than Islam. Non-Muslim of various denominations in Pakistan number about 3.25% of the total population according to the census of 1972. There exists a fullfledged Minorities Affairs Wing in the Federal Ministry of Religious Affairs and Minority Affairs to safe-guard the constitutional rights of minorities, promote their welfare, and to give them a sense of being full and equal citizens of the state.

At its inception, Pakistan possessed very few manufacturing establishments. Industrialization in Pakistan has passed from its initial concentration on textiles to the manufacture of sugar, cement and vegetable ghee and, later on, to more sophisticated chemical and engineering industries. The contribution of the manufacturing sector to the GNP was 14.5% in 1978-79.

The country's major items of exports are rice, cotton and its products, leather and its products, fish, carpets and small industries such as sporting goods and surgical instruments. The total value of exports during 1978-79 was about US$ 1.7 billion. Imports during 1978-79 were valued at about US$ 3.6 billion which included such major items as foodgrains, petroleum and its products, tea, chemicals, fertilizers, edible oils and dairy products.

The domestic economic growth was a major factor in strengthening Pakistan's external payments situation during 1979-80. The latest estimates place the total value of exports during 1979-80 at US$ 2.35 billion. The export performance was dominated by large earnings from the export of cotton, rice, leather, carpets and POL (Petroleum, Oil and Lubricants), which account for 80% of the increase in export earnings during the year. In sharp contrast to the substantial increase in the volume of exports, the quantity of imports was severely restrained. Although payments for merchandise imports increased by about 17.6%, this was entirely due to the upward movement in the prices of POL, fertilizer, and other oil-based items. It was due to extra measures to economize on import payments that a reduction was achieved in the current account deficit in the balance of payments from US$1 130 million in 1978-79 to about US$770 million in 1979-80.

1.3 DEVELOPMENT SCENE

Pakistan has passed through more than three decades of progress, and in this process the economy has altered significantly. The size of the gross national product has grown substantially, its structure has become more diversified and developed, and the techniques of production have been modernized.

Pakistan's Gross National Product (GNP) at current prices rose from Rs. 32.574 billion in the fiscal year 1966-67 to Rs.141.166 billion in 1976-77, to Rs.191.584 billion in 1978-79 and to Rs.227.617 billion in 1979-80. Per capita income at current prices increased from Rs.595 in 1966-67 to Rs.1.884 in 1976-77, to RS 2.459 in 1978-79 and to Rs.2 837 in 1979-80.

Agriculture plays a major role in the economy of Pakistan. It contributes 32% to the GDP, accounts for 36% of foreign exchange earnings from merchandise exports and engages 53% of employed labour.Major large-scale industries like cotton textiles and sugar, as well as medium and small scale agro-based and cottage enterprises, are directly dependent on the agricultural sector for their raw materials. Keeping in view agriculture's importance to the national economy, a high priority has been accorded to its development. Subsidized essential agricultural inputs, fixation of procurement or support prices for some major crops, interest free loans, expanded credit facilities, adequate availability of fertilizers and improved seeds, and the provision of funds for accelerated research have resulted in a 6% growth rate in the agricultural sector, more than twice the rate of the increase in population.

For the group of low-income developing countries (to which Pakistan belongs), the road to progress has become more difficult and demanding over the past decade because of the increasingly hostile international setting. In the first instance, protectionism in developed economies, which has long inhibited export-led growth and industrial development, is once again in the ascendance. Manufactured exports from developing economies are denied access to the markets of developed economies through quotas and tariff barriers. Secondly, the trends in respect of concessional capital flows towards the GDP target (0.7% of GDP), set by the UN at the beginning of the decade, have actually receded from their levels in 1970. Thirdly, world inflation and increases in energy prices have imposed heavy burdens on the balance of payments of non-oil producing developing countries. The rate of inflation, the wide oscillations in commodity prices, and the adverse changes in the terms of their trade, have led to a large increase in the trade deficits of most developing countries and to a growing insecurity regarding their financial viability. This is a harsh reality and, for Pakistan in recent years, it has been harsher than for most other countries, particularly due to a sharp decline in capital flow and because of heightened tension and unanticipated developments in the geopolitical situation in the region.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

The overall objective of the nation is to develop, ideologically, a humane, just and progressive society and economic development is one of the instruments for realizing this overall goal. All the objectives outlined in the Fifth Plan (1978-83) are to be seen as part of the process by which the nation is seeking to fulfil its destiny.

The main focus of the Fifth Plan (1978-83) is on the rapid development of agriculture, based on an efficient utilization of the huge potential of the nation in terms of land, manpower and water resources through an expanded, and more intensive, use of modern inputs and the creation of permanent institutions for continued progress in this vital sector of the economy. The target of a 6% growth rate in agriculture projected for the Plan is considered essential for achieving the objectives of meeting basic needs, stabilizing prices and improving the balance of payments. The projected wheat production is expected to increase sufficiently to eliminate the need for imports by the end of the Plan period. Substantial increases are projected for the export of cotton and rice. New emphasis is placed on minor crops and the development of rainfed areas.

Crop targets are to be assured through certain key programmes. Sizable increases are planned in the allocations for new canals for better utilization of Tarbela water, for canal remodelling, for continued development of ground water resources, and for better on-farm water management. This would result in an increase of 2.5% per annum in the irrigated cropped acreage and make for a considerable improvement in yields per acre. Yields are expected to increase by 4% per annum. Apart from the water development programme, the aim of yield improvement relies on the larger use of fertilizer and improved seeds, the application of pest control, and extended coverage by improved extension services. Fertilizer consumption is expected to almost double over the Plan period, and the bulk of the fertilizer applied will be produced domestically. Improved seeds for major crops will be made available by the Seeds Corporation set up for this purpose. Extension services coverage, under a new system of training and visists, will be augmented to reach 40% of the cropped area. An effective coverage against pests is planned for most of the crops susceptible to pest attack.

In the industrial sector, emphasis is being placed on the completion of the Karachi Steel Mill, and the fertilizer and cement factories under implementation. Public sector industrial development will generally be confined to modernization and balancing of the existing capacity. Combined with the expansion in the private sector, the country will be producting 1.4 million tons of fertilizer in 1982-83, against the present capacity of 0.33 million tons. Cement production is expected to double by the end of 1983 with the completion of seven factories in the public sector and three in the private sector. An active role is being played by the private sector in all the major industries except the few specifically reserved for the public sector. Industrial growth is projected at an annual average rate of 10% as a result of the improved utilization of capacity in both the public and private sectors, the completion of major projects in the public sector, and a more favourable private investment climate.

The strategy of completing on-going schemes, earmarking large investments for early-maturing projects in the productive sector, and making a determined effort to improve productive efficiency, makes for the realization of a growth rate of 7% which would lead to a GDP increase of 40% by 1983. Per capita income is to increase at a projected rate of 4.2% per annum.

Fixed investment is to rise from 16.5% of GNP in 1977-78 to 19.2% in 1982-83. Much more important is the change in composition from public to private sector in the industrial sphere, from a long-gestation capital-intensive to quicker-yielding emphasis in investment, and a shift in favour of social sectors. The ratio of private investment in industry will be nearly 50% for the Plan period as against 26% in 1977-78. By 1982-83, the ratio of public investment in industry will have come down drastically as the on-going projects are completed in the public sector. Rural development programmes in agriculture, water, housing, education, health, rural roads, small-scale industries, and miscellaneous works of local significance are expected to account for 29% of the total public sector programme. Investment in agriculture and water will account for 22%. By the end of the Plan period, 25% of public investment will be in the social sectors.

In the field of energy, Pakistan is presently spending over Rs 1 200 million on the import of crude and petroleum products. This constitutes a heavy foreign exchange expenditure which is nearly 60% of the earnings from the export of raw materials and finished goods. In order to meet the challenge, the strategy for energy during the Fifth Five-Year Plan (1978-83) is as follows:

maximum priority will be given to hydro electricity generation and the commissioning of on-going hydro electric projects;

to achieve integration of the power market and to effect economy in the fuel and power system reserves, high priority will be given to the transmission of bulk power from Tarbela to the southern part of the country on extra high voltage transmission lines;

the distribution arrangements will ensure that the productive requirements of agriculture and industry are met to to the fullest extent possible and that, within the limited resources available, the benefits of commercial energy are extended to the largest number of persons, particularly in rural areas;

exploration for indigenous resources of fossil fuel will be intensified;

the use of gas for productive purposes will be actively facilitated;

quick development of the discovered and proven oil and gas fields will be undertaken;

use of indigenous coal will be encouraged.

The Plan provides for employment generation, income increases, and the availability of essential goods. This is designed to improve the relative position of the urban and rural poor. Laying down the foundations of long-term economic growth is an important objective of the Plan. In order to build up technological skills, investment in basic and engineering industries will be undertaken simultaneously with improvements in productivity in agriculture, training of skilled manpower, and scientific and technological research Economic development under the Plan is conceived as a major step towards wider national integration through the development of interdependence and linkages between regions and provinces.

The strategy of the Fifth Plan is to discourage the consumption of non-essential items, particularly by high-income groups, and to improve the consumption level of essential commodities, particularly for persons in the low-income groups and those living in the rural areas.

Some of the specific programmes designed to attain the objectives of the Plan include the establishment of livestock farms to improve the availability of milk and meat, the encouragement of poultry and egg production, and an increased availability of fish. To overcome seasonal scarcities food-processing units at the village level are planned for the dehydration of vegetables.

The targets for per capita consumption have been related to the nutritional needs of the population and main problem with malnutrition relates to a protein-calorie deficiency. Its solution requires a balance between the adequate supply of foods and the generation of full employment with reasonable incomes. In addition, specific problems with vitamin and mineral deficiency, and those of certain target groups, will be tackled through special projects and programmes.

The Plan provides for improvement in public services particularly education, health, transport and social welfare which, when combined with the increase in private consumption, should raise the standard of living significantly by 1982-83.

The importance of science and technology as major agents of economic growth and socio-cultural development is now universally recognized. In the context of Pakistan, massive social and technological changes are needed to speedily achieve the high-priority development goals set out in the Fifth Plan (1978-83). These are a large increase in agricultural and industrial production, eradication of illiteracy, provision of the basic necessities of life - food, clothing, shelter and health cover - to the common man, optimal exploitation and rational utilization of natural resources, the satisfying of society's growing demand for energy-generation potential, a modernization of the communications network of the country and an overall improvement in the quality of life of the people. All these require the extensive and sustained application of science and technology.

2.2 DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

At Independence in August 1947, Pakistan received a very meagre inheritence in terms of scientific and technological institutions and manpower. However, the problems and issues connected with the development of S&T had been considered and deliberated upon from time to time. The founder of the nation, Quaid-e-Azam Mohamed Ali Jinnah, himself inaugurated a meeting at the end of 1947 for developing an educational policy which included scientific research as well. This was followed by the setting up of a number of important scientific organizations in the 1950s, namely, the Food and Agriculture Council renamed later as the Pakistan Agricultural Research Council (PARC), the Pakistan Central Cotton Committee with its Agricultural Wing for improving cotton varieties and its technological wing known as the Pakistan Institute of Cotton Research Technology, the Pakistan Scientific and Industrial Research Council (PCSIR), the Pakistan Atomic Energy Commission (PAEC), and the Pakistan Medical Research Council (PMRC).

Later, as a consequence of the recommendations of the Scientific Commission appointed in 1959, a number of new major scientific organizations were established. For example, the National Science Council of Pakistan, which was set up in 1962 for coordinating the research activities of various research councils and for serving as a scientific advisory arm to the Government, the Irrigation Research Council (1964) renamed later as the Irrigation, Drainage and Flood Control Research Council, and the Council for Works and Housing Research (1964). A separate Ministry of Science and Technology was created in the Federal Government in 1964 to promote and coordinate scientific research activity in the country. Under its umbrella the Pakistan Science Foundation was established in 1973 as a source of alternative funding, particularly for the universities, in order to support basic and fundamental research applied to the socio-economic needs of the country.

It will be appropriate at this stage to take stock of the existing S&T system in the country in some detail. The Ministry of Science and Technology, which is headed by an Adviser to the President of Pakistan, looks after the working of National Science Council (NSC), the Pakistan Science Foundation (PSF), the Pakistan Council of Scientific and Industrial Research, the Irrigation, Drainage and Flood Control Research Council, the Council for Works and Housing Research, the Pakistan Medical Research Council and the Appropriate Technology Development Organization.

While the functions of the NSC and PSF have been briefly explained earlier, the PSF also manages the Pakistan Scientific and Technical Information Centre (PASTIC).

The Pakistan Council of Scientific and Industrial Research (PCSIR) has established a chain of multi-functional laboratories at Karachi, Lahore and Peshawar. These laboratories have well-trained scientific and technical manpower numbering more than 650 and are engaged in R&D activities in chemical and physical fields, in the area of marine foods, glass and ceramics, minerals, food and fruits, wool, indigenous medicinal plants, oil and fats etc. The PCSIR also runs the National Physical Standards Laboratories (NPSL) at Islamabad, the Fuel and leather Research Centre (FULREC) and Pak-Swiss Training Centre at Karachi.

The Irrigation, Drainage and Flood Control Research Council has established a laboratory known as the Drainage and Reclamation Institute of Pakistan (DRIP) at Hyderabad and is sponsoring a number of projects at the Irrigation Research Institute, Lahore. The Council for Works and Housing Research (CWHR) presently runs the Building Research Station (BRS) at Karachi. Similarly the Pakistan Medical Research Council (PMRC) has set up Medical Research Centres at Karachi and Lahore. As for the Appropriate Technology Development Organization (ATDO), it is primarily engaged in undertaking projects which have a direct bearing upon the spread and adaptation of technology in the rural areas of Pakistan using the research work being carried out in the country.

The Agricultural Research Council which is under the Agricultural Research Division, operates mainly as a financing agency for the promotion of agricultural research in the federal and provincial institutes of the government. It has also set up centres of its own in specific fields.

The Pakistan Atomic Energy Commission is directly linked with the President's Secretariat and runs a number of research institutes primarily directed towards peaceful uses of atomic energy. It also operates the Karachi Nuclear Power Plant and has plans for setting up more plants of a similar nature in other parts of the country. Mention may here be made of the Space and Upper Atmosphere Research Committee (SUPARCO) which runs a specialized centre in Karachi known as the Space and Upper Atmosphere Research Centre.

In the agricultural field, the provincial governments have established provincial agricultural research institutes and centres, and they also conduct extension activities. Some research in basic and applied fields is also being conducted in the universities, including the two Universities of Agriculture and the four Universities of Engineering.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

It will be seen that there has been a gradual, albeit slow, build-up of the infrastructure for S&T effort in the country during the last 32 years. However, the efforts made have not yielded commensurate results, particularly in establishing strong linkages with the Five-Year Plans for economic development, due largely to the lack of requisite support at policy-making levels and the paucity of financial resources made available.

Since rapid change is a characteristic feature of the present age, a science and technology policy can prove purposeful only if it is dynamic and flexible, and is synchronized with Pakistan's development plans which are formulated on a five-year basis.

In order to remove the deficiencies outlined in the preceding paragraphs and ensure close coordination between economic plans and S&T plans, it is desirable to re-structure the S&T system so as to facilitate the formulation, implementation and evaluation of coordinated action plans based on S&T policy. This will provide greater autonomy and intellectual freedom to S&T organizations and workers, and stimulate the creative faculties of the best minds in science to take adequate measures for creating R&D centres in industry to increase productivity and improve the quality of products. In order to ensure the maximum participation and the direct involvement of the people at large in the evolution and application of site-specific technologies, the setting up of the requisite S&T centres at provincial and local government levels is envisaged. It is further proposed to improve the working conditions of the scientists by providing a career structure commensurate with their intellectual attainment. It is also intended to break the isolation of Pakistan in S&T fields. For attaining greater self-reliance through the development of a technological capability as an integral part of the national stategy for self-reliant growth, an effective process of accountability at all levels must be evolved. This will ensure that the nation gets satisfactory returns on its S&T investment in terms of a greater insight into national problems, and improved technologies for their solution.

Existing organizational mechanisms

Scientific and technological effort in Pakistan is presently organized in the following manner:

i. Decision making, planning and coordination

The principal body concerned with the formulation of national policies in the S&T sector, as well as the overall promotion and co-ordination of scientific research and development activities in the country, is the Ministry of Science and Technology. Linked to this Ministry are two important autonomous organizations, namely, the National Science Council and the Pakistan Science Foundation. The major functions of the National Science Council are to advise the government on science policy and matters relating to the promotion of national scientific effort, to review the work of research councils, and to ensure the linkage of science with national development plans. The Pakistan Science Foundation is primarily a financing agency whose main function is to promote basic and fundamental research having a bearing on the socio-economic needs of the country.

ii. Performance of research

S&T research work is largely carried out in :

(a) Autonomous or semi-autonomous organizations administratively linded with the Federal ministries or the President's Secretariat. These include the universities, the Pakistan Council of Scientific and Industrial Research, the Pakistan Atomic Energy Commission, the Pakistan Agricultural Research Council, the National Institute of Electronics, the Appropriate Technology Development Organization, the Irrigation, Drainage and Flood Control Research Council, the Council for Works and Housing Research and the Pakistan Medical Research Council

(b) S&T institutes and field stations (non-autonomous) attached to the federal and provincial governments e. g. the Pakistan Industrial Technical Assistance Centre (PITAC), the Provincial Agricultural Research Institutes and the Rice Research Institutes.

(c) Small scientific and technological R&D units in private industry.

iii. S&T support services

This includes the scientific and technological support services that are indispensable for the execution of R&D, scientific investigation and exploration, the planning and design of development projects and for qualitative as well as quantitative improvements in the production of goods and services. Included under this head are :

- scientific and technological information services;
- scientific testing, quality control and standards services;
- scientific equipment manufacture and maintenance services;
- resources exploration and development services, for example geological, geophysical, meteorological and other surveys; and
- special scientific expeditions;
- scientific and technological statistics;
- consultancy services in various scientific and technical disciplines.

Priorities

Priorities in S&T have to be determined, primarily, in accordance with the national developmental goals. However, the extent of the R&D effort needed for this purpose will be much greater in those specific fields where the requisite scientific knowledge and technology is lacking. Furthermore, opportunities should also be available to the scientific community to undertake R&D in areas of its own choice where it perceives possibilities for the advancement of knowledge or the evolution of technologies which may lead to the creation of new wealth or increases in productivity. For this purpose, it is generally agreed that about 15% of the total investment in scientific R&D should be set aside for "free" research.

In the light of the major problems facing the nation and in order ot integrate S&T effort with economic planning, as embodied in the Five-Year Plan (1978-83), the order of priority for S&T efforts will be as follows:

i. Food and agriculture
ii. Irrigation and water resources
iii. Energy
iv. Industries
v. Mineral resources
vi. Transport and communications
vii. Health and population planning
viii. Physical planning, housing and environment.

As the necessary pre-requisite for making a satisfactory R&D effort, the education and training of manpower will be a common denominator for all the priority areas enumerated above.

Keeping in view the fact that approximately 80% of our population lives in rural areas, it is recognized that the overall R&D capability must be adequately focused on the study and solution of rural problems. This broad determination of priority areas has to be ultimately translated into sectoral and institutional goals and S&T programmes and research projects, both long and short term.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

There has been a gradual build-up of the infrastructure for S&T since Pakistan came into existence. This includes research councils for industrial, atomic energy, agriculture, medicine, housing and works, and irrigation research, and an overviewing National Science Council to coordinate the plans and programmes of these councils. The research councils, from time to time, have been setting up R&D institutes, both multidisciplinary and mono-purpose, in various parts of the country. Major developments during the last ten years include the establishment of a separate Ministry of Science and Technology, a Pakistan Science Foundation, the Pakistan Scientific and Technical Information Centre, the Appropriate Technology Development Organization, the National Physical and Standards Laboratory, the National Institute of Electronics, and the Hydrocarbon Development Institute of Pakistan.

Recently, the nucleus of a National Centre for Technology Transfer has been created, which is being developed to become a full-fledged centre for regulating and monitoring technology transfer transactions. The scheme for the establishment of a Natural History Museum has been approved and it is being implemented. In view of the importance of energy, a separate cell has been created in the Ministry of Petroleum and Natural Resources for the development of conventional, as well as non-conventional, sources of energy. A Science Policy Cell and an Electronics Wing have been created under the Ministry of Science and Technology. A University Grants Commission, on the pattern of similar commissions in other countries, works for the promotion and coordination of education and research in the universities of the country.

Nearly all the scientific R&D activity in the country is financed by the government, both at federal and provincial levels, and is carried out in the sectoral research institutes. There are a number of non-governmental scientific societies and learned bodies, such as the Pakistan Association for the Advancement of Sciences, the Scientific Society of Pakistan and the Pakistan Academy of Sciences. The major function of these societies is the promotion and popularization of science.

Details about the organization of S&T in Pakistan are shown in the Annex "A" chart.

3.2 HUMAN RESOURCES

The total national requirement of S&T professionals in Pakistan has been estimated to be 122 000 by the end of the current 5-year plan (1983), out of which 12 200 should be engaged in R&D. The existing total stock of professional S&T manpower, including the master's degree holders in basic sciences, in the country is not too far below the required level. However, serious imbalances exist in the sectoral distribution of these professionals. There is a great dearth of S&T personnel willing to adopt research as a career, and the total professional manpower engaged in R&D work is less than 5 000. Even in the universities there has been a tapering off in the number of students registering for post-graduate work in the basic sciences. There appears to be a nation-wide stampede amongst students for seats in medical and engineering colleges. Generally, it is only the ones who are left out who turn to post-graduate studies in the basic sciences.

The sub-professionals from science and technology workshops such as technicians and craftsmen, and first degree holders in science, are also in short supply in Pakistan. Efforts are under way to strengthen the existing polytechnic institutions, and to establish new ones to meet this demand fully in the near future. (The polytechnics teach a 3-year diploma course.)

Although the incidence of talent among women is no less than that among men, the number of women S&T professionals and technicians is far below that of men. The main reason for this imbalance is considered to be traditional social customs and the less attention devoted, relatively, to educating women to higher levels. Measures have been proposed in the new Draft Science and Technology Policy to educate and induct a larger number of women into S&T and related occupations.

Migration to other countries

According to a recent study the estimated annual output of qualified medical doctors in Pakistan is 1 000. Out of this, 50% to 70% leave the country to take up employment abroad. The number of engineers produced in the country annually is 1 600, out of which about 20% emigrate to other countries. The rate of emigration of university and college teachers has also been quite high. In one university, over a few years 125 out of 375 teachers left for foreign countries. The situation in many other professional organizations is also very similar.

The loss of trained human resources is not limited only to doctors or engineers. In recent years Pakistan has lost more than 60 000 highly skilled hands including trained technologists such as welders, machinists, draughtsmen, construction workers, plant operators, and maintenance workers, etc. It is estimated that at least 2 million Pakistani professionals are serving in developed countries such as USA, Canada, UK, West Germany, the Scandinavian countries and others. The number of those serving in the Middle Eastern and other developing countries may not be less than this. A breakdown of the manpower emigration for 1971-1975 by occupational category is given in Table (a).

The favourable and adverse effects of emigration are summarized below.

i. Favourable effects

The number of unemployed technical hands in Pakistan has decreased.

The government has become aware of the need for and the value of scientific and engineering professionals. More institutes are being set up and the existing ones are being expanded to cope with the demand.

Pakistanis working abroad are remitting large sums of foreign exchange.

The government encourages Pakistanis working abroad to set up industries at home, and this is beginning to show some positive effect with Pakistan receiving 43 proposals for setting up industrial units at a cost of Rs.1.065 million in 1977.

Another positive effect is that Pakistanis working abroad get the opportunity of working on modern projects. Thus they are enriching themselves with knowledge and experience for subsequent use in Pakistan.

Table (a): Number of Pakistanis selected for overseas employment in public and private sectors through the Bureau of Emigration and Overseas Employment during the period 1971-75 by Occupational Category

Occupational Category	1971-75		
	Public	Private	Total
Engineers	561	240	801
Doctors	1,266	4	1,270
Nurses	461	520	981
Teachers	1 261	62	1,324
Accountants	111	201	312
Managers	1	67	68
Welders	4	1,119	1,123
Stenographers	1	235	236
Storekeepers	6	326	332
Agriculturists	51	11	62
Clerks/Typists	—	1,184	1,184
Foremen/Supervisors	112	342	445
Masons	—	5,109	5,109
Carpenters	23	4,653	4,677
Electricians	45	2,019	2,064
Cooks	—	1,415	1,415
Plumbers	9	2,085	2,094
Waiters/Bearers	—	1,053	1,053
Steel Erectors	—	849	849
Painters	—	807	807
Labourers	—	9,966	9,966
Technicians (all types)	1,976	1,227	2,994
Mechanics	54	1,751	1,805
Cable Jointers	—	615	615
Other Categories	3,365	16,284	19,549
All Categories	9,092	52,144	61,345

ii. Adverse effects

Since the demand in foreign countries is for only able, experienced and good skilled workers and professionals, Pakistan is, in general, losing its talent; with industry and the manufacturing units already experiencing the loss.

Industry and technical establishments are forced to employ under-qualified and less experienced persons in demanding jobs resulting in reduced productivity, lower efficiency, slower technological progress, a lower quality product, the underutilization of resources, and a delay in meeting time-schedules.

Foreign training and manpower development

The most rapid means of manpower training and development for developing countries has been to get their manpower trained in the industrially developed countries. However, this is no longer an easy alternative, since opportunities for foreign training are gradually being curtailed by the developed countries. International organizations such as the Colombo Plan, Unesco and others have also reduced the number of scholarships offered to Pakistan. Training on payment is too costly to be arranged by a poor country. It has been observed by some experts that many developed countries only wanted to raise the level of skill in the developing nations to a point at which they would begin to ask for the modern technologies and thus become a market to sustain the industrial growth of the developed countries. It is similar to the case where, in order to create a textile market, a primitive society was taught the virtue of clothing but refused the art of weaving.

It is also unfortunate that, even where developing country candidates are accepted for training in the industrialized countries, the opportunities for learning more useful and specialized know-how are often restricted. Thus the time spent in foreign training is not always fully productively utilized. International cooperation to overcome such problems in technical manpower development is possible in many ways, some of which are suggested below:

i. International fund for technical training

It is proposed that the world community should set up an International Fund for Technical Manpower Development to support those who deserve to get higher technical know-how, to establish high-standard training facilities in sophisticated fields in the developing countries, and to equip the technical schools and colleges with modern teaching aids.

ii. International education bodies

International education bodies like Unesco, Colombo Plan, IAEA and others should spare more funds for the development and training of manpower from the developing countries. They should also persuade training establishments in the developed countries to be generous in their approach and provide the developing countries' manpower with every opportunity to learn.

iii. Multinational corporations

Multinational corporations should be persuaded to set up training facilities at their bases in the developing countries and to provide experts to train as many locals as possible. By doing so they will win the respect which is especially reserved for teachers in the developing nations and, in this way, their interests will be further protected.

iv. Employment in overseas companies

Foreign companies operating in the developing countries should hire the local, in preference to foreign, citizens. The developing countries can also insist upon this provision when granting permission to foreigners to set up industries.

v. Developing countries' experts pool

During the last 30 years enough technical know-how has been accumulated for various technological fields by the developing countries for these countries to cooperate and form an Experts Pool. This will be to their mutual benefit for the problems of developing countries are, in many respects, common in nature and can best be grasped by experts belonging to these countries.

vi. Regional centres for higher learning

It is very costly to set up learning facilities in modern technical fields such as nuclear technology, lasers, oil and gas exploration, energy conservation and substitution, materials development and others. It would not always be possible for individual countries to establish good centres of learning in such fields due to a lack of funds and expert manpower. Therefore, it will be desirable if regional centres of higher learning are established on a mutual cooperation basis.

vii. Mutual training agreements

Developing countries should conclude mutual agreements for utilizing each other's facilities and plant for the purpose of training. Islands of all types of modern and highly sophisticated technologies can, after appropriate surveys, be located in the developing world. Thus by mutual training agreements, many types of learning can now be made possible in these countries for each other's benefit.

viii. Visiting professors from advanced countries

Due to the brain drain or other reasons, the technical institutes of learning in the developing countries lack experienced and well-qualified teachers. For this reason, many technical institutes and facilities, set up at huge costs, cannot be utilized fully to impart high quality training. Therefore, industrially developed countries can do a positive service to the developing countries by deputing their experienced and qualified teachers to these countries. This will greatly help in the development of the training facilities and the local instructors and students.

3.3 FINANCIAL RESOURCES

The government is at present the major S&T funding agency as the contribution of industry and the private sector is minimal. There are also funds available under some external, international and regional, programmes which are also channelled through the government. Traditionally, government funds flow only in government circles. There are a few private foundations also which support scientific and technical efforts, especially in the fields of R&D and the training of S&T manpower.

The current level of R&D expenditure, about Rs.200 million per annum in the country, is hardly 0.7% of the national development budget (or 0.4% of the total budget). This is much less than the level recommended by CASTASIA I in 1968 (i. e. 5-10% of the national development budget).

The inter-sectoral expenditure on R&D at present is not based strictly on any rational criteria such as the importance of the sector to national development, its contribution to the GNP, the state of existing technology, the needs of society or the general welfare of the people. Similarly, the expenditure incurred in some sectors is also unevenly distributed. Less than 6% of the total R&D expenditure has been expended on R&D in the irrigation and water resources sector. Housing, similarly, attracts only about 0.5% of the total R&D expenditure, while university research has been receiving only about 2.5%. In the agricultural research sector, on which the major portion of R&D allocations is spent, livestock development research during the last two decades was only allocated an amount equivalent to 5% of the funds allocated to crop research, although its contribution amounts to about 40% of the total agricultural production. The government is taking measures to correct the situation so that the expenditure on R&D is based on certain rational criteria.

In many research institutes more than 80% of the operating funds are spent on meeting the salaries of staff, leaving very little for specific expenditure on experimental work. In the universities the situation is not very different.

PART 4.

Policy issues in scientific and technological development

4.1 MAJOR DEVELOPMENTS

National development may be viewed as a continued movement towards fulfilment of the individual and collective aspirations of the people. In the context of Pakistan, the major goals of development may be stated as the achievement of self-reliance in food, the equitable availability of basic necessities like clothing, shelter, and medical care, the eradication of disease, the reduction of illiteracy and unemployment, and the development of energy and other natural resources. Science and technology needs to be extensively employed for the achievement of these national development goals.

The status of science and technology in Pakistan at the time of Independence in 1947 can be summed up by saying that only a few R&D institutions worth their name, and only one university, existed in the area which now constitutes Pakistan. Except for the Punjab, the provinces had no scientific institutions or universities. In the Punjab, active centres existed in the Institutes and Departments of Science within Punjab University and its affiliated colleges such as the Government College, the Animal Husbandry College, King Edward's Medical College and Engineering College at Lahore, and the Agriculture College at Faisalabad. The scientists engaged in research at the University and its colleges or Institutes made significant contributions to physics, chemistry, bio-chemistry, botany, engineering and medicine. The Irrigation Research Institute of the Government of the Punjab at Lahore was the premier research organization in the country in the water sector and had been in existence since 1924. The main scientific and industrial research organization in Pakistan, the PCSIR, was established in 1953 as an autonomous body with the objective of promoting and fostering scientific research and to assist in the industrial development of the country. The Atomic Energy Commission was established in 1956.

A National Science Commission was appointed in 1959 to recommend measures for the future promotion of science and technology in the country. The National Science Council came into being in 1961, as a follow-up to the recommendations of the Science Commission, to coordinate the plans and programmes of the different sectoral councils. The Chairman of the National Science Council is also a member of the Central Development Working Party (CDWP) of the Federal Government.

The Pakistan Science Foundation was set up in 1972. Its functions include research promotion and support, utilization of the results of research, the provision of scientific and technological information services and the promotion of public understanding of science.

The Ministry of Science and Technology has the following main functions:

i. The establishment of institutes and laboratories for research in the scientific and technological fields, especially in irrigation, medicine, industry, housing and works.

ii. The planning and coordination of applied research in the S&T field including the scrutiny of development projects and the coordination of development programmes in this field.

iii. The promotion of applied research and utilization of the results of S&T research carried out at home and abroad.

iv. The guidance of the federal and provincial research institutions in the fields of applied S&T research.

v. The coordination of manpower utilization for S&T research.

vi. Supervision and control of the Pakistan Council of Scientific and Industrial Research (PCSIR), the Pakistan Medical Research Council, the Irrigation, Drainage and Flood Control Research Council, the Council of Works and Housing Research, Pakistan Science Foundation, the Appropriate Technology Development Organization, and the National Science Council.

*vii.*Biological Research including zoology and botany, and the promotion and development of electronics.

The Atomic Energy Commission, which was for sometime attached to the Ministry of Science and Technology, is now working directly under the President. Another major S&T organization, the Pakistan Agricultural Research Council, is working under the Ministry of Food and Agriculture. (See Annex A).

Proposals for the National Science and Technology Policy

Recently, an exercise has been conducted to formulate proposals for the national science and technology policy, through the involvement of the country's scientists, engineers, technologists and users of S&T. As a result of this exercise, a number of recommendations emerged which deal with the organization of S&T, the priorities for future R&D manpower efforts, the financial requirements for implementing the policy proposals and other related issues. Some of the important proposals are described in the next few paragraphs. Based on an international review and on Pakistan's requirements for an S&T policy structure, the proposals for an effective organizational structure for S&T relate to three recognized functional levels:

Level-I: Decision-making, planning and coordination of S&T effort

This level involves priority allocation of resources, planning and decision-making at a comprehensive national scale with inter-ministerial coordination which must rest ultimately at the top political level. The important proposals are, first, the establishment of a broad-based National Council for Science and Technology (NCST) headed by the Chief Executive of the country for providing leadership and overall guidance on all matters pertaining to science and technology and for specifying national priorities for R&D; second, strengthening the Ministry of Science and Technology to undertake the numerous tasks involved in building national S&T capabilities and to serve as the secretariat for the National Council of Science and Technology (NCST); third, the establishment of Science and Technology Departments in the provinces as the counterparts of the Federal Ministry of Science and Technology, which are to act as the provincial focal points for S&T activities; and, fourth, the creation of S&T sections in the Federal Planning Commission and provincial Planning and Development Departments to integrate the S&T programmes with the socio-economic development plans.

Level-II: Coordination, performance of research and the utilization of research results

For this level, which involves the functioning of the sectoral research councils and research promotional bodies including the coordination, promotion and financing of scientific and technological research at the national level, the important proposals are to provide a statutory base for research councils to acquire an autonomous character; to provide them with adequate resources to strengthen the existing research institutions; to constitute a Committee of Chairmen of Research Councils and other S&T Establishments for regular exchange of information, coordination, and the tackling of inter-disciplinary problems; to establish autonomous multi-disciplinary science councils in the provinces; to strengthen the Pakistan Science Foundation to act as a major alternative source of funding; to increase the non-salary operative expenditure by at least 50% of the budget; to establish new research institutes where major gaps exist; to enhance the emphasis on scientific research and post-graduate work in universities and re-orient their effort towards the solution of national problems; to establish R&D units in major industries and R&D associations for small-sized industries; and, to establish a research development corporation to provide risk funds for undertaking pilot-plant and field-scale trials of new technology.

Level-III: S&T support services

Proposals have been made to strengthen the existing S&T services, in particular the S&T information; to create new services, such as equipment manufacture and repair, a national engineering laboratory, and facilities for remote sensing, electronic data-processing equipment and consultancy services; to create services to study mechanisms of technology transfer; to develop indigenous capabilities in design, development and construction; and, to strengthen the appropriate technology development organization and to transfer appropriate technologies to rural communities.

Creation of the following new R&D establishments has been emphasized to fill gaps in the existing scientific R&D national institutions in relation to barani (rain-fed) agriculture, veterinary science, water management, oceanography and marine resources, roads, buildings, ship design and naval construction, power, natural resources, pilot-plant design, electronics, systems analysis and computation sciences, health sciences, appropriate technology, transfer of technology and research utilization, an R&D corporation, solar energy, and metallurgy.

In the fifth Five-Year Plan (1978-83), Science and Technology has been given a prominent place and distinct allocations. The objectives for S&T in the Plan are the establishment of an appropriate structure for the formulation, implementation and constant review of the national S&T policy, the reorganization and strengthening of existing research and development institutions and the establishment of new institutions, where necessary, to form an integrated system for conducting major research tasks related to the socio-economic objectives of the Plan; the education and training of scientific and technical manpower in various fields and at different levels of sophistication to meet the development needs of the country and enhance the indigenous capability for production of needed manpower; the development of science as an egalitarian activity by establishing conditions conducive to the liberation of the innovative and creative talents of the people through the development of indigenous technologies; the allocation of adequate financial resources for the creation, strengthening and operation of these institutions in accordance with the overall policy; the creation of suitable conditions for highly qualified R&D personnel in terms of adequate emoluments, a career structure and a rightful place in society; the development of a strong S&T information system in liaison with national and international R&D institutions for selection, retrieval and dissemination of S&T information.

4.2 ACHIEVEMENTS AND PROBLEMS

A fairly well-developed S&T infrastructure has been created during the last three decades; however, the S&T effort in the country is still inadequate and it has not been able to make a significant contribution to national development. The effectiveness of the entire S&T sector continues to be greatly impaired due to a number of weaknesses:

i. the sub-critical size of the qualified scientific manpower and the meagre outlays on research and development;

ii. the lack of well-defined priorities for scientific research and the imbalances in the S&T effort;

iii. the isolation of the S&T system from the national economic planning process as well as from the users of technology such as the productive sectors of industry and agriculture etc. ;

iv. the inadequacy of university programmes and facilities for post-graduate research degree work;

v. the lack of effective S&T institutions at the grass-roots level, such as field experiment stations, for creating site-specific technologies, which stems from the total absence of a provincial level organizational set-up for promoting the systematic application of science and technology to the development process;

vi. a marked national proclivity towards reliance on foreign sources of technology instead of conscious utilization and promotion of indigenous technology;

vii. the lack of effective coordination between scientific establishments and the fragmentation of the national research effort;

*viii.*the isolation of Pakistani scientists from active centres of learning in the world;

ix. the poor finacial resources of non-governmental scientific societies and learned bodies and their consequent ineffectiveness in creating national science awareness and involving the people at large in the process of technological development.

Sporadic efforts have been made from time to time to deal with one or more of these deficencies. In the absence of a comprehensive and well-coordinated effort to tackle the entire spectrum of these problems, however, the desired impact could not be produced. A national S&T policy, which is expected to provide broad guidelines for remedying these deficiencies and building up an adequate S&T capability, is in the last stages of finalization.

4.3 OBJECTIVES AND PRIORITIES

Objectives

The principal aims of the proposed national S&T policy are:

i. to inculcate a love of science and the study of natural phenomena and to utilize science and technology for the welfare of mankind.

ii. To re-organize, improve and expand the S&T system in the country with a view to making it more efficient, dynamic and self-reliant.

iii. To ensure that the S&T is directed towards the achievement of national goals and aspirations, in particular towards the welfare of the people, the sustained growth of national economy, and the secularity of the country.

iv. To create a national awareness of the vital importance of S&T for achieving the socio-economic uplift of the nation.

v. To imbue the individual with the spirit of scientific inquiry and develop his creative and innovative faculties.

Within the purview of the overall aims stated above, steps will be taken to meet the following specific objectives in different areas of the S&T sector:

Basic sciences:

To promote advanced studies and research in various scientific disciplines.

To create a physical and social environment conducive to the pursuit of science.

Engineering & Technology:

To develop, strengthen, and modernize the engineering and technological base of the country so as to achieve self-reliance in this field, to reduce import of consumer goods and to promote the export of value-added manufactured goods.

To acquire, adapt and apply relevant technologies for increasing the gross national product and to improve the performance of all sectors of the national economy.

To develop the required technical know-how, making full use of appropriate indigenous technologies. for optimal exploitation of the country's natural resources.

Manpower:

To increase the number and improve the quality of scientific and technical manpower at all levels, from highly qualified professionals to skilled technicians, through intensive education and training in various S&T disciplines.

To create suitable opportunities, and a conducive environment, for the purposeful utilization of S&T manpower, including talented Pakistani scientists working abroad, in the relevant sectors of the national economy.

To take appropriate measures for arresting and reversing the phenomenon of brain drain.

S&T Information:

To develop an effective information network for science, engineering and technology, and having adequate links with international information services for providing R&D workers and other interested agencies with speedy access to current knowledge in different S&T fields.

To keep the planners and policy makers informed about the latest advances in science and technology and the potential applications thereof.

Autonomy and Performance Evaluation:

To allow maximum autonomy to R&D institutions and freedom to the research workers to pursue their professional activities according to the policies and guidelines approved by competent authorities an to ensure that they get all necessary facilities for the conduct of their work.

To prescribe suitable criteria and evolve an effective mechanism for periodic evaluation of the performance and achievements of S&T institutions as well as individuals.

Development of S&T Institutions:

To strengthen, develop, and consolidate the exiting S&T institutes. laboratories and centres, taking care that unnecessary duplication and waste of financial, human, and material resources is avoided.

To take necessary steps to sep up R&D institutions wherever vital gaps exist in the national S&T structure.

Priorities

In the light of the major problems facing the nation, the order of priorities for the S&T effort would be as follows:

1. Food and Agriculture

Agriculture, which provides the basic needs of the people, is the main source of foreign exchange earnings and is the sector of the economy providing employment to the majority of the people. The research areas requiring immediate attention are:

i. plant genetics and physiology for the development and regular release of high-yielding crop varieties adapted to various stress conditions;

ii. biological nitrogen fixation and optimal use of fertilizers;

iii. farming systems, cropping patterns, and multiple cropping with combinations of grain and fodder legumes to replace the current capital or energy intensive, resources depleting, and environmentally degrading land use;

iv. agro-climatology, in view of the all-pervading influence of climate on crop and livestock yield;

v. post-harvest technology to save the current 30% loss of produce through wastage;

vi. livestock and poultry breeding, feeding, management and disease control;

vii. development of fisheries (marine and fresh-water); and

viii. food-processing technologies.

In the field of forestry, the priority areas for research would be watershed management, energy plantations, social forestry, arid-zone afforestation, timber harvesting and wood-processing, genetic improvement of indigenous forest trees, the introduction of fast-growing exotics, and range and wildlife management.

2. Irrigation and Water Resources

Water resources occupy a position of paramount importance in the country's economy. There is increasing demand for water in agriculture, industry and the urban areas. A concerted R&D effort will be made to develop and utilize all potential water resources and also to improve operational and management practices in order to reduce loss and wastage as far as possible. In particular, attention will be given to tapping underground water of good quality. Ground water resources of the country, particularly in the arid areas, will be surveyed and the flow-patterns of underground water mapped to work out economically feasible methods of utilization. Reliable monitoring systems and related mathematical models wil be developed, which include both quantity and quality factors and cover single as well as conjunctive, use of ground water.

The twin menace of water-logging and salinity has assumed gigantic proportions causing loss of roughly 50 000 acres of fertile agricultural land every year. Various measures have been undertaken to check and control this problem but it requires greatly enhanced R&D effort to make a major breakthrough. Another main problem is poor water management practices resulting in heavy conveyance-losses in canals, distributaries, minors and water courses which amount in some cases, to about 50% of the diversion at the headworks. R&D effort to devise ways for curtailing such losses would greatly improve the water-availability base for crops and increase the cropping intensity substantially. Analytical tools will be used to monitor the ecological, economic and sociological impact of plans to alleviate drought through inter-basin transfer of water supplies. Research studies will be undertaken to reduce the silt load in rivers and thereby enhance the effective life of dams and other irrigation structures. A Water Resources Data Bank for collection, computerization and speedy retrieval of all information relevant to the water sector will be established.

3. Energy

Energy is one of the basic requirements of all productive sectors of the economy. Pakistan's per capita consumption of energy is among the lowest in the world, being one tenth of the world average and less than half of the average for the developing countries. Substantial enlargement of the energy supply-base would be an essential pre-requisite for rapid economic progress of Pakistan. The advent of energy crises with staggering oil import bills, which currently amount to about 60% of the country's annual foreign exchange earnings, has made it imperative for Pakistan to give very high priority to research on the augmentation of conventional (e. g. oil, gas, coal, hydel), and the development of non-conventional, energy resources. The gap between the locally available conventional resources and the rapidly increasing energy needs of the country is so great that Pakistan will not only have to pursue programmes for the development of nuclear energy, but also acquire or develop, on a top-priority basis, the technology for harnessing solar energy. Other non-conventinal sources of energy such as biogas, wind power and geothermal energy will also need to be pressed into service to the maximum extent possible. Rural energy centres will be established for the integrated use of all the available sources of energy in a given locality to provide an independent, self-contained and reliable power supply system for an area. Energy data banks will be set up for the compilation and prompt supply of basic data for the planning and execution of the energy development programme. Energy plantations (biomass) will be given special attention under the programmes for reafforestation, soil conservation and farm forestry.

4. Industries

Development in industry during the last three decades has been essentially a kind of dependent development as most of the industries have been established on a turnkey basis. The cost has been prohibitive. It will be necessary to ensure an autonomous capability in providing technology needed for industrial development by selective transfer of technology and by promoting the generation and use of indigenous innovative techniques. This will be done by arranging a direct linkage between technology generation and industry. Each major industrial complex will need to establish and R&D cell to cater for its technological development. Small-scale industries will establish R&D associations for the same.

Special emphasis will be given to the development of small-scale industry in rural areas, particularly agro-based (food and nutrition) industries and mineral resources utilization industries, for which the identification, development, transfer and adaptation of intermediate technologies appropriate to the local situation will consitute a high priority.

5. Mineral Resources

While there are indications of valuable mineral deposits in various parts of the country the present contribution of minerals to the GNP is minimal. It is therefore necessary to develop high-level manpower and modern laboratory facilities for mineralogy and mineral technology. The conduct of integrated geophysical, geological and geo-chemical surveys, the adaptation of techniques for the speedy acquisition and processing of geo-data, as well as for the optimal planning of national resource systems will be given high priority.

6. Transport and Communications

In the transport sector, an integrated network of different modes of transport is absolutely vital. This will involve modernization of the railways, especially for long hauls, expansion of the road system, particularly between farm and market, an increased coverage in air transportation, greater use of inland waterways for transport and as substantial increase in marine transport. Much R&D is required to develop improved road-building technologies based on the use of local resources. Also, systems analysis and operational research studies to optimize road and rail transport, as well as civil aviation services, need to be developed on modern lines.

Modern communications involve the extensive use of electronic solid state components and systems which have important applications. Primary emphasis will be on design and development, with a strong R&D base for solid state circuitry and devices. A sizable portion, up to 25%, of the total industrial investment in the high technology sector of electronics is proposed to be earmarked for R&D in order to attain a reasonable indigenous capability level within the next ten years. One project of special importance in this field is the setting up of a Silicon Technology Centre which will be undetaken during the current five-year plan.

4.4 INTERNATIONAL SCIENTIFIC AND TECHNOLOGICAL COOPERATION

International collaboration is sought by developing countries, especially to build up their S&T capabilites and remove shortages of manpower in sophisticated fields. Judicious international and regional cooperation in science and technology can be highly beneficial to the developing countries. The Government of Pakistan has, accordingly, initiated a programme of agreements for scientific and technological cooperation with friendly countries which provide for exchange of information on scientific and technological research, reciprocal visits of scientists and other research personnel, and execution of joint or coordinated research projects. Pakistan is a member of the World Association of Industrial and Technological Research Organization which is making endeavours to promote institution-to-institution contacts at the international level and to improve mechanisms for transfer of technology. Pakistan has also become a founder-member of the International Foundation for Science, which aims at supporting and encouraging scientific research in the developing countries by seeking out and supporting promising young scientists in their home countries and enabling them to perform research projects of benefit to national development. This Foundation also needs to be considerably strengthened. Some research laboratories and establishments have their own arrangements for collaborative work with sister organizations abroad. Pakistan has actively participated in international meetings on the environment, water management, the transfer of technology, desertification, and other subjects.

Pakistan is making efforts to share its knowledge and expertise with other developing countries on bilateral and multilateral bases within the framework of Technical Cooperation among Developing Countries (TCDC). Pakistan has established a special cell in the Economic Affairs Ministry since June 1975 and, for the last decade, has provided technical assistance under such programmes as the RDC and the Colombo Plan.

The Government has also decided to institute a National Technical Assistance Plan (NTAP) with a view to playing a larger and more meaningful role in the programming, monitoring and evaluation of technical assistance. The following are the specific fields in which Pakistan has been, or is capable of, providing assistance:

- academic training facilities in all the major disciplines of the natural and social sciences;
- specific training in various fields of applied science and technology, notably agriculture, medicine, civil, electrical and mechanical engineering, telecommunications, ship building, animal husbandry, railways, public administration and banking;
- provision of experts particularly in education, banking and medical sciences;
- provision of skilled and semi-skilled workers;
- grant of scholarships to students in various fields for undergoing full-time courses in Pakistan institutions;
- emergency assistance at a time of calamity.

For 1977-78, Pakistan allocated Rs. 4.5. million for providing assistance to 69 developing countries which cooperated with Pakistan in different economic and technical fields. So far 362 training facilities, 41 experts, and 151 scholarships have been offered to various countries under the TCDC programmes. Other developing countries have also extended cooperation to Pakistan. It has received technical assistance from Iran in the shape of training, scholarships and experts in fields such as petroleum technology, wood technology, petroleum and gas prospecting, and tool manufacturing. Turkey offered similar facilities in the fields of hydraulics, geophysical prospecting, the iron and steel industry, machine tools, educational equiment, forest planning, dairy technology, and electronics. An RCD Science Foundation to promote S&T effort in the region, launch collaborative research and training projects, exchange S&T information and other programmes, is also being established. Setting up an Islamic Foundation for Science and Technology for Development with similar aims and objectives is also under the active consideration of the governments of Islamic countries. Other countries, notably, Singapore, South Korea, Romania, Poland, and Bulgaria also have technical cooperation programmes.

Pakistan's experience in the field of technical cooperation indicates that great scope exists for enhanced cooperation, provided certain constraints and shortcomings are removed. These pertain to the high cost of experts and the cumbersome and time-consuming procedures involved in taking decisions in developing countries. At the various international forums, including the UN, Pakistan has been pleading for international cooperation and concerted action to assist the developing countries to achieve a large measure of technological self-reliance by building-up an adequate indigenous S&T capabilities to solve their development problems and by working out a system through which they can benefit from each other's capabilities and expertise and reduce their dependence on developed countries. International cooperation is considered essential in the three broad areas of building up and strengthening S&T institutions including those which provide infrastructural and support services, education and training (human resources development), and exchange of knowledge, know-how and information.

A network of cooperating institutions could be developed, particularly among the developing countries to promote joint research effort on common problems, where feasible. Outstanding institutions in developing countries which possess exceptional potential could be declared centres of excellence and specially supported by UN and other international organizations to serve as regional or international centres. Creation of area-specific research institutions at the international level, with links or counterparts in developing countries, could greatly assist in developing indigenous capabilities.

Considerable scope exists for promoting cooperation amongst developing countries, and for improving the shared use of technologies available within the developing countries including technical know-how, skills, machinery, equipment, design, consultancy and construction capabilities. International agencies, especially those of the UN system, should aim at strengthening the local design and consultancy services and ensure the maximum utilization of developing countries' capabilities in the execution of aid programmes.

The developing countries can also cooperate amongst themselves, through measures such as joint purchase of technology and examination of concluded contract agreements, to avoid mistakes. They can cooperate in applied research in, for example, engineering, electronics, fertilizer, agro-chemical, energy, and chemical industries and in the survey of natural resources. Cooperation is also possible in consultancy and design work, industrial training for skills and in developing centres of excellence around reputable institutes. They can also move towards taking collective bargaining action in the acquisition of technology.

The governments of countries from where technologies are supplied through private enterprise should, as part of their aid programme, subsidize the costs of technology and its transfer. They should encourage their R&D establishments to form pairing arrangements with counterparts in the developing countries for work on their specific problems. They should commit resources for R&D work on the problems of developing countries and the training of manpower in sophisticated fields. In all S&T industrial project-funding arrangements, the concept of apportioning a suitable amount for the support of R&D work should be introduced by the developed countries in order to facilitate the assimilation of new technologies. In bilateral technology transfer agreements the cost devoted to consultancy and advisory services should not exceed 30% of the total cost.

In the field of human resource development, a wide scope exists for international cooperation. In addition to direct assistance for the training of scientific and technical manpower in disciplinary fields for which a local capability does not exist, assistance is needed to develop specialized institutions for education and training, for assessment of educational programmes to ascertain their relevance to national needs, for curricular reforms, for the introduction of modern techniques of education and for educational innovations. Special attention should be given to the training of extension workers and to mounting special programmes to train cadres of farmers and industrial workers capable of understanding and applying S&T to their routine work. Scientific communities, in most of the developing countries, are intellectually isolated due to the inadequate facilities for maintaining international liaison. The developed countries can play a very significant role in helping the development countries to reduce the isolation of their scientists and technologists from the active centres of learning and research in the world. It is proposed that each developed country may allocate resources for the participation of scientists and technologists from the developing countries in all international scientific and technological conferences hosted and organized by that country, for supporting visits of scientists and technologists from the developing countries to the counterpart institutions of that country, and, finally, for employing scientists and technologists from developing countries in scientifically and technologically meaningful positions during academic recesses. A minimum number of such facilities should be determined by each country.

The third area of S&T information exchange is one where the need for international cooperation is relatively more pronounced. This is manifest from the stress placed in the NIEO (New International Economic Order) declaration on the need to provide easy access, for the developing countries, to the vast store of scientific and technological knowledge available in the world, particularly the developed world.Considerable efforts are currently afoot within the UN system to improve the flow of S&T information through programmes such as establishing international technological information banks, centres for transfer of technology, and assistance for the development of national S&T information centres. Yet there exists no real point within the UN for broader exchange of S&T information relevant to the needs of developing countries. There is a need to examine the feasibility of creating a single focal point at the UN level for this purpose. Special efforts are also needed to encourage private institutions to provide information on their developed technologies. Similarly, improving access to technologies whose transfer is not subject to private decisions, and which are generated as a result of international collaborative efforts, is another priority area for future action. Action is also required where a proper choice of technologies necessitates more open disclosure by the industrial property market. Exchanges and meetings of scientists, technologists and other personnel concerned with the development and utilization of science and technology should be greatly encouraged and enhanced.

IBRD (World Bank) and other international project-funding organizations should broaden their outlook and provide funds for R&D projects in which returns are not well assured. The lines on which IBRD has recently relaxed its rules, to include educational projects for funding, may also be followed for facilitating the financing of R&D projects in S&T.

In all project aid (whether given by UN agencies or by developed countries on bilateral or multilateral bases), an amount of about 2% should be apportioned for the development of R&D work in the same discipline for which the assistance is given. For example, when aid is given for a dam-building or irrigation project the strengthening of R&D work in dam-building and irrigation should be supported. When aid is given for a steel mill or a road-building project, a component out of the total should be diverted towards the strengthening of R&D in the relevant disciplines so that the technology is more easily assimilated by the recipient country.

In foreign assistance agreements with the recipient countries, a large portion of the total amount goes towards meeting the costs of expatriate experts or advisers. This portion should be kept at a minimum possible level, thereby increasing the proportion for other important items such as equipment and training facilities. At present, in most cases, over 50% of the total cost is consumed in funding the consultancy or expert services.

While conducting feasibility studies and appointing consultants in connection with projects financed by international agencies, preference should be given to the utilization of expertise and services available in the recipient country. The experience of entrusting such work to expatriates has not been very fruitful in the past because they generally tend to have a superficial knowledge of the conditions in the recipient country. The result was that, sometimes, the design and detail of the projects had to be modified. All these factors are, therefore, to be taken into account in the execution of S&T developments projects.

PART 5.

Bibliography

Organization of Science and Technology in Pakistan. National Science Council, Karachi, 1974

Fith Five-Year Plan 1978-83. Planning Commission, Islamabad, 1977

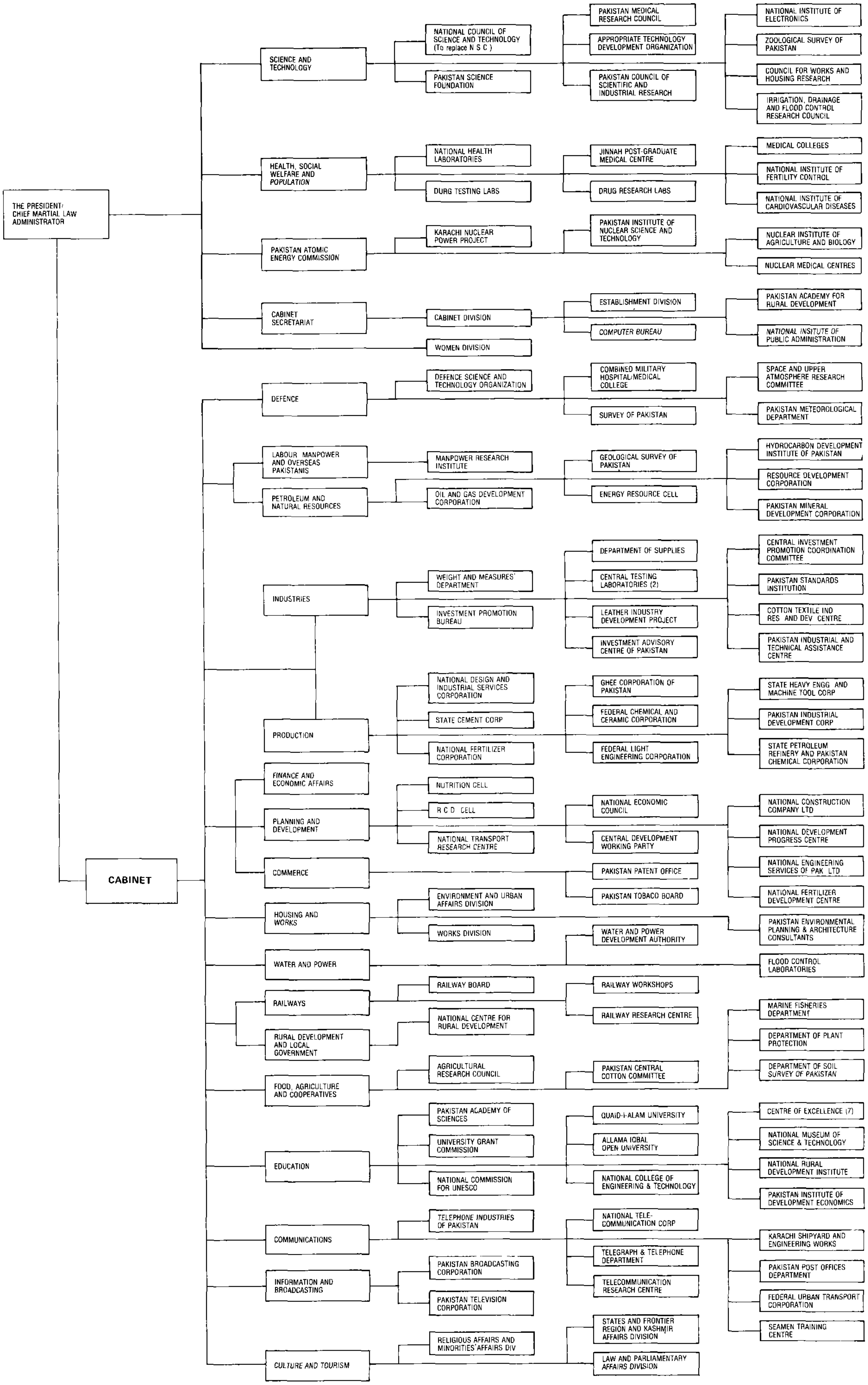
Pakistan National Paper for the UNCSTD-Conference. Ministry of Science and Technology, Islamabad, 1979

Country Summary of Pakistan for the Unesco Meeting of Directors of National Councils for Science Policy and Research in Asia and Oceania. Pakistan Science Foundation, Islamabad, 1975.

Bashiruddin Mahmood. 'Manpower and Technology Transfer'. *Paper presented at the Open National Seminar on Application of Science and Technology for Development, March 6-8, 1978, Islamabad*

Proposals for National Science and Technology Policy. Ministry of Science and Technology, Islamabad, 1980.

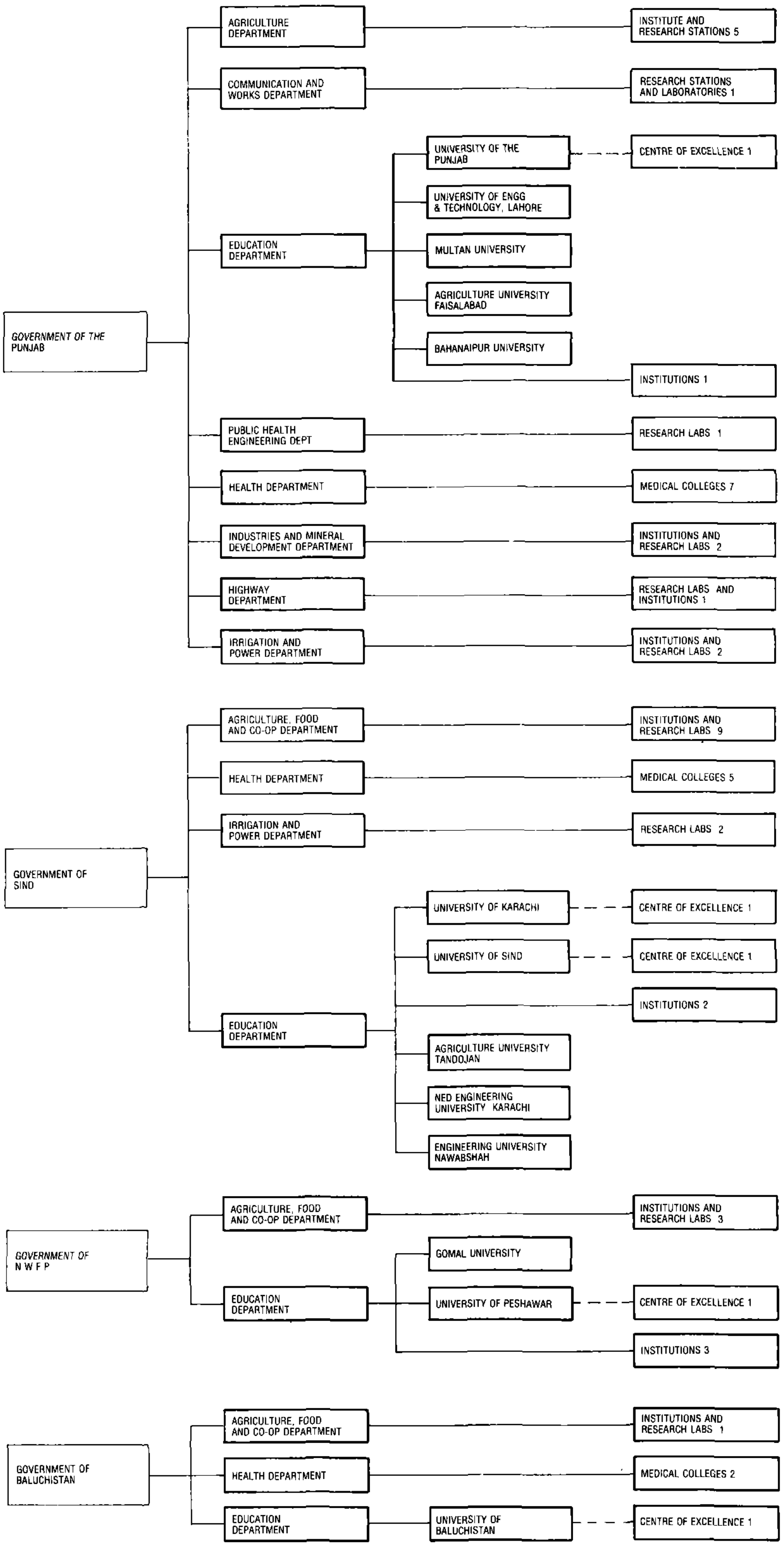
ZONE OF FEDERAL GOVERNMENT MINISTRIES OF



Organization in Pakistan

1979

ZONE OF PROVINCIAL GOVERNMENT



ZONE OF THE CITIZENS AND THE SCIENTIFIC COMMUNITY

National, Regional, Local and disciplinary Scientific societies, Associations and Learned Bodies

- THE INSTITUTE OF ENGINEERS PAKISTAN
- PAKISTAN ACADEMY OF SCIENCES
- PAK INSTITUTE OF ARCHITECTS
- SCIENTIFIC SOCIETY OF PAKISTAN
- PAK ASSOCIATION OF SCIENTISTS & SCIENTIFIC PROFESSIONS
- PAK ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
- PAK MEDICAL AND DENTAL ASSOCIATION
- PAK ENGINEERING CONGRESS
- PAK ENGINEERING COUNCIL
- FEDERATION OF ENGINEER-ASSOCIATIONS
- PAK INST OF CITY AND REGIONAL PLANNING
- THE INSTITUTE OF ELECTRICAL ENGINEERS, PAKISTAN
- PAKISTAN INSTITUTE OF METALLURGICAL ENGINEERING
- PAK ASSOCIATION FOR THE PROMOTIO OF SCIENCE AND APPROPRIATE TECHNOLOGY

- SIND SCIENCE SOCIETY
- SIND INDUSTRIAL AND NATURAL RESOURCES TECHNOLOGISTS ASSOCIATION
- PUNJAB GEOLOGICAL SOCIETY

- PAK STATISTICAL ASSOCIATION
- SOCIETY OF AGRICULTURAL ENGINEERS
- PAKISTAN BOTANICAL SOCIETY
- ZOOLOGY SOCIETY OF PAKISTAN
- SOCIETY FOR THE ADVANCEMENT OF AGRICULTURAL SCIENCES
- SOCIETY FOR THE ADVANCEMENT OF ANIMAL SCIENCES
- ENTOMOLOGICAL SOCIETY OF PAKISTAN
- PAK SOCIETY OF LEATHER TECHNOLOGISTS
- BIOLOGICAL SOCIETY OF PAKISTAN
- ALL PAKISTAN FOOC TECHNOLOGISTS ASSOCIATION
- THE PAK SOCIETY OF PUBLIC HEALTH ENGINEERS
- CANCER SOCIETY KARACHI
- PAK INSTITUTE OF CHEMICAL ENGINEERS
- CHARTER INSTITUTE OF TRANSPORT
- PAK TECHNICAL ACADEMY
- PAKISTAN ENGINEERS FORUM
- PAKISTAN SOCIETY OF BIOCHEMISTS
- YOUNG BIOCHEMISTS ASSOCIATION

Private Organizations

- FOUNDATIONS 2
- DEVELOPMENT INSTITUTE OF PAKISTAN

ANNEX B

Implicate Plan Targets for Employment Generation for Detailed Occupational Groups during the Fifth Five Year Plan Period 1977-78 to 1982-83

OCCUPATIONS	Estimated Employment Level 1977-78	Estimated Manpower Requirements 1982-83	Estimated Employment Generation During Plan Period
Chemists	7,827	9,178	1,351
Physicists	422	566	144
Physical scientists not elsewhere classified	1,294	1,532	238
Physical science technicians	2,271	2,847	576
Architects and town planners	642	693	51
Civil engineers	14,638	17,096	2,458
Electrical and electronics engineers	9,008	10,737	1,729
Mechanical engineers including marine & aeronautical engineers	8,872	10,345	1,144
Engineers not elsewhere classified	6,952	8,096	1,144
Surveyors	3,701	4,526	825
Draughtsmen & cartographers including lithographic artists	22,819	26,632	3,813
Civil engineering technicians	34,333	40,707	6,374
Electrical & electronics engineering technicians	38,082	42,054	3,972
Mechanical engineering technicians	20,325	22,081	1,756
Engineering & related technicians not elsewhere classified	20,249	21,051	802
Aircraft and ship's Officers	1,479	2,058	579
Biologists, zoologists & related scientists	16,212	18,753	2,541
Life sciences technicians	95,972	109,032	13,060
Medical doctors and surgeons	13,172	25,141	11,969
Medical assistants	15,564	22,064	6,500
Dentists	1,323	1,785	462
Dental assistants	1,121	1,224	103
Veterinarians	8,864	10,535	1,671
Dieticians and public health nutritionists	152	177	25
Professional nurses	4,300	9,580	5,280
Professional midwives	4,236	4,872	636
Medical, dental, veterinary & related workers not elsewhere classified including unregistered medical practitioners	42,299	45,051	2,752
Statisticians, mathematicians & sytems analysts	13,728	16,566	2,838
Economists	1,548	2,058	510

PAPUA NEW GUINEA

Table of Contents

PAPUA NEW GUINEA

GEOGRAPHY

Capital city: Port Moresby
Main ports: Lae, Port Moresby, Rabaul, Kieta, Madang, Kimbe
Land surface area: 461,691 sq km

POPULATION (1978)

Total	3.0 million
Density (per sq km)	6
Urban/rural ratio (1976)	0.1
Average rate of growth (1970-78)	2.4% p.a.

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	42.2	10.3	8.7	33.6	5.3	100%

SOCIO-ECONOMIC

Labour force (1971)	
Total	1.1 million
Percentage in agriculture	...
Gross national product (1978)	
GNP at market prices	US $1,820 million
GNP per capita	US $ 600
Real growth rate of GNP per capita (1970-78)	0.2%
Gross domestic product	
Total (in current producers' values) (1975)	US $1,575 million
Percentage by origin (1973)	
Agriculture	26%
Manufacturing, mining & quarrying, electricity, gas & water, construction	40%
Government finance	
National budget (1978)	...
As percentage of GNP	...
External assistance (official, net; 1976)	US $234 million
As percentage of GNP	28.7%
Exports (1978)	
Total exports of goods (1978)	US $780 million
Average annual growth rate (1970-78)	...
External debt (1978)	
Total public, outstanding + disbursed	US $370 million
Debt service ratio (% GNP)	1.8
(% Exports of goods and non-factor services)	4.0

Exchange rate (1978): US $1 = 0.71 Kinas

EDUCATION

Primary and secondary education (1978)	
Enrolment, first level	268,147
As % of (7-12 years)	60%
Enrolment, second level	43,665
As % of (13-18 years)	11%
Combined enrolment ratio (7-18 years)	37%
Average annual enrolment increase (1970-1978)	4.7%

Higher education (third level) (1978)

Teaching staff, total *155*

Students and graduates by broad fields of study:

	Enrolment	Graduates
Social sciences and humanities	1,313	254
Natural sciences	292	21
Engineering	806	126
Medical sciences	123	19
Agriculture	184	47
Other and not specified	169	7
Total	**[1]2,887**	**[1]474**

Number of students studying abroad *306*

Education public expenditure (1978)

Total (thousands of Kinas)	89,320
As % of GNP	6.8%
Current, as % of total	97.1%
Current expenditure for third level education, as % of total current expenditure	...

---

[1] Universities only

Table 1. The Science and Technology Network Major Organizational Functions and Interactions

I - First level - POLICY-MAKING

Country: Papua New Guinea

Organization	Function	Reports To	Advised By	Consults with
National Agricultural Council	Advisory, executive	Cabinet	Standing committees Govt. Departments	Interest groups, universities
National Standards Council	Advisory	Minister for Labour and Industry	Standing committees Govt. Departments	Interest groups, universities
National Cultural Council	Advisory	Minister for Science, Culture and Tourism	Standing committees	Institute of PNG Studies, National Museum
Govt. Departments with S&T role as listed in Part 3.1	Control, Co-ordination, executive, advisory	Appropriate ministers	Various committees	Other Govt. Departments, Provincial Governments, statutory organizations, universities
National Social Science Research Committee	Co-ordination, advisory	Minister for National Planning and Development	Various committees	Universities, interest groups, Government Departments

II - Second level - PROMOTION & FINANCING

Organization	Reports to	Advised by	Consults with
Government Departments via the National Public Expenditure Plan (NPEP)	Appropriate Ministers	Various Committees	Interest groups, universities, other Government Departments
University of Papua New Guinea Research Committee	Academic Board of the University		Various University Deptartments inter groups
Papua New Guinea University of Technology Research Committee	Academic Board of the University		Various University Departments inter groups
International organizations e.g. UNDP, UNESCO, FAO, World Bank, Asian Development Bank, via NPEP			
Bilateral aid arrangements with, e.g. Australia, New Zealand, West Germany, via NPEP			

III - Third level - PERFORMANCE OF SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES

Organisation	Function	Reports to	Consults with
Primary Industry Research Stations, and Botanical Gardens, Agricultural Colleges	STS, R&D	Department of Primary Industry	Interest groups, universities
Bulolo Forestry College, Forest Training Centre	STET	Office of Forests	
Laloki Co-operative College	STET	Department of Commerce	
Defence Force Academy	STET	Department of Defence	
Teachers Colleges (diploma)	STET	Department of Education	
Goroka Teachers College (degree)	STET	Part of University of Papua New Guinea	Department of Education
Technical Colleges (trade certificate)	STET	Department of Education	
Lae Technical College (technician certificate)	STET	Department of Education	Employers
Nurses Training and medical laboratory service establishments	STET, STS	Department of Health	
Colleges of Allied Health Services (paramedical)	STET	Department of Health	
Institute of Medical Research	STS, R&D	Department of Health	University of Papua New Guinea
Legal Training Institute	STET	Department of Justice	University of Papua New Guinea
Office of Environment and Conservation	STS	Department of Lands, Surveys and Environment	Universities, Department of Primary Industry
National Mapping Bureau	STS	Department of Lands, Surveys and Environment	Papua New Guinea University of Technology
National Weather Service	STS	Department of Minerals and Energy	
Energy Planning Unit	STS, R&D	Department of Minerals and Energy	Universities, interest groups, Govt. Departments
Divisions of Geological Survey, Mines, Water Resources	STS	Department of Minerals and Energy	
National Planning Office, Bureau of Statistics	STS	Department of the Prime Minister	Govt. Departments, industry and commerce
Administrative College of Papua	STET	Department of the Public Services Commission	Govt. Departments, industry and commerce
National Computing Centre	STS	Department of the Public Services Commission	Govt. Depts., University of Papua New Guinea
Elcom Training College, Posts and Training College	STET	Department of Public Utilities	
Institute of Papua New Guinea Studies, National Museum	STS, R&D	Ministry of Science, Culture and Tourism	National Cultural Council, universities
Bureau of Industrial Organizations	STET, STS, R&D	Department of Labour and Industry	Unions, employers organizations
Institute of Applied Economic and Research	STET, R&D	Ministry of National Planning and Development	Universities, interest groups
Universities	STET, STS, R&D	Office of Higher Education	Employers, Govt. Departments

Table 2 - Scientific and Technological Manpower

(Data unavailable at time of publication)

Country: Papua New Guinea

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total stock (thousands)	of which working in R&D
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agricultural sciences	Medical sciences	Social sciences		
1965										
1970										
1975										
1979										
1985										
1990										

Table 3 - R&D expenditures

(Data unavailable at time of publication)

Country: Papua New Guinea
Currency:

Table 3a: Breakdown by source and sector of performance

Year:

Unit:

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive				
Higher Education				
General Service				
Total				

Table 3b: Trends

Year	Population (millions)	GNP (in US$ million)	Total R&D expenditures (in)	Exchange rate US $1 =
1965				
1970				
1975				
1979				
1985				
1990				

PART 1.

General features

1.1 GEOPOLITICAL SETTING

Geography

Papua New Guinea lies wholly within the southern tropics. Its territorial boundaries stretch from the equator to latitude 12° South and between longitudes 141° and 160° East. Its total land area is 461 693 square kilometres, comprising the former territory of Papua and the former Trust Territory of New Guinea. Its land area includes the eastern half of the New Guinea mainland, the Bismark Archipelago, the northern-most Solomon Islands and the group of islands extending from the eastern-most part of the mainland. The central core of the mainland consists of a massive cordillera containing a complex of mountain ranges interspersed by wide valleys:

Population

By 1979, the population of Papua New Guinea was just over 3 million and increasing at an annual rate of about 3%. About 45% of the population are 14 years of age or under. High population growth rates are expected to continue to the end of the century, by which time the total population is likely to exceed 5 million. The present population of the national capital, Port Moresby, is about 130 000 people.

Climate

Except in the Port Moresby area, there is regular and generally high annual rainfall in Papua New Guinea. The average is about 2 000 mm. per year, but there are wide variations from 1 195mm. in port Moresby to more than 4 000mm in some areas. There are two seasons: the trade winds lasting from May to October, and the monsoon, lasting from December to March. In the intervening months, winds are variable, often resulting in periods of doldrums. Although rainfall tends to be heavier in the monsoon season, rain can occur at any time in most places.

Temperatures in Papua New Guinea vary little throughout the year, the average daily coastal readings being between 21° C minimum and 32°C maximum. However, temperature varies widely with altitude, and the higland areas can be cool to cold. Some frosts and, occasionally, snow are experienced at altitudes above 2 500 metres.

Papua New Guinea is not usually subject to cyclones. However, much of the country does experience frequent earth tremors and, occasionally, earthquakes. There are many indications of past volcanic activity and several active volcanoes at present. There have been a number of major eruptions this century.

Land Resources

In most part of Papua New Guinea, from seal-level to about 1 000 metres, rainforests grow in profusion and these contain a wide variety of tropical trees and other vegetation. Tropical plantation crops are grown in many coastal areas where the forest has been cleared. The cordillera of the mainland contains a huge complex of well-watered valleys having rich volcanic soil and supporting large populations engaged principally in subsistance farming. There is a total of 250 000 hectares of land under subsistance cultivation, and it has been estimated that 80% of the population relies on this for food.

However, high rainfall and deforesting have combined in some places to produce erosion and the leeching of essential nutrients from the soil. In addition, many deforested areas have been taken over by hardy tropical grasses which, once established, are extremely difficult to remove or control.

Water Resources

As a result of its generally high rainfall, Papua New Guinea has a huge water resource potential. However, most of this resource remains untapped for either hydroelectricity generation or for commercial agriculture. There are several large river systems on the mainland, as well as hundreds of smaller rivers. There are no major river systems on the islands but, rather, many rapid-flowing streams and small rivers. In addition to surface water, ground water is found in many parts of the country and is sometimes used for stock watering, irrigation and town supply. However, water contamination, principally from human and animal wastes, is a problem in many of the more densely populated rural places.

Mineral and Energy Resources

Papua New Guinea is know to have substantial mineral resources, but the extent of these resources has yet to be meaningfully defined. Recent years have seen a notable increase in exploration activity, and significant deposits or occurrences of the following have been established: alumina, chromium, cobalt, copper, gold, graphite, lead, limestone, manganese, nickel, phosphate, platinum, silver, sulphur and zinc. At present, the country is a major exporter of copper, and it also exports significant quantities of gold and silver.

A number of indications of oil and natural gas have been found in various parts of Papua New Guinea, and at least 100 wells are know to have been drilled since 1920, although none has resulted in commercial production. Coal has recently been discovered on the mainland, but its quality and extent are as yet unknown.

Non-mineral Energy Resources

Undoubtedly, the most significant non-mineral energy resource in Papua New Guinea is hydro-power. Three major hydro-electricity generating facilities are in operation, and several new sites are being developed. In addition, further sites have been identified for future development as dictated by demand. Present installed capacity is about 75 megawatts, but the potential is many times this figure. The use of solar energy has grown significantly in the past few years, especially for domestic hot water heating and for powering telecommunications equipment, and wind energy is used in some parts of the country for pumping water.

Native Plant Resources

It has been estimated that, per head of population, Papua New Guinea has the largest native forest resource in the southern hemisphere, and the country is becoming a major exporter of tropical timbers. In addition to the introduced tree and vegetable crops, many local varieties of banana, papaya and root vegetables are to be found in the country.

Marine Resources

Papua New Guinea waters are known to contain large quantities of fish and other commercially significant marine resources. Traditionally, coastal villages have always fished for food and, in recent years, villages have begun preserving some of their catch for sale to local markets or for export. To date, commercial fishing has centred on skipjack tuna for export, but a large fish cannery is soon to be constructed. Increasingly, local fisherman are contributing significant quantities of barramundi, crayfish and prawns to the export trade. Other marine products produced and exported include katsuobushi, trochus and green snail shell, and crocodile skins.

Major Urban Centres

About 80% of the population of Papua New Guinea live in the rural areas. The major urban centres of the country include Port Moresby, Lae, Rabaul, Madang, Wewak and Mount Hagen. With the exception of Port Moresby, none of these had a population exceeding 100 000 by 1979. The country's major seaports handled the following tonnages in 1979: Lae (693 670), Port Moresby (428 640), Rabaul (672 888), Kieta (1 126 447), Madang (301 024) and Kimbe (148 810). There are three international airports: Port Moresby, Kieta and Wewak, but Port Moresby has by far the greatest traffic. The country's total international passenger arrivals and departures for 1979 were 75 905 and 79 785 respectively.

Political System

Papua New Guinea gained full independence from Australia on 16th September, 1975. From that date, the country became an independent state within the Commonwealth, with Queen Elizabeth II as Head of State and the Governor General her representative. Government is by the West-minister-style parliamentary democracy, with a single House of Parliament consisting of 109 members. The Prime Minister is elected by the House. There are also 19 Provincial Governments, each with a Premier and Provincial Assembly. The National Government is in the process of devolving many of its powers to Provincial Governments.

1.2 SOCIO-ECONOMIC AND CULTURAL SETTING

Social Groups

Papua New Guinea's major social groups are native-born Papua New Guineans of predominantly Melanesian origin, and expatriates of mainly European origin who are temporary workers in the country. The available evidence suggests that, before the arrival of Europeans in the last century, there had been a great mixing of people and, in some places, the influence of Polynesian and Micronesian blood is evident. More than 700 distinct linguistic groups have been identified in the country. English is the official language, but Melanesian Pidgin and, to a lesser extent, Hiri Motu, are commonly used lingua franca.

Changes in social structure have come about as a result of outside influences, but the social set-up outside the major urban areas is still as varied as the people themselves. In some communities, inheritance of land and other property is matrilineal; others follow a patrilineal system. The principal community unit is still the village or group of villages, usually of 50 to 1 000 people, where life is generally communal, the economy subsistent, and allegiances seldom extend very far beyond the immediate community. This exclusiveness is gradually breaking down but is still an obstacle to the realization of the concept of a united nation of Papua New Guinea.

Religion

Christianity was introduced by the first missionaries more than a century ago, and many Papua New Guineans would now describe themselves as Christians. However, traditional religious beliefs and rituals are still widely held and practised, and the belief in the efficacy of sorcery and magic is still prevalent in many areas, especially amongst village dwellers.

The Economy

The modern sector of Papua New Guinea's economy is best described as a mixed market economy, although in many rural areas the local economy is still characterised by subsistance farming and barter trade. Most large business enterprises are foreign-owned or controlled, although the National Government owns a commercial bank and a development bank, and also runs postal and telecommunications services, the national airline which operates both domestic and overseas services, and a national shipping line. In addition, the State has a significant shareholding in several large companies operating in the private sector, and the Investment Corporation of Papua New Guinea provides a means whereby individuals and groups who are citizens can share in the ownership of major enterprises. Approximately one person in three in modern sector employment is employed by government (National, Provincial or local).

From the mid-1950s until two years before independence, the Papua New Guinea economy was characterised by a considerable excess in the value of imports over exports, made possible by large grants and other aid from the Australian Government. In the early 1970s the situation was compounded by a dramatic fall in world prices for the country's agricultural exports but, by 1974, export of copper concentrate from the Boungainville Copper Mine had ended the country's dependence on agricultural products, particularly copra. Copper is now Papua New Guinea's major export income earner, followed by coffee, cocoa and copra; however, timber and tuna are rapidly increasing in significance. The manufacturing industries sector is mainly capital-intensive and import-substituting rather than export-orientated, and accounted for about 10% of the GDP in 1979.

At the time of independence in 1975, Australian aid accounted for more than 50% of the National Budget, and that figure had been progressively reduced to about 26% by 1979. However, it is anticipated that Australian aid will continue to be a significant contributor to the budget for at least another decade.

By 1978, Papua New Guinea had regained the balance of trade surplus first achieved in 1974–75. In 1978, exports stood at the equivalent of about $US827 million, and imports were approximately $US694 million. However, preliminary figures indicate a significant deterioration in the position in 1979, owing to a decline in world prices for the country's principal export commodities. The values of main commodities exported in 1978 ($US equivalent) are shown below.

	$US (millions)
Copra	33.8
Cocoa	91.3

Coffee	155.5
Rubber	3.8
Tea	11.4
Timber, logs	17.2
Timber, sawn	6.0
Plywood	4.1
Tuna	29.7
Crayfish, prawns	6.0
Copra oil	18.1
Other coconut products	1.5
Palm oil	15.2
Copper ore and concentrates	315.0

At the end of 1979, the annual rate of inflation stood as just under 6%.

1.3 DEVELOPMENT SCENE

Although Papua New Guinea does not yet suffer significantly from many of the more common problems confronting other developing nations, e. g., overpopulation, widespread malnutrition, concentration of land ownership, inadequate natural resource base, rampant inflation, chronic balance of payments deficit and so forth, several major problems are hindering the development process. Significant among these are problems associated with land tenure, urban drift, high domestic cost structure, technological dependency, lack of trained manpower, high population growth rate, several endemic diseases, and tribal fighting in some areas. However, these problems are balanced by an abundance of natural resources, stable gorvernment, and an increasing market for many of the country's export commoditites.

PART 2

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

Papua New Guinea's "Eight Aims," announced in December 1972, constituted the first real attempt to formulate a strategy for development. They were :

i. A rapid increase in the proportion of the economy under the control of Papua New Guinean individuals and groups and in the proportion of personal and property income that goes to Papua New Guineans;

ii. More equal distribution of economic benefits, including movement toward equalisation of incomes among people and toward equalisation of services among different areas of the country;

iii. Decentralisation of economic activity, planning and government spending, with emphasis on agricultural development, village industry, better internal trade and more spending channelled to local and area bodies;

iv. An emphasis on small-scale artisan, service and business activity, relying where possible on typically Papua New Guinean forms of business activity;

v. A more self-reliant economy, less dependent for its needs on imported goods and services and better able to meet the needs of its people through local production;

vi. An increasing capacity for meeting government spending needs from locally raised revenue;

vii. A rapid increase in the equal and active participation of women in all forms of economic and social activity;

viii. Government control and involvement in those sectors of the economy where control is necessary to achieve the desired kind of development.

The basic element in the thinking behind the "Eight Aims" was that rural development should be emphasised as a vehicle for promoting a more equal distribution of social and economic opportunities. However, being a mixture of both objectives and strategies, they did not prove fully effective in re-directing the resources and activities of the Government. Hence, in an attempt to provide broad guidelines which could then be translated into firm policies for development, the Government promulgated the National Development Strategy (NDS) in October, 1976. The NDS calls for an increased proportion of the nation's resources to be directed to the rural areas in order to reduce inequalities and allow rural dwellers, who constitute the bulk of the population, to participate more fully in the development of the nation. However, rural development is to be accompanied by planned growth of urban areas to provide important services to both rural and urban residents. Successful rural development will stimulate urban growth to service the increased purchasing power of rural dwellers. Concentrating on rural development is seen as having the following important advantages:

i. The strategy promotes economic growth that relies on small-scale and decentralised organisation of production which can be combined with traditional forms of production, and will be under the control of Papua New Guineans;

ii. The strategy calls for a more even spreading of government services and promotes the equal distribution of incomes by involving as many people as possible in the process of economic growth; it is the only strategy that can involve the majority of the population;

iii. The strategy is designed to build on, and maintain, subsistence production, which is Papua New Guinea's most important form of self-reliance.

