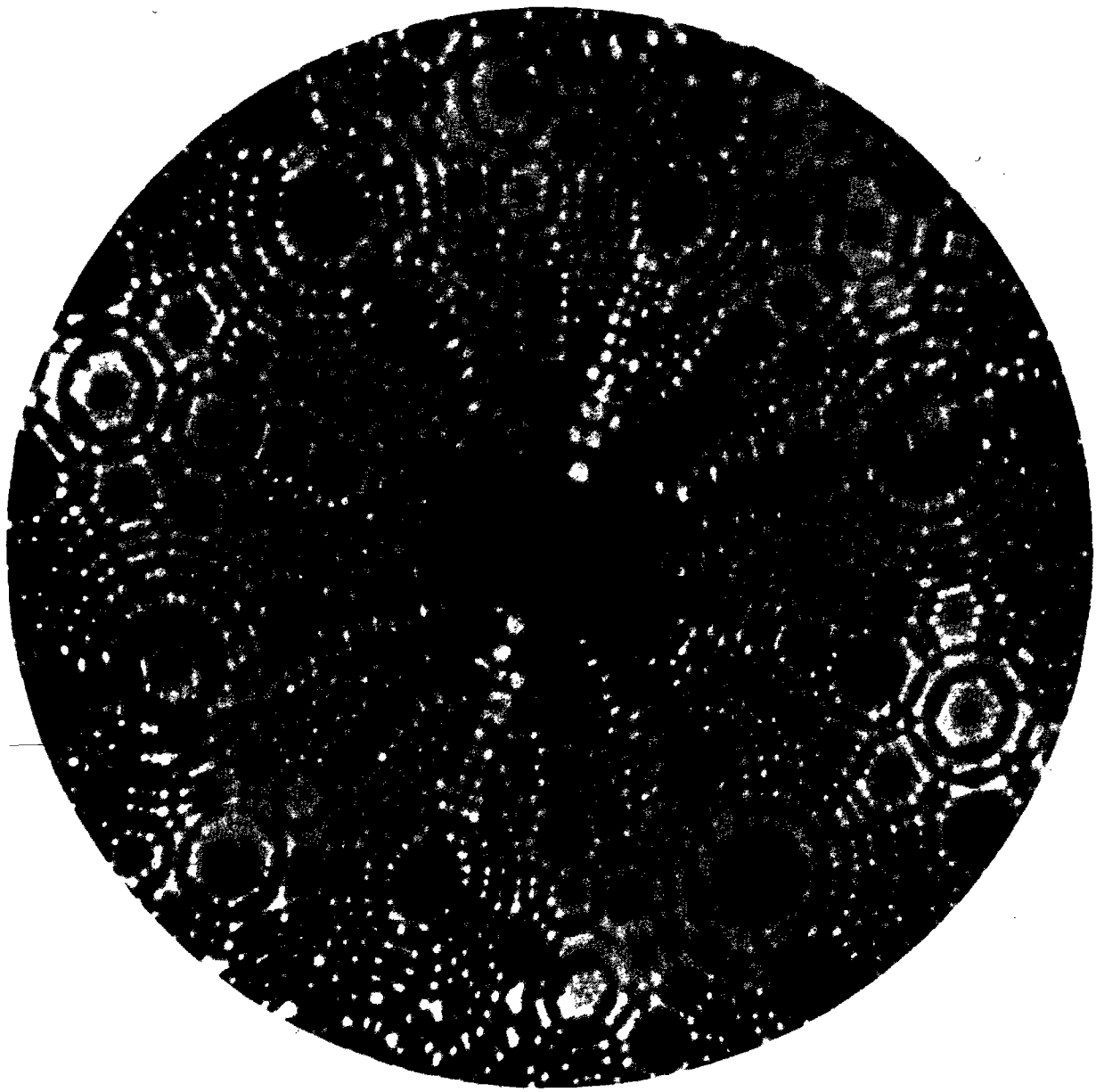
No. 56

Science policy and organization of research in the Republic of Korea

Science policy studies and documents



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PREFACE

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

The series aims at presenting those responsible for scientific research and development throughout the world with factual information on the science 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 science policy-making in the Member States concerned. The selection of the countries in which studies of national scientific policy are undertaken is governed by the following criteria: (a) originality of the methods used in the planning and execution of national science policy; (b) extent of the practical experience acquired in such fields; (c) 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 the planning of science policy, organization and administration of scientific and technological research, and other questions relating to science policy.

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

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

The present study on science policy and the organization of research in the Republic of Korea has been prepared for Unesco by the Korean National Commission for Unesco. The principal author of the study was Mr. KIM Hyung-ki, then Director-General, Bureau of Programme Development and Promotion, Ministry of Science and Technology. He was assisted in his task by a team of experts comprising Prof. SONG Sang-yong, Korean Society of Science History; Dr. KIM In-su, Korea Advanced Institute of Science and Technology; Prof. KOH Kyong-shin, Chung Ang University; and Dr. PARK Eul-yong, Korean Development Institute. The study is made up of the following parts:

Part I: Historical background.

Part II: Administrative organization of science and technology development - institutional structures and operational links.

Part III: Financing of scientific and technical research.

Part IV: Scientific and technological manpower.

Part V: Principal aims of the national science and technology policy.

Part VI: The economic and political background.

Figures on expenditure, manpower, and economic aggregates are given in the tables. The general organization of research in the Republic of Korea as well as the organization of individual institutions is shown in the charts. The appendixes contain selected listes of R & D funding and performing bodies, together with a short bibliography.

The opinions expressed in the study are the sole responsibility of the authors, and do not necessarily coincide with the views of Unesco.

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PART I

Historical Background

I. GENERAL INTRODUCTION

The history of the Republic of Korea dates back only to 1948 when the UN-supervised elections in south Korea culminated in the establishment of the Republic. The history of scientific and technological development in Korea of any international significance, including broad-based education, is even shorter. It was not until 1962 when the nation's First Five-Year Economic Development Plan was put into effect that organized efforts began to be made for the development of science and technology as a matter of priority policy of the government.

During the past two decades, Korea has endeavoured to rise to the opportunity for scientific development and technological innovation, a response which is very much in character and indicative of a much fuller response in the future. Since 1962 Korea has undertaken four consecutive Five-Year Economic Plans to focus national efforts and resources on breaking the inertia of its underdevelopment in many areas, and in bringing about the establishment of the sustainable social infrastructures essential to socio-economic development. For the last eighteen years, since the launching in 1962 of the First Five-Year Economic Development Plan, the economy as a whole has maintained an average growth rate of almost 10 percent per annum, while the per-capita income which was below US$100 in 1961 rose to US$1,279 in 1978 (in current prices), a four-fold increase in real terms for the period. This phenomenal performance has transformed Korea, as the World Bank indicated in 1977, from one of the poorest developing countries, with heavy dependence on agriculture and a weak balance of payments financed almost entirely by foreign grants, to a semi-industrialized, middle-income nation with an increasingly strong external payments position*. Quantitavely, the industrial sector has contributed most extensively to the structural changes in the country's economic and social systems.

It became apparent to the planners that the exploitation of Korea's limited agricultural base or its meager natural resources was likely to provide little more than subsistence while the marginal savings to be realized through even the most rigorous policy of import-substitution and high protection would hardly generate the surplus required for sustained national growth.

For this reason, Korea committed itself to a bold outward-looking development strategy based more on private and entreprenerial initiatives than anything else. To move along these lines required, amongst other things, an enhanced role for science and technology, including the broad-based, well-trained manpower which has been an important pillar from the beginning of Korea's Five-Year Economic Development Plan in 1962.

II. SCIENTIFIC ACHIEVEMENTS IN THE HISTORY OF KOREA

Until the late nineteenth century, science in Korea developed in the shadow of the large and sophisticated nearby civilization of China. Yet the science and technology introduced from China came to a land already technologically experienced in certain fields. The men who lived in the Korean peninsula around the tenth century B.C. for example, had already reached a high level of proficiency in metal-working and alloy-making. With this tradition behind them, the Koreans did not simply accept the innovations from China. They modified and adapted them to local needs and conditions, and this often gave rise to new inventions and discoveries.

The first decisive influence from China was the introduction of Hans's superior metal technology toward the end of the second century B.C. Lolang, which played the role of China's trade base, was the supply center of iron implements for the peninsula. It stimulated entirely new iron smelting techniques which were so successful that even the Chinese and the Japanese purchased Korean iron.

Ornaments and decorations excavated from Silla tombs (57 B.C.-935 A.D.), especially golden crowns and earrings, show that Korean metal-working made great progress in the fifth and sixth centuries. Under the patronage of the royal family, metallurgy gained momentum in the sixth and seventh centuries with the flowering of Buddhist images. Buddhist bells of incomparable beauty, which combined the functions of the traditional *chung* bell and the *t'o* bell of old China, bear witness to the innovative techniques developed by the Korean artisans under the Silla dynasty. In producing these bells, the Silla artisans discovered a new bronze alloy which was highly acclaimed in China.

Efforts to regulate agricultural production combined with the influence of the ancient Chinese astrological concept that celestial phenomena were related to the affairs on earth led to the development of astronomy. In addition to their practical importance for agriculture, astronomy and calendar-making had special bearing on government. Astronomical charts were symbols of royal authority, and under the ancient dynasties the results of astronomical observations were recorded in the form of star maps. In Korea the first of these probably dates back to the Koguryo period (53-668). Star charts in the Koguryo tombs represent the constellations, as well as the sun and moon on circles. First manufactured in China around the second century B.C., the armillary sphere is believed to have been brought into Korea sometime between the Three Kingdoms era and the age of Unified Silla. Instruments similar to it in principle seem to have continued in use during the Koryo Dynasty era (918-1392).

* Growth and Prospects of the Korean Economy, Report No. 1489-KO, February 23, 1977, Document of the World Bank.

The succeeding dynasties of Korea were extremely sensitive to the phenomena of the heavens, especially solar and lunar eclipses. The prediction of eclipses was a part of the monarchic ritual which augmented the dignity of the ruler in the eyes of his people. Many royal astronomers and meteorologists lost their positions or even their lives because of failure to predict such occurrences correctly.

Developments in astronomy during the Three Kingdoms era are exemplified by the construction of the *Chomsongdae* observatory. A graceful, bottle-shaped stone tower nine meters high, the observatory was built at Kyongju in 647. It was probably the center of astronomical activity in the Kingdom of Silla, though its exact function is not known.

The systematic measurement of time in Korea is thought to have begun about two thousand years ago. But the usefulness of sundials is confined to sunny days and so, during the Three Kingdoms era, the clepsydra or water clock came to be regarded as a more useful and reliable time indicator. The first clepsydras were made in 718.

Another well-known relic of the high cultural attainments of Silla is *Sokkuram*, a cave temple. Whereas the Chinese temple made use of a natural grotto, *Sokkuram* is an entirely artificial creation built around a dome and comprising stone structures of circular, triangular, hexagonal, and octagonal shapes, which required a high degree of mathematical and engineering knowledge.

The printed scroll of the *Dharani* Scripture discovered in 1966 was printed in wood-block possibly between 704 and 751. It proved to be the oldest wood-block printing ever known.

It was from Korea that new science and technology was carried into Japan during the early centuries until regular contact between Japan and China became possible. Immigrant Koreans played a great part in the formative phases of Japanese civilization as men of learning, craftsmen, and nobles. Among the Three Kingdoms, Paekche contributed most in transmitting science and technology to Japan.

The outstanding achievements of the Koryo era are the astronomical observations, the printing technology, and the technique for making inlaid ceramics known as the Koryo celadon. The astronomy of Koryo is marked by its development of observational astronomy as well as by its constant efforts for more accurate calendar-making. Its observation records are noted for being independent, accurate, and long-standing. Koryo astronomers were at home with the theory of *Shou-Shi* in calculating a calendar with highly advanced methods. Here, the length of the year which they calculated corresponds with the modern value to the sixth decimal place.

The development of wood-block printing in Koryo was motivated by the wish to repel the Khitan and the Mongol invaders with the aid of the spiritual strength of Buddha. The resulting work, the *Tripitaka Koreana*, is the oldest and finest achievement of the art. Due to the urgent need for a variety of books in a limited number of copies, type-casting with metal was invented some time between the twelfth century and the thirteenth century, long before Gutenberg. There is conjecture that the Koryo typography first spread to Mongol China and then to Europe via the China-Arabia route. Movable metal type, however, made no further development simply because of the strong attachment the people had to the beautiful wood-block printing.

The Koryo celadon earned fame for its artistic beauty and quality. It was produced entirely for the aesthetic enjoyment of the aristocracy. The Koryo celadon is characterized by a unique and artful inlaying technique which was greatly admired by contemporary Chinese scholars. In fact, one of the original inventions of the Koryo artisans was the use of inlays for decorating ceramic works.

Signs of original and creative endeavors are found in various areas of science in the early part of the Yi Dynasty (1392-1910). The invention of rain gauges and water-level marks in the reign of King Sejong in 1441-1442 should be mentioned. These inventions were naturally accompanied by the perfection of methods for the quantitative measurement of precipitation. The scientists and officials of *Soungwan* (Bureau of Astronomy) engaged in the work of compiling meteorological data gathered from outposts in the provinces, countries, and towns of the realm for more than 400 years until the downfall of the dynasty.

The scientific achievements of the Sejong era were not confined to these. Signs of advances are evident in all fields of science and technology, including astronomy, geography, ceramics, architecture, medicine, and agriculture. For example, medicine had been given a firm basis - the heritage of Koryo. The king ordered a comparative study of Korean and Chinese medicines and had scholars compile the *Hyangyak Chipsongbang* (Great Collection of Native Korean Prescriptions) in 1433. In it a total of 703 Korean native medicines were included. Another masterpiece, the *Uibang Yuchui* (Classified Collection of Medical Prescriptions) was published in 1455. Ho Chun's *Tongui Pogam* (Precious Mirror of Eastern Medicine), begun in 1596 and completed in 1610, is one of the greatest medical encyclopedias of East Asia.

Scientific achievement in the Yi Dynasty which reached a peak in the fifteenth century, subsequently underwent a gradual decline. A crushing blow came at this stage of development with the invasion of Hideyoshi from Japan. After this traumatic experience, science in Korea lost its independent and creative base.

During the Japanese invasion in the sixteenth century, an assault vessel named *Kobukson* (Turtle ship) became famous. It was originally launched in 1413 and later improved by Admiral Yi Sun-sin and Na Tae-yong. Though there is controversy as to whether *Kobukson* was the first iron-clad ship in the world, it was no doubt a very efficient warship. It was the culmination of the long tradition of ship-building technology.

The origins of Korean science can be traced back through the technical tradition of craftsmen who passed on their practical experiences and skills from generation to generation. They devoted themselves to empirical phenomena and were little concerned with theoretical explanations. The result was that techniques were developed apart from any systematic experimental method. It was very difficult for those craftsmen, who were officials supported by their government, to have the opportunity to follow their own bent because they had to engage in practical research and manufacture dictated by government policy. In addition, craftsmen were part of society's strict class system and were given little freedom of thought. Their work was made less creative because of the lack of social pressures of rewards for innovation.

It was only in the seventeenth and eighteenth centuries that these traditional techniques acquired a systematic scientific basis, thanks to the advocates of *sirhak*

(practical learning) who rejected the idea of the superiority of philosophical speculation and adopted the slogan *silsa kusi* (verification of truth on the basis of factual studies), thus opening the way to the introduction of Western science and the initiation of a scientific reformation.

Western science and technology found their way into Korea in the seventeenth century. Matteo Ricci's map of Europe was the first Western work to reach Korea. It was brought by Yi Kwang-chong one year after its publication in Peking. In 1630, Chong Tu-won, the Korean envoy to China became acquainted with Johannes Rodriguez, an Italian priest in Peking. Rodriguez presented Chong with books on astrology, the calendar, geography, and also a telescope, an alarm clock, and a cannon, all of which were presented to the King upon Chong's return.

Many other Korean envoys visited the Catholic church in Peking. A small but steady stream of Western works on Christianity and science, translated into Chinese, began to flow from Peking to Seoul. All this Western learning made a considerable impression on Korean scholars. It seems that the rotating-earth theories of Kim Song-mun, Yi Ik, and Hong Tae-yong had something to do with the new cosmology known in China. The introduction of Western science and technology was inevitably piecemeal and indirect. Hence the Sirhak scholars' understanding of it was limited and insufficient.

In the latter half of the nineteenth century, Korea was fully exposed to the challenge of Western civilization as Catholicism, steamships and industrial products made massive inroads into the country. The first reaction among the Confucian scholars was to identify Catholicism with Western technology, but they soon became aware of the utility of superior technology. They decided to learn Western technology, while retaining their Confucian values and morals.

In 1876, Korea discarded the extreme isolationist policy pursued hitherto and opened its doors to the world. Observation teams were sent to Japan and China. There the Korean scholars were shocked by the advanced technology from the West. Korea began to accept all sorts of Western science and technology from the middle of 1880s. The intellectuals launched a movement of enlightenment to reform the established systems with a view to developing the country by introducing Western culture. It was based on the skepticism toward the traditional culture.

In 1894, the *Kabo* Reform was announced as an attempt to modernize the administrative and social systems. Education was modernized with the establishment of schools. Science books were imported and newspapers began to be published. However, the effort to make Western science take root failed because of political and economic instability. After the two wars, Korea fell under the influence of rising Japanese capitalism and was finally annexed to Japan in 1910.

The introduction of Western science was now left in the hands of the Japanese. The early colonial policy of Japan can be characterized by severe oppression and exploitation. After the *Samil* Independence Movement, Japan switched to a so-called cultural policy. Science seemed to be revitalized by the people's awareness and the impact of World War I. There was a nationwide movement for the popularization of science in the 1930s. With Japan's invasion of Manchuria, Korea became the supply base for the continent. The opportunities for Koreans to study science were extremely limited. Thirty-five years of Japanese domination kept Korean science in a vacuum.

III. SERVICES DEALING WITH METROLOGY AND STANDARDIZATION

The first effort toward standardization in Korean history can be found as early as the sixth century during the Silla Dynasty, when the first sundial was invented to measure time accurately. According to te *Sam-Kook-Sa-Ki* (Historical records of the Three Kingdoms), a water clock was invented in the 17th year of King Sung Duk's reign (AD 718) of the Silla Dynasty.

In 1441 (the 23rd year of the reign of the Great King Sejong, Yi Dynasty), a scientific rain gauge was invented, about two centuries before that of Europe. King Sejong named it *Chuk-Woo-Ki* (rain gauge) and distributed it throughout the country to be used in the scientific rainfall measurement system.

The first modern measurement system in Korea was started with the creation of *Pyongshik-Won* (the National Bureau of Weights and Measures) in 1902. In 1905, five years before annexation by Japan, the government of the Yi dynasty enacted the "Weights and Measures Law" to establish and to disseminate metric metrology standards.

More recently, the rapid spurt of the outward-oriented Korean economy during the 1960s prompted the government to reappraise the adequacy of the Korean National Standards System (NSS). In 1973, the government created a new governmental organization, called the Industrial Advancement Administration (IAA) under the purview of the Ministry of Commerce and Industry, absorbing such separate organizations as the Bureau of Standards, the Central Bureau of Standards, and the National Industry Research Institute. The Korea Standards Research Institute (K-SRI) was created as the central body of the NSS. Nine provincial testing laboratories for industrial products, which used to be under the administrative control of provincial governments, were added to the IAA for administrative responsibility.

The need for accurate and precise weighing and measuring has increased with the development of heavy and chemical industries, precision and defense industries. The IAA administers weights and measures in accordance with the Measurement Law, which is to establish an order in commerce and protect consumers by ensuring the appropriate measurements on one hand, and to upgrade the precision technology through establishment of a national measurement standard system on the other. The law governs such systems as measuring instrument manufacturing licences, instruments model approval, certification of measuring instruments, registration of dealers, and the rigid control of illegal measuring instruments.

Following the establishment of the Korea Standards Research Institute, the structure of the NSS was reorganized accordingly.

Major roles and functions of the K-SRI are as follows:

1. To modernize the NSS and maintain its international traceability of national prototypes;
2. To conduct research and development on measurement science and precision technology;
3. To establish and expand education and training programs and systematic technical assistance programs; and

4. To establish a systematic calibration service for precision measurement instruments and facilities.

In December 1978, the Korean Government established a national calibration system (NCS) with K-SRI as the apex organization. Under the scheme, secondary and tertiary calibration organizations are appointed by the government upon K-SRI's recommendation. The secondary calibration organizations include the National Industrial Research Institute, the Korea Atomic Energy Research Institute, the Korea Machinery and Metals Testing Research Institute (which absorbed what used to be known as the Fine Instrument Center), the Air Force and the National Institute of Health.

More than half a dozen private industrial firms have been appointed by the government to act as tertiary calibration organizations. The appointed calibration organizations are authorized to issue official calibration certificates in particular measurement areas. These organizations include a broad spectrum of Korean scientific and technological societies, such as calibration/inspection organizations, research institutes, and industrial firms. In May 1979, the Korea Association of Standards and Testing Organizations (KASTO) was organized in order to coordinate the activities of the member organizations and to promote national calibration services effectively.

K-SRI, as a research institute, does not exercise legal authority directly. Enforcement of regulations and laws or, in other words, legal metrology is in the hands of the IAA of the Ministry of Commerce and Industry. IAA is directly in charge of enforcing various laws and regulations concerning standardization activities, such as the inspection of Korean Industrial Standards (KS), marked industrial products and the testing of consumer products for safety. IAA has its own testing and inspection agency, which is called the National Industrial Research Institute (NIRI). NIRI is one of the several secondary calibration organizations in the calibration network. NIRI also operates provincial branches, which perform inspection and testing jobs.

The Korean Industrial Standards Association (KISA) is in charge of document standards, often called paper metrology. KISA, in close collaboration with IAA and K-SRI, continually adopts, examines, and upgrades Korean Industrial Standards.

The KS standardization lays prime emphasis on standardizing the products, components and materials related to the heavy and chemical industries, with particular attention being given to the conservational aspects of energy and resources. The KS standards are currently being made to conform to such international standards as ISO and IEC in order to eliminate technical barriers arising from the differences, and to make the KS standards more sophisticated.

The Industrial Standards Review Committee, established in accordance with the Industrial Products Quality Control Law, is playing a pivotal role in establishing Korean standards. The Council for Industrial Standardization, a deliberative council on the establishment of the industrial standards, consists of a general assembly, standards council, divisional committee and a technical committee, the last two assuming the most important roles. There are some 30 departmental committees comprising 300 members and 94 professional committees with over 1,000 members drawn from government organizations, industry, and academia.

As of 31 December 1980, there were 7,030 KS standards, compared with 4,106 in 1974. Their breakdown was as follows:

Sector	**Number of standards**
Basic standard and miscellaneous	402
Mechanical	1,407
Electrical and electronic	896
Metallurgy	831
Mining engineering	204
Civil engineering and construction	474
Household, sports and office supplies	192
Food products	91
Textiles	340
Ceramics	323
Chemicals	1,176
Medical facilities	175
Shipbuilding	431
Aeronautical equipment	88
Total	7,030

In principle, the KS mark is granted to manufacturers at their voluntary request. Therefore, manufacturers can produce goods without the KS mark authorization. However, certain goods which are judged by the Industrial Advancement Administration as carrying the danger of causing fire or damage to human life or having potential adverse effects on the well-being of the public have to be listed, with a mandatory KS marking the items. Thus, such items cannot be produced or sold without first obtaining the KS mark.

Those who wish to apply for the KS mark have to submit an application to the IAA's Bureau of Standards with the required papers as specified by the Law. The Bureau then reviews the application papers and dispatches experts to the factory for an on-the-spot inspection. At the factory, the expert inspects the company standards, quality of materials used, process management, quality of products, manufacturing and inspection facilities and determines whether the applicant has a top-quality control system capable of producing the KS standard goods. It also takes samples of the products for quality testing and analysis by an authorized testing organ. If the results are approved by the KS mark Screening Committee composed of government officials and experts, the IAA Administrator grants the applicant the right to use the KS mark.

The follow-up checking system on the state of standardization and quality control as related to the production of KS mark goods is also required to be implemented on the part of the Provincial Governments which culminates, in case of products failing to meet the standards, in the cancellation of the KS mark authorization or in the suspension of sales of the products.

As of 31 December 1980, 665 firms had been granted KS mark authorization. They covered:

Sector	Number of firms
Basic standard and miscellaneous	12
Mechanical	127
Electrical and electronic	181
Metallurgy	74
Mining engineering	6
Civil engineering and construction	84
Household, sports and office supplies	37
Food products	7
Textiles	5
Ceramics	28
Chemicals	103
Medical facilities	—
Shipbuilding	1
Aeronautical equipment	—
Total	665

IV. RESEARCH LABORATORIES AND SERVICES IN THE PRIVATE SECTOR

The research laboratories and services belonging to private enterprise in the extractive or manufacturing sectors have grown in number conspicuously in the last decade or so, commensurate with the nation's rapid industrialization.

The Consultative Body for the Promotion of Research Institutes in the Private Sector was formed in February 1979 to help both sides in developing a more conducive milieu for research and development in private industry. It includes petition to the government for financial, fiscal and administrative support explicitly for private research institutes, which in many firms are still in embryonic stage.

The list of selected major R & D institutes in private industry is presented in Annex VI.

V. TESTING SERVICES

The National Industrial Research Institute (NIRI), which comes under the jurisdiction of the Industrial Advancement Administration of the Ministry of Commerce and Industry, has been a central and comprehensive organ for the testing and analysis of industrial products. It conducts such tests at the request of either government or industries.

The IAA also entrusts the NIRI with most of the tests and analysis it has to do under the laws, such as required for the authorization of KS marks and the approval of electric appliances.

Apart from the central organization, there are nine Provincial Testing Laboratories for Industrial Products (PTLIP), which provide quality test services and technical support to local industries. Both NIRI and PTLIP are being greatly strengthened in terms of new buildings, facilities, equipment, and staff training to cope with ever-increasing demands for sophisticated testing services.

For export goods, the government employs a compulsory inspection system in accordance with the Export Inspection Law to upgrade the quality of goods, thereby enhancing better international acceptance. The items requiring this compulsory inspection are designated by the decree of the Ministry of Commerce and Industry. At the end of 1979, 183 items were listed in this category. The KS mark products and the goods produced by firms which have been determined by IAA to have satisfactory self-inspection systems are exempt from the mandatory inspection system.

There are fourteen governmental testing institutes which are designated to perform the testing of export goods.

Important ones are as follows:

1. National Industrial Research Institute
2. The Nine Provincial Testing Institutes for Industrial Products
3. National Agricultural Products Testing Institute
4. National Seoul Sericulture Testing Institute
5. National Animal Experiment Station
6. National Forestry Experiment Station
7. Technical Research Institute of the Office of National Tax Administration (for liquors)
8. Ginseng Testing Institute of the Office of Monopoly
9. Central Fisheries Products Testing Institute

In the private sector, ten agencies, as listed in Table 1, have been designated by the government to perform the testing and inspection of export goods.

VI. ENGINEERING SERVICES

Apart from the civil engineering construction sectors of the economy, the consulting and engineering design services in Korea are relatively recent. The formation of the Korea Engineering Company in 1969 on a joint ventureship with Toyo Engineering of Japan at the instigation of the Korean government was one of the earlier major steps taken towards establishing a domestic plant engineering capability.

In 1973, the Law for the Promotion of the Engineering Services was promulgated: firstly, to upgrade the minimum standards to be eligible for registration under the law, secondly, to enlarge the opportunities for participation by local engineering firms, and thirdly, to provide financial and fiscal incentives to local engineering firms and to their clients. The law stipulates, amongst other things, that only those who meet the minimum standards for various categories of engineering laid down by the law are permitted to render such services.

As of 1 May 1981, 190 firms have been registered for business in consulting and engineering services. In the category of 'plant engineering', there were 16 firms registered*, of which 12 firms opted for specialization in chemical plants, 7 for general industrial plants, 9 for power plants, and 1 for nuclear power plants. In the category of 'integrated construction', there were 2 firms registered. As for the 'special engineering category', 173 firms were registered for specialization as follows:

Fields of specialization	Number of firms*
Mechanical	26
Metallurgical	2
Chemical engineering	14
Electrical	29
Communication	8
Shipbuilding	5
Construction	69
Construction utilities	12
Textile	2
Mining	9
Geological	28
Production management	5
Information processing	8
Electronics	2

* The total number of 'specialized entries' exceeds the total number of firms, some of the latter specializing in more than one field.

The names and addresses of major Korean engineering firms are to be found in Annex V.

Quite a few engineering firms have been active abroad.

VII. SCIENTIFIC AND TECHNOLOGICAL INFORMATION SERVICES

Planned and organized activities in the field of scientific and technological information in Korea began with the advent of the Korea Scientific and Technological Information Center (KORSTIC) in 1962, originally within the organizational framework of the Korean National Commission for Unesco and subsequently as an independent organization whose board of trustees includes representation of Vice-Minister of Science and Technology, or his representative, or on an ex-officio basis. In May 1969, the Law for the Promotion of KORSTIC was promulgated to establish a legal basis for, among others, budgetary support by the government and the provision whereby all government organizations and national or public educational and research institutions were required to provide KORSTIC with wo copies of their periodicals and/or other reports on science and technology.

KORSTIC is devoted to the systematic collection, processing and storage of scientific, technological and industrial information and to the dissemination of necessary information to industries, academic communities of colleges and universities, R & D institutes, government organizations and individuals. It collects and maintains information material in science and technology by means of purchases, exchanges, and/or gifts. About 7,000 titles of current journals and other material such as patent specifications, technical reports abstracts, indexes, standards, trade catalogues as well as monographs, are presently being acquired. In addition, machine readable data bases such as CAS, INSPEC, ISMEC, COMPENDEX, CIN, WPI, and USGRA are acquired both for the computer-bases selective dissemination service (SDI) and retrospective searching (RS).