In drafting the NDS, however, it was recognised that it would not be effective unless the broad guidelines could be translated into firm policies and definite commitments of expenditure to achieve clearly stated targets. Because implementation of the National Development Strategy required a redirection of Government effort to benefit rural areas, a means had to be devised to control and redirect the pattern of Government expenditure. The National Public Expenditure Plan (NPEP), which came into effect in 1978, represents the first step in a longer-term effort to achieve the necessary redirection of expenditures. The NPEP builds on the existing priority-setting through the National Budget but adopts a time horizon of four years. The NPEP employs a two-fold approach as follows:

i. To control and limit expenditure on existing policy, for in general, total expenditure on existing activities by each department has been kept constant in real terms, i.e., appropriations have been increased only to offset the effects of inflation;

ii. To reserve the limited room for growth in total government expenditure for clearly documented projects to achieve targets in the following strategic areas such as:

Increasing rural welfare;
Rural education;
Helping less developed areas;
Improving subsistence agriculture;
Food production, marketing and nutrition;
Economic production;
Increased Papua New Guinean participation in the economy;
Urban management;
Effective administration; and
Environmental protection.

Under the National Public Expenditure Plan, projects and expenditure proposals are considered for funding under four headings :

New Project submissions
On-going projects
Zero-base projects
Sectoral programmes (SPs)

Zero-base projects are those existing activities which the Government wishes to reassess in the light of recent policy changes and needs, i.e., the activities are treated as if they did not already exist and subjected to the normal NPEP process. Sectoral programmes have been introduced primarily for the purpose of allocating funds for provincial level projects in such a way that both national and provincial priorities can be taken into account and integrated programmes developed. In the 1979-82 NPEP, SPs on rural health and community and secondary education were introduced. The 1980-83 NPEP includes the following SPs (US$)

Provincial Economic Developments:

Small Businesses	711 050.00
Rural Health Services	4269 144.20
Border Development	2025 070.40

Provincial Economic Development: Agriculture/Livestock Provincial Economic Development: Forestry Provincial Economic Development: Fisheries	1422 100.00
Food Crop Programme	729 537.30
Rural Transport Programme	234 420.00
Rural Non-Formal Education	284 105.00
Less Developed Areas Studies	1429 105.00
Community Education	7741 912.40
Provincial High Schools	3012 007.30

The sectoral programmes constitute a large proportion of the expenditure envisaged under the 1981-84 NPEP; anticipated total expenditures over the period in approximate $US equivalents are shown above. Its is worth noting here that even projects which are largely overseas funded must be submitted to the NPEP process so as to ensure that they are in line with national develement priorities. All Government-funded agencies, i.e. Departments, Provinces and Statutory Bodies, must go through the NPEP process to obtain significant increases in funding (in real terms) from the National Budget. The procedures followed for evaluation, fund allocation and project monitoring are illustrated in Annexes 1 and 2, together with target dates for important steps in the process. The information required in NPEP submissions includes:

Strategic objective which the project will primarily achieve
Project objectives
Project description
Physical inputs
Output and benefits
Project inter linkages
Cost details.

Apart from the major physical and economic undertakings in the country identified for funding by the Government under the National Public Expenditure Plan, there are several large development projects funded by private, predominantly foreign, investment which are due to start up in the next five years. These include:

Ramu Sugar Project	234 420.00
Ok Tedi Copper/Gold Mining	1000 000.00
Cape Rodney Rubber Project	1422 100.00
Kavieng Fish Cannery	231 802.30
Vanimo Timber Project	(figures not available)

Projected total project costs in $US equivalents are shown above. In each of these projects, the State is to have a direct minority shareholding.

2.2 DEVELOPMENT POLICY AND SCIENCE/TECHNOLOGY POLICY

At present, the linkages between development policy on the one hand and science and technology policy on the other hand, are very weak. New public sector scientific and technological activities are all subject to the NPEP process and, hence, to broad Government development objectives. However, as outlined in Section 2.3 below, Papua New Guinea does not have, as yet a well-enunciated science and technology policy; such policy can only be inferred from documents such as the National Development Strategy. Hence to a large extent, Government departments and statutory bodies act according to their own perceptions of policy in this area.

The linkages between the "producers" of scientific and technological inputs to the development process and the potential "users" of these inputs are also very weak. There is, for instance, no body equivalent to a Natioanl Science Council; nor is there, within Government, the equivalent of a Science and Technology Policy Unit. However, as outlined in Section 2.3 below, steps are now being taken which may result in the establishment of such bodies.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

Following promulgation of the National Development Strategy in October 1976, the Government instructed the National Planning Office to establish a number of working groups whose task was to formulate policies that would ensure that future Government decisions and expenditure conformed with the NDS. One such group was the Working Party on Technology Policy, whose membership was drawn from Government departments, statutory bodies and academic institutions. Notably, there was little or no private sector representation.

Following its first meeting in early 1977, the Working Party split into several sub-groups as follows:

Building	– techniques, materials and design
Agriculture and nutrition	– food production techniques, processing, storage, export crops
Services	– water, sanitation, power, communications
Manufacturing	– small-scale, large-scale, capital goods industry, further processing of exports
Transport	– modes, roads and bridges, design standards.

Deliberations continued through 1977 and into early 1978, by which time it had become apparent that there was little unanimity amongst the participants. In fact, only the Manufacturing Sub-group of the Working Party on Technology Policy ever submitted formal recommendations to the Government.

In response to a request from the P.N.G. Government in late 1977, UNESCO arranged, under its Regular Programme, for a team of consultants to assist with science and technology policy formulation. Team members made several visits to Papua New Guinea during the period January to August, 1978. The consultants felt that, rather than address themselves to policy formulation *per se*, it would be more appropriate to highlight some of the important policy issues and make recommendations as to institutional arrangements for coordinating scientific and technological activities in the country, and for policy analysis and assessment. Concerning the latter points, the consultants canvassed two specific suggestions namely, the formation of a science and technology coordination and advisory council; and, the establishment of a science and technology policy analysis and assessment unit.

The first approach was rejected by the consultants on the grounds that it was unlikely to attract a significant number of members from the non-government sector and, also, would be subject to difficulties similar to those already encountered by the Working Party on Technology Policy. A council would consist of part-time participants, who would be busy people devoting little direct and continuous attention to science and technology affairs. The alternative approach suggested was the formation of a small science and technology policy analysis unit which, in this policy area, would be the functional equivalent of the National Planning Office. The principal functions of the unit would be:

Identification of issues;

Canvassing advice from both inside and outside Government;

Digesting the issues into terms suitable for Cabinet consideration;

Monitoring implementation of decisions taken;

Observing the operation of the national science and technology establishment, detecting the need for change, and formulating advice as to appropriate responses.

The UNESCO mission culminated in a National Seminar on Science and Technology Policy held in Port Moresby during August, 1978. The seminar was attended by representatives of a wide cross-section of Government and, to a lesser extent, non-Government bodies. It was intended that the seminar would lay the groundwork for the preparation of a draft White Paper on Science and Technology Policy for consideration by the

Government. But, while there was lively debate on many of the important issues amongst the participants, there was no apparent consensus as to where science and technology should be heading. In addition, several of those present questioned the very need for a science and technology policy, and others questioned which Government department should have prime responsibility for its formulation and implementation. As a result, science and technology policy remained largely in abeyance until the present Minister for Science, Culture and Tourism took up his portfolio following a change of government in March, 1980.

Since assuming the portfolio, the Minister has been successful in convincing Cabinet of the need for some form of science and technology administration and, hence, direct access to advice on policy formulation and implementation. In June 1981, Cabinet agreed to the establishment of an embryo structure consisting of two science and technology advisors, whose initial task would be to examine Papua New Guinea's needs in terms of policy formulation, administration and monitoring, and advise the Minister accordingly. Based on their findings, the Minister will make further submissions to Cabinet on the establishment of a national science and technology structure.

Table 1 illustrates the science and technology network as it presently exists in Papua New Guinea, including major organisational functions and interactions. However, it should be emphasised that the present science and technology structure is, at best, loosely defined, with the many government departments, statutory bodies and other organisations engaged in scientific and technological activities often pursuing their own particular briefs with little co-ordination being exercised by the Government. This is a situation which often leads to conflict of interest which, in the absence of a coherent national science and technology policy framework, must be resolved in an ad hoc fashion.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

In Papua New Guinea, the organisations and institutions pursuing scientific and technological activities fall into several broad categories:

i. National Government: departments and statutory bodies, some of which have specialist educational institutions under their control;

ii. Tertiary educational institutions: universities, teachers colleges and technical colleges;

iii. Business enterprises engaged in primary, extractive and manufacturing industries;

iv. Private foundations and research institutes;

v. Professional and industry associations.

The major organisations and institutions engaged in scientific and technological activities are listed below, together with a brief description of the functions of their relevant specialist divisions, departments and sections.

i. National Government Departments

Most scientific and technological activities in Papua New Guinea are under the control of, and largely funded by, the National Government departments engaged in these activities in a significant way include the:

Department of Commerce: business training, small industries development, sericulture development;

Department of Defence: military training;

Department of Education: tertiary education and training including teacher training;

Department of Health: medical research and laboratory services, paramedical training, nurses training;

Department of Lands, Surveys and Environment: environment and conservation monitoring, surveying and mapping;

Department of Labour and Industry: compiling and promulgation of national standards;

Department of Minerals and Energy: meteorological and seismological observation, geological and hydrological surveying, energy planning;

Department of Primary Industry: agricultural training and research, livestock and poultry research, veterinary laboratory services, fisheries training and research, forestry and timber industry training, botanical research;

Department of the Prime Minister: economic and social planning, village development, compiling of economic and social statistics;

Department of the Public Services Commission: administrative training, computer services;

Ministry of Science, Culture and Tourism: sociological and anthropological research, museum services.

ii. National Government Statutory Bodies

A number of statutory organisations in Papua New Guinea are engaged in scientific and technological activities in a significant way. These include:

Bureau of Industrial Organisations: industrial relations training and research;

Institute of Applied Social and Economic Research (IASER): applied sociological, anthropological and economic research, training of researchers;

Papua New Guinea Electricity Commission: electrical training, testing laboratory facilities;

Papua New Guinea Institute of Medical Research: tropical disease and medical research;

Postal and Telecommunications Services: telecommunications training, testing laboratory facilities.

iii. Tertiary Educational Institutions

Papua New Guinea has two publicly-funded universities, and a privately-funded university is currently under construction. The major tertiary educational institutions and the fields of study which they offer are as follows:

Goroka Teachers College: teacher training including technical teacher training;

Lae Technical College: sub-professional (technician) engineering training, business and commerce;

Papua New Guinea University of Technology: accountancy and business studies, architecture, civil, electrical and mechanical engineering, surveying, chemical technology, agriculture, forestry, fisheries technology;

University of Papua New Guinea: sociology and anthropology, psychology, history, economics, language, mathematics, physics, chemistry, commerce, law, medicine, agriculture.

Total enrolments in the above institutions number about 4 000 full-time students. There are, in addition, many post-secondary specialist training establishments under the control of government departments and statutory bodies. These are included in Table 1. It is worth noting that the development of tertiary educational institutions is a very recent phenomenon in Papua New Guinea, the first university having opened its doors in 1964.

iv. Business Enterprises

The nation's largest private employer is Bougainville Copper Limited. The company has its own technical training centre, psychological testing and counselling unit, and specialised laboratory facilities.

v. Private Foundations and Research Institutions

The South Pacific Appropriate Technology Foundation (SPATF) was launched in 1976 with support from both public and private sponsors, as well as international sources. Its principal objective is to promote the use of appropriate technologies (ATs) for national development. SPATF's research and development arm, the Appropriate Technology Development Institute, is active in developing and adapting technologies for local use. SPATF also runs a national AT library and information facility and a small industries development centre.

The Institute of National Affairs is a privately-sponsored research institute which investigates and reports on topics of national importance and seeks to develop a dialogue on these issues between the National Government and the private sector.

The Wau Ecology Institute is a privately-funded research institute affiliated with the Bishop Museum in Honolulu, Hawaii. Its staff is engaged in a wide range of ecological research activities, and its facilities include a research laboratory and a zoo.

vi. Professional and Industry Associations

Papua New Guinea has a number of professional and industry associations which are active in various scientific and technological activities. These include:

Society of Professional Engineers of Papua New Guinea,
Cocoa Industry Board of Papua New Guinea,
Forest Industries Council of Papua New Guinea,
Papua New Guinea Coffee Industry Board.

It should be noted that the last three organisations are supported by levies imposed by the National Government on exports of the respective commodities.

3.2 HUMAN RESOURCES

A central feature of the formal employment scene in Papua New Guinea is the large number of expatriate workers in the country. However, the total number has declined from more than 30 000 in 1971 to around 13 000 today. Of those remaining in the country, some 97% occupy jobs described as "skilled" by the 1980 National Manpower Assessment (NMA). The remaining 3% are concentrated mainly in commerce and business, and community services.

The substantial reduction in the number of expatriate workers over the past ten years has been possible by a rapid expansion in educational facilities in the late 1960s and throughout the 1970s. However, an acute shortage of skilled manpower remains a major obstacle to the achievement of a fully localised labour force. This is true not only in the sense of formal qualifications needed, but also in the sense of the experience required to hold senior positions in both government service and private enterprise.

At present, the localisation position varies considerably from one sector of the economy to another, with the government sector having achieved significantly higher levels than the private sector. The 1980 NMA shows that, while over 90% of all skilled jobs in the government, education and public utility sectors are held by nationals, the figure is below 80% in most other sectors.

Progress has been particularly disappointing in the agriculture, transport and service sectors, where between 25% and 30% of skilled jobs are still held by expatriates.

That the government sector should have achieved a high rate of localisation can be attributed to two factors. First, the National Government has long had localisation as a major policy target and has consistently aimed to increase the proportion of nationals it employs. Second, the government sector has, until recent times, had first choice of many of the students emerging from the education system, owing to comparatively attractive salaries and conditions of service. However, the position is likely to change with the recent introduction of the Employment of Non-Citizens Act which places much more stringent localisation requirements on private sector employers.

The 1980 NMA notes that the future growth of formal employment in Papua New Guinea and, hence, future changes in demand for workers with formal skills, will depend upon a wide range of variables, including:

growth and distribution of sectoral output;
growth of earnings from employment;
technology used in production.

The NMA also notes that, although changes in technology could bring important substitution effects between capital and labour, these are likely to be considerably smaller than the impact on employment of expanded production. Therefore, in attempting to arrive at projections for scientific and technological manpower, the NMA has made use of sectoral GNP growth rates generated by the National Planning Office's input-output model of the Papua New Guinea economy.

Both the quantity and the quality of education and training are currently the subject of considerable debate in Papua New Guinea. On the one hand, the National Government has committed itself to the rapid attainment of universal primary education while, on the other hand, it has launched a Committee of Review into Education Standards.

There can be little doubt that the rapid localisation of primary and secondary teaching positions has led to a deterioration of standards in some areas, notably language and communications skills. This is reflected in learning difficulties experienced by many tertiary students, especially those pursuing studies in scientific and technological disciplines where so many of the academics and teachers are expatriates who are used to teaching students having greater competency in the English language.

It is also worth noting that, unlike their Western counterparts, many Papua New Guineans begin their formal schooling without having had significant contact with the technologies they will encounter at work and in life after they leave school. This lack of exposure to "real life" technology, especially if reinforced by an overly theoretical approach in their school and tertiary studies often leaves Papua New Guinean students ill-equipped to deal with a society undergoing enormous changes in a short span of time, the more so since so many of these changes are the result of either the upgrading of existing technologies or the introduction of totally new technologies.

The 1978 UNESCO mission, in summarising its findings on manpower issues, drew attention to the interconnections between development of scientific and technological manpower, institutional modes of wage setting and the localisation requirements laid down by the National Government. The mission concluded that the formulation of a salary and wages policy was a prerequisite for the effective planning of scientific and technological manpower development programmes. But, to date, little has been done to rectify the many anomalies, particularly in the public sector area, which often lead to administrative and clerical employment being more attractive than scientific and technological employment. However, recent public statements by several Ministers have indicated that these anomalies are now coming under National Government scrutiny.

Although Papua New Guinean women have made significant strides in recent times towards more equal participation in their society, little official encouragement is given for them to enter upon scientific or technological careers. Indeed, women are still very much in the minority in educational institutions and in the modern sector workforce and, while increasing numbers of women occupy senior positions in the public service, they represent only 18% of the total public service employment.

3.3 FINANCIAL RESOURCES

As mentioned previously, most scientific and technological activities in Papua New Guinea are under the control of, and largely funded by, the National Government. This means that most of the country's research and development (R&D) expenditure is subject to the National Public Expenditure Plan process under which all R&D projects costing more than the equivalent of US$22 000 are evaluated according to the procedures illustrated in Annex 1 and with regard to national priorities as elaborated in the National Budget Priorities Schedule (NBPS). The current NBPS includes the following (not necessarily in order of priority):

i. Increasing Rural Welfare: Sectoral programmes of small and medium scale activities aimed directly at providing economic opportunities or improving services to rural people.

ii. Helping Less Developed Areas: Programmes which focus on area development in less developed provinces or in less developed areas within provinces.

iii. Improving General Welfare: Programmes which improve the general level of well-being of Papua New Guineans but not directed exclusively at urban or rural people.

iv. Increasing Economic Production: This category includes all major economic investments, resource development and national infrastructural development.

v. Improving Food Production, Subsistence and Nutrition: Projects aimed at replacement of food imports and supplying urban markets with fresh food as well as projects aimed at improving subsistence production and the general level of nutrition.

vi. Improved Training and Increased Papua New Guinean Participation in the Economy: This category covers all secondary and post-secondary training of Papua New Guineans to increase their skills and involvement in the economy.

vii. Urban Management: Proposals for National Government expenditures in urban areas not elsewhere considered are included in this category.

viii. Effective Administration: This category covers all the necessary additional administrative and technical support expenditures of the National Government.

ix. Environmental Management: This category covers all direct expenditures by the Government on environmental and conservation projects other than those funded as part of major resource development projects.

3.4 SURVEYING OF THE SCIENCE AND TECHNOLOGY POTENTIAL

In Papua New Guinea, the agency most active in the collection and analysis of data on resources available for the national scientific and technological effort is the National Planning Office (NPO). The Manpower Planning Unit of the NPO is especially active in this area as evidenced by the 1980 National Manpower Assessment, and earlier surveys. Also, the NPO, in conjunction with the Bureau of Statistics and the Bank of Papua New Guinea, routinely collects and analyses a wide range of economic and social statistics. Considerable use is made of the NPO's input-output model of the Papua New Guinea economy to forecast future trends and also to assist in formulating the National Government's annual budget.

Both the Bureau of Statistics and the Bank of Papua New Guinea regularly issue statistical bulletins covering a whole range of economic and social indicators.

PART 4.

Policy issues in scientific and technological development

4.1 MAJOR DEVELOPMENTS

Some of the major developments which have occurred in Papua New Guinea over the past ten years and which have had, or are expected to have, a major impact on the conduct of research, on the increase of national scientific and technological capacity, or on the conditions in which science and technology are applied, are as follows:

i. Eight Aims - 1972

ii. National Planning Office - 1974

iii. National Investment and Development Authority - 1974

iv. Office of Environment - 1975

v. Institute of Applied Social and Economic Research - 1975

vi. Independence from Australia - 1975

vii. National Development Strategy - 1976

viii. National Public Expenditure Plan - 1978

ix. UNESCO mission to review science and technology policy issues - 1978

x. Decision to proceed with the Ok-Tedi project - 1980

xi. Decision by Cabinet to establish a science and technology advisory unit within the Ministry of Science, Culture and Tourism - 1981

xii. National Manpower Assessment

A number of agreements relating to scientific and technological cooperation between Papua New Guinea and other countries have been concluded during the past ten years and these, too, are expected to have a significant impact on such activities in the future. These agreements are outlined in Section 4.4 below.

4.2 ACHIEVEMENTS AND PROBLEMS

The pursuit of the National Development Strategy (NDS) and, more particularly, the ongoing National Public Expenditure Plan (NPEP), requires the application of scientific and technological inputs across a wide range of development programme areas, for example, agriculture, forestry, resource exploration and development, housing, health and nutrition, public works including development of transport and communications infrastructure, and development of domestic energy resources. It is a demonstrable fact that present science and technology inputs to many of these areas are inappropriate for, or inadequate to meet, the objectives laid down in the NDS.

That this should be so may be attributed to a number of major problems such as:

insufficient skilled and experienced scientific and technological manpower;

inadequate facilities for research and development (R&D) or R&D facilities pursuing inappropriate or irrelevant projects;

transfers of inappropriate technologies from industrialised countries to Papua New Guinea;

frequent reliance on foreign "experts", rather than fully utilising in-country expertise;

inadequate communication between the "producers" and the "consumers" of science and technology.

One crucial question, to which the National Government has not yet properly addressed itself, is how to provide a mechanism for ensuring that the country's scientific and technological acitvities are being conducted along lines which are consistent with NDS objectives. It is significant to note that the NPEP review process, as presently constituted, does not provide for any independent assessment of the scientific and technological implications of project proposals. This is in marked contrast to, for instance, the financial, manpower and environmental implications, which are assessed independent of the proposing agency.

On the more positive side, Papua New Guinea has achieved much in relation to science and technology (S&T) since independence in 1975. The country's output of S&T manpower is on the increase, S&T subjects are receiving greater emphasis in the schools, and more positions in both government service and private enterprise requiring S&T training and experience are being filled by Papua New Guineans. During this time, the country's capacity to perform indigenous R&D has also increased significantly.

4.3 OBJECTIVES AND PRIORITIES

As mentioned in Section 2.2, in Papua New Guinea, the linkages between development policy on the one hand and science and technology policy on the other hand, are currently very weak. The country does not, as yet, have a well-enunciated or clearly defined science and technology policy; such policy can only be inferred. But it is certain that S&T inputs to the development process will have a large bearing on the success or otherwise of the National Development Strategy, the essence of which was outlined in the 1978-1981 National Public Expenditure Plan in the following terms:

> Eighty five percent of Papua New Guineans live in rural areas. Opportunities for economic development in Papua New Guinea mostly lie in the agricultural sector, and such manufacturing industry as does develop will be based on processing agricultural output or providing inputs to the agricultural sector.
>
> Despite these factors, rates of rural-urban migration are unduly high in relation to the economic opportunities and housing facilities available in the towns. In fact, this migration can be explained, in part, by the availability of superior health and education services in the towns. For these reasons, the main objective of the National Development Strategy is to develop rural areas to ensure that people have the chance to improve their well-being through their own efforts in their own areas.
>
> It must be recognized that self-reliance in rural areas will not come about without massive government support in the form of physical infrastructure, extension and training, credit, marketing assistance, and the provision of such basic services as health, education and communications.

It now remains for the National Government to determine Papua New Guinea's needs in terms of science and technology policy formulation, administration and monitoring, in order to help achieve the objectives of the NDS.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

Papua New Guinea has entered into a number of agreements with other countries which contain provisions for scientific and technological co-operation.

PART 5.

Bibliography

Sources used in compiling this report included the following:

Instructions and Guidelines for New Policy Submission, Evaluation, Funding and Monitoring for the NPEP, Port Moresby, National Planning Office, 1981

National Development Strategy, Port Moresby, National Planning Office, 1976

National Manpower Assessment 1979-1990, Port Moresby, National Planning Office, 1981

National Public Expenditure Plan, 1978-1981, Port Moresby, National Planning Office, 1978

National Public Expenditure Plan, 1981-84, Port Moresby, National Planning Office, 1980

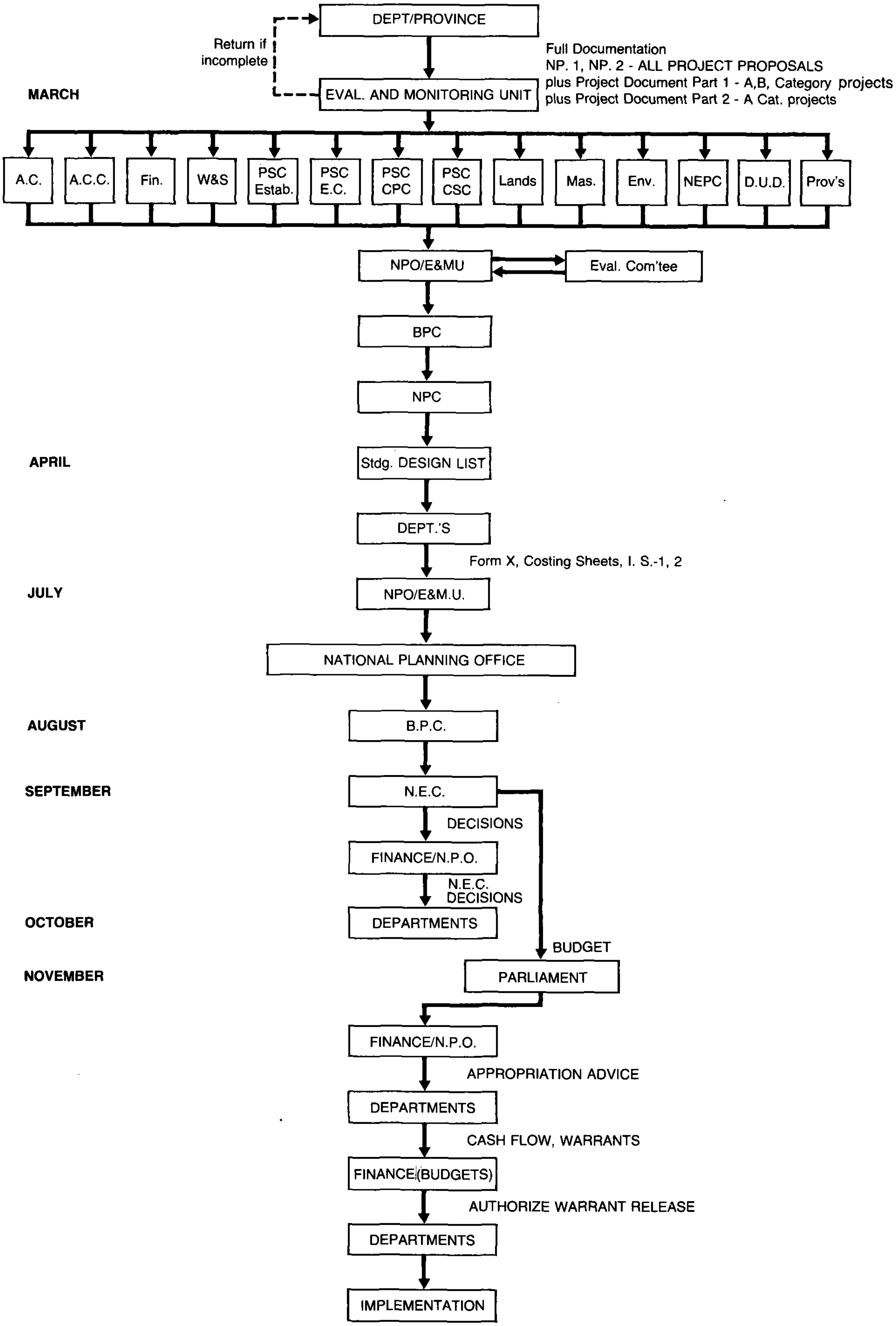
Papua New Guinea Government Official Directory, 1980, Port Moresby, Office of Information, 1980

A review of some Science and Technology Policy Issues in Papua New Guinea by L. Peres, S. Kim and S. S. Durland, Paris, UNESCO, 1978

Summary of Statistics 1974/75, Port Moresby, Bureau of Statistics, 1978.

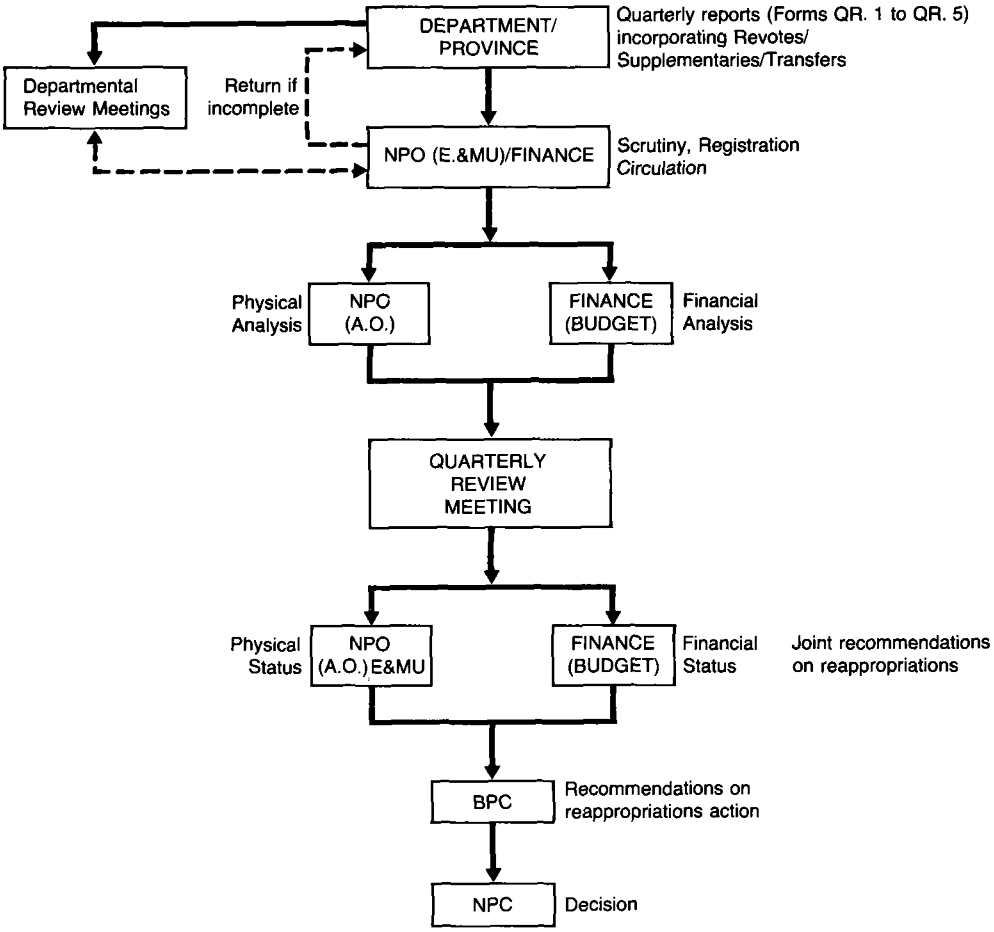
ANNEX 1

Evaluation and Funds Allocation - New Projects



ANNEX 2

Monitoring



PHILIPPINES

Table of Contents

PHILIPPINES

GEOGRAPHY

Capital city: Manila
Main ports: Manila and Bataan, Iloilo, Batangas
Land surface area: 300,000 sq km

POPULATION (1978)

Total	46.4 million
Density (per sq km)	155
Urban/rural ratio (1970)	0.5
Average rate of growth (1970-78)	2.9% p.a.

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	42.5	11.4	9.9	31.8	4.4	100%

SOCIO-ECONOMIC

Labour force (1977)	
Total	*15.0 million
Percentage in agriculture	48.7%
Gross national product (1978)	
GNP at market prices	US $24,410 million
GNP per capita	US $ 530
Real growth rate of GNP per capita (1970-78)	3.7%
Gross domestic product (1977)	
Total (in current producers' values)	US $26,647 million
Percentage by origin	
Agriculture	28%
Manufacturing, mining & quarrying, electricity, gas & water, construction	34%
Government finance	
National budget (1978)	US $4,084 million
As percentage of GNP	17.2%
External assistance (official, net; 1976)	US $380 million
As percentage of GNP	2.1%
Exports (1978)	
Total exports of goods	US $3,425 million
Average annual growth rate (1970-78)	5.4%
External debt (1978)	
Total public, outstanding + disbursed	US $4,188 million
Debt service ratio (% GNP)	2.8
(% Exports of goods and non-factor services)	13.4

Exchange rate (1978): US $1 = 7.38 Pesos

EDUCATION

Primary and secondary education (1978)	
Enrolment, first level	8,178,609
As % of (7-12 years)+	101%
Enrolment, second level	2,820,469
As % of (13-16 years)	63%
Combined enrolment ratio (7-16 years)	88%
Average annual enrolment increase (1970-1978)	3.0%

---

* Not including armed forces and institutional households.

+ The enrolment ratio is the relationship between the number of all pupils enrolled (regardless of their age) and the number of the population of the relevant official ages.

Higher education (third level) (1978)

Teaching staff, total	38,226

Students and graduates by broad fields of study:

	Enrolment	[1]Graduates (1977)
Social sciences and humanities	434,816	42,253
Natural sciences	112,045	10,167
Engineering	353,012	81,708
Medical sciences	95,294	28,534
Agriculture	63,871	7,742
Other and not specified	70,018	4,094
Total	**1,129,056**	**174,498**

Number of students studying abroad	3,046

Education public expenditure (1978)

Total (thousands of Pesos)	3,847,197
As % of GNP	2.2%
Current, as % of total	[2]77.5%
Current expenditure for third level education, as % of total current expenditure	[3]19.9%

---

[1] Data exclude diplomas and certificates of teachers graduating at the third level in non-university institutions.

[2] Not including data for state universities and colleges.

[3] *Including capital expenditure for state universities and colleges.*

Table 1. Nomenclature and Networking of S&T Organizations*

I - First Level - POLICY-MAKING

Country: Philippines

Organ	Function	Linkages	
		Upstream	Downstream
NSDB	Formulation of science policies; co-ordination of S&T activities	Office of the President	FNRI, NIST, FORPRIDECOM, PCARR, PIC, COMVOL, NRCP. SFP, PSHS, NAST
TTB	Formulation of technology transfer policies, co-ordination of governmental activities on technology transfer	Ministry of Trade and Industry	Government agencies with technology transfer activities
PCARR	Co-ordination of research in Agriculture and natural resources	NSDB	Government agencies, academic institutions with research in agriculture
NNC	Co-ordination of research in nutrition	Office of the President	Government agencies undertaking R&D in nutrition

* See Annex 1 *List of Acronyms* for the full name of the organisation abbreviated in Table 1.

II - Second level - PROMOTION & FINANCING

Organ	Function	Linkages	
		Upstream	Downstream
NSDB	Financing of R&D activities	Office of the President	Government and Private agencies
PCARR	Financing of R&D activities in agriculture and natural resources	NSDB	Government and Private agencies with R&D in agriculture and natural resources
NCC	Financing of R&D activities in nutrition	Office of the President	Government and Private agencies with R&D in nutrition
NRCP	Financing of R&D activities in basic sciences	NSDB	Government and Private agencies
CNED	Financing of R&D activities in non-conventional energy sources	Ministry of Energy	Government and Private agencies with R&D in energy
PIC	Promotion and assistance for the financing of inventions	NSDB	Inventors
TRC	Technical, financial, managerial and information assistance of institutions, technology developers, inventors and private firms	MHS R&D institutions	Technology developers, inventors and private firms
Association of Foundations	Financing of R&D	(Private Organization)	Government and Private agencies
POPCOM	Financing of R&D on population control	Office of the President	General Public
BSMI	Promotion and financing of small and medium scale industries	MiTI	Entrepreneurs
SFP	Promotion of science consciousness among the youth and general public	NSDB	General Public
NAST	Identification of outstanding scientists	NSDB	Scientists

III - Third level - PERFORMANCE OF S&T

A. R&D ACTIVITIES

Organ	Function	Linkages
		Upstream
NIST	Research and development of industrial application of indigenous materials	NSDB
FNRI	Development of indigenous food with high calorie high protein count	NSDB
FORPRIDECOM	Research on the utilization of Philippine woods	NSDB
COMVOL	Research on volcanoes and indigenous sources of energy	NSDB
RITM	Research on tropical medicine	MOH
SCC	Research on control and treatment of schistosomiasis	MOH
PAEC	Research on the utilization and effects of nuclear energy	Office of the President
PTRI	Research on textile	MiTI
BMG	Inventory of mineral resources through tectonic and geologic studies	MNR
PIBS	Conducts policy-oriented researches	NEDA
NFA	Research and dissemination of improved post-harvest practices/processing of agricultural products	MA
Colleges and Universities	Research on various areas of S&T	MEC
PSSC	Research on social sciences and humanities and dissemination of information	(private organizations)
AF	Research on various areas of S&T	(private organizations)
PCF	Research on family planning	(private organizations)

B. S&T PROMOTION, EDUCATION AND TRAINING

Organ	Function	Linkages
		Upstream
SFP	Promotion of science consciousness among the youth and general public	NSDB
NAST	Identification and recognition of outstanding scientists	NSDB
PIC	Promotion of inventions	NSDB
PSHS	Preparation of young gifted minds for university *courses in science and math*	NSDB
NMYC	Training of technicians and skilled labour	MOLE
Colleges and Universities	Education and training of scientists and technologists	MEC

III - Third level - PERFORMANCE OF STA

C. TECHNOLOGY DELIVERY AND S&T SUPPORT SERVICES

Organ	Function	Linkages
		Upstream
TRC	Utilization, dissemination and delivery of commercially viable technologies	MHS
	Technical, financial, managerial and information assistance to R&D institutions, technology developers, investors and private firms	
PIC	Assistance to inventors for patenting and commercialization	NSDB
BSMI	Provision of technical information and consulting assistance to small and medium industries	MiTI
MIRDC	Provision of technical services and information for the metal industry	MiTI
BIIP	Provision of statistical information relating to production, sales, expansion plans for various industry sectors	MiTI
BFAR	Dissemination of information pertaining to the utilization of aquatic resources	MNR
BAEx	Dissemination of technologies for rural consumption	MA
DIC	Collection of statistics on mortality and morbidity	MOH
FDA	Monitoring and regulation of quality of foods and drugs on the basis of acceptable of acceptable standards	MOH
BRL	Production of vaccine sera and other biological products, regulation and licensing of clinical laboratories and blood bank	MOH
TRC	Provision of data banks for economic and technological information	MHS
NEPC	Assessment of environmental impact of developmental projects, provision of data banks for economic and technological information	MHS
NPCC	Conducts surveys to determine levels of pollution	MHS
NRMC	Monitoring of the exploitation and development of the country's natural resources and changes in its physical environment	MNR
NCSO	Gathers statistical data on the population	NEDA
FPA	Regulation of the development of fertilizer and pesticide industries, educate agricultural sector on the potential and hazards of fertilizers and pesticides	MA
BAE	Conducts surveys on the economics of agricultural products	MA
BS	Undertakes surveys, characterization and mapping of soils for agricultural production purposes	MA
PAGASA	Conducts astronomical and meteorological observations	MND
BCGS	Undertakes coastal and geodetic surveys and mapping of Philippine territory	MND
NCP	Generation of data on identified nutrition indicators in order to monitor changes in nutritional status	(private organizations)
NFP	Dissemination of nutrition information	(private organizations)

Table 2 - Scientific and Technological Manpower

Country: Philippines

Year	Population (in units)	Scientists and engineers							Technicians	
		Total stock (in units)	of which working in R&D						Total stock (thousands)	of which working in R&D (in units)
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965	31,886,081	81,600	25,600	1,838	11,900	2,187	5,575	4,100		
1970	36,684,981	100,385	31,493	2,261	14,638	2,690	6,858	5,044		
1975	42,070,660	115,482	36,230	2,601	16,840	3,094	7,890	5,802		
1979	47,719,000	128,897	40,433	2,903	18,793	3,453	8,805	6,476		
1985	53,108,000	157,000								
1990	59,846,000	177,026								

Table 3 - R&D expenditures

Country: Philippines
Currency: Peso

Table 3a: Breakdown by source and sector of performance

Year: 1979

Unit: Thousands

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive	820	75,815	876	77,511
Higher Education	84,250	49,347		133,597
General Service	166,914	53,871	14,148	234,933
Total	216,372	143,579	7,830	367,781

Table 3b: Trends

Year	Population (millions)	GNP (in millions)	Total R&D expenditures (in thousands)	Exchange rate US $1 = Peso
1965	31.886	23,382	41,198	3.9
1970	36.685	41,751	65,056	6.4
1975	42.071	114,265	239,233	7.5
1979	47.719	220,935	446,041	7.4
1985	53.108	475,147	985,455	
1990	59.846	979,089	2,046,748	

PART 1.

General Features

1.1 GEOPOLITICAL SETTING

Located in Southeast Asia, 966 kilometres off the Southern coast of Asia, the Republic of the Philippines is an archipelago of some 7 000 islands with a total area of 300 000 square kilometres. The country is geographically divided into three major island groups of Luzon, Visayas and administratively into 12 regions with Metropolitan Manila as the National Capital Region.

The prevailing climate is tropical with two different seasons, a wet or rainy season and a dry season, each of around six months duration.

There are three major urban centres in the nation: Metropolitan Manila (also known as the National Capital Region), Metropolitan Cebu and Metropolitan Davao areas. There is one major international airport at Manila and alternate airports that are also used for international flights at Mactan, Cebu and Zamboanga City. There are also local ports of entry with major port facilities strategically located in the major cities in the country.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

The Philippines has a population of 48.1 million, six million of which are concentrated in the national capital region of Metropolitan Manila. In 1980, the growth rate in population registered at 2.5%.

Though the national language is Filipino, English is widely spoken due to the strong American influence on the educational system.

The 1981 Gross National Product stood at around 310.8 billion pesos at current prices while per capita income amounted to ₱ 6 278.

The country's major exports in terms of value are manufactured products (textiles, electrical equipment, garments, chemical and others) which constitute 40% to 45% of the total value, sugar and coconut oil and other products, minerals (including copper concentrates), and forest products. Its major imports consist mostly of capital goods and crude oil.

1.3 DEVELOPMENT SCENE

Despite its characteristic open economy and the influence of the unfavorable international environment in recent years, the economy continued to make major gains. The specific problems imposed by the external environment are: the large increase in the real price of oil, the political disturbances abroad which heighten global uncertainties, and the widespread deflationary measures adopted in developed countries which tighten international trade and capital markets.

The economy has grown at an annual average rate of 6.5% in the decade ending in 1980, which is comparatively significant compared to 5.2% growth in the previous decade. Notable growth was recorded in exports, domestic energy production, agriculture, infrastructure and industry. Export of nontraditional manufactures grew significantly in the last three years averaging 37% annually. Agricultural output and productivity increased, infrastructure support expanded and industrial growth was sustained, resulting in the expansion of industry's share to overall output from 31.1% in 1972 to 36.5% in 1980. Dependence on imported oil as an energy source, on the other hand, declined from 95% in the early 70's to 83% in 1980.

The accelerated economic development in recent years has also resulted in major social gains. Most significant among these are: the 98% completion of the land transfer program in agrarian reform; the introduction of primary health care; the improved nutrition of preschoolers, pregnant and lactating mothers; the expansion of education and training opportunities at all levels in both formal and unformal system resulting in a literacy rate of 89%; the rise in construction of low cost housing units; the extension of social security coverage to a greater number of workers including the self-employed; and the recognition and attention given to the needs of special groups such as children, women, and the disabled, among others.

The objectives behind the growth in industrial activity in the 1980's are: the accelerated generation of employment opportunities; increased foreign exchange earnings; regional dispersal of industries; self-sufficiency in basic commodities, particularly food; and decreasing the reliance on imported oils as an energy source. Pursuant to these objectives, industrial policy for the 1980's shall consist of:

- a focused and organized export promotion program;
- a rationalization/restructuring of 14 key industrial sectors;
- an accelerated implementation of major industrial projects;
- an accelerated dispersal of industries;
- an increased emphasis in the promotion of small and medium scale industries;
- a continued encouragement of foreign investments in selected areas;
- a closer cooperation and regular dialogue between the government and private sectors in planning; and
- the implementation of industrial policies and programmes.

Industrialization in the 1980's will not be achieved through the protective attitude and stance which the government has taken for the last three decades. The challenges posed by the developments all around the world and the geometric growth in the needs and wants of our people demand long strides in our development. Therefore world competitiveness shall be the common yardstick for determining the viability and economic feasibility of industries and projects.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

A new development plan for 1983-1987 is being prepared at present. The economic objects are: sustained economic growth, equitable distribution of the benefits of development, and total human development. Priority is therefore given to self-sufficiency in basic commodities particularly food, energy, increased export capability, resource and infrastructure development, the creation of employment opportunities and the delivery of social services.

The people's participation in productive and gainful activities will be encouraged through the Kilusang Kabuhayan at Kaunlaran programme (KKK) that stresses efficiency, productivity and labor intensity in investments. This programme aims to mobilize community level resources for productive activities. A diverse set of viable projects ranging from agriculture to industry are envisaged for implementation.

Agricultural yield will be maximized to feed the growing population and to generate the need raw materials for processing into competitive exportable products that earn additional foreign exchange. Industrial productivity will likewise be increased through an investment policy that will promote sectors with comparative advantage, skills training, cost savings techniques and technological improvements. The development of more infrastructure like small-scale irrigation system, mini-hydro projects, farm-to-market roads, bridges school buildings, telecommunication system and other similar projects will be pursued to improve distribution of economic opportunities, to enhance accessibility to rural areas, and to promote marketability of products.

A comprehensive and multisectoral approach to human development will still be pursued. Policies and strategies aimed at fostering self-reliance, strengthening and integrating delivery mechanisms, increasing access to social services, and enhancing community participation will be formulated and implemented. Improving the quality of, and the access to, basic education as well as upgrading educational facilities in engineering and the sciences will be stressed. The primary health care concept will be expanded while nutrition programmes will continue to focus on children and mothers. Availability of low cost financing for housing will be improved and increased. Special programmes will also be intensified for disadvantaged individuals, groups and communities.

Institutional bottlenecks that dampen the private sector's initiative will be eased to invite more active participation in activities conducive to the country's development.

In order to implement the development plan effectively, annual planning, budgeting and programming procedures will be streamlined, coordinated, and placed closely with project implementation schedules. Local governments will be given more involvement by allowing local conceptualization, selection and implementation of programmes and projects. A more responsive and timely statistical system will be developed to enable the government to access and to monitor the progress of implementation of programmes and projects, and to evaluate their impact. Domestic financial resources must be generated to support these programmes and to reduce the country's dependence on external borrowings.

2.2 DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

The National Economic and Development Authority is the Agency responsible for formulating a fully integrated social and economic plan and programmes while the National Science Development Board is the agency in charge of policy formulation, integration, coordination and intensification of science and technology research and development. Both agencies are of ministerial level, the former a line ministry and the latter a support ministry.

The Philippine development policy, which recognized the importance of science and technology in national development, is enunciated in the Constitution of the Republic of the Philippines, Article XV, Sec. 9 (1), as follows: "The State shall promote scientific research and invention. The advancement of science and technology shall have priority in the national development".

To conform with the complementary roles that both policies play in the attainment of development goals, the S&T policy is prepared in consultation with the National Economic and Development Authority and the science community. By the same token, the S&T policy is considered in the development of the overall economic development policy and plan. Thus, development planning and scientific and technological activities work together to enrich the Philippine Development Plan and the National Science and Technology Plan/Programmes in the attainment of national development goals.

Taking into account that every sectoral objective in National Development Plan requires scientific and technological support, the premier science body has adopted policy guidelines that will link S&T with National Development Planning (see Part 4.3 for details).

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

The central coordinating function for national scientific activities in the Philippines is discharged by the National Science Development Board which was created in 1958 by virtue of Republic Act 2067. As the country's primary science body, the NSDB, in coordination with government and private sectors, formulates the national research and development plan. Although the planning exercise is done every five years to coincide with the national economic planning cycle, the plan is reviewed annually to make it more responsive to socio-economic change in the country. The NSDB is also responsible for developing and managing human, physical and financial resources for R&D, for coordinating S&T activities, and for disseminating R&D results in coordination with various public and private agencies.

The policy-making body of the NSDB is a nine-man Board of Governors, consisting of the Chairman and Vice-Chairman of NSDB, the Minister of Education and Culture, the Director-General of the National Economic and Development Authority, the President of the University of the Philippines, the Minister of Trade and Industry, the Minister of Energy and two representatives from the private sector. The NSDB Chairman also sits either as Chairman or member of related Councils, e. g. PCARR, NNC, and TTB.

The national R&D plans and programmes are implemented by research institutes such as the organic agencies of the NSDB, other research centres and ministries with R&D groups; and the academic institutions with R&D capabilities. Three types of funding sources are available for research, namely government subsidy, external loans or grants, and private sources.

Government appropriations constitute one of the main sources of R&D funds. In an annual planning and budget cycle, all government ministries prepare their respective plans and programmes with their corresponding financial requirements. These are submitted to the Ministry of Budget (MOB) for review as regards resource availability. The various plans are consolidated and submitted to the Batasang Pambansa (Parliament) for legislative action and final approval.

External loans or grants, negotiated by respective ministries, serve as an additional source of funds for S&T. These are also augmented by private sources coming from science foundations.

Technology utilization, dissemination and delivery are undertaken by notable government agencies and cooperating private establishments, while science promotion, manpower development and training activities are responsibilities shared by numerous higher educational institutions and government agencies. Private establishments and non-profit organizations play an active role in providing the necessary S&T support services.

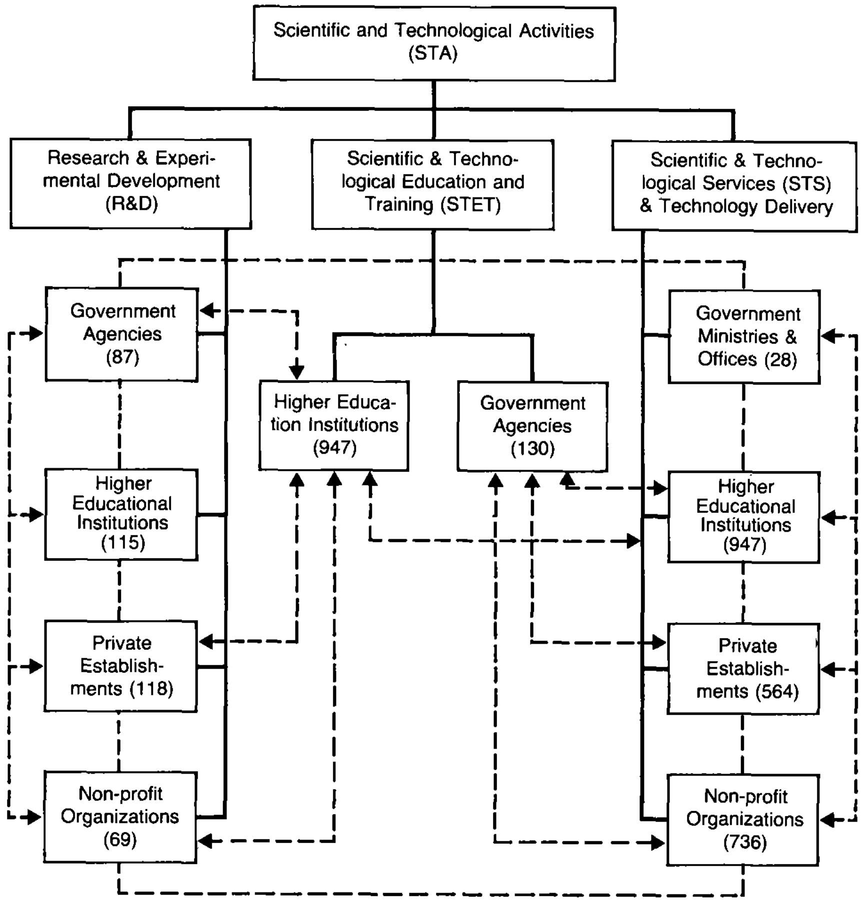
Table 1 briefly enumerates and describes government and private agencies undertaking policy making; financing of S&T activities; R&D; technology delivery; S&T promotion, education and training; and S&T support services.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

The chart below, indicates the different institutions in various sectors, which perform scientific and technological activities (STA).



Notes:
1. The numbers in parenthesis refer to the number of institutions performing STA.
2. The solid lines refer to the categories and sectors of STA, while the broken lines represent the linkages among the sectors.

This chart indicates that a government agency, while performing research and experimental development (R&D) activities, may also undertake training and/or scientific and technological services (STS). A university or college, aside from being engaged in its primary function of academic affairs such as education and training and STS (services provided by the libraries), is sometimes performing R&D activities.

The inter-relationships can briefly be described as follows:

i. R&D and STS depend on manpower produced by public and private educational institutions (STET) which are the responsibility of the government.

ii. The sectors performing R&D may be linked by means of funding resources such as NSBD's linkages with universities, foundations and other government agencies through its grants-in-aid programme, or non-profit foundations granting funds for R&D to other public and private institutions.

iii. As to STS, the services provided by private establishments such as to oil exploration are availed of by the government; libraries, documentation centres, and data banks of universities and colleges are similarly availed of by both public and private institutions.

iv. In the delivery of commercially viable technologies, assistances in the form of technical, financial, managerial and information services are provided by government agencies in various combinations to technology generating government agencies, to private individuals who have developed technologies, and to interested private firms who wish to commercialize the technologies.

Research and Experimental Development (R&D)

i. Government Sector

The R&D performing agencies of the government sector come from the 24 different ministries, constitutional bodies and public enterprises/or corporations (see Annex 2).

In the field of agriculture and natural resources, research and experimental development activities are conducted by a National Network of Research Centres and Stations composed of universities, colleges and government agencies located in the different parts of the country. This network, developed by the Philippine Council for Agriculture and Resources Research (PCARR), is composed of the following :

multi-commodity national research centres (4)
single commodity national research centres (7)
regional research centres (8)
cooperating research stations (130)

Introduced in 1978, the 'consortium concept' has produced ten (10) centres which are now operational. This 'consortium' arrangement maximizes the utilization of pooled resources in the area/region.

In other fields, research performing agencies are also distributed throughout the country through the regional offices. Briefly, 12 agencies were engaged in natural science research, 33 in social sciences, and 14 in medical research in 1980.

ii. Higher Educational Institutions

Among the institutions of higher education, 155 were identified as engaged in research in agriculture, natural sciences, medical sciences, engineering and social sciences for the period 1971 to 1977. The University of the Philippines System is the leading research institution of the academic community in terms of volume of research funds, number of research projects and number of masters and doctoral degree holders in its faculty and research staff.

The other universities and colleges engaged in R&D are listed in Annex 3.

iii. Non-profit Foundations[Organizations

In the Philippine context, foundations include educational institutions, religious groups, social welfare agencies, fund-raising organizations, alumni organizations administered by their parent institutions and other assorted associations. These organizations are required to register with the Securities and Exchange Commisssion (SEC). Foundations engaged in S&T activities are registered with the National Science Development Board which is mandated to undertake the official certification of the STA involvement of these foundations. Donations to these foundations are 100% tax exempt, provided that 60% of their funds are appropriated for research purposes.

Apart from those registered with the SEC and the NSDB, there are other foundations established through special legislation which also enjoy the same privileges as the NSDB-certified foundations. Among these foundations are the International Rice Research Institute (IRRI), the Ramon Magsaysay Award Foundation, the Philippine Rural Reconstruction Movement (PRRM), the Science Foundation of the Philippines (SFP), and others.

In 1979, there were 69 foundations engaged in R&D as identified in Annex 4. The top five R&D performers, as gauged by the volume of their expenditures, are: Population Centre Foundation, Inc.; Philippine Business for Social Progress, Inc. : Filipino Foundation, Inc.; U.P. Engineering Research and Development Foundation, Inc ; and Southeast Asian Science Foundation, Inc.

iv. Private Industry

An on-going statistical survey on R&D expenditure and manpower in the private industry has identified 118 out of the 520 establishments so far covered as having been engaged in R&D for the years 1979 and 1980. The R&D activities in such establishments covered textile research, paper and paper products, chemical and chemical products, petroleum, coal, rubber and plastic products, food, beverages and tobacco products, and others. Annex 5 contains a list of the private industries or companies engaged in R&D in the country.

Scientific and Technological Education and Training (STET)

In 1979, there were 947 higher education, tertiary level institutions offering all fields of science including social sciences and humanities. Of these, 614 were private, while 333 were government institutions.

In the field of basic sciences, 59 offer Bachelor of Science, 16 offer Master of Science, and 4 offer Ph.D. degrees. For the agricultural sciences and natural resources, 64 offer BS, 21 Masters (MS), and 2 Ph.D. degrees. In medical sciences, out of 74 institutions, 61 offer BS, 9 Masters, and 4 Ph.D. degrees. In the field of science education, out of 84 institutions 46 offer BS, 18 Master of Arts in Teaching (MAT), and Master of Science in Teaching (MST), and 1 offers Ph.D. degrees. In the engineering sciences, 88 out of 95 institutions offer BS, while 7 offer Masters of Science (MS) degrees. Twenty-six (26) institutions offer other applied science courses and, of these, 21 offer Bachelor of Science, 4 Master of Science, and 1 offers Ph.D. degrees.

In 1978, the NSDB implemented the institutions Building Programm (IBP) aimed to strengthen and develop institutional capabilities of schools in the different regions of the country, thereby ensuring the supply of a greater number of better trained graduates in the basic/breeder science as well as in the applied sciences. Out of the identified 36 schools, 11 centres, called consortia, were established throughout the country with at least 3 institutions per consortium. They constitute the IBP network which is expected not only to coordinate and integrate R&D in science and technology, but also to strengthen science education in the country. On these 36 institutions, 11 had been identified by NSDB as Regional Science Teaching Centers (RSTCs) and have functioned as such, starting with 5 institutions in 1971, with an addition of 4 in 1973 and 2 in 1980.

Aside from the pre-service and in-service education programme activities for science and math teachers, these institutions serve as resource centres for science curricula and resource material development within their services areas. In this aspect, they are supported by the U.P. Science Education Center.

As strategy to improve the institutions capabilites of these schools, in the sciences under the programme, the following mechanisms are implemented through financial assistance from the NSDB:

faculty development – scholarships for degree and non-degree programmes (pre-service and in-service training programme);
equipment upgrading;
library holdings improvement;
science curriculum development – which includes scholarships established at the institutions for development of undergraduate degree programmes in the breeder sciences.

Recent developments in some regional consortia of institutions point to various agreements that have been made to share existing resources of schools with other member institutions to maximize the development efforts in science education. For example: for faculty, through visiting professorships or partime teaching; for equipment, where advanced laboratory facilities of school are made available to other member schools consortium ; for libraries, with exchange of publications, use of the school libraries, by other member schools; with curriculum, by enabling cross-registration of students in the science programmes of member schools.

Several institutions undertaking some of the scientific and technological services have been discussed in Part 2.3. It is important to mention in this part the number of institutions in the other sectors likewise engaged in STS.

In the higher education sector, there are 947 universities and colleges or schools which are undertaking STS aside from R&D and STET. There are 736 non-profit organizations and foundations, and 284 private industries that have been reported as engaged on one or more of the 10 categories of STS in an on-going statistical survey on R&D.

3.2 HUMAN RESOURCES

The future supply of S&T manpower is calculated in terms of those coming out of schools and universities with specialized education in the sciences.

Adopting the 1965 baseline figure of 81 600 employed scientists obtained by the NSDB Survey of Scientific and Technological Manpower in the Philippine*, the annual graduates of the higher education institutions that are science, science-based and technological in nature were cumulated for every five-year period starting from 1966 and added to the base. Some adjustements were made to correct this base for the death, retirement, and migration rates.

On this calculation, the proportion of scientists and engineers in relation to the population increased from .265% in 60s to .27% in the 70s.

It was noted that the higher education graduate output from the 60s to the 70s increased markedly in both absolute terms and incremental value in the medical and natural sciences, whereas a decrease in the incremental value was seen in the engineering, agricultural and social sciences. For the 80s, an increase but at a decreasing rate, was likewise projected in all fields except agricultural science.

Considering the lack of current date on the proportion of scientists and engineers in R&D, the rate obtained in the 1965 NSDB survey was adopted and applied to the stock. Similarly their distribution among the science fields in 1965 (i. e., 21.9% in the physical sciences, 46.5% in engineering, 15.6% in life sciences and 16.0% in the social sciences) was adopted. The trend shows that scientists and engineers in R&D would increase but at a decreasing rate. This may be partly explained by the constant rate applied.

Scientific Manpower in Government R&D

According to the 1979 NSDB Survey of Research and Experimental Development Expenditures and Manpower in the Government Agencies for Fiscal Years 1971 to 1976, a large part of the increase in the total number of scientists engaged in R&D was seen in agriculture and natural sciences. Next were those who pursued research in the social sciences and humanities. The smallest R&D performing group were those engaged in medical sciences.

Assuming that the same trend in government demand is seen in the 80s, some quantitative conclusions and directions can be derived.

In agricultural sciences, while total scientific manpower supply indicates an increase, government R&D programmes will tend to absorb more than one-half of the increase. The supply available to the private and other sectors will therefore increase at a decreasing rate.

An increase in the supply of engineers is likewise indicated. However, contrary to agricultural scientists, only 1% will be required in government R&D and the remaining 99% would be available to the private and other sectors.

The projected increase of natural scientists will be increasingly absorbed by government manpower requirements, nevertheless, in 1984, more than one half (53%) of the projected increase in supply will be available to the private and other sectors. Assuming that this trend continues beyond 1984, the behavior of this manpower supply will be similar to agricultural scientists.

The increase in scientific manpower in the social sciences and humanities tends to be absorbed solely by the private sectors. The increase in manpower development requirement in government R&D in these fields remains minimal.

The long-term trend for the number of graduates in medical sciences is for all practical purposes, constant. However, government demand for R&D projects increases steadily . The implication is that less and less will be made available to the private sector. This, in itself, indicates a growing scarcity of medical scientists.

The participation rate of women in government R&D is rather high (54.9%) compared to male scientists (45.1%) ; 48.1% of them are in the social sciences, 19.6% in the natural sciences, 17.3% in the agricultural sciences, 10.5% in the medical sciences and 4.6% in the engineering sciences.

Brain Drain

On the phenomenon of brain drain, a survey was conducted in 1969 entitled *Philippine Brain Drain Survey* (1948-1963). The results of this survey revealed that about 7% (or 73 out of 1 038 respondents) of Filipinos who graduated from Philippine Colleges take up permanent residence abroad. For those graduates who did not undertake further studies and those who pursued post-graduate studies locally the emigration ratio was 4-5% (36 emigrants out of a total of 913). A maximum of 40% (32 out of 81) of those who pursued further studies abroad eventually emigrated. Students who enjoyed fellowship support or other scholarship privileges during their studies abroad were about two and a half times more likely to return and stay in the Philippines than those who paid their own way. Among those who pursued further studies abroad, women tended to dominate, while the men prevailed among those who went abroad for non-educational reasons.

In terms of college courses taken, graduates in liberal arts and commerce were more likely to emigrate than those who studied education and law. Graduates from high quality educational institutions in Metro Manila and a greater tendency to emigrate than those who came from lower quality institutions.

With the phenomenon of highly scientific manpower moving out of the country, twin moves in terms of government policy were made. A presidential decree (PD 1502) was issued, among others, to provide for a system of incentives and administrative reform to promote efficiency and productivity of scientific and technological research. In addition, another Presidential Decree (PD 819) was issued to encourage overseas Filipino scientists and technicians to come home and apply their knowledge to the development programmes of the country. Of the 208 awardees since 1975, 89 returned for an invitational period of two weeks, and 119 returned with a contract to serve in either the government or private sector. The awardees are distributed by fields of specialization as follows: engineering sciences: 16; social sciences: 16; physical sciences: 9; mathematical sciences: 6; biological sciences: 12; agricultural sciences: 48, and medical sciences: 12. Distribution by sector of employment is as follows: 66% in educational institutions (public and private), 27% in government and 18% in the private sector.

3.3 FINANCIAL RESOURCES

As mentioned in Part 2.3, funds for research and experimental development (R&D) activities are determined from the budgetary proposals submitted by the different central and regional offices of the national government to the Ministry of the Budget. The proposals which are presented in the form of programmes, projects, activity descriptions (P/P/A) and listing

---

**UNESCO, National Science Policy & Organization of Research in the Philippines,* UNESCO, PARIS, Table 20, p.69

of Key Budgetary Inclusions (KBI) are subjected to technical budget hearings during prescribed months of the preceding year.

Agencies concerned are summoned to justify their respective budgets. As for the regional offices, the Regional Development Councils are consulted to determine the thrusts in each region of the country. The proposed budget is then submitted to the Batasang Pambansa (Parliament) for deliberation and consideration prior to approval by the President.

Aside from the regular appropriations for research projects by the Ministry of the Budget, private sources especially from the NSDB-certified foundations and other non-profit organizations, are available for funding research projects. In addition, external loans or grants from UN organizations and other foreign bodies are negotiated by the government through the NSDB. PCARR, for example, has generated about 200 million for the period 1976-1984 from USAID, UNDP, IBRD, IDRC, and others. These funds are subsequently used for the conduct of research in different sectors.

Financial funding priorities are generally determined by whether projects are supportive of the Philippine Development Plan.

In the case of the NSDB, there are two mechanisms for financing research projects: the integrated programme approach typefied by the NSDB-UP Integrated Programme A&B; and the grants-in-aid to individual researchers from institutions of the government, universties and colleges, foundations and other non-profit organizations. To ensure that research project conform to the priorities of the national R&D programmes, a special provision in the General Appropriations Act states that "Research funds appropriated for the various agencies forming part of the National Science Development Board shall be released upon approval of the Board of Governors".

A similar provision applies to all agriculture research projects, stating that all research programmes and projects shall be directed to the PCARR to determine whether these are based on identified priority research areas.

With regard to R&D expenditure, the Philippines spent a total of about ₱ 466 million in 1979 as shown in Table 3. a. Of this total, 56.5% or 252 million came from government sources and 40.1% from other sources. Only 3.4% or 15.0 million were from foreign sources.

By sectors of performance, the general service sector spent 52.7% or ₱ 235 million of the total R&D funds, and 30% was expended by the higher education sector with the remainder accounted for by the productive sector. Table 3. b. shows that the total amount of ₱ 446 million spent on R&D represented 0.20% of the GNP in 1979. It will also be noted that there was an upward trend in the values for population, GNP, and total R&D expenditure.

The S&T Development Plan for 1983-1987 envisages a major increase in the availability of resources from public and private sources.

From an aggregate level of about 0.45% of GDP in 1982, resources available to S&T will be generated from public and private sources to increase the level to about 1% of GDP in 1983, and then to a steady-state level of about 3% of GDP in 1987 as shown in Table a.

In terms of real R&D work, the aggregate level of resources available will increase from a level of about 0.16% of GDP in 1982 to 0.65% in 1983 and then to a steady-state level of about 2% of GDP in 1987.

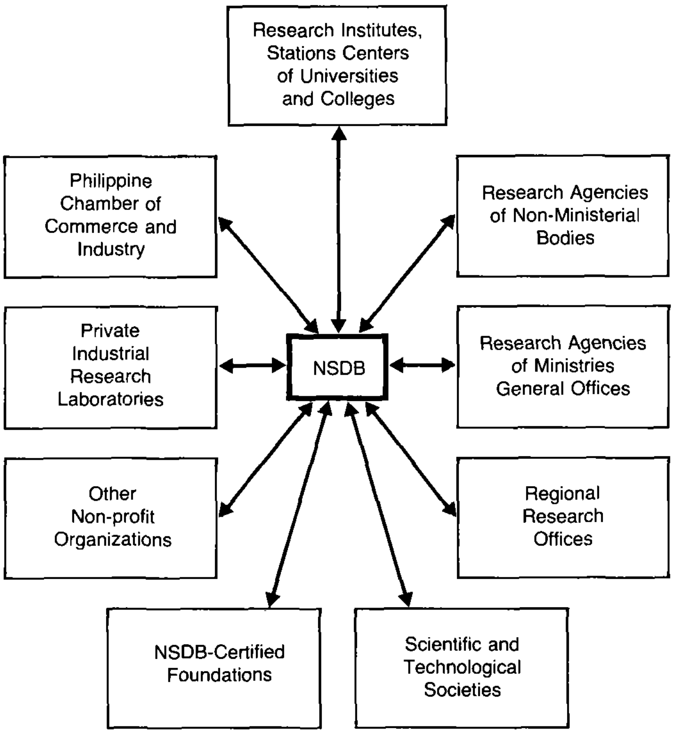
	GDP (Million Pesos)	S&T Expenditure		R&D Expenditure		
		% GDP	Billion Pesos	% of S&T	% of GDP	Billion Pesos
1982	357.5	0.45	1.589	35	0.16	0.254
1983	416.5	1.0	4.16	65	0.65	2.71
1984		2.0		65	1.3	
1985		3.0		70	2.0	
1986	673.5	3.0		70	2.0	
1987	784.6	3.0	23.5	70	2.0	16.4
1988 ff.		3.0			2.0	

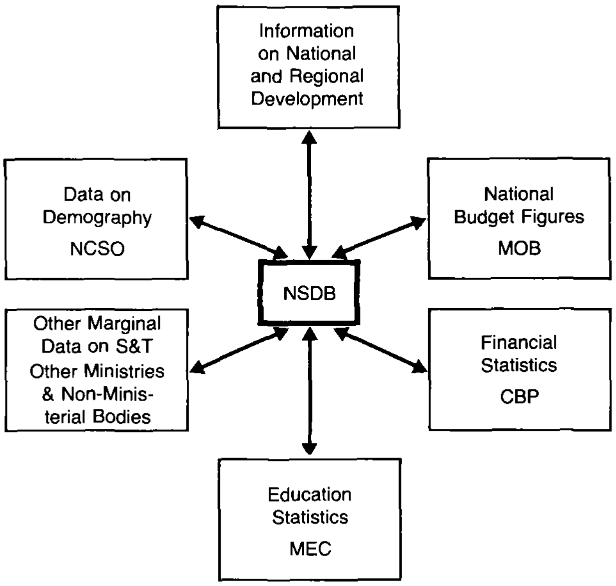
3.4 SURVEYING OF THE S&T POTENTIAL

Intrinsic Data on Science and Technology

The collection of science statistics in the Philippines is being done by the NSDB in coordination with the Statistical Coordination Office (SCO) of NEDA which is responsible for coordinating all statistical activities of the government and its various agencies and instrumentalities.

In response to the statistical questionnaires sent out periodically by the NSDB R&D surveys, the different institutions submit to NSDB the intrinsic data on S&T as shown in the chart:





Notes:

NSDB:	National Science Development Board
NEDA:	National Economic and Development Authority
MOB:	Ministry of the Budget
CBP:	Central Bank of the Philippnes
MEC:	Ministry of Education and Culture
NCSO:	National Census and Statistics Office

Marginal Data

Data on total population, total national budget, education, gross national product and other data essential for analyzing science and technology development such as the percentage of GNP spent for R&D, are produced by various government agencies in accordance with the Philippine Statistical Development Programme. Thus, as indicated in the chart, education statistics are produced by Ministry of Education and Culture (MEC), population census data by the National Census and Statistics Office (NCSO), information on national and regional development plans by the National Economic and Development Authority (NEDA), while national budget figures including appropriations for R&D, other scientific and technological activities, and other financial statistics are produced by the Ministry of the Budget (MOB) and Central Bank (CB) respectively. These data are submitted to NSDB upon request.

The NSDB R&D statistical surveys are conducted using a combination of several approaches to elicit a good response, i. e. , recruitment of field interviewers or researchers; involvement of regional field officials for respondent agencies located in the different regions of the country; and mail or messenger services.

Processing of the survey results is done manually. The processed data is returned to the respondent agencies for validation after which it is presented in the form of reports and distributed to the diverse users.

Generally, the R&D statistical surveys provide important information on the analysis of S&T growth in the country. The data also serve as a basis for science policy formulation and important inputs in the preparation of the national R&D programmes in the different sectors, namely: energy, industry and engineering, agriculture and natural resources, infrastructure and public utilities and social services.

PART 4.

Policy issues in scientific and technological development

4.1 MAJOR DEVELOPMENTS

Scientific and technological infrastructure continues to face the challenge of providing appropriate research and technology to minimize, if not solve, the problems encountered in the various sectors to attain national objectives.

In the energy sector, the country is confronted with the problem of high oil imports which accounted for at least one-tenth of the export revenues in 1973. In 1980, due to the escalation in prices, the oil import bill increased to about one-third of the foreign exchange proceeds. With this situation, the country is forced to find alternative sources of energy to maintain industrial and other economic activities.

Industry is beset by a number of problems, identified as follows: a lack of economically and domestically applicable production processes and equipment particularly for cottage, small and medium scale industries and undercapacity utilization in some industries; the poor quality of some industrial products resulting in their uncompetitiveness in the world market; and an overconcentration of industries in the Metro Manila area.

With the rapid growth of population, the infrastructure and public utilities sector development activities are to be developed further through improved and economical construction techniques. Inadequate financing and a wide geographical area to cover pose some difficulties.

While rice production is sufficient to meet the country's primary needs, a burgeoning population calls for an accelerated and sustained search for improved and appropriate technology to optimize farm productivity and resource utilization. The export and import substitution thrusts involving agricultural commodities require intensive technological inputs; likewise, the harnessing of agro-energy sources such as roots crops, animal waste and tree crops has become a priority concern. Meanwhile, measures have to be developed to cope effectively with critical ecological problems such as soil erosion, forest denudation and water pollution.

Communicable diseases, that are inherent in younger populations in poor areas, exist in the Philippines. While the incidence of death from these diseases has considerably dropped through the years, infections diseases still continue to be the country's major health problem. Diseases of the heart, vascular system and malignant neoplasm, collectively called degenerative diseases, have steadily increased and now rank 2nd, 5th and 6th, causes of mortality, respectively.

Despite a significant improvement in overall nutritional status among pre-school children, many Filipino children remain underweight. Nutrient deficiency, particularly that of iron, vitamin A and iodine, still affects a majority of children and pregnant and lactating mothers.

The national research and development efforts in science and technology will be incomplete without the necessary scientific and technological manpower to implement and maintain such efforts. It is important then that the educational system produce a sufficient number of quality scientists and technologists to ensure an adequate supply in the country. This includes the development of a conducive environment to heighten incentives and improve the quality, depth and coverage of research.

Integral, to the S&T policies, is the accelerated effort to develop local basic and applied research capabilities through an expanded scholarship programme in the baccalaureate, master and doctoral levels in science and technology. This is copuled with an institution building programme to ensure that the colleges and universities of high education produce top quality researchers and scientists.

Major Objectives & Policies for 1983-1987

i. Objectives

Broadly stated, the ultimate aim of science and technology development is to promote the welfare of man. Within this broad context, the S&T plan seeks to contribute substantially to the country's aspirations to increase national productivity and world competitiveness, as well as to improve the quality of life of the Filipino people.

The specific objectives of the 5-year S&T plan are the development of:

(a) an effective and efficient utilization of available technologies to enhance national development;
(b) sufficient S&T potential (manpower and facilities);
(c) an effective and efficient use of S&T potential; and
(d) functional structures and linkages in the science community.

ii. Basic Statements of Policy

As a general statement of policy, science and technological development programme shall be integrated into the overall national development effort. The essence of a mission-oriented research and development is that its conduct must always envisage man and society as the ultimate users and beneficiaries of research outputs.

The basic considerations are as follows:

(a) For science and industry interface – an adequate and responsive technology support system for private and public industries will be strengthened; mission-oriented research will be emphasized in industry, energy, agriculture, natural resources and health; the active substantial involvement of the private sector in R&D will be encouraged.

(b) For development and utilization of S&T potential – resources for S&T, particularly for R&D, will be substantially increased; manpower development programmes for S&T will be expanded and accelerated; a more conducive environment for scientists and technologists will be provided; scientific and technological institutions in the regions will be strengthened to provide an appropriate technological base for the industrial dispersal and countryside development efforts of the government.

(c) For implementational structure – the science community will be encouraged to evolve as a largely self-regulatory but centrally-coordinated and monitored network of R&D organizations; such a structure will seek to provide an atmosphere conducive to creativity by minimizing administrative and non-technical impediments to scientific productivity.

4.2 ACHIEVEMENTS AND PROBLEMS

Local S&T efforts and activities have contributed substantially to the development of the country in terms of developing new and indigenous sources of energy; developing new processes for the utilization of indigenous raw materials, including agricultural and industrial waste products into dollar-saving consumer goods and dollar-earning commodities; diversifying and upgrading our export products to help in the improvement of the country's balance of payments; improving the health and nutritional status of the population ; improving new varieties of crops and production techniques in agriculture; and providing a technological and scientific manpower base.

Accomplishments

Following is a summarization of significant major accomplishments by sector.

i. Energy Sector

The energy crisis in 1973 spurred the search for new and renewable sources of energy, notably, hydro and geothermal energy.

Geothermal investigation of Tiwi, Albay in 1967 succeeded in harnessing underground volcanic heat, not only for the generation of electricity but also for the production of good quality salt. It led to the establishment of a large-scale geothermal plant of 55 MW in 1967 followed by another four 55 MW plants in the Luzon Grid (Makiling-Banahaw fields) and two 3 MW plants in Tongonan, Leyte and Palimpinon, Negros Oriental. With 25 potential areas for geothermal development, the Philippines by the end of 1980, ranked second place in international geothermal energy capability.

In addition, the Philippines has a large amount of hydroelectric resources, most of which are located in Luzon and Mindanao with an estimated 7 000 MW capacity. By 1980, 10% of these resources have been developed.

Efforts are also being focused at developing non-conventional energy sources from agricultural wastes and industrial by-products. Biomass has been successfully utilized to meet the energy requirements of a large-scale industrial farm as well as small scale domestic utilization in the rural areas. The potential of other energy sources such as low pressure gas, dendrothermal or wood-fired energy, and solar energy, are likewise being further explored.

ii. Agricultural and Natural Resources

The thrust of R&D in the sector has been on attaining self-sufficiency in food and industrial raw materials, intensification of land use, and optimal development and conservation of natural resources.

Research played a decisive role in the establishment of a local cotton industry. The creation of a Philippine Cotton Corporation was a boon to textile mills faced with rising import costs.

Significant progress and breakthroughs in some cases have been achieved in the development of higher yielding, more disease and pest-resident, and economically profitable varieties of rice, corn, mungbean, cassava, sweet potato, white potato, wheat, cowpea, lima bean and soybeans. The recently launched corn production programme includes, as a major component, varieties which have been improved through research. The development of embryo culture technique for macapuno coconut and chemical induction of mango flowering are major breakthroughs which boosted the export potential of these special crops.

Research in forestry has been supportive of the following programmes thrusts: forestation, timber management, watershed management and kaingin management, forest patrol and law enforcement.

To support the objective of assessing the country's forest resources for their maximum use and programmed exploitation, researches on identification of plant species, growth performance of selected plants, seed count, reconnaisance surveys, population censuses, floral and faunal surveys, determination of sampling design for source inventory and the like have been conducted. Research which takes into consideration the social and economic factors is also effected.

Research in the mine sector deals with identification of new mining operations effects on the environment. Other sudies relate to investigations of mine accidents, mine tailings, disposal system, ventilation, dust surveys and gas testings in mines. Research on pollution, and other effects of mining activities on environmental conservation and pollution control, have also been conducted.

The direction of fisheries research thrust and support is towards cushioning the effects of high level prices for the benefit of subsistence fishermen, providing the necessary technology and inputs for the attainment of an ideal fish production output, and identification and implementation of various alternative sources of income whether directly or indirectly related to fishing activities.

Substantial strides made in fish production research increased the likehood of reaching self-sufficiency levels for this important protein source. Major development were in rice-fish culture technology, bangus and prawn breeding, and improved fish culture technologies. Among newly-developed technologies applied nationwide rice-fish culture has become popular as it yielded increased farm income (₱ 680 per hectare each cropping season in 1978). Freshwater culture technologies raised the production capacity from 2 tons per ha. in 1975 to an easily attainable rate of 4 tons per ha. in 1980.

iii. Industrial Sector

R&D activities in this sector have been directed towards the exploration of the physical and chemical properties of locally available raw materials for industrial use; establishment of quality control/standardization measures; development of new techniques in the processing of raw materials; adoption of know manufacturing methods to local materials and conditions; and the recovery of waste and by-products from industries and utilization of such materials in the development of new products.

In food processing, techniques for processing and preservation by canning, bottling, smoking, drying, salting and fermentation, which are adaptable to local conditions for fruits and vegetables, meat, fish and marine products, have been developed.

For the chemical industry, a process for big-scale production of ethyl alcohol from cassava tubers, using commercial anylolytic enzymes as saccharifying agents was developed. Other chemicals which have been processed from local sources include cocodiethanol amide and monoethanol amide from coconut oil, both components of the cosmetics and pharmaceutical industry; biodegradable detergents from coconut; magnesium sulfate, sodium and potassium chloride and bromine from sea water; chemicals recycled from aluminium dross and chrome fines; and essential oils for perfume from aromatic plants.

In the field of textiles, a technology adaptable to Philippine conditions was developed for silkworm rearing, mulberry proparagation, cocoon drying and reeling into raw silk ready for weaving. The silk material, which is comparable to imported ones, is used in fabrics for "barong tagalog" (Filipino shirt). Four private enterprises are now engaged in silkworm rearing on a commercial scale.

The development of a simple and economical technology that produces roofing tiles, floor tiles and potteries from clay led to the commercial production of ceramic products and the establishment of factories in the countryside.

With the assistance given to inventors, several inventions have been manufactured and utilized for industrial and agricultural pursuits. These include portable commercial size machines for pulp and paper manufacture, combination dryer and rice mills, kilns for making charcoal, tractor jeeps, multi-purpose grain dryers and wind powered irrigation pumps.

iv. Social Services Sector

R&D activities in the social services sector were directed towards finding solutions to the major health and nutrition problems, including the prevalence of communicable diseases, the increasing incidence of degenerative diseases, malnutrition, and a rapidly growing population.

An integrated medicinal plants programme is being implemented in response to the need to provide cheap drugs and medicinal preparations from indigenous plants for use in the rural areas. Projects undertaken under this programme covered agricultural, dosage formulation, toxicological/clinical/pharmacological studies, and pilot plant formulation aspects, as well as training in, and dissemination of, plant uses. A "Philippine National Formulatry", containing the medicinal preparation and uses of 85 plants was developed and distributed to around 42 000 barangays all over the country.

The possibility of utilizing coconut water for replacement therapy has been explored. Extensive studies indicated that coconut water from unhusked nine-month old fruit can be safely injected into the veins as a substitute for commercial intravenous fluid. An oral treatment to protect diarrheal patients against dehydration was developed by modifying the electrolyte content of the coconut water and adding a preservative.

In view of the insatisfactory protection given by the present vaccines against Cholera El Tor, a new type of vaccine has been developed. This vaccine obtains toxoid from the toxin strain called *Vibrio Cholera* El Tor.

Studies to alleviate protein energy malnutrition, vitamin A deficiency and anemia were also given due emphasis. A number of high calorie and protein food preparations from indigenous sources were developed, such as the instant mongo soup, rice-mongo shrimp curls, a snack food from dehydrated beef blood, cocoweaning cereals, nutripak (a combination of rice and mongo flour with vitamins added), rice-soy and wheat-soy moodles and hamburger made from textured vegetable proteins.

A nationwide survey was conducted in 1978 to meet the urgent demand for the most current information on the national food situation; the nutritional status of the population, the anthropometric data of various age groups in the Philippines, as well as the extent of parasitological infestation in the country. The data obtained provides a valuable input in the planning and assessment of the national nutritional programmes.

v. Infrastructure and Public Utilities Sector

In response to the problem of housing particularly for the low income group, R&D activities focused on the utilization of indigenous resources in the development of housing materials. Agricultural waste products can now be a source of particleboards and decorative plywood panellings, while coconut trunks have several uses as building materials. Lime and agrowastes can now be utilized as cement substitutes for the manufacture of hollow blocks and building blocks.

vi. Scientific and Technological Manpower Resource Development

To ensure a steady supply of highly qualified and competently trained scientific and technological manpower for research and development in science and technology, graduate and undergraduate scholarship programmes in the basic and applied sciences were undertaken to provide incentives to those who would like to pursue careers in science. As of 1981, the NSDB has awarded a total of 1 826 scholarship slots at the baccalaureate level, 630 at the MS level and 67 at the Ph.D. level. It may be noted that majority of the awardees of scholarships at the BS level were from the Philippine Science High School (PSHS) which has prepared some 1 640 secondary students for careers in science and technology since 1964. By and large, 10% of the graduated scholars of the scholarship programmes are now employed in industry, 30% in colleges and universities, 39% in government agencies, and 21% are still pursuing further studies.

Other government agencies such as COCOFED and the U.P. Government Scholarships have also offered some 3 149 scholarship slots at the baccalaureate level for those interested in careers in science and technology. Specifically, in the field of agriculture, the Philippine Council for Agriculture and Resources Research will have produced a total of 39 quality manpower at BS level, 645 at the MS level and 168 at the Ph. D. level, since 1973 and up to the end of the 1983-84 school year.

Additionally, the private sector offers 323 scholarship slots in the fields of science and technology. Of this number, 64 (20%) are in the basic sciences, 150 (46%) in applied sciences and 109 (34%) in other related fields.

Under the NSDB Science Education Programme, 11 Regional Science Teaching Centers (RSTCs) were established to conduct Summer Science Institutes (SSIs) for elementary and secondary school teachers in science and mathematics. The programme, which aims to upgrade the teaching competencies of the present stock of science and mathematics teachers in the first and second levels of the educational system, has an output of 9 347 trained manpower as of 1981. Likewise, the Summer Science Institutes for College Teachers in Physics, Chemistry and Mathematics, which started in 1978 conducted by leading institutions in Metro Manila, have produced 161 trained faculty members.

Innovative programmes for teacher education in science and mathematics were developed to upgrade the quality of science education in the country. Among the projects undertaken on curriculum innovation are the (1) Bachelor of Science in Mathematics for Teachers (BSMT) and Bachelor of Science in Physics for Teachers (BSPT) programmes; (2) Certified Programme for BS degree holders to teach Science/Mathematics in Secondary Schools; (3) Integrated Programme for Science Education for Development (IPSED) of Leyte-Samar Region Undergraduate Teacher Education Programme and Vitalized Teacher Training Programme for Elementary Science Mathematics of Rural Upliftment. To date, 448 scholars are supported by the NSDB under these innovative pre-service teacher education programmes.

To ensure a multiplier effect in the effort to upgrade science education in the country, a graduate scholarship programme leading to a Master of Arts in Teaching (MAT) degree in science and mathematics has been supported since 1969 for the upgrading of faculty members of teacher training institutions, with a priority to the Regional Science Teaching Centres. The Master of Science in Teaching degree in the physical sciences was developed in 1978 in line with the countinuous evaluation and demands for an improvement of the programme. A total of 423 MAT/MST scholarship grants have been awarded to science and mathematics faculty of educational institutions under the programme.

In support of the goal to strengthen science education at the first and second levels, prototype school science equipment were developed. As of 1981, 7 387 science kits for elementary schools throughout the country were distributed; in addition, 87 secondary schools in the country were provided with chemistry kits in cooperation with the German government.

An Institution Building Programme, which aims to develop and strengthen the institutional capabilities of schools in the regions through better programmes in the science, has spurred the formation of science consortia among private and government academic institutions, thereby providing the member institutions the maximum benefits derivable from the joint resources of cooperating schools. A total grant of ₱ 15.82 millions (1978-81), for the improvement of equipment and faculty resources, was provided to reinforce the 36 selected educational institutions in the country under the programme.

PCARR's efforts to strengthen its agricultural research network has mounted to about ₱400 million for the past 5 years, utilizing USAID loan funds and grants from UNDP, IDRC, CIP and others. The assistance consists of providing infrastructure and research equipment to selected research centres throughout the country and a manpower development programme for local and foreign training to agricultural researchers. Foreign grants are likewise provided to specific programmes for particular commodities in forestry, fisheries, crops and livestock.

Under the Balik-Scientist-Programme, 220 foreign-based Filipino scientists had returned to the country, as of December 1981, 59% (or 130 out of 220) of whom are now working permanently in the Philippines. The foreign-based Filipino scientists who were absorbed by government agencies, industry and universities, are expected to provide the country the expertise needed for R&D which is not available locally.

vii. Transfer/Diffusion of Technology and Scientific and Technological Services

A comparative and expanded information handling and dissemination programme was implemented to satisfy the information requirements of the scientific community and to maximize the timely use of research and development results. Tools such as publication of scientific periodicals, brochures, handouts, seminars, workshops, exhibits, press releases and personal consultations were used.

Technology delivery programmes have effectively touched base with the various critical sectors of the economy. These ongoing programmes are specifically developed and implemented for small and medium-scale industries; the rural communities; workers, households and the general public; and for technology developers and generators. Under the Export Industry Modernization Programme, assistance is given to export-oriented small and medium-scale firms involved in the garments, woodworking, food processing and light metals industries for the improvement of their production technologies, thus making them more competitive in the export market.

The Technology Utilization Support System provides technical, financial, managerial and information assistance to institutions and individuals to enable them to launch new or improved methods and equipment into the commercial market. Under this programme, financing in the forms of pre-investment and equity investments are made available to interested venture partners. TUSS also undertakes the delivery of appropriate technologies to the rural areas.

Special package training programmes designed to transfer new technologies, were offered which were tailor-made to the specific training needs and requirements of requesting industries, organizations or groups. Assistance in testing and analysis of various materials, products, devices and processes were also rendered.

A metrology centre is being established to set and maintain the national standards for the five base metric units such as length, mass, temperature, electricity and luminous intensify needed by industry and the scientific community. To support this endeavour, testing and standardization centres are presently being established in the various regions of the country.

Problems Encountered

For research and the application of its results to the relevant sectors of the country to be effective, there is a need for infrastructural services, different types of specialized personnel, training in the use of techniques and processes in the sectors in which the research findings can be applied and, lastly, an adequate level of general scientific education among people working in this field. Accordingly, this would concern activities relating to science teaching and extension work, the training of technicians, engineers, and professionals, as well as services such as scientific and technical information and documentation, scientific instruments and various surveys and studies.

The complexity of these elements is such that a high level of organization and convergence of many different lines of action are required. Hence, in the context of the Philippine situation, the problems which plague the application of S&T to the country's development may be indentified in terms of the following components.

i. In Research and Development

Improved coordination within and between government and private agencies involved in research is required to bring about more balance in the human resources engaged in research, as well as in information and extension services.

The present situation calls for better trained extension officers and agents, improved curricula and training facilities for technicians required by industry and better employment opportunities with compensatory wages for both technicians and engineers to optimize their utilization.

The development of a more effective research management system for health, industry and energy, similar to that in the agricultural sector is indicated. In addition, the need to integrate, with the country's industrial development programme, an effective policy instrument to encourage the private sector to invest more in R&D is strongly indicated. In order, however, to enable the research sector to become more sensitive to industrial needs, the industrial sector must clearly identify areas requiring research backstopping. Thus, given the proper perspective, the research sector can better align its operations in tandem with industrial necessities.

ii. In the Transfer of Technology

An effective mechanism, to ascertain the appropriateness of foreign technology, should be developed to cover the major technological and production gaps in the country's industrialization programme. There is a felt need for a core of competent research and scientific personnel that will advise on what to borrow, from whom to borrow, and how to borrow most profitably and advantageously.

Problems correlated with technology transfer such as inadequate infrastructure, insufficiently trained manpower, inadequate markets and other social, cultural or economic barriers require attention.

iii. In Physical Infrastructure

Facilities for S&T are relatively inadequate in view of the minimal growth in the financial allocation for physical infrastructure, not only in applied but more so in basic research. Similarly, there is a need to make adequate provision in the annual budget for the maintenance and operation of already acquire facilities.

Restrictive regulations that pose difficulties in securing and purchasing science and technology equipment from abroad need to be relaxed. At the same time, there is need to provide a strong mechanism for developing an indigenous capability to manufacture scientific and technical equipment and for promoting their utilization.

iv. In Information Dissemination and Extension Services

The problem of insufficient and, at times, inappropriate data was identified in all sectors. A continuing inventory of resources and updated, well packaged data and information should be ensured for effective development planning.

This generated data and information must be analyzed, packaged and disseminated through defined and developed information channels for use by various identified users at all levels of society, ultimately in aid of development goals, and towards improvement of man's quality of life.

v. In International Linkages

There is need for improving the mechanisms for utilization of existing international and regional linkages for developing national and regional S&T capabilities. Also, while there is realization of available expertise within the region, there is need to devise a mechanism for identification of such available expertise, both nationally and regionally.

vi. In Logistical Support

In order to attain the set objectives in S&T, a dramatic increase in the financial support by the government and the private sectors have to be effected.

4.3 OBJECTIVES AND PRIORITIES

Objectives

In order to contribute more effectively towards to attainment of national development goals, the science and technology plan aims to:

i. Promote research and development for the generation of scientific knowledge and technological know-how both in the public and private sectors, that would lead to the: efficent and economical generation and utilization of various energy sources and technologies for power and other purposes, promotion of the more efficient use of indigenous raw materials and development and improvement of technologies, increase in food production, solution of the country's major health and nutrition problems, conservation and enhancement of the environment ;

ii. Strengthen scientific capabilities of academic institution in the different regions and expand S&T manpower programmes to ensure a steady supply of quality scientists and technicians in the developing growth centres, enhance the capability of research institutions, and promote science conciousness;

iii. Develop effective systems for technology transfer or diffusion services that would lead to engineering, commercialization, or downstream application taking into consideration the social implications;

iv. Enhance national and international linkages on S&T;

v. Increase and development expenditure through diversification of sourcing of resource and involvement of the private sector; and

vi. Encourage the active and substantial involvement and participation of the private sector in R&D.

Policies

Taking into account the various problems that confront the healthy growth of science and technology in the country, policy guidelines have been formulated by the National Science Development Board to support S&T as a major force for the development of the country's social and economic goals.

Basic Statements of Policy

As a general statement of policy, science and technology programmes shall be integrated into the overall national development effort. The essence of a mission-oriented research and development is that its conduct must always envisage man and society as the ultimate users and beneficiaries of research outputs. While much effort and resources were concentrated on developing a strong scientific manpower and facilities for R&D work in the country, similar importance and attention is now being given to the utilization, diffusion and delivery of technologies generated by the R&D organizations.

A. Science, Technology & Industry Interface

i. Mission-oriented research will be emphasized in industry, energy, agriculture, natural resources, and health.

ii. An adequate and responsive technology support system for private and public industries will be further strengthened to respond to the productivity problems of different sectors in the economy.

B. Development and Utilization of S&T potential

i. Resources for S&T particularly for R&D, will be substantially increased.

ii. Manpower development programmes for S&T will be expanded and accelerated.

iii. A more conducive environment for scientists and technologists will be provided.

iv. Scientific and technological institutions in the regions will be strengthened to provide an appropriate technology base for the industrial dispersal and countryside development efforts of the government.

v. International scientists and technologists will be encouraged to contribute to the Philippine R&D efforts.

C. Structure for Implementation

The S&T community will be encouraged to evolve into a strong governmental structure for policy-making in science and technology as well as for coordinating, financing and monitoring the various S&T activities in the country. Such a structure will seek to provide an atmosphere conducive to creativity and technology generation by minimizing administrative and non-technical impediments to scientific productivity.

The national R&D plans and programmes will be implemented by research organizations such as the organic agencies of the NSDB, other R&D groups in other ministries, private research centres, and educational institutions with R&D capabilities. Technology utilization, dissemination, and delivery, are undertaken by notable government agencies and cooperating private establishments. Science promotion, manpower development, and training activities, are responsibilities shared by numerous higher educational institutions and government agencies. These government agencies, higher educational institutions, private establishments and non–profit organizations also play an active role in providing the necessary support services.

Priorities & Programme Thrusts

For S&T to have significant impact on national development, science policies which are integrated with state policies have to be translated into clear cut R&D plans and programmes and the required strategies for successful implementation. These will be oriented towards the:

i. assessment, adaptation, improvement, and utilization of available technologies in the world;

ii. applied R&D that will intensify and optimize utilization of resources and generate employment; and

iii. supportive components in basic and fundamental research to fill gaps in technological knowledge.

In order to make the plan operational and effective, the mission-oriented programmes are being implemented which are planned and coordinated as a total system. They must be time-framed so that their contributions will be immediately and effectively felt. This implies that national concerns and problems must be identified and prioritized, and that delivery and organization of resources for assistance to science research contribute to meeting those concerns and problems. To effect mission-oriented research, various agencies must coordinate with each other for a multi-disciplinary interaction.

Our relatively strong lead in agriculture and forest research will be intensified further. Increasing attention will be given to research support for the fisheries industry and others.

Downstream R&D activities such as testing and standardization services, product formulation, consultancy, and training support will be stepped up for the industrial sector.

Our modest start in R&D on renewable energy sources will be expanded. For the health sector, the main research directions are in the area of primary health care, infectious and communicable diseases, herbal medicine and malnutrition.

But even as we adopt a short range strategy of pragmatic, down-to-earth R&D activities that will improve productivity and the competitiveness of the different sectors, generate employment, and raise family incomes, we shall now lay the foundation of our coming industrialization by organizing and mobilizing industry and R&D task forces for a number of higher technology areas such as:

i. Chemistry and utilization of natural products,

ii. Genetic engineering,
iii. Alternative and renewable sources of energy,
iv. materials science and technology
v. Electronics and computer technology.

Linkage between R&D institutions and technology delivery agencies will be strengthened to fill the critical gap in the delivery of commercially viable technologies. More effort will be put into the delivery of appropriate technologies to the rural areas of the country.

Research and development expenditure will be substantially increased over the next five years to about 3% of GDP per annum. The development of S&T potential (manpower and facilities) will receive about half of the total S&T resources during the initial years of the plan period. There will be a diversified sourcing of resources, with the private sector actively and substantially providing for R&D investment and expenditure in the future through a package of fiscal and other incentives.

Consistent with policy guidelines enumerated above, priority programmes and projects have been set in the following sectors: energy; industry; infrastruture and public utilities; agriculture and natural resources; social services; science promotion and dissemination; and, scientific and technological manpower development; and taking into account chemistry of natural products, biogenetic development, materials development and electronics development.

i. Energy Sector

The priority programmes in the energy sector cover the development of conventional and non-conventional sources of energy and energy conservation systems.

The conventional sources of energy include the development of mineral oil, hydro, coal, geothermal and nuclear sources. For coal, geothermal and nuclear energy sources, R&D focuses on source exploration, utilization and upgrading including waste utilization and treatment to safeguard the environment.

The non-conventional energy programme covers low-pressure natural gas (marsh gas), producer gas, alcohol, dendrothermal, fuel-like substitutes and diesel oils from coconut oil, ocean waves, solar energy, biogas, wind, mini-hydro, hot springs and others. Emphasis is given to the production and generation of alcohol, natural gas, biogas, and solar energy and their environmental effects.

Under energy conservation, systems and devices with at least 10% savings on fuel are being studied including design of buildings. Recycling of fuel-burned wastes for re-utilization or conversion into usable products also forms part of this programme.

ii. Agriculture and Natural Resources Sector

Improved methods of crop, liverstock and fish production are given primary attention to support the drive to produce food and raw materials for self-sufficiency, import substitution and export expansion. Likewise, the country's natural resources are developed through effective forest and environmental management and conservation, mineral assessment and utilization.

The demonstration and packaging of appropriate farming systems to support increased farm production targets is also a priority concern of this sector.

iii. Industrial Sector

There will be a more aggressive and responsive support given by science system to private industries. Emphasis will be on the development of small and medium scale industries particularly in food processing, textiles, wood-based products, ceramics, chemicals, metals and leather. Emphasis is given on the use of abundant and indigenous raw materials for the production of non-traditional as well as traditional export products and import substitutes; development of new technologies; improvement of indigenous and adaptation of imported technologies to enhance technological capabilities; process and design engineering and adaptation and application of methods for quality standardization of products for local and foreign markets. Effluent treatment and processing is also undertaken to minimize or eliminate pollution generated by the industries.

iv. Infrastructure and Public Utilities sector

The priorities of the sector are directed towards the development of innovative housing design and construction techniques and materials, communication and transportation facilities, and minimizing the disastrous effects of natural phenomena.

To overcome the housing shortage and to provide the majority of the population with decent dwelling, the emphasis is on the development of better housing with more efficient utilization of indigenous materials for low cost housing. This includes studies on housing design, standards and building technology to effect savings costs in construction of dwellings.

For communications, emphasis is placed on the local fabrication of communication components like paper cones for industrial speakers and equipment like oscilloscopes, multimeters and other electronic devises.

For transportation, R&D efforts are oriented towards lowering the cost of transportation facilities and components through the utilization of indigenous materials like forest species for railway ties and fabrication of densified wood laminated and light-weight and non-corrosive metals for aircraft parts.

To minimize the damages caused by typhoons, earthquakes tidal waves, etc., studies on disaster risk mapping, cloud and precipitation physics and the development of meteorogical balloons for weather modification, are emphasized for a better understanding of the causes and effects of natural phenomena.

v. Social Services Sector

Research programmes and thrusts under the Social Services Sector aim to contribute to the improvement of the nutritional status of the population in general, and high risk groups such as children, and pregnant and lactating mothers in particular; the decrease in the mortality and morbidity rates due to infectious and degenerative diseases; and the maintenance of an acceptable population growth rate. In the pursuit of these programmes, the utilization of indigenous sources such a medicinal plants and untapped but abundant food sources is emphasized.

Social science research is made part for all the research and development programmes. Efforts are focused on the identification of cultural, social and psychological factors that promote or retard development and productivity.

Science Promotion, Information and Scientific and Technological Manpower Development

This sector is commited to provide the country with a steady supply of professional scientists in both basic and applied sciences through the provision of scholarships at the undergraduate, graduate and post-graduate levels in identified scientific fields. The training of science and mathematics teachers will continue to be supported and will be handled by the country's premier scientists.

In order to increase the capabilities of academic institutions to offer quality science instruction and undertake research, assistance for the development of science faculty, curriculum, library and laboratory facilities, are granted.

With regards to the promotion of science consciousness among the youth, activities and projects such as science clubs, science fairs, mini-research and holding of an Asian Youth Camp, etc., are supported.

A programme of incentives in the form of special awards bonuses, prizes, guarantee fund, grant for printing of scientific publications, travel grants, and such other privileges for inventors and innovators to improve their economic, social and professional status.

In order to strenghten the scientific information exchange linkages, both locally and abroad, a national scientific information network has been established by the National Science Development Board. This is responsible for securing local as well as foreign scientific and technological knowledge for evaluation relative to local needs by means of appropriate technical assistance programmes at national, regional and international levels.

S&T information, particularly on transferable indigenous technologies wanting proper implementation, are properly disseminated by the S&T information network through various means, such as newsprint, radio and TV.

Transfer or Diffusion of Technology and Scientific and Technological Services

Likewise a continuing programme on scientific and technological services is made part of the development efforts to encourage research and other scientific and technological undertakings, and their accelerated transfer and diffusion among the users and industry.

The *scientific programmes* cover transfer of indigenous, and adapted imported technologies, to the users through techno-extension personnel, establishment of pilot plants to show the potential of the research results, and unpackaging of imported technology before agreements are made between local entrepreneurs and exporters of technology. Imported technologies which are suitable to local conditions are either leased or purchased by the entrepreneurs. They may fully utilize the transferred technology or introduce innovations to make the technology fit into their particular needs.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

i. The Philippine Scientific and Technological Cooperation Policy

With the problems confronting mankind, problems that are so staggering and so complex that neither one nation alone nor one group of nations can attempt to solve them, the Philippines has adopted a new foreign policy which is non-ideological, non-aligned and development oriented. It advocates a shift in focus "from do-it-alone national attitudes to machinery for global cooperation, consensus and common pursuit of collective solutions". It recognizes that grater effort toward international cooperation should bring into harness all available scientific and technological knowledge in order to seek ways of making the burdens of mankind less severe.

Having adopted the premise that "scientific discoveries and knowledge transcend national territorial boundaries" and realizing that rapid scientific and technological progress is taking place all around the world, the Philippines answers to the imperative of keeping in close contact with other countries and of promoting scientific and technological cooperation through active participation in, and support of, UN and other international and regional bodies, activities and programmes with the end in view of utilizing advances in science and technology in the interest of peace and for the benefit of mankind. And, by pursuing and maintaining friendly liaison and contats with foreign governments and institutions involved in scientific research and development, pursues cooperative programmes designed to mutually benefit their respective peoples. Such linkages, which basically take the form of inter-institutional, bilateral, regional and multilateral cooperation arrangement, provide avenues for exchange in research manpower, activities, findings, methodologies and the transfer of technologies.

Accordingly, the government has encouraged information interchange between members of the country's scientific community and their foreign counterparts, by initiating and supporting mutually beneficial activities. It has also promoted programmes designed to stimulate scientific progress by allowing exposure of the country's local scientists and academics to counterpart personalities and conditions in foreign countries, thereby providing them opportunities to exchange ideas, talents and techniques, attach problems of mutual concern, work together in unique environments, and share facilities and resources. By the same token, it has opened its doors to foreign science policy-makers and administrators, scientists and researchers, in conformity with the Governemnt's goal of decreasing international tension and improving mutual understanding with other nations and cultures.

ii. Inter-institutional Linkages

The Philippines has persistently subscribed to the long-standing tradition of free exchange of ideas and scientific knowledge between its scientitfic community and their counterparts from different countries working on similar problems. Recognizing its constraints as a developing country, hampered by limited logistical resources to completely and fully support its scientific and technological activities, it has fostered inter-institutional linkages and cooperation in the context not only of sharing knowledge and ideas, but also of resources in carrying out research activities, and manpower and institutional upgrading and development.

iii. Bilateral Cooperation

Over the last ten years, and more particularly, with the advent of the new Philippine foreign policy, the Philippines has forged a number of bilateral agreements on scientific and technological cooperation with both market-economy or non-socialist countries such as Japan, France, Korea, Indonesia, Finland and Federal Republic of Germany, and with centrally-planned economy or socialist countries such as Romania, Hungary and China.

A basic agreement on scientific and technological cooperation entered into by the Philippines with another country is generally aimed at strengthening scientific and technological cooperation between the two countries on the basis of the principles of equality and reciprocity, respect for each other's independence and national sovereignty, non-interference in each other's internal affairs, and mutual benefit. The terms of cooperation usually consists of exchange of professionals and technicians and reciprocal grant of fellowships for graduate and post-graduate studies; study and observation tours; undertaking of special joint studies and research; the exchange of experts, research workers, equipment, instruments, accessories and other materials necessary for the implementation of projects or experiments; the exchange of scientific and technological information as may be deemed necessary by the contracting government.

iv. Regional Cooperation

The Philippines is vigorously implementing the concept of regional cooperation among countries with common problems and mutual interest and the sharing of resources and facilities. President Marcos, no less, has stated: "the future of my country must be linked with that of Asia, and, in particular, with that of the Association of Southeast Asian Nations (ASEAN) whose future in turn, is linked with the rest of the globe".

As an active member of ASEAN which is seen as a vehicle for socio-economic development and political stability in the region, the Philippines pursues and supports political, economic, cultural, social and scientific and technological cooperation on equal terms which would bring mutual benefits and stimulate faster progress for its member nations, namely Indonesia, Malaysia, Singapore, Thailand and the Philippines. With its growth in status and prestige as a viable and dynamic organization, ASEAN looks ahead to being able to continue working towards peace and prosperity for the Southeast Asian community.

Additionally to ASEAN cooperation in S&T, the Philippines plays an active role as a member of the Association for Science Cooperation in Asia (ASCA). ASCA was formally organized in March 1972 in Manila as an offshoot of a meeting of Ministers of Science in Asia, convened by the Philippine Government in November 1970, to explore the possibility of establishing a forum in science and technology in the region. The Association, which started with 7 members and two observers in 1972, has grown into a family of 17 nations working together to promote scientific and technological cooperation in the region.

v. Multilateral Cooperation

The Philippines, through the years, has subscribed to the critical role that the UN system, its member organizations and specialized agencies and other multilateral, organizations such as Unesco, UNDP, ESCAP, UNIDO, WIPO, UNICEF, UNCSTD, FAO, WHO, ILO, ICA, WMO, IAEA, World Bank, ADB, IDRC, etc. play in promoting international cooperation with the aim of utilizing advances in science and technology in the interest of peace and for the benefit of mankind.

Seeking closer identification with the developing nations of the Third World, the Philippines continues to adhere to UN resolutions and decisions which would accelerate the effective implementation of assistance programmes in science and technology at levels compatible with the development requirements of developing countries. She is also fully committed to the establishment of a New International Economic Order, based on equity and aimed at the well-being of mankind. She adheres to the precept that even with the best efforts, sacrifices and achievements of the poor developing countries such as herself at the national and regional levels, the unstinting cooperation of the affluent, economically developed countries is of decisive importance.

ANNEX 1.

List of acronyms

AF	Association of Foundations
ASCA	Association for Science Cooperation in Asia
ASEAN	Association of Southeast Asian Nations
BAE	Bureau of Agricultural Economics
BAEx	Bureau of Agricultural Extension
BCGS	Bureau of Coast and Geodetic Survey
BFAR	Bureau of Fisheries and Aquatic Resources
BIIP	Bureau of Industrial Information and Programmes
BLISS II	Bagong Lipunan Integrated Sites and Services (Phase II)
BMG	Bureau of Mines and Geology
BOI	Board of Investments
BRL	Bureau of Research and Laboratories
BS	Bureau of Soils
BSMI	Bureau of Small and Medium Scale Industries
CASTASIA II	Second Conference of Ministers Responsible for the Application of Science and Technology to Development and those Responsible for Economic Planning in Asia and the Pacific
CNED	Center for Non-Conventional Energy Development
COMVOL	Commission on Volcanology
DIC	Disease Intelligence Centre
ESCAP	Economic and Social Commission for Asia and the Pacific
FAO	Food and Agriculture Organization
FDA	Food and Drug Administration
FNRI	Food and Nutrition Research Institute
FORPRIDECOM	Forest Products Research and Industries Development
FPA	Fertilizer and Pesticide Authority
GDP	Gross Domestic Product
GNP	Gross National Product
IAEA	International Atomic Energy Agency
IBP	Institution Building Programme
ICAO	International Civil Aviation Organization
ILO	International Labour Organisation
KBI	Key Budgetary Inclusion
KKK	Kilusang Kabuhayan at Kaunlaran
MA	Ministry of Agriculture
MEC	Ministry of Education and Culture
MHS	Ministry of Human Settlements
MIRDC	Metals Industry Research and Development Centre
MiTI	Ministry of Trade and Industry
MND	Ministry of National Defense
MNR	Ministry of Natural Resources
MOB	Ministry of the Budget
MOH	Ministry of Health
NAST	National Academy of Science and Technology
NCP	Nutrition Centre of the Philippines
NCSO	National Census and Statistics Office
NEDA	National Economic and Development Authority
NEPC	National Environmental Protection Centre
NFA	National Food Administration
NFP	Nutrition Foundation of the Philippines
NIST	National Institute of Science and Technology
NMYC	National Manpower and Youth Council
NNC	National Nutrition Council
NPCC	National Pollution Control Commission
NRCP	National Research Council of the Philippines
NRMC	Natural Resources Management Centre
NSDB	National Science Development Board
PAGASA	Philippine Atomic Energy Commission
PCARR	Philippine Council for Agriculture and Resources Research
PCF	Population Centre Foundation, Inc.
PIDS	Philippine Institute for Development Studies
PIC	Philippine Inventors Commission
POPCOM	Population Commission
P/P/A	Programme/Projects/Activity Descriptions
PSHS	Philippine Science High School
PSSC	Philippine Social Science Council
PTRI	Philippine Textile Research Council
RITM	Regional Institute on Tropical Medicine
RSTC	Regional Science Teaching Centres
SCC	Schistosomiasis Control Commission
SFP	Science Foundation of the Philippines
TRC	Technology Resource Center
TTB	Technology Transfer Board
TUSS	Technology Utilization Support System
UNCSTD	United Nations Conference on Science and Technology for Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Funds
UNIDO	United Nations Industrial Development Organization
UPS	University of the Philippines System
WHO	World Health Organization
WIPO	World Intellectual Property Organization
WMO	World Meteorological Organization

ANNEX 2.

List of government agencies engaged in R&D (1979-1980)

1. Board of Transportation
2. Bureau of Agriculture Economics
3. Bureau of Agricultural Extension
4. Bureau of Animal Industry
5. Bureau of Coast and Geodetic Survey
6. Bureau of Dental Health Services
7. Bureau of Energy Development
8. Bureau of Fiber and Inspection Services
9. Bureau of Forest Development
10. Bureau of Health Services
11. Bureau of Labor Standards
12. Bureau of Lands
13. Bureau of Mines and Geo-Sciences
14. Bureau of National and Foreign Information
15. Bureau of Plant Industry
16. Bureau of Research and Laboratories
17. Bureau of Secondary Education
18. Bureau of Small and Medium Industries
19. Bureau of Soils
20. Child and Youth Research Centre
21. Commission on Volcanology
22. Cotton Research and Development Institute
23. Dangerous Drug Board
24. Dermatology Research and Training Service
25. Development Academy of the Philippines
26. Education Project Implementing Task Force
27. Energy Research and Development Centre
28. Farm Systems Development Corporation
29. Food and Drug Administration
30. Food and Nutrition Research Institute
31. Food Terminal Incorporated
32. Forest Research Institute
33. Government Arsenal
34. Government Service Insurance System
35. Institute of National Language
36. Insurance Commission
37. Laguna Lake Development Authority
38. Livestock Development Council
39. Local Water Utilities
40. Malaria Eradication Service
41. Management Information System Staff
42. Metropolitan Waterworks and Sewerage System
43. Ministry of Agriculture
44. Ministry of Education and Culture
45. Ministry of Public Works
46. Ministry of Natural Resources
47. Ministry of Social Services and Development
48. Ministry of Trade and Industry
49. National Census and Statistics Office
50. National Children's Hospital
51. National Commission on the Role of Filipino Women
52. National Computer Centre

53 National Economic and Development Authority

54. National Environmental Protection Centre
55. National Food Administration
56. National Family Planning Office
57. National Historical Institute
58. National Institute of Science and Technology
59. National Irrigation Administration
60. National Manpower and Youth Council
61. National Meat Inspection Commission
62. National Museum
63. National Nutrition Council
64. National Police Commission
65. National Research Council of the Philippines
66. National Research and Development Centre for Teacher Education
67. Natural Resources Management Centre
68. National Seamen Board
69. National Tax Research Centre
70. Naval Research and Development Centre (Philippine Navy)
71. Nutrition Centre of the Philippines
72. Office of Civil Defence
73. Philippine Aerospace Development Corporation
74. Philippine Atomic Energy Commission
75. Philippine Bureau of Standards
76. Philippine Coconut Authority
77. Philippine Heart Center for Asia
78. Philippine Institute for Development Studies
79. Philippine Inventors Commission
80. Philippine Tobacco Administration
81. President's Centre for Special Studies
82. Philippine Virginia Tobacco Administration
83. Records Management and Archives Office
84. Rural Workers Office
85. Schistosomiasis Control and Research Service
86. U.S. Naval Medical Research Unit No.2 (Ministry of Health)
87. Veterans Memorial Medical Centre

SOURCE: NSDB 8001 So. "Expenditures and Manpower for Research and Development in Government Agencies Fiscal Year 1979-1980"

ANNEX 3

List of higher educational institutions engaged in R&D in the Philippines (1971-1977)

1. Aklan National College of Fisheries
2. Angeles University Foundation
3. Annunciation College of Bacon
4. Araneta University Foundation
5. Arellano University
6. Asian Social Institute
7. Ateneo de Manila University
8. Baguio Colleges Foundation
9. Baliwag College
10. Bohol Agricultural College
11. Bohol University
12. Bulacan College of Arts and Trades
13. Bulacan National Agricultural School
14. Capiz Institute of Technology
15. Cavite College of Arts and Trades
16. Cebu Institute of Technology
17. Cebu School of Arts and Trades
18. Central Luzon Polytechnic College
19. Central Luzon State University
20. Central Luzon Teacher's College
21. Central Mindanao College
22. Central Mindanao University
23. Central Philippine University
24. Centro Escolar University
25. Colegio de San Agustin de Bacolod
26. Colegio de San Jose Recoletos
27. Colegio de la Purisima Concepción
28. College of the Holy Spirit
29. Davao Institute of Agriculture Foundation
30. De La Salle University
31. Dipolog School of Fisheries
32. Divine Word University
33. Don Honorio Ventura College of Arts and Trades
34. Don Mariano Marcos Memorial State College
35. Don Mariano Marcos State University
36. Don Severino Agricultural College
37. Eastern Pangasinan Agricultural College
38. Far Eastern University
39. FEATI University
40. Filamer Christian Institute
41. Great Plebian College
42. Ilocos Sur Agricultural College
43. Iloilo School of Arts and Trades
44. Iloilo State College of Fisheries
45. Immaculate Conception College
46. Isabela State University
47. La Salle College
48. Langangilang Agricultural College
49. Letran College
50. Luzon Colleges
51. Lyceum of Aparri
52. Lyceum of the Philippines
53. Marikina Institute of Science and Technology
54. Maryknoll College
55. Maydolong National Agricultural School
56. Mindanao Regional School of Fisheries
57. Mindanao State University
58. Mountain State Agricultural College
59. Mountainview College
60. MSU-Sulu College of Technology and Oceanography
61. MSU-Sulu Development Technical College
62. MSU Iligan Institute of Technology
63. M.V. Gallego Foundation College
64. Negros Oriental National Agricultural School
65. Northern Luzon State College
66. Notre Dame of Jolo College
67. Notre Dame of Kidapawan College
68. Notre Dame University
69. Nueva Viscaya State Institute of Technology
70. Pamantasan ng Lunsod ng Maynila
71. Pangasinan College of Fisheries
72. Pangasinan School of Arts and Trades
73. Philippine Christian University
74. Philippine Normal College
75. Philippine Women's University
76. Polytechnic University of the Philippines
77. Regina Carmeli College
78. Samar Regional School of Fisheries
79. Samar School of Arts and Trades
80. San Jose Colleges
81. San Sebastian College
82. Southern Christian College
83. Southern Samar Agricultural College
84. Southern Samar School of Arts and Trades
85. St. Mary's College
86. St. Paul's College
87. Technological University of the Philippines
88. Trinity College
89. UM Tagun College
90. Union College
91. U.P. College Cebut
92. U.P. College of Tacloban
93. U.P. Iloilo
94. University of Eastern Philippines
95. University of Iloilo
96. University of Negros Occidental Recoletos
97. University of Pangasinan
98. University of San Agustin
99. University of San Carlos
100. University of Southern Mindanao
101. University of the Philippines
    (a) Asian Labor Education Center
    (b) College of Arts and Sciences, UP
    (c) College of Engineering, UP
    (d) College of Nursing

(e) College of Public Administration
(f) College of Veterinary Medicine
(g) Department of Biochemistry, PGH
(h) Department of Laboratories
(i) Department of Orthopedics, PGH
(j) Department of radiology and Cancer Institute
(k) Institute of Economic Development and Research
(l) Institute of Environmental Planning
(m) Institute of Public Health, U.P.
Pedro Gil St. , Manila
(n) Institute of Small Scale Industry
(o) Institute of Social Work and Community Development
(p) Local Government Centre
U.P.Padre Faura, Manila
(q) Natural Science Research Centre
(r) Office of Research Coordination
(s) Philippine Eye Research Institute
(t) Population Institute
(u) Science Education Centre
(v) Statistical Centre
(w) U.P. College of Education
(x) U.P. College of Fisheries
(y) U.P. Law Centre

103. Velex College
104. Virgen Milagrosa Educational Institute
105. Visayas State College of Agriculture
106. Wesleyan University Philippines
107. Western Cagayan School of Arts and Trades
108. Western College
109. Western Institute of Technology
110. West Negros College
111. West Visayas State College
112. Xavier University
113. Zamboanga A.E. College
114. Zamboanga del Norte Agricultural College

SOURCE: NSDB Project No. 7807 So. "Survey of R&D Expenditures and Manpower, Facilities in Institutions of Higher Education in the Philippines".

ANNEX 4

List of non-profit organizations engaged in R&D in the Philippines (NSDB certified foundations) (1978 - 1979)

1. A.I.M. Scientific Research Foundation, Inc.
2. Andres Soriano Cancer Research Foundation, Inc.
3. Andres Soriano Foundation. Inc.
4. Angelo King Foundation, Inc.
5. Archbishop Gabriel M. Reyes Memorial Foundation, Inc.
6. Asian Institute of Insurance
7. Assisi Development Foundation, Inc.
8. Ateneo Scholarship Foundation, Inc.
9. Bayanikasan Research Foundation, Inc.
10. Benavides Foundation, Inc.
11. CEU Research and Development Foundation, Inc.
12. Chito Foundation, Inc.
13. Cullion Foundation, Inc.
14: Cyanamid Agricultural Research Foundation, Inc.
15. Davao Research and Planning Foundation, Inc.
16. De La Salle University Science Foundation, Inc.
17. Dr. Jose P. Rizal Memorial Foundation, Inc.
18. Doren B. Gamboa Foundation for Childhood Education, Inc.
19. Economic Development Foundation, Inc.
20. Elena P. Tan Foundation, Inc.
21. Elks Celebral Palsy Project, Inc.
22. El Observatorio de Manila, Inc.
23. Eulogio (Amang) Rodriguez Memorial Foundation, Inc.
24. Faura Research Centre, Inc.
25. Filipinas Foundation, Inc.
26. Financial Executive Institute of the Philippines Research and Development Foundation, Inc.
27. Foundation for Advancement of Surgery and Study of Cancer, Inc.
28. Foundation for Nationalist Studies, Inc.
29. Foundation for Philippine Progress, Inc.
30. Foundation for Retarded Children, Inc.
31. Gregoria Araneta Social Development Foundation, Inc.
32. Human Development Foundation, Inc.
33. Jeepney Drivers Foundation, Inc.
34. Jose Antonio Delgado Memorial Foundation, Inc.
35. Kapatiran-Kaunlaran Foundation, Inc.
37. Makati Rotary Club Foundation, Inc.
38. Manila Archdiocesan Community Development Foundation, Inc.
39. Meralco Foundation, Inc.
40. Mother Edelwina Science Foundation, Inc.
41. Mt. Apo Science Foundation, Inc.
42. Narcotics Foundation of the Philippines, Inc.
43. National Secretariat of Social Action, Inc.
44. NDEA Foundation, Inc.
45. Negros Economic Development Foundation, Inc.
46. PAASCU Reasearch Foundation, Inc.
47. Paranaque Manpower and Community Development Foundation, Inc.
48. Philippine Business for Social Progress, Inc.
49. Philippine Cancer Society, Inc.
50. Philippine Coconut Research and Development Foundation, Inc.
51. Philippine Institute of Pine and Applied Chemistry, Inc.
52. Philippine Social Science Council, Inc.
53. Population Centre Foundation, Inc.
54. Pundasyon sa Pagpapaunlad ng Kaalaman ng Agham
55. Robert T. Villanueva Foundation, Inc.
56. San Miguel Foundation, Inc.
57. Scholarship and Community Building Foundation of the Philippines, Inc.
58. SGB Foundation, Inc.
59. Shanley-Austing Foundation, Inc.
60. Southeast Asian Science Foundation, Inc.
61. Spencer Foundation, Inc.
62. SPE Institute, Inc.
63. St. Scholastica Research and Development Foundation, Inc.
64. Tahanan Foundation, Inc.
65. Tondo Youth Foundation, Inc.
66. U.P. Engineering Research and Foundation, Inc.
67. U.P. Foundation, Inc.
68. U.P. Planning Research Development Foundation, Inc.
69. Xavier Science Foundation, Inc.

ANNEX 5

List of private establishments engaged in R&D in the Philippines (1971-1980)

1. Aclem Paper Mills Inc.
2. Aidsisa
3. Aircon, Inc.
4. Alliance Textile Mills, Inc.
5. Alpha Machinery and Engineering Corporation
6. Amalgamated Motors Inc.
7. Aras-Asan Timber Company Inc.
8. Armal Plastic Co. Inc.
9. Asian Alcohol Corporation
10. Asian Transmission Corporation
11. Atlas Consolidated Mining and Development Corporation
12. Bacolog-Morcia Milling Co. Inc.
13. Bataan Pulp and Paper Mills Inc.
14. Berbac's Chemical Inc.
15. Beta Electric Corporation
16. Biophil Inc.
17. C. Alcantara and Sons Inc.
18. C.C. Unson Co. Inc.
19. CFC Corporation
20. Camara Steel
21. Canlubang Automotive
22. Century Chemical Corporation
23. Chemical Group of Companies
24. Columbia Tobacco Co. Inc.
25. Cyanamid Agricultural Research Foundation Inc.
26. DMG Inc.
27. Daikins Phils. Inc.
28. Dutch Boy Philippines Inc.
29. Edward Keller Phils. Inc.
30. El Salvador Timber Co. Inc.
31. Elizalde Paint and Oil Factory Inc.
32. Elizade Rope Factory Inc.
33. Engineering Equipment Inc.
34. Erector Inc.
35 Evertex Industries Inc.
36. Far East Industrial Supply
37. Filipinas Foundation, Inc.
38. Firestone Tire and Rubber Co. of the Philippines
39. First Farmers Milling and Marketing Cooperative Association, Inc.
40. Francisco Motors Corporation
41. Fuller Pain Manufacturing Corp.
42. G.A. Machineries
43. GMA Radio Television Arts
44. Gas Corporation of the Philippines
45. Globesco Inc.
46. Hawaiian Philippines Co.
47. Industrial Fiber Products Corporation
48. Industrial Textile Manufacturing Co. of the Philippines
49. International Pharmaceuticals Inc.
50. Interpolymer Corporation
51. Johnson & Johnson
52. Kawasaki Motors (Phils.) Corp.
53. Kimberley-Clark Phils Inc.
54. LMG Chemicals Inc.
55. La Tondena Inc.
56. Lepanto Consolidated Mining Company
57. Mabuhay Vinyl Corporation
58. Manila Cordage Company
59. Marcopper Mining Corporation
60. Maria Christina Chemical Industries, Inc.
61. Maria Christina Fertilizer Corporation
62. Marsman and Company Inc.
63. Medical Doctors Co. Inc.
64. Mobil Oil Philippines Inc.
65. Muller and Philips Manufacturing Corporation
66. Neltex Development Company Inc.
67. Mordist Manufacturing Corporation
68. Norkis Trading Company
69. Oceanic Pharmacal Inc.
70. Oriental Petroleum and Minerals Corporation
71. Pacific Flour Mills Inc.
72. Pacific Oil Products, Inc.
73. Pacific Products Inc.
74. Pampanga Sugar Development
75. Pantranco North Express Inc.
76. Pantranco South Express Inc.
77. Paper Industries Corporation of the Philippines
78. Paramount Vinyl Products
79. Perlon Textile Mills inc.
80. Petrophil Corp.
81. Philippine Appliances Corporation
82. Philippine Belt Manufacturing Corp.
83. Philippine International Footwear Inc.
84. Philippine Packing Corporation
85. Philippine Petrochemical Products Inc.
86. Philippine Pigments and Resins Corporation
87. Philippine Refining Co. Inc.
88. Philippine Rock
89. Philippine Standard Sanitary Wares Manufacturing Corporation
90. Philippine Wallboard Corporation
91. Philips Wire and Cable Corporation.
92. Planters Products Inc.
93. Procter and Gamble
94. Ramie Textile
95. Resins Incorporated
96. Rio Tuba Nickle Mining Corporation
97. Royal Porcelain Corporation
98. San Miguel Corporation
99. Solid Mills Inc.
100. St. Christopher Steel Corporation
101. Standart Electric Manufacturing Corporation

102. Starlight Industrial Co. Inc.
103. Taggat Industrial
104. Twin Rivers Research Centre
105. Union Glass and Container Corporation
106. Union Industries Inc.
107. United Laboratories Inc.
108. Universal Far East Corporation
109. Universal Robina Corporation
110. Vacu-lug Philippines Inc.
111. Victorias Milling Co. Inc.
112. Vitarich Corporation
113. Vulcan Industrial and Mining Corporation
114. Wearever Textiles Mills Inc.
115. Western Minolco Corporation
116. Wise and Company Inc.
117. Wire Rope Corporation of the Philippines
118. Wyeth-Suaco Laboratories Inc.

SOURCE: NSDB 8102 So. "Survey of Expenditure and Manpower for Research and Experimental Development in the Private Industry Sector, 1971-1980".

SAMOA

Table of Contents

SAMOA

GEOGRAPHY

Capital city: Apia
Main ports: Apia, Asau
Land surface area: 2,842 sq km

POPULATION (1978)

Total	0.15 million
Density (per sq km)	54
Urban/rural ratio	0.3
Average rate of growth (1970-78)	0.9%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	...	...	...	...	...	100%

SOCIO-ECONOMIC

Labour force (1976)	
Total	0.04 million
Percentage in agriculture	61.1%
Gross national product (1978)	
GNP at market prices	...
GNP per capita	...
Real growth rate of GNP per capita (1970-78)	...
Gross domestic product (1972)	
Total (in current producers' values)	US $45 million
Percentage by origin	
Agriculture	49%
Manufacturing, mining & quarrying, electricity, gas & water, construction	7%
Government finance	
National budget (1976)	...
As percentage of GNP	...
External assistance (official, net; 1976)	...
As percentage of GNP	...
Exports	
Total exports of goods (1978)	...
Average annual growth rate (1970-78)	...
External debt (1978)	
Total public, outstanding + disbursed	...
Debt service ratio (% GNP)	...
(% Exports of goods and non-factor services)	...

Exchange rate (1978): US $1 = 0.74 Tala

EDUCATION

Primary and secondary education (1978)	
Enrolment, first level	33,349
As % of (7-12 years)	...
Enrolment, second level	18,068
As % of (13-16 years)	...
Combined enrolment ratio (7-16 years)	...
Average annual enrolment increase (1970-1978)	3.3%

Higher education (third level) (1978)

Teaching staff, total	53

Students and graduates by broad fields of study:

	Enrolment	Graduates
Social sciences and humanities	425	...
Natural sciences	...	...
Engineering	...	...
Medical sciences	...	...
Agriculture	...	...
Other and not specified	...	...
Total	**425**	...
Number of students studying abroad	302	

Education public expenditure (1978)

Total (thousands of Tala)	3,012
As % of GNP	...
Current, as % of total	89.7%
Current expenditure for third level education, as % of total current expenditure	...

Table 1. Nomenclature and Networking of S&T Organizations

(Data unavailable at time of publication)

I - First level - POLICY-MAKING

Country: Samoa

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
....	....	....	....	....

II - Second level - PROMOTION & FINANCING

Organization	Linkages		
	Upstream	Downstream	Others
....	....	....	....

III - Third level - PERFORMANCE OF S&T

Establishment	Function	Linkages	
		Upstream	Others
....	....	....	....

Table 2 - Scientific and Technological Manpower

(Data unavailable at time of publication)

Country: Samoa

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total stock (thousands)	of which working in R&D
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965										
1970										
1975										
1979										
1985										
1990										

Table 3 - R&D expenditures

(Data unavailable at time of publication)

Country: Samoa
Currency:

Table 3a: Breakdown by source and sector of performance

Year:

Unit:

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive				
Higher Education				
General Service				
Total				

Table 3b: Trends

Year	Population (millions)	GNP (in US$ million)	Total R&D expenditures (in)	Exchange rate US $1 =
1965				
1970				
1975				
1979				
1985				
1990				

PART 1.

General Features

1.1 GEOPOLITICAL SETTING

The Samoan group of island extends from 13°26' to 14°22' S. latitude and from 168°10' to 172°48' W. longitude, and is about 1 600 miles east of New Zealand. The archipelago is devided administratively into two parts: the six islands east of 171° W. longitude constitute American Samoa, a dependency of the U.S., and the nine islands west of the 171° meridian constitute Western Samoa, a UN trust territory administered by New Zealand. Western Samoa consists of the inhabited islands of Upolu, Savaii, Manono and Apolima and the uninhabited islands of Fanuatapu, Namua, Nuutele, Naulua and Nuusafee.

Western Samoa has a total land area of 2 842 sq. km. Savaii, the largest island, has an area of 703 sq. ml. and is 60 miles long. Upolu has an area of 430 sq. ml. and is 58 miles long. The other seven islands of Western Samoa are quite small.

All the Samoan islands, except Nuusafee, are rocky and of volcanic origin. Upolu and Savaii have high inland ridges rising to peaks of 6 095 ft. in Savaii, and 3 608 ft. in Upolu. These islands have little level and except along the coast. The soil is alluvial and quite fertile in the valleys. Because of the heavy rainfall, the soil on hillsides is thin and there is no subsoil.

The climate of the islands is tropical but equable for a good portion of the year. From May to November strong southeast winds blow and the islands have experienced many severe hurricanes. June and July are the coolest and most pleasant months. The average temperature is 79.3° F. with a mean range from 73.8° to 84.7°. Rainfall is generally heavy; the central ridges receive over 200 in. annually.

The population of Western Samoa was 154 000 in 1978 with a population density of 54 inhabitants per sq. km. The capital city, Apia, had a population of 32 099 in 1976.

Transport

There are 931 kms. of roads in the islands, of which nearly 200 km. are bitumen surfaced. Main roads total 401 km, secondary roads 144 km. , and plantation roads 352 km. Major road construction being carried out includes a central road crossing the island of Upolu.

Registered vehicles

	1976	1977*	1978*
Passenger cars and buses	580	546	532
Private cars and lorries	1,289	1,304	1,362
Motor cycles	120	131	118
Pick-ups	1,574	1,599	1,639

* Provisional estimates

There are deep-water wharves at Apia and Asau.

There are regular passenger and cargo services linking Western Samoa with Australia, New Zealand, American Samoa, Fiji, French Polynesia, New Caledonia, Solomon Islands, Tonga, Panama, U.S. west coast port and various ports in Europe. Shipping companies operate regular cargo services to Western Samoa. There is an international air service operating from Apia, and domestic services.

Political System

The office of Head of State is presently held by His Highness Malietoa Tanumafili, who holds this post for life. After that the Head of State will be elected by the Legislative Assembly for a term of five years.

Executive power lies with the Cabinet, consisting of a Prime Minister, supported by the majority in the Legislative Assembly, and eight Ministers selected by the Prime Minister. Cabinet decisions are subject to review by the Executive Council, which is made up of the Head of State and the Cabinet.

Since the General Election of February 25th, 1967, the Legislative Assembly has consisted of 47 members with a three-year term. Samoans and non-Samoans have separate electoral rolls; two members from the individual voters' roll are elected by universal adult suffrage and the other 45 members by Matai (elected clan leaders) in 41 traditional electoral constituencies.

Judicial System

The Supreme Court is presided over by the Chief Justice and has full jurisdiction for both criminal and civil cases. Appeals lie with the Court of Appeal.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

Population

Samoans are a Polynesian people and closely akin to the people of Hawaii and the Maoris of New Zealand.

The official languages are English and Samoan. The Samoan language is believed to be the oldest form of Polynesian speech in existence. It is closely related to the Maori, Tahitian, Hawaiian and Tongan languages.

Despite the increasing contacts with the western world, Samoan culture is still the dominant influence in the lives of the people. The basic unit of Samoan society is the aiga, an extended family system headed by the matai. Kinship ties are important in Samoan social and economic life and all who are related by birth or adoption are recognized as belonging to one aiga.

Most of the population have become converts to Christianity. In Western Samoa, one half of the population is affiliated with the London Missionary society. Other major religious affiliations in Samoa are Roman Catholic, Methodist, Mormon and Seventh-Day Adventist.

Economy

Western Samoa's main exports are copra, cocoa, desiccated coconut and bananas, which are shipped to New Zealand, Australia and the United Kingdom. A serious economic slump which began in 1976, was eased in early 1977 by the rising price of copra and the fluctuating price of cocoa. Estimated revenue for 1978 was $A22.2 million, 18.4 per cent higher than the 1977 total. Aid for 1978 from Australia, New Zealand, other Commonwealth countries and the EEC was expected to reach $A8.6 million.

The Government's current financial programme aims to strengthen the balance of payments position and maintain reasonable price stability. In support of this programme, the International Monetary Fund, in February 1978, approved a special stand-by arrangement whereby Western Samoa was authorized to purchase up to the equivalent of 725 000 Special Drawing Rights over the following year.

Budget ('000 tala)

Revenue	1976	1977	1978*
Tax on income	1,867	2,674	2,890
Customs	6,739	9,422	9,650
Other tax revenue	93	98	502
Other receipts	3,521	3,225	5,694
Total	12,220	15,419	18,736

* Provisional

Budget ('000 tala)

Expenditure	1976	1977	1978*
Economic services	2,255	2,502	2,700
Social services	5,453	5,369	5,700
Other current expenditure	3,166	4,138	4,645
Investments	11,500	15,640	22,800
Total	21,464	27,469	35,845

* Provisional

Exchange rates, in 1979, were £1 = 1.937 tala (i. e. 100 tala = £51.63 = US$112.56). Per capita income was US$20[illegible].

1.3 DEVELOPMENT SCENE

Rural Development

In Western Samoa a programme of rural development has now be in under way for some time. However, the village structure presents some developmental problems.

Each village is largely autonomous and village affairs are very much a matter for the village to decide; only on disputes of extreme importance, such as those concerning land or titles, is a central authority invoked. As a consequence, the central government has to work through village structures if it is to achieve anything in a village at all. So, in the conception of the rural development programme, there was no thought of the government imposing a plan on the country. Either the initiative was to come from the villagers themselves, or the programme would be doomed.

Villages were invited by the government go work out their development priorities and, with the help of government personnel, draw up projects to be submitted for government approval. If approval was given, the government undertook to pay 65% of the total material costs of the project, the village being required to make a cash down-payment of 5% and raise the remaining 30% at the end of the project by way of a loan from the Development Bank. Given the fact that the initiative for projects is largely in the hands of local village organisations, it is not surprising that they tend to opt for projects which are within their own capabilities, except perhaps for the capital outlay and some technical assistance. This means that there has been a heavy bias towards agricultural projects.

There are currently about 470 projects approved in something like 180 villages, but not all of these are being implemented simultaneously. Villages tend to work through their projects one by one, depositing their five per cent down-payment project by project. When the five per cent has been paid into the rural development fund, the materials for that project are then delivered to the village together with any technical assistance needed. But the villagers must themselves implement the project, expertise being given on an advisory basis only.

This, of course, means that in terms of the total costs of a project, the village may well contribute more than its national 35%. It supplies all labour and, at times, materials such as fencing posts and building timber. But the government contribution may differ as well, since a number of items, such as fertilizer, are heavily subsidised.

The programme is active in about half the villages in the country and has been running since mid-1977. Though it is not possible to quantify the success of the programme, there are indications that it is achieving some of the hoped-for goals. For instance, it is creating new opportunities in villages against a background of general decline. It has contributed to an increase in the availability of a number of traditional crops such as taro and bananas. Villages with cocoa plantations in serious need of rehabilitation are using the scheme, and this will benefit the country's export efforts. The poultry projects will be a major factor in achieving national self-sufficiency in eggs.

All this is achieved for very little money. Because so many people are involved in the project (about 40% of the population) the relative cost is low. So far only a million dollars have been spent, administered by a rural development staff of five together with 184 Pulenu'u. This must surely be one of the greatest advantages of a decentralised system – its low costs.

Decentralisation does, however, have disadvantages as far as outside donors to a programme are concerned. The biggest donor is the European Economic Community, which requires outline costings of projects before implementation. Given that much of the initiative for projects remains within the village, changes do occur, and this can cause problems. However, the other donors, Australia and New Zealand, have given direct grants to the rural development fund and receive interim reports on how their money was spent when they so request.

Critics of the programme abound, both within and outside the country, however, the programme is continuing and it remains a unique and bold approach to improving the lives of rural Samoans.

Natural Resources for Development

Fishing Industry

The commercial fish catch for domestic consumption amounted to 1 700 tons in 1976, with 650 tons of tuna being caught. Foreign vessels using longline catch methods accounted for 160 tons. The Japanese fleet caught 24 tons by pole and line catch in the 200 mile exclusive economic zone.

Regarding fishing facilities, there are two harbours with port facilities: Apia on Upolu and Asau on Savai'i. Vessels usually lie at moorings, and vessels up to 7.7 m can be accomodated at the FAO boatbuilding yard near Apea. The FAO Danida boat building project near Apia builds the Alia type catamarans in ply or aluminium, and other wooden boats up to about 9 m. There a 6-7 ton freezer at Apia fishmarket: a similar one is planned for Savai'i under Japanese aid.

Fishing is administered by the Government Fisheries Department which has collected statistics since 1978, has a staff of 78, and four boats for training and trial fishing. Depending on the size of the vessel the fishing method is either long lining, trolling, bottom lining or surface fishing.

However, Western Samoa still imported $A700 000 worth of fish in 1976 and made no fish exports whatsoever.

Agriculture

Agriculture employs 67% of the total workforce in Western Samoa. With copra and cocoa accounting for 72% of the visible exports of W. Samoa in 1979. However, the exports of cocoa beans fell from 2 717 tons to 1 389 tons from 1971 to 1972. Furthermore, the number of people employed in agriculture, forestry and fishing fell by 10.5% between 1966 to 1971.

Soils in Western Samoa are derived from olivine basalt and are relatively fertile, yet 51% of the land area has soils of "low-to-very-low" natural fertility or is too steep or poorly drained to be of significant use for agriculture. A further 35% is generally too rocky for mechanized agriculture.

For the last thirty years most emphasis in the encouragement of export agriculture has been given to production in the mixed subsistence-cash cropping system.

The promotion of cocoa and copra in Western Samoa has been promoted within this system. The banana export trade, which was extremely important for Western Samoa until relatively recently, was also based on production by village farmers operating within the mixed subsistence-cash cropping mode.

For a variety of reasons it seems unlikely that this production system can continue to meet the growing demands which both government and farmers place on commercial agriculture. In the first place, apart from returns from export levies, which for obvious reasons governments are reluctant to increase, relatively little revenue is obtained from incomes generated by smallholder agriculture. In most cases the impossibility of collecting income tax from self-employed smallholders, even where their incomes exceed that which would be liable for taxation if obtained within the wage sector, means that smallholder agriculture is of limited attraction to government as a revenue source. From the viewpoint of many farmers the area of land available to them is frequently inadequate. Absolute land shortage, or social barriers to access to land, prevent the establishment of holdings which would be commercially viable in a dominantly commercial system.

One of the important trends in export agriculture, particularly with items such as bananas and other perishable foods, has been for the standards of packing and marketing to rise in the importing countries. An example is provided by the import of bananas into New Zealand. Until the mid-1960's, Fiji, Tonga and Western Samoa supplied the whole market and production came almost entirely from small village producers. When problems of disease, shipping and hurricane damage prevented these countries from maintaining a supply (a situation in itself closely related to their small size) New Zealand turned to Ecuador for its banana requirements. Despite the longer distances from the source of supply, the Ecuadorian fruit arrived in New Zealand in much better condition than the average Pacific island product. In particular, the standardized size, evenness in stage of ripeness and absence of marking and bruising, all made the product much more attractive to whole-salers, retailers, and consumers, despite some preference for the taste of Pacific island bananas. These qualities, which are now what the market prefers, are achieved through largescale production employing a high level of agronomic technology, careful handling and packing, grading for size, and the chemical control of the ripening process. Until such time as the Pacific island countries can match the reliability of supply, standardization of product, and quality of production from Ecuadorian estates, there is little prospect of recapturing the New Zealand market. It is doutful if this can be done under the mixed subsistence-cash cropping system.

In Western Samoa the plantations operated by the Western Samoa Trust Estate Corporation (WSTEC) might well be developed to provide a revenue base for government and a stable core for export production. An earlier choice of an unsuitable planting material resulted in a major decline in WSTEC's cocoa production and demonstrates some of the risks involved by small countries in dependence on a narrow crop range. It also demonstrates the need for extremely high levels of managerial and agronomic competence.

WSTEC provides an example of a form of state-owned plantations which may become increasingly attractive to both national and sub-national governments in several Melanesian countries. Whether such enterprises will have much impact on smallholder producers is doubtful unless deliberate attempts are made to utilize management and technical skills available on the estates to provide a supra-structure for neighbouring smallholders, both 'independent' farmers and those producing within the village systems. For those countries where land is more plentiful the long-term goal should probably be to develop a variety of system under which smallholders can combine under some form of joint marketing and input provision.

However, despite the very important contribution of agriculture to the domestic economy of Western Samoa, important efforts are being undertaken to conserve certain areas of Western Samoa's natural environment. The natural environment of Western Samoa is characterised by rain forests and mangrove swamps. These areas provide a natural resource but will also need careful management and legislative protection. Western Samoa adopted the Stevenson Memorial Reserve and Mount Vaea Scenic Ordinance in 1958, The Forests Act (1967) allows for the delaration of Protected Lands. The National Parks and Reserve Act (1974) administered through the Forestry Division provides for National Parks, and Nature, Recreation and Historic Reserves. At present, there are four existing nature reserves; and 29 other reserves are proposed.

PART 2.

Scientific and technological potential

2.1. HUMAN RESOURCES

Western Samoa had a total of 541 scientist engineers and technicians in 1973, 140 of the 350 scientists and engineers were female and 36 of the 164 technicians. 140 scientists and engineers, 92 technicians and 48 auxiliary personnel. Integrated R&D was undertaken by 73 workers; 30 scientists and engineers, 18 technicians and 25 auxiliary personnel. Non-integrated R&D was being conducted by 65 researchers: 25 scientists and engineers, 25 technicians, 15 auxiliary personnel. In higher education 85 R&D personnel were active in research, 60 scientists and engineers, 21 technicians and 4 auxiliary personnel. Finally, 57 persons were working in general services, 25 scientists and engineers, 28 technicians and 4 auxiliary personnel.

2.2. FINANCIAL RESOURCES

The total expenditure for research and experimental development by type of expenditure for 1978 was as follows: a total expenditure of 2.5 million Tala, with a capital expenditures 2 million Tala and a current expenditures 0.5 million Tala.

The current expenditure for research and experimental development can further be subdivided for research and experimental development by type of R&D activity. Current expenditure in 1977 amounted to a total of 341 000 Tala. 62 000 Tala (18.2%) were spent on fundamental research; 49 000 Tala (14.4%) on applied research; and 230 000 Tala (67.4%) on experimental development.

Detailed by sector of performance, R&D expenditure in 1978 reached a total of 2.5 million Tala; 1.251 million were spent on integrated R&D in the productive sector; 0.556 million Tala on non-integrated R&D. Higher education received 0.282 million Tala and general services were given 0.211 million Tala.

Total and current expenditure for performance of research and experimental development can be detailed by source funds. The 2.5 million Tala spent in 1978 came from: government funds (1.5 million Tala or 60%); productive enterprise funds (0.5 million Tala or 20%); foreign funds (0.2 million Tala or 8%); and others (0.3 million Tala or 12%).

The total intramural R&D expenditure was 217 000 Tala in 1975 distributed over the major development areas as follows: 8.9% for agriculture; 8.7% for industrial development; 7% for energy; 28.5% for transport and communications; 9.2% for education services; 28.0% for health services; 2.8% for advancement of knowledge; 6.9% others.

PART 3.

Developmental problems

3.1. EMIGRATION

Upon independence in 1962, Western samoa was given a quota of 1 500 migrants a year by New Zealand, but by the early 1970s net migration had increased to about 4 000 a year. Although the current economic problems in New Zealand may have slowed this migration down a little, the current population profile for Western Samoa shows a net migration rate of 2% a year. This disappearance of manpower may hamper the future development of the country.

3.2. Development Funding

Western Samoa is member of the International Bank for Reconstruction and Development (IBRD). In the International Bank for Reconstruction and Development, Western Samoa subscribed 17 shares (0.01% of the total). It has a voting power of 267 votes or 0,8% of the total. Ever since 1976, the World Bank has assisted the development of Western Samoa. In that year, the Bank approved the provision of technical assistance for the formulation of a Coconut Oil Processing Mill Project. Implementation of the Project is given a high priority in the Government's current Development Plan. Since coconut is the most important primary commodity in Western Samoa, the Government aims at processing of coconut and its derivatives into higher-value products for export as well as for domestic sale. The achievement so far, however, has been very limited.

Expressed in terms of copra equivalent, the annual production of coconut in Western Samoa during the past few years has ranged from about 31 000 to 35 000 tons, of which on the average about 16 000 tons a year were exported and the rest consumed domestically. On the basis of the existing population growth rate and the per capita domestic consumption of coconuts, it is estimated that the country will continue to have a surplus copra production of at least 15 000 tons per year in the foreseeable future. The surplus copra production will be sufficient to support the operation of the proposed coconut oil processing mill. The mill, when completed, will have a capacity to process about 40 tons per day or about 13 000 tons per year.

In Fiscal 1981 (1 July 1980-30 June 1981) Western Samoa received 2 million dollars of assistance for agriculture and rural development from the IDA. This project will assist the government in increasing agriculture protection and export earnings, save foreign exchange, and provide better incomes and employment opportunities in the rural sector. Co-financing is being provided by the Asian Development Bank (ADB) of $3 million, and the Australian Development Assistance Bureau (ADAB) of $2 million. The total cost of this project is $7.8 million.

Western Samoa is member of the International Development Association with 7 537 votes (0.21% of the total). Its total subscription and supplementary resources are US$111 000. As of 30 June 1981, Western Samoa had three IDA credits for a total amount of US$14.4 million.

Western Samoa is also a member of the World Bank's International Finance Corporation which is concerned with investing in productive private enterprise.

Western Samoa is a member of the Asian Development Bank (ADB) which can be regarded one the Pacific's major international finance institution. It has received technical assistance as well as loans from the 'Special Funds '; these loans carry a 1% annual service charge and enjoy a 40 year repayment period with a 10 year grace period in respect of the principal.

Pacific countries which are signatories of the Lomé Convention are entitled to participate (inter alia) in the activities of the European Development Fund (EDF) - an agency for financial and technical co-operation between the European Economic Commission (EEC) and associated overseas states and territories. Three countries in the Pacific (Fiji, Tonga and Western Samoa) are signatories to the Lomé Convention and have been allocated specific drawing rights (units of account or UA).

In addition to support for individual countries in the region, there is a $10 million UA programme for regional projects to be undertaken through the South Pacific Bureau for Economic Co-operation (SPEC). These were, in May 1978:

	UA ($"000,000)
Telecommunication Network	4.3
Telecom Training Centre	1.5
Applied Agricultural Research	1.0
Marine Resources Centre	1.0
Regional Rural Development Centre	1.2
Reserve	1.0
	10.0

Such regional projects will be funded on a grant basis while specific country assistance is in the form of loans on special terms.

The Prime Ministers of Tonga, Fiji and Western Samoa signed a Memorandum of Agreement (1977) for submission to the European Development Fund for a regional rural development fund to be implemented by the University of the South Pacific.

Bilateral Aid

Bilateral aid from Australia included $A97 000 for economic planning and public administration; $A535 000 for public utilities; $A231 000 for agriculture, forestry and fishing; $A1 864 000 for industry, mining, construction; $A404 000 for trade, banking and tourism; $A264 000 for education; $A286 000 for social infrastructure; $A120 000 for other purposes. Total Australian aid to Western Samoa was $A3 801 000.

National Development Bank

Together with Fiji, the Cook Islands, Solomon Islands, and Tonga, Western Samoa has established what may well be the Pacific prototype of a development bank which is geared to serve all sectors of commerce, industry and agriculture. In addition to providing credit for all project sectors of the economy with a marginal "development flavour", they also provide guarantee and equity facilities to support cash flow in projects which might otherwise not be in a position to "get off the ground". Involved trading and development banks are: the Bank of Western Samoa, the Pacific Commercial Bank, and the Development Bank of Western Samoa.

PART 4.

Bibliography

The Islands States of the Pacific and Indian Oceans: Anatomy of Development. The Australian National University Development Studies Centre Monograph no. 23, R.T. Shand, (ed.)

Annual Report. The World Bank.

World Development Report.

Statistical Yearbook. Unesco. 1980.

South Pacific Bulletin.

A. Dahl, *Regional Ecosystem Survey of the South Pacific Area* Technical Paper 179 SP p/IUCN.

SINGAPORE

Table of Contents

SINGAPORE

GEOGRAPHY

Capital city: Singapore
Main ports: Port of Singapore
Land surface area: 581 sq km

POPULATION (1978)

Total	2.3 million
Density (per sq km)	4,018
Urban/rural ratio	(Reported to be 100% urban)
Average rate of growth (1970-78)	1.5%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	29.3	12.4	11.7	39.4	7.1	100%

SOCIO-ECONOMIC

Labour force (1978)

Total	1.0 million
Percentage in agriculture	1.8%

Gross national product (1978)

GNP at market prices	US $7,600 million
GNP per capita	US $3,260
Real growth rate of GNP per capita (1970-78)	6.6%

Gross domestic product (1976)

Total (in current producers' values) (1976)	US $5,915 million
Percentage by origin	
Agriculture	2%
Manufacturing, mining & quarrying, electricity, gas & water, construction	35%

Government finance

National budget (1978)	US $1,816 million
As percentage of GNP	23.7%
External assistance (official, net; 1976)	...
As percentage of GNP	...

Exports (1978)

Total exports of goods	US $10,134 million
Average annual growth rate (1970-78)	9.8%

External debt (1978)

Total public, outstanding + disbursed	US $1,134 million
Debt service ratio (% GNP)	4.0
(% Exports of goods and non-factor services)	2.3

Exchange rate (1978): US $1 = 2.27 Singapore Dollars

EDUCATION

Primary and secondary education (1978)

Enrolment, first level	297,102
*As % of (6-11 years)	109%
Enrolment, second level	187,713
As % of (12-17 years)	57%
Combined enrolment ratio (6-18 years)	80%
Average annual enrolment increase (1970-1978)	−0.7%

---

* The enrolment ratio is the relationship between the number of all pupils enrolled (regardless of their age) and the number of the population of the relevant official ages.

Higher education (third level) (1978)

Teaching staff, total	1,592

Students and graduates by broad fields of study:

	Enrolment	Graduates
Social sciences and humanities	10,539	2,088
Natural sciences	1,520	501
Engineering	10,948	3,111
Medical sciences	846	189
Agriculture	...	...
Other and not specified	261	...
Total	**24,114**	**5,889**

Number of students studying abroad	3,619

Education public expenditure (1978)

Total (thousands of Singapore Dollars)	439,065
As % of GNP	2.5%
Current, as % of total	92.5%
Current expenditure for third level education, as % of total current expenditure	14.7%

Table 1. Nomenclature and networking of S&T Organizations

I - First Level - POLICY-MAKING

Country: Singapore

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
Ministry of Education	Co-ordination, executive and advisory. Formulation and implementation of educational policies.	Cabinet Parliament	Technical colleges (2) Vocational & Industrial Training Board, Institute of Education, Science Centre Board, National University of Singapore	Other ministries
Ministry of Trade and Industry	Control, co-ordination, executive and advisory.	Cabinet Parliament	Singapore Institute of Standards & Industrial Research, Economic Development Board, Jurong Town Corporation, Science Council of Singapore	Other ministries
Ministry of Health	Policy direction, control and administrative support services, and administering legislation	Cabinet Parliament	Hospitals (13) Pathology Department Department Scientific Services	Other ministries
Ministry of Communications	Direction and co-ordination of activities and agencies involved in the provision of land, sea, and air transport as well as postal, telecommunications and telephone services.	Cabinet Parliament	Meteorological Services Department Telecommunications Authority of Singapore	Other ministries
Ministry of the Environment	Control, co-ordination and executive	Cabinet Parliament	Sewerage Department Vector Control & Research Department, Quarantine & Epidemiology Department	Other ministries
Ministry of National Development	Control and executive	Cabinet Parliament	Public Works Department Primary Production Department	Other ministries

II - Second Level - PROMOTION & FINANCING

Country: Singapore

Organization	Linkages	
	Upstream	Downstream
Ministry of Trade & Industry	Cabinet Parliament	Economic Development Board Jurong Town Corporation Science Council of Singapore
Economic Development Board	Ministry of Trade and Industry	Industrial training centres (4) Financial Assistance Schemes (Skills Development Fund, Product Development Assistance schemes, etc.) Kent Ridge Science Park
Jurong Town Corporation	Ministry of Trade and Industry	Industrial estates Kent Ridge Science Park Industrial port and marine base International petroleum centre
National Computer Board	Ministry of Finance	Government departments, agencies and educational institutions

III - Third level - PERFORMANCE OF S&T

Establishment	Function	Linkages	
		Upstream	Other Major
International University of Singapore	R&D, STET	Ministry of Education	Regional and international research centres
Public Works Department	R&D, STS	Ministry of National Development	
Primary Production Department	R&D, STS	Ministry of National Development	Local and regional research centres
Sewerage Department	R&D, STS	Ministry of the Environment	
Quarantine and Epidemiology Department	R&D, STS	Ministry of the Environment	
Vector Control and Research Department	R&D, STS	Ministry of the Environment	
Department of Scientific Services	R&D, STS	Ministry of Health	Various other government departments
Pathology Department	STS	Ministry of Health	
Meteorological Services Department	R&D, STS	Ministry of Communications	Other government departments, local and regional research centres
Science Council of Singapore	STET, R&D	Ministry of Trade and Industry	Local, regional, and international scientific institutions
Singapore Institute of Standards and Industrial Research	R&D, STET, STS	Ministry of Trade and Industry	Industry and commerce, regional and international research centres
Singapore Polytechnic	R&D, STET	Ministry of Education	Industry and commerce, regional and international research centres
Ngee Ann Technical College	R&D, STET	Ministry of Education	Industry and commerce, regional and international research centres
Nanyang Technological Institute	R&D, STET	Ministry of Education	
Vocational and Industrial Training Board	STET	Ministry of Education	Industry and commerce, regional and international research centres
Science Centre Board	STET	Ministry of Education	
Applied Research Corporation	R&D, STS		Institutions of higher learning, research centres in the ASEAN countries, Australia, New Zealand and the United States

STA : Scientific and technological activities
STET : Scientific and technological education and training
STS : Scientific and technological services

Table 2 - Scientific and Technological Manpower

Country: Singapore

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total stock (thousands)	of which working in R&D
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965	1.88									
1970	2.41									
1975	2.26									
1979	2.38		461	134	143	28	83	73		267
1980		44							39.7	
1985	2.56									
1990	2.70									

Table 3 - R&D expenditures

Country: Singapore
Currency: Singapore Dollar

Table 3a: Breakdown by source and sector of performance

Year: 1978

Unit:Millions

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive	15.470	13.905		29.375
Higher Education	8.235	7.368	0.618	16.222
General Service	4.069	3.077	0.824	7.970
Total	27.775	24.350	1.442	53.567

Table 3b: Trends

Year	Population (millions)	GNP (in millions)	Total R&D expenditures (in millions)	Exchange rate US $1 = 2.04
1965	1.88			
1970	2.41	4.73		
1975	2.26	10.31		
1979	2.38	14.34	37.2	
1985	2.56			
1990	2.70			

PART 1.

General Features

1.1 GEOPOLITICAL SETTING

The Republic of Singapore is strategically situated betwen latitudes 1°09' and 1°29' North and longitudes 103°38' and 104°06' East. It consists of a main island and 54 islets. The main island is about 41.8 kilometres long and 22.5 kilometres broad, and has a coastline of 193.7 kilometres. The total land area of Singapore, including the islet, is 617.8 square kilometres. This makes Singapore one of the smallest nations in the world. In addition to its small size, Singapore is also essentially a city state as its rural sector is negligible.

As a result of its successful family planning programme initiated in 1966, Singapore has been able to reduce its annual population growth rate and by the end of June 1980, it had a population of 2.41 million persons and a population density of 3 900 persons per square kilometre. Being near the equator, Singapore has a tropical climate with a high daily average temperature and relative humidity, which is moderated by the influence of the sea. Rain falls throughout the year but is most heavy during the months of November to January because of the Northeast Monsoon. The water supply system has 7 treatment works with a total rated treatment capacity of 1 317 000 cubic metres a day. The average daily consumption of water in 1980 was 667 446 cubic metres, and per capita consumption was 96 cubic metres.

Singapore is the second largest port in the world in terms of tonnage handled and the port of call for more than 150 major shipping lines from various countries. The Changi International Airport which began operations on July 1, 1981 serves more than 30 international airlines. In 1979, the former Paya Lebar International Airport recorded a total of 65 775 commercial aircraft movements and served more than 6.4 million passengers.

After 140 years of colonial rule by the British, Singapore attained self-government in June 1959 and independence in August 1965 after separation from Malaysia. The Head of State is the President, who is elected by parliament for a term of four years. The Head of Government is the Prime Minister who is appointed by the President and who presides over the cabinet which has 14 members. Parliament is unicameral and the 75 members are elected by the people for a term of five years. During the last general election in December 1980, the ruling People's Action Party (PAP) was returned to power for the fifth successive time.

The public bureaucracy is made up of the Singapore Civil Service (SCS) and the various statutory boards. The SCS has a total of 15 ministries and in 1979 it employed nearly 69 000 persons. The statutory boards were created by the PAP government after 1959 to expedite the implementation of socio-economic development programmes. For example, the Housing and Development Board was created in February 1960 to tackle the housing shortage, and the Economic Development Board was formed in August 1961 to promote economic development. There are now a total of 82 statutory boards which provide employment for 65 000 persons.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

National Profile

Singapore is a multi-racial nation where Chinese account for 77% of the population, Malays 15%, Indians 6% and other ethic groups 2%. The population of Singapore stood at 2 413 945 as in June 1980. Of these 27% were below the age of 15. English is the language of administration. The other official languages are Chinese, Malay and Tamil; 84% of the population are literate in at least one of the official languages. The main religions are Islam, Buddhism, Christianity and Hinduism. Other important indicators are:

Ratio of males: females	1 042: 1 000
Rate of population growth	1.2% p. a.
Persons per doctor	1 222
Persons per telephone	3
Persons per TV	6
Per capita GNP at market prices	$7 167

Economic Performance

Against the backdrop of sluggish world economic conditions, the expansion of the Singapore economy since 1975 continued uninterrupted. Gross domestic product (GDP) in real terms grew at 10.2% in 1980, the first double-digit annual growth rate since the 1974-75 world recession.

The economic growth was broadly based. The manufacturing sector which grew by 12% continued to be the prime mover of the economy. It contributed a quarter of the real GDP growth as a result of strong external demand and greater diversification in products and foreign markets.

The second largest source of growth was the finance and business services sector. It expanded by 17%, contributing 23% of the economic growth and replacing the trade and transport and communication sectors as the second largest source of growth. The impetus came from the rapid expansion of the Singapore economy and the economies of its neighbours, the boom in construction and property markets, and the active trading in stocks and shares.

Transport and communication grew moderately by 12% and accounted for 20% of the real GDP growth. Commerce, the largest economic sector, expanded at a steady rate of 7%, buoyed by the flourishing retail business and tourist trade. The construction sector experienced a 10% growth, boosted by the sharp increase in public sector development expenditure and the substantial demand for office space, hotels, residential accomodation and shopping complexes.

The balance of payments was in net overall surplus, rising to $1.4 billion in 1980. The higher oil bill and larger import of intermediate and capital goods widened the trade deficit to $9.9 billion compared with $7.4 billion in 1979. Major export commodities are mineral fuels, machinery and equipment. Trade deficit was offset by higher capital inflows as a result of increased foreign investment, favourable performance of the economy, and the strength of the Singapore dollar.

1.3 DEVELOPMENT SCENE

Early Development

Modern Singapore was not originally conceived as a diversified economy. The British founded it as a free port. Regional trade accounted for 38% of Singapore commerce in 1884. This depended primarily on the British East India Company's monopoly of the China trade. The development of tin mines in

Malaya and rubber plantations in the region provided new economic opportunities. The introduction of modern processes for tin smelting in 1887 made Singapore the smelting exporting centre for the region's tin.

The opening of the Suez Canal in 1869, the advance of steamships and the beginning of the international telegraph in 1870 launched the era of modern international trade, which catalysed Singapore's role as an entrepot. Singapore became the export centre for the primary commodities produced in the region, such as rubber, copra, tin, sugar, tea and spices.

Development in the Sixties

With increasing demands for direct trading by Singapore's neighbours, the entrepot trade, the mainstay of the economy and the main impetus to the development since her finding in 1819, faced an uncertain future in 1959. Moreover, Singapore was at that time suffering from a substantial amount of unemployment. Added to this was the continuing increase in the population growth rate of 3.3% (1959). Furthermore, apart from its strategic location at one of the major crossroads of the world, Singapore has few other resources which it could fall back on to solve its economic problems. In other words, when Singapore entered the Sixties, it was already burdened with the problems of economic vulnerability.

Conscious efforts were made in the beginning of the Sixties to industrialise. This was undertaken firstly to create employment opportunities for the expanding labour force and to provide Singapore with an alternative economic base to entrepot trade. In the early part of the decade, the industrialisation programme was oriented towards the more labour-intensive and import-substitution industries. However, the limitation of this policy in the context of the small domestic market led to a re-direction towards export-oriented industries. By 1965, the Government began actively encouraging the change from import-substitution to export-promotion industries. Efforts were concentrated on the development of infrastructure conducive to industrial ventures the training of necessary technical and skilled manpower, and the setting up of technical and vocational institutions. The Government also introduced a series of policy acts aimed deliberately at promoting investment in industries. For instance, tax incentives were introduced and the Employment Bill and the Industrial Ordinance Acts, directed at attracting foreign investors with the higher discipline in labour relations, were passed. During the Sixties, real GDP grew at a creditable rate of 8.7% per annum.

Development in the Seventies

By 1970, the unemployment problem was almost over. Singapore began to embark on a new phase of industrial development with emphasis on higher-skill and technology. Priority was given to industries that manufactured high quality products for worldwide markets. Industries demanding high skill and producing goods of a higher value-added nature were encouraged.

Double-digit growth rates continued into the Seventies until the oil crisis and world recession of 1974-1976 interrupted the new industrialisation programme. Fear of a recession and consequential unemployment caused the economy to cling on to labour intensive industries, so that economic upgrading had to slow down. As a result of the economic activation programme, the Singapore economy weathered the recession successfully and the economy grew at an average annual rate of 8.2% in 1976-79, as compared to a growth rate of 6.8% in 1974 and 4.0% in 1975.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

Although economic growth in the Seventies was creditable, it was achieved more through a quantitative input of workers than productivity increases. Industries and services hence remained too labour-intensive. By the end of the decade, the problem of a labour shortage surfaced. With the danger of protectionism in advanced industrial countries and a tight labour supply at home, the Government has to embark on an economic restructuring programme aimed at upgrading industries and services to produce high value-added products. The sectors that are earmarked as pillars of growth of the economy for the next ten years are manufacturing, trade, transport and communications, and the service sectors, namely, tourism, financial, medical and computer services.

Sectoral Objectives

Manufacturing

By the end of this decade, it is hoped that a commendable industrial base would have been established with industries ranging from the manufacturing of machine tools, aerospace components, and petro-chemicals to electronic and computer software developments. These are high value-added products that would be able to withstand better the pressures of protectionism. To achieve the objective, the Economic Development Board (EDB), together with the Jurong Town Corporation (JTC), will continue to improve the industrial infrastructure and expand manpower development and introduce suitable fiscal incentives to enhance the country's attractiveness to new and more sophisticated investments.

Trade

The Department of Trade (DOT) continues to be the key body to carry out the task of trade development. Local manufacturers will be encouraged to step up their export drives. It is hoped that, by 1990, manufactured goods will form about 60% of the country's exports.

Services

Financial Sector

In the Eighties, we shall develop Singapore into a financial supermarket offering a wide and sophisticated range of financial services. Banks will be encouraged to improve their efficiency and productivity through greater computerisation and other forms of automation. The Monetary Authority of Singapore (MAS) will be the key body to advance this objective.

Transport and Communications

Our role in air transportation will grow in its importance in the Eighties. Together with the continued upgrading of our port and telecommunications services, the growth of our national airlines and shipping lines and the establishment of aircraft and servicing industries, this sector should remain an important pillar of growth for the economy.

Tourism

The Singapore Tourist Promotion Board (STPB) will continue to enhance the attractiveness of Singapore for tourists.

Computer Services

The promotion of computer services industries will form an integral part of our economic restructuring programme in the Eighties. Computers will be used to improve our productivity, both in the public and private sectors. Exports of computer software and services will also be encouraged.

As a key policy instrument for economic restructuring, high wage increases of about 20% were introduced in May 1979 to discourage labour-intensive industries in carrying out their activities and assisting industries to mechanise and improve productivity. Fiscal incentives and manpower training were also noted to be essential tools for achieving economic restructuring. To assist companies to switch to high-skill industries, the Skills Development Fund (SDF) was established and companies may ask for financial assistance to meet the training needs of its manpower.

2.2 DEVELOPMENT POLICY AND SCIENCE/TECHNOLOGY POLICY

The prime objective of the economic restructuring programme for the Eighties is to develop Singapore into a modern industrial economy based on science and technology, skills and knowledge. Science and technology policy is thus a derivative of the development policy.

The Government in its efforts to upgrade the quality and competitiveness of Singapore's manufactured goods and services in world markets will continually seek foreign expertise and technologies through the Multinational Corporations (MNCs), using their modern technology and access to world markets. At the same time, local manufacturers will be assisted to make the grade. The inflow of foreign investments will provide opportunities for local entrepreneurs to acquire modern technology and know-how through joint ventures and participation in supporting industries.

While MNCs with new technology and products will be encouraged to continue to invest in, and set up, manufacturing industries in Singapore, it is recognised that appropriate programmes for the development of an indigenous technological base and R&D capability should also be formulated. Hence, the Government has developed a long-term R&D plan for Singapore. To encourage MNCs to shift some of their research activities to Singapore, as well as local industries to undertake R&D, tax concessions are being introduced. The Product Development Assistance Scheme (PDAS) introduced recently will also assist local industries in research and product development. To stimulate interest in practical research work, the Government has also increased its funding for public institutions undertaking research work. A block vote of $50 million, spread over a 5-year period, has been implemented. Also under way is the development of a Science Park to stimulate collaboration between University, Government research organisations and industries.

The critical factor determining our economic performance in the Eighties will be the availability and quality of our manpower. Consequently, a sufficient number of engineers and technicians as well as R&D personnel will have to be trained for the higher-skill industries and services. Plans have been made to expand the first-year enrolment at the National University of Singapore (NUS) by 20%, Polytechnic and Ngee Ann Technical College by 40%, and the Vocational and Industrial Training Board (VITB) and EDB Training Centres by 125%. The Nanyang Technological Institute (NTI) has been set up to train 1 000 practice-oriented engineers a year for industry while the NUS will concentrate in producing engineers with an aptitude for R&D work. The manpower development programme will also cover the training needs of existing workers. The VITB is working out an operational plan to step up continuing education and training to retrain existing workers to meet the higher skill needed by industries and services as they upgrade and restructure. The SDF will be used to subsidise employers to release their workers for such continuing training courses.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE & TECHNOLOGY

Scientific and technological policies in the public sector are formulated along sectoral lines. Each government ministry has within its sphere of interest and responsibilities a number of statutory boards and specialised departments/units which plan and implement their own scientific and technological programmes. Major decisions on scientific and technological programmes are, however, undertaken at cabinet levels. The various ministries and government institutions which undertake scientific and technological activities are summarised in Table 1.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

The public bodies that perform science and technological services (in some instances R&D) are as follows:

(1) Science and Technological Services

The Telecommunication Authority of Singapore (TAS)

TAS is responsible for both domestic and external telecommunication services of the country. In the last decade, the number of telephones increased by 4.7 times, and international traffic increased by 22 times.

The Electronic Data Processing (EDP) Services of Telecom continues to develop and expand its activities in providing computer support services to improve Telecoms operational efficiency and service to subscribers.

Singapore's first multi-channel international transmission link was established in 1967, with the inauguration of the South East Asia Commonwealth Submarine Cable System linking Singapore to Australia. Singapore is the western terminus of the Commonwealth Submarine Cable System.

The first segment of the ASEAN Submarine Cable Network linking Singapore to the Philippines was inaugurated on October 3, 1978. This $122 million project with a capacity of 1 380 circuits, complements the existing satellite links between the 2 countries.

The Indonesia-Singapore Submarine cable was completed, and put into service in April 1980. The completion date for the Singapore-Malaysia-Thailand cable has been scheduled for the third quarter of 1982.

Singapore's first communication satellite earth station on the island Sentosa was officially opened in October 1971. The single antenna, beamed towards INTELSAT (International Telecommunication Satellite Organisation) III over the Indian Ocean, was modified to give access to INTELSAT IV in July 1972 thereby providing direct communication with Australia, Hong Kong, India, Indonesia, Japan, Philippines, Thailand, UK and West Germany.

Erection of a second antenna in 1974 gave access to the Pacific Ocean Region Satellite thus linking Singapore with the People's Republic of China, New Zealand, South America and the USA.

Further modification of the first antenna in 1978 allowed communication with the newly launched INTELSAT IVA giving contact with new locations in the Middle East, Africa and Europe.

New modifications to meet technical requirements for the Dual Polarisation Frequency Re-Use transmission technique, to be completed in the third quarter of 1980, will double the transmission capacity to 12 000 channels using the INTELSAT V satellite series.

Singapore Institute of Standards and Industrial research (SISIR)

SISIR is a statutory body established in 1973. SISIR was formed to assist industries by upgrading the technology and the quality of local products, to promote acceptance of Singapore-made products, to provide technical and consultancy services, and to encourage industrial research and development in local industries.

The Institute has 6 divisions, namely the Engineering Division, the Materials and Electrotechnology Divisions, Chemical Technology Division, the Standards and Extension Services Division, the Planning and Development Division and the Secretariat to undertake the day-to-day operations of the Institute.

Each division is responsible for specific operations; the Standards and Extension Services Division, for instance, is responsible for standardisation and quality assurance, dissemination of technical information, and computer services and industrial design.

Department of Scientific Services

The Department of Scientific Services is the main government scientific institution providing scientific back-up services required by the ministries and departments in their respective programmes. These include the eradication of drug abuse, quality control of medicinal products, protection of the public with regard to food, collection of revenue for alcoholic beverages and pollution control.

Meteorological Services Department

The Meteorological Services Department operates three weather forecast offices and four meteorological observation stations.

Primary Production Department

The Primary Production Department is responsible for the implementation of Government policies on agricultural and fisheries development in Singapore. Its major functions are to plan, develop and manage farming estates, conduct research on intensive farming methods, animal nutrition and disease control and provide extension services to farmers and fishermen.

Public Works Department

The Public Works Department provides a whole range of engineering, architectural and building control services. In addition, the department is responsible for the maintenance of all government plants, machinery and public buildings. In 1980, the Department spent $593.4 million, $171 million more than in the previous year. Development projects accounted for $479 million or 81% of the total expenditure.