The fastest expansion in KORSTIC activities has been in the area of industrial technology, for which small and medium-sized industrial firms constitute the major clients. Some of the activities undertaken with the primary purpose of assisting industrial firms are:

1. Publication services, including the periodic publishing of:

(i) Current Indexes to Journals in Science and Technology (monthly or semimonthly)
(ii) Current List of Foreign Patents (every ten days)
(iii) Package for Foreign Patent SDI (monthly)
(iv) Current Contents of Journals in Social Science (monthly or bimonthly)
(v) New Products and New Technology (monthly)
(vi) State-of-the-Art Report in selected industries (machine industry bimonthly)
(vii) Directory of On-going Research in Science and Technology in Korea (annual), and
(viii) *Technical Information Bulletin by Type of Industry (TIB-BTI)*, which has been published since 1974, on contracts with industrial associations or cooperatives, to keep member firms informed of the most recent scientific, technological, and industrial developments abroad. These bulletins grew in number to sixteen, ranging in field from automobiles to cosmetics.

2. Technical consultation services to industries concerning the development of new techniques and new products, and foreign technology. For the purpose of strengthening this service, KORSTIC has been providing a Field Liaison Service since 1974 whereby Field Liaison Officers from KORSTIC visit industrial firms to help them identify their information requirements and to provide them with necessary information.

3. Establishment of Regional Referral Service Centers in September 1979 in collaboration with the Korea Chamber of Commerce and Industry.

In 1975, a computer systems laboratory was established at KORSTIC to introduce computerized information processing systems involving computerized SDI services, and to develop new information processing systems such as KIPS (Korean Information Processing System, which involves a joint use of Han-gul which is the Korean alphabet, and of Chinese characters), ORRS (On-going Research Retrieval System) and AIMS (Automatic Information Material Management System).

KORSTIC has been striving to meet the acute need for disseminating documentation techniques by holding training courses in various aspects of documentation or by publishing a bimonthly professional journal *Documentation and Information Services.*

In an effort to broaden an international exchange of information, KORSTIC publishes English editions of *Korean Scientific Abstracts* (bimonthly) and *Korean Medical Abstracts* (quarterly) and has been entering into bilateral agreements for either information exchange or exchange of translation services, or entering into a regional information transfer scheme such as 'TECHNONET ASIA'.

In addition to KORSTIC, there are several scientific and technological research institutes which periodically publish various information analyses specific to their fields of endeavour, such as resources and energy.

Table 1. Private testing and inspection agencies for export goods

Name of organization	Address	Date founded	Items for Inspection and testing
1. Korea Textile Inspection & Testing Institute	50-1 Yuksam-dong Kangnam-ku, Seoul	1 April 1969	13 types of goods such as cotton threads
2. Korea Fabric & Clothing Testing Institute Foundation	892-64 Jaeki-dong Dongdaemun-ku, Seoul	1 April 1969	6 types of fabric silk 10 types of clothing and trousers
3. Knit Inspection & Testing	48 1st Street, Shinmun-ro Chongro-ku, Seoul	1 April 1969	16 types of knitted goods
4. Korea Electric Testing & Inspection Foundation	393-17 Hapjong-dong Mapo-ku, Seoul	2 March 1970	23 products such as radios
5. Korea Chemical & Metallic Products Inspection Foundation	539-8 Kajwa-dong Incheon city Kyonggi-do	1 April 1969	36 types of goods such as footwear
6. Korea General Merchandise Inspecting Foundation	459-28 Garibong-dong Yungdungpo-ku, Seoul	26 April 1971	25 types of goods such as wigs, leather goods and toys
7. Korea Mineral Inspecting	35-24 Tongui-dong Chongro-ku, Seoul	16 April 1969	19 mineral products such as fluorspar, tungsten and zinc ores
8. Korea Export Packaging Inspection Laboratory Foundation	50 Garibong-dong Yungdungpo-ku, Seoul	4 June 1969	packaging paper
9. Korea Institute of Machinery & Metal	222-13 Kuro-dong Yungdungpo-ku, Seoul	30 Dec. 1976	34 types of goods such as bearings, lathe and bicycles
10. Korea Registrar of Shipping	62-5 1st St., Taepyung-ro Chung-ku, Seoul		ships of various types

PART II

Administrative Organization of Science and Technology Development - Institutional Structures and Operational Links

I. FORMULATION OF NATIONAL SCIENCE AND TECHNOLOGY POLICY

During the past two decades since the launching of the First Five-Year Economic Development Plan, scientific and technological development has been recognized as one of the most important factors in the industrial and economic development process in Korea. By establishing the Ministry of Science and Technology (MOST) in the first year of the Second Five-Year Economic Development Plan in 1967, the Korean Government formally committed itself to a bold imaginative approach, formulating long-term plans and aims for scientific and technological development. As a result, science and technology has played an integral and crucial role in the country's phenomenal economic growth, transforming it from one of the poorest agricultural countries to a semi-industrialized middle-income nation.

In order to overcome in a short time the lack of experience and manpower in the scientific and technological field and the general ignorance of Korean populace about it, a rather strong and efficient centralized government organization was very much needed. Accordingly, MOST was inaugurated in 1967 to be in charge of formulating basic policies and plans implementing and co-ordinating them, and formulating budgets for those concerning scientific and technological development. The administrative structure of the Ministry is given in Annex II.

Besides MOST, several other ministries are involved in the development effort. Specific plans and problems related to a given field in science and technology are dealt with by the appropriate ministries. The main relevant features and functions of these ministries are given below in detail.

For deliberation of fundamental and overall policy and policies in fields cutting across several ministries, a National Council for Science and Technology was established in 1973 and attached to the Prime Minister's Office. It consists of the Prime Minister as the Chairman and ministers of related ministries and a few well known scientists and engineers as its members. In recent years, however, 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 Promotion of Science and Technology, the Comittee for Technological Development, and the Deliberation Committee for Engineering Service, which have been attached to MOST to assist it in formulating and coordinating the scientific and technological policies and plans. The overall administrative structure for science and technology is given in Annex I.

II. ORGANIZATION FOR COORDINATION AND IMPLEMENTATION OF NATIONAL SCIENCE AND TECHNOLOGY POLICY

A. Ministry of Science and Technology

The Ministry of Science and Technology (MOST) was set up in 1967 with the following responsibilities: establishment of basic policies, integration and coordination of the plans for scientific and technological development, technical cooperation with international agencies and foreign governments, development and utilization of atomic energy, and other matters concerning scientific and technological development.

The Ministry started out with two bureaux of Promotion and Technical Cooperation in addition to the offices of Planning and Management, and Research Coordination. Coming under the direct jurisdiction of the Ministry were the Office of Atomic Energy, the Central Meteorological Office, the Geological Survey, and the National Science Museum. The National Computer Center and the National Astronomical Observatory were created subsequently and also put under the Ministry's direct control.

At the end of 1980 the Ministry had five bureaux. Program Development and Promotion, Technical Cooperation, Atomic Energy, Nuclear Regulatory, and Information and Systems Development, and three directorates for General Planning, Manpower Planning and Technology Development. The Ministry also operates the Daeduk Science Administration Office.

The Minister and the Vice-Minister of Science and Technology respectively serve as ex-officio Chairman and Vice-Chairman of the *Atomic Energy Commission*, which has also two standing commissioners, and two non-standing commissioners.

The Commission is in charge of formulating and/or reviewing major policies regarding the peaceful uses of atomic energy, R & D plans for nuclear fuel and nuclear energy applications, regulatory measures relating to nuclear material and nuclear reactors, and counter measures for protection against radioactive environmental hazards.

There used to be two special government-assisted, but autonomous, research institutes concerned with the peaceful applications of atomic energy. They were:
the Korea Atomic Energy Research Institute (KAERI), and
the Korea Nuclear Fuel Development Institute (KNFDI)
These two institutes were merged in December 1980 under the new organizational framework of the Korea Advanced Energy Research Institute.

There used to be other well-known research and academic institutes which came under the Ministry's purview:
the Korea Institute of Science and Technology (KIST), and the Korea Advanced Institute of Science (KAIS).

These two institutes were merged in KAIST (Korea Advanced Institute of Science and Technology). Also coming under the Ministry's purview were:
the Korea Scientific and Technological Information Center (KORSTIC),
the Korea Science and Engineering Foundation (KOSEF)
the Korea Technical Qualification Testing Agency and the Changwon Master Craftsmen's College.

In addition, such special research institutes as the Korea Institute of Machinery and Metals, the Korea Research Institute of Chemical Technology, the Korea Institute of Electronics Technology, the Korea Research Institute of Ships and the Korea Standards Research Institute, all of which used to fall under the purview of the Ministry of Commerce and Industry, have been transferred to the Ministry of Science and Technology for support and surveillance.

Likewise, those institutes, which used to come under the purview of other ministries - such as the Korea Energy Research Institute, the Korea Research Institute of Geoscience and Mineral Resources and the Korea Electric Research and Testing Institute (KERTI), which were under the Ministry of Energy and Resources, the Korea Telecommunications Research Institute which was under the Ministry of Communication, the Korea Ginseng Research Institute and the Korea Tobacco Research Institute which were under the Office of Monopoly of the Ministry of Finance - have all been transferred to the Ministry of Science and Technology, as they were or after merger between related institutes. The new set-up of special research institutes can be seen in the organization chart of the Ministry (Annex II).

B. Ministry of Education

The Ministry of Education is the central government organ in charge of education. The Ministry is responsible for establishment of policy regarding all aspects of education and exercises control and supervision over educational policy implementation.

The organization of education administration in Korea may be examined at three levels: national, provincial, and district.

The Constitution provides that education at all levels is under the responsibility of the Ministry of Education, which is assisted by provincial boards of education in affairs pertinent to primary and secondary education. At the district level, there are offices of education for primary and lower secondary education under the control of the provincial board of education.

The Ministry of Education is assisted by the Education Policy Deliberation Committee which gives counsel to the Minister on important issues affecting education.

Within the Ministry, there are three offices - the Planning and Management Office, the Office of School Supervision, and the Office of Educational Policy - and eight bureaux: Elementary and Secondary Education, Higher Education, Teacher Education and Certification, Curriculum and Textbooks, Junior College and Industrial Education, Non-formal and International Education, Physical and Health Education, and Educational Facilities. These are subdivided into sections.

Under the direct supervision of the Minister is the Public Information Officer, and under the direct supervision of the Vice-Minister are the Emergency Planning Officer and Inspector General.

Under the Ministry's direct control are the national universities and colleges, teachers' colleges and the special technical colleges, and schools.

The subsidiary organizations attached to the Ministry are the National Institute of Education, the National Central Library, the History Compilation Committee, the National Academy of Science, and the National Academy of Arts.

Apart from the integral administrative organization, the Ministry is supported by a number of 'organic' agencies such as Korea Educational Development Institute (KEDI), the Academy of Korean Studies, and the Korean Institute for Research in the Behavioral Sciences (KIRBS), and others.

The National Institute of Education was established in 1974 as an organic agency under the Ministry of Education, charged with the conduct of research and studies concerning education, the production and distribution of educational materials, and the training of teaching personnel.

The basic unit of local educational administration is the Board of Education in each of the provinces and the Special Cities of Seoul and Busan. Each board is composed of seven members selected by the local autonomous body. The Superintendent is the head of the executive body appointed by the President on the recommendation of the Minister of Education.

Each Board of Education has a Special City/Provincial Institute of Education, a Student Science Center, and Public Libraries. Each of the Special City/Provincial Institutes of Education conduct research to improve primary and secondary education, carry out studies concerning the establishment and operation of schools, and are responsible for the training of teaching personnel centered around problems peculiar to the locality. The distribution of educational materials is also a responsibility of each Special City/Provincial Institute of Education. These local institutes have contributed greatly to the development of curricula suited to the prevailing conditions within their respective areas of jurisdiction.

In addition to these governmental research institutes, the *Korea Educational Development Institute* (KEDI) was founded in 1972 as a special legal entity to assure it an independent status in its research activities.

KEDI conducts comprehensive and scientific research concerning the goals, objectives, content and methods of education, and develops the means of meeting them with a view to the establishment of long-range educational policy guidelines. Its principal research activities are in three fields: (1) basic research concerning education, (2) educational curricula and tutorial methods, and (3) research concerning educational policy. It also specializes in research concerning educational broadcasts in order to promote effective utilization of the broadcasting in public education.

In basic educational research, the Institute conducts theoretical studies on such subjects as the history of education, philosophy, sociology, psychology and methodology of educational evaluation, and prepared materials and data necessary for the establishment of educational policy by the government and the development of educational curricula.

As to the educational broadcasts, the Institute conducts studies on the production of educational broadcasting programs and the utilization of broadcasting media for educational purposes. Since 1974, it has engaged in the production of radio programs for primary

school students and those for broadcast and correspondence school students. Since the middle of 1980 it has also engaged in the production of television programs for high school students.

The *Academy of Korean Studies* was established in 1978 to carry out in-depth studies concerning the essential spiritual heritage of the Korean nation. It sponsors research projects on Korean philosophy, history, education, society, and various other aspects of traditional Korean culture. In 1980 the Academy established, and thereafter operated, the Graduate School of Korean Studies. This school offers post-graduate degrees in Korean studies.

The *Korean Institute for Research in Behavioral Sciences* was established in 1968 as a non-profit organization. It has carried out a number of research projects in the fields of education, social development, development of study habits, and counselling services. In the area of social development studies, the Institute has dealt with such problems as population pressure and juvenile problems. In the counselling sector, it has studied the transition in behavioral patterns from childhood to adulthood.

It also sponsors study meetings and seminars on various aspects of behavioral science and has on-going information exchange programs with a number of foreign research groups in this field.

In order to reinforce the research function of universities, many of them have established (university) *research institutes* covering a wide range of disciplines and problems. Varying greatly in scale of finance and operation, they together have rendered great contributions over the years to the development of education and to the development of capabilities in selected areas in Korea.

Amongst *other organizations* directly or indirectly *engaged in educational research,* the Korean Federation of Education Assocation and the Korean Society for the Study of Education may be mentioned. The latter has more than a thousand members and comprises a number of specialized research committees on such subjects as the philosophy of education, the history of education, education administration, educational psychology, infant education, and comparative education.

The Federation is primarily concerned with the protection and promotion of the interests of teachers, but at the same time conducts various research programs designed to promote its primary objectives. The Federation sponsors annually a national convention of first-line teachers.

Besides these there are many organizations, large and small, covering various aspects of educational research throughout the country.

C. Ministry of Commerce and Industry

The Ministry of Commerce and Industry deals with matters related to commerce, foreign trade, industry, patents and standards. To discharge these mandates, the Ministry has two sub-ordinate offices headed by sub-cabinet-level heads and maintained in separate offices outside the Ministry's main office. They are the Industrial Advancement Administration and the Office of Patents.

The Industrial Advancement Administration was established in 1973 in an effort to reinforce governmental activities related to the promotion of industrial technology, the quality of industrial products, industrial standards and measurements, and the inspection of export merchandise. Moreover, the protection of the consumer is also an important task of the agency. The central administration includes such operative bureaux as the Bureau of Quality Control, the Bureau of Extension Sciences, the Bureau of Standards, and the Bureau of Inspection.