Various other departments such as the Metrication Board and the Computer Services Department also provide scientific and technological services in their respective areas. Various other statutory boards have been set up for the development of utilities and infrastructure development and to manage essential services such as water, gas, public housing, parks and highway development. Many of them have developed their own scientific and engineering departments to serve their own requirements.

(2) Science and Technological Education and Training

The public bodies performing science an technological education and training (and in the institutions of higher learning, R&D), are:

National University of Singapore (NUS)

The National University of Singapore has eight faculties, namely, Arts and Social Sciences, Law, Science, Medicine, Dentistry, Engineering, Architecture and Building, Accountancy and Business Administration, and three schools, namely, Postgraduate Medical Studies, Postgraduate Dental Studies and Management.

Ngee Ann Technical College and Singapore Polytechnic

The two colleges undertake the training of technicians to diploma level. Courses offered by the two colleges cover various engineering subjects, shipbuilding and repairing and building science. The courses are reviewed periodically and modified, or new courses introduced, to meet the changing needs of the industrial sector.

Nanyang Technological Institute

The new Nanyang Technological Institute (NTI) in Jurong will have its first student enrolment in 1981. These engineering students will take their first year course at the National University of Singapore (NUS) together with the NUS students. Hence the NTI will only take in its first batch of about 600 second year students in July 1982. Thereafter the intake of students is expected to increase eventually to 900. The NTI's 4 year course will aim at producing practice-oriented engineers and will be complementary to engineering training at the NUS. Graduates of the Institute will receive NUS degrees.

A committee has been set up to plan and develop the curriculum structure and staff recruitment policy for the NTI. Academic staff of the Institute are expected to be engineers with considerable experience in industry. Initially lecturers may be recruited from abroad. The Institute will eventually have a student population of 3 000 and a student to staff ration of 10:1.

Government-Industries Training Centre Administered by the Economic Development Board (EDB)

The EDB was incorporated in 1961. Its primary mission was to promote the establishment of new industries and accelerate the growth of existing ones. The EDB is also responsible for ensuring that skilled scientific and technical manpower needs of new industries are met through industrial training schemes.

Since 1972, EDB, in collaboration with 3 private firms and the Japanese Government, has established 4 Joint Training Centres. These centres produce highly skilled workers in the field of precision engineering. As at April 1981, more than 1 700 apprentices have completed 2 years in centre training.

In 1982 and 1983, EDB will be extending its training activities to include specialised courses and skills. Three new training institutes are being set up in 1982/83 in collaboration with the German, French and Japanese governments. The German-Singapore Institute will train production engineering technicians. The French-Singapore Institute will produce technicians in electro-technology, and the Japan-Singapore Institute of Software Technology will provide professionals in computer software technology.

The EDB administers the Skills Development Fund (SDF). The Fund was established in 1979 to further the concept of continuing training of industrial workers and upgrading of business and manufacturing operations. The SDF provides financial assistance for:

training programmes organised by employers to upgrade the skills of their employees;

introduction of more sophisticated machinery and skilled operations in business firms and manufacturing companies.

Government Training Centres Managed by the Vocational and Industrial Training Board (VITB)

The Board is responsible for all vocational training and continuing education. The Board runs 18 training institutions and centres offering full-time and part-time courses.

It is responsible for the basic training of school leavers in industrial, commercial and service skills, the supervision of programmed training for young persons undergoing apprenticeship and traineeship schemes, the training, re-training and upgrading of workers to meet employment changes and needs, and the provision of continuing education for adults in academic, language and other areas.

Science Centre

The Science Centre was established with the aim of developing an interest among the youth and the general public in the principles and application of science and technology.

The emphasis of the Science Centre is on contemporary science and its application to society in general. The Centre houses exhibits illustrative of the physical sciences, life sciences, and applied sciences, and also provides films, demonstrations, guided tours and publications.

Science Council of Singapore

The Science Council of Singapore was established in 1967. It plays a role in the promotion of science and technology for development. Programmes undertaken in the year 1979 include seminars, industrial exhibitions, publications on developmental aspects of science and technology and televised skill competitions to promote public understanding of the importance of skills development.

In support of the Government's policy to promote R&D in Singapore, the Science Council will further organise programmes aimed at raising the social status of R&D personnel and scientists in Singapore, so as to encourage brighter students to pursue a career in R&D.

(3) Research and Experimental Development Activities (R&D)

Singapore Institute of Standards and Industrial Research (SISIR)

In 1980, production/process design and development formed the bulk of R&D projects undertaken by SISIR. This is a unique service provided by SISIR and was carried out either, initially on an in-house basis and later commercialised by transfering the product to a private enterprise, or on a contract basis where the private enterprise jointly participated in the R&D project. A number of research contracts and projects with fees valued at S$1.2 million were completed during the year 1980. This was a 32% growth in terms of value over the previous year. The programme has helped industry to improve its production methods and quality of products, and to generate innovations which were subsequently commercialised. Three products were successfully developed and sold to local firms under licence while another three electronic products are being developed for the computer and telecommunication industries.

The R&D group as a whole has been expanded and it has now 50 engineers, chemists, food technologists, physicists and metallurgists, besides the technical supporting staff. For engineering development, facilities have also been upgraded to include an engineering computer and a computer numerical control (CNC) machine. Activities in quality assurance, testing and inspection of industrial plants grew in consonance with the demands of industry.

Under the Institute's latest Development Plan, priorities for the forthcoming years will include the establishment of a Materials Technology and Application Centre, the development of other R&D facilities with special emphasis on product and process development in engineering, food and fine chemicals, and upgrading in Standardisation, Quality Assurance and Information Services, Metrology, Non-Destructive Testing and Specialised industrial Services to meet industry's needs.

National University of Singapore

For a description of the University's increased R&D efforts, refer to Part 2.1.

Public Works Department

The Public Works Department (PWD) is setting up an Energy Research Unit within the department to initiate and coordinate research on energy conservation in government buildings. The PWD, which has a wide range of professional expertise and resources, is in a position to undertake this area of research. In setting up this Energy Research Unit, the PWD hopes to apply its resources to a systematic study of energy conservation issues, and eventually become a leading specialist body in this field.

A Committee on Energy Conservation in Buildings was formed in 1976 and has already successfully completed many assignments. The most significant was a 2 1/2 year research project which resulted in the publication of an energy conservation handbook. This Committee had provided the opportunity for dialogue on energy conservation between members from the National University of Singapore, professional bodies and the Public Utilities board.

The Committee's work has been concentrated on commercial buildings in the private sector. The PWD has now decided to take the lead in setting up the Energy Research Unit to tackle the energy problems in government buildings which differ significantly from commercial buildings in many respects.

Applied Research Corporation

The Applied Research Corporation (ARC) is a non-profit research and consultancy company which undertakes project assignments for private and public organisations.

ARC was established in 1973 and draws on the services of over 1 200 specialists from the NUS, Ngee Ann Technical College and Singapore Polytechnic as project advisors and consultants, in addition to its own full-time professional and support staff.

ARC's fields of research and consultancy cover, broadly, economics, management, applied sciences and engineering. Since its establishment, it has carried out a total of 304 projects (1973-1980), ranging from feasibility studies and surveys to hardware development.

Department of Scientific Services

The Department had made progress in its research on the development of low-cost, protein-rich foods under the ASEAN Protein Project. A soy milk powder was formulated from soya waste. A snack food, similar to crisps and crackers popular with school children, was developed using cereals and legumes.

3.2 HUMAN RESOURCES

Tertiary institutions, technical institutes and vocational schools provide the main supply of science and technology manpower in Singapore. The student enrolment figures (1980) for the National University of Singapore (NUS) stood at 9 078, of whom 444 were reading for higher degrees or a post-graduate diploma. The Singapore Polytechnic (SP) and the Ngee Ann Technical College (NATC) together have 11 000 students whilst the Vocational and Industrial Training Board's (VITB) eighteen training institutions had 8 765 students. Graduate output of technical and skilled manpower from all the institutions is summarised in the table below. For the expansion of manpower resources, first year enrolment at the NUS will be increased by 20%, the SP and NATC by 40%, and the training centres of the VITB and Economic Development Board by 125%. The Nanyang Technological Institute will be set up to train 1 000 practice-oriented engineers a year. A new polytechnic will be formed to train 2 500 supervisors and skilled workers.

Table: Output of Graduate, Technical and Skilled Manpower (1977-81)

	1977	1978	1979	1980	1981
Graduate (University)					
Science (including Pharmacy) and Engineering	625	587	800	861	931
Medicine, Dentistry and Architecture	266	295	261	296	235
Arts and Social Sciences, Law, Accountancy and Business Administration and Education	1,466	1,540	1,702	1,488	1,178
Technical (Singapore Polytechnic and Ngee Ann Technical College)	2,800	3,103	3,155	2,549	2,728
Skilled					
VITB	6,785	6,446	5,893	8,162	4,540*
EDB Training Centres	270	302	294	326	583
TOTAL	12,212	12,273	12,105	13,682	10,195

* Figures up to September 1981

To cater for the increased student population, more teaching staff (local and overseas) are being recruited. The NUS is aiming for a staff-student ratio of 1: 10 for all faculties except medicine and dentistry which, because of their service functions to the public, will have a lower ratio of 1:4 and 1:6 respectively.

The university has established a diffusion laboratory and will step up the teaching of computer science and carry out research in software development.

For the expansion and upgrading of its research facilities and activities, the university will increase the funds substantially in the next few years and will work towards a research expenditure of 5% of the total budget, which is roughly the amount which leading universities set aside for research. In the past, the NUS research fund amounted to only 0.7% of the total budget in 1979 and 1.08% in 1980.

The university has revised its research scholarship scheme to attract more students to do research and post-graduate work by increasing the emoluments of the scholarships and introducing a senior research scholarship scheme for graduates with outstanding academic records and who are interested in research. This is in addition to the existing senior tutorship scheme under which outstanding graduates interested in an academic career are appointed to the university.

In addition to upgrading post-graduate research, the university will build up its collection of engineering and technical books and journals so that the library can become a reference centre for scientific and technical information to service R&D personnel from industry. In addition to two existing Master's courses in Construction Engineering and in Industrial Engineering, two new Master's courses in Electrical and Mechanical Engineering will be introduced to upgrade the training of practising engineers. The Committee also proposes to look into the running of short intensive continuing education courses to enable practising engineers to keep abreast of advances in technology.

In a national survey concluded in 1979, it was found that a total of 1 672 persons were engaged in either full time or part time R&D activities, out of which 933 (56%) persons were in the public sector. These included 461 scientists and engineers, 391 technicians and 163 administrative and other supporting personnel in the public sector.

Of the 461 R&D scientists and engineers, 65% (298) were employed in institutions of higher learning, 20% (92) in government departments and the remaining 15% (71) in statutory bodies; 75 (16%) of these researchers were females and the percentage was slightly less than the percentage of total female scientists and engineers in the scientific and engineering population (18.5%). In terms of field of training, 31% of the 461 research scientists and engineers were trained in Engineering and Technology, 29% in Natural Sciences, and 18% in Medical Sciences. Of the remaining scientists, 73 (16%) had qualifications in Social Sciences and Humanity and 28 (6%) in Agricultural Sciences; 233 (51%) of research scientists and engineers in the public sector were doctorate holders, 17% with a Master degree, and 32% with a Bachelor degree. In addition, 88% of the doctorate degree holders were staff of institutions of higher learning, 9% were employed in government departments, and the rest in statutory boards.

Although there were 461 R&D scientists and engineers in the public sector, only 60 (13%) were full-time researchers while the remaining 401 (87%) carried out R&D activities on a part-time basis. The part-time researchers spent between 10% and 60% of their normal working time on research. Most of them devoted 25% of their time to R&D activities. The part-time nature of most R&D work is due to the fact that R&D activity forms only a part of a normal worker's duties. A majority of these part-time researchers worked in institutions of higher learning (70%). In the government and statutory departments about 26% of the R&D scientists and engineers worked full time. More than 35% of the research scientists and engineers in Agricultural and Social Sciences worked full time while full-time researchers undertaking other areas of research constituted less than 6% of the research scientists and engineers.

Using the concept of Full Time Equivalent (FTE) as a measure of the efforts of scientists and engineers devoted to R&D activities, there were 461 FTE research scientists and engineers in Singapore, of which 169 were in the public sector. Similarly, the total number of FTE research technicians in Singapore was 267. Table 2 contains a summary of scientific and technological manpower in Singapore. The ratio of researchers to the total population of Singapore was about 0.2 per 1 000 and was quite low compared to that of the developed countries, such as 2.5 per 1 000 in USA, 1,5 in Japan and 1.1 each in United Kingdom and Germany.

The private sector, however, accounted for 292 (63%) of the Full Time Equivalent R&D scientists and engineers and $24.86 million (67%) of the total R&D expenditure.

3.3 FINANCIAL RESOURCES

R&D Expenditure

A national R&D survey conducted in 1978 revealed that the total R&D expenditure in Singapore, including both the private and public sectors, amounted to $37.2 million for 1978. This is only 0.21% of Gross Domestic Product (GDP) compared to the average 2% of GDP for the developed countries.

The public sector accounted for $12.3 million of the R&D expenditure and this represented 33% of the Singapore total R&D expenditure. The expenditure was incurred by a total of 28 establishments - 15 government departments, 9 statutory boards and 4 institutions of higher learning. The expenditure for each establishment ranged from $30 000 to $6.4 million and averaged $440 000. Furthermore 67% ($8.2 million) of the public sector R&D expenditure was spent in institutions of higher learning, 20% ($2.5million) in government departments and 13% ($1.6 million) in the various statutory bodies.

The R&D expenditure of the institutions of higher learning constituted 8.8% of their budgets of $93 million in 1978. The statutory bodies R&D expenditure was only $1.6 million, representing 0.07% of the total budget of about $2 300 million. The government departments spent 0.06% of the total budget of $4 500 million on R&D. (This excludes grants/loans provided to the various statutory bodies.)

The discrepancy in R&D spending between the tertiary institutions and government/statutory bodies is due to differing emphasis placed on R&D within the institutions. R&D is actually considered as part of the normal function of the academic staff of the university but this is not so in government or statutory bodies, and the functions of the latter are geared towards the provision of services to the general public.

Almost all the R&D expenditure of the public sector was incurred within the organisations. Operating expenditure amounted to $9.4 million and accounted for 77% while capital expenditure amounted to $2.68 million (23%). The bulk of expenditure in R&D is spent on the provision of manpower. In 1978, 58% of the total R&D expenditure was invested on this item.

Sources of Research Fund

The sources of research fund for the public sector were either from the establishment's own fund, from clients, or from external grants or donations. Some 84.9% of the research expenditure in the public sector was derived from the establishment's own funds and a large portion (57%) of the funds originated directly or indirectly from the government. Contributions from foreign governments and international organisations were also significant, and funds from these sources constituted 11.7% of the research expenditure. Most of these funds came from Australia, Japan and international organisations such as the International Atomic Energy Agency, the World Health Organisation and the International Development Research Centre.

Government ministries also provided grants amounting to $180 000 (1.5%) to statutory bodies and institutions of higher learning to undertake R&D work. Funds from local companies as client payment for R&D work by statutory bodies amounted to 0.5% ($64 000). In addition, private donations amounting to $173 000 (1.4%) for R&D work were received by the universities. Table 3 (a) contains a summary of R&D expenditures for the year 1978.

The Government on its part has created a block vote of $50 million for the promotion of directed industrial research and development in the public sector.

Apart from the block vote, there are tax incentive and cash grants available to companies undertaking R&D. These include double tax deduction and investment allowance incentives and the Product Development Assistance Scheme.

Table 3 (b) contains a summary of financial outlays in terms of the country's Gross National Product. Statistics on total R&D expenditures are available only for the year 1979.

PART 4.

Policy issues in scientific and technological development

4.1 MAJOR DEVELOPMENTS

The government has been placing increasing emphasis on the role of science and technology in national development over the last 10 years. It has implemented several programmes aimed at improving the national scientific and technological capabilities and creating favourable conditions for scientific research and development activities. Three major developments in this area are summarised below.

Expansion of institutions

To provide skilled and professional/technical manpower for new high technology industries, the government has over the past two years embarked on a programme to upgrade and expand the University, Singapore Polytechnic and Ngee Ann Technical College. In addition, new EDB training centres and vocational training institutes have been set up. The German Singapore Institute is one such centre which is being set-up. The institute aims to train production technicians in all aspects of production engineering and technology. It has a planned enrolment of 400 at full operation.

Development of Local Scientific and Technological Capabilities

Two institutions, SISIR and ARC have developed their consultancy services and R&D capabilities to meet the demands of the increasingly sophisticated manufacturing sector. These have been described under Part 3.1.

An area of high priority for the national interest is the development of local expertise in computer applications. The functions of the national computer Board (NCB) formed in 1981 are as follows:

- to select, recruit and train computer personnel to operate and maintain decentralised computerised systems for the various government ministries and departments;
- to provide computer software and hardware consultancy services;
- to promote computer awareness and appreciation among senior government officials;
- to set up in-house computing facilities and operate centralised information systems;
- to act on request as the purchasing agent for computer hardware, software and consultancy services by ministries.

Along with the setting up of the NCB, two software institutes have already been established in Singapore. The Institute of Systems Science (ISS) is established to transfer information systems technology to Singapore. It is a partnership between the NUS and IBM Singapore and conducts courses aimed at:

- training information systems analysts for industry;
- upgrading skills of existing data processing professionals;
- non-professionals and senior executives.

The Japan-Singapore Institute of Software Technology (JSIST) has been set up to provide the professional manpower required in the field of computer software technology in Singapore. The JSIST will also upgrade Electronic Data Processing professionals and managers and provide middle and senior management training in the application of computers.

A third institute tentatively called the Information Processing Training Institute will be set up in middle of 1982 and will complement the training facilities provided by the ISS. The Institute will produce basic programmers and systems analysts.

Economic Restructuring

As discussed in Part 2.2, all sectors of the economy recognise that with the need to restructure and upgrade the economy, it is imperative that greater emphasis be placed on the expansion of the national S&T capacity and the conduct of research in Singapore in the coming years.

4.2 ACHIEVEMENTS AND PROBLEMS

The application of science and technology to the econonomic and social development of Singapore has achieved some degree of success in the following areas:

Public housing
Land reclamation
Port development
Population control
Primary food production
Telecommunications
Industrialisation.

Public Housing

Singapore's experience in the provision of public housing has stimulated interest around the world. During the short span of the past 17 years, some 58% of the populace were given decent accommodation by the Government Housing and Development Board in over 270 000 housing units. In terms of engineering technology, the progressive strength system of construction and metal formwork are used. Metal formwork opens an avenue where a high standard of workmanship can be achieved without requiring large numbers of very skilled carpenters and plasterers. Greater efficiency in construction has also been achieved with the use of concrete mixers, dumpers, steel-cutting and bending machines, and other labour saving devices.

Land Reclamation

Singapore has added 5% to its land area through reclamation. Reclamation for Singapore is a necessity. With a dense population and a rapid pace of socio-economic development, additional land has to be created for industrial, commercial, port development and recreational use. In terms of reclamation technology, the large scale reclamation carried out is made possible by a blend of indegenous skills with Japanese and European dredging and reclamation expertise using sophisticated dredging machinery and equipment.

Port development

To maintain her position as one of the world's leading ports, Singapore has decided to provide full containerised cargo-handling operations. Containerisation is a relatively new technology for cargo handling. The technology involved in operating a large-scale modern container terminal is of a high level. The technology is 'imported' since the equipment and machines are purchased from abroad. The container berths and the marshalling yard are also examples of high technology engineering as they were built on decked concrete supported by piles on the sea bed. As a result of exposure to the high technology, corresponding local engineering and operational expertise was built up, particularly in wharf construction and handling, as well as maintenance and repair of sophisticated operational equipment.

Population Control

Singapore has successfully managed to control its population growth. There has been a decline in the rate of natural increase from 2.3% in 1966 to 1.2% in 1979. Through a combination of aggressive promotion of family planning, a comprehensive family planning medical service, the liberalisation on the laws relating to sterilisation and abortion and a properly designed incentive/disincentive system, the government has effectively driven home the message that 'two is enough'. Singapore has achieved its first demographic goal of replacement level defined as one female child replacing one woman. The second and more long-term is to maintain replacement level from 1975 onwards in which event it has been projected that the population will grow from its current 2.4 million to about 3.5 million in the year 2030 when zero population growth will be reached and the population in Singapore will stabilize at this size.

Primary Food Production

Singapore produces only 25% of its vegetables consumed. It also has to depend on imports for supplies of meat. Livestock production accounts for some 80% of the total agricultural output in the country.

The Primary Production Department (PPD) is responsible for the comprehensive planning and the application of suitable techniques of modern science and technology to agricultural and husbandry development. Various specialised bodies were established under the PPD. These include the Pig and Poultry Research Training Institute, the Veterinary Diagnostic Laboratory, as well as a Farm School.

Telecommunications and Industrialisation

These have been discussed in earlier sections.

As Singapore becomes more industrialised and urbanised, a host of socio-economic problems appear. Such problems include the shortage of adequate science and technology manpower, energy resources, environmental control and technology transfer. The need for the judicious application of science and technology will be increasingly felt.

4.3 OBJECTIVES AND PRIORITIES

Singapore's industrialisation drive has been largely dependent on foreign expertise and technology provided through the multinational companies , for Singapore did not possess an indigenous technology. It was possibly the quickest way to gain access to modern technology in Singapore's initial stages of industrialisation.

Because of the relative ease with which technology was acquired, there has been no pressure or incentive for local industry to develop an indigenous technological capability. However, for the long-term sustenance and growth of Singapore as it develops into modern industrial economy, it is recognised that an indigenous capability must be developed to assess and assimilate foreign technology. It has been pointed out in Part 2.2 that the Government is currently developing a long-term R&D programme to satisfy this need. The lack of trained personnel, shortage of funds and inadequate research information are some of the main obstacles facing R&D activities in Singapore. Since resources are limited, priorities will be given to areas of research identified as of national importance to Singapore and which should thus be concentrated upon for greater benefit. Examples are micro-processor applications and materials science.

Singapore is totally dependent upon oil for energy. As oil is getting scarce, more expensive and subject to interruptions, it is expedient to consider alternate energy sources. Currently, Singapore is examining the possibility of using coal and nuclear energy to diversify its energy requirements.

Equally important is the area of environmental control, particularly the problem of waste disposal. Singapore presently churns out about 2 000 tonnes of solid refuse daily in addition to liquid waste. Although a multi-million dollar incineration plant has been built to reduce refuse to 10% of its original volume, and the growing problem of liquid waste contained by a massive extension of the sewerage system, these two measures may not be adequate in the very long term. The monitoring of new technologies in the treatment and disposal of waste must be carried out constantly.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

Singapore participates in a number of activities in the fields of science and technology at both regional and international level. Regional cooperation among ASEAN member countries is being conducted through its Committee on Science and Technology (COST) and the Association for Science Cooperation in Asia (ASCA). At the international level, technical assistance has been rendered through various United Nations Programmes, the International Atomic Energy Authority and the United Nations Educational, Scientific and Cultural Organisation (Unesco).

Singapore plays an active role in the ASEAN Committee on Science & Technology (COST), established within the ASEAN framework in 1972 to foster and promote regional cooperation in science and technology. In 1975, COST initiated research projects on development of low cost protein foods to combat malnutrition.

The Australian Government has provided substantial funding for these projects under the ASEAN-Australian Economic Cooperation Programme. The projects have entered the third phase and Singapore continue to undertake projects on:

Food Packaging
Development of Low Cost High Protein Food
Maintenance of Bacteria Culture Collection.

Australia is also funding, under this Economic Cooperation Programme, two other ASEAN projects on:

Food Waste Materials and
Food Technology Research and Development.

COST has also established a Sub-Committee to look after the project on an ASEAN Climatic Atlas and Compendium. This cooperative project is an ASEAN effort to process and analyse the climatic data of the 5 countries and compile the findings into a climatic altas and compendium of climatic statistics. The UNDP has provided assistance for this project.

Several of ASEAN's dialogue partners, including Australia, EEC, Japan, New Zealand and the USA have also expressed interest in cooperation with ASEAN on non-conventional energy research. COST has identified several research areas, for which the USA has commited US$1 million towards:

- coal training,
- energy conservation in buildings,
- water pumping technologies.

In the environmental area, a working group was established to formulate and implement an ASEAN environmental programme. Funding for the various projects were obtained mostly through the United Nations Environmental Programme (UNEP) and the United Nations Development Programme (UNDP), and also from Australia and Japan.

An ASEAN-EEC Cooperation Programme on Science and Technology was established in 1981 whereby the EEC committed 2.8 million ECU to finance COST projects in the fields of energy, environmental management and manpower development. The projects comprise a two-year programme of training, studies, technical assistance and seminars.

ASEAN COST is also having discussions with third parties, including Canada, UNDP, New Zealand and Japan, with a view to establishing cooperation in the fields of:

- biotechnology,
- marine sciences,
- corrosion,
- materials processing,
- non conventional energy research,
- low-cost housing technologies,
- setting up a technology information bank for reference in technology selection, and
- anti-pollution technologies for urban and rural areas.

Singapore also participates in a number of programmes organised under the auspices of the United Nations and its specialised agencies, as well as the Colombo Plan Technical Cooperation Scheme.

Under the Colombo Plan, Singapore received many experts from various countries of the UN in the past decade. Experts under the Colombo Plan were made available by Australia, Canada, India, Japan, New Zealand, and the UK. The main fields of expertise embraced technical education, industrial development, urban renewal, telecommunications, hotel catering, primary production and horticulture.

Singapore also offers training awards under the Colombo Plan. A total of 1 000 awards were offered for 1975-77. Trainees came from ASEAN member countries, Bangladesh, Bhutan, Burma, Nepal, Pakistan and Sri Lanka. Training was offered in various technical, industrial and administrative fields.

Technical assistance from the UNDP was received by way of experts, fellowships and equipment. Expertise and training were received in fields such as industrial development, technical education, primary production, telecommunication and port management. The major UNDP assisted projects involved the Telecommunications Training Centre, the Singapore Polytechnic and the National Productivity Board.

Under the scheme, Singapore provided training facilities for overseas candidates from the ASEAN member countries, Burma, Ghana, Guyana, India, Pakistan, Sri Lanka, and other countries in the UN, with fellowships financed by UN agencies.

Two projects were undertaken by the Singapore Institute of Standards and Industrial Research (SISIR) under the UNDP scheme. These were the Applied Metrology Programme and the project in Industrial Supporting Services. A third project proposed was the development of a Materials Technology and Application Centre (MTAC). The Centre is expected to evolve over the next 5 years and will eventually provide a full-range of services covering applied research and development, consultation, testing and process engineering for manufacturers.

In addition a SINTESD Agreement (Agreement for Industrial, Technical and Scientific Cooperation between Singapore and New Zealand) between Singapore and New Zealand is currently running into its fifth year. The Agreement has proven to be successful in promoting cooperation between Singapore and New Zealand parties in the areas of Trade, Investment, Educational and Technical Training, and Consultancy.

In the areas on electrical product testing and evaluation, metallurgical diagnostics and failure analysis, and solar energy research and applications, SISIR has also concluded a Technical Agreement with the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) of West Germany. Other organisations that have ties with SISIR include the Production Engineering Research Association of the United Kingdom, the Bundesanstalt für Materialprüfung (BAM) of West Germany, and the Central Organisation for Applied Scientific Research (TNO) of Holland.

UNDP has also assisted in the expansion of the School of Industrial Technology and the School of Nautical Studies in the Singapore Polytechnic.

Singapore is a member of the Commonwealth Science Council (CSC) of which the Science Council of Singapore is the Republic's official representative. Currently the CSC is supporting eight regional collaborative research and development programmes. The projects on metrology and rural technology involve participation by members in the Asia/Pacific region. Singapore takes part in the metrology programme.

PART 5.

Bibliography

Sections 1.1 & 1.3

Public Utilities Board *Annual Report* 1981

Port of Singapore Authority *Annual Report* 1980

HDB *Annual Report* 1980/81

Urban Redevelopment Authority *Annual Report* 1980/81

Ministry of National Development *Annual Report* 1980

Singapore Economic Development Board *Annual Report* 1980/81

Singapore Yearbook 1978, publisher: Ministry of Culture, Publicity Division

The Singapore Manufacturer 4 No.1 1981. Publisher: The Singapore Manufacturers Association

Science & Technology Quarterly, Science Council of Singapore, Volumes 1 & 2, 1980/81

Section 1.2

Singapore Yearbook 1980, Publisher: Ministry of Culture, Publicity Division

Singapore Investment News, March 1980

Section 2.2

EDB publication on *'Singapore 2000' - The engineering of rapid industrialisation*

Ministry of Trade & industry Circular MT 101/4-06 (on $50million allocation for R&D)

National paper submitted by the Ministry of Science and Technology for Unesco country reports on Singapore 1979

Jurong Town Corporation *Annual report* 1980/81

Science & Technology Quarterly, Science Council of Singapore, Volumes 1 & 2, 1980/81

Singapore Economic Development Board *Annual Report* 1980/81

Singapore Economic Development Board Investment News

Sections 2.1 & 2.3

National paper submitted by the Ministry of science & Technology for Unesco country reports on Singapore 1979

EDB publication on *'Singapore 2000' - The engineering of rapid industrial advance*

Singapore Yearbooks 1976 & 1978, Publicity Division, Ministry of Culture

Science Council of Singapore *Annual Reports* for 1972-1975

Singapore Economic Development Board *Annual Report* 1980/81

Sections 3.2 & 3.3

Science & Technology Quartely, Science Council of Singapore, Volumes 1 & 2, 1980/81

Singapore Science Bulletin No. 3, 1980

Singapore Investment News - EDB publication October 1980

Campus News - Published by the National University of Singapore

Census of Population 1980 (Release No. 3)

Sections 3.1 & 4.1

Singapore Yearbook 1970-1978 Publisher: Ministry of Culture, Publicity Division

Port of Singapore Authority *Annual Report* 1980

Telecoms *Annual Report* 1979/80, International Press

Singapore Yearbook of Statistics 1980/81 Publisher: Department of Statistics

Ministry of the Environment *Annual Report* 1980

Ministry of Health *Annual Report* 1979

Singapore Institute of Standards and Industrial Research *Annual Report* 1980/81

Department of Scientific Services *Annual report* 1980

Ngee Ann Technical Colege *Annual Report 1979/80*

Singapore Science Centre *Annual Report* 1979/80

National University of Singapore - *General Information 1981/2*

Public Utilities Board *Annual Report* 1980

Singapore Polytechnic *Annual Report 1980/81*

Vocational and Industrial Training Board *Annual Report* 1980/81

Singapore Economic Development Board *Annual Report* 1980/81

Science and Technology Quarterly, Science Council of Singapore, Volumes 1 & 2, 1980/81

Section 4.4

Singapore Institute of Standards and Industrial Research *Annual Report* 1980/81

Science Council of Singapore *Annual Reports* 1978-81

Science and Technology Quarterly, Science Council of Singapore, Volumes 1 & 2, 1980/81

SRI LANKA

Table of Contents

SRI LANKA

GEOGRAPHY

Capital city: Colombo
Main ports: Colombo, Trincomalee
Land surface area: 65,610 km

POPULATION (1978)

Total	14.3 million
Density (per sq km)	219
Urban/rural ratio (1971)	0.3
Average rate of growth (1970-78)	1.7%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	37.7	11.4	9.7	35.0	6.2	100%

SOCIO-ECONOMIC

Labour force (1971)

Total	4.5 million
Percentage in agriculture	40.8%

Gross national product (1978)

GNP at market prices	US $2,870 million
GNP per capita	US $200
Real growth rate of GNP per capita (1970-78)	1.9%

Gross domestic product (1977)

Total (in current producers' values)	US $3,676 million
Percentage by origin	
Agriculture	39%
Manufacturing, mining & quarrying, electricity, gas & water, construction	19%

Government finance

National budget (1978)	US $749 million
As percentage of GNP	28.0%
External assistance (official, net; 1976)	US $151 million
As percentage of GNP	4.3%

Exports (1978)

Total exports of goods	US $846 million
Average annual growth rate (1970-78)	−3.8%

External debt (1978)

Total public, outstanding + disbursed	US $1,013 million
Debt service ratio (% GNP)	3.6
(% Exports of goods and non-factor services)	9.2

Exchange rate (1978): US $1 = 15.61 Rupees

EDUCATION

Primary and secondary education (1978)

Enrolment, first level	[1]1,957,137
As % of (5-10 years)	94%
Enrolment, second level	[2]1,248,415
As % of (11-17 years)	52%
Combined enrolment ratio (5-17 years)	52%
Average annual enrolment increase (1970-1978)	[2]2.6%

---

[1] Refers to public education only.
[2] Second level education refers to general education and teacher training only.

Higher education (third level)

Teaching staff, total (1976)	2,498	

Students and graduates by broad fields of study:

	[1] Enrolment (1978)	Graduates (1975)
Social sciences and humanities	9,988	2,767
Natural sciences	2,106	340
Engineering	3,295	639
Medical sciences	1,569	268
Agriculture	527	65
Other and not specified	...	...
Total	**17,485**	**4,079**
Number of students studying abroad (1978)	2,772	

Education public expenditure (1978)

Total (thousands of Rupees)	933,640
As % of GNP	2.2%
Current, as % of total	95.1%
Current expenditure for third level education, as % of total current expenditure	1.4%

---

[1] Not including students pursuing non-degree courses.

Table 1. Nomenclature and Networking of S&T Organizations

I - First Level - POLICY-MAKING

Country: Sri Lanka

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
Ministry of Finance and Planning	Examining and reporting on S&T development projects; preparation of the national budget	Cabinet and Ministers		Ministries
Committee of Development Secretaries	Interministerial co-ordination and liaison with the Cabinet	Cabinet and Ministries		

II - Second Level - PROMOTION & FINANCING

Organization	Linkages		
	Upstream	Downstream	Others
Ministries whose functions include areas of S&T	Ministry of Finance & Planning Ministry of Plan Implementation Committee of Development Secretaries	Departments, statutory boards and other state institutions	

III - Third level - PERFORMANCE OF S&T

Establishment	Function	Linkages	
		Upstream	Others
Ceylon Institute of Scientific Research (CISIR)	Scientific & industrial research, training, advisory and testing services	Ministry of Industries and Scientific Affairs (MISA)	Board of directors CISIR
National Engineering Research and Development Centre (NERDC)	Promotion of development & transfer of technology	MISA	Board of directors NERDC
Bureau of Ceylon Standards (BCS)	Preparation of codes of practice and specifications, and testing of products	MISA	Board of directors BCS
Industrial Development Board (IDB)	Development of technology in the private and public industrial sector	MISA	Board of directors IDB
National Science Council (NSC)	Advising the government disseminating S&T information and funding research	MISA	Board of directors NSC
Atomic Energy Authority (AEA)	Utilization of atomic energy for economic development	MISA	Board of directors AEA
Central Agricultural Research Institute and a number of research stations	Research and development in agricultural crops - breeding, cultivation, management, marketing, etc.	Ministry of Agricultural Development and Research	
Tea, Rubber and Coconut Research Institutes	Research on tea, rubber and coconut	Ministry of Plantation Industries and Ministry of Coconut Industries	Respective boards of directors
Department of Geological Survey	Geological mapping and research and development in relation to Sri Lankan mineral resources	Ministry of Industries and Scientific Affairs	

Establishment	Function	Linkages	
		Upstream	Others
Forest Department	Forestry development and research	Ministry of Land and Land Development	
Fisheries Surveys & Research Division of the Ministry of Fisheries	Research and development in fisheries	Ministry of Fisheries	
Central Engineering Consultancy Bureau (CECB)	Consultancy in designing, construction and supervision of hydro-development projects	Ministry of Mahaweli Development	Board of directors (CECB)
State Engineering Corporation (SEC)	Engineering - consultancy and construction	Ministry of Local Government, Housing and Construction	Board of directors
Medical Research Institute (MRI)	Research and diagnostic work and the preparation of vaccine	Ministry of Health	
Universities (8)	Graduate and post-graduate education, research	Ministry of Higher Education (MHE)	University Grants Commission
Technical Colleges (20)	Basic and middle level technical training	MHE	
Research and Development sections of technical departments, boards, corporations and other state institutions e.g. Sugar Corporation, Steel Corporation, Department of Minor Export Crops, etc. (over 50)	Matters connected with research and development in the respective areas	Head of the respective developments, boards, etc.	

Table 2 - Scientific and Technological Manpower

Country: Sri Lanka

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (in units)	of which working in R&D						Total stock (in units)	of which working in R&D
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1966	11.439	n.a.							n.a.	
1973		6,845								
1977 1978	13.942 14.184	6,488	604	213	199	177	15	2		
1979	14.490	n.a.								

Table 3 - R&D expenditures

Country: Sri Lanka
Currency: Rupee

Table 3a: Breakdown by source and sector of performance

Year: 1975

Unit: Thousands

Sector of performance / Source	National		Foreign	Total
	Government funds	Other funds		
Productive	17,023	19,947		36,970
Higher Education	1,382			1,382
General Service	5,735	1,010[(a)]		6,745
Total	24,140	20,957	1,010	45,097

(a) Estimated

Table 3b: Trends

Year	Population (millions)	GNP (in millions)	Total R&D expenditures (in thousands)	Exchange rate US $1 = Rupee
1965	11.439		13,009	4.7619
1970	12.516	13,444	21,517	5.9124
1975	13.496	26,364	45,097	7.0833
1979	14.490	52,147		
1985				
1990				

PART 1.

General Features

1.1 GEOPOLITICAL SETTING

Sri Lanka is a tropical island situated between 5°54' and 9°52' north latitude and 79°39' and 81°53' east longitude. Its climate is equable and oceanic. It has an area of 65 600 square km. From the sea coast the land rises to an elevation of 2 500 m, in the south-central part of the island, but 3/4 of the country consists of a broad peneplain, close to sea level. This peneplain is most extensive in the northern and eastern regions. At sea level the mean monthly temperature ranges from 25° to 30° C. At higher altitudes there is a drop in the mean temperature at the rate of approximately 1° C for 150 m. rise in elevation. Being near the equator, there is little seasonal variation in day length. The rainfall has a seasonal distribution. The south-west quadrant of the island receives rainfall throughout most of the year with a peak during the period of south-west monsoon from June to August. In the rest of the island rainfall occurs mainly during the period of the north-east monsoon (October-December), and dry weather prevails in the period June to September. This region is the so called "Dry Zone" which, in centuries past, was dotted by thousands of man-made reservoirs which provided water for irrigating rice cultivation.

Water has an important role to play in the economy of Sri Lanka. Besides being the main factor sustaining agriculture, the mainstay of the economy, it provides 90% of the electricity generated in the country. The other main natural resources of the country that are exploited at present include gems, graphite, limestone, kaolin, rock phosphate and mineral sands. Exploration for oil has not been successful so far. In the sphere of forestry, though Sri Lanka timbers were at one time well-known in overseas markets, this resource has dwindled sharply in the past few decades.

The population of Sri Lanka is estimated at 14.5 million (mid year 1979). Colombo, Sri Lanka's capital city, has an estimated resident population of 0.6 million.[11]

The country is provided with a good network of public roads (26 790 km. in 1978). The railway has much more restricted coverage (1 453 km.). There is one major international airport close to Colombo and a few minor domestic airports in some of the other towns. The main seaports are in Colombo, Galle and Trincomalee.

Sri Lanka has a recorded history dating back to the pre-Christian era. Western domination started with the conquest of the maritime districts by the Portuguese in 1505. They ruled for nearly 150 years and were replaced by the Dutch East India Company in 1654. The Dutch rule, also confined to the maritime areas, ended with the British invasion in 1796. Sri Lanka became a British colony in 1802. In 1948 Sri Lanka became an independent member of the British Commonwealth. In 1972 Sri Lanka was declared a free and independent republic but it continued to be a member of the Commonwealth. The present constitution of Sri Lanka was adopted by Parliament in 1978.

According to the 1978 constitution of the Democratic Socialist Republic of Sri Lanka, sovereignty rests with the people and is exercised through Parliament.[17] Parliament consists of elected representatives. Franchise is universal and has been so for fifty years. All persons over 18 years of age who are citizens of the country are eligible to be registered as voters. The constitution guarantees fundamental rights to all Sri Lankans. These rights are, inter alia, the freedom of thought, speech and religious belief. All citizens are equal before the law.

The President of the Republic, who is elected by the people, is the head of state and of the Cabinet of Ministers and the Commander-in-Chief of the armed services. The Prime Minister and the other Ministers are appointed by the President from the Members of Parliament. The President and the Members of Parliament hold office for a maximum of six years after which a general election is mandatory.

The President and the Cabinet of Ministers are responsible for the direction and control of the government. The President presides at meetings of the Cabinet. The subjects and functions of the government are assigned to different Ministers by the President who may himself retain some subjects and functions. Each ministry has a secretary who is appointed by the President. A ministry comprises one or more departments, boards and other statutory bodies. Matters connected with the appointment, transfer and disciplinary control of public servants rests with the Cabinet of Ministers. Some of these powers are delegated to the Public Service Commission.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

Sri Lankans comprise a number of ethnic groups: the main races are Sinhalese (71.9%) and Tamil (20.5%). The main religions are Buddhism (67.4%), Hinduism (17.6%), Christianity (7.7%) and Islam (7.1%). Sinhala is the official language; but both Sinhala and Tamil have been recognised as national languages by the constitution, and both languages are used in the administration in the northern and eastern parts of the country.

Agriculture is the mainstay of the economy. It accounts for one third of the Gross Domestic Product and one half of employment.[13] Tea, rubber and coconut are the main plantation crops, and they account for 75% of the export earnings (in 1979).[3] Rice is the staple food of Sri Lankans. At present local production of rice mets 85 to 90% of the demand, and it is expected to reach the level of self sufficiency within the next few years.

In the decade of the seventies, the economy of Sri Lanka was marked by two distinct phases. Up to 1977, the growth of the economy was stifled by severe import controls, chronic shortages of foreign exchange, heavy subsidies on food, and a heavily overvalued currency. As expected, for a country which imports all its oil requirements and most of its industrial goods, the oil crisis severely exacerbated an already ailing economy. The average annual growth rate of the Gross National Product (GNP) in the decade 1968 to 1977 was 3.1%.[10]

In 1977, the new government that took office introduced sweeping economic reforms in an attempt to resuscitate the economy. Imports were liberalized, a realistic and unitary rate of exchange was adopted for the rupee (in place of former dual rate), and the system of general consumer subsidies was gradually dismantled. Simultaneously the government invited foreign industrialists to invest in the newly created industrial processing zones by offering a package of incentives which included a wide range of tax exemptions and duty-free import of machinery and raw materials.[13] The industrial promotion zones are relatively small, well defined areas. Apart from these, in the country at large too, private investments were encouraged through a wide range of incentives.[12,14]

The result of these economic reforms was a sudden increase in the rate of growth of the GNP which shot up to 8.2% in 1978. It was obvious that this rate of growth which was the immediate and spontaneous response of the economy to the new "open" policy, could not be sustained at that level, and it fell to 6.2% in 1979. This was still higher than the projected growth rate for the period 1978-1983 which is 6.0%.[2,3] With the increase in economic growth, the GNP per capita showed a marked rise in the period 1977 to 1979. However, the 1979 figure of US$ 217[4] still places Sri Lanka among the poorest countries of the world.

In contrast to the GNP, Sri Lanka's Physical Quality of Life Index (PQLI) which is a widely accepted index of socio-economic development, is almost on par with many developed countries.[10] The parameters used for defining PQLI include infant mortality, life expectancy and literacy. Sri Lanka's high standard in relation to these factors is a reflection of the policy of successive governments to promote socio-economic development on an egalitarian basis and not concentrate on boosting GNP alone.

With the liberalization of the economy in 1977 the volume of imports rose sharply, more so because of the pent-up demand of the earlier period where import levels remained almost stagnant. This, together with two other factors, the rapid escalation in the prices of manufactured goods and crude oil which are imported and the relatively stagnant prices of most of the primary products which are exported, resulted in a growing trade deficit.[3] Fortunately, large-scale capital inflow from the International Monetary Fund and other sources help to sustain Sri Lanka's development effort at a high level. The economic policy of the present government appears to have inspired confidence in Sri Lanka among developed countries and this has resulted in increased aid from these countries. In the three year period ending June 1980, the government had concluded aid agreements to the value of Rs. 22 829 million; over one third of this in the form of outright grants. In the 1981 budget announced by the Minister of Finance in November 1980, the estimated expenditure was Rs. 28 071 million.[5] Over a quarter of this (Rs. 8 100 million) is expected to be met from foreign sources, mainly as concessionary loans and outright grants. The major part of the aid received goes into development projects, for example, the Mahaweli irrigation/power scheme, agriculture and rural development projects, and water and sewerage projects.

1.3 DEVELOPMENT SCENE

The programme of development set out by the government aims at providing the basic needs and improving the living standards of the people, particularly in the poorest sections of the community. This involves increasing employment, providing adequate housing, extending water and sanitary services, improving health and education, and increasing the economic levels of the rural population. In its strategy for development the government focuses special attention on three lead projects, while at the same time giving the needed impetus to the other sectors of the economy. These three lead projects are the creation of Industrial Promotion Zones, housing and urban development, and the accelerated Mahaweli irrigation and power development scheme.

The aim of setting up Industrial Promotion Zones was to attract export-oriented industries, with both local and foreign capital, into specially demarcated geographical areas, by offering attractive incentives. By the middle of 1980 a total of 111 projects involving an investment of Rs. 3 000 million were approved.[15] The total employment on the projects at present (1980) is approximately 8 000.

In the sphere of housing, the rate of house construction had been far slower than the increase in demand, and this prompted the government to give high priority to public investments in housing. Work on 21 000 units was started in 1978 and 1979. In addition, 15 000 were under construction on aided self-help schemes. These projects, though they will improve appreciably the urban and suburban housing situation, are still barely adequate to cope with the problem. A more ambitious programme had been proposed but it had to be scaled down because of economic constraints.[13]

With regard to water and sewage, the government is shortly to embark on a major scheme to provide an improved sewage and water service to Colombo and its suburbs. In 1979, 22 water supply schemes were completed and a further 40 were under construction. The government aims at providing safe pipe-borne water to 70% of the population by 1990.[13]

The accelerated Mahaweli irrigation and power scheme which involves extremely heavy investments had to be scaled down because of economic constraints and limitations of implementation capacity. On the present programme 120 000 acres (48 600 ha) of new land will be irrigated, and 410 MW of installed capacity of electricity will be added to the present all-island capacity of 381 MW by 1984.[13]

In the sphere of agriculture, the increases in the annual yields of paddy could be considered satisfactory. In 1977, 80.4 million bushels (1.66 million tonnes) of paddy were produced. This increased to 90.6 million bushels (1.87 million tonnes) in 1978. As a result of reduced fertiliser inputs and adverse weather conditions the crop increased only marginally in 1979 (91.8 million bushels), but preliminary estimates for 1980 indicate that the 100 million bushel mark has been exceeded. The yield per unit area increased from 50.7 bushels per acre (2.59 t/ha) in 1978 to 53 bushes per acre in 1979.[1,2,3]

Paddy, covering 30% of Sri Lanka's cultivated land area and extending to nearly all parts of the country, is perhaps the most important single crop influencing the overall performance of the economy. The paddy sub-sector alone accounts for the employment of 860 000 persons which is nearly thrice the employment in the whole of the manufacturing industries sector (374 000 persons).[12] Although paddy production presents an optimistic picture, the agriculture sector as a whole has shown slow growth in 1979 – 2% as compared with 10.4 and 5.4% in 1977 and 1978 respectively.[13] The three main plantation crops showed an uneven performance. Tea production increased only marginally, coconut production increased 8%, while rubber production declined. The increase in the case of coconut should not give room for optimism as it has to be viewed against a backdrop of a steady and appreciable decline in production in the period 1972 to 1977.[3,4]

In the industrial sector, the economic reforms of 1977 had a sharp and immediate impact. In 1978 the growth rate (in real terms) of this sector was 11%. This fell to 4% in 1979. It would, of course, have been unrealistic to have expected the growth rate to be maintained at the 1978 level. This is because the 1978 rate reflected the immediate impact which the economic reforms had on an industry which had previously been operating at a greatly reduced capacity due to shortages of raw materials, equipment and spares. As expected, the increased production levels were more evident in the private sector than in the state industries.[3,4] Earnings from industrial exports nearly doubled, from Rs. 1.9 billion in 1978 to Rs. 3.7 billion in 1979.[4] This was almost entirely due to a considerable increase in the earnings from the export of textiles, garments and petroleum products.

Besides the incentives that are given for the setting up of industries in the Industrial Promotion Zones there are generous tax concessions and other incentives given for a wide range of industries, particularly for small and medium scale labour-intensive industries set up in rural areas. Tax concessions are also extended to housing projects, processing industries, rural and urban development projects, and the construction of new hotels for tourism.[14]

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

Prior to 1977, economic development depended very heavily on public sector investments. In the industrial sector, a number of corporations were set up, and many private industries were taken over by the Government. During this period, private sector industries were severely hit by foreign exchange restrictions that curtailed imports of raw materials, equipment and spares, and many industries were running with obsolescent machinery and at low levels of efficiency. In the plantation sub-sector, the implementation of land reform measures resulted in the redistribution of land, and in the process, a high proportion of the tea and rubber lands came to be vested in the state.

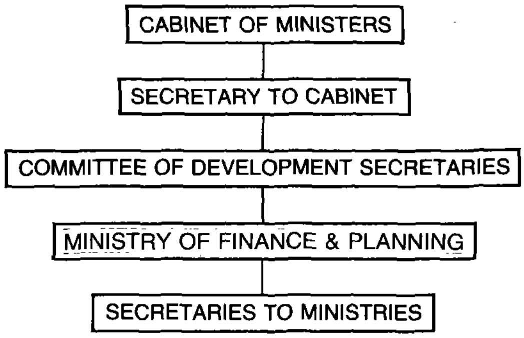
The new government that came into power in 1977 adopted a fundamentally different approach in tackling the problems of under-development. In the economic revival that the government set out to achieve, a prominent role was given to private industry. The removal of import restrictions enabled private entrepreneurs to import machinery, spares and raw materials, and so to boost capacity utilization. The removal of import restrictions also resulted in industrial goods and good items, rarely seen before, being freely available on shop shelves. Faced with competition from imported goods and the decision of the government not to subsidise corporations that sustain losses due to inefficient operation, the public sector corporations have had to improve their efficiency and the quality of their goods. Many corporations have responded positively to this challenge and have increased production and efficiency.

The setting up of the Industrial Promotion Zones in a few selected areas was intended to bring about a rapid transformation of the industrial sector by attracting foreign capital, transferring technology, providing employment, and increasing exports. In the country as a whole, the government, while attempting to improve the efficiency of corporations and other business undertakings run by the state, was averse to setting up more public corporations. Instead, the almost stagnant private sector was encouraged to expand, using both local and foreign capital. Many fiscal and other incentives were provided for the setting up of a wide range of industries such as agro-industries, fisheries, hotels and tourism, housing, textile and garment manufacture, etc. Proposals for private investments from foreign sources are examined by a Foreign Investment Advisory Committee chaired by the head of the treasury and composed of the secretaries of key ministries.[12,14]

In the sphere of agriculture, paddy cultivation is carried out by private farmers. However, state intervention is necessary to sustain this sub-sector. Heavy government investments are made on irrigation schemes which provide water for rice cultivation. Fertilizers are supplied by the government at a subsidised price; extension services and seed material are provided through the Department of Agriculture; the paddy is purchased at a guaranteed price and milled by the Paddy Marketing Board; and credit facilities and crop insurance are provided by a number of state institutions.

Public sector development projects like the Mahaweli scheme, housing construction projects, agriculture research and development, petroleum refining, and electricity generation are carried out by the ministries to which these functions are assigned. The monitoring of public sector programmes is done by the Ministry of Plan Implementation which is directly under the President. For the effective coordination of programmes that affect different ministries, the government has set up a Committee of Development Secretaries. The convenor for this Committee is the Secretary, Ministry of Finance and Planning, and the Chairman is the Secretary to the Cabinet of Ministers. The secretaries of the ministries involved in major development activities are members of this Committee. The Secretary to the Cabinet serves as Chairman of the Committee, so that he can function effectively as a liaison between the secretaries to the ministries and the Cabinet. Besides attending to inter-ministerial coordination of the implementation programmes of the government, the Committee also plays a role in matters of national policy.

DEVELOPMENT POLICY FRAMEWORK



2.2 DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

Broadly, there has been little difference in the long-term development goals of successive governments in the past 20 years or so. Concisely stated, the basic objective of these governments has been to achieve socio-economic development by providing the basic needs of the people, namely, health, education, employment, and a better quality of life. However, as would be clear from the foregoing part of this paper, the strategies adopted to achieve the goals of development have been different. The formulation and implementation of development policy are at present undertaken by the ministries in charge of the different sectors and sub-sectors. Coordination of the different elements of development policy is carried out by the Ministry of Finance and Planning and the Committee of Development Secretaries.

In regard to science and technology, the Sri Lanka Association for the Advancement of Science, the largest professional body of scientists in Sri Lanka, had for many years urged successive governments to define and enunciate a national policy. The National Science Council (NSC) after its formation in 1968, lent its support to this move. Finally, in 1978, His Excellency the President of Sri Lanka, in his inaugural address to the annual sessions of the Sri Lanka Association for the Advancement of Science, made a statement which spelt out the broad guidelines for scientific and technological development in Sri Lanka.[7] Since then, the NSC has submitted proposals to the government on different aspects of implementation.

As a general rule policy matters relating to any area of science and technology are, as in the case of development policy, dealt with by the ministry concerned. In recent years, however, the National Science Council has been called upon to advise the government on many important matters related to science.

Some of the key areas of S&T and the ministries responsible for the formulation of both development and S&T policies in the respective areas are given below:

Main S&T policy areas	*Ministry*
Paddy, subsidiary food crops and minor export crops	Agricultural Research & Development
Tea and rubber	Plantation Industries
Coconut	Coconut Industries
Industry	Industries & Scientific Affairs
Health	Health
Electricity	Power and Energy
Fisheries	Fisheries
Forestry	Land & Land Development
Animal husbandry	Rural Industrial Development
Water services & drainage	Local Government, Housing & Construction
Technical education, higher education and research	Higher Education

When a ministry initiates a project proposal in one of its areas of activity it will do so using the technical expertise available in the appropriate institution(s) under it. If the project is a major one, and it affects development policy or S&T policy, it will have to be put up to the Cabinet for approval. In such cases, the Ministry of Finance and Planning and the Committee of Development Secretaries study the proposals and submit their views to the Cabinet when the project is put up for approval.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

The Ministry of Industries and Scientific Affairs has under it a number of corporations and statutory bodies, among which there are six organizations dealing with major scientific activities of national importance. These are the National Science Council, the Ceylon Institute of Scientific and Industrial Research, the Industrial Development Board, the Bureau of Ceylon Standards, the Atomic Energy Authority and the National Engineering Research and Development Centre.

According to the National Science Council law, the Council is expected *inter alia* to advise the Minister in charge of scientific affairs on the formulation of science policy and the application of science and technology to development. Since there are many other ministries that deal with science and technology, besides the Ministry of Industries and Scientific Affairs, matters of national policy pertaining to science and technology are not routinely referred to the NSC, but are dealt with by the appropriate institutions in the ministries concerned. For example, policy matters related to technical education would be dealt with by the University Grants Commission under the Ministry of Higher Education; any proposal for the expansion of a livestock breeding programme would be put up by the Department of Animal Production and Health and the National Livestock Development Board, both under the Ministry of Rural Industrial Development; and any changes in the Mahaweli multi-purpose scheme would be a matter for the Ministry of Mahaweli Development. However, where controversial issues arise, or when more than one ministry is involved, or when a subject does not clearly fall within the functions of any one ministry, the National Science Council may be called upon to examine and report on the subject.

Some of the recent activities of the NSC in the area of science policy are the preparation of a draft paper embodying national science policy guidelines, and the preparation of reports on a number of subjects, namely, science education in rural schools, post-graduate training of scientists, salaries and leave privileges of scientists, the feasibility of obtaining electric power from the ocean thermal gradient, and the experimental rural energy centre in south Sri Lanka. In another case, the Secretary-General of the NSC served as the Convenor and Chairman of a committee examining a proposal to establish an Agricultural Research Council covering the fields of agriculture, forestry, fisheries and livestock. The NSC's most recent assignment is to report on the controversy regarding the use of atomic energy for electric power generation. The NSC, besides advising the government on matters referred to it, may, on its own, examine and report on any issues of S&A that it considers to be of national importance.

The NSC is a statutory body appointed by the Ministry of Industries and Scientific Affairs. The members of the Council function for three years except for the Secretary-General who is the executive head and an ex-officio member of the Council. The Secretary-General is appointed for a specified period by the Minister on the recommendation of the Council. Meetings of the Council are presided over by a Chairman who is appointed by the Minister from among the members.

The NSC carries out its role as a scientific advisory body to government through committees of experts. Scientists and technologists with the required expertise are selected by the Council to serve as members of these committees. The committees report to the Council.

From the foregoing, it would be seen that, although one of the functions assigned to the NSC is science and technology policy formulation, in practice it deals with such matters only in specific instances. Its reports on such specific issues will normally be submitted to the Ministry of Industries and Scientific Affairs. If the matter in question affects another ministry, the Ministry of Industries and Scientific Affairs will forward the report to that ministry direct or through the President.

Recently, a proposal has been made to create a new Authority that will replace the NSC and to place it directly under the President so that its advisory role could encompass the full range of science and technology. Among the functions to be specially assigned to the Authority would be to advise the President on natural resources development and energy.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

In Sri Lanka the institutions which perform scientific and technological activities can be broadly discussed under the following headings:

S&T education and training

Research and development, and associated

S&T services

Scientific and technical education and training

The structure of the institutions of higher education have gone through several changes during the last decade. In January 1978, the several campuses of the then University of Sri Lanka were given university status with a large measure of autonomy. While general policy matters and financial allocations are under the newly created University Grants Commission, internal organization and academic policy planning come within the purview of the university administration. There are at present six universities and two university colleges. The seventh university is also in the process of being established.

In decentralizing and establishing new institutions for higher education, the government has given consideration to the need to spread out such organizations on a country-wide basis, parly to serve the needs of students in different regions and partly to facilitate the national programme for regional development.

Except for the University of Moratuwa in the Western province, which is basically an institution for engineering sciences, the other universities and colleges cater to a range of disciplines in the Arts and Sciences. At present medical studies are concentrated in the University of Colombo in the Western Province, and the University of Peradeniya in the Central Province. Post-graduate degree programmes are available in almost all universities, but in the fields of agriculture and medicine post-graduate studies and examinations are conducted by two institutes established specially for this purpose. The expected intake of students for universities and university colleges during the 1980-81 academic year is as follows:

Medical and Veterinary	490
Engineering	450
Agriculture	155
Natural Sciences	360

The establishment of an External Examinations Agency has now enabled a large number of students who fail to enter the universities to prepare for degree examinations as external candidates. Training at professional levels leading to government-approved degrees and diplomas, are provided by the Institute of Engineers Sri Lanka and the Institute of Chemistry Sri Lanka.

R&D and associated scientific and technical services

In Sri Lanka research and experimental development in the fields of science and technology are performed by a number of separate organizations. There is no apex organization to coordinate, control and monitor these activities. Nevertheless the existing structure has functioned reasonably well. The distribution of S&T functional areas in the state sector is given in Part 2.2 of this report.

Historically, the foundations of organized scientific research were laid in Sri Lanka during the period of the British rule - the emphasis then being on public health, fisheries and agriculture. The establishment of a Department of National Museums in 1873, the Bacteriological Institute in 1900 and the Ceylon Agricultural Society in 1904 was a reflection of this policy. The Bacteriological Institute was later transformed into the Medical Research Institute, and the Ceylon Agricultural Society provided the nucleus for the establishment of the Department of Agriculture.

The beginnings of industrial research can be traced back to the creation of an Industrial Research Laboratory in 1941 and the Rubber Service Laboratory in 1948. The resources of these two institutions were later transferred to the Ceylon Institute of Scientific and Industrial Research (CISIR) in 1955.

Learned societies and professional bodies have played a vital role in the development of S&T activities in the country. Founded in 1945, the Sri Lanka Association for the Advancement of Science (SLAAS) is the largest and most representative body of scientists in the country. The association holds an annual session to provide a forum for scientists to present and discuss the results of their original research. One of the major achievements of the SLAAS was the response of the government to its persistent call for the establishment of a National Science Council. Established by and Act of Parliament in 1968, the National Science Council has matured into a major institution for the promotion of S&T activities in Sri Lanka. Its main objectives and functions have been discussed in Part 2.3 of this report.

The major R&D institutions in Sri lanka are as follows:

The Central Agricultural Research Institute (CARI) is the main research and experimental development organ of the Department of Agriculture and is situated in Peradeniya, approximately 100 km. from Colombo. The department runs several other research stations in various parts of the country, which are so located to deal with problems associated with the different agro-climatic regions of Sri Lanka. The Department of Agriculture is headed by the Director of Agriculture, and its research aspects are handled by the Deputy Director (Research). Each of the main research stations are also headed by a deputy director.

The CARI has eight divisions each with a Head of Division, who is effectively the project leader, and several research officers. The research programmes of the Institute are generally linked to the national agricultural development programme of the Department of Agriculture. However, many of the research projects are initiated and formulated by the research officers. Research findings are disseminated through the Extension Services Division of the Department, which is itself headed by a deputy director. This division has a network of regional offices with several agricultural instructors attached to each regional office. The department is also assisted in its extension services by the Agricultural Information Division which prepares and distributes information packages to users.

Under the Department of Agriculuture is also a Veterinary Research Institute which is headed by an Assistant director. The research and extension services of this Institute are carried out by research officers and veterinary surgeons.

The growing interest and importance of plantation sector during the first quarter of this century, resulted in the creation of separate Research Institutes for Tea, Rubber and Coconut. Each of the institutes is headed by a director and deputy director (Research). The main functions of the Institutes are to study all aspects of crop husbandry with the objective of maximizing production.

Organizational aspects of the three institutes are comparable, there being several functional divisions, each managed by a head of section and assisted by several research officers. Research programmes are generally problem-oriented, but research interests of individual officers are also largely satisfied. Each research institute is managed by a Board of management with the Chairman functioning as a working or non-working director.

The three crop research institutes, being statutory bodies, enjoy a reasonable measure of autonomy with respect to most matters. All three institutions receive government grants in addition to cess-collections from exports of the products of the crops they serve. These institutes have their own extension services to transfer the know-how to growers. Each institute disseminates its findings through their respective quarterly journals and other bulletins.

The Medical Research Institute (MRI), established in Colombo, functions basically as a service unit to the Department of Health. It has 14 medical officers, 13 research officers and 85 laboratory technicians. The institute is headed by a director and its organization is typical of a government department. Some divisions function mainly to carry out routine examinations which invariably lead to problem-oriented research projects. Formulation and selection of research programmes is made solely by individual research staff.

The Ayurvedic Research Institute, established by the Government in 1962, has as its main objective to carry out research and development on the indigenous system of medicine. A part-time director functions as the chief executive of this institute. The major divisions of chemical research, drug research and literary research are without staff and hence no major progress has been reported.

The Department of Irrigation has as its main objective, the development of water resources for irrigated agriculture. The research wing of the department has six divisions and is headed by a deputy director. The Land Use Division has as its head a specialist scientific officer, who is assisted by soil chemists, soil surveyors, cartographers and other supporting staff. The research projects are specifically related to national programmes leading to the developement of irrigated agriculture.

R&D activities, in relation to the development of the industrial sector, are mainly carried out by the S&T organizations of the Ministry of Industries and Scientific Affairs. The major S&T institutions in this Ministry are:

The Geological Survey Department;

Ceylon Institute of Scientific and Industrial Research (CISIR);

National Science Council (NSC);

National Engineering Research and Development (NERD) Centre;

Atomic Energy Authority (AEA);

Bureau of Ceylon Standards (BCS); and the

Industrial Development Board (IDB).

The Geological Survey Department has as its main function the study and exploration of the mineral resources of the country. The department is headed by a director, deputy director and a technical staff of ten geologists, two chemists and a geophysicist. Apart from normal geological surveys it has in recent years started an exploration programme on raw materials for nuclear energy. It is also engaged in the study of heavy mineral potential and copper-magnetite deposits in the North Eastern regions of Sri Lanka, and a study of the coral and dolomitic limestone deposits in the country.

The Ceylon Institute of Scientific and Industrial Research was set up to provide the industry with expertise and services for the development of industrial process, testing and quality control, it has 16 research divisions and is headed by a director who is assisted by a deputy director for research. There are 69 research officers and about 90 supporting staff. The Governing Board of the Institute is appointed by the Minister. A Research Planning Council composed of heads of technical sections, as well as outside specialists in science, engineering and industry, advises the Board on all matters pertaining to planning of scientific research. Formulation of research projects is mainly made by individual research officers. The findings of research are generally put out in the form of reports. A serious drawback is the lack of a technical journal for the Institute to publicize its important research findings.

The work of the National Science Council is discussed in Part 2.3 of this report. The chief executive of the Council is the Secretary-General who is assisted by the Deputy Secretary-General, an Assistant Secretary-general and seven scientific officers.

The NERD Centre has as its main function the promotion, development and commercial utilization of indigenous inventions. It supports pilot plant and development work, and provides a consultancy sercice on engineering and technological matters. It is managed by a board of directors, whose Chairman functions as a working director. It has eight divisions each with a head of section. The centre selects its R&D projects of national interest from those referred to it by government institutions, and private sector organizations.

The Atomic Energy Authority (AEA) was established in 1969. Its main function is to develop the necessary resources for the utilization of atomic energy for economic development. It also maintain a national radiation protection service to enforce atomic energy regulations. The authority comprises a working chairman and six members, who comprise the Board of Management, and a technical staff of scientific officers.

The Bureau of Ceylon Standards was established in 1964 with the responsibility to prepare and implement standard specifications of both industrial and consumer products. It also administers its own certification marks scheme and export inspection programmes. The Bureau is headed by a director, who is assisted by five assistant directors, eight senior standard officers and 44 other officers serving the sections dealing with standards, testing, textile technology and statistics.

The Industrial Development Board can be considered as one of the major extension services wings of the Ministry of Industries and Scientific Affairs on matters pertaining to small and medium-scale industries. It has scientists and engineers as well as development and extension officers numbering about 50. It has an executive chairman and a general manager.

The research activities of the Universities are largely geared to the training of young scientists to scientific methodology. Hence the emphasis is not always linked to practical applications. The financial resources of universities for scientific research are highly inadequate, and hence the assistance of outside agencies are sought by the academic staff to sponsor research. The National Science Council has been the major organization supporting scientific research in universities. However, in recent years collaborative research projects with foreign universities supported by international funding organizations have largely met the demands of the university researchers. Within the country links established by the engineering and chemistry departments of universities with industry have had fruitful results.

The Government Analysts Department provides analytical investigative and advisory services to other government departments and state corporations. Its services include scientific analysis and issue of reports on productions sent by courts of justice, police and local administrative bodies for administration of the criminal procedure code.

The Forest Department's research activities have not been very extensive. Research has mainly been in silviculture, entomology and timber utilization. Sri Lanka has three botanic gardens administered by the Department of Agriculture. These three gardens are situated in three agro-climatic regions and are supervised by the Superintendent of Gardens. Primarily established for the purpose of investigating the flora of the country and introduction of economic crops such as tea, rubber, cocoa and cinchona, these gardens have become centres of botanical research and flori-cultural development. All these gardens have representative collections of tropical and temperate plants from different parts of the world. The Royal Botanic Gardens established in 1821 to receive exotic plants, enjoys world-wide fame for its wealth of tropical vegetation.

Conservation of wild life in Sri Lanka is an important aspect of state policy. The enforcement of the fauna and flora protection ordinance is the responsibility of Department of Wild Life Conservation. A total of 6 197.69 square kilometres (2 392.93 sq. miles) consisting of a little over 9% of the total land area of the country has been proclaimed as protected. The National Zoological Garden of Sri Lanka located 10 km. south of Colombo is maintained by the State. It covers an extent of 21.04 hectares (52 acres) and is considered to have the best collection of fauna in Asia.

The activities on marine and inland fisheries is within the purview of the Ministry of Fisheries. The recently established research stations for fisheries have been handicapped by a shortage of research personnel. The Ministry of Fisheries is now collaborating with the Biology Departments of the universities in carrying out its research activities in inland fisheries.

The Department of National Museums run one major museum in the capital city and three other provincial museums. The Colombo Museum, established in 1877, consists of sections on ethnology, anthropology, geology, entomology, zoology and botany. The research carried out by these sections are published in the official journal of the Department.

In Sri Lanka, the major components of S&T information activities are located in the network of libraries attached to R&D institutions. Majority of these libraries specialize in specific areas and cater to the persons working within these institutions. Other information centres such as the public libraries in urban areas and the libraries associated with foreign missions, also contribute significantly to the S&T information system. The university libraries have comprehensive collections, especially that of the University of Peradeniya which is the legal depository.

The creation of the Sri Lanka Scientific and Technical Information Centre (SLSTIC) at the national Science Council in 1975, provided a strong base to serve as the clearing-house for S&T information activities. The Industrial Development Board with its specialized library and documentation centre, provides the Industrial Information Service (IFS) to industrialists and institutions. This is possibly the only information unit in the country which prepares and distributes packaged information in technology.

3.2 HUMAN RESOURCES

The first extensive survey of scientific and technical personnel in the country was carried out by the National Science Council during 1977-78. The results of this survey, which did not include technicians, are summarized in Table 2.[18] A previous survey carried out in 1973 was not amenable to an analytical study and is therefore not shown in the table. However, it was noted that the total number of professionally and academically qualified S&T personnel had dropped from 6 845 in 1973 to 6 488 in 1977. This is also reflected in the national coefficient of scientists and engineers (i.e. S&T personnel per 10 000 population), which fell from 5.2 in 1973 to 4.6 in 1977. One reason attributed to this trend is the emigration of professionals to developed countries.

When the total stock of S&T personnel is considered, approximately 20% are found to be in the Agricultural Sector, while industries account for 22%. Excluding secondary school teachers which number 2 076 the break-down of the remaining S&T personnel according to major fields is as follows:

Natural Science	1 095
Engineering & Technology	2 420
Medical Science	23
Agricultural science	869
Social Science	5

This indicates that while 55% were engaged in the engineering field only 19% were in the field of agriculture. It was also observed that 0.6% of the S&T personnel were females, with the male to female ratio at 14: 1.

Although the total number of scientific and technical personnel engaged in R&D during the survey period numbered 969, when computed on the basis of Full Time Equivalent (FTE) it was only 604. Of the latter 35.3% were on natural sciences, 32.9% on engineering and technology, 29.3% on agricultural sciences and 2.5% on medical science.

The survey also revealed that horizontal job mobility was low, with 46% of the respondents being in their first job, 34% in their second job and 14% in their third job. This was probably a reflection of the non-availability of employment opportunities during the period prior to the survey. More than 50% of the respondents considered that their university and other training were essential for their jobs, while 45% thought that this training was moderately useful. One 1% of the respondents said that this training serve no useful purpose. In relation to job satisfaction 24% claimed that they were extremely satisfied, while 65% appeared to be moderately satisfied, and 11% dissatisfied.

A study carried out in 1976 had shown that the migration of professionally skilled personnel to Britain from 1968-1974 had been 1 013, of which medical personnel numbered 430 and engineers 260. This same survey estimated the "net social" gain to Britain from the migration of engineers and doctors to be nearly 56 million pounds sterling during that period.

A Cabinet Committe appointed in 1974 to study and make recommendations on this problem of brain drain, found that over a 38-month period from May 1971 to June 1974, 1 705 persons had left the country for employment abroad.[16] This amounted to 18% of the total number of professional and technical personnel available in the country in 1971. This committee identified two main causes for migration, viz., the lack of opportunity for the development of professional competence, and dissatisfaction with working conditions, particularly the remuneration levels.

Some of the principal measures adopted then by Sri Lanka to restrict migration were:

i. the compulsory Public Service Act of 1981 which required professionals to serve the country for five years after graduations;

ii. the Passport (Regulations) and Exit Permit Act of 1971 which required anyone leaving the country for employment to enter into an agreement to remit a portion of the earnings; and

iii. the requirement to enter into service bonds, where persons sent abroad for training or further education were required to serve the government for a specific period after their return.

The Cabinet Committee in its deliberations considered the negative effects of these measures and recommended among others the following measures:

i. to review the Compulsory Service Act of 1971;

ii. to reduce the period of obligatory service after study/training abroad to a maximum of 10 years, with the option to encash a part or the entire period of obligatory service;

iii. to allow professionals in the public service to take up to five years of no-pay leave during their careers to take up assignments abroad;

iv. to provide relief measures on income tax for earnings in foreign currency; and *v*. to abolish the requirement of foreign exchange remittances, included in the Passport and Exit Permit Act.

In spite of these far-reaching recommandations of the Cabinet Committee, the migratory trend of professionals increased, possibly more due to economic reasons rather than because of the relaxation of restrictive measures.

In the latter part of the decade the migratory pattern changed on account of the new openings in the African and West Asian countries. While most of those proceeding to developed countries had plans to take up permanent residence abroad, those leaving for developing countries had entered into fixed-term contracts which made their stay temporary. In terms of skills too the migratory pattern differed, there being a larger proportion of doctors emigrating to developed countries as against a higher proportion of accountants and engineers moving out to developing countries.

During the four-year period from 1976 to 1979 the total flow of labour to the Middle Eastern countries has been computed at 23 674 of which the professions numbered 428 or 1.8% of the total. The middle levels made up 7.3% while the balance consisted of skilled and unskilled labour. This serious depletion in the stock of economically active technical, skilled and semi-skilled personnel has been viewed with grave concern, especially on account of the government's commitments to the massive development programme comprising the irrigation and hydro-power-accelerated Mahaweli Project, the Investment Promotion Zone, the Urban Development and Housing Construction Programme.

Against this grim outlook is the prospect of new employment opportunities, which is however observed with caution. On the other hand the phenomenal increase in foreign currency transfers by migrant labour, has been viewed with relief. The Central Bank of Ceylon records that credit transfers had increased from Rs.190 million in 1977, to Rs.610 million in 1978 and Rs.935 million in 1979. The net transfer for these three years had, however, been Rs.122 million, Rs.342 million and Rs.754 million respectively. It has also been estimated that approximately 70% of these inward remittances were received from Sri Lankans employed in the Middle Eastern countries.

3.3 FINANCIAL RESOURCES

Budgetary allocation of funds for scientific research in the state sector is generally based on estimated expenditure. However, in the case of the plantation research institutes, financial support is available from two sources. A cess collection on the export value of products of the crop served by the Institute, and an outright grant from the government. These institutes also draw incomes from the sale of the produce of their estates. However, technical services and know-how are provided free of charge to the users.

Financial allocation for government departments and other statutory bodies performing R&D functions are through the annual votes which are included in the estimates of the respective Ministries. Hence these estimates are generally subject to scrutiny and approval of the ministry concerned as well as the Ministry of Finance and Planning.

As pointed out elsewhere, financial resources available for university researchers through normal university channels, are grossly inadequate. However, the needs of university researchers are now largely met by organizations such as the National Science Council, and international bodies such as the International Foundation for Science (IFS), the Swedish Agency for Research Cooperation in Developing Countries (SAREC), and the World Health Organization (WHO).

The R&D expenditure during the year 1975 is shown in Table 3a in relation to source of funds and sector of performance.[9] Out of a total expenditure of Rs.45.097 million, 53.5% has come from government funds while the balance comprise funds from productive enterprise and special funds. In relation to expenditure 82% has gone to the productive sector, 15% to the general service sector and only 3% to the higher education sector (Table 3a).

In terms of current rupee value, the expenditure on R&D had increased from Rs.13 million in 1966 to Rs.45.1 million in 1975, showing a mean annual growth rate of 15.8% (See Table 3b). But in terms of the constant rupee, the increase has been from Rs.13.2 million in 1966 to Rs.22.9 million in 1975. During this same period the per capita expenditure on R&D had increased three-fold from Rs.1.14 in 1966 to Rs.3.32 in 1975.

During the period 1966-75, Agricultural Science continued to received the major component of research funding, although the percentage of the national expenditure on agriculture did no increase proportionately. The National R&D coefficient which is the total expenditure on R&D expressed as percentage of the Gross National Product increased from 0.169 in 1966 to 0.206 (at current factor cost) in 1975. It was estimated that the extra expenditure on R&D required in 1975 to reach the 1.0% level for the National R&D coefficient (at current factor cost) would have been Rs.174.25 million.

3.4 SURVEYING OF THE S&T POTENTIAL

The main institution in Sri Lanka which surveys and monitors the scientific and technical effort in the country is the National Science Council. The Council's work in this field is guided by a statutory working committee on Science Policy Research.

The last survey on S&T manpower was carried out during 1977-78. This was in fact the most comprehensive survey ever carried out in this field in Sri Lanka. A tested questionnaire, coded for computer analysis was used in this survey. The issue of the questionnaire was followed by personnal visits by the survey staff, to ensure a high response. Once the completed questionnaire was received, the material was edited, and coded data were extracted for computer analysis. This survey covered all sectors of the economy, but excluded the secondary schools and colleges. The classification an teminology used were based on Unesco recommendations.

The first comprehensice survey on R&D expenditure was carried out by the National Science Council during 1976-1977 and covered the 10-year period from 1966-1975.[9] This survey was again carried out by staff members of the Council visiting each institution separately to extract, collect and collate available data. The classification and terminology used were as recommended by Unesco.

The survey results are generally published by the Council and these also form the inputs for the Unesco surveys. The Sri Lanka Scientific and Technical Information Centre (SLSTIC) of the National Science Council surveys, monitors and analyses the S&T information needs of the country. It coordinates the activities of the S&T libraries and documentation centres in Sri Lanka, and through this network keeps track of all S&T publications and documents produced in the country.

The Social Science Research Centre of the National Science Council monitors the activities in Social Sciences. It has recently completed a survey of social scientists in the country. Apart from the National Science Council, the Department of Census and Statistics, the Ministry of Plan Implementation and the Central Bank of Sri Lanka, survey and monitor technical manpower requirements through sample surveys, computations, etc.

PART 4.

Policy issues in scientific and technological development

4.1 MAJOR DEVELOPMENTS

The major developments in the late 1960's and early 1970's which enhanced and catalysed scientific activity in the country were:

- the creation of the National Science Council by the government in response to the agitation of the scientific community; and
- the decision of the Ministry in charge of scientific affairs to sponsor R&D on its own, independent of such activities in other ministries.

In 1975, this Ministry's research sponsorship policy was delegated to the National Science Council, which facilitated administration of awards through liberalized management procedures. Although the Council's contribution to the Gross National Expenditure on R&D was small, its impact was substancial in the higher education sector, where opportunities opened up for young scientists to obtain research-based postgraduate degrees. This programme of the National Science Council thus not only increased the research activities in the country, but also helped to increase the S&T capacity of the country. Further, by the establishment of a major information unit (SLSTIC) in the National Science Council in 1975, to service the needs of researchers, and providing country-wide coordination of S&T information activities, a new thrust was made into the provision of S&T services.

In recent years the most meaningful step taken by the State is the promulgation of the National Science and Technology Policy by the Executive Head of State in December 1978. Since then, the National Science Council as well as the Sri Lanka Association for the Advancement of Science have been preparing plans for the implementation of the policy issues.

In the field of higher education major strides were made with the creation of a Minitry of Higher Education. The decentralization of university education and increase in the number of universities and university colleges to step-up the output of medical, science and engineering graduates, was a major move to increase the S&T capacity of the country. The manpower training programmes of the Post-graduate Institute of Agriculture and the Post-graduate Institute of Medicine were directed to increase the pool of specialists in these fields.

In the Government sector the formation of the Sri Lanka Engineering Service in 1971 and the Sri lanka Scientific Service in 1976 have been significant steps to improve the working conditions of the State sector scientists and technologists. This also brought the scientists and technologists on par with the decision-making administrative hierarchy in the country.

More recently, with the hope of curtailing or reversing the migratory trends of academically qualified personnel, the government stepped in to provide many incentives which included special allowances, right of private consultancy practise, abolition of the Compulsory Service Act and permission to import motor vehicles for private use. The impact of these concessions are yet to be evaluated.

4.2 ACHIEVEMENTS AND PROBLEMS

It is recognized that the biggest single factor responsible for retarding the development of the S&T capacity in Sri Lanka is the migration of academically and technically qualified personnel. Sri Lanka is not the only country faced with this problem. In fact, most of the developing countries are plagued by this malaise.

A brief review of the situation in Sri Lanka is given in Part 3.2 of this report. The positive and negative effects of brain-drain is being widely discussed and, at present, the main thrust has been to devise means of increasing the trained manpower resources of the country.

The Government of Sri Lanka has recognised the gravity of the problem and attempted to reverse the process through what may be called an open policy supported by a range of incentives. However, the attraction of very high wages payable in developed and newly rich countries continue to lure away the professional and skilled sectors of the economy.

The present Government is also strongly committed to the guarantee of fundamental freedoms, and has accordingly reassured that it will not attempt to impose any restrictive measures to counter brain-drain. In the alternative it has, as one solution, decided to increase the educational and training facilities in the country with the ultimate goal of maintaining the equilibrium despite depletion through migration. To this end it has increased considerably the intake of students to universities. Two of the new universities have been given facilities to commence medical faculties. At the secondary school level, an effort is being made to increase the S&T bases in the country by increasing teacher training courses coupled with the equipping of laboratories in the rural sectors.

The scope of training at the middle and lower levels has been considerably widened during the past two years with the vitalizing of the National Apprenticeship Board. At present it offers training facilities in:

123 trades for the category of craft apprenticeship;
10 fields for technician-level apprentices;
11 fields for special engineering apprentices; and
11 fields for under-graduate engineering apprentices.

In the fields of information and documentation, import restrictions prior to 1977 adversely affected the purchase and acquisition of scientific literature. Although financial allocation for the acquisition of scientific literature had increased over the years, these were not proportional to the increase in prices of these items; and the widening gap naturally resulted in a sharp drop in the inflow of literature.

However, during the past few years due to liberalization of imports, many items of equipment such as calculators, photocopiers and even computers became freely available. The popularity of these, and specially of photo-copiers for information dissemination, is an indication of the new inroads on the development of S&T services in the country.

One of the major constraints in the application of science and technology for development in the past is that the wealth of scientific expertise available in the country has not been fully utilized in the decision-making process. However, the declaration of a National Science and Technology Policy by the present government in 1978 has given much hope to a change of attitude. In fact some aspects of the implementation of this Policy have already received the consideration of the government. Many matters on science policy are also now referred to the National Science Council for its advice and recommendations. More recently State approval has been received for the creation of an Institute of Theoretical Studies which will be placed directly under the Head of State. There is thus a new awakening on the need to develop a strong S&T base in the country to promote development.

4.3 OBJECTIVES AND PRIORITIES

The policy objectives which have been deduced and formulated through the experiences of the past are very precisely stated in the seven-point National Science and Technology Policy promulgated by His Excellency the President of the Republic of Sri Lanka in December 1978. The main facets for the development and use of scientific and technological capabilities were stated as follows by His Excellency:

> "What then are the fields in which scientists and technologists can help the Government and, vice versa, Government help them? I will adopt fully the following objectives as the National Science and Technology Policy of Sri Lanka.
>
> *1.* To use as an integral part of the developmental strategy of the country and to involve scientists in the formulation of policy and in decision-making at the highest levels.
>
> *2.* To foster scientific activity in all its aspects and in its widest possible scope, and to maintain a vigorous drive towards self-reliance in national scientific and technological capability.
>
> *3.* To provide equal and adequate opportunities for all to acquire a basic education in science.
>
> *4.* To ensure that our institutions of education and research will produce scientists and technologists of the highest calibre.
>
> *5.* To provide our scientists and technologists with good working conditions, adequate remuneration, due recognition for their efforts and access to scientific knowledge and activity in other parts of the world.
>
> *6.* To make available as widely as possible within the country the fruits of scientific and technological activity.
>
> *7.* To cultivate among our people an appreciation of the value of science and scientific method as an indispensable part of a modern society. "

The statement is a clear indication of the government's appreciation of the role of science and technology in achieving the development objectives of the country, and the aspiration of its people.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

The need for S&T cooperation, at the national, regional and international level, is fully recognized by the government. However, collaborative and cooperative efforts in S&T at the national level have been slow to start. At present the main cooperation programmes have been between the universities and the industrial sector. Inter-institutional collaborative programme are basically related to problem-oriented R&D projects.

A the regional level many programmes have been initiated, of which one is the bilateral agreement on cooperation in S&T between the governments of Sri Lanka and India. Under this agreement counterpart institutions in the two countries are linked on joint programmes which involve exchange of information, exchange of technical personnel for training, transfer of know-how, joint R&D programmes etc.

Apart from such bilateral agreements, Sri Lanka is also a collaborative partner on several projects supported by Unesco, WHO, FAO, UNEP and other international organizations such as the Commonwealth Science Council (CSC), the Association on Science Cooperation in Asia (ASCA), International Council of Scientific Unions (ICSU) and its Committee on Science and Technology in Developing Countries (COSTED). The inter-country collaborative programmes of Commonwealth Science Council have received the strong support of the government mainly for the following reasons: it is one of the few international organizations which relies on the expertise available within the country, to propose, formulate and implement R&D programmes. CSC programmes are also popular since it helps to link-up through a network scientists and technologists directly involved in the implementation of collaborative programmes.

At the international level, the inter-regional programmes of the various UN Agencies and other international organizations have been supported by Sri Lanka. Apart from the above, at a less formal level the role of foreign funding agencies such as SAREC and IFS in funding R&D, and in assisting inter-university collaborative projects have received the approval of the government.

PART 5.

Bibliography

Central Bank of Ceylon (1978) *Annual Report for 1977* Colombo

Central Bank of Ceylon (1979) *Annual Report for 1978* Colombo

Central Bank of Ceylon (1980) *Annual Report for 1979* Colombo

Central Bank of Ceylon (1980) *Review of the Economy, 1979* Colombo

de Mel, The Hon. Ronnie (1980) *Budget Speech 1981* Department of Government Printing, Colombo

Gunawardena, Lalitha (1976) "The Drain to U.K. " *Economic Review* (Sri Lanka), I (2) 4-5

Jayewardene, His Excellency J.R. (1979) "Inaugural Address of the 34th Annual Session of the Sri Lanka Association for the Advancement of Sciences". *Proceedings of the 34th Annual Session, Part II* Colombo

Marga Institute. *Case studies in Reverse Transfer of Technology (Brain Drain): A Survey of Problems and Policies in Sri Lanka.* Document TD/B/C.6/AC.4/4 - United Nations Conference on Trade and Development, 1977

National Science Council of Sri Lanka. *Survey on Research and Experimental Development in Sri Lanka 1966-1973,* 1977

National Science Council of Sri Lanka. *United Nations Conference on Science and Technology for Development, Sri Lanka National Paper.* Colombo, 1978

Sri Lanka, Department of Census and Statistics. *Statistical Pocket Book of Sri Lanka 1979.* Colombo, 1980

Sri Lanka, Ministry of Finance and Planning. *A Guide to the Foreign Investor outside the Investment Promotion Zone* Colombo, 1980

Sri Lanka, Ministry of Finance and Planning. *Public Investment (1980-1984).* Colombo, 1980

Sri Lanka, Ministry of Industries and Scientific Affairs. *Sri Lanka's Industrial Policy.* Colombo, 1980

Sri Lanka, Ministry of Plan Implementation. *Performance January to June 1980.* Colombo, 1980

Sri Lanka, Sessional Paper No. X of the Government. *Report of the Cabinet Committee Inquiring into the Problem of Technologically, Professionally and Academically Qualified Personnel leaving Sri Lanka,* 1974

Sri Lanka, Department of Government Printing. *The Constitution of the Democratic Socialist Republic of Sri Lanka* Colombo, 1978

National Science Council. *Survey of Scientific and Technical Personnel,* unpublished.

THAILAND

Table of Contents

THAILAND

GEOGRAPHY

Capital city: Bangkok
Main ports: Bangkok
Land surface area: 514,000 km

POPULATION (1978)

Total	45.1 million
Density (per sq km)	88
Urban/rural ratio (1970)	0.2
Average rate of growth (1970-78)	2.8%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	42.2	11.0	9.3	32.5	4.9	100%

SOCIO-ECONOMIC

Labour force (1978)

Total	21.9 million
Percentage in agriculture	73.2%

Gross national product (1978)

GNP at market prices	US $23,390 million
GNP per capita	US $520
Real growth rate of GNP per capita (1970-78)	4.5%

Gross domestic product (1977)

Total (in current producers' values)	US $18,157 million
Percentage by origin	
Agriculture	28%
Manufacturing, mining & quarrying, electricity, gas & water, construction	28%

Government finance

National budget (1978)	US $3,200 million
As percentage of GNP	13.7%
External assistance (official, net; 1976)	US $231 million
As percentage of GNP	1.4%

Exports (1978)

Total exports of goods	US $4,085 million
Average annual growth rate (1970-78)	12.2%

External debt (1978)

Total public, outstanding + disbursed	US $1,777 million
Debt service ratio (% GNP)	0.9
(% Exports of goods and non-factor services)	3.7

Exchange rate (1978): US $1 = 20.33 Baht

EDUCATION

Primary and secondary education (1977)

Enrolment, first level	6,955,623
As % of (7-13 years)	82%
Enrolment, second level	[1]1,147,476
As % of (14-18 years)	28%
Combined enrolment ratio (7-18 years)	62%
Average annual enrolment increase (1970-1977)	[1]3.6%

---

[1] Second level education refers to general education and teacher training only.

Higher education (third level) (1977)

Teaching staff, total	12,986	
Students and graduates by broad fields of study:		
	[1]Enrolment	Graduates (1976)
Social sciences and humanities	181,873	20,692
Natural sciences	10,389	1,359
Engineering	10,255	2,131
Medical sciences	9,749	2,750
Agriculture	4,610	846
Other and not specified	...	...
Total	**216,876**	**27,778**
Number of students studying abroad	10,243	

Education public expenditure (1978)

Total (thousands of Baht)	16,148,301
As % of GNP	3.4%
Current, as % of total	67.9%
Current expenditure for third level education, as % of total current expenditure	11.5%

---

[1] Including open admission university.

Table 1. Nomenclature and Networking of S&T Organizations

I - First Level - POLICY-MAKING

Country: Thailand

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
National Economic and Social Development Board	Planning and evaluation of economic and social development plans (5 years) including plans for science, technology and environment	Office of the Prime Minister		Various ministries
Ministry of Science, Technology and Energy (MSTE)	Planning for science, technology and energy	Cabinet	Office of the National Research Council, etc.	Various ministries
National Research Council	Planning for R&D	Ministry of Science, Technology and Energy (MSTE)		Various ministries
National Energy Administration	Planning for energy	MSTE		National Research Council
National Environment Board	Planning for environment and co-ordination of environmental work	MSTE		National Research Council, National Economic and Social Development Board

II - Second Level - PROMOTION & FINANCING

Country: Thailand

Organization	Linkages		
	Upstream	Downstream	Others
Budget Bureau	Office of the Prime Minister		
National Research Council	Ministry of Science, Technology and Energy		
Department of Technical and Economic Co-operation	Office of the Prime Minister		
Institute for the Promotion of Teaching Science and Technology	Ministry of Education		
National Commission for Unesco	Ministry of Education		
Department of Agricultural Extension	Ministry of Agriculture and cooperatives		
Department of Industrial Promotion	Ministry of Industry		
Department of Hygiene	Ministry of Health		
Royal Institution	*Office of the Prime Minister*		
Science Society of Thailand			National Research Council, other professional associations
Agricultural Science Society of Thailand			National Research Council, other professional associations
Engineering Institute of Thailand			National Research Council, other professional associations
Medical Association of Thailand			National Research Council, other professional associations
Pharmaceutical Association of Thailand			National Research Council, other professional associations
Southeast Asian Ministers of Education Secretariat (SEAMES)			Ministry of Education, Office of University Affairs
Association of Southeast Asian Nations (ASEAN) Committee on Science and Technology			Ministry of Foreign Affairs, Ministry of Science, Technology and Energy and other agencies

III - Third level - PERFORMANCE OF STA

Establishment	Function	Linkages	
		Upstream	Others
Thailand Institute of Scientific and Technological Research	R&D (on contractual basis), STS	Ministry of Science, Technology and Energy	National Research Council
Department of Science Services	STS, R&D, STET *(Chemistry)*	Ministry of Science, Technology and Energy	
Office of Atomic Energy for Peace	STS, R&D	Ministry of Science, Technology and Energy	
National Energy Administration	STS, R&D	Ministry of Science, Technology and Energy	
Technology Transfer Center	STS	Ministry of Science, Technology and Energy	
Institute for the Promotion of Teaching Science and Technology	STET, R&D	Ministry of Education	National Education Commission
Department of General Education	STET	Ministry of Education	National Education Commission
Department of Vocational Education	STET	Ministry of Education	National Education Commission
Department of Non-Formal Education	STET	Ministry of Education	National Education Commission
Department of Teacher Training	STET	Ministry of Education	National Education Commission
Office of the Private Education Commission	STET	Ministry of Education	National Education Commission
Chiang Mai University	STET, R&D, STS	Office of University Affairs	
Chulalongkorn University	STET, R&D, STS	Office of University Affairs	
Kasetsart University	STET, R&D, STS	Office of University Affairs	
Khon Kaen University	STET, R&D, STS	Office of University Affairs	
King Mongkut's Institute of Technology	STET, R&D, STS	Office of University Affairs	
Mahidol University	STET, R&D, STS	Office of University Affairs	
Prince of Songkhla University	STET, R&D, STS	Office of University Affairs	
Ramkhamhaeng University	STET, R&D, STS,	Office of University Affairs	
Srinakharinwirot University	STET, R&D, STS	Office of University Affairs	
Silapakorn University	STET, R&D, STS	Office of University Affairs	
Asian Institute of Technology	STET, R&D, STS		International agencies
Department of Agriculture	STS, R&D	Ministry of Agriculture and cooperatives	
Department of Fisheries	STS, R&D	Ministry of Agriculture and cooperatives	
Department of Livestock	STS, R&D	Ministry of Agriculture and cooperatives	

Establishment	Function	Linkages	
		Upstream	Others
Department of Royal Forest	STS, R&D	Ministry of Agriculture and cooperatives	
Department of Royal Irrigation	STS, R&D	Ministry of Agriculture and cooperatives	
Department of Land Development	STS, R&D	Ministry of Agriculture and cooperatives	
Department of Mineral Resources	STS, R&D	Ministry of Industry	
Thai Industrial Standards Institute	STS	Ministry of Industry	
Department of Medical Science	STS, R&D	Ministry of Public Health	
Government Pharmaceutical Organization	STS	Ministry of Public Health	
Department of Meteorology	*STS*	*Ministry of Communication*	
Department of Post and Telegraph	STS	Ministry of Communication	
Department of Aviation	STS	Ministry of Communication	
Department of Highways	STS	Ministry of Communication	
Department of Harbour	STS	Ministry of Communication	
Military Research and Devt. Center	R&D	Ministry of Defence	
Armed Forces Research Institute for Medical Science	R&D	Ministry of Defence	
Department of Army Science	STS	Ministry of Defence	
Department of Naval Science	STS	Ministry of Defence	
Electricity Generating Authority of Thailand	STS	Office of the Prime Minister	
Provincial Electricity Authority	STS	Ministry of Interior	
Department of Accelerated Rural Development	STS	Ministry of Interior	

Table 2 - Scientific and Technological Manpower

Country: Thailand

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (in units)	of which working in R&D						Total stock (thousands)	of which working in R&D (in units)
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences		
1965	30.6									
1970	34.4									
1973	39.9	7,900[a]								
1975	42.3	11,547[b]								
1978	45.2		2,010[d]	341	222	901	546			
1979	46.1	28,213[c]								
1980	46.9								230,000[e]	
1985	52.1									
1990	66.7									

a. Survey by the Office of the National Research Council (NRC); 7,900 answers, while 15,000 questionnaires were sent.

b. Survey by NRC; 11,547 answers while 20,000 questionnaires were sent.

c. Survey by NRC; questionnaires were sent *not to individuals* but to 10,432 organizations; 97% or 632 government offices, 94% or 1,722 educational institutions, 40% or 3,139 private organizations answered the questionnaires. The number of 28,213 is believed to be close to actual total stock since organizations that did not answer the questionnaires most likely do not have scientists or engineers.

d. Survey by NRS; 2,010 is the number of researchers answering questionnaires. Numbers in the row can represent minimum numbers of researchers in each field.

e. Estimated from production rates during 1975-1978, comprising 190,000 industrial technicians and craftsmen and 40,000 agricultural technicians.
Source: Fifth National Social and Economic Plan (Science and Technology).

Remarks:

(1) *Accumulated number of graduates in science and engineering as at 1979 is 66,000. Source: Unesco.*

(2) Incomplete availability of reliable data permits only partial filling of the Table. Estimates, if made, will most likely mislead.

(3) Ratio of scientists and engineers working in R&D to total stock during 1965-1981 is believed to have increased yearly.

(4) Ratio of technicians working in R&D to total stock may be lower or higher than ratio in (3) since one research engineer may generate R&D works for only a few or many technicians, depending on nature of work.

Table 3 - R&D expenditures[a]

Country: Thailand
Currency: Baht

Table 3a: Breakdown by source and sector of performance

Year: 1979

Unit: million

Source / Sector of performance	National		Foreign[b]	Total
	Government funds	Other funds		
Productive	1,331		115.4	1,446.4
Higher Education				
General Service				
Total	1,331		115.4	1,446.4

Table 3b: Trends

Year	Population (millions)	GNP (in millions)	Total R&D expenditures (in millions)	Exchange rate US $1 = Baht
1965	30.6			
1976	42.2	330,000	900	20
1977	44.2	400,000	1,050	20
1978	46.1	510,000	1,331	20
1985	52.1			
1990	66.7			

(a) Data Incomplete. Most recent figures from Office of National Economic and Social Development Board and the Office of the National Research Council are included here.

(b) Source: Department of Technical and Economic Co-operation data and analysed by the National Research Council.

PART 1.

General features

1.1 GEOPOLITICAL SETTING

This report is about a Southeast Asian country formerly known to outsiders as Siam. The country has been officially named "Thailand" since the Second World War in 1939, a name corresponding to the words "Muang Thai", literally "the Land of the Thais". The word "Thai" means free or independent, and perhaps the realization of this fact has implanted this concept as a characteristic trait in the people who call themselves "Khon Thai" or "Free Men". Many aspects of the behaviour of Thais, individually as well as collectively, may be traced back for better or for worse to this basic love of freedom.

The country is situated in Southeast Asia and the geographical location is indicated, together with its neighbouring countries on the accompanying map. Relevant statistics are also given.

Thailand is divided into four regions: the mountainous North where certain temperate plants can grow in the cool season; the rolling plateau of the Northeast where tropical jungles used to flourish; the central plain region whose fertile land produces enough rice to feed the nation and some other peoples of the world; and the hilly South, rich in minerals as well as plants. Fresh water is plentiful in the wet season but, in the dry season, water is rather scarce due to limited rainfall. Fish and other aquatic animals are popular for local consumption as well as export. The role of water in the life of the Thai people is considerable, from household to agricultural uses, generation of hydro-electricity, and transportation. Houses can be seen lining the banks of rivers and canals. Many of the canals are man-made, mostly for irrigation, flood control and navigational purposes.

Politically, Thailand has been under a constitutional monarchy since 1932, prior to which it was under absolute monarchy. Basically the Constitution recognizes the King as the Head of State with the legislative function exercised through the National Assembly, the executive function through the Cabinet, and the judicial power through the Court. The three elements are independent of each other and act as balancing forces in this particular system of monarchical democracy.

The country is divided into 72 provinces each with a Governor linking his province to the Central Government. These provinces are officially grouped into six regions, excluding Bangkok, namely the Central, East, West, North, Northeast and South Regions. The National Assembly is composed of a House of Representatives and a Senate. The Executive Branch consists of 14 ministries, namely, the Office of the Prime Minister, and the Ministries of the Interior, Agriculture and Cooperatives, Education, Defence, Finance, Industry, Foreign Affairs, Commerce, Public Health, Justice, Communications, Office of University Affairs, and Ministry of Science, Technology and Energy. The Court is divided into the Court of First Instance, the Court of Appeal and the Supreme Court.

1.2 SOCIO-CULTURAL AND ECONOMIC SETTING

As previously mentioned, it was probably the love of freedom that caused the Thais, resisting foreign domination, to migrate southwards from China and eventually to settle in their present land. The nation's history may be conveniently taken to start then, and the first period may be referred to as the Sukhothai Period which lasted from the 13th to the 14th Century when the capital was at Sukhothai. During the second period, from the 14th to the 18th century, the capital was moved further down to Ayudhaya. Finally, the present or Bangkok Period has lasted from the 18th century up to the present time. It was in 1932, during the reign of the 7th King of the Bangkok Dynasty, that Thailand changed from an absolute monarchy to a constitutional one.

Although every Thai is free to choose his or her own religion, most of the Thai people are Buddhists, probably due to the many appealing features of Buddhism, including its freedom-oriented philosophy. A list of selected general, economic and social statistics taken from official sources is given below. (1)*

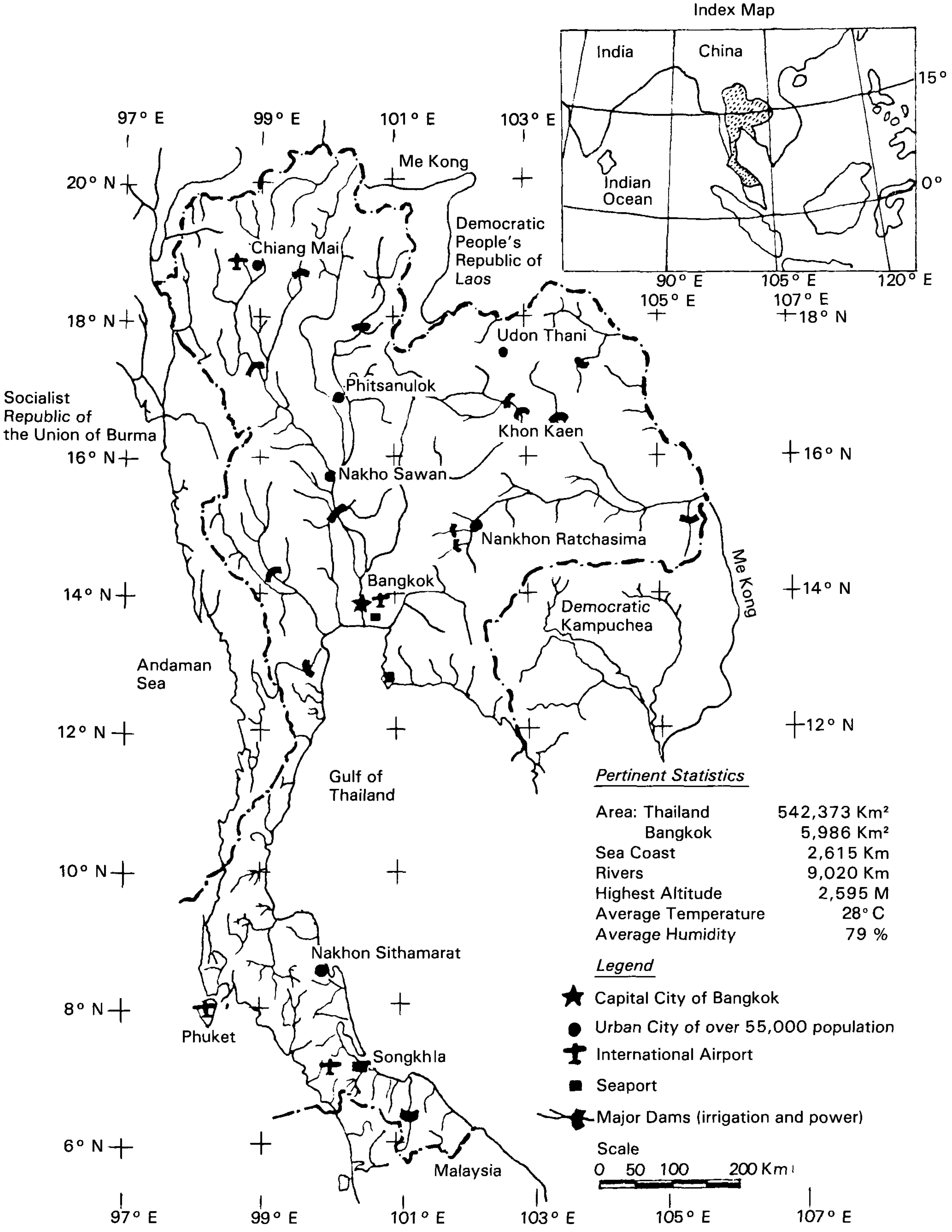
Statistical Profile for 1979-80

(1) General	
Capital	Bangkok Metropolis
Bangkok Population	5 153 902
Thailand Population	46.96 million
Population Growth Rate	2.3% per annum
Religion	95.24% Buddhist 4.02% Muslim 0.60% Christian 0.14% others
(2) Economic	
Currency	Baht (US$1 = 20 Bahts)
GNP	420 000 million Bahts
GDP	430 000 million Bahts
Per capita income	12 800 Bahts
Imports (value)	146 130 million Bahts
Exports (value)	108 260 million Bahts
Balance of trade	37 870 million Bahts
Major products (annual production):	
Agriculture	
Rice	18.6 million tons
Kenaf	280,000 tons
Cassava	14 million tons
Sugar Cane	15.7 million tons
Fish	2.9 million tons
Tobacco	56 700 tons
Rubber	585 000 tons
Mining (annual production)	
Tin	48 000 tons
Tungsten	329 tons
Antimony	494 tons
Transportation	
Roads	51 162 kilometres
Railway lines	3 765 kilometres
Tourism	1 591 455 visitors spending US$562 million
(3) Social	
Labour force	Approx. 44% of total population

---

* Numbers refer to bibliographical footnotes in Part 5 (p. 559).

Geographical Features of Thailand



Pertinent Statistics

Area: Thailand	542,373 Km²
Bangkok	5,986 Km²
Sea Coast	2,615 Km
Rivers	9,020 Km
Highest Altitude	2,595 M
Average Temperature	28° C
Average Humidity	79 %

Legend

- ★ Capital City of Bangkok
- ● Urban City of over 55,000 population
- ✈ International Airport
- ■ Seaport
- Major Dams (irrigation and power)

Scale
0 50 100 200 Km

Unemployment	Approx. 1% of labour
Minimum wage	54 Baht per day
Health	
Birth rate per 1 000 population	24.6
Death rate per 1 000 population	5.2
Ratio of physicians to total population	1 : 7 568
Ratio of hospital beds to total population	1 : 675
Education	
Literacy Rate	86%
Primary Schools	31 100
Secondary Schools	3 758
Universities	14.

The Thai alphabet has 44 consonants and 32 vowels. With five tone levels, the spoken language is melodious as well as phonetic but difficult for foreign adults to learn. Poetically the language's musical nature adds flavour to the rich and evocative meaning of the words. Although there are several spoken dialects, practically all can speak the national language except for a very few southeners. The artistic culture, demonstrated by the language, carries through to other areas such as music, drama, dancing, architecture, painting, sculpture, pottery, food preparation, dressmaking, etc. They are dominated by serene, articulate, tasteful and colorful characteristics.

These seemingly diverse forces somehow impert a sense of hospitality and joyfulness to the Thai people. The Thais are a warm-hearted people, and by and large most Thais will readily help anyone in trouble, whether a foreigner or another Thai. Family ties are very strong in all parts of the country and, above all, the nation is united by its love for, and devotion to, His Majesty the King and the Royal Family. The Thais love festivals, and there are many traditional festivities. Normally unaggressive, the Thais may become fierce fighters if necessary, perhaps another sign of a love of fredom. There is not much segregation as regards social groupings except perhaps in an economic sense.

The statistics above may be considered a summary of Thailand's economic situation. Thailand can still be regarded as an agrarian country, but with an increasing industrial development. Hence, the major commodities produced in the country are agricultural, notably rice, tapioca, rubber, maize, sugar, pineapple, jute and kenaf, tobacco, beans, teak, sorghum, and water-harvested products. More than half of the total exports consists of these items. Minerals, which are exported in the form of ore, are mainly tungsten, fluorite, barite, etc. Tin, one of the few minerals being exported in metal form, amounted to 74% of total mineral exports in 1980. At present, potential sources of natural gas, petroleum, rock salt, and potash, are being explored,with great promise for the future.

1.3 DEVELOPMENT SCENE

Thailand enjoyed a relatively high growth rate in the economy during most of the past two decades, with an average of 6-7% in real terms. Per capita GNP is now approximately US$640. The agricultural sector has continued to be the most important sector in the Thai economy in terms of value added, employment, and foreign exchange earnings, yet much of the economic growth can be attributed to the fast expanding industrial sector. Presently, the agricultural sector accounts for about 26% of GDP, and this percentage for GDP, as well as exports, has remained constant throughout the 1970s. (2) By contrast, the industrial sector has been expanding at an annual rate of over 10% and now accounts for about 20% of GDP. (2) This expansion has had a significant effect on the reduction of imports and the increase of exports. Presently, the manufacturing output consists mainly of processed food, beverages and tobacco, construction materials, intermediate products, and non-durable and durable consumer goods. Most of the industrial activity is centered around the suburbs of Bangkok and in nearby provinces. Hence, for the rest of the country the single most important source of income and livelihood continues to be agriculture.

In the late 1970s the economy of Thailand, like other developing countries without major petroleum resources, came under severe pressure from having to meet increasing costs. Inflation has also become a major problem and, at present, there is almost a 20% increase in the consumer price index each year. Despite these setbacks, however, Thailand's economy still has a relatively bright outlook compared with many other developing countries.

In contrast to economic development, social development in Thailand in the past two decades has not been as successful. The gap in income distribution between various parts of the country, and between different income levels, has remained wide. For example, per capita income of people in the northeast is only 15% of those in Bangkok. (2) Most of the poor live in rural areas. Unemployment in urban areas and underemployment in rural areas continue to be burdensome problems. The high rate of population growth, more than 3% per year in the 1960s, has resulted in the present large increase in the labour force. The population growth rate, however, has now been reduced to around 2.3% and a further reduction is anticipated. Urban migration has continually intensified, creating problems of settlement and congestion, especially in Bangkok. The swelling of population has also contributed to the problems of deforestation and environmental pollution.

Against this background of both success and failure with economic and social development in Thailand, what are the prospects for the future? Increasing costs of petroleum and other imports will loom as the most important problem for the economy. Other problems of social development, complicated by economic, political and other factors, will continue to beset the country. However, Thailand's rich natural resources are an important factor favouring development. Human resources are also a potentially valuable factor, if the problems of education and training can be successfully tackled. Science and technology are important tools for the development of both natural and human resources, and will therefore play a critical role in setting the development scene for Thailand.

PART 2.

Science and technology policy framework

2.1 DEVELOPMENT POLICY FRAMEWORK

For the past two decades planning for development in Thailand has been made in five-year periods, except the first period which covered six years. The National Economic and Social Development Board has the responsibility for planning and following up on the Economic and Social Development Plan. During the period of the four Development Plans, Thailand saw a number of major changes, partly encouraged by deliberate planning but to a certain extent due to uncontrolled external and internal factors.

The First Plan, started in 1961, emphasized the building up of the economic infrastructure, namely, construction of highways, irrigations dams, and power plants. This orientation necessitated the introduction of new and advanced technologies from developed countries. In the Second Plan, emphasis was placed on the further building up of an economic infrastructure and social development. The concept that manpower was a major factor for carrying out a development plan was fully accepted and, thereby, the national development programme for vocational education was launched. Moreover, the Applied Scientific Research Corporation of Thailand was set up to assist in the industrialization of the country. An evaluation of the two plans reveals that the public development strategy has contributed significantly to the very high growth rate of production, but the income disparity between urban and rural people has also now become more evident.

The Third Plan, covering 1972-1976, put an emphasis not only on the improvement of the economic structure and the maintenance of economic stability through increased production, but also on the alleviation of problems relating to the widening income gap and inequitable distribution of social services. Irrigation canals and feeder roads were built to help bring about the development of the rural people. In this Plan period attention was also called to the development of scientific and technological manpower, for example, physicians, engineers and technicians found to be in short supply during the Second Plan. The Technology and Environment Planning Division was set up in 1975 within the Office of the National Economic and Social Development Board in order to formulate the science and technology development plan, and the environmental plan, as integral parts of the National Economic and Social Development Plan.

The Fourth Plan, to be ended in September 1981, stressed rather heavily the importance of promoting social justice by reducing socio-economic disparities, improving mass welfare, and rehabilitating environmental conditions. In this Plan, scientific and technological development were taken as one of the major development strategies. In 1979, the Ministry of Science, Technology and Energy was established as the central policy-making, planning, coordinating and promoting body for these areas in the government.

Major trends during the four plans include the following:

i. A high rate of growth in total production, averaging more than 7.5% per year, with the manufacturing sector playing an increasing role.

ii. A change in the international trade structure, with an increasing dependence on imports, especially petroleum, which resulted in an increasing trade gap and a deficit in the balance of payments.

iii. Increasing disparity in income distribution and continuing problems of poverty, especially in northeastern and northern parts of the country.

iv. An increase in labour supply and unemployment, primarily due to the discrepancy between the large population and the relatively smaller economic growth rates.

Considering these trends in the economic and social picture in the formulation of the Fifth National Economic and Social Development Plan, which is due to start in 1982, the plan therefore aims at achieving the following objectives (3):

i. An appropriate economic growth, not to exceed 5-6% per year.

ii. An appropriate growth pattern which should result in a more equitable income distribution, alleviation of poverty, and creation of employment.

iii. Adjustment of the present structure in agricultural and industrial sectors with an emphasis on increasing the agricultural yield per area rather than increasing the agricultural area, and on the promotion of industry in the rural sector.

iv. Increasing the efficiency in the utilization and conservation of important natural resources.

Strategies aimed at achieving these objectives should emphasize, wherever possible, the conservation of, and increasingly efficient utilization of, dwindling natural resources. Important strategies include (3):

i. Strategies for restructuring the national economy in which the agricultural sector will be given the top priority, since it accounts for 60% of foreign earnings and more than 75% of national employment. Increases in agricultural yields will be promoted through more intensive use of technology. More varieties of crops and animals will be promoted, especially those which will contribute toward exports. The industrial sector will be promoted on the basis of benefits in terms of foreign currency earnings, creating of jobs, and development of rural areas. More emphasis will be given to small or medium-scale undertakings which have a high employment content.

ii. Strategies for development and management of national energy resources in which emphasis is to be given to restraining the import of energy resources, and to conserving available resources. Alternative energy resources will be developed, and the current pattern of energy production and utilization will be examined, especially in the transport and industrial sectors which have a high demand.

iii. Strategies for distribution of development benefits and national services to rural areas. Different strategies will be applied according to the characteristics of the different areas in terms of existing land fertility, poverty, and security problems. Self-reliance will be encouraged wherever possible. Reducing the rate of population increase will be given a high priority, especially in areas of high poverty.

iv. Strategies for reform of national fiscal and financial policy. Earnings by the government sector will be increased to about 16-17% of GNP, mainly by reforming the current tax structure. Free market competition will be promoted, with measures to ensure against economic monopoly.

v. Strategies for the coordination of economic and social planning with defence planning for a better balance to be found in the provision for economic and social development and for national defence.

vi. Strategies for social development whereby the distribution of social services will be improved, aiming especially at the most needy population. Educational services will emphasize qualitative improvements and promotion of compulsory and non-formal education. Improvement of health services will be brought about mainly through the primary health care system, with the emphasis on protective rather than remedial aspects. Cultural and other aspects of social services will be improved in accordance with the changing character of the society.

vii. Strategies for improvement in government machinery for economic and development administration.

These strategies are vital for successful implementation of development policy and government machinery will be improved to achieve a maximum adherence to the National Economic and Social Development Plan by reforming budgeting and programme formulation at the ministry level, by increasing the control over and capacity for planning and implementation at the local level, and by creating a system for the evaluation of implementation adjustments in the original plans at various levels.

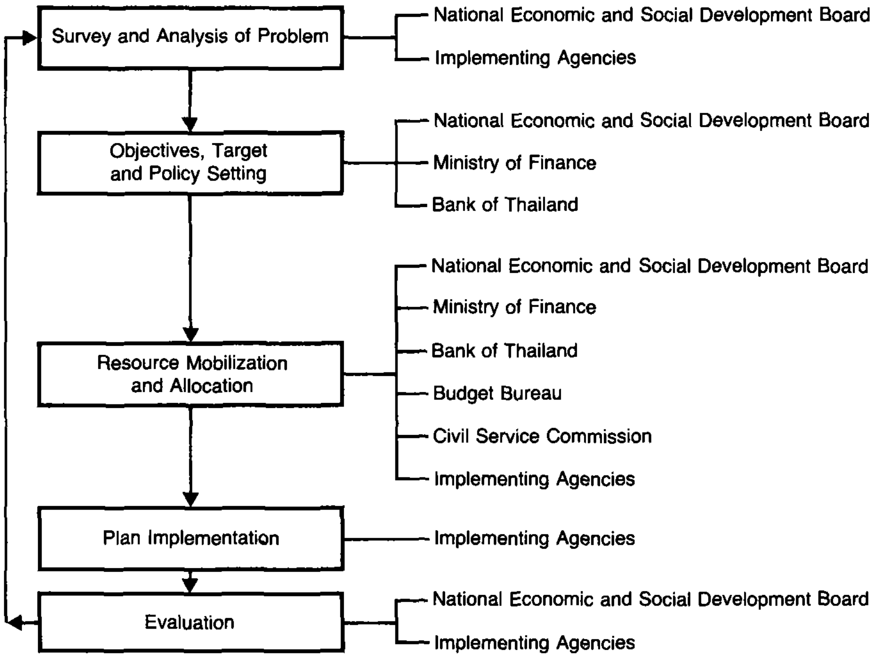
Three major steps are involved in the formulation of the National Economic and Social Development Plan (3). First, important problems and limiting factors are identified in various areas of development. Secondly, policies and strategies are formulated both at the macro and micro levels. Thirdly, projects are selected and refined according to the formulated policies and strategies. Throughout this process, the implementing agencies are in continous contact with the National Economic and Social Development Board, and they also have an important role in the final formulation of projects.

Although the National Economic and Social Development Board is responsible for all these steps, it does not limit its work only to its own officials but delegates a major amount of planning to various people in universities, government offices, and the private sector who comprise the sub-committees and working groups. Chart 1 shows the various steps and partners involved in the formulation of the Plan.

At present the science and technology policy is integrated with development policy. However this integration is relatively new and can be further improved. The Ministry of Science, Technology and Energy is expected to evolve into a central planning agency working in coordination with the National Economic and Social Development Board. The proposed National Council for Science and Technology should play a crucial role in the integration of policies in the future. This integration is all the more needed in view of the multiplicity of planning agencies with science and technology at present.

Chart 1

Development Planning Procedures



2.2 DEVELOPMENT POLICY AND SCIENCE AND TECHNOLOGY POLICY

In the Fifth National Economic and Social Development Plan there is, for the first time, a science and technology plan as an explicit part of the development plan. Planning has concentrated on three areas: the application of science and technology to increase efficiency in production leading to export promotion and import reduction, and the strengthening of the national scientific and technological capacity.

The first and second areas with their emphasis on both the utilization of, or the satisfying of, the demand side of the national production system will play important roles in meeting the development objectives outlined in Part 2.1. The third area, which emphasizes improving the supply side, has implications far beyond the Fifth Plan, and deals with problems of national targets for research and development expenditure, manpower planning, reorganization of scientific and technological institutions and infrastructure, and development of specific areas of science and technology which have a high potential for the country in the near future.

Apart from this macro level planning in science and technology, the Fifth National Economic and Social Development Plan also incorporates planning at micro levels, both in major economic sectors and in major scientific and technological institutions. Major tasks involved in finalizing the Plan are the coordination of the planning at various levels, the identification of key projects and the formulation of investment programmes.

Like any other activities, scientific and technological activity in all government agencies must be projected in the Development Plan before approval can be given. Even when the activity has been incorporated in the Plan, budget approval is not automatic and has to be reviewed before the budget year by the Budget Bureau and finally by Parliament.

Unlike other activities, scientific and technological activity, especially research and development, cannot be accurately predicted in terms of major results to be achieved per unit input. However, past achievements do give a trend for future productivity per unit input of an institution. Planning and budgeting for science and technology in Thailand still does not take this special characteristic fully into account. Hence, the budget for an institution would be typically based on the budget in previous years, irrespective of amount of output in terms of innovative value.

This emphasis needs to be developed in Thailand, and incorporated as a consideration which determines the funding of various institutions.

2.3 POLICY-MAKING MACHINERY FOR SCIENCE AND TECHNOLOGY

Two government agencies presently take major responsibility for national science and technology policy in Thailand. The first, the National Research Council, an agency in the newly-created Ministry of Science, Technology and Energy, has the function of formulating research and development policy, and implementing it through support of research projects in various government agencies and universities. In addition, the Council compiles statistics on important science and technology indicators, such as manpower and the government budget for research and development. The second, the Division of Technology and Environment Planning, an office within the National Economic and Social development Board, has the function of formulating policy for science and technology as a component of overall development policy. Both agencies work in an open fashion and appoint numerous outsiders, mainly from universities and other government and private agencies, to various subcommittees. With the recent establishment of the Ministry of Science, Technology and Energy, the Under-Secretary's Office is also playing an increasing role in science and technology policy formulation and control of implementation.

Chart 2 shows the organization of the Ministry of Science, Technology and Energy, Chart 3 the Office of the Under-Secretary, and Chart 4 the National Research Council. Chart 5 shows the organization of the National Economic and Social Development Board.

The establishment of the Ministry of Science, Technology and Energy is a major outcome of a series of attempts, spearheaded by the National Research Council, to reform the science and technology policy machinery of the country. Although the formation of the National Research Council in 1956 was an important step in the promotion of science and technology, its function, as the name implies, is limited mainly to research and development areas. Other science and technology activities, although not neglected by the Council, naturally cannot be its main occupation. Furthermore, a revision of the charter in 1964 adds research policy in the social sciences and humanities to its responsibilities. With its limited budget and manpower these broad responsibilities place a strain on the capacity of the Council to serve as the main policy and promotion agency for all fields and all levels of science and technology activities.

In 1972, the National research Council with the cooperation of the U.S National Academy of Science, organized a workshop on science policy and planning in Thailand. A major recommendation from this workshop was that a committee be appointed by the government to conduct a thorough study of the structure of science and technology in Thailand and to make definite proposals for an effective governmental administrative structure capable of defining, planning, and implementing national policy in science and technology for economic, educational and social development.

Chart 2

Organization Chart - Ministry of Science, Technology and Energy

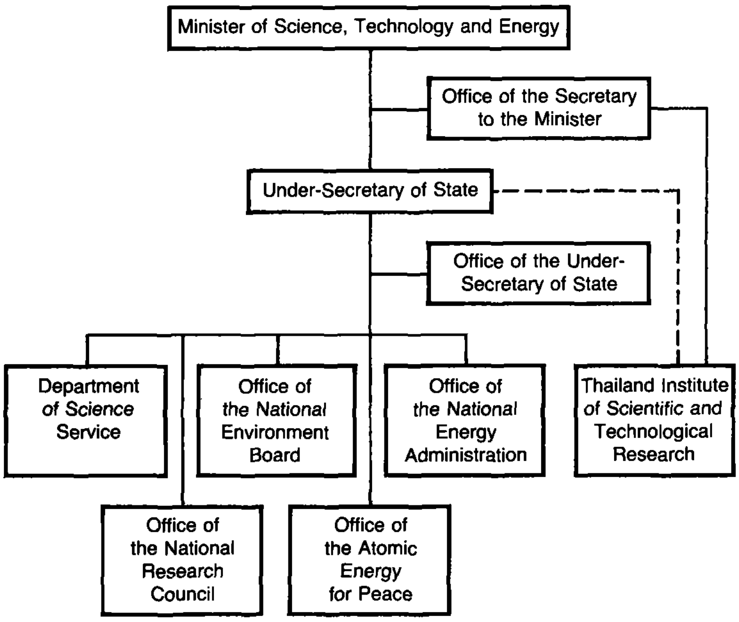


Chart 3
Office of the Under-Secretary of State

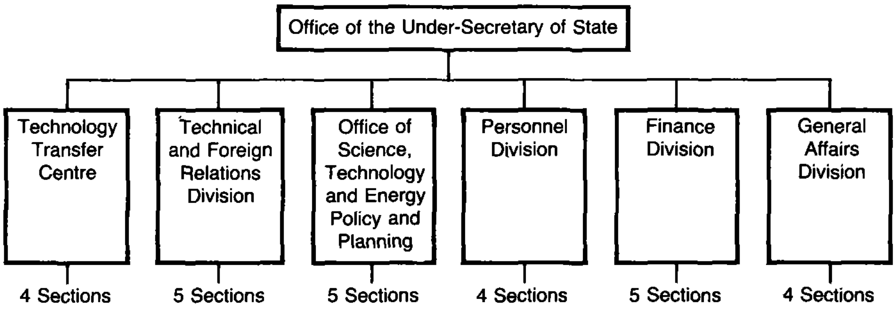


Chart 4
Office of the National Research Council

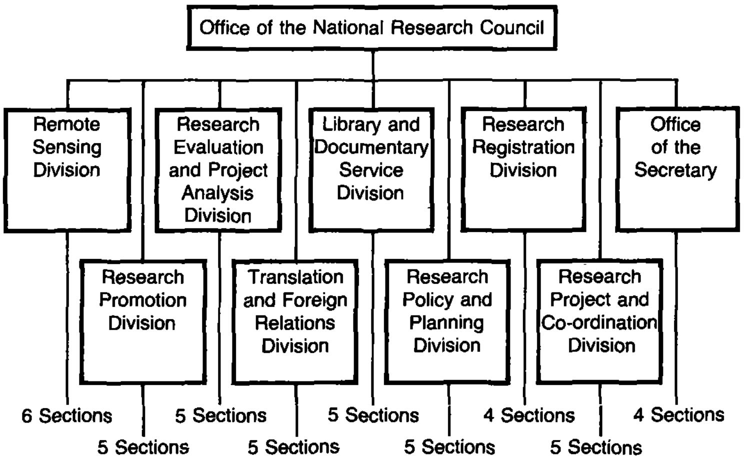
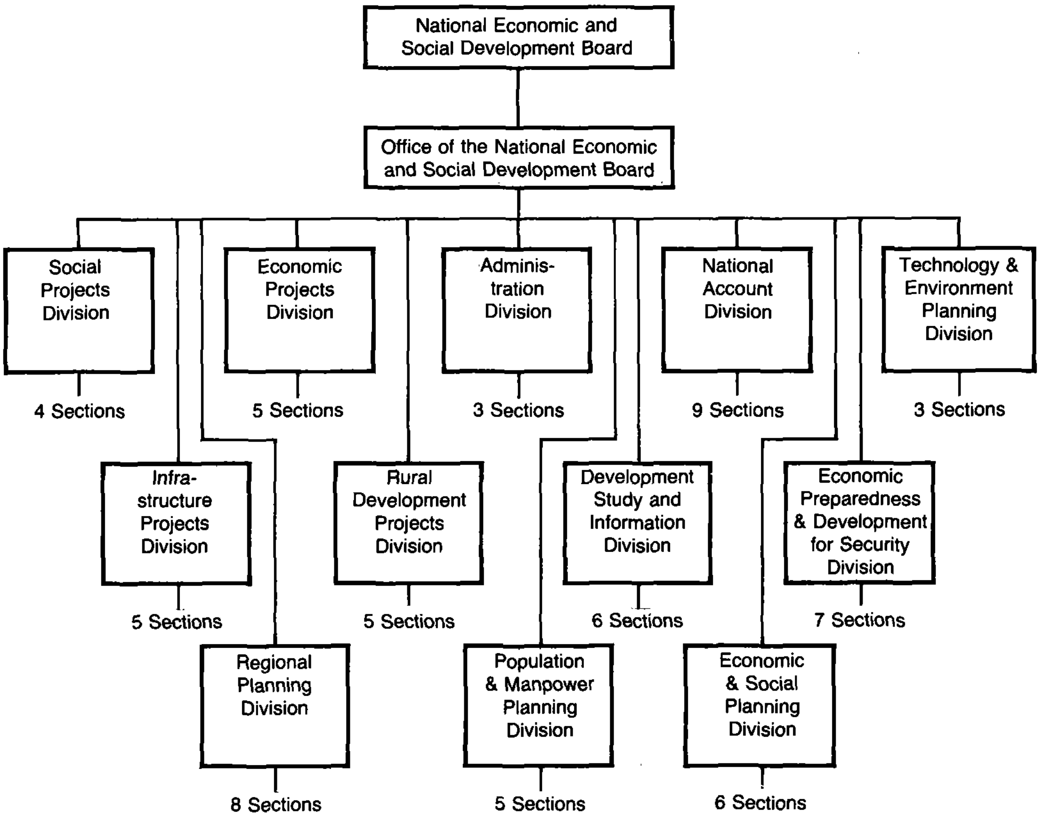


Chart 5
Organization of the National Economic and Social Development Board



This first major effort, however, bore no immediate tangible result. In 1976, the National Research Council organized another two major seminars on policy and planning, as a result of which a working group was appointed to lay down a basis for the formulation of an effective science and technology policy and the establishment of a Ministry of Science, Technology and Energy. Finally, in 1979, after consideration of the proposal by two successive governments, the new structure was formed under the title of the Ministry of science, Technology and Energy.

Parallel with the development of the government machinery for science and technology based on the proposals of the National Research Council, development in the integration of science and technology with economic and social planning took place at the National Economic and Social Development Board. A small Division of Technology and Environment Planning was set up in 1976, and acted as the secretariat for a Subcommittee for Science and Technology Planning. The Subcommittee commissioned a number of studies in preparation for the Fourth National Economic and Social Development Plan (1977-1981) and, in the Fifth Plan, explicitly formulated a science and technology plan.

Although the National Economic and Social Development Board and the Ministry of Science, Technology and Energy have close coordination at various levels, unity in planning of science and technology for development is still to be desired, and a tentative proposal is being considered for the establishment of a Science and Technology Council, chaired by the Prime Minister, and with key ministers, scientists, technologists and development planners as council members. This Council will take overall responsibility for policy formulation and control of implementation, not only in the agencies of the Ministry of Science, technology and Energy, but in all government agencies whose task has major science and technology components.

Promotion and financing of research and development and scientific and technological services is mainly done by the implementing institutions themselves. Hence universities and government agencies have their own research and development budget. However, the National Research Council plays a supporting role and will fund research projects in various institutions through an open–competition system, and through subcontracting. Recently, the Council has also been encouraging research and development activities through provision of annual research awards.

There is little data at present on the role played by the private sector in carrying out and supporting research and development. However because of the large size of the manufacturing sector in the GNP and the type of products, there must be a considerable amount of scientific and technological activity, including research and development. A survey on the scientific and technological potential of the private sector is presently being undertaken.

There are numerous societies and associations for the professions in, or related to, science and technology. Important among these are the Science Society of Thailand, the Agricultural Science Society of Thailand and the Engineering Institute of Thailand. Although these societies could play a far more significant role in supporting science and technology in the country, even the limited activities at present have a tangible influence on the academic atmosphere and morale of the scientists and technologists. For example, the annual science symposium organized by the Science Society of Thailand jointly with other societies and with the support of the National Research Council, is an important event where more than 200 research papers are presented. These societies also publish journals for their own professional members as well as general readers.

Services related to technology transfer are still very rare in Thailand at present. With respect to vertical transfer, whereby ideas flow from basic scientific knowledge and through applied research and development leading to technological innovation, the only institution specially designated to do this task is the Thailand Institute of Scientific and Technological Research, first set up in 1963 as the Applied Scientific and Research Corporation of Thailand. With respect to horizontal transfer, that is, propagation of known technology to user groups, a small Centre for Technology Transfer was recently set up in the Ministry of Science, Technology and Energy. Both institutes related to the two types of technology transfer still have small scales of operation, and need to be further strengthened considerably.

Table 1 lists major science and technology organizations in Thailand at policy-making level, promotion and financing level, and performance level.

PART 3.

Scientific and technological potential

3.1 INSTITUTIONAL NETWORK

By far the majority of institutions which perform scientific and technological activities in Thailand are government agencies. These may be classified into two main groups: the universities, and government departments and institutions (see Table 1).

There are presently 11 major universities in Thailand, including the internationally controlled Asian Institute of Technology, which have substantial scientific and technological activities. Of these Chulalongkorn University has the oldest Faculty of Science (formerly called the Faculty of Arts and Sciences) dating back to 1915, while Mahidol University has the oldest medical school, founded in 1889. These two universities still maintain a strong tradition in science and technology as measured by various indicators and worthy of their long history. For example, Chulalongkorn University has produced more scientists and technologists than any other university in Thailand. Mahidol University is well known internationally for its research and graduate training programmes in science and medicine. Of the others, Chiang Mai University deserves a special mention as being a provincial university with a good scientific and technological output. Kasetsart University specializes in agriculture, while King Mongkut's Institute of Technology and Asian Institute of Technology share prominence in engineering. Apart from education and Training (STET), all the universities to varying extents perform research and development (R&D) and service (STS) work. Each university has its own budget for all these activities which is allocated through the Office of University Affairs and supplemented by its own income, from the National Research Council, or from other national and international agencies.

Among the government departments and institutions, the recently founded Ministry of Science, Technology and Energy is the most important in the infrastructure. The other main organizations are the Thailand Institute of Science and Technology Research and the Department of Science Services. While both perform both R&D and STS, the former concentrates on R&D while the latter concentrates on STS. The work allocated to this Ministry is mainly of a general nature, while specific work in agriculture, industry, health and education is done separately by the relevant departments in various ministries. Hence, for example, the Department of Fisheries runs the Marine Biological Center, the Department of Mineral Resources is responsible for geological surveying, while the Department of Medical Science has a major role in food and drug analysis. Again, these various departments are allocated their own budget for their scientific and technological activities which cover both R&D and STS, and may be further supported by their own income or by outside grants from, for instance, the National Research Council.

A major component of STS and STET work is the transfer of knowledge and practice to the general population. Extension and promotional work falls mainly on the government departments, but private organizations, including professional associations, also have a definite role. The Science Society of Thailand, for example, has contributed to the promotion of science through various non-formal channels. The role of private organizations, however, can be much more effective than at present and needs more serious consideration.

3.2 HUMAN RESOURCES

The calibre of human resources in science and technology varies with the field of endeavour. Medicine attracts the highest quality students, while engineering is a close second in this respect and is followed by management science. Pharmacy, architecture, law, economics and agricultural science are also popular fields of study. The quality and relevance of training to the need of the country tends to vary with the amount of research and development conducted in each field of study. Agriculture has the largest number of personnel in both STS and R&D (Table 2). Little R&D is done in industry. Technology is mostly bought in unpackaged forms. The effectiveness of the transfer of science and technology from abroad varies with the amount of R&D conducted in each field. Engineering R&D is done mostly in the field of energy and electronics.

Since quality and relevance of training in universities, as well as effectiveness in the transfer of S&T, depend on the amount of R&D, therefore, R&D which is relevant to the need of the country will be emphasized and adequately financed in universities and research institutes. Academic and financial assistance will be sought from abroad with strong government endorsement. University-industry cooperation will be promoted and should result in mutual benefit. Government measures and incentives will be used to persuade private enterprises to undertake more R&D in their fields of business.

Science and technology researchers are not accorded high status in government nor in private service. Consequently, many excellent researchers must change and become indifferent administrators. Women suffer no handicap in research careers. The brain-drain from Thailand to other countries is not a serious problem, but the brain-drain from government to private sector is considerable and can deal a crippling blow to the technology sector of government works. The government is planning to provide some monetary incentives to university lecturers in order to counter the brain-drain problem.

Qualified technicians and industrially skilled workers are in short supply and training systems for technicians and skilled workers will be reformed. Strong socio-economic incentives coupled with a National Qualification System are needed to persuade students to undertake skill training and technician training with pride and satisfaction. Qualified skilled workers and technicians will be accorded a social and economic status equivalent to those of engineers. Due to the important role of S&T manpower in the country's development, training of scientists, engineers, technicians, and skilled workers will be given top priority in government budget allocations.

3.3 FINANCIAL RESOURCES

Government funds for research are proposed and obtained by the relevant agencies through regular budget procedure in the Budget Bureau and Parliament. The National Research Council (NRC) has both a screening role and a monotoring role for government research funds. However, there is no agency directly responsible for evaluation work. The NRC also allocates funds for research projects that it deems relevant to the needs of the country. Funds for these projects are about 50 000-200 000 Baht per project. The NRD also awards funds of about 50 000 Baht per project to research projects proposed by government agencies and universities. An effort is being made by the National Economic and Social Development Board to allocate government funds for research and development proportional to the GNP, i. e. 0.5% of the GNP by the year 1986. In 1978, the government budget for R&D was 0.22% of the GNP and 71% of this fund was spent for R&D agriculture and irrigation. Other sectors, namely, industry, public health, transport, energy, conservation of natural resources, and environment, were allocated 1%-7% for each sector.

3.4 SURVEYING OF THE S&T POTENTIAL

The newly created Ministry of Science, Technology and Energy has the direct responsibility of collecting and analysing numerical data and other information on the human and financial resources available for the national scientific and technological effort. The National Research Council is an agency within this Ministry. The National Economic and Social Development Board shares some of the Ministry's responsibilities but on a relatively macro scale. The Office of University Affairs, the Ministry of Education especially the Vocational Education Department, and the National Education Commission, also monitor and plan human resources for S&T.

It should also be mentioned that Thailand is cooperating with other countries in ASEAN in order to develop S&T indicators and continuously monitor these indicators as part of the ASEAN Plan on Science and Technology for Development.

In surveying S&T potential in terms of budget and manpower data can be obtained relatively easily from government agencies by searching government records or through questionnaires. However, difficulty has been encountered in surveying the private sector, since no effective mechanism exists for data collection. Manpower planning is imperative for national development, and a comprehensive survey must be conducted in order to determine the present shortage or oversupply of S&T manpower at all levels and branches of disciplines. Industrial and agricultural planners, together with education planners, must collectively decide on the manpower survey methodologies. To be successful, such surveys need expertise as well as money. In this regard, international organizations will be requested to provide assistance in the form of manpower survey specialists, as well as funds needed for the survey.

PART 4.

Policy issues in scientific and technological development

4.1 MAJOR DEVELOPMENTS

The National Research Council (NRC) was inaugurated in 1956 with the main object of ensuring that scientific research activities were geared to national development needs and goals. In the beginning the NRC was divided into six scientific branches: physical sciences and mathematics, medical sciences, chemical and pharmaceutical sciences, biological sciences, agriculture and forestry, and engineering and industrial research. The NRC later combined the biological science branch with the agriculture and forestry branch and added five more branches in the humanities and the social sciences. In 1979, the NRC became one of the eight offices which are under the control of the Ministry of Science, Technology and Energy. The functions of the Ministry are as follows:

i. To determine policy, plans, schemes and projects, relating to science, technology, energy and the environment.

ii. To control, conduct, command and perform work related to science, technology, energy and the environment according to the policy, plans, schemes and projects for efficient working and good coordination so as to bring socio-economic benefits and national stability.

iii. To form the working plan, and follow up and evaluate work related to science, technology, energy and the environment.

iv. To improve the plan, scheme and project concerned to ensure that it be always appropriate and modern.

v. To develop technology within the country towards production and marketing.

vi. To provide services and promote both internal and external technology transfer.

vii. To study, analyse, research and provide significant data on science, technology, energy and the environment.

viii. To collect, compile and propagate the outcome of the research and development relating to science, technology, energy, and the environment.

In the field of STET, three major developments can be discerned in the past ten years. The first is the successful launching of graduate programmes up to Ph. D. level in various fields of science and technology, first at Mahidol University and then at Chulalongkorn and other universities. With partial help from the University Development Commission, this successful development led to the second major development, namely the staffing of new provincial universities mainly by the new graduates. Hence for the first time in Thailand's history, a new S&T capability at university level has been built mainly through endogenous efforts. The third major development is the revision of school curricula in S&T, spearheaded by the work of the Institute for the Promotion of Teaching Science and Technology. It remains to be seen how these new developments will proceed, but it can certainly be concluded now that the past ten years have seen a dramatic increase in self-reliance in STET in Thailand.

4.2 ACHIEVEMENTS AND PROBLEMS

In the evaluation of the Fourth Five-Year National Development Plan three major achievements were found. (2) The first was an increase of agricultural production reaching 8.6%. The second was that the export of textiles, electrical products, and canned food was increased. The third was the establishment of an organization responsible for science and technology as a ministry.

However the problem of poverty is still unsolved because of the rocketing price increase of imported oil. The low prices for agricultural products compared with industrial products worsened the problem of poverty for the majority of the population living in rural areas. In addition, industrial investment was also adversely affected. To solve these problems, the government has adopted urgent strategies, including supporting the majority of the population by increasing agricultural production, subsidizing farmers' and labourers' incomes, emphasizing a definite income redistribution policy in the next Five-Year Development Plan, as well as scientific and technological policies emphasizing the development of appropriate technologies for agriculture and industry to contribute to economic and social stability.

In terms of S&T capacity, the last decade has been quite eventful. At the level of R&D, capacity has increased dramatically at the university level and is linked to major developments in graduate programmes mentioned earlier. Biomedical science dominates the list of major achievements in R&D, while agriculture, basic science and technology follow. In STET, achievements can be mentionned in terms of increasing the number of graduates at various levels. However, accompanying these achievements are problems of quality, both of the R&D work and the graduates produced. Furthermore, the question of the relevance of R&D and training programmes to national needs has been frequently raised.

In terms of the application of S&T to national development, the last ten years can still be regarded as the initial phase. Owing to the still weak infrastructure, major achievements could not be expected. However, there are now some promising trends. For example, more industrial products, at increasing levels of technological complexity, are now produced within the country. More technical personnel at high level are recruited endogenously. Technology transfer, both vertical and horizontal, is gradually occurring, although still with a very poor efficiency. One major problem still to be tackled is the gap between the university, where most of S&T talent lies, and the private sector, where much of this is needed. An encouraging trend is developing, however, whereby universities are actively seeking contracts for S&T work from the private sector. Because the major universities are in the civil service, a proper balance still has to be found between the traditional and the new role of universities.

4.3 OBJECTIVES AND PRIORITIES

In order to attain the objectives of the national development plan a policy on science, technology and energy has been formulated along the following lines. (3, 5)

i. Research work, and scientific and technological services, will be accelerated with emphasis on the development of agriculture and industry to contribute to economic and social stability.

ii. Scientific and technological plans will be formulated to control the exploitation of natural resources so that this can benefit the development of the country with a minimal effect on the environment.

iii. Efforts will be made to propagate technological knowledge that can lead to the development and application of science and technology available, inside the country and abroad, to solve the economic, social and environmental problems.

iv. Efforts will be made to accelerate and promote the survey for and development of all forms of energies and to put new energies into use as soon as possible in order to reduce domestic oil consumption.

v. Efforts will be made to coordinate all work on energy to ensure continuous efficiency of energy management, and channel their research work along the same direction.

vi. The prices for energy which are now in operation will be fixed in accordance with the country's economic and social conditions.

vii. Procurement, production, and use of energy will be controlled in the interests of austerity and the utmost benefit of the people, and so as to ensure sufficient and suitable availability of energy both in normal times and in time of emergency.

viii. Natural resources will be conserved and developed. The use and reuse of these resources will be organized in such a way that they provide the most benefit to the society.

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION

In 1979, Thailand was granted technical assistance from aid-giving sources totalling about US$111.3 million. (6) The assistance was derived from five main sources:

United States of America	US$13.4 million
United Nations	US$16.8 million
Colombo Plan Countries	US$66.6 million
Third Countries and Foundations	US$12.5 million
Volunteer Programmes	US$2.0 million

There are non-governmental organizations providing some technical assistance to Thailand in the fields of public health, population environment, agriculture, etc. Those organizations include the Asian Productivities Organization, the Friedrich Naumann Stiftung Foundation, the Ford Foundation, the International Hillman Assistance Programme, the International Rice Research Institute, Population Council/Australia Education, the Rockfeller Foundation, and the Southeast Asian Ministers of Education Organization. The assistance is in the form of providing experts, fellowships, equipment and other items worth around US$6 million.

The first meeting of ASEAN Ministers of Science and Technology held at Pattaya, Thailand, on October 27-28, 1980, discussed existing scientific activities in ASEAN and noted their increasing importance for the development of member countries. In order to strengthen cooperation in S&T, the meeting agreed that:

i. ASEAN Ministers and/or officials of S&T should meet to formulate policies and guidelines for ASEAN cooperation in the field of Science and Technology.

ii. An ASEAN Trust Fund possibly set up from international organizations and third world countries could be studied in support of ASEAN cooperation in the field of S&T for development.

iii. Exchange of S&T information among ASEAN member countries should be encouraged.

iv. More technical meetings and workshops among scientists and technologists should be encouraged.

v. Recognized professional scientific societies should be supported by the member countries in organizing cooperative activities.

vi. Exchange of scientists and technologists among ASEAN countries to work in research institutions should be promoted.

vii. Research and development cooperation among research and development institutions should be strengthened and continued.

viii. A plan of action on S&T for development should be formulated.

ix. Knowledge on science policy and planning should be periodically exchanged.

In addition to ASEAN cooperative programmes, Thailand has many major bilateral and multilateral programmes in S&T. Significant among those launched in 1979 are, the Promotion of the Faculty of Engineering of the King Mongkut's Institute of Technology, North Bangkok Campus (Germany), the Fuel Alcohol Project (United Kingdom, France, Australia, Austria), Thai-Australian Land Development (Australia), Water Resources Development in the Northeast (New Zealand), Dairy Industry Development (New Zealand), Mae Wang-Kew Lom Irrigated Agriculture Development Project (Japan), Production of Perfumery Oils (France), Artificial Insemination Project (Netherlands), Nutrition Research Teaching and Training Programme (Netherlands), Sukhotahi Ground Water Project (United Kingdom).

It is difficult to draw general conclusions about these diverse programmes, but it may noted that a successful cooperative programme in Thailand tends to have the following features:

i. The programme relies mainly on Thai personnel both at the technical and the administrative level. However, constraints regarding civil service regulations and low salary levels ned to be dealt with.

ii. The programme is in line with national needs, and is not implanted without adequate consideration of long-term goals.

iii. The scope of the programme is within the capacity and long-term interests of the local personnel.

iv. The programme does not create a gap between the personnel within and outside it.

v. The programme has adequate financial and other supports, and yet is within the capacity of Thailand to continue supporting even after the cooperative phase.

PART 5.

Bibliographical footnotes

(1) *Thailand into the 80's,* Prime Minister's Office, 1979. *Statistical Country Profile for Administrators,* Office of the National Education Commission, 1979.

(2) *Evaluation of Development in the First Half of the Fourth Development Plan (1977-1979),* National Economic and Social Development Board, 1980.

(3) *Summary of Concepts in the Fifth Development Plan (1982-1986),* Steering Sub-committee for the Fifth Development Plan, National Economic and Social Development Board, 1980.

(4) *Report of the Studies for Science and Technology Planning for the Fifth Development Plan,* National Economic and Social Development Board, 1980.

(5) *Research policy and planning of the National Research Council, 1977-1981,* Policy and Planning Division.

(6) *Sixteenth Compendium of Technical Assistance to Thailand, 1979,* Development Assistance Groups for Thailand.

USSR

Table of Contents

ANNEXES

USSR

GEOGRAPHY

Capital city: Moscow
Main ports* (Far East): Vladivostok, Nakhodka, Vanino
Land surface area: 22,402,200 km

POPULATION (1978)

Total	261.6 million
Density (per sq km)	12
Urban/rural ratio (1977)	1.6
Average rate of growth (1970-78)	0.9%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	24.8	9.7	9.2	43.1	13.2	100%

SOCIO-ECONOMIC

Labour force (1979)	
Total	134.9 million
Percentage in agriculture	...
Gross national product (1978)	
GNP at market prices	US $967,820 million
GNP per capita	US $3,700
Real growth rate of GNP per capita (1970-78)	4.3% p.a.
Gross domestic product (1977)	
Total (in current producers' values)	US $540,020 million
Percentage by origin	
Agriculture	17%
Manufacturing, mining & quarrying, electricity, gas & water, construction	63%
Government finance	
National budget (1978)	...
As percentage of NMP	...
External assistance (official, net; 1976)	...
As percentage of GNP	...
Exports	
Total exports of goods (1978)	US $ 52,216 million
Average annual growth rate (1970-78)	7.8%
External debt (1978)	
Total public, outstanding + disbursed	...
Debt service ratio (% GNP)	...
(% Exports of goods and non-factor services)	...

Exchange rate (1978): US $1 = 0.66 Roubles

EDUCATION

Primary and secondary education (1978)	
Enrolment, first level	33,640,000
As % of (7-14 years)	99%
Enrolment, second level	10,484,900
As % of (15-16 years)+	104%
Combined enrolment ratio (7-16 years)	100%
Average annual enrolment increase (1970-1978)	– 1.4%

* Soviet Union - A Geographical Survey, p. 265, Progress Publishers, Moscow, 1976.

+ The enrolment ratio is the relationship between the number of all pupils enrolled (regardless of their age) and the number of the population of the relevant official ages.

Higher education (third level) (1978)

Teaching staff, total	...

Students and graduates by broad fields of study:[1]

	Enrolment [2]	Graduates
Social sciences and humanities	1,892,500	330,000
Natural sciences	...	...
Engineering	2,342,200	331,300
Medical sciences	368,100	58,300
Agriculture	507,000	70,400
Other and not specified	...	...
Total	**5,109,800**	**790,000**
Number of students studying abroad	1,224	

Education public expenditure (1978)

Total (thousands of Roubles)	31,304,700
As % of NMP	6.2%
Current, as % of total	83.8%
Current expenditure for third level education, as % of total current expenditure	13.7%

---

[1] These figures have been provided by the USSR according to their own systems of classification. Medical sciences include physical culture and sport. Engineering includes transport and communications. Natural sciences are included in the other broad fields of study.

[2] Including evening & correspondence courses.

Table 1. Nomenclature and Networking of S&T Organizations*

I - First level - POLICY-MAKING

Country: USSR

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
USSR State Committee on Science Techology	Policy-making and promotion		Individual sectors and Union Republics	Academy of Sciences of the USSR

---

* Information on nomenclature and networking of S&T organizations was not provided in Table 1 format.
For further details on USSR S&T organizations, see Part 2.3, pp. 574-575, and Part 3.1, p. 576.

Table 2 - Scientific and Technological Manpower*

Country: USSR

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total stock (thousands)	of which working in R&D
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agricultural sciences	Medical sciences	Social sciences		
1965		2,401							12,066	
1970		2,999							16,841	
1975		3,790							22,796	
1979		4,264							26,400	
1981	266.6									
1990										

---

* Data on S&T manpower not provided in Table 2 format. For information on S&T manpower in the USSR, see Part 3.2, pp. 576-578.

Table 3 - R&D expenditures*

Country: USSR
Currency: Rouble

Table 3a: Breakdown by source and sector of performance

Year:

Unit: billion

Sector of performance \ Source	National		Foreign	Total
	Government funds	Other funds		
Productive				
Higher Education				
General Service				
Total				

Table 3b: Trends

Year	Population (millions)	GNP (in)	Total R&D expenditures (in)	Exchange rate US $1 = Roubles
1965	229.6			
1970	241.7			
1975	253.3			
1979	262.4			
1980	264.5			
1985				
1990				

* Data on R&D expenditures not provided in format of Tables 3(a) and (b). For further information on such expenditures, see Part 3.3 (p. 578), Table (h) p. 580 and Annex 1 (pp. 589-591).

Introduction

This report is the USSR's contribution to the work of the Second Conference of Ministers Responsible for the Application of Science and Technology to Development and those Responsible for Economic Planning in Asia and the Pacific (CASTASIA II). It contains a brief account of the past performance, present situation and prospects for further development of science and technology in our country, and of the application of the achievements of scientific and technological progress to the comprehensive social and economic development of the Soviet State. These questions are analyzed from the viewpoint of the international significance of USSR experience in the development of science and technology, taking into consideration the applicability of individual components of that experience to the developing countries of the Asia and Pacific region. The position of the USSR on the main items of the conference agenda is also examined in this connection.

Over the years of Soviet rule, the USSR has transformed itself from a backward and predominantly agrarian country into one of the economically most advanced nations. From 4% in 1913, our country's share of world industrial production had risen to 20% in 1979. In 1920, 56% of the population were illiterate; by the mid-seventies the transition to a ten-year universal secondary education system had been completed. By 1979, one in four of the world's scientific workers belonged to the USSR. As a general indication of the effects of socio-economic development on the well-being of the population we may take the average life expectancy, which has risen from 32 years before the Revolution to the present 70 years. These facts make it reasonable to suppose that the development experience of the USSR may be of considerable interest to the developing countries in their struggle to overcome their economic backwardness and to attain economic independence.

The key to the successful development of the economy, science and technology in the Soviet Union lies in the achievement of far-reaching social transformation, the removal of social and institutional barriers to social progress, and the direct subordination of economic, scientific and technological development to the goal of enhancing the well-being of broad masses of the people. At the same time, many basic laws and strategic principles of scientific and technological development formulated and implemented in the USSR are of universal significance and applicable in States with a different social system. They take on even more significance when viewed in relation to the measures envisaged in the regional development strategy for the countries of Asia and the Pacific to widen, in the 1980s, the popular base of socio-economic development and to free development from its parochial or elitist character.

The effectiveness of scientific and technological development in the countries of Asia and the Pacific, and of international cooperation in this field, is largely dependent on favourable external conditions both at the regional level and world-wide. In creating such conditions, the preservation and strengthening of peace and international detente, cessation of the arms race and elimination of the imperialist policy of aggression and neocolonialism have a cardinal role to play. The Soviet Union has put forward a number of important specific proposals on this subject.

Progress towards a healthier international situation and towards solving the problems of detente and disarmament will have a stimulating effect on the process of solving the entire set of problems connected with restructuring international economic relations on terms of equality and justice. The USSR position of principle in matters of international economic, scientific and technological relations was set out in the Soviet Government's statement of 4 October 1976. The Soviet Union supports the demands of the developing countries for the restructuring of international economic relations on a just and democratic basis. The most important objectives in that field are to eliminate neo-colonialism in economics, science and technology, to halt the exploitation of the natural and human resources of the developing countries by the transnational corporations and to remove all forms of coercion and discrimination from international trade and technology transfer. During the fifth session of the United Nations Conference on Trade and Development, the United Nations Conference on Science and Technology for Development, the third session of the UNIDO General Conference, and the eleventh special session of the United Nations General Assembly, and at regional level during the 37th session of ESCAP, the Soviet Union has submitted a large number of constructive proposals with a view to the attainment of those objectives.

Our country is giving, and will continue to give, the developing countries extensive assistance in establishing their national economic, scientific and technological potential on the basis of complete equality, mutual advantage, non-interference in the domestic affairs of other states, and respect for national sovereignty. The USSR is ready to make every effort to ensure the success of the Conference, in particular by passing on to all interested countries its experience in achieving all-round social, economic, scientific, technological and cultural progress in an historically brief time.

The structure and content of this report take into account the foregoing considerations and also the guidelines for the preparation of country reports issued by the Unesco Secretariat (Unesco/NS/ROU/474).

PART 1.

General characteristics of the economic and social development of the USSR

1.1 GEOGRAPHY AND POPULATION

In terms of territory the Soviet Union is the world's largest State. It covers an area of 22 400 000 square kilometres, or 22 270 000 square kilometres excluding inland seas. Of this area, farmland accounts for 6 060 000 square kilometres, or 27.2%, while forests cover 7 910 000 square kilometres, or 35.5%. The earth, subsoil, waters and forests are exclusively the property of the State. Of the total land area, 50% is classified as State land and State forest holdings, 35.6% is in use by State agricultural enterprises, and 11.2% has been made over, rent-free and in perpetuity, to cooperative agricultural enterprises (see Reference 1, 1979, p. 237).

Climatic conditions in the Soviet Union vary widely from Arctic wastes to humid subtropics. Much of the eastern part of the country now being developed has a severe climate of the extreme continental type and includes large areas of permafrost. These conditions impose particular demands for the development of constructional and industrial technology, and for the provision of optimum working and living conditions for the inhabitants.

The USSR possesses substantial reserves of fossil fuel and other mineral resources. Over the last 25 years, as a result of intensified theoretical studies in the earth sciences, coupled with more extensive and more efficient field prospecting, the increase in proven reserves has exceeded consumption by a factor of two in the case of coal, by a factor of 20 in the case of natural gas, and by a factor of between 4 and 36 in the case of iron ore and alloying metal ores, by a factor of 7 in the case of most non-ferrous ores, and by a factor of 10-12 in the case of phosphorites (see Reference 2, p. 13). At the same time, the exhaustion of many old mineral deposits, including some major deposits, and the shift of the main centres of the mining industry to the east and north of the country have complicated the attainment of some economic and social goals (see Reference 3, p. 1).

On 1 January 1981 the population of the USSR was 266 600 000. Essential figures concerning the population are given in Annex 1. Over the years of Soviet rule, the economic development of the country, speeded up by the implementation of profound social transformations in the interests of the broad masses of the working people, has led to a qualitative improvement in the material well-being and a rise in the educational level of the population. Because of this, the change form a traditional to a modern rate of reproduction has been very rapid by comparison with Western Europe.

The objectives of population policy in the USSR are to consolidate the family as the most important cell of the socialist society; to provide women with more favourable conditions in which to combine maternity with active participation in employment and public activities; to improve maintenance of children and the disabled at public expense; to improve the health of the population, increase life expectancy and prolong working life.

	1913	1940	1960	1970	1979
Urban population as a percentage of the total	18	33	49	56	63
Birth rate per thousand population	45.5	31.1	24.9	17.4	18.2
Mortality per thousand population	29.1	18.0	7.1	8.2	10.1
Natural increase per thousand population	16.4	13.2	17.8	9.2	8.1

Sources: See References 1, 1979, p. 7; 4, pp. 44 and 69

1.2 SOCIAL AND POLITICAL SYSTEM

The USSR Constitution adopted in 1977 proclaims that the Soviet Union is a socialist state of the whole people, expressing the will and interests of the workers, peasants and intelligentsia and of the working people of all the nations and nationalities of the country. The political foundation of the USSR is constituted by the Soviets of People's Deputies, which are elected by all citizens of the USSR who have reached the age of 18 on the basis of universal, equal and direct suffrage by secret ballot. The leading and guiding force of Soviet society and the nucleus of its political system is the Communist Party of the Soviet Union (see Reference 5).

As to its national structure, the USSR is an integral, federal multinational State formed as a result of the voluntary association of the 15 Union Republics on the principle of socialist federation. The jurisdiction of the Union of Socialist Soviet Republics covers the pursuit of a uniform social and economic policy; determination of the main lines of scientific and technological progress and the general measures for rational exploitation and conservation of natural resources; the drafting of State plans for the economic and social development of the USSR and the consolidated budget of the USSR; the management of a single monetary and credit policy; the formulation of prices and wages policy; the direction of the sectors of the economy and enterprises under Union jurisdiction, and general direction of sectors under Union-Republican jurisdiction; defence matters; representation of the USSR in international relations and coordination of the relations of Union Republics with foreign States and with international organizations; foreign trade and other forms of external economic activity on the basis of State monopoly; and a number of other matters.

The highest body of State authority of the USSR is the Supreme Soviet of the USSR, which consists of two chambers having equal rights: the Soviet of the Union, and the Soviet of Nationalities. The former is elected by constituencies with equal populations; the latter on the basis of equal representation of each Union Republic, regardless of population, and of statutory representation of the Autonomous Republics, Regions and Areas established on national lines. The highest executive body of the USSR is the Council of Ministers of the USSR, which is responsible to the Supreme Soviet of the USSR. The All-Union and Union-Republican Ministers and the State Committes work under the direction of the Council of Ministers. The highest body of State authority of a Soviet Republic is its single-chamber Supreme Soviet; the highest executive body is the Council of Ministers of the Union Republic, which directs the work of the Union-Republican and Republican Ministers. The local bodies of State authority are the regional, district, urban and rural Soviets of People's Deputies.

The social basis of the USSR is the alliance of the workers, peasants and intelligentsia. As a result of the building of a developed socialist society in the Soviet Union, a new social and historical community has been formed - the Soviet people. The class composition of the population is shown in Annex 1. The USSR Constitution lays upon the State the obligation to help in further enhancing the social homogeneity of society: specifically in the elimination of class differences and of essential distinctions between town and country and between mental and physical labour, and in the all-round development and drawing together of all the nations and nationalities of the USSR.

1.3 ECONOMIC SYSTEM

The foundation of the economic system of the USSR is socialist ownership of the means of production in the form of State property belonging to all the people and collective farm and cooperative property. The country is managed on the basis of State plans for economic and social development, with due account of the sectoral and territorial priciples and by combining centralized direction with the managerial independence and initiative of enterprises. For this purpose, active use is made of management accounting, profit, cost and other economic levers and incentives.

In the period of building socialism, the economic strategy of the Soviet Union was aimed at a radical transformation of the entire system of productive forces on the basis of the introduction of large-scale mechanized production in all sectors of the economy. The most important components of that strategy were:

- comprehensive industrialization, including extra-fast development of the basic sectors of industry and infrastructure;
- accelerated establishment of a national scientific and technological potential;
- development of large-scale farming on a cooperative basis;
- all-round development of human resources through the establishment of a State system of public education and specialist training, public health and social security;
- integral development of the different economic regions of the country, including measures to raise the level of development of formerly backward outlying regions;
- close coordination of plans for economic and social development.

The implementation of this strategy made it possible, within a historically brief period, to turn the Soviet Union into an economically advanced State and to ensure that development was accompanied by full employment of the able-bodied population and a steady rise in the material and cultural level of living for broad strata of the population. The main indicators of the economic and social development of the USSR from 1965 to 1980 are shown in Annex 1.

In 1980, the Soviet Union completed its Tenth Five-Year plan. During the tenth quinquennium the country's economy developed in the direction of a further rise in the Soviet people's well-being on the basis of a dynamic growth in social production, greater efficiency and higher quality of work. By comparison with the ninth quinquennium, the national income increased by 400 billion roubles, industrial production by 717 billion roubles and agricultural output by 50 billion roubles. Capital investment in the economy totalled 635 billion roubles. Fixed assets increased by 40%, more than 1 200 large-scale industrial plants were commissioned. Output of consummer goods increased by 21%. Over the five years, 329 billion roubles more of the national income was spent on raising the living standards of the population than in the ninth quinquennium (see Reference 3).

Scientific and technological progress and improved management techniques resulted in greater efficiency of production. The productivity of social labour increased by 17%; the increase in productivity accounted for 75% of the increase in industrial output, the entire increase in agricultural output, and 90% of the increase in construction (see Reference 3).

The main factors limiting the rate of economic development in the tenth quinquennium were a shortage of manpower due to the slowdown in population growth from the early 1960s onwards; an increase in production costs in the mining industry due to the exhaustion of many old mineral deposits and the shift of the mining centres to the eastern and northern regions of the country; inadequate concentration of investment, which delayed the completion and commissioning of productive facilities; the failure of the machinery of planning and administration, and of management techniques, to keep abreast of modern requirements; and unfavourable weather conditions for agriculture in 1977, 1979 and 1980.

PART 2.

Planning and administration of scientific and technological progress

2.1 PLANNING OF SOCIO-ECONOMIC DEVELOPMENT

Under the USSR Constitution, the planning of economic and social development is under the general direction of the Supreme Soviet of the USSR; in the Union and Autonomous Republics it rests with the Supreme Soviets of the Republics; and in the territories, regions, districts and towns, it rests with the local Soviets of People's Deputies. Draft plans are prepared and submitted for the approval of the highest bodies of State authority of the USSR and of the Union and Autonomous Republics by the Council of Ministers of the USSR and the Councils of Ministers of the Republics; and, in the case of local Soviets of People's Deputies, by their Executive Committees. The preparation of economic and social development plans is carried on both through a system of special planning bodies and through a system of sectoral administrative bodies. The relationships between them are shown in Table (a).

Table (a) - Economic Planning and Administrative Bodies

	Bodies of State authority	**Executive and Administrative Bodies**	**Planning Bodies**	**Sectoral Administrative Bodies**	**Production combines, *enterprises, and* institutions in the non-productive sphere**
Union bodies of the USSR	Supreme Soviet of the USSR	Council of Ministers of the USSR	State Planning Committee of the USSR	All-Union Ministries and departments of the USSR Union-Republican Ministries and departments of the USSR	Enterprises in institutions in the Union hierarchy
Bodies of the Union Republic	Supreme Soviet of the Union Republic	Council of Ministers of the Union Republic	State Planning Committee of the Union Republic	Union-Republican Ministries *and departments of the Union Rep.* Republican Ministries and departments of the Republic	Enterprises and institutions *in the Union hierarcy* Enterprises and institutions in the Republican hierarchy
Bodies of territories, regions, districts and towns	Soviet of People's Deputies	Executive Committee of the Soviet of People's Deputies	Planning division administration of the Executive Committee	Sectoral divisions administrations of the executive Committee	Enterprises and institutions in the local hierarchy

Note: To simplify the table, the planning and administrative bodies in the Autonomous Republics are not shown.

The centralized direction of the social and economic development of the USSR is carried on, the initiative of local authorities is exercised, and the managerial independence of enterprises developed on the basis of a unified system of interrelated plans which have the force of directives. This system comprises:

- the State plan for economic and social development of the USSR;
- the plans of USSR Ministries and departments for sectors within the Union and Union-Republican hierarchy;
- the plans of Union (and Autonomous) Republics for the economic and social development of those Republics as a whole and for the economy within the Republic's ambit;
- the plans of Ministries and departments of the Union (and Autonomous) Republics for sectors within the Union-Republican and Republican hierarchy;
- the economic and social development plans of territories, regions, districts and towns,
- the plans of the sectoral divisions (administrations) of local Soviets of People's Republics;
- the economic and social development plans of productive combines and enterprises, and those of institutions in the non-productive sphere.

The State plan for the economic and social development of the USSR lays down guidelines for development in both sector and territorial terms. The plan is made up of the following sections:

- aggregate economic indicators which measure the development of the economy as a whole;
- targets for scientific research and for application of the achievements of science and technology in the economy;
- targets for the development of the main sectors of the economy (industry, agriculture, transport and communications, etc.);
- targets for capital construction;
- indicators of the development of geological prospecting;
- indicators of the employment, training and distribution of skilled workers;
- targets for the profits, production costs and distribution costs;
- targets for the development of trade and public catering, consumer services and public utilities;
- targets for social development and the enhancement of public welfare, including targets for the growth of real incomes, of manual and non-manual workers' earnings and collective farmers' remuneration, targets for payments to the public out of social consumption funds, and targets for the development of social security, education, public health, etc.;
- targets for environmental protection;
- targets for the economic and social development of the Union Republics and the location of productive forces;
- indicators of the development of external economic relations;

- targets for improving the administration of the economy and raising the level of management;
- material balance sheets for the main types of products.

In 1981 the Soviet Union began to implement the eleventh five-year plan, which ensures that social and economic development will be kept on course and that the specific features of the new quinquennium will be taken into account. The main objective for the new quinquennium is to bring about a further rise in the well-being of Soviet people on the basis of steady, progressive development of the economy, faster scientific and technological progress, setting the economy on an intensive course of development, more rational use of the country's potention for production, through economic use of all resources and an improvement in the quality of work. On that basis, the following strategic objectives have been set for the eleventh five-year plan.

i. **To carry out systematic measures to ensure a steady rise in the well-being of the people** by improving the supply of consumer goods, improving housing conditions, working conditions and medical services, increasing the effectiveness of the system of material incentives and the incentive effect of piece rates, and increasing the social consumption funds;

ii. **To ensure the progressive growth of the economy and to improve the structure of social production;** more particularly, to ensure extra-fast development of those sectors which generate progressive structural changes; to continue the re-equipment of the basic sectors of industry; to secure higher growth rates for the production of consumer goods in comparison with the production of capital goods in industry; to provide for comprehensive development of the agro-industrial and food production complex and accelerate the industrialization of agricultural production and the use of progressive technologies; and to concentrate capital investments in the most important sectors and in installations ready for commissioning;

iii. **To increase the efficiency of social production and improve the quality of the goods produced and services rendered on the basis of comprehensive intensification of the economy;** to obtain 85% to 90% of the increase in national income by increasing labour productivity through making more rational use of material, manpower and financial resources; to raise the equipment/manpower ratio and increase the comprehensive mechanization and automation of production processes; to increase the proportion of top-quality products; to increase the return on capital by reducing the time required for running in and to ensure the economical use of resources of fuel and energy, metals, etc.;

iv. **To secure a further increase in the pace of scientific and technological progress** through faster re-equipment of production; the development and application of radically new machinery and materials and progressive technologies; a substantial reduction in the lead time for the application of the achievements of science and technology to production; and the refinement of standards and technical specifications;

v. **To strengthen the protection of nature** and ensure rational use and reproduction of natural resources;

vi. **To improve administration and raise the level of management in all units of the economy;** more particularly, to intensify the drive for the end-results that are best for the economy, steadily to improve planning; to develop, by every possible means, initiative, a businesslike approach and a creative search for unused resources; and to increase the responsibility of managers for the results and quality of work;

vii. **To increase the effectiveness of external economic relations** by intensifying socialist economic integration with the CMEA member countries and by expanding cooperation with the developing countries and mutually advantageous trade with the advanced capitalist countries (see Reference 3, p.2).

Table (b) - Main Targets of the Eleventh Five-Year Plan

Indicator	Growth by 1985 as a % of 1980
National income	18-20
Productivity of social labour	17-20
Gross industrial output of which:	26-28
Means of production	26-28
Consumer goods	27-29
Labour productivity in industry	23-25
Gross agricultural output	12-14
Labour productivity in agriculture	22-24
Freight carried by rail	14-15
Labour productivity in rail transport	10-12
Capital investment	12-15
Per capita real income	16-18
State and co-operative retail trade turnover	22-25
Average monthly earnings of manual and non-manual workers	13-16
Collective farmers' incomes from the social economy	20-22
Social consumption funds	20
Numbers qualifying as skilled workers with secondary education	60
Gross industrial output by Union Republic:	
RSFSR	24-27
Ukrainian SSR	20-23
Byelorussian SSR	26-29
Uzbek SSR	22-25
Georgian SSR	30-33
Azerbaijan SSR	29-32
Lithuanian SSR	21-24
Moldavian SSR	30-33
Latvian SSR	15-18
Kirghiz SSR	21-24
Tajik SSR	24-27
Armenian SSR	29-32
Turkmen SSR	21-24
Estonian SSR	14-17

Source: see Reference 3, pp. 2 to 6

2.2 RELATIONSHIP BETWEEN SOCIO-ECONOMIC POLICY AND SCIENCE AND TECHNOLOGY POLICY

In the USSR the development of science and technology has always been regarded as a most important force for change and an essential condition of social and economic progress. Soviet society is vitally interested in speeding up scientific and technological progress and in the fullest possible utilization of its results. The attainment of the fundamental long-term goal of a socialist society – maximum satisfaction of the growing material and spiritual needs of all its members – largely depends on these factors.

The basic laws of the application of scientific and technological progress to social development are embodied in the USSR Constitution of 1977. It is stipulated, in particular, that by relying on the creative initiative of the masses, socialist emulation and the achievements of scientific and technological progress, and by improving the forms and methods of economic management, the State ensures growth of the productivity of labour, an increase in the efficiency of production, a rise in the quality of work, and dynamic, planned and proportionate development of the economy (Article 15). The State concerns itself with improving working conditions, safety and labour protection and scientific organization of work, and reducing and ultimately eliminating all arduous physical labour through comprehensive mechanization and automation of production processes in all sectors of the economy (Article 21). In accordance with society's needs, The State provides for planned development of science and the training of scientific personnel and organizes the application of research findings in the economy and other spheres of life (Article 26). Under the Soviet Constitution, citizens of the USSR are guaranteed freedom of creative scientific and technical work. This freedom is ensured by extensive development of scientific research and of invention and rationalization. The State provides the necessary material conditions for this and support for voluntary societies and unions of creative workers, and organizes the introduction of inventions and proposals for rationalization in the economy and other spheres of life (Article 47).

2.3 PRINCIPLES OF SCIENCE AND TECHNOLOGY POLICY AND ORGANIZATION OF THE PLANNING AND ADMINISTRATION OF SCIENTIFIC AND TECHNOLOGICAL PROGRESS

In the USSR the subordination of scientific and technological *progress to the following fundamental principles of science and* technology policy:

- scientific and technological progress should be oriented towards social and economic goals, and its social and economic implications should be taken fully into account;
- measures to develop science and technology should follow a plan;
- scientific and technological efforts should be concentrated on solving key problems of development;
- science and technology should be developed in an integrated manner as an organic part of a complex system in which education, R&D, production and consumption interact with one another;
- the effectiveness of decisions concerning science, technology and organization and the implications of their application should be evaluated from a standpoint of the long-term prospects and interests of society as a whole;
- the pattern of R&D, preparation for production and putting into production should correspond with the prevailing specific circumstances;
- every effort should be made to develop the country's own scientific and technological potential as fast as possible and at the same time the fullest possible use should be made of attainable and mutually advantageous international cooperation.

As we have already seen, the science and technology development plan is an organic part of the State plans for economic and social development. The system for planning scientific and technological progress includes:

- a long-term forecast, covering the main trends in the development of science and technology for the next 15 to 20 years;
- a five-year annual plan dealing with scientific and technological problems and targets;
- an annual plan, which refines the targets of the five-year plan and spells them out in more detail taking into account any newly discovered potential and needs for development of the economy.

The task of forecasting scientific and technological progress consists in making a reasoned identification of the key problems of science and technology and predicting the time required for their scientific and technical solution. In modern Soviet economics, such forecasting has become highly reliable, since virtually all fundamental and applied research is concentrated in State research institutes and higher educational establishments, with the result that forecasts can be based on time schedules for research work on specific subjects.