The National Industrial Research Institute and nine Provincial Testing Laboratories for Industrial Products (PTLIP) come under the direct administrative control of the Industrial Advancement Administration.

The Korea Standard Research Institute (KSRI) was created as an autonomous, non-profit organization, but under the aegis of the Industrial Advancement Admnistration. It serves as a supreme national standard organ designated by the Measurement Law to preserve and propagate primary national standards, conduct research and development in precision science and measurement techniques, provide technical guidance to the industry, and train professional weighing and measuring technicians.

The Korea Standard Association as a corporate private body has operating ties with the Industrial Advancement Administration for the carrying out of field-level activities such as training, guidance programs, and publication related to quality control and industrial standardization.

The National Industrial Research Institute (NIRI) is the oldest governmental research and testing institute in the field of industrial technology and products. With the advent of such institutes as the Korea Institute of Science and Technology and the mushrooming of private industrial R & D institutes, the emphasis placed on R & D is being shifted more towards the testing and analysis of industrial products.

The new premises for NIRI, places for the modernization of equipment, and the training of staff for both NIRI and PTLIPs, currently being implemented, will all substantially improve NIRI's special testing capabilities such as reliability tests, large-scale load and flow tests, integrated property tests and high-temperature tests, thereby contributing to the development of the heavy and chemical industries and to the protection of consumers as well.

The Patent Administration is in charge of administration, registration and protection of industrial properties, which includes patents, utilities, designs, and trademarks in accordance with the Patent Law, and juridical settlement on issues related to industrial properties.

The Government of the Republic of Korea became a member of the World Industrial Property Organization in March 1979 by depositing its instrument of accession to the convention establishing the Organization.

The following statistics illustrate the trend of industrial property application and registration in Korea both by Korean nationals and by foreigners.

Year	Industrial property applications				
	Total	Patents	Utilities	Designs	Trademarks
1967	9,918	1,177	3,594	1,919	3,228
1970	17,659	1,846	6,167	4,522	5,124
1971	19,880	1,906	6,810	5,348	5,816
1975	26,387	2,914	7,290	6,707	9,476
1976	28,694	3,261	8,378	6,018	11,037
1979	34,839	4,722	7,957	8,371	13,789
1980	37,261	5,070	8,558	10,075	13,558

Source: Patents Administration

Patents applied and registered by origin

Origin	1975		1976		1977		1978		1979		1980	
	Applied	Regist'd	Applied	Regist'd	Applied	Regist'd	Applied	Regist'd	Applied	Regist'd	Applied	Regist'd
Korean	1,326	212	1,436	191	1,179	104	994	133	1,034	258	1,241	186
Foreigners	1,588	230	1,825	288	1,962	170	3,021	294	3,688	1,161	3,829	1,446
Total	2,914	442	3,261	479	3,139	274	4,005	427	4,722	1,419	5,070	1,632

Source: Patents Administration

Utilities applied and registered by origin

Origin	1975		1976		1977		1978		1979		1980	
	Applied	Regist'd	Applied	Regist'd	Applied	Regist'd	Applied	Regist'd	Applied	Regist'd	Applied	Regist'd
Korean	7,052	1,032	8,117	1,106	7,199	577	6,212	922	7,215	1,556	7,936	1,315
Foreigners	238	14	261	9	402		433	7	742	225	622	478
Total	7,290	1,046	8,378	1,115	7,601	577	6,645	999	7,957	1,781	8,558	1,753

Source: Patents Administration

D. Ministry of Agriculture and Fisheries

The Ministry of Agriculture and Fisheries embraces under its organizational umbrella the largest number of research and technical institues among government ministries, not to mention the number of research and technical personnel.

The Office of Rural Development and the Office of Fisheries are given mandates for both R & D and extension services in their respective fields.

Apart from these two offices, which are headed by sub-cabinet-level director-generals, there are eight testing and/or technical institutes which come under the direct jurisdiction of the Minister of Agriculture and Fisheries. They are the following:

National Silk Conditioning House
National Agricultural Products Inspection Office
National Animal Quarantine Office
National Agricultural Materials Inspection Office
National Plant Quarantine Office
National Livestock Breeding Station
National Silkworm Research Station
National Seeds Production and Distribution Office

In addition, there is one autonomous, but government-assisted, research institute, called the Korea Rural Economic Institute, which was created in 1978 as the successor institution replacing the former National Agricultural Economics Institute of the Office of Rural Development. This Institute publishes the semi-annual *Journal of Rural Development,* in English, in order to facilitate international interchange of ideas and experiences related to rural development.

The Office of Rural Development (ORD) is composed of the Planning and Management Office, the Research Bureau, the Rural Guidance Bureau, the Technical Dissemination Bureau, and the Farm Management Bureau. There are thirteen subordinate institutes:

Agricultural Sciences Institute
Veterinary Research Institute
Agricultural Engineering Utilization Institute
Crop Experiment Stations (3)
Horticultural Experiment Station
Sericultural Experiment Station
Livestock Experiment Station
Alpine Experiment Station
Cheju Experiment Station
Rural Nutrition Institute

At the local level there are nine Provincial Offices of Rural Development under the administrative jurisdiction of Provincial Governors, 174 City and County rural Guidance Offices under Mayors and Chiefs, and 1,470 Branch Guidance Offices at township level, all engaged in rural development programs.

The Office of Rural Development has a staff force of over 9,000 of which 10% research workers, about 85% extension workers and the rest do administrative work.

The major thrusts of the Agricultural Sciences Institute center around three priority program areas: rice breeding, which includes development of varieties; varietal improvement of upland crops; and soil improvement through extensive soil survey and testing.

Because of the overwhelming importance of rice to Korean agriculture, the rice breeding program has enjoyed the highest priority for some years with marked successes, but not without problems. The target of the rice breeding program was to increase the yield of milled rice to 6.5 tons per hectare while improving disease and insect-resistance and the quality of the rice itself.

The program in 1980 involved seed multiplication of five new varieties such as 'Ir 342' in 20 hectares in the Philippines during winter, their trial in farmers' fields covering 2,400 hectares, the multiplication of some 3000 promising breeding lines and the evaluation of germplasm resources involving 500 varieties from 46 countries. For plant protection, resistance testing was extended to cover a total of 32,400 lines at 32 locations, including overseas.

For the varieties improvement of upland crops, the breeding targets in 1980 were to increase barley yields to 4.5 tons, wheat to 5.5 tons, soybeans to 3.2 tons, and corn to 10 tons per hectare.

For the soil improvement program in 1980, a detailed soil map was to be published for the entire country, based on survey results from 2,330,000 hectares of cultivated land and 321,000 hectares to be developed. In addition, projects such as soil testing involving 50,000 samples, improvement of newly-reclaimed lands and polders, and research on the application of rice straw to different soils were to be conducted.

E. Ministry of Health and Social Affairs

The Ministry of Health and Social Affairs deals with matters related to public health, epidemic prevention, public hygiene and sanitation, medical and pharmaceutical administration, public relief, emigration, women's and children's welfare, and family planning. Its responsibilities also cover national health insurance programs. There are two separate agencies under the control of the ministry:

the Office of Labor Administration and
the Office of Environment.

For the public health side, there is a National Institute of Health, the largest of its kind in Korea. The National Chemistry Laboratories, the National Institute for the Prevention of Infectious Diseases, the National Institute of Herb Drugs, and the National Institute of Public Health were all put together in 1963 under the new organization framework of the National Institute of Health.

The Institute is engaged in such services as:

1. Reference laboratories for confirmatory diagnosis and epidemiological surveillance of communicable diseases
2. Production and quality control study of biological products
3. The quality control, research and its study of drugs and foods
4. Research and study for the promotion of health
5. Training of public health workers for their qualification
6. Implementation of national examination for the health workers, which includes medical doctors, dentists, herb doctors, pharmacists, nurses and medical technologists.

The National Institute of Health administers the National Standards Radiation Dosimetry Laboratory which has two authorized centers, namely, the National Reference Center and the National Medical Equipment Maintenance Center.

F. Ministry of National Defense

The Ministry of National Defense deals with every aspect of the country's military affairs including research and development in the fields of science and technology that might have some implications for, and applications to, the military.

The Agency for Defense Development is a quasi-governmental R & D institute which was given the mandate to perform such activities.

G. Ministry of Construction

The Ministry of Construction is responsible for establishing and coordinating plans for national land development and control, preservation, utilization, development and renovation of land and water resources, and construction of cities, roads, highways, ports, harbours and housing. There are two governmental research and technical agencies under the direct control of the Ministry. They are the National Contruction Research Institute and the National Geography Institute.

The *National Construction Research Institute*, which began as the Civil Engineering Laboratory of the Ministry of Home Affairs in 1954, carries out tests, investigations and studies on standards of public works and building construction, in addition to research and development on new construction methods and technical assistance of public works and projects building. The Institute also conducts educational and training programs for employees of the central and local governments as well as people from the construction industries.

The *National Geography Institute* was established in 1974 by the absorption of the Survey Department of the National Construction Research Institute.

In addition to the governmental institutes, there is one autonomous, but government-assisted, institute, the Korea Research Institute for Human Settlements, under the purview of the Ministry of Construction. It was established in 1978 to work on the national land development plan, land and housing policy analysis, urban policy analysis, and national land information management.

H. Ministry of Energy and Resources

The Ministry of Energy and Resources was established in 1977 to be in charge of matters related to energy and mineral resources. It inherited some of the responsibilities which used to be under such ministries as the Ministry of Commerce and Industry and the Ministry of Science and Technology.

While the Ministry does not have any governmental institutes as such, it has under its purview three autonomous special research institues. They are the Korea Research Institute of Geoscience and Mineral Resources (KIGAM), the Korea Energy Research Institute, and the Korea Electric Research and Testing Institute.

The *Korea Research Institute of Geoscience and Mineral Resources* was established in its present form in May 1976 after converting the governmental institute of the then Geological and Mineral Institute of Korea into an autonomous institute. The history of this institute dates back to 1918 when the Geological Survey was first founded.

The *Korea Energy Research Institute* replaced in May 1980 the Korea Institute of Energy Conservation, which was established in 1977, by enlarging the scope of its activities, such as planning for energy supply and demand as well as R & D in renewable energy sources. It

also absorbed the Solar Energy Research Institute, which was an affiliated institute of the Korea Institute of Science and Technology.

These two institutes are about to be merged again under one umbrella organization, the Korea Power and Resources Research Institute, and to be transferred to the Ministry of Science and Technology for support and surveillance.

The *Korea Electric Research and Testing Institute* was established in December 1976 under the aegis of the Korea Electric Company for testing of, and R & D in, heavy electrical equipment. This institute was absorbed in December 1980 by the Korea Institute of Comunication Technology and the responsibiliy for its administrative support and surveillance was also transferred to the Ministry of Science and Technology.

I. Ministry of Home Affairs

The Ministry of Home Affairs, which is responsible for local administration, civil emergency planning, protection of lives and property, and national registries, has under its jurisdiction two subordinate agencies: the National Police and the Office of Forestry.

The Office of Forestry, which used to be an integral part of the Ministry of Agriculture and Forestry, has three research institutes:

1. The Forestry Research Institute, established in 1922, engages in research for forest management, silviculture, forest soils, forest protection and wood utilization in addition to managing experimental forests and to inspecting forest products.
2. The Forest Resources Research Center
3. The Forest Genetics Research Institute

J. Ministry of Transportation

The Ministry of Transportation has two separate offices under its control, each headed by a sub-cabinet-level administrator. They are the Korean National Railroads and the Office of the Maritime and Port Administration.

The Korean National Railroads controls the Research Institute for Railroads, which is one of the oldest governmental research institutes in Korea.

The *Hydrographic Office* also comes under the jurisdiction of the Ministry of Transportation. The history of the Hydrographic Office dates back to 1949 when the Korean Navy instituted the Hydrographic Division, which within four years, became the Republic of Korea Hydrographic Office

The functions of the Hydrographic Office are to collect and evaluate the accurate and timely hydrographic and oceanographic data obtained from the field surveys in Korean waters and adjacent seas and oceans by mariners and concerned maritime agencies throughout the world. It compiles, produces and distributes nautical charts and publications to mariners and maritime agencies for the safe navigation of domestic and foreign vessels of the merchant-marine as well as the military, and it provides basic scientific data for the management and exploitation of marine resources, and the development of coastal industries. In addition, the Office is involved in the exchange of hydrographic information among member states of the International Hydrographic Organization (IHO) and the East Asia Hydrographic Commission. The Office operates six survey vessels.

K. Ministry of Finance

The Ministry controls and supervises three separate offices which come under its jurisdiction. They are the Office of Monopoly, the Office of National Taxation, and the Office of Customs Administration.

The *Office of Monopoly* used to operate the Central Monopoly Research Institute until May 1978 when the Institute was dissolved to give birth to two new independent research institutes, one on Ginseng, and the other on Tobacco. Both institutes derived financial support mainly from the Office of Monopoly but were merged with each other in late 1980 under the umbrella organization of the Korea Ginseng-Tobacco Research Institute. The newly merged institute has been placed under the administrative support and surveillance of the Ministry of Science and Technology.

L. Economic Planning Board

The Economic Planning Board (EPB), headed by the Deputy Prime Minister, takes charge of matters concerning the establishment of overall plans for development of the national economy, formulation and execution of the government budget, and mobilization of resources, investment and economic cooperation with foreign countries and international organizations.

Thus, EPB is the apex ministry for central planning and budgeting. Under the direct jurisdiction of EPB, there is a Bureau of Statistics which compiles basic economic information. Affiliated with the EPB in the form of autonomous institutes, but finances mostly by EPB, are two research institutes, the Korea Development Institute and the Korea International Economic Institute.

The *Korea Development Institute* (KDI) was established in 1971 under the KDI Law of 1970 by the Government as a 'think-tank' on economic and social development issues. The KDI disseminates research results through publication, both in Korean and English, and through collaboration with the Government in the formulation of socio-economic policies and plans.

The *Korea International Economic Institute* was established in 1977 by absorbing the Korea Foundation for Middle East Studies, which had been organized in 1975, to act as a 'think-tank' in formulating and reviewing government policies on international trade, finance, economic cooperation, transfer of capital and technology, and overseas energy and issues related to other resources development.

PART III

Financing of Scientific and Technical Research

I. ACCOUNTING

The total expenditure on scientific and technical research in Korea has increased significantly in the past decade. As Table 2 shows, the absolute value in national currency has increased over 14 times, from W10.5 billion in 1970 to W152.4 billion in 1978, while that in United States currency has increased 9.4 times from US$33 million to US$314 million during the same period. The difference in the rate of increase between the two currencies stemmed from changes in exchange rate during the period. For this reason, the subsequent discussion on the growth rate will be based on the US currency index rather than the local currency.

The total expenditure has increased not only in absolute value but also in comparison with major economic indicators. For example, the total expenditure as a percentage of the national income has, as shown in the table, increased 67 per cent from 0.49 in 1970 to 0.82 in 1978, whereas as a percentage of the gross national product, it has increased 63 per cent from 0.41 to 0.67 during the same period. The per-capita expenditure has also increased from US$1.03 in 1970 to US$8.51 in 1978. The investment in scientific and technological research has indeed outstripped the economy in terms of GNP, which grew six-fold from US$7.8 billion to US$47.3 billion during the same period. This fact indicates the recognition on the part of the Korean Government of the importance of science and technology for development and its determination to establish a sound foundation for economic and social development in the future.

II. THE FLOW OF FUNDS

In the early stage of industrialization, the government played the most significant role in providing funds for scientific and technical research. Industry has, however, expanded its own research and development efforts in an attempt to strengthen its international competitiveness through developing and improving products and processes, as changes occurred from labor-intensive light industries to more capital- and technology-intensive heavy and chemical industries in the second half of the 1970s. Specifically, the absolute amount of the public sector in the origin of scientific and technical research funds, as shown in Table 3, has increased steadily from US$23.4 million in 1970 to US$152.3 million in 1978. Its share, however, has significantly decreased during the same period, from 70.3 per cent to 48.4 per cent. In contrast, industry's investment in research and development has increased almost 17 times from US$9.6 million in 1970 to US$161.1 million in 1978, raising its share from 28.7 per cent to 51.2 per cent. Other sectors, including higher educational institutions, played a minimal role as a generator of funds for scientific and technical research.

It is the public sector that carried out most of scientific and technical research in 1970. For example, the public sector accounted then for 83.9 per cent of the use of funds allocated for research, while industry and higher educational institutions accounted for 12.6 per cent and 3.5 per cent, respectively. Since then, industry's share has increased fro a mere 12.6 per cent in 1970 to 35.3 per cent in 1978, while research in higher educational institutions also increased from 3.5 per cent to 13.4 per cent during the same period. These changes in the origin and allocation of funds indicates the structural changes in industry and the gradual shift of competitive basis in industry from a cheap labor force towards technology.

III. FUNCTIONAL ALLOCATION OF FUNDS

Engineering and life sciences have remained the most important fields in terms of research fund allocation during the 1970s. Engineering and life sciences have accounted for 41.9 per cent and 37.9 per cent respectively of the total funds utilized for research in 1970, and 63.7 per cent and 25.0 per cent respectively in 1978. The share of physical and social sciences which accounted for 15.6 per cent and 4.6 per cent respectively in 1970 has slightly decreased by 1978.

In the early period of industrialization, the public sector played a major role in all four fields. Table 4 shows that the public sector accounted for 81.7 per cent, 77.1 per cent, 92.9 per cent, and 79.2 per cent for physical sciences, engineering, life sciences and social sciences respectively. However, by 1978 industry's share in research had increased significantly in the fields of physical sciences and engineering, while the share of higher educational institutions increased noticeably in physical and life sciences, rising from 1.7 per cent and 2.9 per cent in 1970 to 35.5 per cent and 19.7 per cent in 1978. No information is available to allow a further breakdown of research expenditures of different sectors by type of research such as basic research, applied research and development.

Public expenditure on scientific and technical research has also significantly increased in the past decade. For example, the absolute value of the public expenditure as shown in Table 5, has increased from US$23.4 million in 1970 to US$152.3 million in 1978. In other words, public research expenditure has increased 65 per cent during the period. But when one looks at the expenditure as a percentage of Korea's state budget, it is seen to have remained almost unchanged during the period. The Korean government has increased investment in science and technology, but only in proportion to increases in the state budget. In the course of national development, many projects, including expansion of the infrastructure, called for public financing. Science and technology received only a fair share of public funds. However, in light of the importance of science and technology as a basic foundation for future development and their long-term nature, a more ambitious investment program for science and technology can be justified.

Table 5 also shows the percentage of public expenditure in the country's total expenditure on scientific and technical research. It shows that in spite of significant increases in absolute amount, the share of public funds has decreased significantly from 70.3 per cent in 1970 to 48.4 per cent in 1978. This trend simply reflects the fact that industry's own investment on scientific and technical research has exceeded the growth of public expenditure. Public expenditure on defense research is held confidential and is not available for analysis.

Public expenditure on scientific and technical research in higher education has increased significantly in absolute value during the past decade, as shown in Table 6, but its share in total public expenditure on scientific and technical research and also in the country's total expenditure on research is still insignificant, apart from in 1978. The table shows that the absolute value of public expenditure for research in the higher education sector has increased in local currency from W371 million in 1970 to W11.9 billion in 1978, and in US dollars from US$1.2 million to US$24.6 million during the same period, a 32-fold increase in local currency terms and over a 20-fold increase in US currency.

Public expenditure for research in the higher education sector as a percentage of total public expenditure on scientific and technical research has decreased steadily, from 5.0 in 1970 to 2.4 in 1976. Consequently, its share in the country's total expenditure on research has also decreased from 3.5 per cent in 1970 to 1.5 per cent in 1976. Compared to total public expenditure in higher education, research expenditure has decreased from 7.5 per cent in 1970 to 3.0 per cent in 1976. The table indicates that public expenditure for research in the higher education sector has made a significant jump in 1978. It appears as though there were a policy change in research investment in higher education. It should be noted, however, that the numerical increase in the table stemmed from a change in accounting for research in higher education, not an actual increase of investment over previous years.

While expenditure for industrial research has significantly increased, as shown in Table 3, support from the public sector for industrial research has remained virtually unchanged in absolute value in US currency and has consequently decreased in proportion to other indices. For example, Table 7 shows that the absolute value of public support for industrial research in local currency has increased approximately two times, from W86 million in 1970 to W160 milion in 1978. However, in US currency the absolute value remained unchanged at the level of US$0.3 million, except in 1972 and 1976. As such, its share in total public expenditure on research has decreased steadily from 1.2 per cent in 1970 to 0.2 per cent in 1978. Its share in the country's total expenditure on research has decreased from 0.8 per cent to 0.1 per cent during the same period. In fact, industry received only 6.5 per cent of its research funds from the public sector in 1970, and that proportion has decreased to 0.3 per cent by 1978.

From the data presented so far, it can be inferred that government policy for industrial research has been to provide indirect support. That is, increased expenditure from the public sector has been mostly directed towards developing the science and technology infrastructure, such as applied research institutes and information centres that are designed to support directly and indirectly industrial efforts in research and development.

The size of public expenditure on international scientific activities has been insignificant in Korea. Table 8 shows that the absolute value in local currency of investment in international scientific activities has slightly increased from W4.7 billion in 1970 to W5.1 billion in 1978, while, in US currency, it has in fact decreased from US$15 million to US$10.5 million during the same period, reflecting a 30 per cent decrease in eight years. Its size as a percentage of total public expenditure on research has relatively decreased, from 64.1 per cent in 1970 to 6.8 per cent in 1978.

When public expenditure on scientific and technical research is broken down by ministries, Table 9 shows that the Ministry of Science and Technology, which is included under 'Others', accounted for over 54 per cent in 1971 and 37.3 per cent in 1973. The Ministry of Agriculture spent 17.3 per cent in 1971 and 22.3 per cent in 1973. The Ministry of Education also accounted for 13.6 - 23.3 per cent of public money spent on research. Other ministries account for less than 5 per cent of public spending on scientific and technical research in Korea. Data for the defense ministry and for 1976 and 1978 are not available. The size of expenditure of productive enterprises and public services on scientific and technical research has significantly increased, especially in the late 1970s. Table 10 shows that the size of expenditure has risen from W3.1 billion in 1970, to W5.2 billion in 1974, and to W77.9 billion in 1978 in local currency; in US currency the increase was $9.9 million in 1970 to $161 million in 1978.

When the expenditure of productive enterprises and public services on research is broken down by sector of activity, manufacturing accounts on average for almost 70 per cent. The share of the manufacturing sector has changed from 67.0 per cent in 1970 to 78.1 per cent in 1978. Food and agriculture is also an important sector in research. Its share, however, has decreased from 12.1 per cent in 1970 to 7.2 per cent in 1978. In contrast, the education sector's share has increased from 4.6 per cent to 10.8 per cent during the same period. The significant drop in research expenditure in the manufacturing sector in 1974 reflects the first oil shock and its impact on manufacturing.

Industry's expenditure on scientific and technical research, as shown in Table 11, has increased drastically in the past decade in parallel with industrialization. The table shows that the absolute value in national currency of industry's research investment has increased 41 times from W1.3 billion in 1970 to W53.8 billion in 1978, and in US currency 26 times from $4.2 million to $111.2 million during the same period. As such, its share in the country's total expenditure on scientific and technical research has also increased from 12.6 per cent in 1970 to 35.3 per cent in 1978.

Table 2. Total expenditure on scientific and technical research

Expenditure	Year				
	1970	1972	1974	1976	1978
Absolute values:					
- in million wons	10,548	12,028	38,182	60,900	152,418
- in thousand US dollars	33,305	30,153	78,889	125,827	314,914
Growth index (1970 = 100)*	100.0	90.5	236.9	377.8	945.6
As percentage of national income	0.49	0.37	0.67	0.63	0.82
As percentage of gross national product as factor cost	0.41	0.31	0.56	0.50	0.67
Per inhabitant:					
- in wons	327	359	1,101	1,698	4,117
- in US dollars	1.03	0.99	2.27	3.51	8.51

* In this table and subsequent ones the calculation of growth indices is based on the value of indicators expressed in US currency so as to obviate distortions due to national currency devaluation during the period.

Source: Ministry of Science and Technology, *Science and Technology Annual,* 1971, 1973, 1975, 1977, 1979

Table 3. Breakdown of total expenditure on scientific and technical research by source of funds and sector of performance

		1971	1972	1973	1974	1975
I. Source of funds						
- Public sector	Wons, millions	7,414	7,965	25,051	39,182	73,723
	US dollars, millions	23.4	20.0	51.8	81.0	152.3
	Percent	70.3	66.2	65.6	64.3	48.4
- Industry	Wons, millions	3,024	3,835	13,131	21,348	77,971
	US dollars, millions	9.6	9.6	27.1	44.3	161.1
	Percent	28.7	31.9	34.4	35.2	51.2
- Higher education	Wons, millions	—	—	—	—	—
	US dollars, millions	—	—	—	—	—
	Percent	—	—	—	—	—
- Others	Wons, millions	110	228	—	280	725
(foreign govts. and	US dollars, millions	0.4	0.6	—	0.58	1.50
int'l organizations)	Percent	1.0	1.9	—	0.5	6.4
Total	Wons, millions	10,548	12,028	38,182	60,900	152,418
	US dollars, millions	33.4	30.2	78.9	125.8	314.9
	Percent	100	100	100	100	100
II. Sector of performance						
- Public sector	Wons, millions	8,852	9,542	21,862	43,780	78,073
	US dollars, millions	28.0	23.9	45.2	90.5	161.3
	Percent	83.9	79.3	57.2	71.9	51.3
- Industry	Wons, millions	1,325	2,137	9,799	15,141	53,802
	US dollars, millions	4.2	5.4	20.3	31.3	111.2
	Percent	12.6	17.8	25.7	24.9	35.3
- Higher education	Wons, millions	371	349	6,521	1,979	20,543
	US dollars, millions	1.2	0.9	13.5	4.1	42.4
	Percent	3.5	2.9	17.1	3.2	13.4
- Other	Wons, millions	—	—	—	—	—
	US dollars, millions	—	—	—	—	—
	Percent	—	—	—	—	—

Source: Ministry of Science and Technology, *Science and Technology Annual,* 1971, 1973, 1975, 1977, 1979

Table 4. Breakdown of total expenditure on scientific and technical research by sector of performance and field of activity

Sector of performance		1970 Phy. Sc. (Excl. Eng.)	1970 Eng. Sc.	1970 Life Science	1970 Soc. & Hum. Sc.	1970 Total	1972 Phy. Sc. (Excl. Eng.)	1972 Eng. Sc.	1972 Life Science	1972 Soc. & Hum. Sc.	1972 Total	1974 Phy. Sc. (Excl. Eng.)	1974 Eng. Sc.	1974 Life Science	1974 Soc. & Hum. Sc.	1974 Total	1976 Phy. Sc. (Excl. Eng.)	1976 Eng. Sc.	1976 Life Science	1976 Soc. & Hum. Sc.	1976 Total	1978 Phy. Sc. (Excl. Eng.)	1978 Eng. Sc.	1978 Life Science	1978 Soc. & Hum. Sc.	1978 Total
Public Sector	in thousand wons	1,340	3,405	3,719	388	8,852	697	4,346	3,904	482	9,429	483	6,295	14,326	661	21,755	1,617	26,142	15,031	990	43,780	458	49,087	26,215	2,312	78,072
	in thousand US dollars	4.2	10.8	11.7	1.2	27.9	1.8	10.8	9.8	1.2	23.6	1.0	13.0	29.6	1.4	45.0	3.3	54.0	31.1	2.1	90.5	0.9	101.4	54.2	4.8	161.3
	Field breakdown (%) within sector	15.1	38.5	42.0	4.4	100.0	7.4	46.1	41.4	5.1	100.0	2.2	28.9	65.9	3.0	100.0	3.7	59.7	34.3	2.3	100.0	0.6	62.9	33.6	2.9	100.0
	Sector breakdown (%) within field	81.7	77.1	92.9	79.2	83.9	49.9	81.3	88.7	87.7	80.7	65.1	94.2	97.8	87.9	95.3	40.7	63.6	88.3	87.8	69.2	3.1	50.6	68.8	94.7	51.2
Industry	in thousand wons	272	88.6	167	—	1,325	659	866	379	—	1,904	10	270	168	—	448	2,214	14,429	848	—	17,491	9,099	40,325	4,379	—	53,802
	in thousand US dollars	0.9	2.8	0.5	—	4.2	1.7	2.2	1.0	—	4.9	0	0.6	6.3	—	0.9	4.6	29.8	1.8	—	36.2	18.8	83.3	9.1	—	111.2
	Field breakdown (%) within sector	20.5	66.9	12.6	—	100.0	34.6	45.5	19.9	—	100.0	2.2	60.3	37.5	—	100.0	12.7	82.5	4.8	—	100.0	16.9	75.0	8.1	—	100.0
	Sector breakdown (%) within field	16.6	20.1	4.2	—	12.6	47.2	16.2	8.6	—	16.3	1.4	4.1	1.2	—	2.0	55.8	35.1	5.0	—	27.7	61.4	41.5	11.5	—	35.3
Higher Education	in thousand wons	28	126	116	102	372	40	133	117	55	345	249	114	155	91	609	140	550	1,152	137	1,979	5,251	7,679	7,484	129	20,543
	in thousand US dollars	0.1	0.4	0.4	0.3	1.2	0.1	0.3	0.3	0.1	0.8	0.5	0.2	0.3	0.2	1.2	0.3	1.1	2.4	0.3	4.1	10.8	15.9	15.5	0.3	42.5
	Field breakdown (%) within sector	7.5	33.9	31.2	27.4	100.0	11.6	38.6	33.9	15.9	100.0	40.9	18.7	25.5	14.9	100.0	7.1	27.8	58.2	6.9	100.0	25.6	37.4	36.4	0.6	100.0
	Sector breakdown (%) within field	1.7	2.8	2.9	20.8	3.5	2.9	2.5	2.7	10.2	3.0	33.5	1.7	1.0	12.1	2.7	3.5	1.3	6.7	12.2	3.1	35.5	7.9	19.7	5.3	13.5
Total	in thousand wons	1,640	4,417	4,002	490	10,549	1,396	5,345	4,400	537	11,678	742	6,669	14,649	75.2	22,812	3,971	41,121	17,631	1,127	63,250	14,808	97,091	38,078	2,441	152,418
	in thousand US dollars	5.2	13.9	12.6	1.6	33.3	3.5	13.4	11.0	1.4	29.3	1.5	13.8	30.2	1.6	47.1	8.2	85.0	35.2	2.3	130.7	30.6	200.6	78.7	5.1	315.0
	Field breakdown (%) within sector	5.6	41.9	37.9	4.6	100.0	12.0	45.8	37.6	4.6	100.0	3.3	29.2	64.2	3.3	100.0	6.3	65.0	26.9	1.8	100.0	9.7	63.7	25.0	1.6	100.0
	Sector breakdown (%) within field	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Ministry of Science and Technology, *Science and Technology Annual*, 1971, 1973, 1975, 1977, 1979, unpublished data.