The main lines of development for science and technology are laid down, and the scientific and technological problems of importance to the economy are formulated, by the USSR State Committee on Science and Technology in conjunction with the Academy of Sciences of the USSR; for the individual sectors and Union Republics, forecasts of, and draft plans for the development of science and technology are prepared by the sectoral ministries and departments of the USSR and the Union Republics.

The essential factors which guarantee that the approach to the formation of a science base in the USSR will be systematic and that the base itself will be efficient are as follows:

- the provision of purposeful, planned and comprehensive training for scientific personnel, firstly, by giving the appropriate orientation to the secondary education system, secondly, by expanding the network of higher educational establishments, and lastly through a State system for the planned distribution of specialists and State supervision of the certification of specialists with higher scientific qualifications;
- the establishment of a system of scientific institutions which ensure that fundamental research is carried on in all the basic sciences;
- the development of science both in its traditional strongholds and concurrently throughout the country, including the previously backward outlying regions;
- the planned and intensive formation of a science infrastructure, including in particular the production of scientific and experimental equipment and the design and construction of special buildings and installations;
- extensive development of mass non-governmental and creative organizations such as science, or science-and-technology societies, or associations of inventors and systems engineers;
- the parallel formation of an organizational system to generate and coordinate scientific research at State level, including in particular the establishment of the Academy of Sciences of the USSR with its regional departments and branches, the academies of sciences in the Union Republics, and specialized sections of the academies of sciences – medical, agricultural and educational – and the Government Committee for the Coordination of Research and Development of the USSR State Committee on Science and Technology.

One of the most important features of the science and technology strategy of the USSR is the machinery for applying the achievements of science and technology to production and for developing and transferring technology. In the Soviet Union the following system of organizational and economic measures has been instituted in this field:

- centralized systems of specialized design and technology organizations have been set up in all sectors of the economy;
- State planning and supervision of large scale technological innovations have been introduced;
- industrial and commercial secrecy has been abolished, and a system has been established for the transfer of scientific and technological information free of charge or at cost between all State and cooperative organizations and enterprises;

- the State has undertaken to acquire all necessary documentation concerning patents and licences, and to make it available free of charge to economic organizations and those engaged in production;
- a comprehensive, differentiated State system has been established for standardizing essential types of products and elements of technological progress;
- a system of soft credit and incentives has been introduced for technological innovations, based on an evaluation of their social and economic impact.

PART 3.

Scientific and technological potential of the USSR

3.1 THE SYSTEM OF SCIENTIFIC AND TECHNOLOGICAL INSTITUTIONS

A system for State administration of the development of science and technology and the application of their achievements to production has been established and is working successfully in the USSR. At the apex of this system are the Presidium of the Academy of Sciences of the USSR and the USSR State Committee on Science and Technology. The system of administration also includes specialized departments (the State committees on standardization, on inventions and discoveries, on meteorology and environmental protection, on atomic energy, etc.), the management of sectoral and regional departments of the Academy of Sciences of the USSR, the sectoral ministries and departments, and regional administrative bodies.

The system of scientific research and design organizations in the USSR embraces all the fundamental branches of modern science and technology. It includes:

- the scientific research institutes of the Academy of Sciences of the USSR and of its regional departments and branches, and those of the academies of sciences of the Union Republics and the specialized sectoral academies (see Table (c)).
- scientific research institutions at universities and other higher educational establishments under the USSR Ministry of Higher and Secondary Specialized Education and the corresponding ministries of the Union Republics;
- scientific research and design organizations under the sectoral ministries and departments of the USSR and the Union Republics;
- science and production combines and specialized R&D organizations attached to production combines and enterprises;
- design and technology subdivisions and standardization divisions of production enterprises.

An important place in the country's scientific potential is occupied by the State-wide system of scientific and technological information. It comprises 10 All-Union Institutes, 86 sectoral institutes, 15 Republican institutes, some 100 intersectoral territorial centres and over 100 000 scientific information divisions of enterprises and institutions (see Reference 2, p. 21).

One of the important instruments of scientific and technological policy is the State system of standardization. This system is based on the application of various categories of standards ranging from All-Union State Standards to the standards and technical specifications laid down by Union Republics and individual enterprises.

3.2 SCIENTIFIC PERSONNEL

Table (d) shows the essential figures on personnel employed in science and scientific services, by level of qualifications and the numbers of specialists with higher or secondary specialized education employed in the economy. In 1979, about 25% of all the scientific workers in the world were working in the Soviet Union. Half the scientific workers were employed in the technological sciences, some 30% in the natural and mathematical sciences, and 20% in social sciences and humanities (see Reference 2, p. 20).

One of the chief factors in the unusually accelerated growth of the scientific and technological potential of the USSR is the rapid pace at which higher and secondary specialized education has been developed and its quality improved. The essential characteristics of the Soviet system of higher and secondary specialized education are: that personnel training is oriented and planned in accordance with the long-term needs of economic development; that the instruction is given free of charge; that study of specialized disciplines is organically linked with the study of outlook-forming social and political disciplines; and that the State guarantees to place the young specialists in work when their training is completed. Higher and secondary specialized educational establishments are evenly distributed over all the Union Republics, and impart the instruction in the national languages. Quantitative indications concerning the development of higher and secondary specialized education are provided by the figures in Tables (e) and (f) and Annexes 2 to 4.

Table (c) - Academy of Sciences of the USSR, Academies of Sciences of Union Republics and Sectoral Academies (1979)

	Scientific Staff	of whom: Doctors of Sciences	Candidates in Sciences
Academy of Sciences of the USSR	46,110	4,430	21,080
Academies of Sciences of Union Republics	47,350	2,960	19,520
Sectoral academies*	27,840	1,670	13,280
Total	121,300	9,060	53,880

Note

* The Academy of Arts of the USSR, the 'V.I. Lenin' All-Union Academy of Agricultural Sciences, the Academy of Medical Sciences of the USSR, the Academy of Pedagogical Sciences of the USSR and the Academy of Municipal Economy of the RSFSR.

Source: see Reference 1, 1979, p. 109.

Table (d) - Numbers employed in Science and Scientific Services, and number of specialists with Higher and Secondary Specialized Education

(in thousands)

	1965	1970	1975	1979
Numbers employed in science and scientific services	2,401	2,999	3,790	4,264
As a percentage of total number employed in the economy[1]	2.5%	2.8%	3.2%	3.4%
of whom:				
Scientific workers[2]	664.6	927.7	1,223.4	1,340.6
of whom:				
Doctors of Sciences	14.8	23.6	32.3	37.1
Candidates in Sciences	134.4	224.5	326.8	383.6
Specialists with higher or secondary specialized education employed in the economy	12,066	16,841	22,796	26,400
As a percentage of total number employed in the economy[1]	12.5%	15.7%	19.3%	21.2%
of whom:				
Specialists with higher education	4,891	6,583	9,477	11,100
Specialists with secondary specialized education	7,175	9,988	13,319	15,300
Proportion of women:				
Among specialists with higher or secondary specialized education (%)	58%	59%	59%	59%
Among scientific workers (%)	38%	39%	40%	40%

Notes:

[1] Including manual and non-manual workers and collective farmers [2] Including science teachers at higher educational establishments

Source: Reference 1, 1979, pp. 387-388, 397-398 and 107

Table (e) - Numbers of students at higher educational establishments and pupils at secondary specialized establishments per 10,000 of the population

Year	Students at educational establishments	Pupils at specialized educational establishments	Total
1940	41	50	90
1965	166	158	324
1970	188	180	368
1975	190	177	367
1979	196	176	372

Source: see Reference 1, 1979, p. 499

Table (f) - Numbers of higher and secondary specialized educational establishments

Year	Higher educational establishments	Secondary specialized educational establishments	Total
1965	756	3,820	4,576
1970	805	4,223	5,028
1975	856	4,302	5,158
1979	870.	4,358	5,228

Source: see Reference 1, 1979, p. 492

Table (g) - Expenditure on science

(in billion of roubles)

	1965	1970	1975	1979	1980
Total expenditure	6.9	11.7	17.4	20.2	21.3
of which:					
Financed out of the State budget	4.1	6.4	7.9	9.3	
Financed from other sources[1]	2.8	5.3	9.5	10.5	
Per capita expenditure on science (in roubles)	29	48	69	77	80
Expenditure on science as a percentage of national income	3.6	4.1	4.7	4.7	4.8

Note:

[1] Resources of State and co-operative enterprises and organizations

Source: see Reference 1, 1979, pp. 7, 106 and 555-556

In 1980, more than one million students were admitted to higher educational establishments and 1.5 million to secondary specialized educational establishments. In the course of the year, 2.1 million specialists were placed in employment, including 800 000 with higher education and 1.3 million with a secondary specialized education (see Reference 7, p. 2). During the period of the eleventh five-year plan (1981-1986) the intention is to train around 10 million specialists with higher or secondary specialized education (see Reference 3, p. 5).

3.3 FINANCING THE DEVELOPMENT OF SCIENCE AND TECHNOLOGY

Between 1965 and 1979, expenditure on science in the USSR increased from 6.9 billion roubles to 20.2 billion roubles, and as a proportion of national income it increased from 3.6% to 4.7%. The percentage ratio of expenditure on science to gross capital investment in the economy rose from 12.3% to 15.5%.

The network of scientific research organizations in the USSR is now completing its coverage of all branches of knowledge and production, and science is emerging from the extensive phase of its development. The transition to the intensive phase is accompanied by a gradual stabilization of the share of national income spent on science. The grafting of research on to production, especially at the design and experimental stage, shifts the burden of financing a substantial proportion of expenditure on science from the State Budget directly to the production costs of combines and enterprises. The transition of the science and technology complex to the phase of intensive development has also resulted in a reduction in the average lead time (from the conception of an idea to its application in production), an increase in the proportion of expenditure on research which leads to practical results in production, and an increased volume of expenditure on research projects which require capital investment before the results can be translated into practice.

The system of financing scientific and technological progress is being further improved by the application of the resolution "Concerning the improvment of planning and strengthening the input of economic machinery in increasing the efficiency of production and improving the quality of work", adopted by the CPSU Central Committee and the Council of Ministers of the USSR in 1979. This resolution stipulates inter alia that scientific and technological development in industry shall henceforth be financed out of a united sectoral fund constituted from the profits of enterprises and combining sectoral resources for scientific research work, resources from the fund for running in new technology, and budgetary appropriations for the development of sectoral science (see Reference 9).

PART 4.

Basic trends, results and prospects of science and technology policy

4.1 THE TREND TOWARDS MORE INTENSIVE APPLICATION OF SCIENCE AND TECHNOLOGY FOR DEVELOPMENT PURPOSES

An important trend in the intensification of scientific and technological development is that towards further refinement of the economic methods of administering that development, and the adoption of a systematic and integrated approach to the planning of the "research-development-production" cycle. The solving of these problems is accorded close attention in the resolution "Concerning the improvement of plannning and strengthening the impact of economic machinery in increasing the efficiency of production and improving the quality of work" adopted by the CPSU Central Committe and the Council of Ministers of the USSR in 1979.

This resolution provides for significant changes in the system for planning, financing and administering scientific and technological development. More particularly, it includes among the fundamental planning indicators the economic impact of scientific and technological measures, while targets for the growth of top-quality output, and other indicators of quality are laid down in the appropriate sections of the five-year plans, together with targets for the reduction of manual labour and standards for inputs of material resources. In the planning of capital construction, greater weight is laid on mandatory targets for applying and running in new, highly efficient technologies and types of products, while the reconstruction and modernization of existing enterprises are given precedence over the construction of new facilities. Scientific and technological development not only becomes an integral part of social and economic planning, but permeates all sections of the economic and social development plan and assumes a pivotal role in the process of planning and administration.

Under the conditions now prevailing in the Soviet Union, far more use is being made of long-term forecasting in planning both social and economic development as a whole and the development of science and technology. A unique "Comprehensive programme for scientific and technological progress and its socio-economic consequences for 1976-1980" was prepared in the USSR. Regularly updated and extended in the light of economic requirements and the emergence of new possibilities in science and technology, this comprehensive programme is used as a source in preparing the economic plan.

One of the most important means of accelerating the application of scientific and technological results to production is the integration of science and production. More particularly, the "idea-development-production-consumption"cycle can be speeded up by making use of various forms of association between organizations engaged respectively in scientific research, design and production. Those forms of association include:

- large-scale scientific research centres which disseminate new technology in all sectors of the economy;
- science-and-production combines which develop serial and mass production technology and pass it on to individual sectors;
- economic complexes based on large-scale design technology organizations which have pilot production capacity and turn out new types of products;
- the growing practice of direct economic contracting between scientific research institutions and production plants.

A favourable factor in the development and application of new technology is the formation of large production combines. The role which these combines and science-and-production combines are playing in industrial production is shown by the following figures:

	1970	1975	1979
Number of combines	608	2,314	3,947
Number of production plants contained	2,564	9,558	17,516
Share of marketed output (%)	6.7	24.4	47.1
Share of industrial personnel (%)	6.2	28.8	48.4

Source: see Reference 1, 1979, p. 133

In agriculture 25 science-and-production combines had been formed by 1980.

The development of these new organizational forms for integrating science and production reduces the lead time between the appearance of new ideas and the marketing of new goods embodying them, and accelerates the renewal of technology and of the range of products.

The scientific, technological and production potential of the USSR has now reached a stage at which qualitatively new development objectives can be attained by implementing comprehensive purpose-oriented programmes of inter-disciplinary and inter-sectoral R&D. Examples of such programmes, in whose execution hundreds of scientific research organizations and production enterprises interact with one another, are the development of the fuel and energy complex; the establishment of an agro-industry and food industry complex; the development of the transport system; and a systems approach to the problems of urban development and environmental protection.

4.2 SOME RESULTS OF SCIENTIFIC AND TECHNOLOGICAL PROGRESS IN THE USSR IN THE 1970s

Soviet science is in the forefront of world scientific and technological progress. The achievements of Soviet scientists in various fields of science and technology are widely known. During the 1970s, the development of fundamental and applied scientific research, design and technological development and the application of new technology in all the sectors of the economy were all speeded up in the USSR.

The USSR State Committee on Inventions and Discoveries registers every year a wide range of discoveries made by Soviet scientists in various fields of fundamental research. In 1979, for instance, discoveries in the USSR included the formation of a highly basic structural pattern in calcium sillicates which made possible the controlled synthesis of silicate materials and the development of a radically new, energy-saving technology for cement production; electrogyration in crystals (i. e. a change in their natural optical activity on exposure to an external electric field), which is being used to develop radically new units and devices for controlling optical radiation; the phenomenon of complexing and chemical transformations of molecular nitrogen in compounds of transition metals, from which it has been possible to develop new technology for the production of ammonia and hydrazine; the phenomenon of reproduction of the wave pattern of an electromagnetic field, which has been used to develop and apply methods of holographic interferometry; the phenomenon of inversion refraction of the wavefront of light, which has brought a new solution to the problem of designing powerful lasers with extremely high directivity of radiation and the problem of long-distance transmission of energy; the electromagnetic polarization properties of strongly interacting elementary particles; the law of zonal distribution of indicator elements in primary geochemical aureoles in sulphidic hidrothermal ore deposits, which has made it possible to detect concealed ore bodies and has increased the efficiency of geochemical prospecting; the electroacoustic echo in piezoelectric crystals, which has opened up new prospects for the development of multi-functional memory devices and information processing; the direct knock-out of deuterons from atomic nuclei by high-energy nucleons, which has stimulated the development of the theoretical physics of quasi-elastic scattering of high-energy particles in nucleonic associations in nuclei; the nuclear procession of neutrons, which has yielded qualitatively new information about the fundamental properties of matter at low temperatures; and many other phenomena and processes (see Reference 10, 1980, pp. 459-466).

In the 1970s the application of new technology and the scientific organization of work became basic factors in increasing production. Between 1971 and 1979 they accounted for 64% of the total increase in labour productivity in industry and 46% of the increase in gross industrial output. In 1979, action to organize work on scientific lines made it possible to save the labour of almost 400 000 workers (see Reference 1, 1979, pp. 47 and 112).

Table (h) - Expenditure on measures of the application of new technology to industry and their economic impact

	1970	1975	1979
Number of measures for the application of new technology (in thousands)	423	621	725
Actual expenditure on the application of new technology (in billions of roubles)	5.01	7.52	8.88
Number of workers nominally released (in thousands)	399	576	592
Additional profit from the application of new technology (in billions of roubles)	1.97	2.82	3.00
Annual economic impact of the application of new technology (in billions of roubles)	2.64	3.83	4.48

Source: see Reference 1, 1979, p. 112

Some indicators of technological progress in the USSR economy in 1965-1979 are shown in Annex 5. In 1980 some 4 000 new models of machinery, equipment, appliances, instruments and automation systems were developed in the economy; 12 000 mechanized flow-lines and automatic lines were installed at industrial plants; more than 5 000 production sections, shops and production plants were fully mechanized or automated; 520 automated accounting, planning and control systems were installed; and some 4 million inventions and rationalization proposals were applied in practice (see Reference 7, p. 1).

One of the promising trends of technological progress in the 1970s was the extensive application of automated control systems at various levels.

Table (j) - Installation of automated control systems (ACS)

	1966-70	1971-75	1976-80
Number of automated control	414	2,309	2,197
of which			
ACS at enterprises	151	838	297*
Technological process ACS	170	564	1,291
Territorial organization ACS	61	631	316*
ACS in Ministries and departments	19	168	61*
Automated information processing system	13	108	92*

Note:
* 1976-79 *Source:* see Reference 1, 1979, pp. 114, 7, 1

The development of the socialist society has fostered a substantial increase in creative activity among the working people of the USSR. This has been reflected *inter alia* in the increased importance of popular invention and rationalization in the economy, in which broad strata of the working population take part. The economic impact of invention and rationalization may be seen from the figures given in Annex 6.

4.3 BASIC TRENDS OF SCIENCE AND TECHNOLOGY POLICY FOR 1981-1990

The CPSU Central Committee's draft "Main Guidelines for the economic and social development of the USSR in 1981-1985 and for the period up to 1990" lays down a comprehensive programme for the development of science and technology (see Reference 3). The strategic aims of science and technology policy for the 1980's are subordinated to the need to solve the problems attendant upon further progress, and to switch the economy more quickly on to the tracks of intensive development. Plans are being made to pursue comprehensive purpose-oriented programmes in order to solve the most important problems of science and technology; to reduce substantially the lead times for the development and application of new technology; to strengthen the links between science and production; to improve the system for evaluating the technological level of the products developed and manufactured; to augment the pilot production capacity of research and design organizations; to make prompt corrections to the course of R&D and to the organizational structure of scientific institutions in accordance with the requirements of the scientific and technological revolution; to make more efficient use of the scientific potential of higher educational establishments and to improve the training of scientists and science teachers; to promote the development of voluntary creative activities in science and technology among inventors and rationalizers; and to strengthen the part played by science and technology societies in accelerating scientific and technological progress.

In the *social sciences,* priority is given to the following lines of research:

- dissemination of the experience which the CPSU and the international Communist and workers' movement have gained in their revolution and transformation, and study of the fundamental theoretical problems of Marxism-Leninism;
- broadening research into theoretical questions of advanced socialism, methods of increasing the efficiency of production, scientific and technological progress, the administration of the economy, land policy, population and labour resources;

- research into problems of the social structure and political system of mature socialism, and problems of Communist upbringing and all-round harmonious development of the individual;
- research into the natural laws of the world socialist system, socialist economic intregration and external economic relations;
- study of the economics and politics of capitalist and developing countries, and critical study of anti-Communism and of bourgeois and revisionist conceptions of social development.

In the *natural and technological sciences,* the main lines are:

- the development of mathematical theory and its practical applications and development of the physics of elementary particles and the atomic nucleus;
- the development of nuclear power engineering and laying down foundations of thermonuclear power engineering, and the improvement of techniques for transforming and transmitting energy;
- the development of processes of chemical technology for obtaining new substances and materials with specified properties, and technologies for the integral utilization of raw materials and by-products using closed technological cycles;

improvement of the quality of equipment and reduction of its consumption of materials and energy;

- improvement of computer hardware and of information transmission and processing equipment, increasing the efficiency of automated control system, and expanding the network of computers and computer centres for collective use;
- study of the mechanism of the physiological, biochemical, genetic and immunological processes of vital activity,
- improvement of the prophylaxis, diagnosis and treatment of the most widespread diseases and the development of new medicines and medical equipment;
- the development of highly productive strains of plants, livestock and useful micro-organisms, the creation of new physiologically active substances and the development of biochemical production processes;
- the further study and conquest of outer space;

improvement of the effectiveness of measures to protect nature, rational use of the resources of the biosphere, the world ocean and the continental shelf, and improvement of weather forecasting techniques.

The development of fundamental and applied research makes it possible to lay down the following main guidelines for the *application of scientific and technological achievements to production* in the 1980s:

- development of the production and extensive utilization of industrial robots and inbuilt automatic control system using micro-processors and mini-computers, and the establishment of automatic shops and factories;
- optimization of the unit capacity of equipment and reduction of its size, metal content, energy consumption and unit cost;

the development of multi-functional machinery and equipment which can be adjusted to changes in technology production processes or types of products; extensive application of the modular principle in mechanical engineering and the use of standardized components and assemblies;

- the development of radically new means of transport which consume substantially less fuel and energy;
- an increase in the tensile strength of metals and alloys and in their resistance to corrosion, heat and cold, and increased production of new construction materials, coverings and articles made of powdered metals, powdered alloys and refractory compounds;
- development of the production of ultra-pure, semiconducting, super-conducting, new polymers and composition materials with a set of specified properties, and of heat-resistant and chemical resistant non mettalic materials;
- the extensive application of simple, low-waste and waste-free technological processes, the integral use of solid and heavy liquid fuels and the manufacture of synthetic fuel;
- the use of electrochemical, laser and radiation techniques for processing metals, materials and articles;
- faster application of automatic quality control and product testing techniques;
- securing integral and more complete extraction of the useful components from ores, and the working of poor and complex deposits;
- increasing the scale of utilization of renewable sources of energy (hydraulic, solar, wind and geothermal energy).

4.4 SCIENTIFIC AND TECHNOLOGICAL COOPERATION BY THE USSR WITH FOREIGN COUNTRIES

The Soviet Union calls for extensive cooperation with all interested States in the development of science and technology and the application of scientific and technological achievements. The position of the USSR in matters of international scientific and technological cooperation is based on the priciples of peaceful cooperation between States with different social systems, respect for national sovereignty and non-interference in the domestic affairs of other States, genuine equality and mutual advantage.

The most important prerequisites for successful cooperation in science and technology are the preservation and strengthening of peace, the consolidation of detente and the cessation of the arms race which swallows up a large share of the world's scientific and technological resources needed to speed up social and economic development. At the same time, the development of mutually advantageous economic, scientific and technological cooperation can help to strengthen mutual trust between States and spurs the process of detente.

The USSR calls for the elimination of all forms of exploitation, dictation and discrimination in international economic relations, including scientific and technological relations. Our country supports the just demands of the developing countries for a restructuring of international economic relations on a just and democratic basis, demands which are aimed at overcoming the unequal and dependent position of those countries in the world capitalist economy. The Soviet Union, actively participating in the efforts of the international organizations in devising a new international economic order, has put forward many specific proposals on the subject which takes particular account of the vital interests of developing States. The economic, scientific and technological relations which the USSR and the other socialist countries maintain with the developing countries are a practical embodiment of the new type of international relations which is free from exploitation and oppression. The USSR calls for the fastest possible formulation and implementation of a universal Code of Conduct on the Transfer of Technology and of a Code of Conduct for Transnational Corporations designed to curb the uncontrolled sway of the imperialist monopolies in the developing countries, which conflicts both with the national interests of those countries and with the interests of the development of the world community as a whole.

The scientific and technological cooperation of the USSR with foreign countries is based on extensive use of long-term intergovernmental and interdepartmental agreements and active participation in multilateral cooperation through the United Nations and its specialized agencies. In 1979 bilateral cooperation was carried on under 330 science and technology agreements covering work on more than 4 300 problems and subjects. The USSR takes part in the activities of more than 550 international organizations, 340 of which are engaged in studying and solving problems of social, economic, scientific and technological development.

The Soviet Union provides socialist and developing countries with extensive technical assistance in solving key problems of social and economic development. By 1 January 1980, 3 965 enterprises, including 1 642 in ESCAP countries, had been or were being built or designed abroad with the technical assistance of the USSR on the basis of inter-State agreements. Of these enterprises 2 435, including 1 127 in ESCAP countries, had been fully or part commissioned. Pride of place among projects receiving the technical assistance of the USSR goes to key enterprises in industry (2 268 plants), agricultural enterprises (459), transport and comnmunications enterprises (418) and social and cultural facilities (518). The geographical distribution of projects receiving technical assistance from the USSR abroad is shown in Annex 7, their sectoral distribution in Annex 8, and the capacity of enterprises built or being with the assistance of the USSR in foreign countries in Annex 9. The total capacity of the industrial enterprises build abroad with the technical assistance of the USSR is comparable to the total industrial potential of an industrially advanced State. Thus the capacities of plant built with USSR technical cooperation for electric power generation and the production of pigiron, steel, rolled metal and soda ash exceed the total capacities which the Soviet Union itself possessed at the beginning of the 1960s; the capacities for cement production correspond to those of Soviet industry in the mid 1950s, and so on.

Scientific and technological cooperation with the socialist countries is largely carried on through the Council for Mutual Economic Assistance (CMEA). Int the 1970s, cooperation between CMEA member countries entered a new phase in its development, that of integration. The "Comprehensive Programme of Socialist Economic Integration", which was adopted in 1971 and has since been applied with success, has led to more efficient utilization of the combined scientific and technological potential of those countries for the purposes of social and economic development of the socialist community; to thorough coordination of R&D; to the execution of integrated programmes of research; and to the application of their findings to production on a multilateral basis. A leading role in the coordination of the CMEA countries' research networks is played by the CMEA Committees on Cooperation in Planning and on Scientific and Technological Cooperation, established in 1971. By 1 August 1980, multilateral scientific and technological cooperation between CMEA countries was being pursued under 120 agreements in 24 international economic, scientific and technological organization of the socialist countries, seven international teams of scientists and 57 coordinating centres, with some 3 000 research and design organizations taking part (see Reference 11). Scientific and technological integration between socialist countries is pursued mainly through programmes for the optimum utilization of natural resources, faster technological progress, and specialization and cooperation in mechanical engineering. Special attention is paid to speeding up the scientific and technological development of the relatively less developed CMEA countries and equalizing their level of development with that of others. A vivid example of successful cooperation in science and technology is provided by the results of the "Interkosmos" programme, in the course of which seven international teams of cosmonauts worked in earth orbit between 1978 and 1980. Agreements have been reached for cosmonauts from India and France to participate in this work.

The basic principle of the USSR's scientific, technological and economic cooperation with the developing countries is the community of vital interests shared by world socialism and the national liberation movement in the struggle for peace and social and economic progress and against exploitation and oppression. This community of interests is the reason for the identity or proximity of views between the socialist and developing countries on the chief problems of world development. The fundamental characteristics of scientific, technological and economic cooperation between the USSR and the developing countries are as follows:

- it is based on the principles of equality and mutual advantage, respect for national sovereignty and non-interference in the domestic affairs of other States; technical assistance is not accompanied by the imposition of any conditions whatsoever - direct or indirect, political or other - on the recipient countries;
- cooperation is carried on primarily on the basis of intergovernmental agreements; ever increasing use is being made of long-term agreements for the comprehensive solution of problems pertaining to the development, transfer and application of technology; cooperation between firms complements inter-State cooperation and is pursued in strict compliance with the principles laid down in the intergovernmental agreements and under strict State control;
- in contrast with the operations of the transnational corporations, which strive to gain control over national production in the developing countries, the ownership and management of installations built with the technical assistance of the USSR remains in the hands of the developing countries themselves;
- scientific, technological and economic cooperation is concentrated in the State sector of the developing countries' economy; this arrangement is the most progressive form of socialization of production and the best fitted for using the results of technology transfer to attain nationwide objectives of both an economic and a social nature. Cooperation with the State sector assumes particular importance in connection with the implementation of the Development Strategy for the Third United Nations Development Decade, which provides for a qualitative broadening of the popular base of economic growth in the developing countries. The USSR also favours extensive development of cooperation with the national private sector;

by far the greater part of USSR technical assistance to the developing countries is used to build key enterprises for national industry, infrastructure and agriculture, which forms what might be called "fulcra of development" in the national economy and which have a substantial multiplier effect, both directly and indirectly, on economic and technological modernization. More specifically, many projects of cooperation have provided the impetus for faster development of small-scale production, the economic transformation of whole areas and so on. In India, for example, under 10 main schemes of Soviet technical cooperation, more than 850 small-scale associated or ancillary enterprises have been or are being set up;

- the technical assistance of the USSR to the developing countries is a package comprising coordinated delivery of equipment, transfer of technology, training of national personnel, secondment of Soviet specialists, etc. ; this ensures both that more effective use is made of the imported equipment and technology and that employment is found for the trained local personnel, thus averting a "brain-drain". During the construction and operation of enterprises built with the assistance of the USSR in the developing countries, over 400 000 skilled workers and middle-ranking specialists have be trained, some 170 educational establishments have been set up and more than 25 000 specialists from developing countries have undergone training in the USSR (see Reference 2, p. 34);
- the fact that the technical assistance of the USSR aims at establishing a domestically based reproductive cycle in the developing countries and enabling them to achieve self-sustaining growth is demonstrated by the import replacement and export orientation given to the installations built; assistance in developing the production of modern capital equipment; and assistance in establishing in large countries,

balanced, multi-sectoral industrial complexes producing everything from raw materials to intermediate and finished products, including equipment for their own plant, and complete with centres for training skilled personnel and R&D organizations;

- the arrangements whereby most of the credits advanced by the USSR are repaid in commodities produced by the developing countries releases large sums in foreign currency and helps the borrowing countries to speed up the development of their exports; favourable conditions for export development were created by the Soviet Union in 1965 in removing all import duties on goods from the developing countries, whereas year by year the developed capitalist countries are raising new discriminatory protectionist barriers against exports from the developing countries.

The CPSU Central Committee's draft "Main guidelines for the economic and social development of the USSR in 1981-1985 and for the period up to 1990" provides for further long-term development, on a basis of equality, of mutually advantageous trade and comprehensive economic, scientific, technological and other relations between the Soviet Union and the developing countries, and for economic and technical assistance to those countries in the construction of industrial plant and of power engineering, agricultural and other projects which will help to consolidate their economic and political independence (see Reference 3, p. 6).

PART 5.

Uses for science and technology in the social and economic development of the developing countries of Asia and the Pacific: some conclusions from the experience of the USSR

5.1 A SOCIAL AND ECONOMIC DEVELOPMENT STRATEGY FOR THE 1980s

Over the years of independence, the developing countries of Asia and the Pacific have made substantial advance in social and economic development: in establishment domestic industry, in laying their economic, scientific and technological infrastructure, and in developing education and public health. In the late 1970s and early 1980s, however, social problems, more especially problems of employment, have grown more acute in many States, necessitating some adjustment of the strategic aims of development. The difficulties, which have substantially heightened social and political tensions in a number of countries and slowed down their economic growth and the pace of structural improvements in their economy, were due both to external and to internal factors.

The most important external obstacles to accelerated social and economic development include:

- the agressive policy of the leading imperialist powers, which are the main cause of armed conflicts and political tension in the region. At the present stage, the developed capitalist countries are striving to make the widest possible use, in their own interests, of the reactionary regimes in a few relatively advanced developing countries which pursue an essentially sub-imperialist policy of coercion towards other developing States;
- the continuing exploitation of the developing countries by the advanced capitalist countries through the investment powered expansion of transnational corporations, unequal terms of trade, discrimintation in the transfer of technology, the "brain-drain" from the developing countries and so on;
- the worsening instability of the world capitalist economy and the exacerbation of its structural crises (the energy, monetary, raw material and ecological crises), of which the advanced capitalist countries are striving to shift the burden on to the peripheral and dependent part of the system. The consequences include intensification of the discriminatory protectionist policy pursued by the advanced capitalist countries towards exports from the developing countries; the deterioration of the average terms on which the West extends credit to the developing countries, with an increasing proportion coming from expensive private sources; the worsening of the terms of trade for the oil-importing developing countries; the convulsions of the capital monetary system by which the balance of payments of the developing countries are hardest hit; the deterioration of the terms for the transfer of Western technology; and, lastly, the stubborn resistance of the advanced capitalist countries to the restructuring of international economic relations on a just and democratic basis.

In many countries of the region that are developing on capitalist lines, the worsening internal difficulties arise primarily from the localized or geographically restricted nature of their development, which leaves a substantial proportion of the able-bodied population, particularly in rural areas, untouched by economic progress. The absence of any profound social transformation which would make these sections of the population benefit from national economic development has widened the gap between the modern capitalist sector and the traditional periphery, and sharply increased both apparent and concealed unemployment. As import replacement has reached its limits and the effort to export has encountered growing difficulties due to the growth of protectionism in the advanced capitalist countries, the scope for the modern sector to develop in isolation has shrunk. The growth of production depends increasingly on the dynamics of domestic demand, and primarily the effective demand of the urban and rural working class. In the second half of the 1970s, the combination of these processes led to a slackening in the rate of economic, and especially, industrial development in many countries of the region and necessitated some re-orientation of national and international development strategies.

At the present stage, the main domestic prerequisite for faster economic development and the solution of pressing social problems is wider participation in the social and economic development process by the broad masses of the people. This key objective gained wide recognition during the formulation of the international and regional strategy for the Third United Nations Development Decade. Its achievement presupposes the attainment of two related goals. The firs goal is to affect, in all units of the economy, profound social transformations which will give the mass of direct producers access to modern means of production, create incentives and opportunities for them to take an active part in building the economy and reduce inequalities in incomes and property. The second goal is to establish a balanced economic and industrial structure and overcome the lack of cohesion between the various sectors of the economy. In the experience of the USSR, an important way of bringing the economic structure into balance is by speeding up industrialization and widening its popular base, more particularly through extra-fast development of basic sectors of industry, the country's own scientific and technological potential and the economic and social infrastructure; by eliminating imbalances between and within sectors of industry; by integrating industry with agriculture and large-scale smaller-scale industry; and by industrializing areas outside big towns. The attainment of these goals is inconceivable without the assignment of a qualitatively more important role to the State sector and to comprehensive social and economic planning, for the spontaneous regulators of the market serve to accentuate economic inequality and further fragment the society.

The most important extenal prerequisites for faster economic development in the countries of the region are the establishment of lasting peace and security both regionally and worldwide; disarmament; and the extensive development of good-neighbourly cooperation. Another such prerequisite is the restructuring of international economic relations on a just and democratic basis. It should be borne in mind that the establishment of a new international economic order can do little to speed up economic progress in the developing countries unless the fruits of the new order reach the broad masses of the population: in other words, unless radical social reforms take place in those countries. Otherwise it will do no more than bring the income and consumption levels of the propertied classes in advanced capitalist countries and developing countries closer together, leaving the most acute problems of poverty unsolved as before.

5.2 A STRATEGY FOR SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

Significant differences between developing countries in the level and directions of social and economic development explain substantial differences in the science and technology policies of individual States. At the same time, the effectiveness of the application of science and technology to development depends on the compliance with certain general requirements and laws. The development of the USSR makes it possible to state a number of imperatives for the successful development of science and technology which are of universal validity and applicable in countries exhibiting different social and economic conditions. They include:

- the need for priority development of the country's own scientific and technological potential, so as to ensure both the independent pursuit of R&D and the selection and adoption of world scientific and technological achievements to suit local conditions;
- the subordination of scientific and technological development to the purposes of all-round social and economic development; integration of the development of science and technology with that of society at the levels of long-term strategy, current policy-making, direct administration and evaluation of final results;
- planned and phased development of science and technology based on carefully selected priorities and achieved by developing a unified system of State scientific institutions and, in "mixed" economies, also by expanding State regulation and coordination of R&D in the private sector, *inter alia* into organizations belonging to transnational corporations;
- careful consideration of the long-term effects of scientific and technological progress on relations between society and production, social and psychological values and the environment; purpose ful action to overcome its adverse consequences;
- the parallel pursuit of fundamental and applied R&D bearing in mind that the optimum proportions between them change in the course of development;
- the establishment of an organization and economic mechanism embodying a single "scientific idea – development – production" cycle, to ensure that a larger proportion of research finds practical application in production and that the lead time required to develop and apply new technology is reduced;
- the application of modern scientific and technological achievements in all priority fields and all social and economic sectors, including the expansion of State measures for the development and application of technological innovation to small-scale production in town and countryside;
- the concentration of national R&D on a limited number of key lines which can lead to world-class results;
- maintenance of the optimum qualitative and quantitative proportions between development of scientific and technological potential and education, between the different levels of education, and between general education and professional training;
- taking advantage of mutually beneficial international scientific and technological cooperation, including cooperation with the socialist countries, regional and subregional integration, and selective use of the technology of transnational corporations under strict State control and in accordance with national priorities.

The creation of a national scientific and technological potential is an important prerequisite for speeding up economic growth and attaining genuine economic independence. Unconditional reliance on direct imports of technology without creating a national scientific and technological base will not only fail to solve the developing countries' problems but, in the longer term, may stunt their growth and exacerbate structural imbalances in the economy. A scientific and technological potential of their own enhances the developing countries' bargaining power in acquiring foreign technology. It enables them to make an informed choice for importing technology, adapt it to local conditions and thereafter keep it up to date; to sharply reduce their initial outlay on technological imports by "unpackaging" the technology to be imported; and to avoid repeated import of identical or similar technology and so on.

The scientific and technological revolution creates certain conditions which enable the developing countries to avoid mechanically repeating the technological evolution that has taken place in the industrially advanced countries. In practice, however, those conditions can only be achieved through the optimum combination of the country's own R&D with world scientific and technological experience. Natural and social circumstances in the developing countries make specific demands on technology which are by no means always met by the technology available on the world market. To be more particular, in several countries of the region, reliance on technological imports from the advanced capitalist countries has deepened the gulf in technological and social conditions between the large-scale capitalist form of enterprise and other forms of production, and intensified the fragmentation of the economy.

To a significant extent, the world capital market in technology is represented by obsolescent, second-rate technology. Its use without modernization may prove worthwhile in import-replacing sectors, but it will leave the developing countries chronically uncompetitive when their products are launched on foreign markets. Because the transnational corporations have the monopoly in some of the latest types of technology, it is priced at levels which either are inaccessible to the developing countries or have extremely adverse consequences for the competitiveness of the products manufactured with that technology. All these factors combine to demonstrate that the creation of a national scientific and technological potential in conjunction with the campaign to eliminate all forms of discrimination and coercion in the international transfer of technology, is a vital objective for the developing countries.

In certain developing countries, the development of the system of higher education and scientific institutions has sometimes been prompted less by the requirements of social and economic development than by the demand of wealthy and middle-class urbanites for highly paid employment, preferably in the civil service. The pressure of that demand has preserved a colonial educational structure unrelated to the needs of development; it has overcrowed the universities with students of law, commerce, the humanities and certain natural sciences, while producing too few engineers, technicians, physicians and teachers; and it has led to the uncontrolled proliferation of small private colleges dispensing instruction of extremely poor quality. The growth of unemployment among the educated and the anxiety to stem the "brain-drain" have spurred goverments to organize more and more new science centres which provide highly paid employment by which bear little relation to the country's needs. A contributory part in this has often been played by considerations of political prestige, so that even small countries have aspired to possess a full range of scientific institutions in virtually every field of science. Furthermore, research has been sidetracked by dependence on foreign subsidies, and more particularly on donations from private foundations in the West: the Ford Foundation, the Rockefeller Foundation and others. The scientific institutions receiving such subsidies have frequently served the interests, not of their own economy, but of the advanced capitalist countries; in a number of cases they have simply become intelligence-gathering channels for the imperialist secret services.

The combination of these processes has broken the inter-relationship between the development of science and higher education on the one hand, and social and economic development on the other. The increase in the proportion of national income spent on science has ceased to be a yarstick of genuine scientific and technological progress; science has come to be less an instrument of social and economic progress than a device for indirectly subsidizing the urban rich and middle classes, who have had access to higher education, out of the states's budget and, in the last analysis, out of the ill-lined pockets of the broad mass of taxpayers.

Consequently, the integration of scientific and technological development with social and economic development is a most important objective for the science and technology policy of the developing countries. That policy should include in particular:

- *unified and centralized State planning of social and* economic scientific and technological development on a long-term, medium-term (five-yearly) and annual basis;
- unity in the planning of all phases of scientific and technological development, from the training of scientific personnel and the development of scientific ideas to their application to production;
- unity in the administration of scientific and technological progress and production in priority sectors at the level of sectoral ministries and departments and of State and private corporations;
- *effective inter-departmental and inter-company coordina*tion of scientific research in related areas under a single State plan;
- the removal of restrictions on vertical and horizontal transfer of technology within a country, including the technology used by branches and subsidiary companies of transnational corporations. A useful part in achieving this may be played by comprehensive purpose-designed programmes for the solution of top-priority economic problems in which research, development and production organizations all take part, and by the establishment of State technological data banks in priority sectors, primarily for the use of enterprises in the State sector, small-scale and medium-scale entrepreneurs and so on;
- an increase in the proportion of R&D which reaches the stage of application to production, and a reduction in the lead time for the application of new technology;
- overcoming the dispersion of State appropriations for science and the duplication of R&D in both the State and the private sector;
- making the financing of applied R&D and the provision of material incentives for those engaged in them conditional upon the economic effectiveness of applying their results to production;
- making the development and import of technology consistent with the prospects for raising the capital investments needed to apply the new technology, so as to preclude both underutilization of the scientific and technological results for lack of capital to invest, and capital formation on a basis of obsolete technology for lack of new technology;
- the proportionate development of higher and secondary specialized education to provide the necessary scientists, engineers and technicians to apply new technology to production; full employment of highly qualified specialists, and curtailment of the "brain-drain";
- the extensive development of a national system of standardization;
- adoption and implementation of legislation designed to overcome the harmful consequences of scientific and technological progress, including in particular, legislation on labour protection and industrial safety, protection of nature and the rational use of natural resources, prevention of pollution, etc. The need for such measures is especially urgent in that the transnational corporations are now seeking to transfer to developing countries the economically "dirty" borderline processes and those harmful to human health.

In a number of developing countries, mechanical copying of the scientific and technological evolution of the advanced capitalist countries has been one of the factors in widening the gap between large-scale capitalist production and the mass of small-scale producers, particularly in rural areas; in fragmenting the economy even further; in increasing unemployment and inequalities in wealth; and in exacerbating social conflicts. At the same time, the attempts bering made in some countries of the region to keep an artificial brake on scientific and technological progress, to preserve outdated technology and the social and production relationships that go with it, are not only unconductive to the solution of social problems but also a serious obstacle to successful economic and social development.

In our view the developing countries, rather than building a "Great Wall of China" to keep out the achievements of the modern scientific and technological revolution - a course wich would inflict enormous damage on them - should make judicious use of those achievements for their social and economic integration and to expand the popular base for economic development. In this connection, prime importance attaches to scientific and technological measures to integrate industry with agriculture and large-scale with small-scale industry, and to industrialize areas outside big towns. Promising specific directions in which these objectives could be pursued include the following:

- the development of a State for training engineers and technicians for the development, importation and adapting of technology for small-scale production; the development of technological service centres for small-scale enterprises, *inter alia* on industrial estates;
- standardization of the products of small-scale enterprises and State monitoring of the quality of those products, especially those supplied to large-scale enterprises and those for export;
- establishment of State machine-tractor centres, agrobiology, agrochemistry and other centres capable of integrally developing, publicizing and demonstrating new agricultural techniques, supervising the practical application of new agrotechnological methods on peasant holdings; supplying modern agricultural equipment, hiring out farm machinery, etc. The better the peasants are organized in cooperatives, the more effective these measures will be;
- the attachment of sponsored experimental villages to agricultural teaching and research institutions or large-scale industrial enterprises producing tractors, fertilizers, etc.;
- the concentration of agricultural research on developing relatively labour-intensive technology using predominantly biological and chemical rather than mechanical means to increase productivity;
- the development of a range of light machinery suitable for the partial mechanization of farms up to 2.5 hectares in size;
- the development of new types of agro-industrial technology to provide additional employment for the rural population and ensure the full utilization of by-products and waste from agricultural production;
- the development of technology for generating energy and producing chemicals from agricultural raw materials.

PART 6.

References

1. *Narodnoe khozyaistvo SSSR v ... godu. Statisticheski ezhegodnit* (The national economy of the USSR in the year... . Statistical yearbook), Moscow, "Statistika" (published annually).

2. "Nauka i tekhnika na sluzhbe sotsial'no-ekonomicheskogo progressa ; opyt i perspektivy" (Science and technology in the service of social and economic progress : experience and prospects), *Doklad SSSR na Konferentsii OON po nauke i tekhnike* (Report of the USSR to the United Nations Conference on Science and Technology for Development), Moscow, 1979.

3. "Osnovnye napravleniya ekonomicheskogo i sotsial'nogo razvitiya SSR na 1981-1985 gody i na period do 1990 goda. Proekt Ts KPSS" (Main guidelines for the economic and social development of the USSR in 1981-1985 and for the period up to 1990. Draft of the CPSU Central Committee, *Pravda,* 2 December 1980.

4. *Narodnoe khozyaistvo SSSR za 60 let* (The national economy of the USSR over 60 years), Moscow, "Statistika", 1977.

5. *Konstitutsiya (Osnovnoi zakon) Soyuza Sovetskikh Sotsialisticheskikh Respublik* (Constitution (Fundamental Law) of the Union of Soviet Socialist Republics), Moscow, "Politizdat", 1977.

6. "O Gosudarstvennom byudzhete SSSR na 1981 god i ob ispolnenii Gosudarstvennogo byudzheta SSSR za 1979 god", Doklat ministra finansov SSSR V.F. Garbuzova" (Concerning the State budget of the USSR for 1981 and the execution of the State budget of the USSR in 1979, Report of V.F. Garbuzov, Minister of Finance of the USSR), *Pravda,* 23 October 1980.

7. "Ob itogakh vypolneniya Gosudarstvennogo plana ekonomicheskogo i sotsial'nogo razvitija SSSR v 1980 godu. Soobshchenie TsSU SSSR" (Concerning the results of the implementation of the State plan for the economic and social development of the USSR in 1980. Communication of the Central Statistical Administration of the USSR), *Pravda,* 24 January 1981.

8. Planirovanie narodnogo khozyaistva SSSR (Planning of the USSR economy), Moscow, "Ekonomika", 1973.

9. *"Ob uluchshenii planirovaniya i usilenii vozdeistviya khozyaistvennogo mekhanizma na povyshenie effektivnosti proizvodstva i kachestva raboty", Postanovlenie is CK KPSS i Soveta Ministrov SSSR"* ("Concerning the improvement of planning and strengthening the impact of economic machinery in increasing the efficiency of production and improving the quality of work. " Resolution of the CPSU Central Committee and the Council of Ministers of the USSR, Moscow, "Politizdat", 1979.

10. *Ezhegodnik Bol'shoi Sovetskoi Entsiklopedii* (Yearbook of the Great Soviet Encyclopaedia), Moscow, "Sovetskaja Enciklopedija" (published annually).

11. *Pravda,* 20 August 1980.

ANNEX 1

Main indicators of the social and economic development of the USSR from 1966 to 1980

	1965	1970	1975	1979	1980
A. *Population figures and social indicators*					
Population (in millions)	229.6	241.7	253.3	262.4	264.5
Urban population (in millions)	120.7	136.0	151.9	163.6	166.2
As percentage of total population	53	56	60	62	63
Rural population (in millions)	108.9	105.7	101.4	98.8	98.3
As percentage of total population	47	44	40	38	63
Population distribution by sex (%)					
Male	45.7	46.1	46.4	46.7	46.7
Female	54.3	53.9	53.6	53.3	53.3
Birth rate (%)	18.4	17.4	18.1	18.2	
Mortality rate (%)	7.3	8.2	9.3	10.1	
Natural growth of the population (%)	11.1	9.2	8.8	8.1	
Class structure of the population (%)					
Manual workers	75	56.8	61.2	61.8	
Non-manual workers		22.7	22.4	23.1	
Collective farmers and co-operative handicraft workers	24.6	20.5	16.4	15.1	
Distribution of economically active population by educational level (%)					
Higher	6.5	8.7	10.0	83	
Secondary	58.7	68.0	70.5		
Other	33.8	23.3	19.5	17	
B. *Indicators of economic development*					
Gross social product (in billions of roubles) at current prices	420.2	643.5	862.6	1 028.1	
of which:					
Industry	266.2	409.0	558.3		
Agriculture	71.2	103.8	122.3		
Transport and communications	18.3	25.7	36.7		
Construction	40.3	67.6	91.7		
Trade, State purchases, supply of materials and machinery, and other	24.2	37.4	53.6		
Proportion of gross social product by sector (%):					
Industry	63.4	63.6	64.7		
Agriculture	16.9	16.1	14.2		
Transport and communications	4.4	4.0	4.3		
Construction	9.6	10.5	10.6		
Trade, State purchases, supply of materials and machinery, and other	5.7	5.8	6.2		
National income from production (in billions of roubles at current prices):	193.5	289.9	363.3	438.3	454
Consumption fund (in billions of roubles at current prices)	140.3	201.3	266.4	323.7	
Accumulation fund and other expenditures (in billions of roubles at current prices)	50.2	84.2	96.6	107.2	
Capital investment (in billions of roubles at comparable prices)	56.0	80.6	112.9	130.6	133.5
of which:					
In industry	18.0	29.6	40.8	46.1	
In agriculture	8.9	12.2	23.5	26.3	
In transport and communications	4.8	7.8	12.4	16.2	
In housing construction	8.1	13.4	16.3	17.3	
In science, culture and education	3.0	4.5	6.0	6.4	
In other sectors	9.9	14.5	15.9	18.3	

	1965	1970	1975	1979	1980
Proportion of capital investment by sector (%):					
Industry	36.9	36.0	35.5	35.3	
Agriculture	18.2	17.2	20.4	20.2	
Transport and communications	10.0	9.5	10.9	12.4	
Housing construction	16.7	16.4	14.2	13.3	
Science, culture and education	6.1	5.5	5.2	4.9	
Other sectors	12.1	15.4	13.8	13.9	
Economically active population (in millions)	76.9	90.2	102.2	110.6	112.5
of which, in:					
Industry	27.4	31.6	34.0	36.0	
Agriculture	8.9	9.4	10.5	11.4	
Transport and communications	8.3	9.3	10.7	11.7	
Construction	7.3	9.0	10.6	11.2	
Trade, catering, supply and sale of materials and machinery, and State purchases	6.0	7.5	8.9	9.5	
Science, culture and education	9.4	11.5	13.4	14.9	
Other sectors	9.6	11.9	14.1	15.4	
Proportion of employment, by sector (%):					
Industry	35.6	35.0	33.3	33.0	
Agriculture	11.5	10.4	10.3	10.3	
Transport and communications	10.8	10.3	10.5	10.6	
Construction	9.4	10.0	10.4	10.1	
Trade, etc.	7.8	8.3	8.7	8.6	
Science, culture and education	12.2	12.7	13.1	13.5	
Other sectors	12.5	13.2	13.8	13.9	
State budgetary revenue (in billions of roubles)	102.3	156.7	48.8	281.5	284.8
of which, revenue from:					
State and co-operative enterprises	93.9	142.9	199.1	256.8	259.4
Taxes levied on the population	7.7	12.7	18.4	23.2	25.3
State budgetary expenditure (in billions of roubles)	101.6	154.6	214.5	276.4	284.5
of which, on:					
The economy	44.9	74.6	110.7	151.4	149.4
Social and cultural measures and science	38.2	55.9	77.1	92.8	97.2
Defence	12.8	17.9	17.4	17.2	17.1
Administration	1.3	1.7	2.0	2.4	2.4
Proportion of State budgetary expenditure (%):					
on:					
The economy	44.2	48.2	51.6	54.8	52.5
Social and cultural measures and science	37.6	36.2	35.9	33.6	34.2
Defence	12.6	11.5	8.1	6.2	6.0
Administration	1.3	1.1	0.9	0.9	0.8
C. *Indicators of level of living*					
Average monthly earnings of manual and and non-manual workers (in roubles)	129.2	164.5	198.9	224.0	232.0
Money wages	96.5	122.0	145.8	163.3	168.5
Payments and benefits out of social consumption funds	32.7	44.5	53.1	60.7	63.5
Payments and benefits received by the public from social consumption funds (in billions of roubles)	41.9	63.9	90.1	110.2	116.5
Commissioning of residential buildings (in millions of m^2 of useful floor area)	97.6	106.0	109.0	101.9	108.0
Number of medical personnel per 10,000 of the population	96.7	114.4	131.0	139.1	
of which:					
Physicians	23.9	27.4	32.6	36.3	
Nurses	72.8	87.0	98.4	102.8	
D. *External economic indicators*					
Foreign trade turnover (in billions of roubles)	14.6	22.1	50.7	80.3	92.0
Exports (in billions of roubles)	7.4	11.5	24.0	42.4	
of which, to:					
Socialist countries	5.0	7.5	14.6	23.6	
Developed capitalist countries	1.4	2.2	6.1	12.5	
Developing countries	1.0	1.8	3.3	6.3	

	1965	1970	1975	1979	1980
Imports (in billions of roubles)	7.2	10.6	26.7	37.9	
of which, from:					
Socialist countries	5.0	6.9	14.0	21.4	
Developed capitalist countries	1.5	2.5	9.7	13.2	
Developing countries	0.7	1.1	3.0	3.2	
Commodity structure of exports (%):					
Machinery, equipment and means of transport	20.0	21.5	18.7	17.5	
Fuel and electric power	17.2	15.6	31.4	42.2	
Ores and concentrates, metals and metalware	21.6	19.6	14.3	9.1	
Other goods	41.2	43.3	35.6	31.2	
Commodity structure of imports (%):					
Machinery, equipment and means of transport	33.4	35.5	33.9	38.0	
Ores and concentrates, metals and metalware	9.8	9.6	11.6	11.2	
Foodstuffs and raw materials for their production	20.2	15.9	23.0	21.9	
Consumer manufactures	14.4	18.3	12.9	11.4	
Other goods	22.2	20.7	18.6	17.5	
E. *Growth indices (1965 = 100)*					
Gross social product	100	143	194	230	
National income from production	100	145	191	237	237
Gross industrial output	100	150	215	258	267
of which:					
Means of production	100	151	220	267	277
Consumer goods	100	150	205	239	247
Gross agricultural output	100	123	126	138	134
Freight turnover	100	139	188	217	224
State and cooperative retail trade turnover	100	148	202	239	252
Fixed productive assets	100	148	224	299	321
Capital investment	100	144	202	233	238
Manual and non-manual labour force	100	117	133	144	146
Productivity of social labour	100	139	173	197	201
Per capita real income	100	133	165	188	195
Average wages and salaries	100	126	151	169	174
Remuneration of collective farmers	100	146	179	221	225
Per capita payments and benefits out of social consumption funds	100	145	195	230	241

Sources: see References 1, 1965, pp. 7-8, 42, 531-532; 1, 1970, pp. 482-483; 1, 1975, pp. 506-507; 1, 1979, pp. 7-8, 32-33, 36, 45-46, 54, 363, 366-367, 378-388, 394, 412, 528-529, 405-406, 533-554; 6; 7

ANNEX 2

Training of highly skilled personnel

(in thousands)

	1965	1970	1975	1979
Graduate students				
Number, of whom:	90.2	99.4	95.7	96.1
Full-time students	51.5	55.0	41.9	38.8
Part-time students	39.2	44.4	53.8	57.3
Number completing studies that year, of whom:	19.2	25.9	26.0	24.1
Full-time students	13.5	15.5	16.2	14.5
Part-time students	5.7	10.4	9.8	9.6
Students at higher educational establishments				
Number, of whom:	3 861	4 581	4 854	5 186
Students attending day time classes	1 384	2 241	2 628	2 932
Students attending evening classes	569	658	644	653
Students taking correspcndence courses	1 708	1 682	1 582	1 601
Enrolments that year, of whom:	854	911	994	1 043
Students attending day time classes	378	500	594	638
Students attending evening classes	125	127	130	134
Students taking correspondence courses	350	284	270	271
Number graduating that year, of whom:	404	631	713	790
Students attending day time classes	225	335	433	493
Students attending evening classes	43	82	80	85
Students taking correspondence courses	136	214	200	212
Pupils at secondary specialized educational establishments				
Number, of whom:	3 659	4 388	4 525	4 646
Pupils attending day time classes	1 835	2 558	2 817	2 910
Pupils attending evening classes	628	645	516	521
Pupils taking correspondence courses	1 196	1 185	1 192	1 215
Enrolments that year, of whom	1 100	1 338	1 404	1 446
Pupils attending day time classes	582	837	896	939
Pupils attending evening classes	170	160	153	139
Pupils taking correspondence courses	348	342	355	368
Number completing studies that year, of whom:	622	1 033	1 157	1 253
Pupils attending day time classes	333	603	752	820
Pupils attending evening classes	105	161	125	114
Pupils taking correspndence courses	184	269	279	319

Source: see Reference 1, 1979, pp. 110, 492, 498-499

ANNEX 3

Specialists graduating from higher and secondary specialized educational establishments, by sectors

	1965		1970		1975		1979	
	in 1000s	% of total	in 1000s	% of total	in 1000s	% of total	in 1000s	% of total
Higher educational establishments								
Industry and construction	139.9	34.6	214.2	34.0	260.0	36.4	292.3	37.0
Transport and communications	19.3	4.8	28.2	4.5	33.3	4.7	39.0	4.9
Agriculture	36.0	8.9	68.7	10.9	62.6	8.8	70.4	8.9
Economics and law	32.1	7.9	50.9	8.1	60.5	8.5	63.6	8.1
Public health, physical education and sport	30.6	7.6	42.9	6.8	53.9	7.6	58.3	7.4
Education	142.1	35.2	219.2	34.7	235.3	33.0	258.1	32.7
Art and cinematography	3.9	1.0	6.7	1.1	7.8	1.1	8.3	1.1
TOTAL	403.9	100.0	630.8	100.0	713.4	100.0	790.0	100.0
Secondary specialized educational establishments								
Industry and construction	250.7	40.3	418.2	40.4	451.0	39.0	470.7	37.6
Transport and communications	50.9	8.2	78.9	7.6	92.0	8.0	104.3	8.3
Agriculture	88.1	14.1	144.4	14.0	178.0	15.4	204.6	16.3
Economics and law	81.3	13.1	132.8	12.9	158.5	13.7	182.8	14.6
Public health, physical education and sport	75.9	12.2	135.6	13.1	137.1	11.8	145.5	11.6
Education	59.7	9.6	105.3	10.2	114.2	9.9	118.6	9.5
Art and cinematography	14.9	2.4	18.1	1.8	26.2	2.3	26.8	2.1
TOTAL	621.5	100.0	1 033.3	100.0	1 157.0	100.0	1 253.3	100.0

Source: see Reference 1, 1979, p. 502

ANNEX 4

Fields of specialization of persons graduating from higher and secondary specialized educational establishments

(in thousands)

	1965			1970			1975			1979		
	VUZ	SSUZ	Total	VUZ	SSUZ	Total	VUZ	SSUZ	Total	VUZ	SSUZ	Total
1	2	3	4	5	6	7	8	9	10	11	12	13
Geology and mineral prospecting	3.2	2.5	5.7	5.1	4.8	9.9	5.9	5.7	11.6	5.9	5.6	11.5
Mining	4.0	6.0	10.0	6.3	11.7	18.0	8.3	13.1	21.4	8.4	10.8	19.2
Power engineering	7.0	26.6	34.6	10.5	44.8	55.3	14.1	47.7	61.8	17.0	45.0	62.0
Metallurgy	4.8	6.6	11.6	6.5	10.2	16.7	7.8	10.9	18.7	8.4	12.5	20.9
Mechanical engineering and instrument-making	46.0	86.3	132.3	69.0	124.0	193	73.0	125.6	198.6	82.7	130.1	212.8
Electrical engineering and electrical instrument-making, electronics and automation	21.6	18.7	43.3	40.5	31.8	72.3	49.6	33.8	83.4	51.1	36.3	97.4
Radio engineering and communications	14.0	21.8	35.8	19.8	30.9	50.7	18.8	31.6	50.3	21.5	35.8	57.3
Chemical engineering	10.1	13.4	23.5	16.1	23.3	37.4	15.4	19.0	34.4	14.1	18.6	32.7
Forestry engineering, wood, cellulose and paper technology	2.9	6.4	9.3	3.3	8.5	11.8	4.7	10.6	15.3	5.1	11.7	16.8
Food industry technology	4.8	18.8	23.6	7.9	28.8	36.7	10.5	39.5	50.0	11.6	43.4	55.0
Light and textile industry technology	3.2	17.2	20.4	5.4	24.7	30.1	7.6	24.8	32.4	8.4	26.6	35.0
Construction	21.3	36.2	57.5	30.3	61.9	92.2	44.8	99.8	144.6	57.8	105.6	163.4
Geodesy and cartography	0.9	1.1	2.0	1.0	1.5	2.5	1.3	2.8	4.1	1.8	3.8	5.6
Hydrology and meteorology	1.0	1.5	2.5	1.1	1.7	2.8	1.3	1.6	2.9	1.3	1.7	3.0
Agriculture and forestry	33.9	68.7	102.6	58.3	120.1	178.4	58.9	142.3	201.9	60.3	161.6	221.9
Transport	9.6	33.6	43.2	14.9	55.6	70.5	17.5	60.4	77.9	20.7	71.5	92.2
Economics	40.8	104.1	144.9	75.6	188.6	264.2	95.6	208.3	303.9	105.3	238.1	343.4
Law	6.9		6.9	8.1		8.1	13.1		13.1	15.9		15.9
Public health and physical education	31.0	76.0	107.0	43.8	138.5	182.3	53.6	142.0	195.6	57.5	150.1	207.6
University specialists	30.7		30.7	48.7		48.7	54.6		54.6	61.2		61.2
Education	99.3	59.5	158.8	152.2	100.0	252.2	154.7	109.1	263.8	166.5	115.5	282.0
Art	3.9	16.3	20.2	6.4	21.2	27.6	7.3	26.9	34.2	7.5	26.9	34.4
TOTAL	403.9	631.5	1 025.4	630.8	1 033.3	1 664.1	713.4	1 157.0	1 870.4	790.0	1 253.3	2 043.3

Source: see Reference, 1979, pp. 500-501

Note: VUZ - Higher educational establishments
SSUZ - Secondary specialized educational establishments

ANNEX 5

Some indicators of technological progress in the economy

	1965	1970	1975	1979
Presence of mechanized flow lines and automated lines in industry (in 1000s)	48.9	100.4*	131.2	160.5
of which:				
Automated lines	6.0	10.9*	17.1	24.3
Number of fully mechanized and automated production processes in industry (in 1000s):				
Enterprises	1.9	5.0*	5.4	6.4
Shops, production sections, etc.	22.4	44.2*	66.2	83.5
Energy available to labour in industry (1965 = 100)	100	130	165	184
Electric power available to labour in industry (1965 = 100)	100	126	159	173
Capacity of power plants with steam pressure in excess of 130 atmospheres (as percentage of overall capacity of termal power stations)	23	37	73	78
Capacity of power plants operating at supercritical steam parameters (as percentage of overall capacity of thermal power stations)	5	19	31	32
Oil extraction using formation pressure support techniques (as percentage of total oil extraction)	70	74	84	87
Strip mining of coal at working faces in gently sloping and and medium steep seams (as percentage of all coal cut from working faces where loading is required)	19	60	85	90
of which:				
Strip mining using mobile hydraulic supports	9	30	60	72
Percentage of blast furnaces operating with:				
- increased gas pressure below the fire bar	91	94	96	96
- natural gas	67	77	81	88
Oxidized steel smelting (as a percentage of total steel smelted)	51	60	67	78
Percentage of automated looms in the:				
Cotton industry	72	84	92	
Wool industry	47	58	73	
Silk industry	46	71	81	
Capacity of mechanical equipment, electric motors and electric appliances in agriculture (in millions of h.p.)	231.7	322.1	457.4	576.5
Per worker	7.7	11.2	16.8	22.9
Per 100 hectares of land under cultivation	100	148	190	248
Mechanization of farm work (%):				
Grain harvesting	100	100	100	100
Sugar-beet harvesting with combines	67	78	86	90
Potato lifting	54	79	92	94
- with combines	11	24	42	43
Cotton picking	22	32	43	53
Milking	27	56	83	89
Integrated mechanization of railway loading and unloading operations (%)	64	80	90	91

* 1971 data

Source: see Reference 1, 1979, pp. 115-120, 123-124, 127

ANNEX 6

Invention and rationalization in the economy

	1965	1970	1975	1979
Number of originators of rationalization proposals and patent applications (in 1000s)	2 935	3 659	4 336	4 580
Number of rationalization proposals and patent applications filed (in 1000s)	4 076	4 591	5 113	5 030
Number of inventions and rationalization proposals applied to production (in 1000s)	2 841	3 414	3 977	4 019
of which: inventions	6.9	8.1	14.9	20.5
Expenditure on invention and rationalization (in millions of roubles)	147	229	319	359
Economic benefits resulting from the application of inventions and rationalization proposals (in millions of roubles)	1 908	3 004	4 805	6 264
of which: from the application of inventions	158	262	828	2 030

Source: see Reference 1, 1979, p. 111

ANNEX 7

Number of enterprises and other installations built or being built or planned abroad with the technical assistance of the USSR under inter-State agreements

	As of 1 January 1980	
	Total under agreements	of which: commissioned
TOTAL	3 965	2 435
In socialist countries	2 793	1 782
of which:		
Bulgaria	307	191
Hungary	122	96
Viet Nam	269	189
German Democratic Republic	82	35
Cuba	438	184
Mongolia	621	389
Poland	218	136
Romania	159	114
Czechoslovakia	42	26
Albania	45	45
China	256	256
DPR Korea	70	58
Laos	34	3
Yugoslavia	130	70
In developing countries	1 157	643
of which:		
Algeria	100	62
Afghanistan	147	73
Bangladesh	15	11
Burma	7	7
Guinea	31	25
Egypt	107	94
India	74	53
Iraq	98	61
Iran	118	66
Yemen Arab Republic	11	11
Mali	15	12
Morocco	6	4
PDR of Yemen	32	14
Nepal	8	6
Pakistan	13	7
Syria	56	30
Sudan	15	8
Turkey	14	8
Sri Lanka	10	9
Ethiopia	59	4

Source: see Reference 1, 1979, p. 570

ANNEX 8

Enterprises and other installations which are the object of USSR technical assistance to foreign countries: distribution by sector of the economy

		As of 1 January 1980	
	Total	of which:	
		In socialist countries	In developing countries
Total enterprises	3 965 (2 435)	2 793 (1 782)	1 157 (673)
Industry	2 268 (1 490)	1 751 (1 207)	508 (278)
Electric power	388 (270)	281 (208)	99 (58)
Iron and steel	106 (72)	84 (55)	21 (16)
Non-ferrous metallurgy	137 (96)	120 (88)	17 (8)
Coal	93 (66)	69 (55)	42 (11)
Oil refining	71 (48)	60 (39)	11 (9)
Chemical and petrochemical	151 (90)	142 (85)	9 (5)
Mechanical engineering and metal-working	331 (226)	257 (182)	74 (44)
Building materials	242 (104)	208 (91)	34 (13)
Light industry	76 (47)	51 (37)	25 (10)
Food industry	308 (207)	233 (182)	75 (25)
Flour milling and mixed feed production	131 (91)	62 (47)	69 (44)
Agriculture	459 (245)	308 (175)	151 (70)
Transportation and communications	418 (278)	294 (210)	119 (63)
Education, culture, public health and other	539 (245)	282 (88)	257 (157)
Housing and public utilities	81 (52)	69 (43)	12 (9)

Note: in parenthesis: the number of enterprises commissioned

Source: see Reference 1, 1979, p. 571

ANNEX 9

Capacity of installations which are the object of USSR technical assistance to foreign countries

	Total	As of 1 January 1980	
		of which:	
		In socialist countries	In developing countries
Power stations (millions of kW)	83.1 (43.4)	53.9 (35.3)	16.0 (7.2)
Pig iron (millions of tons)	50.2 (33.0)	30.8 (22.6)	17.8 (8.8)
Steel (millions of tons)	66.0 (37.0)	44.7 (27.1)	19.6 (8.2)
Rolled ferrous metals (millions of tons)	53.5 (37.2)	40.2 (29.7)	13.2 (7.5)
Iron ore (millions of tons)	36.9 (22.9)	22.9 (12.0)	14.0 (10.9)
Oil refining (millions of tons)	77.7 (49.3)	59.7 (37.7)	18.0 (11.6)
Coal (millions of tons)	86.7 (37.4)	65.2 (34.3)	21.5 (3.3)
Coke (millions of tons)	28.7 (19.9)	15.6 (11.1)	13.1 (8.8)
Metal-cutting lathes (thousands)	6.0 (5.1)	4.4 (4.4)	1.6 (0.7)
Metallurgical, mining, forging and pressing, lifting and haulage equipment (thousands of tons)	255 (235)	100 (80)	155 (155)
Tractors (thousands)	102 (82)	92 (72)	10 (10)
Mineral fertilizers (thousands of tons)	2 977 (2 397)	2 872 (2 292)	105 (105)
Sulphuric acid (thousands of tons)	1 561 (1 521)	1 441 (1 401)	120 (120)
Soda ash (thousands of tons)	2 070 (1 770)	2 070 (1 770)	
Synthetic rubber (thousands of tons)	321 (176)	321 (176)	
Cement (millions of tons)	19.5 (7.2)	15.8 (6.6)	3.7 (0.6)
Cotton textiles (millions of metres)	315 (135)	184 (104)	131 (31)

Note: in parenthesis: output of enterprises already commissioned

Source: see Reference 1, 1979, pp. 572-573

KAZAKH SOVIET SOCIALIST REPUBLIC

Table of Contents

Table 1. Nomenclature and Networking of S&T Organizations*

I - First level - POLICY-MAKING

Country: Kazakh SSR

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
Council of Ministers of the Kazakh Union Republic	Planning, co-ordination, and financing	USSR State Committee for Science and Technology; Academy of Sciences of the USSR	Subordinate scientific, design and technological organizations and enterprises of the Republic	Academy of Sciences of the Union Republic, the branch institutes, higher education establishments, scientific societies, ministries and departments

---

* No data in the format of Table 1 was provided. For information see Part 3.3 (p. 613).

Table 2 - Scientific and Technological Manpower*

Country: Kazakh SSR

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D						Total stock (thousands)	of which working in R&D
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering and Technology	Agricultural sciences	Medical sciences	Social sciences		
1965										
1970										
1975										
1979										
1981										
1990										

---

* Data on S&T manpower not provided in Table 2 format. For information on S&T manpower in the Kazakh SSR, see Part 4.1, p. 615.

Table 3 - R&D expenditures*

Country: Kazakh SSR
Currency:

Table 3a: Breakdown by source and sector of performance

Year:

Unit: billion

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive				
Higher Education				
General Service				
Total				

Table 3b: Trends

Year	Population (millions)	GNP (in)	Total R&D expenditures (in)	Exchange rate US $1 =
1965				
1970				
1975				
1979				
1980				
1985				
1990				

* Data on R&D expenditures not provided in format of Tables 3(a) and (b). See Part 4.2 (pp. 615-616) for further information.

Introduction

Socio-economic progress in modern society is not possible unless use is made of the world-wide achievements of the scientific and technological revolution. However, if scientific and technological advances are to be applied in an economically and socially effective way, the increasing pace, complication and cost of such advances call for a certain pre-existing foundation in social production, its sectoral structure, science, the education and vocational training of the labour force, the organization of work and production and the material and cultural living conditions of the population i. e. , everything that, in economics, is included under the term "the level of socio-economic development" of a country or region.

The social backwardness of developing countries is not only a consequence of their low level of economic development but is a pre-existing obstacle to economic and social progress and to the establishment of a modern industry based on scientific and technological advances.

A high natural growth rate for population and manpower, which in developed countries serves to accelerate social production and bring down its cost, has the effect in developing countries of slowing down the rate of production and consumption. Here, the need to raise the level of consumption comes into conflict with the need to expand production and with the increase in the proportion of savings in the national income. As a result of this conflicting interdependence, the problem of accelerating the economic development of developing countries in itself represents a vicious circle, and improving their level of social and economic development is an extremely contradictory and complex process. Nonetheless, the history of the development of human society now has examples of the successful overcoming of technological, economic and social backwardness within an extremely short period of time. This is the experience of the USSR, which is not only the experience of the economic take-off of the country as a whole, but also that of balancing the technical, economic and social development of regions within the country. These tasks are both of equal urgency for the economic development of developing countries, since in most of them the general economic take-off is hindered by the still considerable backwardness of their individual regions, the economies of which are based on a very primitive system, such as patriarchal subsistence farming and small-commodity production.

The Soviet Government's deliberate policy of balancing the level of economic development of different regions of the country has led to the establishment, on the territory of the former outlying national districts of the Russian Empire (Kazakhstan, Kirghizia, Uzbekistan, Tajikistan and Turkmenia), which in the past were backward in every respect of socialist states with a socio-economic, scientific and technological potential that in its level of development fully conforms to the modern conception of a developed economy.

For these reasons, the socio-economic development and building up of the scientific and technological potential of the Kazakh Soviet Socialist Republic – a socialist state in the USSR that in the recent past constituted one of the backward regions of the Asian part of the Soviet Union – cannot fail to be of interest to the Asian countries that are the chief participants in the CASTASIA II Conference.

PART 1.

General characteristics

1.1 NATURAL CONDITIONS

The Kazakh Soviet Socialist Republic is a Soviet, Socialist State that is one of the 15 co-equal and sovereign union Republics making up the USSR. The Kazakh SSR was formed in 1920 as an Autonomous Republic within the RSFSR and became a Union Republic on 5 December 1936. The Republic lies in the south west of the Asian part of the USSR. To the north it borders on the RSFSR; to the south, on the Turkmen, Uzbek and Kirghiz Union Republics; to the east, on China.

The Kazah SSR is the USSR's second largest Union Republic (after the RSFSR) and has the third largest population (after the RSFSR and the Ukrainian SSR).

The territory of the Kazakh SSR covers 2 717 300 sq. km. At the beginning of 1980, the population of the Republic numbered 14 858 000. Kazakhs and Russians make up more than two thirds of the population, the remainder being composed of Ukrainians, Byelorussians, Tartars, Uzbeks, Koreans and Germans. More than a hundred different national and ethnic groupings are represented in the Kazakh SSR. Over half (54%) of the population live in the towns. One of the particular features of the Republic's socio-economic development is its low population density (5.5 per sq. km). The Republic is divided into 19 provinces containing a total of 218 districts. The Republic now has 82 towns, 193 urban-type communities and 2 276 village (aul) soviets. Alma Ata, the Republic's capital, has a population of 932 000.

Owing to the territory's inland position and size, it has a marked continental climate with regional differentiation. The north of the Republic has cold, long winters; the central part has moderately cold winters; the south has, on the whole, moderately mild and short winters. The mean January temperature ranges from -18°C in the north to -3°C in the south. The temperature can drop to -45°C in the northern and central parts of the Republic and to -35°C in the south. In the plains, the summers are long and dry, and are warm in the north, very warm in the central part, and hot in the south. The mean July temperature ranges from 19°C in the north to 28-30°C in the south.

One natural characteristic of the Kazakh SSR is its lack of water. Precipitation over the entire territory is light and quite variable. The surface waters are spread unevenly over the territory of the Republic, and the river system is sparse and non-perennial. The mean annual precipitation is 300-400mm. in the forest-steppe areas, dropping to 250 mm. in the steppe and less than 100 mm in the semi-desert and desert areas.

The Kazaksh SSR occupies the watershed area between the rivers of the internal drainage basins of central Asia and the Arctic Ocean basin. The major rivers (the Irtysh, the Ural and the Syr-Daria) skirt the territory of the Republic. The few rivers that are to be found in central and western Kazakhstan have an extremely low streamflow. In summer, many of them dry up completely or break up into separate pools. The mountain and foothill regions of the east and south-east are an exception, having a multitude of mountain streams that provide a significant source of energy and are a reliable source of water for irrigating huge tracts of fertile land.

Because of the limited surface flow over the greater part of the Republic, groundwater is of considerable, and in many places decisive, significance for the development of industry.

The soil cover shows marked zonality and deep stratification. There are few chernozems, a narrow strip in the north and the southern chernozems of the arid steppe, making 4.9% of the total soil area. The predominant soils are chestnut soils (approximately 35%), brown soils (21.6%) and grey-brown soils (22.0%). The chernozems and chestnut soils are cultivated.

1.2 POLITICAL STRUCTURE

The Kazakh SSR, like all the other Union Republics of the Soviet Union, has its own Constitution and its own supreme organs of state authority.

The Republic's highest authority is the single-chamber Supreme Soviet of the Kazakh SSR, elected for a four-year term by secret ballot on the basis of universal, equal and direct suffrage. It exercises all the rights laid down in the Constitution, passes laws operative for the territory of the Republic and approves the national economic plan and State budget of the Kazakh SSR.

Between sessions of the Supreme Soviet of the Kazakh SSR, the highest State authority in the Republic is the Presidium of the Supreme Soviet, which is accountable to the Supreme Soviet for all its activity.

The Supreme Soviet forms the Government of the Republic, the council of Ministers of the Kazakh SSR, which is the highest executive and administrative organ in the Republic and is accountable to the Supreme Soviet. The Council of Ministers which is the government, issues decisions and orders on the basis of the laws in force, and continuously monitors their execution. It coordinates and directs the work of the ministries and ministerial departments and takes the necessary measures to safeguard public order, protect the interests of the State and defend the rights of citizens.

The local organs of power in the provinces, districts, towns and auls are the respective soviets of workers' deputies, elected by the people for a two-year term on the basis of universal, equal and direct suffrage by secret ballot.

The highest judicial organ, the Supreme Court of the Republic, is elected by the Supreme Soviet of the Kazakh SSR for a five-year term and is composed of two judicial colleges (for civil and criminal cases) and a Plenum. The Supreme Court supervises the work of all the judicial organs of the Kazakh SSR.

A major role in directing the State and its socio-economic development is played by the Communist Party of the Kazakh SSR, the trade unions of the Republic, and its Lenin Communist League of Youth. The Communist Party numbers among its members the most outstanding representatives of the working class, rural workers and the intelligentsia, and provides leadership in all areas of the Republic's social life.

The trade unions of the Kazakh SSR are very much organizations of mass participation, the principle of whose practical work is to develop the activity and initiative of manual and office workers. The work of the trade unions is concerned particularly with the promotion of socialist competition and communist labour, satisfaction of the workers' material and cultural needs and the development of physical culture and sport. The trade unions devote great attention to the introduction of the most recent scientific and technological advances into industry and to the development of technological progress in every branch of the economy.

The Lenin Communist League of Youth of the Kazakh SSR is a mass youth movement that plays and active part in every sphere of the social life of the Republic.

The Kazakh SSR has its own national flag, emblem and anthem. The territory of the Republic cannot be altered without its consent. The SSR's right to secede from the USSR is reserved to it in its Constitution of the USSR.

PART 2.

Economic and socio-cultural development

2.1 PRESENT LEVEL OF SOCIO-ECONOMIC DEVELOPMENT

The level of economic and cultural development now attained in the Kazakh SSR places it among the States with a developed economy. The powerful econonomic potential now available in the territory of the Republic has been built up entirely during the period of Soviet power (1920-1980). After the October Revolution, the Soviet state encountered the problem of the very marked differences that existed between the socio-economic development levels of the country's regions and national republics. The outlying eastern ethnically heterogeneous, national districts were at an extremely low level of socio-economic development, with patriarchal and feudal conditions dominant. Up to the October Revolution, Kazakhstan was still a territory of nomadic herdsmen, with a primitive industry for the extraction of certain minerals and the processing of agricultural produce. It is enough to say that, in 1926, the per capita level of industrial production in Kazakhstan was a bare 7% of that for the Union as a whole and some 38 to 40 times lower than in the central, industrially developed districts of the country.

In parallel with the improvement of the country's economy as a whole, the Soviet Union successfully overcame another less complex and important problem, that of balancing the socio-economic development levels of the country's different regions. The need to narrow the gap between the economic development levels of the different regions of a socialist country, and the possibility of doing so, represent an objective process determined by the nature of socialism and corresponding to its long-term goals. The need for this process arises from the need to establish genuine industrial equality between the regions of the country as an objective basis for the creation of approximately equal living standards for the population and conditions for economically efficient management. The possibility of balancing economic development levels in the different regions is governed by socialist relations of production, public ownership of the means of production and the planned, deliberate development of the socialist economy, which enable financial and material resources to be centralized and directed towards the satisfaction of regional socio-economic needs.

In view of the need to balance the economic development levels of the different regions of the country, and taking advantage of the opportunity provided by socialism for doing so, the Soviet Government has at all times consistently and tirelessly implemented an ever more complete policy of accelerated economic development for the Kazakh SSR and similar regions.

In the early years of Soviet power, the assistance provided by central regions was of an unplanned, ad hoc nature. In later years, however, as the economy of the central regions of the USSR became established and developed, that assistance grew continually, the policy adopted in the five-year plans being of a clearly directive nature for the accelerated development of the economy of formerly backward regions.

In practical terms, this policy was put into effect through economic growth rates which were faster for the economically less developed regions of the country than for the more developed ones, allocating the regions in question a greater volume of capital investment, and redistributing in their favour the necessary means production for capital construction and expanded production.

Thus, the total volume of capital investment in the national economy of the Kazakh SSR increased by 65 times during the period 1920-1940, whereas investment for the USSR as a whole increased on average by a factor of 26. The corresponding figures for the period 1940-1960 were 10.8 and 6.5 respectively.

An abundance of minerals, an accelerated increase in manpower resources as a result of both the natural and migratory growth of the working population and the redistribution of capital investment between republics in favour of the Kazakh SSR have made for a very vigorous development of the Republic's overall social production. Industrial production in the Republic has developed particularly rapidly. The result is that the Republic's economic potential is many times greater than it was before the Revolution. Furthermore in per capita national income, a basic, generally applicable indicator of a country's economic development, the Kazakh SSR falls very little short of the average level for the Soviet Union.

One of the most characteristic features of the economic development of the Kazakh SSR is the fact that profound qualitative changes have occurred in the structure of the national economy, reflecting its transformation into a highly developed industrial and agrarian Republic. In 1920, agricultural production in the Kazakh SSR was fifteen times greater than industrial production. By the end of just the second five-year plan, the volume of industrial production had already overtaken that of agricultural production. The figures for 1979 show that gross industrial output was 3.8 times greater than that of agriculture. The actual sectoral structure of industry has also been substantially transformed. In 1920, Group A (production industries) accounted for only 12% of industrial output; in 1980, it accounted for 75% of the Republic's industrial output. In the breakdown of work by territories in the Union, Kazakhstan's industry is represented by a variety of sectors. Among these, a leading place is occupied by non-ferrous metallurgy, which is of Union-wide importance. The opening up of new oil and gas fields on the Mangyshlak peninsula has significantly increased Kazakhstan's contribution to the USSR's oil resources and has led to the development of the gas extraction and gas processing industry.

Substantial changes have also taken place in the sectoral structure of the Republic's agricultural economy. This is now a highly mechanized branch of the national economy, in which many types of crop production have been developed side by side with the raising of livestock. Between 1913 and 1979, Kazakhstan's overall gross agricultural output increased by a factor of 8.

An enormous impact not only on the development of the agricultural economy but also on the whole economy of the Kazakh SSR resulted from the opening up, during the period 1954-1956, of 25.5 million hectares of virgin and long-fallow land in the Republic, a process that turned Kazakhstan into one of the major grain-producing areas of the USSR. Before the opening up of the virgin and fallow lands (1943-1953), Kazakhstan's average annual grain harvest amounted in all to 2.1 million tons; in 1954-1958, it reached 13.8 million tons; in 1966-1975 it reached over 20 million tons; and in 1976-1979, more than 27 million tons. Before the virgin and fallow lands were opened up, Kazakhstan delivered to the State 1-1.5 million tons of grain, representing 3-5% of the USSR's total grain purchases. In volume of state grain purchases, the Republic now takes second place in the country (after the RSFSR), and it leads in grain marketability. The opening up of the virgin lands placed Kazakhstan among the USSR's foremost centres of livestock production. A quarter of the country's present sheep population is concentrated in the Kazakh SSR. Thirty-four per cent. of all astrakhan sold in the USSR is provided by Kazakhstan.

The successful development of social production in the Kazakh SSR has provided the material foundation for greater employment and an increase in the population's income, consumption, education and culture. At the present time, over 90% of the working population of the Republic is engaged in social production. Capital construction and the creation of new jobs have been so vigorous that the Republic's economy is experiencing a shortage of manpower. The Republic, along with the entire country, has solved the problems connected with universal, compulsory secondary schooling. In 1979, 80.7% of those employed in the national economy had received a higher or secondary education (either complete or incomplete). The Republic has solved the problems of health care, pre-school education for children, social security and many other problems to do with social and cultural development.

Table (a) - Basic indicators of economic and social development in the Kazakh SSR during the period 1965-1979, expressed as percentages (taking the figure for 1965 as 100%)

	1970	1975	1978	1979
Gross social product	151	196	226	232
National income produced	163	199	233	238
Gross industrial output	156	222	248	253
Gross agricultural output	154	138	184	191
Mean annual figure of those employed in the national economy	114	130	140	143
Average monthly wage of workers and employees	126	151	163	167
Remuneration of collective farm workers	145	164	191	193
Credits and services provided from public expenditure	161	232	273	287

The development of production under socialism and the raising of the level of economic development are not ends in themselves, but a means of improving the living standards of the population of the country and of its regions. It is thus extremely important to evaluate the consequence of raising the level of economic development of the USSR's formerly backward regions in terms of the higher living standards of their populations, and what has been achieved by the policy of balancing the differences between the country's national republics, as shown by indicators of the population's standard of living.

This is important for other reasons too. Bourgeois economists, when considering ways of accelerating the economic development of underdeveloped countries, criticize the Soviet method of economic development, believing its chief weakness to be its disregard for the value of consumption as a means of rapid production growth. Such an inference is essentially self-contradictory. A growth in production cannot but lead to a growth in consumption under any production system. Which classes and strata of the population derive benefit from the results of increased production is another matter.

An objective analysis of the statistics of economic development and the standard-of-living index of the population of the USSR and its regions shows the radical improvements made in the living conditions of the population of the country and the national republics, and refutes the assertions of the bourgeois economists. As the figures show, the expansion of production in our country and its regions has been accompanied by a proportional increase in consumption by the population.

The rapid growth in the national income of the eastern republics of the USSR has brought about a corresponding increase in the incomes and consumption of their populations. A characteristic feature of the process in the republics in question is a rapid climb, in comparison with the average figures for the Union, in the indices reflecting living standards, which have become much closer to average living conditions Union-wide, and even surpassing them in some ways.

2.2 FACTORS FAVOURING OR HINDERING SOCIO-ECONOMIC DEVELOPMENT

The factors that favour the further economic and social development of the Kazakh SSR are as follows:

i. The exceptional wealth and variety of the raw materials base for industrial development. Comparison of the known reserves of minerals with the present level of extraction and processing shows that there is a vast potential for increasing the exploitation of natural minerals. There are particularly great opportunities for developing such branches of industry as non-ferrous metallurgy, and the fuels, power, and chemicals industries.

ii. The existence of circumstances permitting a higher degree of specialization in a number of industrial sectors. These circumstances include the reserves of raw materials, the USSR's system for the Union-wide division of social labour and the enormous capacity of its home market.

iii. The availability of manpower due to both the relatively high natural increase in the labour force and to the net credit balance resulting from migratory movements of labour.

iv. The Republic's position within the structure of the USSR, a country processing a powerful economic potential, which makes it possible to redistribute financial and material resources in the interest of the Republic's socio-economic development and to reach rapid, effective solutions to large-scale economic problems that often cannot be solved by the efforts of an individual republic.

Problems that hinder the socio-economic development of the Kazakh SSR include the following:

i. The low population density in the Republic, the uneven distribution of the population, and the existence of vast almost unpopulated expanses of desert and semi-desert.

ii. The shortage of water and the irregularity of precipitation, which cause fluctuations in agricultural production.

iii. The growing discrepancy between social production and the development of the Republic's transport system.

iv. The relatively high construction costs for production and social infrastructure projects, resulting from a combination of historical and economic causes.

v. The existence of shortcomings in the organization of social production.

PART 3.

Planning system for the Union Republic's socio-economic development

3.1 METHOD OF FORMULATING CURRENT AND LONG-TERM PLANS

Five-year and annual plans for the economic and social development of the USSR are worked out for the USSR's different Union Republics and economic districts.

The five-year economic and social development plans for the Union Republics are based on the main guidelines laid down for economic and social development in the USSR over a ten-year period. Preparation of the five-year plans, including the allocation of annual targets, is done on the basis of Control Figures issued by the State Planning Committee of the USSR and of the draft five-year plans of the Republic's ministries and departments and of those Union-controlled enterprises and organizations located on its territory.

The annual economic and social development plans of the Union Republics are compiled on the basis of the targets and economic quotas for that year in the five-year plans put forward by industrial combines (enterprises) and organizations.

The five-year and annual plans for the economic and social development of the Union Republics contain three sections; plans for that part of the economy administered by the Councils of Ministers of the Union Republics, basic targets for the part of the economy that is under Union control; and basic targets for the Republic as a whole.

For the Union Republic, the first stage in drawing up plans for economic and social development is to work out the national economic balance and the inter-sectoral balance for production and the ditribution of output. These planning balances make it possible to start determining, in an informed way, rates and proportions for the development of the economy and the efficiency of the Union Republic's social production.

The accounting indicators for the aggregate social product and national income are used to determine the structure of the Republic's social production, the participation of the various sectors of its national economy in generating the national income, and the sources of savings and capital investment. Statistics on the national income, consumption and savings make it possible to analyse the level of economic development and the living standards of the Republic's population and the relationship between production and use of national income in the Republic. The correlation between the rate of growth of national income and expenditure on consumption makes it possible to establish a relationship between the growth of productivity and the level of consumption.

The calculation of balances in individual commodities is very important for improving the supply of material and equipment for the national economy and planning freight movements. It covers the totality of production and consumption of these resources within the Republic, regardless of the authority under which the producers and consumers come. An important place in the Republic's economic planning system is occupied by figures showing the rise in the level of specialization of the Union Republic's economy, the increase in its contribution to the solution of all-Union problems and the growth in the complexity of the economy within economically valid limits. At the same time, in determining the specialization of the Republic's economy, reference is made to the feasibility of bringing the stucture of the economy more closely into line with natural and economic conditions and of rationally combining the specialized sectors with the service sectors and the production infrastructure. In this connection, great attention is paid to the discovery of shortcomings and ways of eliminating them in the use of natural resources and the siting of industries within the Republic.

At present stage of the socio-economic development of socialist society and of national economic planning, long-term and annual manpower balances have an increasingly significant part to play. Such balances must take into account, in an impartial way, labour force requirements together with the actual demographic situation of the population and of manpower resources, not only for the Republic as a whole but also broken down by individual towns and districts.

Balancing manpower resources requires statistics on the number of workers and employees and the total wages bill for the Republic, including a breakdown of the figures by national economic sector, and also on the growth of productivity and the rise in the average wage.

Social development plans are worked out for all ministries and departments in the Republic (regardless of where their controlling authority is located), schools and pre-school institutions, higher and secondary specialized educational establishments, public health departments and housing and utilities departments.

As the plans are being carried out, the State Planning Committee of the Union Republic takes steps to ensure integrated economic and social development within the Republic and systematically checks on fulfilment of the planned targets, reporting on its work quarterly, and as a rule at the end of the year, to the State Planning Committee of the USSR.

3.2 OVERALL GOALS AND CURRENT TASKS

The socio-economic development of the Kazakh SSR for the period 1981-1985 and up to 1990 naturally depends on the general, overall socio-economic goals of the USSR for that period. The main priorities for the Republic's socio-economic development are also determined in relation to the country as a whole. Those goals and priorities have been set out in the first part of this report.

One feature of the general socio-economic development of the Kazakh SSR for the period 1981-1985 and up to 1990 is that the problem of increasing the efficiency of social production is more acute for the economy of the Republic than for the country as a whole. This is not only because the economic efficiency indices for social production are lower than the all-Union average but also because of the predominance in the structure of the Republic's economy of capital-intensive and highly resource-intensive sectors in which the impact of productivity causes substantial changes in the economic efficiency index of the entire social production of the Republic and of the country.

At the same time, however, the Kazakh SSR's economic and social development plan for 1981-1985 and the period up to 1990 covers the Republic's own development problems and priorities.

The most distinctive feature of the Kazakh SSR's economic development is the plan for accelerated production of electricity and the devising of steps to achieve this. It is planned to generate, in 1985, 90-95 thousand million kilowatt hours, which is more than one and a half times greater than the 1979 level (58,700 million kilowatt hours). The electricity generating growth rate in 1981-1985 will be more than double the rate of growth of the Republic's industrial output. The priority development of electricity generating capacity is one of the chief preconditions for making use of the world-wide advances in science and technology and for increasing labour productivity in all sectors of material production and the non-productive sector of the Kazakh SSR.

For the current and longer-term economic and social development of the Kazakh SSR, great importance is attached to the consolidation and development of raw materials supplies for the Republic's traditional specialized sectors - non-ferrous and ferrous metallurgy. To achieve this in the period 1981-1985, it is planned to introduce facilities for the extraction of iron ore at the Kachar ore-enriching combine and to step up the extraction of ore at the Zhairem complex ore field.

Kazakhstan has an important immediate and long-term role in increasing the extraction of oil and gas and the refining of oil. In this connection, it is planned to expand geological prospecting for oil and gas in western Kazakhstan, to speed the opening up of oil fields in the Buzachi peninsula, to increase the primary refining of oil by a factor of 2.1 in the period 1981-1985 and to complete the construction of the Chimkent refinery.

In view of the vast territory of the Kazakh SSR, great importance is attached to the planning of territorial production complexes (TPKs) in order to improve the organization of social production and make it economically more efficient.

In the theory and practice of the USSR's economic planning, the systematic establishment and development of various grades of TPK is considered to be one of the progressive forms of the territorial organization of industry. A TPK is a technologically economically based interrelationship of evenly combined developing and industries and plants that are responsible to various ministries and departments and are concentrated in a limited area and sharing its resources and infrastructure.

The TPKs take in specialized plants, supplementing their production, ensuring the rational use of manpower and proving the necessary infrastructure, power supplies, buildings and transport and socio-cultural facilities.

The main purpose of the planning, establishment and development of a TPK, and of checking that the plans have been carried out, is to provide the complex with development goals and achieve a greater economic effect by means of the planned selection of the main industries making up the TPK; attaining the optimal development levels for specialized industries; observing a proper balance in the TPK between specialized industries, and service and ancillary industries, between industrial and transport development, between organizations and the construction materials industry, and between the development of material production and that of the non-productive sector; the efficient use of resources of every kind, including scrap from basic production; and the coordination of the activities of the ministries and departments taking part in the formation of the TPK.

In the Kazakh SSR at the present time, the planning of territorial production complexes is proceeding equally actively in two directions, namely, towards the improvement of those TPKs already in existence (Karagnad, Djezkazgan, Ust-Kamenogorsk, Guryev and others) and towards the formation of new ones. Of the latter particular mention should be made of Pavlodar-Ekibastuz, Karagau-Djambul and Mangyshlak.

The 1981-1985 plan provides that, in the Pavlodar-Ekibastuz TPK the extraction of coal and the production of alumina will be stepped up, work will be continued on the installation of four-million-kilowatt state district power stations, the second stage of the oil refinery will be brought into operation and reconstruction of the Pavlodar tractor factory will be completed.

Both in the current five-year plan and in the longer-term plan up to 1990, the Kazakh SSR has an important role to play in the solution of the USSR's food problem, with the development of agriculture providing a basis for solutions to that problem. The Kazakh SSR's chief task in this connection consists in augmenting its production of grain, beef cattle and fine-fleeced sheep and also in preparing and implementing measures to stabilize agricultural production, especially the production of hard and resilient wheats. To this end, in 1981-1985 it is intended to continue constructing a network of group water supply system for agricultural purposes, to bring into use 400-420 thousand hectares of irrigated land and to bring water to 15 million hectares of pasture in desert and semi-desert areas.

3.3 PLANNING OF SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

Planning the development of science and technology is a most important component in the state system of directing scientific and technological progress and in the overall system of state plans in the USSR and each Union Republic.

Before the draft national economic development plans are drawn up, the Council of Ministers of the Union Republic, the Academy of Sciences of the Union Republic, the branch academic institutes, higher educational establishments, scientific societies, ministries and departments prepare proposals for applying to the economy of the Republic the results of completed scientific research and for organizing further work, in the scientific institutions and design offices of the ministries and departments, on the most promising fundamental and applied research possibilities. These proposals are submitted to the USSR State Commitee for Science and Technology and to the Academy of Sciences of the USSR, which examine them and draw up the scientific and technological development plan for the five-year period. This plan contains specific tasks and measures for the development and introduction into the national economy of new technological processes, for the production of high-output machinery and equipment, for the use of new, more economical materials, and for the comprehensive mechanization and automation of production.

On the basis of this plan, the Council of Ministers of the Union Republic draws up and consolidates the five-year and annual plans for the different sectors of the Republic relating to scientific and technological development for the subordinate scientific, design and technological organizations and enterprises. These plans lay down the tasks arising out of government decisions, state plans and the scientific and technological R&D programmes and plans established by the USSR State Committee for Science and Technology, measures for raising the scientific and technological level of production and output, and planned targets for the introduction of the major new types of production and technological processes devised in other branches of industry together with the material and financial resources for carrying out the measures planned.

The plans also include research work in the natural and social sciences.

3.4 CORRELATING SOCIO-ECONOMIC WITH SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

Socio-economic and scientific and technological development policies are closely interrelated. The effective economic and social application of advances made by science and technology internationally can be singularly complicated on account of the overall social backwardness of a country. At the same time, no substantial rise in the economic level and standard of living of a country is possible unless use is made of those advances. The Soviet Government has recognized this interrelationship and continues to do so both in its long-term policy for the country's socio-economic development and in its current five-year and longer-term plans for the development of the economies of the USSR and its union republics.

The accelerated development of industry in the Kazakh SSR and similar formerly backward regions, with the associated balancing of the socio-economic development of the national republics, represents the fulfilment of a long-term, deliberate policy of creating more or less equal conditions for the economically and socially effective application throughout the country of the world-wide advances in science and technology.

In the five-year and annual plans for the socio-economic development of the country and the Union Republic, the relationship between socio-economic and scientific and technological development is taken carefully into account in all aspects.

The acceleration of scientific and technological development and the fullest possible use in the economy of scientific and technological advances are regarded as basic factors for the growth of production, the raising of its economic efficiency, the improvement of output quality and the broadening of the range of products.

In planning to raise the technical level of production and simultaneously to draw up targets for the launching of new and higher-quality products, to withdraw obsolete products from production, to put into operation integrally mechanized and automated plant, workshops and subdivided basic and ancillary production units, account is taken of indices of production volume, equipment utilization levels, materials consumption rates and productivity.

Reduction of the amount of labour expended, through the implementation of scientific and technological measures, (broken down by ministries and department within the Republic) is covered in the labour and key personnel plan; the lowering of net costs is covered in the net costs and profits plan; the economic use of materials through the introduction of new techniques and technology is covered in the plan for reducing materials-expenditure rates.

In the plan for 1981-1985 and the period up to 1990, greater economic efficiency is being directly sought through the implementation of scientific and technological measures.

The effectiveness of the scientific and technological measures included in the five-year plans is evaluated in general terms from the overall economic effect attained in the economy through the use of scientific and technological advances.

The annual economic effect is defined as the total savings in all productive resources (manpower, materials and capital investment) achieved by the manufacturers and users of new technology and benefiting the economy as a result of the production and application of new technology; savings that, in the final analysis, represent an increase in the national income. The annual economic effect appears in the five-year plan as an accounting indicator, and is used for evaluating the contribution made by sectors, combines and works towards increasing the efficiency of social production and for selecting the most effective lines of scientific and technological development.

Net incremental profit (reduction in net costs) resulting from the introduction and use of new technology during the period covered by the plan is taken as an acceptable indicator of ecoonomic efficiency.

Planned net incremental profit accruing from the introduction of new technology is determined by the formula:

$$\Delta N_t = (H_i - C_i) A_i - (U_l - C_l) A_t$$

where ΔN_t is the planned net incremental profit for the year t, in roubles;
H_i and C_i are then the wholesale price (not including turnover tax) and net unit production cost of new output in the planning year t, in roubles; U_i and C_i are the wholesale price (not including turnover tax) and net unit production cost of equivalent output in the year preceding the introduction of the new technology, in roubles; A_t is the production volume of new output in the planning year t.

The planned reduction of net cost through the use of new technology in the production processes is expressed by the formula:

$$\Delta C = (C_l - C_t) A_t$$

where C_t and C_l represent net unit output cost (labour) in the planning year t and in the year preceding introduction of the new technology, in roubles; A_t is the volume of production in the planning year t in actual units.

Savings are defined for all instances of variable expenditure on raw materials, supplies, fuel, power, wages including additional charges and other production outgoings directly associated with the measures implemented.

The effectiveness of scientific and technological measures is correlated with the corresponding sections of the socio-economic development plans through the following basic indicators:

i. Production

Growth in the volume of production on account of the introduction of new technology; (a) major types of output in the units of measurement adopted in the plan; (b) growth in the volume of (standard) net commodity output; (c) growth in the volume of top-quality output; (d) increase in the proportion of top-quality output in the overall volume of (standard) net commodity output;

ii. Labour

(a) Greater productivity through the introduction of new technology; (b) a corresponding drop in the numbers of industrial workers; (c) corresponding savings in the wages bill.

In addition to the above-mentioned indicators of the effective use of new technology, calculations are made of the reduction in expenditure per unit of consumption capacity, i. e. per unit of productivity, plant and other similar factors. These calculations are made in terms both of value and of actual units of measurement.

PART 4.

Scientific and technological potential of the Kazakh SSR and the process by which it is formed

4.1 GENERAL LEVEL OF EDUCATION OF THE POPULATION AND LEVEL OF EMPLOYMENT IN SCIENCE

The scientific and technological potential of the Kazakh SSR was created and developed in parallel with the development of social production within the Republic and the raising of its economic and social development level.

The formation of the country's scientific and technological potential is a complex process involving the creation of industrial sectors of the economy and making corresponding changes in the sectoral structure of material production and of industry in particular; building up new production resources and increasing the quantity of machinery available to labour; the raising of the level of education and specialized training of the labour force; creating a network of specialized scientific research institutions and scientific personnel; and improving the organization of labour, in all spheres of activity as well as in science.

As a result of the successful development of all these aspects, the Kazakh SSR has been equipped with up-to-date materials and machinery capable of using the modern advances made by the scientific and technological revolution. The Republic's principal production resources which have been created in recent years are in keeping with present-day ideas for acceptable engineering and technology. The quantity of machinery available to labour in most of the industrial sector exceeds the all-Union average.

It would be difficult to talk about opportunities for scientific and technological development in pre-revolutionary Kazakhstan, where in 1920 only 18.3% of the population between the ages of 9 and 49 were literate. Practically speaking, the Republic possessed no specialists with higher or secondary education.

Over the past 60 years, a revolution has taken place in the Kazakh SSR in education and the training of specialists, so that the contemporary requirements of scientific and technological progress are now satisfied.

According to the 1970 census, the literacy rate in the Republic was 99.7%. The rural population in this case was on a level with the urban population, thus providing favourable conditions for solving the problem of the industrialization of agriculture.

Kazakhstan's first higher education establishment was the Institute of Education, opened in 1928 with 75 students. In the Republic today, 251 000 students are receiving an education in 55 higher education establishments, including two universities.

Six million people are receiving some form of education in the Republic, representing 51% of the total population aged 7 and over. In other words, virtually one person in two is studying.

An important event in the development of science and technology was the founding in 1946 of the Academy of Sciences of the Kazakh SSR. It now comprises 25 research institutes, in which 3 700 scientific workers are employed. The Eastern Department of the All-Union V.I. Lenin Academy of Agricultural Sciences is situated in Kazakhstan, which also has many other scientific research institutes specializing in a variety of fields.

Table (b) - Extent of education of the population (according to population census statistics)

	Number of educated members of the population per 1000		
	Higher and Secondary education (complete or (incomplete)	Comprising	
		Higher education	Secondary education (complete or incomplete)
All members of the population aged 10 or over			
1939	83	6	77
1959	347	17	330
1970	468	35	433
1979	633	60	573
Economically active members of the population			
1939	99	8	91
1959	447	28	419
1970	654	59	595
1979	807	93	714

There were 1 727 scientific workers in Kazakhstan at the end of 1940 and 3 305 in 1950.

The increase in the number of scientific workers over the period 1960-1979 can be seen in the table below.

The number of scientific workers of Kazakh nationality has increased fastest of all. Whereas the total number of scientific workers in the Republic rose from 9 623 in 1960 to 32 011 in 1975 (3.3 times as many), the number of Kazakh scientific workers rose during that period from 2 064 to 10 305, i.e. it increased five-fold.

The number of specialists graduating from the Kazakh SSR's higher and specialized education establishments is increasing extremely rapidly.

The largest proportion of graduates from higher education is made up of workers in agriculture (4 072 among those graduating in 1979), construction (3 544) and engineering and instrument-making (1 728).

Of those completing specialized secondary education, the largest proportion (1979) specialize in agriculture (14 000), economics (12 400), health and physical culture (9 300), education (7 400) and construction (7 200).

Table (c) - Number of scientific workers in the Kazakh SSR
(at the end of each year)

	1960	1965	1970	1975	1979
All scientific workers (including science teachers in higher education establishments)	9 623	18 226	26 802	32 011	34 741
Number with academic degrees:					
Doctorates	157	232	421	607	707
Master's degrees	2 123	3 255	6 272	9 642	10 840
Women scientific workers	3 456	8 035*	10 723	13 161	14 021
Number of women with academic degrees:					
Doctorates	11	...	79	117	131
Master's degrees	546	...	1 771	2 862	3 399
Number of post graduate students	879	1 743	2 485	2 557	2 409

* at the end of 1966

Table (d)

	Numbers graduating from higher education establishments (in thousands)	Numbers graduating from specialized secondary education establishments (in thousands)
1940	2.2	5.5
1960	10.3	20.5
1970	27.5	48.0
1975	31.3	57.5
1979	36.0	66.7

4.2 FUNDING SOURCES FOR SCIENTIFIC RESEARCH WORK AND CHARACTERISTICS OF BUDGETARY EXPENDITURE ON SCIENCE

The sources of funding for scientific research work in the Kazakh SSR, as in the USSR as a whole, are the State budget and the consolidated science and technology development fund. This derives its income from deductions from the planned profits of enterprises in accordance with the quota set for the ministry (or department) as a percentage of net (standard) or commodity output. In addition, the consolidated fund receives part of the extra profit (the sum of additions to wholesale price) arising from the creation of new products. Science and technology development funds are set up only in enterprises that have changed over to the new planning system. Ministries and departments, that have not gone over to the new system of planning and financing for scientific research work, account for expenditure or scientific research and experimental design work in the net cost of industrial production, transportation, building and installation work in their plans relating to operating expenses and to outlay on the overheads of trading, supply, sales, procurement, and in construction estimates.

The figures given below for expenditure on science in the Kazakh SSR state budget therefore do not reflect the total of such expenditure. Essentially, they show expenditure on the development of science in non-profit organizations, i.e. academies of science and higher education establishments.

The figures do give an idea, however, of the rate of growth of funding for expenditure on these branches of science and on the specialized higher and secondary education of key personnel.

The socio-economic development of the economy, including scientific and technological development, of each republic and of the country as a whole is based on a compulsory statistical accounting system for which generally established forms, schedules and indicators are laid down.

This accounting system serves as a form of control for the execution of plans and also as an initial statistical base for the drawing up of current and long-term plans for economic, scientific and technological development.

Table (e) - Expenditure in the State budget of the Kazakh SSR
(in millions of roubles)

	1960	1970	1975	1979
Total expenditure on education and science	378.0	1 002.9	1 422.9	1 696.9
Comprising:				
Specialist training in higher educational establishments	31.4	70.3	100.8	132.0
Specialist training in specialized secondary education establishments	18.9	45.8	72.4	91.5
Industrial trade training	44.6	87.6	147.8	178.9
Science	21.7	37.2	47.1	52.0

4.3 NEED TO ACCELERATE SCIENTIFIC AND TECHNOLOGICAL PROGRESS

Among the major problems influencing the speeding up of the growth rate of scientific and technological potential, and the qualitative transformation of that potential, is the fact that the rise in the country's level of socio-economic development is exhausting the reserve of spare manpower. In 1970, already 92% of the USSR's total potential work force was engaged in social production. The remaining 8% not involved in social production consisted mainly of mothers of large families in the eastern parts of the country.

In such a situation, a basic requirement for expanding social production is higher productivity, and that can be achieved more quickly by making use of international advances in science and technology and by increased mechanization in all fields.

Increased mechanization and the refurnishing of production apparatus are made necessary by world-wide factors as well, for example, the world-wide scientific and technological revolution that is taking place and the considerable opportunities it provides for reducing aggregate labour input, calculated in relation to productivity.

PART 5.

References

Constitution of the USSR.

Constitution of the Kazakh SSR.

Principal directions of the economic and social development of the USSR for 1981-1985 and the period up to 1990.

Guidelines for the preparation of state plans for the economic and social development of the USSR. Moscow, Statistika, 1980.

The economy of the USSR in 1979. Statistical yearbook. Moscow, Statistika, 1980.

The economy of Kazakhstan in 1976. Kazakhstan Statistical Yearbook. Alma Ata, 1977.

The economy of Kazakhstan over a 60-year period. Statistical collection. Alma Ata, 1980.

G. Myrdal. *An international economy, problems and prospects* (Russian edition) Moscow, 1958.

SOCIALIST REPUBLIC OF VIET NAM

Table of Contents

SOCIALIST REPUBLIC OF VIET NAM

GEOGRAPHY

Capital city: Hanoi
Main ports: Hai Phang, Da Nang, Vung Tau, Nha Trang
Land surface area: 329,556 sq km

POPULATION (1978)

Total	49.9 million
Density (per sq km)	151
Urban/rural ratio	...
Average rate of growth (1970-78)	2.2%

By age group:	0-14	15-19	20-24	25-59	60 and above	Total
	41.3	10.2	8.7	34.0	5.8	100%

SOCIO-ECONOMIC

Labour force	
Total	...
Percentage in agriculture	...
Gross national product (1978)	
GNP at market prices	...
GNP per capita	...
Real growth rate of GNP per capita (1970-78)	...
Gross domestic product	
Total (in current producers' values)	...
Percentage by origin	
Agriculture	...
Manufacturing, mining & quarrying, electricity, gas & water, construction	...
Government finance	
National budget	...
As percentage of GNP	...
External assistance (official, net; 1976)	...
As percentage of GNP	...
Exports	
Total exports of goods (1978)	...
Average annual growth rate (1970-78)	...
External debt (1978)	
Total public, outstanding + disbursed	...
Debt service ratio (% GNP)	...
(% Exports of goods and non-factor services)	...

Exchange rate (1979): US $1 = 2.06 Dong

EDUCATION

Primary and secondary education (1978)	
Enrolment, first level	7,337,436
*As % of (6-10 years)	113%
Enrolment, second level	[1]3,379,506
As % of (11-16 years)	52%
Combined enrolment ratio (6-16 years)	82%
Average annual enrolment increase (1975-1978)	[1]1.2%

[1] Second level education refers to general education only.

* The enrolment ratio is the relationship between the number of all pupils enrolled (regardless of their age) and the number of the population of the relevant official ages.

Higher education (third level) (1978)

Teaching staff, total 15,183

Students and graduates by broad fields of study:

	Enrolment	Graduates
Social sciences and humanities	71,833	63,680
Natural sciences	5,180	2,609
Engineering	32,161	30 277
Medical sciences	11,926	11,837
Agriculture	12,771	11,722
Other and not specified	3,131	...
Total	**137,002**	**17,799**

Number of students studying abroad 15,158

Education public expenditure

Total	...
As % of GNP	...
Current, as % of total	...
Current expenditure for third level education, as % of total current expenditure	...

Table 1. Nomenclature and Networking of S&T Organizations

(Data unavailable at time of publication)

I - First level - POLICY-MAKING

Country: Viet Nam

Organ	Function	Linkages		
		Upstream	Downstream	Major Collateral
....	....	....	....	....

II - Second level - PROMOTION & FINANCING

Organization	Linkages		
	Upstream	Downstream	Others
....	....	....	....

III - Third level - PERFORMANCE OF STA

Establishment	Function	Linkages	
		Upstream	Others
....	....	....	....

Table 2 - Scientific and Technological Manpower

Country: Viet Nam

Year	Population (millions)	Scientists and engineers								Technicians	
		Total stock (in units)	of which working in R&D							Total stock (in units)	of which working in R&D
			Breakdown by field of educational training (in units)								
			Natural sciences	Engineering and Technology	Agri-cultural sciences	Medical sciences	Social sciences	Education			
1965											
1970											
1978		100%	5%	22%	8%	9%	25%	30%			
1980	53	263,000(a)								540,000(a)	
1985											
1990											

(a) Estimates based on Educational Statistics

Table 3 - R&D expenditures

(Data unavailable at time of publication)

Country: Viet Nam
Currency:

Table 3a: Breakdown by source and sector of performance

Year: Unit:

Source / Sector of performance	National		Foreign	Total
	Government funds	Other funds		
Productive				
Higher Education				
General Service				
Total				

Table 3b: Trends

Year	Population (millions)	GNP (in)	Total R&D expenditures (in)	Exchange rate US $1 =
1965				
1970				
1975				
1979				
1985				
1990				

PART 1

General features

The name of this country is the Socialist Republic of Vietnam (S.R.V.). It has an area of 329 566 square kilometres, and a population of fifty-three million. During the period 1970 to 1975, the annual growth rate was 2.3%. The ratio of males to females was 48.5: 51.5

The capital city of Vietnam is Hanoi. The area of this city is 2 133 square kilometres and its population is 2 570 000.

Vietnam's climate is humid, monsoonal and tropical. The relative humidity is 80% average per year and the average annual rainfall is 1 800 - 2 000 mm. Each year the country is battered by, on average, ten storms.

For communications, the country has both air and sea transport. The major seaports are Hai Phong, Da Nang, Vung Tau, and Nha Trang. The major airports are Noi Bai, Gia lam, Tan Son Nhut, Da Nang, and Hue.

Politically, Vietnam became independent in September 1945, when the Democratic Republic of Vietnam, forerunner of the present-day Socialist Republic of Vietnam, established its state power. After three decades of struggle against colonialism, imperialism and their consequences, national reunification was achieved and socialist construction was started on a nationwide basis.

With regard to education, in the academic year of 1979/1980 the number of university students was 158 800. In the same year, the number of students attending secondary school was 11 803 800 and the number of students receiving vocational secondary schooling was 169 500.

PART 2

National science and technology policy (STP)

2.1. SYSTEM OF SCIENCE AND TECHNOLOGY POLICY-MAKING AND IMPLEMENTING AGENCIES

Functional principles for State organs in the science and technology domain are established in the SRV Constitution adopted by the Sixth National Assembly at its Seventh Session (18 December 1980). As specified in the Constitution, art. 42,

> "The State will promote the scientific and technological revolution with a view to developing production forces, raising labour productivity, stepping up socialist industrialization, improving the people's living standard, strengthening national defence capacity and building an advanced science and technology".

It is stated, furthermore, in Art. 43, that:

> "Social, natural and technical sciences will all be strongly developed"
>
> "The State will see to it that education and dissemination of science and technology is widely effected; teaching and research are geared to production, life and defence; the contingent of managerial, scientific and technical personnel and technical workers is developed and put to rational use; research, discovery and invention efforts are encouraged; applied research is given due attention; self-reliance, initiative and creativeness are brought into play while trying to apply the world's advanced scientific and technological achievements, and international cooperation in science and technology is strengthened".

The National Assembly

The national Assembly is the top-level representative organ of the people and the highest state authority in the SRV. With regard to the organization of scientific and technological activity, it performs the supreme functions, as specified in the Constitution, of taking decisions concerning state planning and budgetary issues, including those related to S&T development planning and investment for different planned periods.

By means of the Regulations for the organization of the State Council and the Council of Ministers, which provide for its decision-making power in the establishment or dissolution of ministries and state commissions, the National Assembly exerts its power to lay down the groundwork for the organization and management of S&T activity.

The State Council

The State Council is the highest standing body of the National Assembly. It performs the duties and rights stipulated by the constitution, legislation and bills of the National Assembly.

The Committee for Science and Technology, and the Economic, Planning and Budgetary Committee

Both of these organizations are under the National Assembly and are the standing bodies which assist the latter in examining and auditting reports, drafting laws, projects of State plans, budgets, and other projects related to S&T development, and in exerting the power of supreme supervision in conjunction with the State Council.

The Council of Ministers

The Council of Ministers is the highest executive and administrative body of the National Assembly. In the organization of S&T activity, the Council ensures uniform management of the implementation of guidelines, policies and development plans in social and natural sciences and technology; adopts all measures to encourage every effort in research, discovery, invention and innovation activities; provides guidance in applying scientific and technological achievements to economic and cultural development, to the strengthening of national defence potential and the improvement of the people's living conditions; carries out the policy of protecting, improving and regenerating natural resources and environmental preservation and improvement; exerts official management of activities in standardization, metrology and quality control of products; directs the building-up S&T information and forecasting capacities. With regard to the implementation of science and technology policy, the council of Ministers adopts definite execution plans for each specific period and provides guidance for, and takes control over, the implementation by the various sectors, localities and units of their respective plans.

The management of S&T activity by the Council of Ministers is effected through system of agencies composed of:

the functional bodies directly subordinate to the Council of Ministers, namely the State Commission for Science and Technology, the State Planning Commission, the Ministry of Finance and the Ministry of Supply, etc. ,

the various sector-oriented techno-economic ministries and general departments;

the people's committees of the provinces and cities.

The State Commission for Science and Technology (SCST)

This Commission is the central government agency responsible for state management of all S&T activities in the whole country and for the conduct of S&T policy. One of its main tasks is to elaborate directions and plans for S&T development on a national scale and submit them to the Council of Ministers for approval.

The Commission is headed by a president who is a member of the Council of Ministers and who is assisted by a number of vice-presidents and commission members.

The Commission President is nominated by the National Assembly at the instance of the chairman of the Council of Ministers. The vice-presidents and commission members are appointed by the Chairman of the Council of Ministers. The president, vice-presidents and Commission members are all on the staff of the Commission.

The Commission President is directly accountable to the Council of Ministers for the supervison and control of the implementation of state policy on S&T and of short and long term S&T plans by the various sectors and localities.

There are specialized S&T councils to act as consultants to the Commission President in separate fields such as mechanical engineering, metallurgy, chemical industry, energy, etc. They are staffed with scientists and economic managers from different ministries, general departments, R&D institutions and universities. Those on the staff of the Commission act as executives or scientific secretaries of the councils.

Each sector of the national economy or locality must have its own S&T development plans for every year and every period of five years, and such plans must cover, among other things, research projects, application of results, elaboration and introduction of technical standards, metrological equipment, quality control, external cooperation, etc.

The Commission helps the various ministries, general departments, provinces and cities in S&T forecasting, in drawing up plans for scientific research and key programmes of S&T progress, which are eventually generalized by the Commission into a draft State S&T development plan before being submitted to the Government for approval. The Commission is in charge of official management of standardization, metrology and quality control activities and international S&T cooperation throughout the country. The Commission also provides guidance to the various sectors and localities in S&T management through legal regulations, and runs training courses and conducts seminars on this subject.

Each province and city administered by the central government, has a Committe for Science and Technology. It is through these departments and committees that S&T manpower is deployed in a concerted manner by the Commission on a national scale.

Regarding grassroots units (R&D institutes, universities, etc.), research activities and their results will be controlled by the Commission through a formal system of registration on a periodic basis (See Figure 1).

Concerning the conduct of research projects within the framework of key state programmes of S&T progress, any difficulties arising therefrom will be notified by the Commission to the Council of Ministers, or will be dealt with by the Commission itself, depending on the hierarchical distribution of managerial functions of the state organs.

The Ministry of Secondary Vocational and Higher Education

The Ministy of Secondary Vocational and Higher Education has the responsibility of submitting to the Council of Ministers development plans for tertiary and post-university education and vocational training.

The Ministry of Education

The Ministry of Education is answerable to the Council of Ministers for development plans for general and complementary education.

The Commission for Social Sciences

The Commission for Social Sciences is responsible for the organisation of research on theoretical matters in philosophy, political economy, literature, history, philology, and archaeology, etc.

The Vietnam Scientific Research Centre (VNSRC)

The Vietnam Scientific Research Centre is in charge of the organisation of research into problems of natural sciences - mathematics, physics, chemistry, biology, sciences of the earth, and oceanography.

The State Planning Commission (SPC)

This Commission is a functional body of the Council of Ministers, which is responsible for the planning of the national economy. On the one hand, it co-operates closely with SCST in integrating draft state S&T plans into draft state economic development plans, and finalizing plans for applying major scientific achievements and advanced technologies of great importance, plans for capital construction of research institutions and production plans of the ministries and localities, and, on the other, it directs the system of planning agencies under the various ministries, localities and grassroots units in their joint efforts with S&T managerial agencies at the same level to draw up S&T plans as an integral part of the economic development plans for related programmes and to supervise the implementation of such plans.

The Ministry of Finance

The Ministry of Finance, and its agencies at different levels, in conjunction with SCST and the system of S&T managerial agencies, are responsible for drawing up draft financial plans for S&T activities and, once these plans are approved, for allocating R&D budgets and taking control over their use in compliance with established regulations so as to ensure the greatest effectiveness with invested resources.

Other Ministries

The ministries and general departments in charge of sector-oriented techno-economic management have, within the scope of their respective sectors, the functions of providing guidance in drafting S&T forecasts, effecting official management of the implementation of S&T policy and R&D projects, and controlling the application of scientific achievements and technological progress related to their own sectors on a nation-wide scale.

The People's Committees of the provinces and cities, in their capacity as executive bodies of the corresponding people's councils, and as local administrative state organs, are accountable to both the Council of Ministers and their respective provincial people's councils, for making full use of all the potential and resources at their disposal to fulfil state plans for economic, cultural and S&T development, strengthening defence capacity and improving the people's living standard within their territorial administration.

Scientific Associations

Encouragement is given to the formation of scientific associations with a view to pooling all S&T efforts for vigorous S&T development, for higher S&T standards among the working people, for broader co-operation with foreign scientists and national and international S&T organizations and for greater foreign assistance to S&T development in Vietnam.

The past years have seen the formation of the association of Traditional Medicine, the Association of Mathematicians, the Association of Physicists, the Association of Biologists and S&T societies in various branches of industry. There are also organizations for cooperation with foreign countries, like the France-Vietnam Medical Association.

2.2. GUIDING PRINCIPLES OF S&T POLICY

1. S&T must be closely combined with production and social life, and must be quickly turned into one of the primary development factors for the national economy. S&T achievements made in the country must be promptly applied to production, life and defence. Special attention must be given to promoting, on a scientific basis, typical cases and models in

economic and social life, and to working out effective methods for their rapid proliferation. Achievements of science and technology in the fraternal socialist countries, and other countries in the world, must be mastered and promptly applied to our specific conditions.

2. S&T development must be comprehensive, synchronized and well-proportioned, with due concentration on key directions, spearhead sciences, technologies, and priority programmes. Spontaneity and dissipation of efforts must be combatted.

3. There must be a good combination of natural, social and engineering sciences, with great emphasis on applied research and development, while due attention must be given to directed basic research.

4. Guidance and management of S&T development must be effected both in scope and in depth, on all scales (small, medium, and large) at all degrees (from low to high levels, and from the simple to the complicated) and must have in view both immediate demands and long-term development.

5. Attention must be paid to bringing into play creativeness in S&T activities, enhancing the spirit of collective mastery and socialist cooperation, combining activities of the nucleus formed by the scientific and technical staff and broad mass movements in order to make full use of all existing potential and future capabilities, and quickly obtaining practical effects in the service of economic and social objectives.

6. While promoting self-reliance, initiative and creativeness, efforts must be made to broaden international co-operation in S&T, first of all with the Soviet Union and other member states of the CMEA, and with international organizations and other countries in this region. Cooperation with fraternal Laos and Kampuchea should receive special attention.

PART 3.

Scientific and technological potential

3.1. INSTITUTIONAL NETWORK

A R&D system has been brought into existence over the past 25 years. The process can be illustrated by the following figures:

	1955	1965	1975	1978
Number of R&D institutions	0	9	54	125
Number of universities and colleges	2	16	39	61
R&D personnel (in units)	—	1 800	11 000	15 000
University and college teaching staff members (in units)	40	2 700	8,600	12,260

By the end of 1980, the composition of R&D institutions was as follows:

Research institutes in natural sciences	10
R&D institutions attached to ministries	76
Design and project institutes	25
Research institutes in social sciences education, culture and art	29
Total	140

Of this total of 140 R&D institutions, 9 had been in operation for more than 15 years; 24 from 10 to 15 years; and 21 from 5 to 10 years. It follows from this that more than 50% of the R&D institutions were set up within the 1976-1980 period, that is, after the country had been reunified.

Concerning the personnel of these institutions, there are 20 institutions with staff (including support personnel) of more than 300; 9 institutions with staff of between 200 and 300; 19 with staff of between 100 and 200; and the rest with staff of less than 100.

Universities and colleges play an active and effective role in R&D activities and in promoting the application of scientific results and advanced technologies to production.

Alongside the above-mentioned R&D system there have been set up, in different provinces, cities, enterprises and production complexes, hundreds of R&D offices, experimental stations and farms and laboratories, which constitute an important link in the transfer of research results from laboratory scale to production scale, as well as ensuring prompt, effective, and extensive application of advanced technologies to production.

3.2. S&T MANPOWER

The SRV Government pays constant attention to the training of S&T personnel. The available stock of S&T manpower, at present, is composed of over 3000 post-graduates (doctors and associate doctors); over 260 000 university and college graduates; and over 540 000 secondary-level technicians.

The specialization structure of university-level and postgraduate S&T personnel assumed the following proportions in 1978:

Natural sciences	5%
Engineering and Technology of which 22% in Industry, 8% in Agriculture	31%
Social sciences	25%
Medical sciences	9%
Education	30%
Total	100%

About 10% of the above personnel category were trained abroad, and some 30% were women. Their age-group breakdown was:

Under 30	38.38%
31-40	36.57%
41-55	23.57%
Over 56	1.28%

Problems of greatest moment concerning the effective use of S&T personnel are:

i. To create adequate technical and material conditions so as to enable the S&T staff to conduct R&D activities and to apply the obtained results to production in a fruitful manner.

ii. To intensify, both quantitatively and qualitatively, the training of post-graduates and leading scientists for major S&T programmes and projects.

iii. To conduct periodic upgrading specialized courses for the majority of university level S&T personnel and to keep them abreast with up to date achievements in science and technology.

3.3 FINANCIAL RESOURCES

R&D activities are financed from three sources, the state budget, self-help resources, and bank credits.

State Budget

The state budget allocates finances to R&D projects, which are usually known as State Programmes of Scientific and Technological Progress, and to the functioning of S&T institutions (including spendings on salaries and techno-material facilities). In order to meet the pressing demands of S&T development, the R&D investment from the State budget have been growing over the years:

	1977/1976	1979/1978	1981/1980
Growing rate (%)	113	125	138

For the next five years (1981-1985) the SRV Government has envisaged raising further the budgetary allocations to R&D efforts.

Self-help Resources

Self-help resources of production and business establishments, most of which come from their own funds for stimulating production development. These resources are meant mainly for technological improvement on the spot and for making R&D contracts with scientific institutions, universities and colleges. At present, investments from these resources account for about 20% of the total R&D expenditure throughout the country. Numerous measures have been envisaged to raise the ratio to 30-40% in the forthcoming years.

Bank credits

In case of insufficient resources to cover financial needs for the introduction of S&T findings into production, R&D institutions or production and business establishments can be granted credits by the Vietnam State Bank on favourable terms.

3.4 STRENGTHENING COOPERATION WITH FOREIGN COUNTRIES

In the present conditions, *international co-operation is a very important component of the State Policy on Science and Technology*. Co-operation in science and technology must effectively help raise the technical standards of production and research, must save time and resources in research, quickly increase the country's S&T potentials and accelerate the formulation and development of basic S&T policies for the country, and successfully carry out the socialist integration and international distribution of labour in the domain of science and technology.

Multi-faceted co-operation with the Soviet Union and the other members of the CMEA will be broadened. At the same time, steps will be taken to enter into co-operation with developing countries having similar natural conditions, and with other countries as well, to acquire advanced technologies suitable to our own conditions and capacities on the basis of equality and mutual benefit. Co-operation with scientific organizations of the United Nations system will be further developed. *Special attention will be given to developing close co-operation and mutual assistance among the three fraternal countries in Indochina.*

International co-operation must be *selective*, with *constant effort to develop forms of co-operation which are effective and practical* through joint projects relevant to Vietnam and of interest to all parties. Co-operation with corresponding scientific institutions in the Soviet Union and other socialist countries will be intensified. Necessary conditions will be arranged to enable more contacts between Vietnamese scientists and technologists and the scientific circles abroad, in order to keep our scientists abreast of the latest progress in world science and technology. *Very great attention will be attached to the combination of co-operation in science and technology with economic co-operation,* the former taking the lead as a prerequisite for the development of the latter.

Transfer of technologies must be made selectively. Efforts must be made to gradually import technologies relevant to Vietnam's natural conditions and its S&T capabilities.

3.5 ACHIEVEMENTS AND PROBLEMS

Achievements

A multidisciplinary S&T structure has been created on the basis of demands by the national economy, and S&T activities have helped to solve, to a certain degree, problems in production, welfare and national defence.

A great number of scientists, technologists and technical workers have been trained for many specializations, and S&T development is involving more and more overseas Vietnamese.

An R&D system has been formed with the research institutes under the Vietnam Scientific Research Centre and the Commission for Social Sciences, and the R&D institutions, experimental stations and designing offices of various ministries, branches and localities, and this R&D system has managed to solve many S&T problems related to the national economy. A broad managerial system has also been instituted, consisting of SCST, the many ministerial S&T departments, local S&T committees, and factory technical offices. This system is making its effect felt in all S&T activities in the country.

Secondary vocational and higher education, strongly developed over the past years, can now train scientists, technologists and technical workers for many different specializations. Basic general education, universal and free, has helped raise general cultural and technical standards for the advancement of S&T. Thanks to this, a great number of young people are trained every year for future S&T activities.

S&T information has received great attention from the state. A Central Institute for Scientific and Technological Information exists side by side with information bodies set up in various ministries, sectors and localities. Thanks to this system there has been a steady flow of information on latest S&T results, new progress in technology, recent inventions and innovations, etc.

Problems

There are, however, many big problems which have an inhibiting effect on S&T development and capacity due to objective and subjective factors.

i. Objective factors

National construction in general, and S&T development in particular, are both taking place in the context of a poor economy. Moreover, the aftermath of many years of destructive war has made it almost impossible to achieve strong, stable economic, social and scientific development. On the other hand, the application of S&T progress is made difficult by a relatively low level of technical knowhow which is a result of the backward agricultural economy initially.

ii. Subjective factors

There has been a lack of organization and co-ordination in the training and employment of S&T personnel, which has led to an insufficient use of S&T potential. The existing structure of specializations, and the existing level of proficiency, are not entirely suited to the development of key S&T projects. Besides, there are not enough highly qualified experts for research.

The R&D system is not adequately equipped. Most of the essential equipment and materials, particularly machine parts, components and chemicals, are imported, which makes it difficult to take the initiative in carrying out S&T tasks.

The information system, for its part, is unable to keep research institutions abreast with latest developments. Supplying scientists with timely, correct and complete information is difficult because of the lack of stable sources, reproduction facilities and modern data processing and retrieval equipment. S&T workers, therefore, have to spend much time and labour in collecting and retrieving needed information. The language barrier also constitutes an obstacle for a great number of S&T cadres in the exploitation of S&T information.

External co-operation with the countries whose natural and economic conditions are similar to ours, especially with other countries in the region, has not fully developed.

Many effective forms of co-operation are still lacking which would help solve certain problems encountered in the country and bring into play the potential capacity of Vietnamese scientists and technologists in those fields in which other countries are also interested.

In brief, the principal, most frequently encountered difficulties, reside in a weak material and technical basis resulting from many years under feudalism and colonialism, and in the lack of necessary conditions enabling the full use of the country's potential, including its S&T capacity, for economic development purposes.

PART 4.

Policy issues in scientific and technological development

4.1 TASKS AND OBJECTIVES OF SCIENCE AND TECHNOLOGY POLICY (STP)

As a constituent part of the economic and social development strategy, the STP of the SRV should direct all S&T activities at the concrete tasks of serving the development of production, the normalization and gradual betterment of the people's life, and the consolidation and strengthening of the country's defence potential. S&T must concentrate on studying the laws governing the development of nature, society and man in Vietnam, and in international relations. The aim is to help fully promote the right of the labouring people to collectively master and strongly develop the forces of production, to establish new relations of production, and to carry out the tasks of building socialism and defending socialist Vietnam.

The tasks and objectives of STP have been established as follows:

i. To give full play to science as the driving force in all domains of economic, cultural and social activities; to force ahead with the S&T revolution in close conjunction with the revolution in the relations of production, and the revolution in culture and ideology, so as to make science a direct productive force in service of the struggle for the application of the socialist revolutionary line and for building a socialist economy, thereby helping to better meet the material and cultural needs of the people, i. e. food, clothing, housing, health care, education, transport and other needs concerning defence and security. At the same time, an effort must be made to provide the SRV with an advanced science and technology.

ii. Throughout the transition to socialism all activities of science and technology must aim at serving, in the most efficient way, the cause of socialist industrialization as the central task; helping to achieve a gradual reorganization and equipment of the entire national economy on the basis of modern S&T and carrying out mechanization, automation, electrification and chemicalization, threreby upgrading the economy from small-scale production to a large-scale socialist production with a modern, industrial economic structure; and actively contributing to the laying down of the material and technical foundations for socialism, the steps for which must be taken within three or four five-year plans. For the time being S&T must be directed at the task of accelerating the developing of a number of important industrial branches such as energy, materials, mechanical engineering, metallurgy chemical engineering, transport and communications, etc., and other industries directly related to agricultural production.

In the years to come efforts must be made to activate S&T, and to apply S&T advances promptly and on a large scale, in order to help carry out at any costs the primary tasks of bringing about a tremendous, comprehensive development of agriculture, of giving full scope to the country's advantages in manpower, land and tropical resources, of gradually giving shape to a large-scale socialist agriculture, which will thus satisfactorily solve the urgent problems of food, industrial materials, consumer goods, and exports.

iii. To promote the creative power of S&T in combination with the superiority of socialism and the fine traditions of the nation; to strive for an active contribution to building a new culture which combines all that is characteristic of socialism, the nation, the party and the people, and to building up a socialist, new-type man who must be both revolutionary, and scientifically minded, have a high sense of collective mastery, socialist patriotism and proletarian internationalism, love for work and science, be capable in his function as the master of the society, sound in mind and body, and wholeheartedly devoted to the struggle for the country's independence and freedom for the ideals of socialism and communism.

iv. To make every effort to train a contingent of S&T cadres and skilled workers while never losing sight of a uniform plan for a rational structuring of the specializations and skills needed for economic, cultural and social development on a national scale, in each sector, each locality and each unit, and in agreement with plans for the development of the key branches of S&T for both the present and future; to ensure the availability of leading scientists and experts for research, teaching and production, and of competent cadres for the organization and management of natural, social and technical sciences. These important demands must be judiciously incorporated in the tasks and contents of general secondary and higher education, vocational training and mass motivation in general.

v. An important contribution must be made by S&T to the re-organization of production and the improved management of the economy, the society, and S&T with a view to building a new system of management.

vi. To actively extend cooperation with foreign countries on S&T in conjunction with economic cooperation, (the former being a premise for developing the latter), and in the most suitable forms and on the basis of equality and mutual benefit – to pay great attention to a selective importing of technologies, and to adopt forms of economic and S&T cooperation which are likely to give a stimulus to the major branches of the national economy and to export oriented production.

vii. To allow S&T to exert all their creative power so as to utilize all the productive potential of the country with a view to achieving higher productivity of a higher quality, to making full use of all sources of materials and energy, saving labour and costs, generating higher economic efficiency and increasing social wealth; thereby helping solve urgent, immediate problems, namely the development of production, the gradual stabilization and betterment of the people's life, and the consolidation and strengthening of the defence capacity, while stepping up the enlarged production to constantly increase national income and build a civilized, happy life for the people in accordance with the principles and moral norms of the socialist regime.

viii. To conduct in-depth exploitation of existing S&T potential while continuing to prepare for their further development in all domains in a synchronized, harmonious and selective manner; to make every effort to provide the SRV with modern science and technology, including all necessary social, natural and technical sciences and technologies and structure them in such a way that they may satisfy the demands of economic, cultural and social development.

4.2 PRIORITY DIRECTIONS

Priority will be given to a number of directions of great importance for the development of the economy, culture, society, and the country's S&T potential, with due attention being attached to the main trends of S&T development in the world. Priority will also be given to developing fully those sciences and technologies which may have direct bearing on Vietnam's advantages in natural resources, tropical conditions and manpower. Efforts must be concentrated on solving in a fundamental way the problems of food, of developing consumer goods and expanding exports, of fuel and energy supply for production and everyday life, of raising production levels and output in mechanical engineering, metallurgy and chemical industry, of ensuring steady supplies of materials for the various branches of the national economy, and of transport and communications.

General basic surveys will be continued as the basis for the establishment of an industrial-agricultural economic structure for each region and for the whole country, and an agricultural-industrial one at the district level, and for a scientifically well-grounded re-organization of production and improvement of economic and social management science. Efforts must be made to increase the technical and technological standards, especially in agriculture, in the production of consumer goods, in the industries of energy, mining, metallurgy, oil and gas, machine building, electronics, and chemical engineering. Modern scientific methods must be extensively applied to research and to various branches of the national economy. A close coordination of the development of these branches, and that of social sciences, must be ensured.

Social sciences must strive for a thorough understanding of the laws governing the development of the Vietnamese society and nation, in accordance with the historical process, towards the mastery of the country's destiny. Efforts must be concentrated on theoretical and practical problems encountered in economic, social, cultural and S&T development of a country engaged in socialist construction, in building a large-scale socialist economy from small-scale production, and in shaping a new-type, socialist man.

4.3 PROBLEMS CONCERNING THE DEVELOPMENT OF S&T POTENTIAL AND IMPROVEMENT OF S&T MANAGEMENT

In pursuit of the objectives of S&T policy, a decisive factor will be the full exploitation of all existing S&T potential in terms of personnel, organization and material and technical bases with a view to solving the most pressing demands in economic and social development; the mobilization of all S&T forces in programmes of scientific and technological progress and research projects; and the working out of necessary regulations and measures to favourably enable the scientific and technological staff to effectively serve production and life. At the same time development of S&T potential must be continued in a comprehensive, balanced manner for the attainment of both immediate and long term objectives in S&T policy.

i. Training, upgrading and use of S&T personnel

Efforts must be made to plan in a rational way the training, upgrading and use of S&T personnel with a view to giving full scope for the development of the capacities of each individual and of the whole contingent.

To quickly form complete S&T units capable of handling the most important, most decisive problems of science and technology while paying attention to reinforcing production units with capable S&T staff who will effectively help in the application of S&T to production.

A policy must be instituted to stimulate S&T personnel engaged in teaching to take part in research and production and, inversely, those engaged in research, production and management, to take part in teaching, especially leading specialists and other highly competent researchers.

Suitable policies and organizational measures must be adopted to enable overseas Vietnamese to take a direct part, in greater numbers, in S&T development at home.

A strong stimulus must be given to post-graduate training, under strict supervision as to planning and quality, to ensure a well-proportioned S&T structure. Training at this level must be extended in the country to cover both associate doctors and doctors. Teaching cadres must be standardized according to their academic degrees.

Special attention must be given to the training, upgrading and proper employment of skilled workers as an indispensable force which will help in the introduction of S&T into production and with improving the quality of products, and which will join the masses of labouring people in the march on the S&T front, in developing technical innovation and production rationalization proposals. On the basis of complete equality in education, and of the availability of high quality education to everybody, attention must be paid to training excellent S&T specialists and to providing the nation with real talents.

ii. Improvement of the system of R&D institutions

As the highest research body of the SRV, the Academy of Sciences will be founded and be staffed with highly competent scientists and technologists who are well-grounded in politics and have made considerable contributions to the construction and defence of the country and who are the worthy representatives of our national science. The Academy will conduct fundamental research in social and natural sciences while undertaking prospective research directions in those branches of S&T which are decisive to economic, social and S&T development in the country. The Academy will provide guidance on research directions in the natural and social sciences on a nation-wide scale and take part in the elaboration of the national STP.

R&D institutions in the various economic and technical sectors must be re-adjusted, re-organized and strengthened on a principle of attaining uniformity in activities from research to production. These also include important design and experimentation offices and trial-production establishments. Science-production complexes must be gradually licked into shape with a view to shortening the lapse of time in introducing research results into production.

Each university must be simultaneously a teaching institution and a research base, and make full use of its techno-material bases while setting up specialized thematic research groups or interdisciplinary research bodies.

iii. Adequate investment in S&T activities

It should be clearly understood that the poorer the conditions of the economy and the lower the level of production, the greater attention one has to give to investment in S&T activities and to the training of S&T personnel and skilled workers. Only in this way can one quickly raise social productivity and radically solve problems arising in production and the economy as a whole.

On the basis of a rational reorganization of R&D system, investment must be made selectively to ensure that the institutions which have been set up may operate smoothly throughout the R&D process and may promptly put into practice the research results obtained.

iv. Strengthening material and equipment supplies to R&D as an imperative condition for S&T development

All essential material and equipment for R&D must be controlled on a national scale, from planning, allocation of foreign exchange, import, manufacture at home, to replacement and repair.

Effective forms must be worked out to organize joint use of equipment for full exploitation of the existing capacity and to provide scientific services in analysis, experimentation, renting equipment and maintenance of scientific equipment.

An effort must be made to build enterprises specializing in the production and manufacture of scientific material and equipment.

v. Special attention must be paid to the development of S&T information as an extremely important factor for S&T development.

S&T information must actively help in shortening the time lapse between research and production and in improving administration and management quality.

S&T information must combine domestic information with foreign information, and S&T information with techno-economic information, all of which must be disseminated. The existing information system must be consolidated and developed and gradual steps must be taken to build a national system comprising specialized and sector-oriented information centres, information offices in research, teaching, production and management bodies, in localities and economic regions.

Information on discoveries and inventions must be improved and library services, translation and publication of valuable foreign scientific literature stepped up.

Steps must be taken to modernize S&T information activity so as to make it compatible with foreign and international information systems.

Discovery and invention activity in the country must be developed and international co-operation stepped up for broader exchanges of patents and licences while organizational measures must be created for their wide and effective adaptation to the country's specific conditions. This is an important approach to accelerating S&T progress.

vii. Improvement of the management system

Efforts must be exerted to improve S&T planning to make it a really effective instrument for management. The planning method of targeted programming should be developed to overcome such drawbacks as dispersion, duplication and inefficiency of S&T activities.

S&T planning must be based on long-term forecasts, and aimed at solving the most pressing problems of economic planning and must constitute an indispensable organic component of planning. Its contents must embrace the entire process from research and design to trial production and production, and must strike a balance between financial resources and techno-material means.

Supervision and control must be stepped up with regard to the execution of plans, so must the evaluation of the quality of the execution.

The use of economic levers must be increased and various forms of incentive adopted to stimulate S&T activities and accelerate the introduction of S&T achievements into production. The financial allocation and management processes must be improved to suit each type of S&T activity.

Economic accounting must be gradually applied to a number of types of R&D while encouraging economic contracts between R&D bodies, as well as betweeen them and production units. Attention must be paid to the use of both moral and material incentives regarding S&T personnel on the basis of the productivity of their creative labour and the economic effectiveness of their S&T activities.

Managerial measures must be combined with the organization of mass movements through the activities of the Federation of Trade Unions and the Ho Chi Minh Communist Youth Union.

The S&T management system must be improved along the lines of strengthening the functions, tasks and competency of the agencies concerned, while consolidating and developing the activity of the S&T councils at all levels and in different sectors so that they can fulfil their advisory function regarding their respective leading staff.

PART 5.

Bibliography

Constitution of the Socialist Republic of Vietnam.

Laws on the Organization of the SRV State Council.

Laws on the Organization of the SRV Council of Ministers.

Decrees on the Organization and Activity of Ministries and State Commissions.

Resolutions of the IVth Congress of the Communist Party of Vietnam.

Resolution of the Political Bureau of the Central Committee of the Communist Party of Vietnam on Science and Technology Policy. 1981.

Vo Nguyen Giap. *Some Problems of the Scientific and Technological Revolution in Vietnam.* Su That, Hanoi: 1976.

Evaluation of Results in S&T Co-operation Over the Past 20 Years, (1956-1976) and Principles, Directions and Contents of S&T Co-operation in Forth-Coming Years. The External Co-operation Department under SCST.

Statistics Yearbooks of the Democratic Republic of Vietnam (1971, 1972, 1973, 1974, 1975).

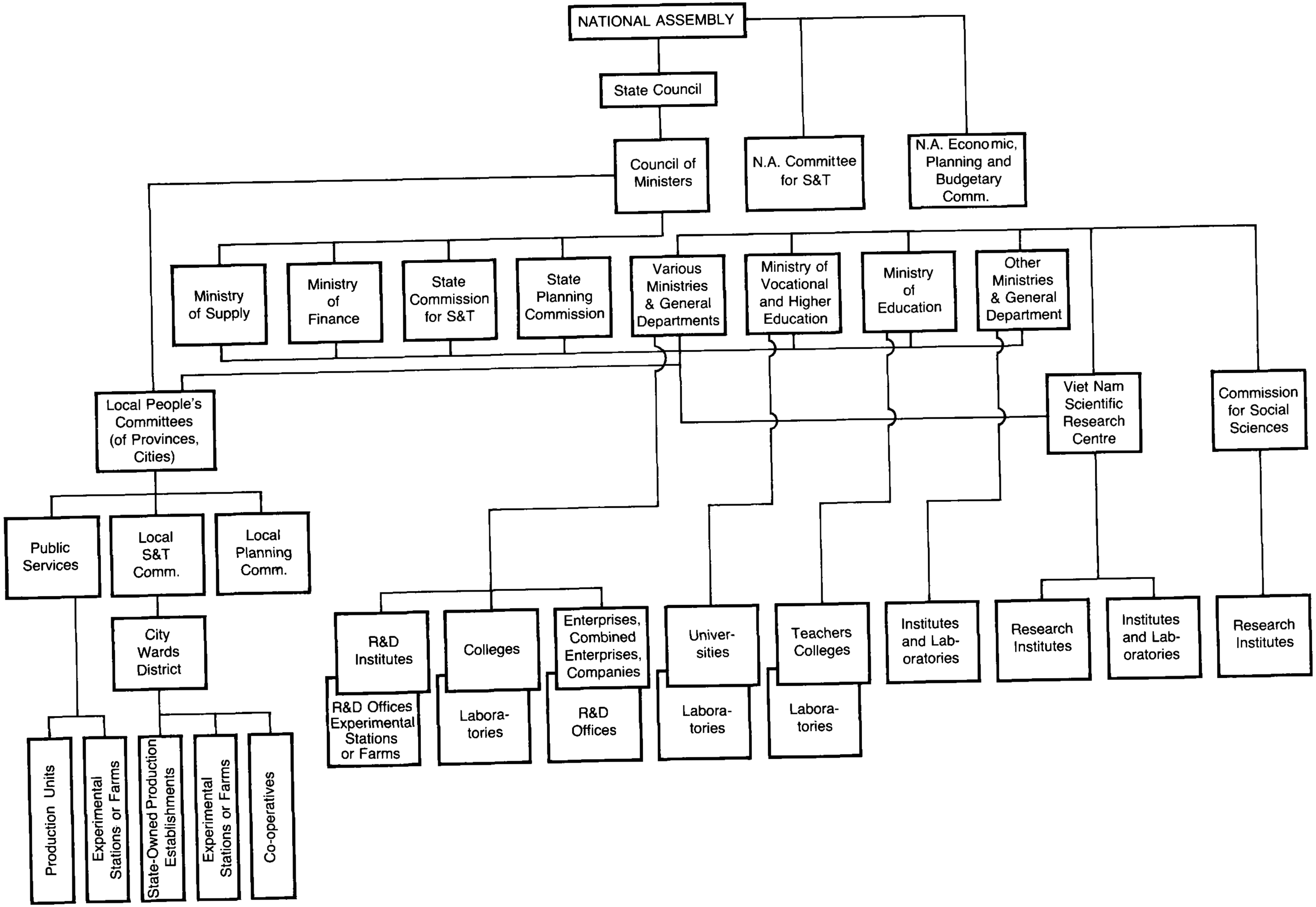
Statistics Yearbooks of the Socialist Republic of Vietnam (1976, 1977, 1978, and 1980)

Final Report – Meeting of Directors of National Councils for Science Policy and Research in Asia and Oceania (Malaysia, 24-29 November 1975).

The Draft Inter-Country Programme for Asia and Pacific. 1982-1986. UNDP, New-York: 1981.

Country Programme for Vietnam: UNDP Assistance Requested by the Government of Vietnam for the Period 1982-1986.

Figure No. 1 - DIAGRAM OF S&T ACTIVITY IN THE SRV



Annex A

Distribution : limited

UNESCO/NS/ROU/474
Paris, 27 June 1980
Original : English

UNITED NATIONS EDUCATIONAL,
SCIENTIFIC AND CULTURAL ORGANIZATION

Second Conference of Ministers responsible for the application
of science and technology to development and those responsible
for economic planning in Asia and Oceania (1982)

CASTASIA II

GUIDELINES FOR THE PREPARATION OF COUNTRY REPORTS ON SCIENCE AND TECHNOLOGY POLICY

Contents

Please address all enquiries on
this document to :
The Coordinator, CASTASIA II Conference
Division of Science and Technology Policies,
Unesco
Place de Fontenoy
75700 PARIS, France

SC-80/WS/45

I - INTRODUCTION

Subject to approval by its next General Conference (Belgrade, September-October 1980), Unesco plans to hold a second ministerial Conference for the Asia and Oceania region (CASTASIA II) in the first half of 1982. The first CASTASIA was held in New Delhi in 1968.

The Conference will bring together ministers responsible for the application of science and technology to development and ministers responsible for economic planning from all countries of Asia and Oceania which are Member States of Unesco,* as well as representatives of a number of UN institutions and regional intergovernmental and non-governmental organizations.

The purpose of the Conference is to take stock of major science and technology developments which have taken place in the region in the recent past and provide guidance for the expansion of regional cooperation activities in the future.

It is envisaged that the Conference will examine the following questions on its agenda :

(1) Trends in the countries of the region in respect of scientific and technological development since the first CASTASIA Conference in 1968;

(2) Obstacles in the way of this development, and the means of increasing the scientific and technological potential of the participating countries;

---

* Afghanistan, Australia, Bangladesh, Burma, China, Democratic Kampuchea, Democratic People's Republic of Korea, India, Indonesia, Iran, Japan, Lao People's Democratic Republic, Malaysia, Mongolia, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Republic of Korea, Singapore, Socialist Republic of Viet Nam, Sri Lanka, Thailand, Union of Soviet Socialist Republics.

(3) Problems involved in the direction and organization of research and of scientific and technological services due in particular to changes in employment policies; and

(4) Prospects afforded by regional cooperation.

The review and assessment of current national and regional activities and the examination of prospective cooperation programmes and arrangements will be made within the broad framework of the new international economic order, as well as, more specifically, in relation to the recommendations of the United Nations Conference on Science and Technology for Development (UNCSTD, Vienna, August 1979).

Purpose of guidelines

Prior to the Conference, the Secretariat will issue a number of documents to serve as reference material in the discussion of the various agenda items. One of these documents will report on the state of progress in science and technology in the region with an overall analysis of trends, region-wide, and a description on a country-by-country basis of resources, achievements and problems, and related policies and priorities.

According to now established practice in the organization of regional ministerial conferences on science and technology policy by Unesco, the progress report will be compiled from contributions prepared by national teams, under the authority of the national body responsible for science and technology policy where such body exists. The present guidelines are being issued for these teams to ensure homogeneity in presentation and treatment, and it is therefore kindly requested that they be adhered to to the fullest extent possible, both as regards information coverage and concepts used. This will facilitate the work of the Secretariat in carrying out subsequent cross-country analyses and international comparisons, and in editing and formating the manuscripts.

II - PRACTICAL CONSIDERATIONS

Nature of documents to be prepared

Two types of documents are being requested from national authorities : (1) the manuscript of a country report, to be established according to the substantive guidelines described in section III and (2) on separate forms, the three data sheets (one data sheet on S&T organizations and two statistical tables on S&T manpower and on R&D expenditure) filled in according to the format shown in Tables 1, 2 and 3 in Section III.

Information base

Much of the information base needed for preparing the country report and filling in the data sheets is likely to be available in some form or other. The authors of the country reports are especially referred to two outstanding sources of information :(1) the national papers prepared for UNCSTD and (2) statistical surveys of scientific and technological activities conducted periodically in the Member States by Unesco (Questionnaire STS/Q/781, dated April 1978, and a short version, STS/Q/791, dated April 1979, circulated through Unesco National Commissions). The information contained therein must however be up-dated and adapted in a form suitable to the country reports.

Length of manuscript

In order to ensure balance in information content, account must be taken of the variable amount of such information which can justifyably go into a report, depending on the size and complexity of scientific activity going on in the country. On that basis, it is recommended that the length (in standard pages , standard page = 320 words) of manuscripts be approximately as follows :

45-50 pages : China, India, Japan, USSR.
35-45 pages : Australia, Bangladesh, Burma, Indonesia, Iran, Korea Korea (DPR), Korea (Republic of), Malaysia, New Zealand, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, Vietnam.
25-30 pages : Afghanistan, Kampuchea, Laos, Mongolia, Nepal, Papua New Guinea.

Deadline for submission

Manuscripts and data sheets should reach the following addressees at the latest by 1 November 1980 :

one copy to : Director of the relevant Regional Office of Unesco :

(1) South and Central Asia :

Unesco House,
17 Jor Bagh (Lodhi Road)
NEW DELHI 110003
India

(2) South-East Asia :

United Nations Building
Jalam Thamrin 14
273 JKT Tromolpos
JAKARTA
Indonesia

two copies to : The Coordinator, CASTASIA II Conference
Division of Science and Technology Policies
UNESCO
7 Place de Fontenoy
75700 PARIS
France.

Channel of transmission

To facilitate communications with the Secretariat, it is advised that responsibility for co-ordinating the various activities leading up to a consolidated draft of the country report be entrusted to the National Liaison Committee for CASTASIA II which has been appointed at the request of Unesco. This link will allow the Secretariat to solve any difficulties which may arise in the editing of the manuscripts before printing.

Identification

In transmitting the report, please give the names and addresses of (1) the organization under whose responsibility the report was established and (2) the principal organizations, if any, which have contributed to its establishment.

III - STRUCTURE AND CONTENT

The country report is meant to provide the reader with a factual and up-to-date account of past trends, current situation and planned developments of scientific and technological activity in the given country. It should lead him, from the consideration of facts and figures and a description of mechanisms and processes, to an understanding of the problems facing the country and enable him to assess the related policies. Therefore the following standard structure is proposed, with an indication of the percentage length of the report to be devoted to the treatment of each part :

Standard structure of country report		Percentage of total length
Part 1	GENERAL FEATURES	15 %
1.1	Geopolitical setting	
1.2	Socio-cultural and economic setting	
1.3	Development scene	
Part 2	SCIENCE AND TECHNOLOGY POLICY FRAMEWORK	25 %
2.1	Development policy framework	
2.2	Development policy and science and technology policy	
2.3	Policy-making machinery for science and technology	
Part 3	SCIENTIFIC AND TECHNOLOGICAL POTENTIAL	25 %
3.1	Institutional network	
3.2	Human resources	
3.3	Financial resources	
3.4	Surveying of the S&T potential	
Part 4	POLICY ISSUES IN SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT	30 %
4.1	Major developments	
4.2	Achievements and problems	
4.3	Objectives and priorities	
4.4	Scientific and technological cooperation	
Part 5	BIBLIOGRAPHY	5 %

In order to enhance the impact of the text, it is suggested that authors resort to a limited number of tables and charts to present information in compact form.

Apart from the tables and charts which would be incorporated in the text, authors are requested to establish three data sheets to be produced separately from the report. These data sheets are referred to as Tables 1, 2 and 3 in this section.

In the overall progress report document to be published by Unesco, each country report will be accompanied by two country profile data sheets : (1) a table showing basic data on demographic, economic, educational and scientific and technological statistics, and (2) a chart displaying the structure of the national S&T advice and executive system. These two country profile data sheets will be prepared by the Secretariat on the basis of (1) statistics published by the United Nations and its Specialized Agencies, and (2) information contained in Tables 1, 2 and 3.

Instructions are given below on the content of each section and sub-section.

PART 1 - GENERAL FEATURES

1.1 Geopolitical setting

Brief description of major geographical and physical features of the country, including : official name (in English), geographical location, land surface (in sq. km.) and population, of both the country and its capital city; climate characteristics; land and water resources; other natural resources ; major urban centres; major seaports and airports and average traffic. Brief description of the political system of the country, e.g. supreme authority, executive and legislative bodies, administrative structure, etc...

1.2 Socio-cultural and economic setting

Brief description of the social and cultural features of the population (composition of social groups, religious groups, language groups, etc..) and of the country's economy (major economic sectors and their relative importance, major export commodities, trade balance, etc..)

1.3 Development scene

Brief description of the development scene of the country, e.g. major problems hindering the development process, their interconnection, specify whether transient or endemic. Also mention major assets, favourable conditions, etc..

PART 2 - SCIENCE AND TECHNOLOGY POLICY FRAMEWORK

2.1 Development policy framework

State the current global and sectoral objectives and priorities of development and outline major undertakings (physical, economic or otherwise), if any, planned for the coming 5-10 years.
Brief description of procedures used in development planning, evaluation and control, with an itemization of those government bodies playing a key role in the process. This description may conveniently be supported by an organization chart showing graphically the various steps and partners involved in the process.

2.2 Development policy and science/technology policy

Describe briefly the current situation as regards the relationship between the two policy areas, and the degree of interdependence between the two policy formation processes (procedural and institutional linkages). Specify on what basis, and by which arrangements, scientific and technological activity is being made consonant with development goals and objectives, is being funded, and the innovation potential of its results is being taken into account in the very setting of such goals and objectives.

2.3 Policy-making machinery for science and technology

The degree of formalisation in this policy area varies considerably according to countries, and it is therefore necessary to go into somewhat more detail in this section, in order to enable the reader to grasp common underlying issues.

First outline the development of national S&T policy making bodies from a broad historical perspective (i.e. in the past 15 years).

Identify the national body or bodies which currently play the major role in formulating the government's science and technology policy, and describe their salient features (main authority to which it relates, composition, working methods, linkages to technical ministries and research establishments, etc..). This description may conveniently be supported by an organization chart showing the internal structure of the main body and its connections with the institutional environment.

Give a brief description of organizations exercising ancillary functions, i.e. promotion and financing of R&D and scientific and technological services (STS).

Give a brief account of the role played in science and technology policy-making by, wherever applicable, the private sector, by the academic community, by professional associations of scientists and technologists (learned societies, academies of sciences, etc..)

Give a brief description of national institutions established to provide services related to technology transfer (whether of the vertical or horizontal variety).

Table 1

In order to have an overall view and a clear understanding of the network of relationships linking the various organizations or bodies involved in the policy-making process, a data sheet should be prepared according to the format shown in Table 1. In order to minimize the size of the lists of organizations, these should be treated in aggregates whenever possible, e.g. an entry should be labeled CSIR laboratories, or State universities, etc.. without itemizing them. In that case however, an indication should be given of the size of the category, e.g. the number of laboratories or universities involved.

COUNTRY :

Table 1 - Nomenclature and networking of S&T organizations

I - First level - POLICY-MAKING

ORGAN (e.g. Councils, boards, committees, commissions, agencies, government departments etc..)	FUNCTION (e.g. control, coordination, executive, advisory)	LINKAGES		
		Upstream linkage	Down-stream linkages	Major collateral linkages
...	...	...	...	...

II - Second level - PROMOTION & FINANCING

ORGANIZATION	LINKAGES		
(e.g. Professional associations- private or public -, research or university grants committees, research councils, academies of science, funding agencies, foundations, etc..)	Upstream (authority to which it reports)	Downstream (performance organizations concerned)	Other linkages (if any)
...	...	...	...

III - Third level - PERFORMANCE OF STA *

ESTABLISHMENT (e.g. research establishment, institute, academic institution, etc..)	FUNCTION (e.g. major type of activity : R&D, STET, STS)*	LINKAGES	
		Upstream linkage (authority to which it reports)	Other major linkages (e.g. advisory board, funding agency, etc..)
...	...	...	...

* STA : Scientific and technological activities
STET : Scientific and technological education and training
STS : Scientific and technological services

PART 3 - SCIENTIFIC AND TECHNOLOGICAL POTENTIAL

3.1 Institutional network

Describe briefly the range of institutions which perform scientific and technological activities (R&D, STET and STS; see Definitions, under Section IV). Give in outline indications on the size of the major ones, their recent historical development, their working methods, and their internal efficiency and external effectiveness.

3.2 Human resources

Describe in qualitative and quantitative terms the current state and trends of human resources development in science and technology. Quantitative figures are to be conveniently summed up according to the format shown in Table 2. Please fill in as comprehensively and accurately as possible. Provide information on past trends and expected future trends of the supply of S&T manpower, as measured by university graduates output (total number together with a breakdown according to level - from doctorate level down - and to field, as in Table 2). On the qualitative side, provide information on : the quality, adequacy and relevance of training; career development for scientific researchers, including access of woman to research careers; legislation in force, or contemplated, to ensure public service status to research scientists, etc...; the extent of gains/losses due to brain-drain, and the position of the government on that question, viz. the positive and negative aspects of the phenomenon, with substantiating figures to capture it quantitatively (e.g. the average yearly loss in percentage of the total stock of S&T personnel due to brain-drain).

3.3 Financial resources

Give a description of government financing mechanisms for research. State on what basis financial outlays are determined. Provide information on past, current and projected trends in R&D expenditure by filling in Table 3. Table 3a is intended to give a picture of the financing structure in a given year, preferably 1979, or else the most recent year for which information is available; Table 3b a picture of evolution over time of overall financial outlays.

Table 2 - Scientific and technological manpower

Country : ☐

Year	Population (millions)	Scientists and engineers							Technicians	
		Total stock (thousands)	of which working in R&D**						Total stock (thousands)	of which working** in R&D (in units)
			Total number (in units)	Breakdown by field of educational training (in units)						
				Natural sciences	Engineering & technology	Agricultural sciences	Medical sciences	Social sciences		
1965										
1970										
1975										
1979										
1985*										
1990*										

* Projected

** In full time equivalent (FTE, see Definitions under Section IV).

Table 3 - R&D expenditures

Country :

Currency :

(e.g. rupee, kina, yen, etc..)

Table 3a : Breakdown by source and sector of performance

Year :

Unit (e.g. thousands, millions, crores, etc..) :

Source Sector of performance	National		Foreign	Total
	Government funds	Other funds ●		
Productive				
Higher education				
General service				
Total				

● Specify which major type of funds (e.g. private funds, productive enterprise funds, special funds, foundations, etc...) :

Table 3b : Trends

Year	Population (millions)	GNP (in: ____________)**	Total R&D expenditures (in : ________)**	Exchange rate 1 US. $ =
1965				
1970				
1975				
1979				
1985 *				
1990 ●				

* Projected

** Specify which currency unit (e.g. thousands, millions, etc..)

3.4 Surveying of the S&T potential

Give details on existing institutional and organizational arrangements for collecting and analysing numerical data and other information on the resources available for the national scientific and technological effort. Specify whether centralized services exist to perform this task, and methods used in surveying, processing and utilizing the information.

PART 4 - POLICY ISSUES IN SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

4.1 Major developments

List major developments which have occurred in the country over the past ten years and which have had or are expected to have a major impact on the conduct of research, on the increase of the national S&T capacity, or on conditions in which science and technology are applied.

4.2 Achievements and Problems

Describe briefly achievements and problems in developing the S&T capacity of the country and/or in applying S&T to its development. Mention the major problems encountered in this process.

4.3 Objectives and priorities

Mention the major policy objectives which derive from these problems, and the priorities set for the science and technology policy of the country.

4.4 Scientific and technological cooperation

Describe the S&T cooperation policy of the country, and outline the major cooperation programmes which the country conducts at present, including those undertaken under bilateral agreements.

PART 5 - BIBLIOGRAPHY

Statements in the text should be supported by appropriate documentation, whenever applicable and possible. List here the reference material referred to in the text, indicating :

(1) the exact title of the work;
(2) the place of publication and name of publisher;
(3) the year of publication.

The works listed in the bibliography should be numbered and referred to by their number in the text.

IV - DEFINITIONS

For the sake of clarity we recall here the definitions of the main concepts used in the guidelines. These definitions are adapted from conventional usage, or from internationally adopted texts (e.g. Recommendation concerning the International Standardization of Statistics of Science and Technology, adopted by the Unesco General Conference in 1978). Whenever local usage differs, and the same terms are used in a country report with different meaning or scope, this should be indicated in a footnote.

DEVELOPMENT

The term refers to the process of growth and change which a community undergoes over time in all aspects (cultural, social, educational, scientific and technological etc.. not just economic) of its evolution, and in directions dependent on set valuation criteria. The development goals represent these directions at the broadest level (e.g. satisfaction of basic human needs, economic self-reliance, income distribution, full employment, etc..) The development objectives specify anticipated achievements aimed at in the various sectors of activity (agriculture, industry, health, education, etc..) through the application of given development strategies which set rules for determining alternative courses of action (e.g. agricultural vs. industrial development, urban vs. rural development, export vs. domestic market orientation of production, etc..). Development plans display, over given periods, the quantitative targets to be aimed at, and the related mix of resources to be committed.

SCIENCE AND TECHNOLOGY

Science refers to the body of knowledge, comprising empirical observations and intellectual constructs (theories), which provides for a rational understanding of physical systems (physical sciences), living systems (life sciences) and social systems (social sciences), through the disclosure of experimentally verifiable laws which govern their behaviour. The term here is also meant to cover mathematics. Technology refers to the body of scientifically based processes and procedures aimed at achieving a practical purpose, especially the production of goods and services.

For the purpose of classifying scientific manpower data by field of educational training, the fields of science and technology are conveniently broken down as follows :

(1) Natural sciences, including : astronomy, bacteriology, biochemistry, biology, botany, chemistry, computer sciences, entomology, geology, geophysics, mathematics, meteorology, mineralogy, physical geography, physics, zoology, other allied subjects.

(2) Engineering and technology, including : engineering proper, such as chemical, civil, electrical and mechanical engineering, and specialized subdivisions of these ; forest products; applied sciences such as geodesy, industrial chemistry, etc.; architecture; the science and technology of food production; specialized technologies or interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology; other allied subjects.

(3) Medical sciences, including : anatomy, dentistry, medicine, nursing, obstetrics, optometry, osteopathy, pharmacy, physiotherapy, public health, other allied subjects.

(4) Agricultural sciences, including : agronomy, animal husbandry, fisheries, forestry, horticulture, veterinary medicine, other allied subjects.

(5) Social sciences, including : anthropology (social and cultural) and ethnology, demography, economics, education and training, geography (human, economic and social), law, linguistics, management sciences, political sciences, psychology, sociology, organization and methods, miscellaneous social sciences and interdisciplinary, methodological and historical S&T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences.

The expression science and technology policy as used here, refers to the sum of legislative and executive measures taken by a government, on the basis of accepted principles and methods, and designed so as to build up the national scientific and technological potential with a view to meeting a country's political and development goals (economic, social and cultural, including the country's contribution to the advancement of science as such). The national scientific and technological potential (STP) comprises the whole of the organized resources (manpower, finance, equipment and information) which the country has at its sovereign disposal for the purposes of discovery, invention and technological innovation and for the study of national and international problems that science and its applications involve.

In reference to the transfer of technology, a distinction is conveniently made between two broad varieties : (1) Vertical transfer : process whereby ideas flow from basic scientific knowledge, through applied research and experimental development, to their embodiment in technological innovations and (2) horizontal transfer : process whereby a technology is being propagated through different industrial branches in the same country or through similar industrial branches in other countries (conventional usage of the expression "technology transfer" usually refers to this last case).

SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES (STA)

We refer here to systematic activities concerned with the generation, advancement, dissemination, and application of scientific and technical knowledge in all fields of science and technology. These include three broad categories of activities : research and experimental development (R&D), scientific and technological education and training (STET) at broadly the third level (i.e. university level or equivalent), and scientific and technological services (STS).

(1) Research and experimental development : systematic, creative activity undertaken in order to increase the stock of knowledge, or to make use of existing knowledge to devise new applications. A number of categories should be distinguished :

(i) Research in the natural sciences, engineering and technology, and the medical and agricultural sciences : aims at ascertaining the links between, and the nature of, natural phenomena, generating knowledge of the laws of nature and contributing to the practical application of this knowledge of laws, forces and substances;

(ii) Research in the social sciences : aims at increasing or improving knowledge of man, culture and society, including use of such knowledge for the solution of social problems.

In either of the above two categories, research may be classified as either fundamental or applied. Fundamental research : experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular or specific application or use in view. Applied research : original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

(iii) Experimental development : systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products and devices, to installing new processes, systems and services, and to improving substantially those already produced or installed.

(2) S&T education and training (STET) : all activities comprising specialized non-university higher education and training, higher education and training leading to a university degree, post-graduate and further training, and organized lifelong training for scientists and engineers. These activities correspond broadly to ISCED levels 5,6 and 7.

(3) Scientific and technological services (STS) : this category covers the following types of activities :

(i) S&T services provided by libraries, archives, information and documentation centres, reference departments, scientific congress centres, data banks and information-processing departments.

(ii) S&T services provided by museums of science and/or technology, botanical and zoological gardens and other S&T collections (anthropological, archaeological, geological, etc.).

(iii) Systematic work on the translation and editing of S&T books and periodicals (with the exception of textbooks for school and university courses).

(iv) Topographical, geological and hydrological surveying ; routine astronomical, meteorological and seismological observations; surveying of soils and of plants, fish and wildlife resources; routine soil, atmosphere and water testing; the routine checking and monitoring of radioactivity levels.

(v) Prospecting and related activities designed to locate and identify oil and mineral resources.

(vi) The gathering of information on human, social, economic and cultural phenomena, usually for the purpose of compiling routine statistics, e.g. population censuses; production, distribution and consumption statistics; market studies; social and cultural statistics, etc.

(vii) Testing, standardization, metrology and quality control : regular routine work on the analysis, checking and testing, by recognized methods, of materials, products, devices and processes, together with the setting up and maintenance of standards and standards of measurement.

(viii) Regular routine work on the counselling of clients, other sections of an organization or independent users, designed to help them to make use of scientific, technological and management information. This activity also includes extension and advisory services organized by the State for farmers and for industry but does not include the normal activities of project planning or engineering offices.

(ix) Activities relating to patents and licences: systematic work of a scientific, legal and administrative nature on patents and licences carried out by public bodies.

SCIENTIFIC AND TECHNOLOGICAL MANPOWER

Category of personnel comprising scientists and engineers, and technicians. The total stock of either category of personnel refers here to the total number of persons in a country at a given time with a training background which qualifies them for the given category, whether they are economically active or not, and whether their professional occupation is in line with their background or not.

Scientists and engineers are defined as professionals who have either :

(1) completed education at the third level leading to an academic degree, or

(2) received third-level non-university education (or training) not leading to an academic degree but nationally recognized as qualifying for a professional career, or

(3) received training, or acquired professional experience, that is nationally recognized as being equivalent to one of the two preceding types of training (e.g. membership of a professional association or the holding of a professional certificate or licence),

in any of the fields of science and technology mentioned above.

The technicians refer to persons who have received vocational or technical training in any branch of knowledge or technology, in accordance with the following criteria :

(1) that they have completed the second stage of second-level education. These studies are in many cases followed by one or two years' specialized technical studies, which may or may not lead to a diploma;

(2) that they have received three of four years' vocational or technical education (whether leading to a diploma or not) following completion of the first stage of second-level education;

(3) that they have received on-the-job training (or acquired professional experience) that is nationally recognized as being equivalent to the levels of education defined under (1) or (2) above.

Full-time equivalent (FTE) is a measurement unit representing one person working full-time for a given period. The unit is used to convert figures relating to the number of part-time workers into the equivalent number of full-time workers. If for instance, a category comprises 300 persons, of which 100 work full time, 100 work half time, and 100 work 1/4 time, the FTE of these 300 persons would be equal to $100 + \frac{1}{2} x\ 100 + \frac{1}{4} x\ 100 = 175$ persons.

R&D EXPENDITURES

The total R&D expenditure refers to payments from all sources made during a reference year for the performance of R&D activities in institutions or installations established in the national territory as well as installations physically situated abroad : land or experimental facilities rented or owned abroad and ships, vehicles, aircraft and satellites used by national institutions. The category covers both capital and current expenditures.

The reference year is the period of 12 consecutive months to which the statistical data relate. When this period carries over from one calendar year to the next, the year in which the period started is taken as the reference year.

The expenditures are made in sectors of performance and originate from sources of funds as defined below.

SECTORS OF PERFORMANCE

The sectors of performance identify those areas of the economy in which R&D work is performed. The term "sector of performance" distinguishes the execution or performance of R&D activities from their financing (source of funds : see next definition). It is defined as a sector of the national economy comprising a significant number of institutions carrying out R&D activities that present a certain degree of homogeneity with respect to the principal function or service provided irrespective of source of funds, the authority to which such institutions are responsible or the category of R&D being carried out. Three major sectors of performance are here distinguished : productive sector, higher education sector and general service sector, defined as follows :

(1) Productive sector, comprising : (i) domestic and foreign industrial and trading enterprises situated within the country which produce and distribute goods and services for sale, and institutions directly serving them with or without contract, whatever their form of ownership (public and private), and (ii) governmental, non-governmental and non-profit institutions most of all of whose R&D activities indirectly serve one or more of the categories or classes of activities with a two-or three-digit classification in the International Standard Industrial Classification of all Economic Activities (ISIC).