Table 5. Public expenditure on scientific and technical research**

	1970	1972	1974	1976	1978
Absolute values:					
- in million wons	7,414	7,965	25,051	39,182	73,722
- in million US dollars	23.4	20.0	51.8	81.0	152.3
Growth index (1970 = 100)*	100	85.5	221.4	346.2	650.9
As percentage of State budget	1.1	0.7	1.5	1.2	1.2
As percentage of total expenditure on scientific and technical research (see Table 2)	70.3	66.2	65.6	64.4	48.4

* *See Table 2, footnote*
** Civil research only. Data on research for defense purposes are not available.
Source: Ministry of Science and Technology, *Science and Technology Annual,* 1971, 1973, 1975, 1977, 1979

Table 6. Public expenditure on scientific and technical research in higher education

	1970	1972	1974	1976	1978
Absolute values:					
- in million wons	371	349	621	924	11,922
- in million US dollars	1.2	0.9	1.3	1.9	24.6
Growth index (1970 = 100)*	100	75	108	158	2,050
As percentage of public expenditure on scientific and technical research	5.0	4.4	3.5	2.4	16.2
As percentage of total expenditure on scientific and technical research	3.5	2.9	2.7	1.5	7.8
As percentage of public expenditure on higher education	7.5	5.0	4.9	3.0	15.7

* *See Table 2, footnote*
Source: Ministry of Science and Technology, *Science and Technology Annual,* 1971, 1973, 1975, 1977, 1979

Table 7. Public expenditure on scientific and technical research in industry

	1970	1972	1974	1976	1978
Absolute values:					
- in million wons	86	226	157	316	160
- in million US dollars	0.3	0.6	0.3	0.7	0.3
Growth index (1970 = 100)*	100	200	100	233	100
As percentage of public expenditure on scientific and technical research	1.2	2.8	0.9	0.8	0.3
As percentage of total expenditure on scientific and technical research	0.8	1.9	0.7	0.5	0.1
As percentage of industry's expenditure on scientific and technical research	6.5	10.6	29.7	2.1	0.3

* *See Table 2, footnote*
Source: Ministry of Science and Technology, *Science and Technology Annual,* 1971, 1973, 1975, 1977, 1979

Table 8. Public expenditure on international scientific and technological activities

	1970	1972	1974	1976	1978
Absolute values:					
- in thousand wons	4,765,543	6,001,451	6,347,176	5,315,288	5,111,040
- in thousand US dollars	15,048	15,045	13,114	10,982	10,560
Growth index (1970 = 100)*	100	100	87.2	73.0	70.2
As percentage of total expenditure on scientific and technical research	64.1	75.0	25.2	13.3	6.8

* *See Table 2, footnote*

Source: Ministry of Science and Technology, *Science and Technology Annual,* 1971, 1973, 1975, 1977, 1979

Table 9. Breakdown of public expenditure on scientific and technical research by departments or ministries

Department or Ministry		1971	1972	1973	1974	1975
Food and Agriculture	wons, millions	2,207	2,150	2,901	—	—
	US dollars, millions	5.9	5.4	7.3	—	—
	%	17.3	18.8	22.3	—	—
Industry	wons, millions	427	736	470	—	—
	US dollars, millions	1.1	1.9	1.2	—	—
	%	3.4	6.5	3.6	—	—
Construction	wons, millions	334	82	548	—	—
	US dollars, millions	0.9	0.2	1.4	—	—
	%	2.6	0.7	4.2	—	—
Energy	wons, millions	—	—	—	—	—
	US dollars, millions	—	—	—	—	—
	%	—	—	—	—	—
Transport	wons, millions	24.7	548	345	—	—
	US dollars, millions	0.7	1.4	0.9	—	—
	%	1.9	4.8	2.7	—	—
Communications	wons, millions	466	229	349	—	—
	US dollars, millions	1.3	0.6	0.9	—	—
	%	3.6	2.0	2.7	—	—
Education	wons, millions	1,733	2,575	3,022	—	—
	US dollars, millions	4.6	6.5	7.6	—	—
	%	13.6	22.6	23.3	—	—
Health	wons, millions	440	498	503	—	—
	US dollars, millions	1.2	1.3	1.3	—	—
	%	3.5	4.5	3.9	—	—
Defence*	wons, millions	—	—	—	—	—
	US dollars, millions	—	—	—	—	—
	%	—	—	—	—	—
Other**	wons, millions	6,852	4,555	4,849	—	—
	US dollars, millions	18.4	11.4	12.2	—	—
	%	54.1	40.1	37.3	—	—
Total	wons, millions	12,706	11,373	12,987	39,462	74,447
	US dollars, millions	34.1	28.7	32.8	81.5	153.8
	%	100.0	100.0	100.0	—	—

* Not available.

** 'Other' includes the Ministry of Science and Technology, the Ministry of Finance, and Provincial departments.

Source: Ministry of Science and Technology, *Science and Technology Annual,* 1972-1975.

Table 10. Expenditure of productive enterprises and public services on scientific and technical research by sector of activity

Sector of activity		1970	1972	1974	1976	1978
Food and agriculture:	wons, thousands	376,325	776,099	1,649,079	992,011	4,613,926
	US dollars, thousands	1,193	1,945	3,407	2,050	11,599
	%	12.1	19.1	31.5	4.6	7.2
- Agriculture, forestry and fisheries	wons, thousands	174,675	192,068	1,462,667	—	779,712
	US dollars, thousands	553	481	3,022	—	1,611
	%	5.6	4.7	27.9	—	1.0
- Food industries	wons, thousands	202,283	584,031	186,412	992,011	4,834,214
	US dollars, thousands	640	1,464	385	2,050	9,988
	%	6.6	14.4	3.6	4.6	6.2
Industry:	wons, thousands	2,221,678	2,730,314	2,386,145	18,679,927	61,206,888
	US dollars, thousands	7,031	6,843	4,930	38,594	126,461
	%	70.9	67.2	45.6	87.2	78.5
- Extractive	wons, thousands	120,956	85,164	41,018	39,082	331,885
	US dollars, thousands	383	213	85	81	644
	%	3.9	2.1	0.8	0.2	0.4
- Manufacturing	wons, thousands	2,100,721	2,645,150	2,345,127	18,640,845	60,895,502
	US dollars, thousands	6,648	6,629	4,845	38,513	125,817
	%	67.0	67.2	45.8	87.0	78.1
Construction	wons, thousands	119,156	84,809	272,937	—	467,827
	US dollars, thousands	377	213	564	—	967
	%	3.8	2.1	5.2	—	0.6
Energy	wons, thousands	—	—	9,217	—	—
	US dollars, thousands	—	—	19	—	—
	%	—	—	0.2	—	—
Transport	wons, thousands	270,544	315,964	204,857	—	77,971
	US dollars, thousands	856	729	423	—	161.1
	%	8.6	7.8	3.9	—	0.1
Communications	wons, thousands	—	—	—	—	—
	US dollars, thousands	—	—	—	—	—
	%	—	—	—	—	—
Education	wons, thousands	145,337	155,498	307,895	966,614	8,429,140
	US dollars, thousands	460	390	636	1,997	17,416
	%	4.6	3.8	5.9	4.5	10.8
Health	wons, thousands	—	—	197,725	—	—
	US dollars, thousands	—	—	409	—	—
	%	—	—	3.8	—	—
Other	wons, thousands	—	—	207,113	799,904	2,183,193
	US dollars, thousands	—	—	428	1,653	4,511
	%	—	—	4.0	3.7	2.8
Total	wons, thousands	3,133,673	4,062,479	5,234,968	21,438,456	77,971,196
	US dollars, thousands	9,917	10,182	10,816	44,294	161,098
	%	100	100	100	100	100

Source: Ministry of Science and Technology, *Science and Technology Annual,* 1971, 1973, 1975, 1977, 1979, unpublished data.

Table 11. Expenditure by industry on scientific and technical research

	1970	1972	1974	1976	1978
Absolute values:					
- in million wons	1,325	2,137	529	15,141	53,802
- in million US dollars	4.2	5.4	1.1	31.3	111.2
Growth index (1970 = 100)*	100	129	26	745	2,645
As percentage of total expenditure on scientific and technical research	12.6	17.8	2.3	24.9	35.3

* *See Table 2, footnote*

Source: Ministry of Science and Technology, *Science and Technology Annual,* 1971, 1973, 1975, 1977, 1979

PART IV

Scientific and Technological Manpower

I. EDUCATIONAL SYSTEM

Due to the exceptionally high concern, private and public, about education, educational development in Korea has taken place earlier and more rapidly than development in other sectors. The continual educational efforts since independence have brought an expansion of education that currently accounts for 9 per cent of the GNP in resource consumption. The rapid economic development in the 1960s and 1970s would not have been possible without this high level of development in the education sector.

When, in 1948, the Republic of Korea governent came into being, the National Assembly was elected, and the Constitution promulgated, one of the first legislative acts of the National Assembly was to enact the Education Law. The Education Law thus enacted clearly sets forth the basic direction and objectives of education in this country. It is stipulated in Article 1 that the purpose of education is to enable every citizen to perfect his personality, uphold the ideals of universal fraternity, develop a capability for self-support in life, and enable him to work for the development of a democratic state and for the common prosperity of all mankind. A fundamentally Western-oriented educational system was brought in and despite cultural incompatibility, the system took root, helped as it was by the sudden upsurge in demand for higher education.

The general system of education in Korea comprises four stages: primary, lower secondary, upper secondary, and higher education forms. The primary school provides six years of compulsory elementary education to children between the ages of 6 to 11. Pupils aged from 12 to 14 attend middle school which offers three years of upper secondary education, and the graduates of high schools attend either junior colleges or senior colleges (universities) to receive higher education.

The high schools are generally divided into two categories of general and vocational. The latter include agricultural, commercial, fishery, and technical high schools. The higher educational institutions include junior technical colleges (two years), junior teachers' colleges, and colleges and universities (four years). Originally designed to offer literacy programs, civil schools still exist only at secondary level. There are special schools offering elementary and secondary education for the deaf, for the blind and for the mentally or otherwise physically handicapped children. Preschool education is provided by the kindergartens. The current school system is shown in Graph 1 and the number of schools of different types in 1979 is indicated below.

The size of the student population has increased rapidly in recent years, as can be seen in Graph 2. The increase has been most notable for middle and high school. Between 1969 and 1978 the number of middle school students increased two-fold, and the percentage of primary school leavers advancing to middle schools rose from 58.4 per cent in 1969 to 92.9 per cent in 1979. Some 81 per cent of all middle school leavers went on to continue high school education in 1979, and the ratio is expected to rise to 91.5 per cent by 1991. In view of such development, it seems inevitable to extend compulsory education to the middle school level in the near future.

Number of schools by level (1979)

Schools	Total	National	Public	Private
Kindergarten	794	-	26	768
Primary school	6,450	16	6,356	78
Middle school	2,056	5	1,308	743
Academic high school	724	6	337	381
Vocational high school	536	5	297	272
Junior vocational college	127	20	26	91
Junior teachers' college	11	11	-	-
College & university	84	19	1	64
Graduate school	100	28	-	72
Special schools	51	2	10	39
Others	14	2	-	12

Source: Education in Korea, 1979-1980, Ministry of Education, Republic of Korea, p. 35

II. RESOURCES FOR EDUCATION

The major resources for education are the budget of the Ministry of Education, tuition and other fees paid by parents, expenses shared by private foundations, and those shared by other agencies and individuals. In 1979 the total public expenditure on education was US$2,445,329,000 which represented about 6 per cent of the GNP and an increase of 675 per cent over the 1972 budget (Table 12). Out of the total expenditure for education, 21.5 per cent (526 million dollars) was spent on higher education in 1979 compared with 16.3 per cent in 1972.

The 1980 budget for the Ministry of Education (MOE) was 1,879 million dollars representing 3.1 per cent of GNP and 18.9 per cent of the total government budget. The ratio of MOE budget to GNP fell below the 3 per cent level for four years beginning in 1973, but since 1977 it has been maintained steadily just above 3 per cent. Education in local areas is largely financed by the central government. In the past few years the central government's share of the expense of education in local areas has increased continuously while the local government's share has decreased. In 1979 about 80 per cent of the expense was covered by central government.

The following table shows the breakdown of expenditure on education as among the different sectors of the government, parents, foundations, and other agencies and individuals by type and level of schools for 1977. For schools of all levels, public and private, 51.5 per cent is covered by the government, 44.5 per cent by the

parents, 1.2 per cent by foundations, and 2.4 per cent by others. The government's budget is largely used for primary compulsory education and junior teachers colleges, and while expenditure on middle, high school, and four-year colleges is largely met by parents. In the case of the regular four-year colleges, the government's share is 25.6 per cent, parents' 64.3 per cent, foundations' 2.5 per cent, and others' 7.6 per cent.

Relative distribution of the budget of educational expenditure by source
(in percentages)

	Gov't	Found'ns	Parents	Others
Nat'l & public schools	75.0	-	23.9	1.1
Private schools	2.1	3.7	89.1	5.1
Kindergartens	6.7	9.8	82.1	1.4
Primary schools	94.5	0.1	5.2	0.2
Middle schools	22.4	1.1	74.1	2.4
High schools	28.5	1.7	67.4	2.4
Junior teachers' colleges	84.1	-	8.4	7.5
Four-year colleges	25.6	2.5	64.3	7.6
Special schools	69.8	14.2	10.6	5.4
Total	51.5	1.2	44.9	2.4

Source: Educational Expenditure in the Republic of Korea, 1977, Korean Educational Development Institute, 1977, p. 91

III. SCIENTIFIC AND TECHNOLOGICAL TRAINING IN HIGHER EDUCATION

The total number of students in higher education in 1979 was reported as 444,578 in 334 institutions staffed by 19,174 faculty members. Of the 334 institutions, 84 were colleges and universities, having an aggregate of 100 graduate schools attached to them. Table 13 lists the number of establishments of higher education and their enrollment from 1969 to 1979. About 25 per cent of the student body is represented by women. The geographical distribution of higher education establishments in Korea is listed in Table 14.

Colleges and universities in Korea operate under strict enrollment quotas set by the government. Because of the gap between college admission limits and the number of applicants graduating from high schools, the competition through entrance examinations has become more intense year on year. The number of applicants for college admission rose from 223,159 in 1975 for a quota of 57,950 amounting to 26.0 per cent of applicants to 290,233 applicants against a total opening of 65,750 (22.7 per cent) in 1977.

The recent trend in manpower development in Korea is well indicated in Table 15 (Graph 3), Table 16, and Table 17, which show respectively the distribution of total number of students in higher education, of first-year students in higher education, and of the graduates in higher education in various disciplines during the academic years of 1969 and 1979. Up to the early 1960s education in the social sciences and liberal arts was emphasized and educational facilities in general were expanded without taking industrial manpower requirements into consideration. Such a policy resulted in a shortage of scientists, engineers, technicians, and skilled persons needed for the rapid industrial and economic development of the late 1970s. In order to increase the supply of required scientific and technological manpower, the Korean government implemented manpower development planning with special emphasis on training and education in science, engineering and craftmanship. Accordingly, the proportion of students in higher education in the discipline of technology increased from 16.9 per cent in 1969 to 19.3 per cent in 1974, 22.4 per cent in 1977, and 30.8 per cent in 1979. In recent years, technology students have represented the largest group of students in higher education. The proportion of students in the social sciences and humanity studies remained rather constant, at around 19 per cent, representing the largest group in 1969, but the second largest, behind the technology group, in 1979.

Graduate school education has expanded rapidly in response to the rising demand for highly educated manpower in the academic institutions, research organizations, and top-level corporate management since the beginning of 1970s. Total enrollments in graduate courses in 1969 numbered 6,155 and ten years later in 1979 the total had risen more than four-fold to 25,789 spread among 100 graduate schools. Of the 1979 total enrollment, 22,754 were pursuing master's degree courses while the remaining 3,035 were working for doctorate degrees. Actual enrollments, however, normally fall short of the authorized limits. In 1979, the enrollment amounted to 91.6 per cent of the authorized maximum for MA programs and 73.2 per cent for PhD programs. Table 18 shows the breakdown, by discipline, of the number of doctorates conferred annually from 1970 to 1979. The following table shows the distribtion of graduate students in various disciplines during the academic year 1979. The largest number of students are working for an MA in social science studies (31.2 per cent) and for a PhD in medicine (34.0 per cent). Out of the total number of graduate students, 14.9 per cent are in the field of engineering and only 7.8 in the field of physical sciences.

Graduate students by fields, 1979

	Total	MA	PhD
Languages & literature	1,525	1,213	312
Fine arts	936	936	-
Liberal arts	1,160	983	177
Social sciences	7,561	7,110	451
Gymnastics	186	186	-
Physical sciences	2,028	1,668	360
Engineering	3,866	3,452	414
Medicine	3,108	1,076	1,032
Agriculture & forestry	957	756	201
Fishery marine	136	100	36
Pedagogy	4,326	4,274	52
Total	25,789	22,754	3,035

Source: Education in Korea, 1979-1980, Ministry of Education, Republic of Korea, p. 63

A special type of graduate school, the Korea Advanced Institute of Science (KAIS), was established in 1970 by the Korean Government in order "to produce for Korean industry a supply of engineers and applied scientists who combine high ability with advanced training oriented towards the technological needs of modern industry". In addition, the institute was expected to

stimulate graduate education in science, which was plagued with undue emphasis on memorization, inadequate laboratory training, lack of contact with the real world outside of the campus, and shortage of professors with modern training.

From the outset, the Institute was allowed to chart its own course, guided by the collective wisdom of the faculty, with minimum interference from outside. It was placed outside the jurisdiction of the Ministry of Education, thus freed from many of its stifling rules and regulations. A self-perpetuating Board of Trustees composed of representatives of government, industry, the academic world and the research establishments provides general guidance of the operation. The government, through the Ministry of Science and Technology, provides adequate operating funds on a continuing basis. Supply of top-quality applicants is guaranteed by government measures which among other things underwrite the entire cost of education, exempt sucessful applicants from military obligations, and guarantee placement after graduation. The students are required to serve in domestic industrial, educational, or research organizations for three years after graduation.

KAIS was authorized to confer Doctor of Philosophy (PhD), Professional Engineer, and Master of Science (MS) degrees. The first class of 92 MS students graduated in August 1975, and as of the summer of 1979, there were 527 students in MS, 186 in Professional Engineering, and 107 in PhD programs with 72 full-time faculty members and 70 adjunct professors and visiting professors from abroad.

Parallel with the education of scientists and engineers, the Government has given special attention to the training of technicians. A quantitative expansion of vocational education has been made, with emphasis on intensive technical training, especially for the heavy and chemical industries and other priority areas. In addition, enterprises, as the end users of trained technicians, are encouraged to establish 'attached vocational schools' on their premises. Firms with a specified number of employees are required by law to conduct in-plant training themselves or to pay the fees for outside training.

IV. UTILIZATION OF SCIENTIFIC AND TECHNOLOGICAL MANPOWER

As of December 1978, the total number of research personnel was 30,214, of which 14,749 (48.8 per cent) were researchers, 8,909 (29.5 per cent) research assistants, and 6,556 (21.7 per cent) other personnel who helped with clerical and accounting work. The distribution of research personnel among different types of employer organizations was 32.3 per cent in industry, 28.5 per cent in universities, and 39.2 per cent in research institutes of government and non-profit organizations. The corresponding distribution of researchers was 29.2 per cent in industry, 38.8 per cent in universities, and 32.0 per cent in research institutes. The educational level of researchers in different sectors were: in industry 0.9 per cent PhD holders, 6.0 per cent MS, 88.6 per cent BS, and 4.5 per cent below BS; in universities 41.9 per cent PhD, 45.1 per cent MS, 12.5 per cent BS, and 0.5 per cent below BS; and in research institutes 9.4 per cent PhD, 19.7 per cent MS, 61.0 per cent BS, 9.9 per cent below BS. Such an analysis shows that universities have not only the highest number of researchers but also the most qualified ones. Although the industry sector has a relatively high number of research personel, it falls far behind the universities in their educational level. Table 19 lists the distribution of scientists and engineers, employed and engaged in research, in different sectors and in different disciplines (Graph 4).

The demand for creative scientific research has been rising in direct proportion to the rapid progress of science and technology and the increasing pace of economic and social change. In 1973 there were about 6,000 persons engaged in research, either in research organizations or business enterprises, and although the number of researchers increased to 14,749 in 1978, it represented only four per ten thousand of the total population while this proportion was 38 in the USSR (1976), 25 in the USA (1975), 24 in Japan (1977), 15 in West Germany (1975), and 12 in France (1975). Considering the fact that all developed countries have more than ten scientists per ten thousand and also considering the recent historical technological developments in Japan, the long-term development plan for Korea requires 6 scientists per 10,000 population by 1981, 11 by 1986, and 18 by 1991.

The projected technical manpower demand required in Korea for continued economic growth and industrial development is shown in the table below.

The total high-level technical manpower, expected to grow at a much higher rate than the projected three percent growth rate for the general employment, would represent 7.6 per cent of the total work force by 1991.

Forecast of demand for technological manpower (unit: 1 000 persons)

Qualifications	1979	1981	1986	1991	Average annual growth rate (%) 1982-1986	Average annual growth rate (%) 1987-1991
Employed population (A)	13,664	14,299	16,714	18,454	3.17	2.00
Technological manpower (B)	641	736	1,044	1,402	7.23	6.08
Scientists	17	22	43	83	14.28	14.22
Engineers	181	203	280	441	6.59	9.53
Technicians*	444	511	721	878	7.14	3.98
B/A (%)	4.7	5.2	6.2	7.6		

* Only technicians with vocational high school or at least one year's technical training are included here. Manual workers and simple operative technicians are not included.

Source: Ministry of Science and Technology, *Science and Technology Annual*, 1981, p. 15.

The demand is especially high for heavy and chemical industries. Several measures such as the reinforcement and promotion of graduate school education and expansion of engineering colleges and vocational training facilities are already being taken to meet this high demand for technical manpower in the future.

In recent years the Korean government has been systematically developing new institutions to support the science-based industries which increasingly characterize Korea's expanding economy. The transfer of technology from advanced countries in the form of plants and licensing has been the mainstay of the development of industrial technology in Korea. Recent experience gained in Korea strongly suggests that the choice of appropriate technology can be properly made only when the technology importing country has itself the capability of making relevant decisions and to negotiate with the transferring country. This experience further suggests that the adaptation and improvement of imported technology is only possible when a specific level of indigenous R & D capability exists. The 1980s are set as the decade during which the Korean economy will achieve a more highly developed industrialized status with indigenous innovation capability, making it possible to compete successfully in international markets.

The Korea Scientific and Technological Information Center (KORSTIC) was established in 1962 to collect and disseminate scientific information. The Korea Institute of Science and Technology (KIST) was founded in 1966 with aid from the American Government. KIST is a non-profit organization that carried out research and development projects for the Korean industry and the Korean government. As the first modern multi-disciplinary research institute in Korea, it was given by the government an unprecedented degree of research autonomy and flexibility, the financial stability, and a research environment adequate to attract qualified manpower. It has successfully acted as a medium of technological development on the basis of imported technology and as the centre for the development of industrial technology within the country. The Ministry of Science and Technology (MOST) was established in 1967, to spearhead an intensive effort on the part of the government to strengthen the base of the nation's technological industries. In a similar fashion, the Agency for Defense Development (ADD) was activated in 1970 to co-ordinate defense-oriented research and development activities in Korea. In addition, a new independent research organization, the Korea Development Institute (KDI), was established in 1971 to perform policy-oriented research for the Korean economy and to assist the Korean government in developing strategic policies. All these new institutions are located in a large-scale "Science Park", which acts as the intellectual centre for the national industrial development through the application of science and technology.

As development of industrial technology approached a more mature and sophisticated stage, R & D became more diversified, specialized and complex, requiring interdisciplinary co-ordination. This led government planners to believe that KIST alone could not accommodate all the nation's R & D needs, and it established specialized research institutes to support strategic industries, along principles similar to those of KIST.

These include:

Standards Research Institute
Shipbuilding Research Institute
Chemical Technology Research Institute
Energy Conservation and Management Research Institute
Nuclear Fuel Development Institute
Heavy Electrical Equipment Testing Institute
Telecommunications Research Institute
Machinery and Metal Testing and Research Institute
Electronics Research Institute
Ocean Research and Development Institute
Regional Development Institute
Solar Energy Research Institute

The majority of these institutes are located in Daeduk Science Town in Chungnam Province. The Korea Atomic Energy Research Institute was established in 1959 as part of the Office of Atomic Energy, an organization responsible for the peaceful development of nucelear energy. Until KIST was estabished in 1966, it was the only research institute which offered relatively modern facilities and a stimulating atmosphere for research. In 1973 it was reorganized as a government-supported corporate body, and in 1975 it established Daeduk Engineering Center as a branch institute for the effective implementation of nuclear fuel projects. The Center was reorganized the following year as the Korea Nuclear Fuel Development Institute, being an independent and autonomous corporate body. The Korea Science Foundation was estabished in 1977 to provide support for basic and applied research and to stimulate scientific co-operation between Korean and foreign scientists through co-operative research, joint seminars, workshops, and exchange of scientists.

In addition to the government-supported research institutes many new research centres were established by universities and colleges and, in recent years, also by industry. The following table of statistics on research institutes affiliated with universities and colleges shows that about two-thirds of the 548 institutes were established within the past decade. Most of them are established by school authority and are operated with limited amounts of funds and personnel. About half of the institutes have an annual budget of less than US$10,000. The activity of the institutes is presented in a report or research journal published by most of the institutes, usually annually.

One of the best known university-affiliated research institutes is the Natural Products Research Institute of Seoul National University. It was initially founded in 1939 and was reorganized in 1946, one year after liberation. Original research is continually carried out on natural products such as Ginseng and other medicinal plants. Its two annual journals, *Annual Report of the Natural Products Research Institute* and *Bulletin of the Natural Products Research Institute* are well received by scholars in relevant fields. Some other well-known institutes are the Research Institute for Environmental Science of Hanyang University (founded in 1978, US$30,000 annual budget and 50 affiliated researchers), the Institute of Industrial Science and Technology of Korea University (founded in 1967, US$23,000 budget and 45 members), and the Institute of Electronic Technology of Gyeong-Bug National University (founded in 1978, US$13,000 budget and 30 members). The Research Institute for Basic Science was founded at Seoul National University in January of 1979 with a budget of more than one million US dollars. All the professors in the College of Natural Science are affiliated with the research institute.

Until very recently virtually no research and development work was carried out by industry itself, in sharp contrast to advanced countries. However, in the late 1970s as the private business sector grew larger in scale, industrial companies started to establish company-affiliated research centres to solve the particular difficulties they faced in their manufacturing processes and to carry out general R & D work. The Government took an active interest and encouraged them by giving loans and tax-exemptions for expenses incurred in R & D activities. Sangyong Research Center in Daeduk Science Town and electronic research institutes of Gold Star and Samsung are largest among the newly established industry research centres.

Such an expanded effort for research and development by government, academia, and industry has made the scientific and technological community much more vigorous and productive in recent years than before. As a result many Korean scientists and engineers educated and working in advanced countries have returned to Korea during the past decade.

Like other less well-developed countries in Asia, Korea suffered from the problem of 'brain-drain' in the 1960s. Discouraged by poor graduate school education and poor research facilities, many students went abroad to the USA, the United Kingdom, the Federal Republic of Germany, and other Western countries for their advanced studies. Once educated, they were reluctant to return to Korea for reasons such as the lack of job opportunities and the poor research environment. Even if they chose to return, their foreign training was often not suitable for the needs of a developing country like Korea.

Realizing the problem of brain-drain, the Korean government took several effective measures to recruit able Korean scientists and engineers working abroad. Since its establishment in 1966, KIST alone has brought back more than one hundred expatriate Korean scientists, and along with KAIS and other recently established research institutes in the Science Park and Daeduk Science Town, it is now staffed mostly by overseas-educated researchers. Many scientists also have joined universities and colleges for teaching and research.

Research institutes affiliated with universities and colleges

Classification of universities and colleges		Private	Public	Total
Establishing authority	Government laws	52	—	52
	School rules & regulations	25	325	350
	Members themselves	86	60	146
	Total	163	385	548
Year of establishment	1941-1950	—	—	2
	1951-1960	—	—	12
	1961-1970	—	—	167
	1971-1975	—	—	153
	1976-1979	—	—	208
	Unspecified	—	—	6
Discipline	Inter-disciplinary	13	50	63
	Language	9	11	20
	Fine arts	1	6	7
	Humanities	22	66	88
	Social science	48	133	181
	Physical education	4	6	10
	Natural science	15	27	42
	Technology	9	31	40
	Medical science	13	32	45
	Agricultural science	13	9	22
	Education	10	14	24
	Oceanography	6	—	6
	Total	163	385	548

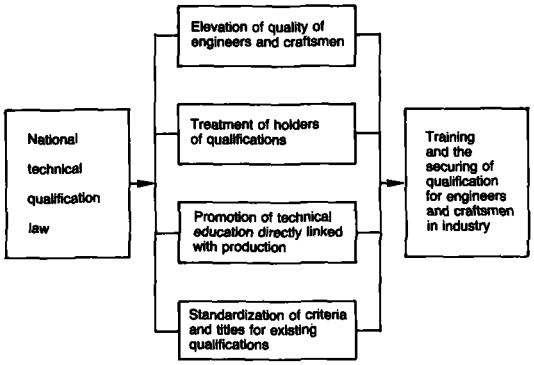
Source: Ministry of Education, *Statistics of Research Institutes Affiliated with Universities and Colleges*, 1980. 4.1.