(2) Higher education sector, comprising : establishments of education at the third level which require as a minimum condition of admission successful completion of education at the second level or evidence of the attainment of an equivalent level of knowledge, together with research institutes, experimental stations, hospitals and other R&D institutions serving such establishments and directly administered by or associated with them.

(3) General service sector, comprising : (i) bodies, departments and establishments subordinate to the central,State (in federal systems), provincial, district or county, municipal, town or village authorities that serve the community as a whole and provide a wide range of services such as administration, maintenance and regulation of public order, public health, culture, social services, promotion of economic growth, welfare and technical progress, etc.; (ii) institutions such as national scientific research and technology councils, academies of sciences, professional scientific organizations and other institutions which serve the whole of the community; (iii) institutions whose R&D activities are carried out for the general benefit of agriculture, industry, transport and communications, building and public works or the public electricity, gas and water services, i.e. activities classified under a single-digit reference in the ISIC.

SOURCES OF FINANCING

(1) Government funds : funds provided by the central, State (federal) or local authorities and originating from the ordinary or extraordinary budget or from extra-budgetary sources. It also covers funds received from public intermediary institutions established and wholly financed by the State.

(2) Foreign funds : funds received from abroad for national R&D activities. Includes funds received from international organizations, foreign governments or institutions, and organizations or companies abroad which have affiliated or parent organizations or companies situated in the domestic territory.

(3) Other funds : includes funds allocated to R&D activities by institutions classified in the productive sector as productive establishments or enterprises and all sums received from the "Technical and Economic Progress Fund", in countries with a centralized economy, and other similar funds. Also includes funds that cannot be classified under any of the preceding heading, e.g. "own funds" of establishments in the higher education sector, endowments and gifts.

Annexe A

Distribution: limitée

UNESCO/NS/ROU/474
Paris, le 27 juin 1980
Original anglais

ORGANISATION DES NATIONS UNIES
POUR L'EDUCATION, LA SCIENCE ET LA CULTURE

Deuxième Conférence des Ministres chargés de l'application de la science et de la technologie au développement et des Ministres chargés de la planification économique en Asie et en Océanie (1982)

CASTASIA II

DIRECTIVES POUR LA PREPARATION DES RAPPORTS NATIONAUX SUR LES POLITIQUES SCIENTIFIQUES ET TECHNOLOGIQUES

Table des matières

Toutes les demandes de renseignements
relatives à ce document doivent être adressées au:
Coordonnateur, Conférence CASTASIA II
Division des politiques scientifiques et technologiques
Unesco
Place de Fontenoy
75700 PARIS, France

SC-81/WS/19

I - INTRODUCTION

Sous réserve de l'approbation de la prochaine Conférence générale (qui doit se tenir à Belgrade en septembre-octobre 1980), l'Unesco envisage de tenir, au cours du premier semestre de 1982, une deuxième conférence ministérielle pour la région de l'Asie et de l'Océanie (CASTASIA II). La première CASTASIA s'était tenue à New Delhi en 1968.

Cette Conférence réunira des ministres chargés de l'application de la science et de la technologie au développement et des ministres chargés de la planification économique en provenance de tous les pays d'Asie et d'Océanie qui sont membres de l'Unesco(+), ainsi que des représentants d'un certain nombre d'institutions des Nations Unies et d'organisations régionales inter-gouvernementales et non-gouvernementales.

Le but de cette Conférence est de faire le point des principaux progrès scientifiques et technologiques qui ont eu lieu dans la région au cours des dernières années et de fournir des indications en vue du développement des activités régionales à mener en coopération à l'avenir.

Il est prévu que les questions suivantes seront inscrites à l'ordre du jour de la Conference:

(1) Tendances de l'évolution scientifique et technologique depuis la première Conférence CASTASIA en 1968;

(2) Obstacles à cette évolution et moyens d'accroître le potentiel scientifique et technologique des pays participants;

(3) Problèmes liés à l'orientation et à l'organisation de la recherche et des services scientifiques et technologiques en raison, notamment, des changements intervenus dans les politiques de l'emploi; et

(4) Perspectives offertes par la coopération régionale.

(+) Afghanistan, Australie, Bangladesh, Birmanie, Chine, Inde, Indonésie, Iran, Japon, Kampuchea démocratique, Malaisie, Mongolie, Népal, Nouvelle-Zélande, Pakistan, Papouasie-Nouvelle-Guinée, Philippines, République démocratique populaire lao, République populaire démocratique de Corée, République socialiste du Viet Nam, Singapour, Sri Lanka, Thaïlande, Union des républiques socialistes soviétiques

L'examen et l'évaluation des activités nationales et régionales en cours et l'étude des programmes et des arrangements de coopération envisagés se feront à la lumière du nouvel ordre économique international et, plus précisément, en liaison avec les recommandations de la Conférence des Nations Unies sur la science et la technique au service du développement (CNUSTED, Vienne, août 1979).

Objectif des directives

Avant la Conférence, le Secrétariat diffusera un certain nombre de documents aux fins de référence pour l'examen des différents points de l'ordre du jour. L'un de ces documents fera rapport sur les progrès réalisés en matière de science et de technologie dans la région et comportera une analyse d'ensemble des tendances au niveau de la région et une description, par pays, des ressources, des réalisations et des problèmes, ainsi que des politiques et des priorités correspondantes.

Conformément aux pratiques maintenant établies à l'Unesco dans l'organisation de conférences ministérielles régionales relatives aux politiques scientifiques et technologiques, les rapports d'activité seront établis à l'aide de contributions préparées par des équipes nationales sous l'autorité, lorsqu'ils existent, des organismes nationaux responsables des politiques scientifiques et technologiques. Les présentes directives sont publiées à l'intention de ces équipes, afin d'assurer l'homogénéité de la présentation et traitement des informations; les pays sont donc priés de s'y conformer dans toute la mesure du possible, aussi bien en ce qui concerne la portée des informations que les concepts utilisés. La tâche du Secrétariat en sera facilitée lorsqu'il effectuera par la suite des analyses entre pays et des comparaisons internationales et qu'il procédera à l'édition et à la mise en forme des manuscrits.

II - CONSIDERATIONS D'ORDRE PRATIQUE

Nature des documents à préparer

Les autorités nationales sont priées de soumettre deux types de documents: (1) un projet de rapport national qui devra être établi conformément aux directives figurant à la section III, et (2) sur des formulaires séparés, trois feuilles de données (une feuille de données relative aux organisations scientifiques et techniques et deux tableaux statistiques indiquant la main d'oeuvre scientifique et technique et les dépenses de recherche et développement) qui devront être présentées sur le modèle des tableaux 1, 2 et 3 à la Section III.

Source des informations

La majeure partie de l'information nécessaire pour préparer les rapports nationaux et remplir les feuilles de données existe vraisemblablement déjà sous une forme ou sous une autre. Les auteurs des rapports nationaux devraient se référer notamment à deux sources particulièrement importantes: (1) les rapports nationaux préparés à l'occasion de la CNUSTED et (2) les enquêtes statistiques sur les activités scientifiques et techniques conduites périodiquement par l'Unesco dans les Etats membres (Questionnaire STS/Q/781, daté d'avril 1978 et une version abrégée de ce questionnaire, STS/Q/791, datée d'avril 1979, et diffusés par l'intermédiaire des Commissions nationales de l'Unesco). Toutefois, les informations contenues dans ces documents devront être mises à jour et adaptées à la présentation des rapports nationaux.

Importance des contributions

Afin d'assurer un certain équilibre des informations présentées, il convient de tenir compte du volume d'information que l'on peut raisonnablement faire figurer dans ces rapports, lequel varie selon l'importance et la complexité de l'activité scientifique du pays considéré. Il est donc recommandé que la longueur des rapports (en pages standard, une page standard = 320 mots) soit approximativement la suivante:

45-50 pages:	Chine, Inde, Japon, URSS
35-45 pages:	Australie, Bangladesh, Birmanie, Indonésie, Iran Corée (RPD), Corée (République de), Malaisie, Nouvelle-Zélande, Pakistan, Philippines, Singapour, Sri Lanka, Thaïlande, Viet Nam

25-30 pages: Afghanistan, Kampuchea, Laos, Mongolie, Népal, Papouasie-Nouvelle-Guinée.

Date-limite pour la présentation des rapports

Les projets de rapport et les feuilles de données devront parvenir à l'adresse suivante le 1er novembre 1980 au plus tard:

un exemplaire au: Directeur du Bureau régional intéressé de l'Unesco:

(1) Asie du Sud et du Centre:

Unesco House
17 Jor Bagh (Lodhi Road)
NEW DELHI 110003
Inde

(2) Asie du Sud-Est:

United Nations Building
Jalam Thamrin 14
273 JKT Tromolpos
JAKARTA
Indonésie

deux exemplaires au:

Coordonnateur, Conférence CASTASIA II
Division des politiques scientifiques et technologiques
Unesco
7, place de Fontenoy
75700 PARIS
France.

Voies de transmission

Pour faciliter les communications avec le Secrétariat, nous estimons que la responsabilité de coordonner les différentes activités aboutissant à la rédaction du projet définitif de rapport national devrait être confiée au Comité national de liaison pour CASTASIA II qui a été nommé à la demande de l'Unesco. Ce système de liaison permettra au Secrétariat de résoudre toutes les difficultés que pourrait poser l'édition des manuscrits avant leur impression.

Identification

Lors de la transmission des rapports, veuillez indiquer les nom et adresse (1) de l'organisation responsable de l'établissement du rapport et (2), le cas échéant, des principales organisations ayant contribué à sa rédaction.

III - STRUCTURE ET CONTENU

Le rapport national est censé fournir au lecteur un compte-rendu factuel et à jour des tendances passées, de la situation actuelle et de l'évolution prévue des activités scientifiques et technologiques dans le pays considéré. Ce rapport devrait permettre au lecteur, à l'aide des faits et des chiffres et de la description des mécanismes et des processus, de comprendre les problèmes auxquels le pays considéré doit faire face et d'évaluer les politiques correspondantes. C'est pourquoi nous proposons pour ces rapports la structure-type suivante et nous indiquons, en pourcentage, la longueur relative que chacune des parties devrait avoir:

Structure type des rapports nationaux		Pourcentage par rapport à la longueur totale du rapport
1ère Partie	CONSIDERATIONS D'ORDRE GENERAL	15 %
1.1	Cadre géopolitique	
1.2	Cadre socio-culturel et économique	
1.3	Situation du développement	
2ème Partie	CADRE DES POLITIQUES SCIENTIFIQUES ET TECHNOLOGIQUES	25 %
2.1	Cadre des politiques de développement	
2.2	Politiques de développement de politiques scientifiques et technologiques	
2.3	Mécanisme de décision en matière de science et technologie	
3ème Partie	POTENTIEL SCIENTIFIQUE ET TECHNOLOGIQUE	25 %
3.1	Réseau institutionnel	
3.2	Ressources humaines	
3.3	Ressources financières	
3.4	Inventaire du potentiel scientifique et technologique	
4ème Partie	POLITIQUES DU DEVELOPPEMENT SCIENTIFIQUE ET TECHNIQUE - QUESTIONS MAJEURES	30 %
4.1	Principaux développements	
4.2	Réalisations et problèmes	
4.3	Objectifs et priorités	
4.4	Coopération scientifique et technologique	
5ème Partie	BIBLIOGRAPHIE	5 %

Afin de rendre le texte plus clair, nous suggérons aux auteurs de l'illustrer au moyen de quelques tableaux et graphiques qui permettront de présenter l'information sous une forme condensée.

En dehors des tableaux et des graphiques qui seront incorporés au texte, les auteurs sont priés d'établir séparément trois feuilles de données qui, dans cette section, sont désignées sous le nom de tableaux 1, 2 et 3.

Dans le rapport général d'activité qui sera publié par l'Unesco, chacun des rapports nationaux sera accompagné de deux feuilles de données résumant le profil du pays considéré: (1) un tableau présentant des données statistiques de base se rapportant à la démographie, l'économie, l'enseignement, la science et la technologie, et (2) un graphique présentant la structure du système national de décision et de consultation scientifiques et technologiques. Ces deux feuilles de données seront préparées par le Secrétariat sur la base (1) des statistiques publiées par l'Organisation des Nations Unies et ses institutions spécialisées, et (2) des informations contenues dans les tableaux 1, 2 et 3.

Des instructions relatives au contenu de chaque section et sous-section sont données ci-après.

1ère PARTIE - CONSIDERATIONS D'ORDRE GENERAL

1.1 Cadre géopolitique

Brève description des principales caractéristiques géographiques et physiques du pays, et en particulier: nom officiel (en français), situation géographique, superficie (en km^2) et population du pays d'une part et de sa capitale d'autre part; caractéristiques climatiques, ressources en terres et en eau; autres ressources naturelles; principaux centres urbains; principaux ports de mer et aéroports et traffic moyen. Brève description du système politique du pays; par exemple, autorité suprême, organes exécutifs et législatifs, structure administrative, etc.

1.2 Cadre socio-culturel et économique

Brève description des caractéristiques sociales et culturelles de la population (composition des groupes sociaux, des groupes religieux, des groupes linguistiques, etc.) et de l'économie du pays (grands secteurs économiques et leur importance relative, principaux produits d'exportation, balance commerciale, etc.)

1.3 Situation du développement

Brève description de la situation du développement dans le pays en indiquant, par exemple, les principaux problèmes qui freinent le processus de développement, leur interconnexion et leur nature (problèmes passagers ou endémiques). Indiquez également les principaux aspects positifs, les conditions favorables, etc.

2ème PARTIE - CADRE DES POLITIQUES SCIENTIFIQUES ET TECHNOLOGIQUES

2.1 Cadre des politiques de développement

Indiquer les objectifs et les priorités globaux et sectoriels du développement et préciser, le cas échéant, les principaux programmes envisagés pour les 5-10 ans à venir (d'ordre matériel, économique ou autre). Brève description des procédures utilisées dans la planification, l'évaluation et le pilotage du développement, assortie d'une énumération des différents organismes gouvernementaux qui jouent un rôle primordial dans ce processus. Cette description pourra être accompagnée par un organigramme indiquant les différentes étapes et les différents partenaires intervenant dans le processus.

2.2 Politiques de développement et politiques scientifiques et technologiques

Décrire brièvement les rapports actuels entre ces deux secteurs de l'action des pouvoirs publics et le degré d'interdépendance entre les processus d'élaboration des deux politiques (liens institutionnels et procéduraux). Indiquer sur quelle base et selon quelles modalités l'activité scientifique et technologique est adaptée aux buts et objectifs de développement et financée et comment le potentiel d'innovation de ses résultats est pris en compte dans l'établissement même de ces buts et de ces objectifs.

2.3 Mécanismes d'élaboration des politiques scientifiques et technologiques

Ces mécanismes étant plus au moins explicites selon les pays, il est nécessaire de donner quelques détails dans cette section, afin de permettre au lecteur de saisir les problèmes communs fondamentaux sous-jacents.

Premièrement, décrire l'évolution des organismes responsables de l'élaboration des politiques scientifiques et technologiques nationales sur une assez longue période (c'est-à-dire au cours des 15 dernières années).

Identifier l'organisme national (ou les organismes nationaux) qui, à l'heure actuelle, joue(nt) le rôle principal dans la formulation de la politique scientifique et technologique du gouvernement et décrire ses caractéristiques esssentielles (autorité principale dont il relève, composition, méthodes de travail, liens avec les ministères techniques et les établissements de recherche, etc.). Cette description peut être utilement illustrée par un organigramme indiquant la structure interne du principal organisme responsable et ses liens avec l'environnement institutionnel.

Donner une brève description des organisations exerçant des fonctions accessoires, comme la promotion et le financement de la recherche - développement et des services scientifiques et techniques (SST).

Résumer le rôle joué, le cas échéant, dans l'élaboration des politiques, par le secteur privé, le milieu universitaire, les associations professionnelles de scientifiques et de techniciens (sociétés savantes, académies des sciences, etc.).

Décrire brièvement les institutions nationales établies en vue de fournir des services liés au transfert de technologie (du type vertical ou horizontal).

Tableau 1

Pour avoir une vue d'ensemble et une bonne compréhension des liens entre les différentes organisations ou organismes intervenant dans le processus d'élaboration des politiques, une feuille de données devrait être préparée conformément au modèle indiqué dans le Tableau 1. Afin de réduire l'importance des listes d'organisations, celles-ci devraient, dans toute la mesure du possible, être condensées, c'est-à-dire qu'on devrait utiliser des vocables génériques (par exemple, laboratoires CNRS, universités d'Etat, etc.) sans en donner le détail. Dans ce cas, toutefois, il conviendrait de préciser l'importance de chacune des catégories en indiquant, par exemple, le nombre de laboratoires ou d'universités pris en compte.

PAYS:

Tableau 1 - Nomenclature des organisations S - T et liens existant entre elles

I - Premier niveau - ELABORATION DES POLITIQUES

ORGANISME (par exemple, conseils, bureaux, comités, commissions, agences, services gouvernementaux, etc.)	FONCTION (par exemple, contrôle, coordination, rôle exécutif, consultatif)	LIENS		
		En amont	En aval	Principaux liens collatéraux
...	...	...	...	...

II - Deuxième niveau - PROMOTION ET FINANCEMENT

ORGANISATION	LIENS		
(par exemple, associations professionnelles - privées ou publiques -, comités chargés de l'octroi de bourses de recherche ou d'études, académies des sciences, institutions de financement, fondations, etc.)	En amont (autorité dont elle relève)	En aval (organisations chargées de l'exécution)	Autres (le cas échéant)
...	...	...	...

III - Troisième niveau - EXECUTION DES AST(+)

ETABLISSEMENT (par exemple, établissement de recherche, institut, établissement universitaire, etc.)	FONCTION (par exemple, type principal d'activité: R et D, EFST, SST)+	LIENS	
		En amont (autorité dont il relève)	Autres liens majeurs (conseil consultatif, institution de financement, etc.)
...	...	...	...

(+) AST : Activités scientifiques et techniques
EFST : Enseignement et formation scientifiques et techniques
SST : Services scientifiques et techniques

3ème PARTIE - POTENTIEL SCIENTIFIQUE ET TECHNIQUE

3.1 Réseau institutionnel

Décrire brièvement l'éventail des institutions qui exercent des activités scientifiques et technologiques (R - D, EFST, et SST; voir définitions à la Section IV). Donner quelques indications sur la taille des institutions les plus importantes, leur développement historique récent, leurs méthodes de travail, leur efficacité interne et externe.

3.2 Ressources humaines

Décrire du point de vue qualitatif et quantitatif l'état actuel et les tendances de la mise en valeur des ressources humaines scientifiques et techniques. Les indications chiffrées doivent être résumées selon la présentation indiquée au Tableau 2. Veuillez remplir le tableau de manière aussi complète et précise que possible. Donner des indications sur les tendances passées et prévues prochainement concernant l'évolution du stock des personnels S et T, à partir par exemple du nombre de diplômés des universités (nombre total et ventilation par niveau - en partant du niveau du doctorat - et par spécialité comme indiqué au Tableau 2). Du point de vue qualitatif, donner des informations sur la qualité, l'utilité et la valeur de la formation; sur le déroulement de la carrière des chercheurs scientifiques, y compris les possibilités d'accès des femmes aux carrières de recherche; sur la législation en vigueur ou envisagée pour assurer un certain statut aux chercheurs scientifiques; sur l'importance des gains/pertes dus à l'émigration des compétences ("brain-drain") et la position du gouvernement sur cette question (aspects positifs et négatifs du phénomène), avec des chiffres permettant d'en saisir les aspects quantitatifs (par exemple, la perte annuelle moyenne due à l'émigration des compétences en pourcentage de l'ensemble des personnels S et T).

3.3 Ressources financières

Décrire les mécanismes officiels de financement de la recherche. Indiquer sur quelles bases les dépenses sont fixées. Donner des informations sur les tendances passées, actuelles et projetées des dépenses en matière de recherche - développement en remplissant le Tableau 3. Le Tableau 3a a pour but de donner une image de la structure financière pour une année donnée, 1979 de préférence, ou à défaut, la dernière année pour laquelle il existe des données; le tableau 3b vise à illustrer l'évolution dans le temps des dépenses totales.

3.4 Inventaire du potentiel S et T

Donner des détails sur les arrangements administratifs et institutionnels existants pour la collecte et l'analyse des données numériques et autres informations sur les ressources disponibles pour l'effort scientifique et technologique national. Préciser s'il existe des services centralisés pour remplir cette tâche ainsi que les méthodes utilisées pour recueillir, traiter et utiliser l'information.

Tableau 2 - Personnel scientifique et technique

Pays: ☐

nnée	Population (en millions)	Scientifiques et Ingénieurs							Techniciens	
		Effectif total (en milliers)	dont employés à des travaux de R - D **						Effectif total (en milliers)	dont employés à des travaux de R-D** (en unités)
			Nombre total (en unités)	Ventilation selon la formation reçue (en unités)						
				Sciences exactes et naturelles	Sciences de l'ingénieurs	Agriculture	Sciences médicales	Sciences sociales		
1965										
1970										
1975										
1979										
1985*										
1990*										

* Chiffres projetés

** En équivalent plein temps (EPT, voir définitions à la Section IV).

Tableau 3 - Dépenses en R - D

Pays:

Monnaie nationale:

(par exemple: roupie, kina, yen, etc.)

Tableau 3a: Ventilation par source de financement et par secteur d'exécution

Année:

Unité (par exemple: milliers, millions, etc.):

Source Secteur d'exécution	Nationale		Etrangère	Total
	Fonds publics	Fonds divers *		
Secteur de la production				
Secteur de l'enseignement supérieur				
Secteur de service général				
Total				

*Indiquer la source principale des fonds (par exemple: fonds privés, fonds des entreprises de production, fonds spéciaux, fondations, etc.):

Tableau 3b: Tendances

Année	Population (en millions)	PNB (en: ________)**	Dépenses totales de R - D (en: ________)**	Taux de change 1 $ US. =
1965				
1970				
1975				
1979				
1985*				☒
1990*				☒

* Chiffres projetés

4ème PARTIE - POLITIQUES DU DEVELOPPEMENT SCIENTIFIQUE ET TECHNIQUE - QUESTIONS MAJEURES

4.1 Principaux développements

Indiquer les principaux développements survenus dans le pays au cours des dix dernières années, qui ont exercé ou devraient exercer une influence majeure sur la recherche, sur l'augmentation de la capacité S et T nationale ou sur les conditions dans lesquelles la science et la technologie sont appliquées.

4.2 Réalisations et problèmes

Décrire brièvement les réalisations accomplies et les problèmes rencontrés dans le développement de la capacité S et T du pays et/ou dans l'application de la S et T à son développement.

4.3 Objectifs et priorités

Mentionner les principaux objectifs fixés compte tenu de ces problèmes et les priorités établies pour la politique scientifique et technologique du pays considéré.

4.4 Coopération scientifique et technologique

Décrire la politique du pays en matière de coopération scientifique et technologique et exposer les principaux programmes de coopération actuellement exécutés par le pays, y compris ceux qui sont menés en vertu d'accords bilatéraux.

5ème PARTIE - BIBLIOGRAPHIE

Dans toute la mesure du possible, les indications données dans le texte devront être étayées par la documentation correspondante. Donnez ici la liste des documents de référence cités dans le texte, en indiquant:

(1) le titre exact de l'ouvrage;

(2) le lieu de publication et le nom de l'éditeur;

(3) l'année de publication.

Les ouvrages mentionnés dans la bibliographie seront numérotés et l'on se réferera à eux dans le texte au moyen de ce numéro.

IV - DEFINITIONS

Pour plus de clarté, nous rappelons ici les définitions des principaux concepts utilisés dans ces directives. Ces définitions découlent de l'usage ou de textes adoptés à l'échelon international (voir par exemple les Recommandations concernant la normalisation internationale des stastistiques relatives à la science et la technologie, adoptée par la Conférence générale de l'Unesco en 1978). Dans le cas où l'usage local diffère et où les mêmes termes sont utilisés dans un rapport national avec un sens différent, il conviendra de l'indiquer dans une note en bas de page.

DEVELOPPEMENT

On entend par là le processus de croissance et de changement que connait une collectivité au fil des ans dans tous les domaines de son évolution (culturelle, sociale, éducative, scientifique et technologique, etc. et pas seulement économique) et ceci dans des directions liées à des critères de valeur bien déterminés. Les buts du développement correspondent à ces directions au niveau le plus large (c'est-à-dire la satisfaction des besoins humains essentiels, l'indépendance économique, la distribution du revenu, le plein emploi, etc.). Les objectifs de développement précisent les résultats visés dans les différents secteurs d'activité (agriculture, industrie, santé, éducation, etc.) pour la mise en oeuvre de certaines stratégies de développement qui établissent des règles en vue de déterminer différentes possibilités d'action (par exemple: développement de l'agriculture par opposition au développement de l'industrie, développement urbain par opposition au développement rural, production orientée vers l'exportation par opposition à un type de production orientée vers le marché intérieur, etc.). Les plans de développement indiquent, pour des périodes données, les objectifs quantitatifs à atteindre et les différents types de ressources à engager dans ce but.

SCIENCE ET TECHNOLOGIE

Par Sciences on entend l'ensemble des connaissances, comprenant des observations empiriques et des constructions intellectuelles (théories), qui permettent une compréhension rationnelle des systèmes physiques (sciences exactes et naturelles), des systèmes vivants (sciences de la vie) et des systèmes sociaux (sciences sociales), grâce à la découverte des lois expérimentalement vérifiables qui les gouvernent. Dans le cas présent, ce terme s'applique également aux mathématiques. Par technologie, on entend l'ensemble des procédés et des procédures reposant sur des connaissances scientifiques, et ayant pour but des réalisations pratiques, particulièrement la production de biens et de services.

En vue de classer les données relatives aux personnels scientifiques selon les divers types de formation reçus, les différentes disciplines scientifiques et techniques sont classées comme suit:

(1) Sciences exactes et naturelles. Ranger sous cette rubrique: astronomie, bactériologie, biochimie, biologie, botanique, chimie, informatique, entomologie, géologie, géophysique, mathématiques, météorologie, minéralogie, géographie physique, physique, zoologie et disciplines connexes.

(2) Sciences de l'ingénieur. Ranger sous cette rubrique les sciences de l'ingénieur proprement dites, telles que le génie chimique, le génie civil, l'électrotechnique et la mécanique et leurs subdivisions spécialisées; les produits forestiers; les sciences appliquées telles que la géodésie, la chimie industrielle, etc.; l'architecture; la science et la technologie de la production des aliments; les technologies spécialisées ou domaines "interdisciplinaires" tels que analyse des systèmes, métallurgie, mines, technologie des textiles, et disciplines connexes.

(3) Sciences médicales. Ranger sous cette rubrique: anatomie, art dentaire, médecine, obstétrique, optométrie, ostéopathie, pharmacie, physiothérapie, santé publique, techniques des soins infirmiers, et disciplines connexes.

(4) Les sciences de l'agriculture: agronomie, zootechnie, pêche, sylviculture, horticulture, médecine vétérinaire, et disciplines connexes.

(5) Les sciences sociales. Ranger sous cette rubrique: anthropologie (sociale et culturelle) et ethnologie, démographie,. économie, éducation et formation, géographie (humaine, économique et sociale), droit, linguistique, sciences de la gestion, sciences politiques, psychologie, sociologie, organisation scientifique du travail, sciences sociales diverses et les activités S et T interdisciplinaires, méthodologiques et historiques relatives aux disciplines de ce groupe. L'anthropologie physique, la géographie physique

et la psycho-physiologie sont en principe à classer dans les sciences exactes et naturelles.

L'expression "politique scientifique et technologique" se rapporte ici à l'ensemble des mesures exécutives et législatives prises par un gouvernement, sur la base de principes et de méthodes reconnus, conçues de manière à constituer le potentiel scientifique et technologique national en vue de réaliser les objectifs politiques et de développement du pays (économiques, sociaux et culturels) et de contribuer au progrès de la science en tant que tel. Le potentiel scientifique et technologique national (PST) comprend l'ensemble des ressources organisées (main d'oeuvre, finances, équipement et information) dont le pays dispose souverainement pour découvrir, inventer et innover sur le plan technologique et pour étudier les problèmes que posent la science et ses applications aux niveaux national et international.

En ce qui concerne le transfert de technologie, on distingue en général, deux grandes catégories: (1) le transfert vertical: processus par lequel les idées nées de connaissances scientifiques de base aboutissent à des innovations techniques par l'intermédiaire de la recherche appliquée et du développement expérimental, et (2) le transfert horizontal: processus par lequel une technologie est étendue à différentes branches industrielles d'un même pays ou à des branches industrielles similaires dans d'autres pays (l'expression "transfert de technologie" se réfère généralement à ce dernier cas).

ACTIVITES SCIENTIFIQUES ET TECHNOLOGIQUES (AST)

Nous entendons par là les activités systématiques liées à la production, la promotion, la diffusion et l'application des connaissances scientifiques et techniques dans tous les domaines de la science et de la technologie. Elles comprennent trois grandes catégories d'activité: la recherche scientifique et le développement expérimental (R - D), l'enseignement et la formation scientifiques et techniques (EFST), généralement du troisième degré (c'est-à-dire de niveau universitaire ou équivalent) et les services scientifiques et techniques (SST).

(1) Recherche scientifique et développement expérimental: Activité systématique et créatrice visant à accroître le stock de connaissances ou utilisation de ce stock de connaissances pour imaginer de nouvelles applications. Il faut distinguer plusieurs catégories:

(i) Activités de recherche scientifique dans les sciences exactes et naturelles, les sciences de l'ingénieur, les sciences médicales et agricoles: ces activités visent à déterminer les liens et l'essence des phénomènes naturels, à établir les lois qui les régissent et à faciliter l'utilisation à des fins pratiques des lois, des forces et des corps existant dans la nature;

(ii) Activités de recherche scientifique dans les sciences sociales: ces activités ont pour but l'accroissement ou l'amélioration des connaissances de l'homme, de la culture et de la société, y compris leur application à la solution des problèmes sociaux.

Dans chacune des deux catégories ci-dessus, il y a lieu de faire la distinction entre recherche fondamentale et recherche appliquée. Recherche fondamentale: travaux expérimentaux ou théoriques visant essentiellement à acquérir de nouvelles connaissances sur les fondements des phénomènes et de faits observables sans but ou application pratique particuliers. Recherche appliquée: recherche originale visant à acquérir de nouvelles connaissances, mais en vue d'un but ou objectif pratique particulier.

(iii) Développement expérimental: travaux systématiques utilisant des connaissances existantes, acquises par la recherche et/ou l'expérience pratique et visant à mettre au point de nouveaux matériaux, produits et dispositifs, à mettre en place de nouveaux procédés, systèmes et services, et à améliorer substantiellement ceux qui existent déjà.

(2) Enseignement et formation S et T (EFST): Toutes les activités d'enseignement et de formation de niveau supérieur non universitaire spécialisé, d'enseignement et de formation supérieurs conduisant à un diplôme universitaire, de formation et de perfectionnement postuniversitaires et de formation permanente organisée de scientifiques et ingénieurs. Ces activités correspondent en général aux degrés 5, 6 et 7 de la CITE.

(3) Services scientifiques et techniques (SST): Ranger sous cette rubrique les types d'activités suivantes:

(i) Les services S et T fournis par les bibliothèques, les archives, les centres d'information et de documentation, services de références, centres de congrès scientifiques, banques de données et services de traitement de l'information.

(ii) Les services S et T des musées de science et/ou de technologie, des jardins botaniques et des jardins zoologiques, ainsi que d'autres collections S et T (anthropologiques, archéologiques, géologiques, etc.).

(iii) Travaux systématiques ayant pour but la traduction et l'édition de livres et périodiques S et T (à l'exception des manuels pour l'enseignement scolaire et universitaire).

(iv) Les relevés topographiques, géologiques et hydrologiques; les observations de routine astronomiques, météorologiques et séismologiques; les inventaires des sols, des végétaux, des poissons et de la faune sauvage; les tests de routine des sols, de l'air et des eaux; le contrôle et la surveillance courants des niveaux de radioactivité.

(v) La prospection et les activités associées qui ont pour but la localisation et la détermination des ressources pétrolières et minérales.

(vi) La collecte d'informations sur les phénomènes humains, sociaux, économiques et culturels dont le but est dans la plupart des cas le rassemblement des statistiques courantes comme, par exemple, les recensements démographiques; les statistiques de production, distribution et consommation; les études de marché; les statistiques sociales et culturelles, etc.

(vii) Essais, normalisation, métrologie et contrôle de qualité; travaux courants et réguliers ayant pour objet l'analyse, le contrôle et l'essai des matériaux, produits, dispositifs et processus par des méthodes connues, ainsi que l'établissement et le maintien de normes et d'unités légales de mesure.

(viii) Travaux courants et réguliers ayant pour but de conseiller des clients, d'autres sections d'une organisation, ou des utilisateurs indépendants et de les aider à appliquer des connaissances scientifiques, techniques et de gestion. Cette activité comprend également les services de vulgarisation et de consultation organisés par l'Etat pour les agriculteurs et pour l'industrie, mais exclut les activités courantes des bureaux d'études et l'ingénierie.

(ix) Activités concernant les brevets et les licences: travaux systématiques de nature scientifique, juridique et administrative, concernant les brevets et les licences, et réalisés dans des organismes publics.

PERSONNEL SCIENTIFIQUE ET TECHNIQUE

Catégorie de personnel comprenant les scientifiques et ingénieurs et les techniciens. On entend par effectif total de chacune de ces catégories le nombre total de personnes qui, dans un pays donné, à un moment donné, ont reçu une formation correspondant à la catégorie considérée, que celles-ci soient ou non économiquement actives et que leur activité corresponde ou non à la formation qu'elles ont reçue.

Les <u>scientifiques et ingénieurs</u> comprennent toutes les personnes dont la formation répond aux critères suivants:

(1) Avoir fait des études du troisième degré complètes jusqu'à l'obtention d'un grade universitaire, ou

(2) Avoir fait des études (ou acquis une formation) non universitaire du troisième degré ne conduisant pas à l'obtention d'un grade universitaire, mais reconnues sur le plan national comme pouvant donner accès à une carrière de scientifique ou d'ingénieur, ou

(3) Avoir acquis une formation ou une expérience professionnelle reconnues équivalentes sur le plan national à l'un des deux types de formation précédents (par exemple: appartenance à une association professionnelle, obtention d'un certificat ou d'une licence professionnelle),

dans l'une des disciplines scientifiques ou techniques mentionnées ci-dessus.

Les <u>techniciens</u> comprennent les personnes qui ont reçu une formation professionnelle ou technique dans n'importe quelle branche du savoir ou de la technologie, selon les critères suivants:

(1) Avoir fait des études complètes du second cycle du second degré. Ces études sont dans beaucoup de cas suivies d'une à deux années d'études de spécialisation technique sanctionnées ou non par un diplôme;

(2) Avoir fait trois ou quatre années d'études professionnelles ou techniques (sanctionnées ou non par un diplôme) après achèvement du premier cycle de l'enseignement du second degré;

(3) avoir reçu une formation sur les lieux de travail ou acquis une expérience professionnelle considérée comme équivalant sur le plan national aux niveaux d'éducation définis sous (1) ou (2) ci-dessus.

L'<u>Equivalent plein temps</u> (EPT) est une unité d'évaluation qui correspond à une personne travaillant à plein temps pendant une période donnée. On se sert de cette unité pour convertir en nombre de personnes à plein temps le nombre de celles qui travaillent à temps partiel. Si, par exemple, une catégorie donnée comprend 300 personnes dont 100 travaillent à plein temps, 100 à mi-temps, et 100 le quart de temps, l'EPT de ces 300 personnes sera égal à $100 + \frac{1}{2} \times 100 + \frac{1}{4} \times 100 = 175$ personnes.

DEPENSES DE R - D

Les dépenses totales de R - D correspondent à toutes les sommes quelle que soit leur origine, effectivement versées au cours d'une année de référence pour l'exécution d'activités de R - D dans les institutions ou installations situées sur le territoire national, y compris dans les installations qui sont géographiquement situées à l'étranger: terrains ou installations d'essai acquis ou loués à l'étranger, ainsi que navires, véhicules, aéronefs et satellites utilisés par les institutions nationales. Cette catégorie couvre aussi bien les dépenses en capital que les dépenses courantes.

L'année de référence est une période de 12 mois consécutifs à laquelle se réfèrent les données statistiques. Lorsque cette période s'étend sur deux années civiles, on considère comme année de référence celle où la période a commencé.

Ces dépenses sont effectuées dans certains secteurs d'exécution et sont couvertes par des sources de financement définies ci-après.

SECTEURS D'EXECUTION

Les secteurs d'exécution sont les secteurs de l'économie dans lesquels s'exercent les activités de R - D. La notion de "secteur d'exécution" permet de distinguer entre l'exécution des activités de R - D et leur financement (sources de financement: voir définition suivante). Le secteur d'exécution est défini comme étant un secteur de l'économie nationale groupant un nombre important d'institutions qui réalisent des activités de R - D présentant une certaine homogénéité du point de vue de leur fonction principale ou du service rendu, indépendamment de leur source de financement, du type de contrôle ou de la catégorie de R - D considéré. On distingue trois grands secteurs d'exécution: le secteur de la production, le secteur de l'enseignement supérieur et le secteur de service général.

(1) Le secteur de la production, comprenant: (i) les entreprises industrielles et commerciales nationales et étrangères situées dans le pays, qui produisent et distribuent des biens et des services contre rémunération ainsi que les institutions desservant directement ces entreprises, avec ou sans contrat, quelles que soient leurs formes de propriété (publique et privée), et (ii) les institutions gouvernementales et non-gouvernementales et les institutions à but non lucratif dont les activités de R - D servent

principalement ou exclusivement mais de façon indirecte une ou plusieurs catégories ou classes d'activités désignées par deux ou trois chiffres de la Classification internationale type, par industries, de toutes les branches d'activité économique (CITI).

(2) Le secteur de l'enseignement supérieur, comprenant: les établissements d'enseignement du troisième degré exigeant comme condition minimale d'admission d'avoir suivi avec succès un enseignement complet du second degré ou de faire la preuve de connaissances équivalentes, ainsi que les instituts de recherche, stations d'essais, hôpitaux et autres institutions de R - D qui desservent ces établissements et leur sont directement rattachés ou associés.

(3) Le secteur de service général, comprenant: (i) les organismes, ministères et établissements des administrations publiques - administrations centrales, administrations des Etats d'une fédération, des provinces, des districts, villes et villages - qui desservent l'ensemble de la communauté et fournissent une large gamme de services: administration, défense et règlementation de l'ordre public, santé publique, culture, services sociaux, promotion de la croissance économique, du bien-être et du progrès technique, etc.; (ii) les institutions telles que les conseils nationaux de la recherche scientifique et de la technologie, les académies des sciences, les organisations scientifiques professionnelles et autres institutions qui rendent service à l'ensemble de la communauté; (iii) les institutions dont les activités de R - D sont exécutées au profit de l'ensemble de l'agriculture, de l'industrie, des transports et communications, du bâtiment et des travaux publics ou des services publics d'électricité, de gas et d'eau, c'est-à-dire les activités désignées par un seul chiffre de la CITI.

SOURCES DE FINANCEMENT

(1) Fonds publics: fonds provenant du budget ordinaire ou extraordinaire, ou d'origine extrabudgétaire, fournis par le gouvernement central ou celui des provinces ou par les autorités locales. Entrent également dans cette catégorie les fonds provenant d'institutions intermédiaires publiques créées et intégralement financées par l'Etat.

(2) Fonds étrangers: fonds reçus de l'étranger pour les activités de R - D nationales -- y compris ceux provenant d'organisations internationales, gouvernements ou institutions étrangers -- ainsi que les fonds privés, provenant des organisations ou sociétés installées à l'étranger, qui ont des organisations ou sociétés mères ou affiliées situées sur le territoire national.

(3) <u>Fonds divers</u>: Dans cette catégorie entrent les fonds affectés aux activités de R - D par les institutions classées dans le secteur de la production comme des établissements ou des entreprises de production et tous les fonds provenant des "Fonds de développement technique et économique" qui existent dans les pays à économie centralisée et d'autres fonds analogues. Y entrent également les fonds qui ne peuvent être classés dans l'une des rubriques précédentes, par exemple les fonds propres des établissements du secteur de l'enseignement supérieur, les dotations ou les dons.

Annex B

Sources used in the preparation of general country data

Sources utilisées dans la préparation des tableaux d'informations générales pour chaque pays

GEOGRAPHY	
Capital city (except for Hong-Kong and Singapore)	The Stateman's Yearbook 1979/1980 edited by John Paxton The Macmillan Press Ltd. 1979
Main ports (except for China and USSR)	1975 UN Statistical Yearbook, pp. 505-509
Land surface area	1978 UN Demographic Yearbook
POPULATION (1978)	
Total	1978 UN Demographic Yearbook
Density (per sq. km.)	1978 UN Demographic Yearbook
Urban/rural ratio	Basic data used in the computation were obtained from the 1978 UN Demographic Yearbook
Average rate of growth (1970-1978)	
By age group	UN Population estimates as assessed in 1980 (medium variant) — Unesco Office of Statistics Data Bank
SOCIO-ECONOMIC	
Labour force	
Total	ILO International Yearbook of Labour Statistics (1977, 1978, 1979 & 1980 editions)
Percentage in agriculture	Percentage in agriculture were calculated using absolute figures given in the above-mentioned yearbook
Gross national product (1978)	
GNP at market prices	1980 World Bank Atlas
GNP per capita	Computed using WB figures for GNP and UN population figures
Real growth rate of GNP per capita (1970-78)	1980 World Bank Atlas
Gross domestic product	
Total (in current producers' values)	1978 UN Statistical Yearbook; in converting GDP in national currency into US dollars, IMF exchange rates shown in 1980 Unesco Yearbook were applied
Percentage by origin	
Agriculture	
Manufacturing, mining & quarrying, electricity, gas & water, construction	
Government finance	
National budget	IMF International Financial Statistics Yearbook (1979, 1980 & 1981 editions). In converting national currency into US dollars, IMF exchange rates shown in Unesco Statistical Yearbook were applied. National budget (refers to revenues) as % of GNP was computed using the budget in national currency and the GNP also in national currency (in Unesco Office of Statistics Data Bank)
As percentage of GNP	
External assistance (official, net; 1976)	UN Economic and Social Survey of Asia and the Pacific, 1978
As percentage of GNP	
Exports	
Total exports of goods (1978)	World Development Report, 1980; the World Bank
Average annual growth rate (1970-78)	
External debt (1978)	
Total public, outstanding + disbursed	World Development Report, 1980; the World Bank
Debt service ratio (% GNP) (% Exports of goods and non-factor services)	
Exchange rate (1978)	1980 Unesco Statistical Yearbook
EDUCATION Statistics	Unesco Office of Statistics

Unesco publications: national distributors

ALBANIA. N Sh Botimeve Naim Frasheri, TIRANA
ALGERIA: Institut Pédagogique National (IPN), 11, rue Ali-Haddad, ALGER Office des Publications Universitaires (OPU), Place Centrale Ben Aknoun, ALGER, ENAL, 3 Bd Zirout Youcef, ALGER *Periodicals only:* ENAMEP, 20, rue de la Liberté, ALGER
ANGOLA· Distribuidora Livros e Publicações, Caixa Postal 2848, LUANDA
ARGENTINA. Librería El Correo de la Unesco, EDILYR, S.R.L., Tucumán 1685, 1050 BUENOS AIRES
AUSTRALIA: *Publications:* Educational Supplies Pty Ltd., P.O. Box 33, BROOKVALE 2100, N S W. *Periodicals:* Dominie Pty., Subscriptions Dept, P O Box 33, BROOKVALE 2100, N.S.W *Sub-agents:* United Nations Association of Australia, P O Box 175, 5th Floor, Ana House, 28 Elizabeth Street, MELBOURNE 3000; Hunter Publications, 58A Gipps Street, COLLINGWOOD, Victoria 3066.
AUSTRIA· Buchhandlung Gerold & Co , Graben 31, A-1011 WIEN
BAHAMAS: Nassau Stationers Ltd, P.O.Box N-3138, NASSAU
BANGLADESH. Bangladesh Books International Ltd., Ittefaq Building, 1 R.K. Mission Road, Hatkhola, DACCA 3.
BARBADOS· University of the West Indies Bookshop, Cave Hill Campus, P.O Box 64, BRIDGETOWN
BELGIUM Jean De Lannoy, 202, Avenue du Roi, 1060 BRUXELLES. CCP 000-0070823-13.
BENIN· Librairie nationale, B.P. 294, PORTO NOVO. Ets. Koudjo G Joseph, B.P 1530, COTONOU; Librairie Notre-Dame, B P 307, COTONOU
BOLIVIA: Los Amigos del Libro, casilla postal 4415, LA PAZ. Avenida de las Heroinas 3712, casilla postal 450, COCHABAMBA.
BOTSWANA· Botswana Book Centre, P.O. Box 91, GABORONE
BRAZIL. Fundaçao Getúlio Vargas, Serviço de Publicaçoes, caixa postal 9 052-ZC-02, Praia de Botafogo 188, RIO DE JANEIRO (GB)
BULGARIA· Hemus, Kantora Literatura, boulevard Rousky 6, SOFIJA
BURKINA FASO: Librairie Attie, B.P. 64, OUAGADOUGOU. Librairie Catholique 'Jeunesse d'Afrique', OUAGADOUGOU.
BURMA· Trade Corporation no (9), 550-552 Merchant Street, RANGOON
CANADA: Renouf Publishing Company Ltd., 2182 St. Catherine Street West, MONTREAL. Que., H3H 1M7.
CHAD Librairie Abssounout, 24 av. Charles de Gaulle, B P 388, N'DJAMENA
CHILE Bibliocentro Ltda., Constitución n° 7, Casilla 13731, SANTIAGO (21)
CHINA China National Publications Import and Export Corporation, P O Box 88, BEIJING
COLOMBIA: Instituto Colombiano de Cultura, Carrera 3A n.° 18-24, BOGOTA
COMOROS Librairie Masiva, 4 rue Ahmed Djoumi, B.P. 124, MORONI
CONGO Commission Nationale Congolaise pour l'Unesco, B P 493, BRAZZAVILLE. Librairie Populaire, B P 577, BRAZZAVILLE (branches in Pointe Noire, Loubomo, Nkayi, Makabana, Owendo, Ouesso and Impfondo).
COSTA RICA· Librería Cooperativa Universitaria, Cuidad Universitaria 'Rodetigo Facio', SAN JOSÉ
CUBA. Ediciones Cubanas, O'Reilly No. 407, LA HABANA *For "The Courier":* Empresa Coprefil, Dragones No. 456 e/Lealtad y Campanario, HABANA 2.
CYPRUS. MAM, Archbishop Makarios 3rd Avenue, P O. Box 1722, NICOSIA
CZECHOSLOVAKIA: SNTL, Spalena 51, PRAHA 1. (Permanent display)· Zahranicni literatura, 11 Soukenicka, PRAHA 1. *For Slovakia only:* Alfa Verlag Publishers, Hurbanova nam 6, 893 31 BRATISLAVA. *For the Courier' only:* PNS-UED, Jindrisska 14, PRAHA 1.
DENMARK Munksgaard Export and Subscription Service, 35 Nørre Søgade, DK-1370 KØBENHAVN K
DOMINICAN REPUBLIC: Librería Blasco, Avenida Bolivar, No 402, esq. Hermanos Deligne, SANTO DOMINGO
ECUADOR· *Periodicals only:* Dinacur Cia Ltda, Santa Prisca n.° 296 y Pasaje Sans Luis, Oficina 101-102, Casilla 112-B, QUITO *All publications:* Casa de la Cultura Ecuatoriana, Núcleo del Guayas, Pedro Moncayo y 9 de Octubre, casilla de correos, 3542, GUAYAQUIL, Casa de la Cultura Ecuatoriana, avenida 6 de Diciembre n.° 794, casilla 74, QUITO, Nueva Imagen, 12 de Octubre 959 y Roca, Edificio Mariano de Jesús, QUITO
EGYPT. Centre for Unesco Publications, 1 Talaat Harb Street, CAIRO
EL SALVADOR· Librería Cultural Salvadoreña, S A , Calle Delgado No. 117, apartado postal 2296, SAN SALVADOR
ETHIOPIA. Ethiopian National Agency for Unesco, P.O Box 2996, ADDIS ABABA
FINLAND: Akateeminen Kirjakauppa, Keskuskatu 1, SF-00100 HELSINKI 10, Suomalainen Kirjakauppa Oy, Koivuvaarankuja 2, 01640 VANTAA 64
FRANCE. Librairie de l'Unesco, place de Fonenoy, 75700 PARIS CCP 12598-48.
GABON: Librairie Sogalivre (Libreville, Port Gentil and Franceville), Librairie Hachette, B.P 3923, LIBREVILLE
GERMAN DEMOCRATIC REPUBLIC Buchhaus Leipzig, Postfach 140, 701 LEIPZIG or international bookshops in the German Democratic Republic.
GERMANY FEDERAL REPUBLIC OF S Karger GmbH, Karger Buchhandlung, Angerhofstrasse 9, Postfach 2, D-8034 GERMERING/MUNCHEN *For scientific maps only.* Geo Center, Postfach 800830, 7000 STUTTGART 80 *For* 'The Courier' (German, English, Spanish and French edition). M. H. Baum, Deutscher Unesco-Kurier-Vertrieb, Besaltstrasse 57, 5300 BONN 3
GHANA· Presbyterian Bookshop Depot Ltd., P.O. Box 195, ACCRA Ghana Book Suppliers Ltd , P O Box 7869, ACCRA, The University Bookshop of Ghana, ACCRA. The University Bookshop of Cape Coast, The University Bookshop of Legon, P O Box 1, LEGON
GREECE· International bookshops (Eleftheroudakis, Kauffmann, etc); John Mihalopoulos & Son S A , International Booksellers, 75 Hermou Street, P.O.B 73, THESSALONIKI, Commission Nationale Hellénique pour l'Unesco, 3 rue Akadimias, ATHENS
GUADELOUPE. Librairie Carnot, 59, rue Barbès, 97100 POINTE-À-PITRE
GUATEMALA: Comisión Guatemalteca de Cooperación con la Unesco, 3a Avenida 13-30, Zona 1, apartado postal 244, GUATEMALA
HAITI: Librairie 'A la Caravelle', 26, rue Roux, B.P 111-B, PORT-AU-PRINCE
HONDURAS: Librería Navarro, 2a Avenida N° 201, Comavaguela, TEGUCIGALPA
HONG KONG Swindon Book Co., 13-15 Lock Road, KOWLOON, Federal Publications (HK) Ltd, 2D Freder Centre, 68 Sung Wong Toi Road, Tokwawan, KOWLOON, Hong Kong Government Information Services, Publication Section, Baskerville House, 22 Ice House Street, HONG KONG
HUNGARY. Akadémiai Könyvesbolt, Váci u. 22, BUDAPEST V; A K V Könyvtárosok Boltja, Népkoztársaság utja 16, BUDAPEST VI.
ICELAND· Snaebjörn Jonsson & Co., H.F., Hafnarstraeti 9, REYKJAVIK
INDIA· Orient Longman Ltd , Kamani Marg, Ballard Estate, BOMBAY 400 038; 17 Chittaranjan Avenue, CALCUTTA 13; 36a Anna Salai, Mount Road, MADRAS 2, 80/1 Mahatma Gandhi Road, BANGALORE 560001; 5-9-41/1 Bashir Bagh, HYDERABAD 500001 (AP), 3-5-820 Hyderguda, HYDERABAD 500001. *Sub-depots.* Oxford Book & Stationery Co , 17 Park Street, CALCUTTA 700016; Scindia House, NEW DELHI 110001, Publications Section, Ministry of Education and Social Welfare, 511, C-Wing, Shastri Bhavan, NEW DELHI 110001.
IRAN, ISLAMIC REPUBLIC OF: Iranian National Commission for Unesco, Seyed Jamal Eddin Assad Abadi Av., 64th St., Bonyad Bdg., P.O. Box 1533, TEHRAN.
IRELAND: The Educational Company of Ireland Ltd , Ballymount Road, Walkinstown, DUBLIN 12, Tycooly International Publ. Ltd., 6 Crofton Terrace, DUN LAOGHAIRE, Co. Dublin
ISRAEL A B C Bookstore Ltd., P.O Box 1283, 71 Allenby Road, TEL AVIV 61000.
ITALY: Licosa (Libreria Commissionaria Sansoni S.p A), Via Lamarmora 45, casella postale 552, 50121 FIRENZE, FAO Bookshop, Via delle Terme di Caracalla, 00100 ROME
IVORY COAST· Librairie des Presses de l'Unesco, Commission nationale ivoirienne pour l'Unesco, B.P 2871, ABIDJAN
JAMAICA: Sangster's Book Stores Ltd., P.O. Box 366, 101 Water Lane, KINGSTON, University of the West Indies Bookshop, Mona, KINGSTON
JAPAN. Eastern Book Service Inc., 37-3 Hongo 3-chome, Bunkyo-ku, TOKYO 113
JORDAN· Jordan Distribution Agency, P O B 375, AMMAN.
KENYA: East African Publishing House, P.O. Box 30571, NAIROBI
REPUBLIC OF KOREA: Korean National Commission for Unesco, P.O. Box Central 64, SEOUL
KUWAIT The Kuwait Bookshop Co Ltd , P O Box 2942, KUWAIT
LEBANON Librairies Antoine, A Naufal et Frères, B P 656, BEIRUT
LESOTHO: Mazenod Book Centre, P.O. MAZENOD
LIBERIA: Cole & Yancy Bookshops Ltd., P.O. Box 286, MONROVIA
LIBYAN ARAB JAMAHIRIYA: Agency for Development of Publication and Distribution, P O Box 34-35, TRIPOLI
LIECHTENSTEIN· Eurocan Trust Reg., P O B. 5, FL-9494, SCHAAN
LUXEMBOURG Librairie Paul Bruck, 22, Grande-Rue, LUXEMBOURG
MADAGASCAR· Commission nationale de la République Démocratique de Madagascar pour l'Unesco, Boite postale 331, ANTANANARIVO
MALAWI· Malawi Book Service, Head Office, P.O. Box 30044, Chichiri, BLANTYRE 3
MALAYSIA. Federal Publications Sdn. Bhd., Lot 8238 Jalan 222, Petaling Jaya, SELANGOR. University of Malaya. Cooperative Bookshop, KUALA LUMPUR 22-11
MALI· Librairie populaire du Mali, B.P. 28, BAMAKO
MALTA· Sapienzas, 26 Republic Street, VALLETTA
MAURITANIA: GRA.LI CO.MA, 1, rue du Souk X, Avenue Kennedy, NOUAKCHOTT
MAURITIUS. Nalanda Co. Ltd., 30 Bourbon Street, PORT-LOUIS
MEXICO: SABSA, Insurgentes Sur n° 1032-401, MÉXICO 12, DF; Librería El Correo de la Unesco, Actipán 66. Colonia del Valle, MÉXICO 12, DF
MONACO. British Library, 30, boulevard des Moulins, MONTE CARLO
MOROCCO. Librairie 'Aux belles images', 282, avenue Mohammed-V, RABAT, C.C.P. 68-74 *For 'The Courier' (for teachers).* Commission nationale marocaine pour l'Education, la Science et la Culture, 19, rue Oqba, B.P. 420, AGDAL-RABAT (C C P 324-45), Librairie des écoles, 12, avenue Hassan II, CASABLANCA; Société Chérifienne de Distribution et de Presse, SOCHEPRESS, angle rues de Dinant et St Saëns, B.P. 683, CASABLANCA 05.
MOZAMBIQUE: Instituto Nacional do Livro e do Disco (INLD), Avenida 24 de Julho, 1921-r/c e 1° andar, MAPUTO
NEPAL. Sajha Prakashan, Polchowk, KATHMANDU
NETHERLANDS· *Publications·* Keesing Boeken B V , Joan Muyskenweg 22, Postbus 118, 1000 BC AMSTERDAM. *Periodicals.* D & N-Faxon B V., Postbus 197, 1000 AD AMSTERDAM
NETHERLANDS ANTILLES. Van Dorp-Eddine N.V., P.O Box 200, Willemstad, CURAÇAO, N A
NEW CALEDONIA. Reprex SARL, B.P. 1572, NOUMÉA
NEW ZEALAND: Government Printing Office Bookshops: Retail Bookshop – 25 Rutland Street, Mail orders – 85 Beach Road, Private Bag, C P O , AUCKLAND. Retail – Ward Street; Mail orders – P O. Box 857, HAMILTON Retail – Cubacade World Trade Center, Mulgrave Street, (Head Office); Mail orders – Private Bag, WELLINGTON Retail – 159 Hereford Street; Mail orders – Private Bag, CHRISTCHURCH Retail – Princes Street; Mail orders – P.O. Box 1104, DUNEDIN
NICARAGUA Librería Cultural Nicaragüense, calle 15 de Septiembre y avenida Bolivar, apartado n ° 807, MANAGUA, Librería de la Universidad Centroamericana, Apartado 69, MANAGUA
NIGER· Librairie Mauclert, B P. 868, NIAMEY
NIGERIA· The University Bookshop of Ife; The University Bookshop of Ibadan, P.O Box 286; The University Bookshop of Nsukka, The University Bookshop of Lagos. The Ahmadu Bello University Bookshop of Zaria.
NORWAY· *Publications.* Johan Grundt Tanum, Karl Johans Gate 41/43, OSLO 1, Universitets Bokhandelen, Universitetssentret, P.O B 307, Blindern, OSLO 3 *For 'The Courier':* A/S Narvesens Litteraturtjeneste, Box 6125, OSLO 6.
PAKISTAN· Mirza Book Agency, 65 Shahrah Quaid-i-Azam, P.O. Box 729, LAHORE 3
PANAMA· Distribuidora Cultura Internacional, Apartado 7571, Zona 5, PANAMA
PARAGUAY: Agencia de Diarios y Revistas, Sra. Nelly de Garcia Astillero, Pte. Franco 580, ASUNCIÓN
PERU. Librería Studium, Plaza Francia 1164, Apartado 2139, LIMA
PHILIPPINES: National Book Store Inc., 701 Rizal Avenue. MANILA.
POLAND: ORPAN-Import, Palac Kultury, 00-901 WARSZAWA, Ars Polona-Ruch, Krakowskie Przedmiescie N° 7, 00-068 WARSZAWA
PORTUGAL: Dias & Andrade Ltda, Livraria Portugal, rua do Carmo 70, LISBOA
PUERTO RICO: Librería Alma Mater, Cabrera 867, Rio Piedras, PUERTO RICO 00925.
ROMANIA ARTEXIM Export/Import, Piata Scienteii n° 1, P O Box 33-16, 70005 BUCURESTI
SAUDI ARABIA: Dar Al-Watan for Publishing and Information, Olaya Main Street, Ibrahim Bin Sulaym Building, P.O Box 3310, RIYADH
SENEGAL· Librairie Clairafrique, B.P. 2005, DAKAR, Librairie des 4 vents, 91, rue Blanchot, B.P. 1820, DAKAR
SEYCHELLES. New Service Ltd., Kingsgate House, P O Box 131, MAHÉ, National Bookshop, P.O Box 48, MAHÉ.
SIERRA LEONE· Fourah Bay College, Njala University and Sierra Leone Diocesan Bookshops, FREETOWN
SINGAPORE: Federal Publications (S) Pte. Ltd., Times Jurong, 2 Jurong Port Road, SINGAPORE 2261
SOMALIA: Modern Book Shop and General, P.O Box 951, MOGADISCIO
SPAIN: Mundi-Prensa Libros S.A., Castelló 37, MADRID 1; Ediciones Liber, apartado 17, Magdalena 8, ONDÁRROA (Vizcaya), Donaire, Ronda de Outeiro, 20, apartado de correos 341, LA CORUÑA, Librería Al-Andalus, Roldana, 1 y 3, SEVILLA 4, Librería Castells, Ronda Universidad 13, BARCELONA 7.
SRI LANKA: Lake House Bookshop, Sir Chittampalam Gardiner Mawata, P.O. Box 244, COLOMBO 2.
SUDAN: Al Bashir Bookshop, P.O. Box 1118, KHARTOUM
SURINAME: Suriname National Commission for Unesco, P.O. Box 2943, PARAMARIBO
SWEDEN *Publications.* A/B C E Fritzes Kung. Hovbokhandel Regeringsgatan 12, Box 16356, S-103 27 STOCKHOLM. *For 'The Courier':* Svenska FN-Förbundet, Skolgrand 2, Box 150 50, S-104 65 STOCKHOLM (Postgiro 18 46 92). *Subscriptions:* Wennergren-Williams AB, Box 30004, S-104 25 STOCKHOLM
SWITZERLAND· Europa Verlag, Rämistrasse 5, 8024 ZURICH, Librairies Payot (Geneva, Lausanne, Basel, Berne, Vevey, Montreux, Neuchâtel, Zurich).
SYRIAN ARAB REPUBLIC Librairie Sayegh, Immeuble Diab, rue du Parlement, B P 704, DAMAS
THAILAND: Suksapan Panit, Mansion 9, Rajdamnern Avenue, BANGKOK. Nibondh & Co. Ltd., 40-42 Charoen Krung Road, Siyaeg Phaya Sri, P O. Box 402, BANGKOK; Suksit Siam Company, 1715 Rama IV Road, BANGKOK
TOGO: Librairie Evangélique, B P. 378, LOMÉ; Librairie du Bon Pasteur, B P. 1164, LOMÉ. Librairie universitaire, B.P. 3481, LOMÉ
TRINIDAD AND TOBAGO· Trinidad and Tobago National Commission for Unesco, 18 Alexandra Street, St. Clair, PORT OF SPAIN
TUNISIA: Société tunisienne de diffusion, 5, avenue de Carthage, TUNIS
TURKEY Haset Kitapevi A.S , Istiklâl Caddesi, N° 469, Posta Kutusu 219, Beyoglu, ISTANBUL
UGANDA. Uganda Bookshop, P.O. Box 7145, KAMPALA
USSR· Mezhdunamdnaja Kniga, MOSKVA G-200
UNITED KINGDOM: HMSO Publications Centre, P.O Box 276, LONDON SW8 5DT, Government Bookshops· London, Belfast, Birmingham, Bristol, Edinburgh, Manchester; Third World Publications, 151 Stratford Road, BIRMINGHAM B11 1RD. For scientific maps only. McCarta Ltd, 122 King's Cross Road, LONDON WC1X 9DS.
UNITED REPUBLIC OF CAMEROON· Le Secrétaire Général de la Commission nationale de la République Unie du Cameroun pour l'Unesco, B.P. 1600, YAOUNDÉ, Librairie des éditions Clé, B.P. 1501, YAOUNDÉ. Librairie St Paul, B P. 763, YAOUNDÉ; Librairie aux Messageries, Avenue de la Liberté, B P. 5921, DOUALA, Librairie aux frères réunis, B.P. 5346, DOUALA, Centre de Diffusion du Livre Camerounais, B P. 338, DOUALA.
UNITED REPUBLIC OF TANZANIA; Dar es Salaam Bookshop, P.O. Box 9030, DAR ES SALAAM
UNITED STATES UNIPUB, 205 East 42nd Street, NEW YORK, N Y 10017. *Order for books and periodicals:* UNIPUB, Box 1222, ANN ARBOR, MI 48106.
URUGUAY Edilyr Uruguaya, S.A., Maldonado 1092, MONTEVIDEO
VENEZUELA: Librería del Este, Av Francisco de Miranda, 52, Edificio Galipán. Apartado 60337, CARACAS. DILAE C.A. (Distribuidora Latinoamericana de Ediciones C.A.), Calle San Antonio entre Av. Lincoln y Av. Casanova, Edificio Hotel Royal – Local 2, Apartado 50 304, Sabana Grande, CARACAS
YUGOSLAVIA Jugoslovenska Knjiga, Trg Republike 5/8, P O. Box 36, 11-001, BEOGRAD. Drzavna Zalozba Slovenije, Titova C, 25, P O.B 50-1, 61-000 LJUBLJANA
ZAIRE: Librairie du CIDEP, B.P 2307, Kinshasa; Commission nationale zaïroise pour l'Unesco, Commissariat d'Etat chargé de l'Education nationale, B P 32, KINSHASA
ZAMBIA National Educational Distribution Co. of Zambia Ltd, P.O Box 2664, LUSAKA
ZIMBABWE. Textbook Sales (PVT) Ltd., 67 Union Avenue, HARARE

UNESCO BOOK COUPONS

Unesco Book Coupons can be used to purchase all books and periodicals of an educational, scientific or cultural character. For full information please write to. Unesco Coupon Office, 7, place de Fontenoy, 75700 Paris (France) [51]

ISSN 0027-3996

Publicaciones de la Unesco: agentes de venta

ALBANIA· N Sh. Botimeve Naim Frasheri, TIRANA

ALEMANIA (Rep. Fed): S. Karger GmbH, Karger Buchhandlung, Angerhofstr. 9, Postfach 2, D-8034 GERMERING/MÜNCHEN *"El Correo" (ediciones alemana, inglesa, española y francesa):* M. H Baum, Deutscher Unesco-Kurier-Vertrieb, Besaltstrasse 57, 5300 BONN *Para los mapas científicos:* Geo Center, Postfach 800830, 7000 STUTTGART 80.

ALTO VOLTA: Librairie Attie, B.P. 64, OUAGADOUGOU. Librairie catholique "Jeunesse d'Afrique", OUAGADOUGOU

ANGOLA: Distribuidora Livros e Publicações, Caixa postal 2848, LUANDA

ANTILLAS FRANCESAS· Librairie "Au Boul'Mich", 66 avenue des Caraïbes, 67200 FORT-DE-FRANCE (Martinica); Librairie Carnot, 59 rue Barbès, 97100 POINTE-À-PITRE (Guadalupe).

ANTILLAS NEERLANDESAS· Van Dorp Eddine N.V., P.O. Box 200, WILLEMSTAD (Curaçaõ, N.A.).

ARABIA SAUDITA: Dar Al-Watan for Publishing and Information, Olaya Main St., Ibrahim Bin Sulaym Building, P.O. Box 3310, RYAD.

ARGELIA: Institut pédagogique national, 11, rue Ali-Haddad *(ex-rue Zaâtcha), ALGER* ENAL, *3 boulevard Zirout Youcef,* Argel. ENAMEP, 20 rue de la Liberté, ALGER. Office des Publications Universitaires (OPU), place Centrale Ben Aknoun, ALGER.

ARGENTINA: Librería El Correo de la Unesco, EDILYR S R L., Tucumán 1685, 1050 BUENOS AIRES.

AUSTRALIA: *Publicaciones:* Educational Supplies Pty., Ltd., P.O. Box 33, BROOKVALE 2100, N.S W. *Publicaciones periódicas:* Dominie Pty, Ltd , Subscriptions Dept., P.O. Box 33, BROOKVALE 2100, N.S.W. *Subdepósito:* United Nations Association of Australia, P.O. Box 175, 5th floor, Ana House, 28 Elizabeth *Street, MELBOURNE 3000. Hunter Publications, 58A Gipps Street,* Collingwood, VICTORIA 3066.

AUSTRIA: Buchhandlung Gerold & Co., Graben 31, A-1011 WIEN

BAHAMAS: Nassau Stationers Ltd, P.O. Box N-3138, NASSAU.

BANGLADESH: Bangladesh Books International Ltd., Ittefaq Building, 1 R.K. Mission Road, Hathhola, DACCA 3.

BARBADOS: University of the West Indies Bookshop, Cave Hill Campus, P.O Box 64, BRIDGETOWN.

BÉLGICA· Jean De Lannoy, 202, avenue du Roi, 1060 BRUXELLES, CCP 000-0070823-13.

BENIN: Librairie Nationale, B.P. *294, PORTO NOVO;* Ets. Koudjo G. Joseph, B.P. 1530, COTONOU.

BIRMANIA Trade Corporation n.° (9), 550-552 Merchant-Street, RANGOON

BOLIVIA· Los Amigos del Libro, casilla postal 4415, LA PAZ, Av. de las Heroínas 3712, casilla postal 450, COCHABAMBA

BOTSWANA: Botswana Book Centre, P.O. 91, GABORONE.

BRASIL: Fundação Getúlio Vargas, *Serviço* de Publicações, caixa postal 9 052-ZC-02, Praia de Botafogo 188, RIO DE JANEIRO (GB).

BULGARIA· Hemus, Kantora Literatura, bd. Rousky 6, SOFIJA

CANADÁ: Renouf Publishing Company Ltd , 2182, St. Catherine Street West, MONTREAL, Que, H3H 1M7.

COLOMBIA. Instituto Colombiano de Cultura, Carrera 3A n.° 18/24, BOGOTÁ El Ancora Editores, Carrera 6.ª n.° 54-58 (101), Apartado 035832, BOGOTÁ.

CONGO. Librairie populaire, B P. 577, BRAZZAVILLE Commission nationale congolaise pour l'Unesco, B P 493, BRAZZAVILLE

COSTA DE MARFIL: Librairie des Presses de l'Unesco, Commission *nationale ivoirienne pour l'Unesco, B.P. 2871, ABIDJAN*

COSTA RICA: Librería Trejos, S A , apartado 1313, SAN JOSÉ. Librería Cultural "García Monge", Ministerio de la Cultura, Costado Sur del Teatro Nacional, apartado 10.227, SAN JOSÉ

CUBA: Solamente *El Correo de la Unesco:* Empresa COPREFIL, Dragones n.° 456 e/Lealtad y Campanario, HABANA 2. Ediciones Cubanas, O'Reilly n.° 407, LA HABANA.

CHECOSLOVAQUIA: SNTL, Spalena 51, PRAHA 1 *(Exposición permanente),* Zahranicni literatura, 11, Soukenicka, PRAHA 1. *Únicamente para Eslovaquia:* Alfa Verlag, Publishers, Hurbanovo, nam 6, 893 31, BRATISLAVA

CHILE: Bibliocentro, Ltda, casilla 13731, Constitución n.° 7, SANTIAGO (21).

CHINA: China National Publications Import Corporation, West Europe Department, P.O. Box 88, BEIJING

CHIPRE: "MAM" Archbishop Makarios 3rd Avenue. P.O. Box 1722, NICOSIA

DINAMARCA· Munksgaard Export and Subscription Service, 35 Nørre Søgade, DK-1370 KØBENHAVN K

ECUADOR: *Todas las publicaciones:* Casa de la Cultura Ecuatoriana, Núcleo del Guayas, Pedro Moncayo y 9 de Octubre, casilla de correos 3542, GUAYAQUIL. Casa de la Cultura Ecuatoriana, Avenida 6 de diciembre n ° 794, Casilla 74, QUITO. Nueva Imagen, 12 de Octubre 959 y Roca, Edificio Mariano de Jesús, QUITO *Periódicas solamente.* DINACUR Cía Ltda, Santa Prisca n.° 296 y Pasaje San Luis, Oficina 101-102, Casilla 112-B, QUITO.

EGIPTO. Unesco Publications Centre, 1 Talaat Harb Street, EL CAIRO

EL SALVADOR· Librería Cultural Salvadoreña, S.A., calle Delgado, *n.° 117, apartado postal 2296,* SAN SALVADOR

ESPAÑA: Ediciones Líber, apartado 17, Magdalena, 8, ONDÁRROA (Vizcaya), DONAIRE, Ronda de Outeiro, 20, apartado de correos 341, LA CORUÑA, Librería Al-Andalus, Roldana, 1 y 3, SEVILLA-4; Mundi-Prensa Libros, S.A., Castelló, 37, apartado 1223, MADRID-1; Librería Castells, Ronda Universidad 13, BARCELONA 7.

ESTADOS UNIDOS DE AMÉRICA: Unipub, 205 East 42nd St NEW YORK, NY 10017. *Para ordenar pedidos:* Unipub, Box 433 Murray Hill Station, NEW YORK, NY 10157.

ETIOPÍA: Ethiopian National Agency for Unesco, P.O. Box 2996, ADDIS ABEBA

FILIPINAS. The Modern Book Co., 922 Rizal Avenue, P.O. Box 632, MANILA 2800

FINLANDIA: Akateeminen Kirjakauppa, Keskuskatu 1, 00100 HELSINKI 10. Suomalainen Kirjakauppa OY, Koivuvaarankuja 2, 01640 VANTAA 64.

FRANCIA: Librairie de l'Unesco, 7, place de Fontenoy, 75700 PARIS (CCP 12598-48).

GHANA: Presbyterian Bookshop Depot Ltd., P.O Box 195, ACCRA. Ghana Book Suppliers Ltd., P.O. Box 7869, ACCRA. The University Bookshop of Cape Coast. The University Bookshop of Legon, P.O. Box 1, LEGON

GRECIA· Grandes librerías de Atenas (Eleftheroudakis, Kauffman, etc.); John Mihalopoulos & Son S.A., International Booksellers, 75 Hermou Street, P.O.B. 73, THESSALONIKI.

Comisión Guatemalteca de Cooperación con la 3.ª avenida 13-30, zona 1, apartado postal 244,

GUINEA: Commission nationale guinéenne pour l'Unesco, B.P. 964, CONAKRY

HAITÍ· Librairie "A la Caravelle", 26, rue Roux, B.P 111, PORT-AU-PRINCE

HONDURAS· Librería Navarro, 2.ª avenida n.° 201, Comayagüela, TEGUCIGALPA

HONG KONG: Federal Publications (HK) Ltd , 2D Freder Centre, 68 Sung Wong Toi Road. TOKWAWAN KOWLOON, Swindon Book Co., 13-15, Lock Road, KOWLOON. Hong Kong Government Information Services, Publication Section, Baskerville House, 22 Ice House Street, HONG KONG.

HUNGRÍA. Akadémiai Könyvesbolt, Váci u. 22, BUDAPEST V; A.K.V. Könyvtárosok Boltja, Népköztársaság utja 16, BUDAPEST VI.

INDIA: Orient Longman Ltd.: Kamani Marg, Ballard Estate, BOMBAY 400 038; 17 Chittarajan Avenue, CALCUTTA 13; 36a Anna Salai, Mount Road, MADRAS 2; 5-9-41/1 Bashir Bagh, HYDERABAD *500001 (AP); 80/1 Mahatma Gandhi Road, BANGALORE 560001;* 3-5-820 Hyderguda, HYDERABAD 500001. *Subdepósitos:* Oxford Book and Stationery Co., 17 Park Street, CALCUTTA 700016 y Scindia House, NEW DELHI 110001, Publication Unit, Ministry of Education and Culture, Ex. AFO Hutments, Dr. Rajendra Prasad Road, NEW DELHI 110001.

INDONESIA: Bhratara Publishers and Booksellers, 29 Jl. Oto Iskandardinata 3, YAKARTA .

IRÁN: Commission nationale iranienne pour l'Unesco, Seyed Jamal Eddin Assad Abadi Av., 64th St, Bonyad Bdg , P.O Box 1533, TÉHÉRAN Kharazmie Publishing and Disribution Co., 28 *Vessal Shirazi.* Street, Enghélab Avenue, P O B. 314/1486, TÉHÉRAN.

IRLANDA: The Educational Company of Ireland Ltd., Ballymount Road, Walkinstown, DUBLIN 12; Tycooly International Publ. Ltd., 6 Crofton Terrace, Don Laoghaire Co., DUBLIN

ISLANDIA: Snaebjorn Jonsson & Co, H.F Hafnarstraeti 9, REYKJAVIK

ISRAEL: A.B.C. Bookstore Ltd., P.O. Box 1283, 71 Allenby Road, TEL AVIV 61000

ITALIA: LICOSA (Libreria Commissionaria Sansoni S.p.A.), via Lamarmora 45, casella postale 552, 50121 FIRENZE. FAO Bookshop, Via delle Terme di Caracalla, 00100 ROMA

JAMAHIRIYA ÁRABE LIBIA: Agency for Development of Publication and Distribution, P.O. Box 34-35, TRIPOLI

JAMAICA Sangster's Book Stores Ltd., P.O. Box 366, 101 Water Lane, KINGSTON University of the West Indies Bookshop, Mona, KINGSTON

JAPÓN: Eastern Book Service Inc., 37-3 Hongo 3-chome, Bunkyo-ku, TOKYO 113.

JORDANIA: Jordan Distribution Agency, P.O.B. 375, AMMAN

KENYA. East African Publishing House, P.O Box 30571, NAIROBI

KUWAIT· The Kuwait Bookshop Co. Ltd., P.O. Box 2942, KUWAIT.

LESOTHO: Mazenod Book Centre, P.O MAZENOD

LÍBANO: Librairies Antoine, A. Naufal et Frères, B.P. 656, BEYROUTH

LIBERIA: Cole & Yancy Bookshops, P.O. Box 286, MONROVIA.

LIECHTENSTEIN: Eurocan Trust Reg., P O. Box 5, SCHAAN.

LUXEMBURGO: Librairie Paul Bruck, 22, Grand-Rue, LUXEMBOURG

MADAGASCAR. Commission nationale de la République démocratique de Madagascar pour l'Unesco, B.P. 331, ANTANANARIVO.

MALASIA. Federal Publications Sdn Bhd , Lot 8238 Jalan 222, Petaling Jaya, SELANGOR. University of Malaya Co-operative Bookshop, KUALA LUMPUR 22-11.

MALAWI: Malawi Book Service, Head Office, P.O. Box 30044, Chichiri, BLANTYRE 3.

MALÍ: Librairie populaire du Mali, B.P. 28, BAMAKO

MALTA: Sapienzas, 26 Republic Street, VALLETTA.

MARRUECOS. *Todas las publicaciones:* Librairie "Aux Belles Images", 281, avenue Mohammed-V, RABAT (CCP 68.74); Librairie des écoles, 12 avenue Hassan II, CASABLANCA *Únicamente "El Correo" (para el cuerpo docente):* Commission nationale marocaine pour l'éducation, la science et la culture, 19, rue Oqba, B.P. 420, AGDAL-RABAT (CCP 324.45).

MAURICIO: Nalanda Co. Ltd., 30 Bourbon Street, PORT-LOUIS

MAURITANIA: GRA.LI.CO.MA, 1, rue du Souk X, Avenue Kennedy, NOUAKCHOTT

MÉXICO: SABSA, Servicios a Bibliotecas, S.A., Insurgentes Sur n.° 1032-401, MÉXICO 12, D F.; Librería "El Correo de la Unesco", Actipán 66, Colonia del Valle, MÉXICO 12, D.F.

MÓNACO· British Library, 30, boulevard des Moulins, MONTECARLO

MOZAMBIQUE: Instituto Nacional do Livro e do Disco (INLD), avenida 24 de Julho. 1921, r/c e 1.° andar, MAPUTO.

NEPAL: Sajha Prakashan, Polchowk, KATHMANDU

NICARAGUA: Librería Cultural Nicaragüense, calle 15 Septiembre y avenida Bolívar, apartado 807, MANAGUA

NÍGER: *Librairie Mauclert, B.P. 868, NIAMEY*

NIGERIA: The University Bookshop of Ife; The University Bookshop of Ibadan, P.O. Box 286, IBADAN The University Bookshop of Nsuka. The University Bookshop of Lagos. The Ahmadu Bello University Bookshop of Zaria.

NORUEGA: *Todas las publicaciones:* Johan Grundt Tanum, Karl Johans Gate 41/43, OSLO 3. Universitets Bokhandelen, Universitetssentret, P.O.B. 307, Blindern, OSLO 3 *Únicamente "El Correo".* A/S Narvesens Litteraturtjeneste, Box, 6125, OSLO 6.

NUEVA CALEDONIA: Reprex SARL, B.P. 1572, NOUMEA.

NUEVA ZELANDIA: Retail Bookshop, 25 Rutland Street, Mail Orders 85 Beach Road, Private Bag C.P.O., AUCKLAND; Retail 159 Hereford Street, Mail Orders Private Bag, CHRISTCHURCH, Retail Princes Street, Mail Orders P.O. Box 1104, DUNEDIN, Retail Ward Street, Mail Orders, P.O. Box 857, HAMILTON; Retail Cubacade World Trade Centre, Mulgrave Street (Head Office), Mail Orders Private Bag; WELLINGTON.

PAÍSES BAJOS. *Libros solamente:* Keesing Boeken B V., Joan Muyskenweg 22, *Postbus 1118, 1000 BC* AMSTERDAM *Publicaciones periódicas solamente:* D & N — FAXON B V. Postbus 197, 1000 AD AMSTERDAM.

PAKISTÁN: Mirza Book Agency, 65 Shahrah Quaid-i-Azam, P.O. Box 729, LAHORE 3.

PANAMÁ: Distribuidora Cultura Internacional, Apartado 7571, Zona 5, PANAMÁ.

PARAGUAY: Agencia de Diarios y Revistas, Sra. Nelly de García Astillero, Pte. Franco n.° 580, ASUNCIÓN

PERÚ: Librería Studium, Plaza Francia 1164, Apartado 2139, LIMA

POLONIA: Ars Plona-Ruch, Krakowskie Przedmiescie 7, 00-068 WARSZAWA ORPAN-Import, Palac Kultury, 00-901 WARSZAWA

PORTUGAL: Dias & Andrade Ltda., Livraria Portugal, rua de Carmo 70, LISBOA

PUERTO RICO: Librería "Alma Mater", Cabrera 867, Río Piedras, *PUERTO RICO 00925.*

REINO UNIDO· HMSO Publications Centre, 51 Nine Elms Lane, LONDON SW8 5DR. *Para pedidos:* HMSO P.O Box 276, LONDON SW8 5DT. Third World Publications, 151 Statford Road, BIRMINGHAM B11 1RD. *Government bookshops:* LONDON, BELFAST, BIRMINGHAM, BRISTOL, CARDIFF, EDINBURGH, MANCHESTER; *Mapas científicos solamente:* McCarta Ltd., 122 Kings Cross Road, LONDON WC1X 9 DS.

REPÚBLICA ÁRABE SIRIA: Librairie Sayegh, immeuble Diab, rue du Parlement, B P. 704, DAMAS

REPÚBLICA DE COREA: Korean National Commission for Unesco, P O. Box Central 64, SEOUL

REPÚBLICA DEMOCRÁTICA ALEMANA: Librairies internacionales o Buchhaus Leipzig, Postfach 140, 701 LEIPZIG.

REPÚBLICA DOMINICANA: Librereía Blasco, avenida Bolívar n.° 402, esq. Hermanos Deligne, SANTO DOMINGO.

REPÚBLICA UNIDA DEL CAMERÚN: Le secrétaire général de la Commission nationale de la République fédérale du Cameroun pour l'Unesco, B.P. 1600, YAOUNDÉ. Librairie aux Messageries, Avenue de la Liberté, B.P. 5921, DUALA; Librairie aux frères réunis, B.P. 5346, DUALA; Librairie des éditions Clé, B.P. 1501, YAOUNDÉ; Librairie St Paul, B.P. 763, YAOUNDÉ

REPÚBLICA UNIDA DE TANZANÍA· Dar-es-Salaam Bookshop, P.O. Box 9030, DAR-ES-SALAAM.

RUMANIA: ILEXIM, Export-Import, 3 Calea "13 Decembrie", P.O. Box 1-136/1-137, BUCAREST

SENEGAL: Librairie des 4 vents, 91 rue Blanchot, B.P. 1820, DAKAR, Librairie Clairafrique, B P 2005, DAKAR.

SEYCHELLES: New Service Ltd., Kingstate House, P.O. Box 131, *MAHÉ; National Bookshop, P.O. Box 48, MAHÉ*

SIERRA LEONA. Fourah Bay, Njala University and Sierra Leone Diocesan Bookshops, FREETOWN

SINGAPUR: Federal Publications (S) Pte. Ltd. Times Jurong, 2 Jurong Port Road, SINGAPORE 2261

SOMALIA. Modern Bookshop and General, P.O Box 951, MOGA-DISCIO

SRI LANKA: Lake House Bookshop, Sir Chittampalam Gardiner Mawata, P.O. Box 244, COLOMBO 2.

SUDÁN. Al Bashir Bookshop, P.O. Box 1118, KHARTOUM

SUECIA: *Todas las publicaciones:* A/BC. E. Fritzes Kungl. *Hovbokhandel, Fredsgatan 2, Box 16356, 103 27* STOCKHOLM 16. *Publicaciones periódicas solamente:* Wennergren-Williams AB, Box 30004, S-104 25 STOCKHOLM *Únicamente "El Correo":* Svenska FN-Förbundet, Skolgränd 2, Box 150 50, S-104 65, STOCKHOLM

SUIZA· Europa Verlag, Rämistrasse 5, 8024 ZÜRICH, Librairie Payot, 6, rue Grenus, 1200 GENÈVE 11. Libraries Payot en GENÈVE, LAUSANNE, BALE, BERNE, VEVEY, MONTREUX, *NEUCHATEL y* ZURICH.

SURINAME: Suriname National Commission for Unesco, P.O. Box 2943, PARAMARIBO.

TAILANDIA: Nibondh and Co. Ltd., 40-42 Charoen Krung Road, Siyaeg Phaya Sri., P.O. Box 402, BANGKOK, Suksapan Panit, Mansion 9, Rajdamnern Avenue, BANGKOK; Suksti Siam Company, 1715 Rama IV Road, BANGKOK.

TOGO: Librairie évangélique, B.P. 378, LOMÉ. Librairie du Bon Pasteur, B.P. 1164, LOMÉ Librairie universitaire, B.P. 3481, LOMÉ

TRINIDAD Y TABAGO: *National Commission for Unesco,* 18 Alexandra Street, St. Clair, TRINIDAD W.1.

TÚNEZ: Société tunisienne de diffusion, 5, avenue de Carthage, TUNIS.

TURQUÍA: Haset Kitapevi A.S., Istiklâl Caddesi, n.° 469, Posta Kutusu 219, Beyoglu, ISTANBUL

UGANDA: Uganda Bookshop, P O. Box 7145, KAMPALA

URSS: Mežhdunarodnaja niga. MOSKVA G-200.

URUGUAY: Edilyr Uruguaya, S.A., Maldonado 1092, MONTEVIDEO.

VENEZUELA. Librería del Este, Av. Francisco de Miranda 52, Edif Galipán, apartado 60337, CARACAS DILAE C A. (Distribuidora Latinoamericana de Ediciones *C.A.), Calle San Antonio* entre Av. Lincoln y Av. Casanova, Edificio Hotel Royal, Local 2, apartado 50.304, Sabana Grande, CARACAS.

YUGOSLAVIA: Jugoslovenska Knjiga, Trg. Republike 5/8, P.O.B. 36, 11-001, BEOGRAD; Drzavna Zalozba Slovenije Titova C. 25, P.O.B. 50-1, 61-000 LJUBLJANA

ZAIRE: Librairie du CIDEP, B.P 2307, KINSHASA, Commission nationale zaïroise pour l'Unesco, Commissariat d'Etat chargé de l'éducation nationale, B.P. 32, KINSHASA.

ZAMBIA: National Educational Distribution Co of Zambia Ltd., P.O. Box 2664, LUSAKA.

ZIMBABWE: Textbook Sales (PVT) Ltd., 67 Union Avenue, SALISBURY.

[B] SC.85.XIII.52/AF