V. NATIONAL TECHNICAL QUALIFICATIONS SYSTEMS

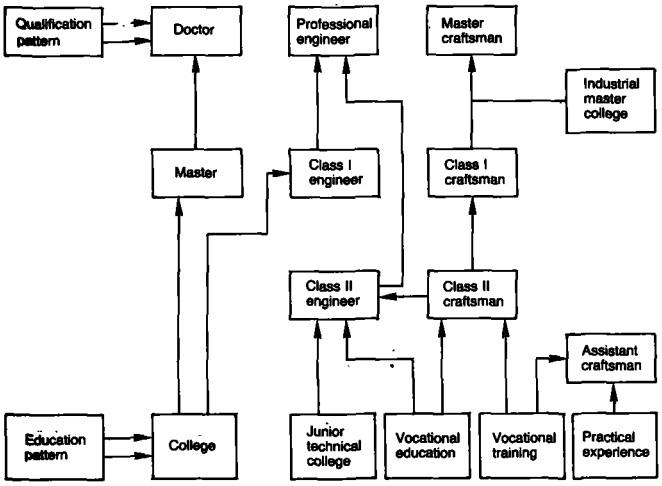
The National Qualification Systems is a system for supplying engineers and craftsmen relevant to industrial demands, through testing them using uniform criteria, and giving preferential socio-economic treatment to those who obtain qualifications.

The system, its purposes and its status are summarized below:

A. Purposes



B. System



C. Technical qualification titles

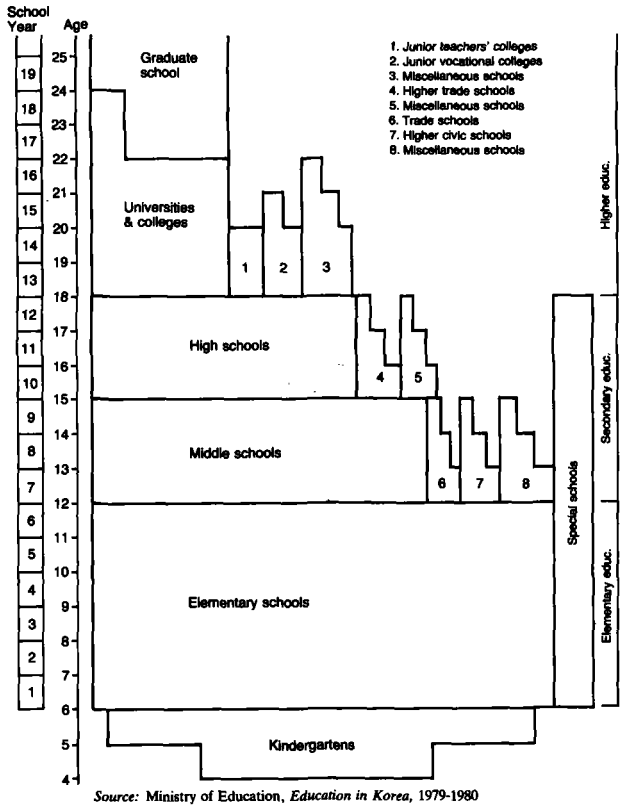
Classification	Technical field	Class	Titles of qualif.
Engineering group	19 Technical fields	Professional eng. Class I engineer Class II engineer	203 titles
Craft group	12 technical fields	Master craftsman Class I craftsman Class II craftsman Assistant craftsman	537 titles
Total			740 titles

D. Result of testing (1975-1980)

Class		No. of candidates	No. of succesful applicants	Ratio
Engineering Group	Professional engineer	12,437	1,422	11.4
	Class I engineer	221,993	53,044	23.0
	Class II engineer	529,533	136,275	25.7
	Total	763,983	190,740	25.0
Craft group	Class I craftsman	106,762	14,126	13.2
	Class II craftsman	2,387,429	399,026	16.7
	Assistant craftsman	232,470	99,110	42.6
	Total	2,726,661	512,265	13.8
Total		3,490,644	763,005	20.1

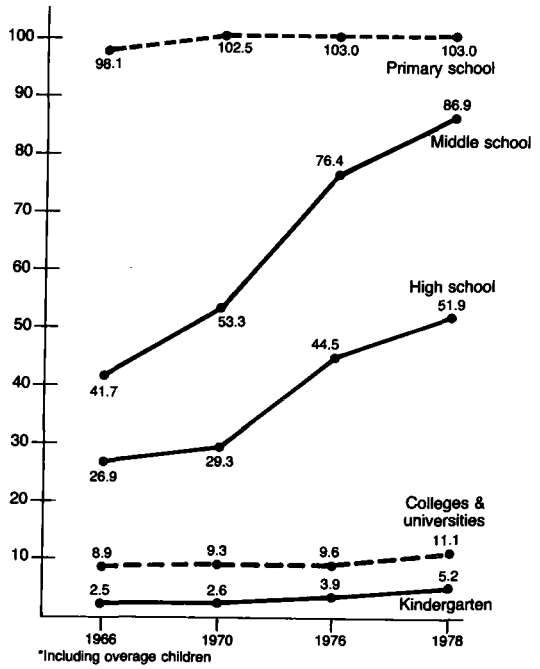
In order to enhance the National Technical Qualification System to meet the growing and changing industrial demands, the Korea Technical Qualification Testing Agency, which was created in 1976, has sought to unify various tests through the delegation and integration of qualification tests and the registration of holders of qualifications previously given by ten other responsible ministers.

Graph 1. The current school system



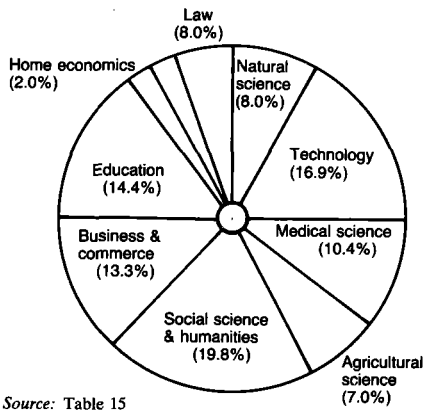
Source: Ministry of Education, *Education in Korea*, 1979-1980

Graph 2. School admission ratio by level



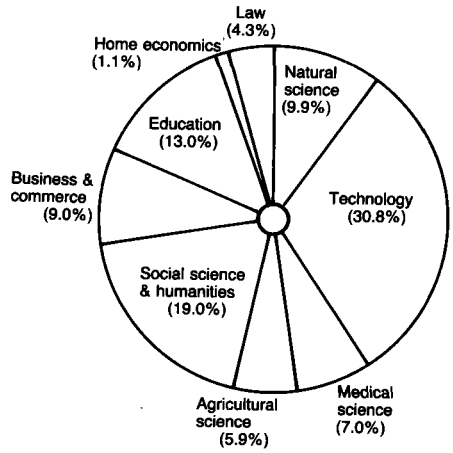
Source: Ministry of Education, *Education in Korea,* 1979-1980

Graph 3. Students in higher education: percentage distribution by discipline, academic year 1969



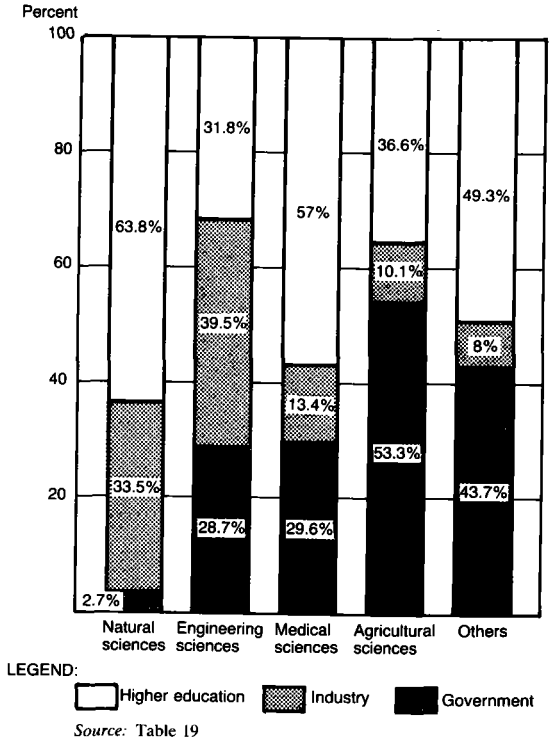
Source: Table 15

Graph 4. Students in higher education: percentage distribution by discipline, academic year 1979



Source: Table 15

Graph 5. Percentage distribution of scientists and engineers engaged in research, by sector of national activity, 1978



Source: Table 19

Table 12. Public expenditure on education in general and higher education, 1972-79

Item	1972	1973	1974	1975	1976	1977	1978	1979
I. Public expenditure on education in general (Unit, million won)	212,065	236,609	277,166	440,369	673,073	849,236	1,072,312	1,430,518
(Unit, $1,000)	568,081	593,153	697,272	909,853	1,390,646	1,754,618	2,215,520	2,445,329
As percentage of national income	6.24	5.41	4.48	5.46	6.26	6.18	5.75	N. A.
Indices	100	112	131	208	317	400	506	675
II. Public expenditure on higher education (Unit, million won)	34,490	40,632	54,628	80,732	113,586	150,536	206,448	307,517
As percentage of public expenditure on education in general	16.3%	17.2%	19.7%	18.3%	16.9%	17.7%	19.3%	21.5%
Indices	100	118	158	234	329	436	599	892
Capital expenditure as percentage public expend. on higher education	13.3%	13.5%	11.2%	10.4%	9.3%	12.3%	17.4%	21.6%
Recurrent expenditure as percentage of public expend. on higher educ.	86.7%	86.5%	88.8%	89.6%	90.7%	87.7%	83.6%	79.4%
III. Public expenditure on scientific and technical research in higher education (Unit, million won)	348	366	6,520	2,181	1,978	5,482	20,543	
As percentage of public expenditure on higher education	1.0%	0.9%	1.9%	2.7%	1.7%	3.6%	9.9%	

Note: Public expenditure on education in general include the budget of Ministry of Education and tuition and other fees shared by parents.
Expenditure figures are based on current price.
Rate of exchange: 1972 373.30 to US$1
1973 398.90 to US$1
1974 397.50 to US$1
1975-1978 484.00 to US$1
1979 585. to US$1

Source: Economic Planning Board, *Economic Indicators*, 1979
Ministry of Education, *Statistical Yearbook of Education*, 1969-1979

Table 13. Higher education: number of establishments, scientific workers and students

	1969	1971	1973	1976	1977	1979
Establishments for higher education	231	236	272	293	302	334
Per one million inhabitants	7.3	7.2	8.0	8.2	8.3	8.9
Colleges and universities	68	71	69	72	73	84
Per one million inhabitants	2.2	2.2	2.0	2.0	2.0	2.2
Scientific workers	3,860	4,707	5,287	5,468	5,850	10,291
% of women	(16.6)	(16.4)	(15.5)	(15.2)	(14.8)	(15.7)
Students enrolled	165,934	186,789	209,643	257,139	278,987	444,578
% of women	27.1%	27.4%	27.9%	26.9%	25.6%	24.1%

Note: Scientific workers include teaching and research staff in scientific fields.
Source: Ministry of Education, *Statistical Yearbook of Education*, 1969-1979

Table 14. Geographical distribution of universities and other higher education establishments, 1979

Area	Population (A)	Number of Universities	University enrollments (B)	No. of other establishments	Enrollm. at other estab'ts (C)	Total (B+C)	(B+C)/A (%)
Seoul	8,114,021	37	151,374	84	32,238	183,612	2.3
Busan	3,034,596	9	28,008	24	12,018	40,026	1.3
Gyeonggi	4,725,900	5	19,719	26	18,163	37,882	0.8
Gangweon	1,844,559	5	11,020	9	2,303	13,323	0.7
Chung Bug	1,447,868	3	11,705	6	1,828	13,533	0.9
Chung Nam	3,000,254	5	17,015	15	7,280	24,295	0.8
Jeon Bug	2,361,873	5	18,380	15	5,645	24,025	1.0
Jeon Nam	4,006,976	4	20,623	24	10,445	31,068	0.8
Gyeong Bug	4,981,813	6	37,030	29	17,553	54,583	1.1
Gyeong Nam	3,380,035	4	12,671	14	5,649	18,320	0.5
Jeju	456,988	1	2,800	5	1,111	3,911	0.9
Total	37,354,883	84	330,345	250	144,233	444,578	1.2

Sources: Ministry of Education, *Statistical Yearbook of Education,* 1969-1979
For population figures, Economic Planning Board, *Korean Statistical Yearbook,* 1980

Table 15. Breakdown of students in higher education by discipline and by sex, 1969-79

Discipline	1969	1972	1974	1975	1976	1977	1978	1979
1. Natural science	13,802	16,080	26,427	31,926	25,421	26,017	31,862	43,831
% Women	31.0	30.0	28.4	30.4	37.2	36.3	33.2	38.2
% Grand total	8.3	8.2	11.8	13.4	9.9	9.3	10.3	9.9
2. Technology	27,997	38,988	43,142	46,167	57,831	62,401	74,320	137,039
% Women	1.1	1.1	1.4	1.3	1.1	0.8	1.5	2.2
% Grand total	16.9	19.9	19.3	19.3	22.5	22.4	24.1	30.8
3. Medical science	17,234	20,510	20,165	19,700	20,449	21,878	22,396	30,955
% Women	51.0	51.3	39.9	36.8	35.4	34.3	32.0	38.3
% Grand total	10.4	10.5	9.0	8.0	8.0	7.8	7.3	7.0
4. Agricultural science	11,659	12,144	11,591	12,998	15,745	17,148	19,240	26,133
% Women	7.5	9.0	9.5	10.9	9.8	9.9	9.8	11.4
% Grand total	7.0	6.2	5.2	5.4	6.1	6.1	6.2	5.9
5. Social science & humanities	32,792	37,033	41,579	43,950	49,133	55,544	63,622	84,495
% Women	41.8	46.6	45.7	44.9	43.1	39.8	39.4	39.9
% Grand total	19.8	18.9	18.6	18.4	19.1	19.9	20.6	19.0
6. Business & commerce	22,071	22,037	21,835	23,579	24,686	26,308	22,657	40,202
% Women	7.0	7.1	7.5	6.5	7.5	5.8	7.1	7.1
% Grand total	13.3	11.2	9.8	9.9	9.6	9.4	7.3	9.0
7. Education	23,829	32,084	40,764	42,160	44,708	49,396	48,435	57,889
% Women	48.6	49.2	50.8	52.5	51.4	49.8	51.9	52.3
% Grand total	14.4	16.4	18.3	17.7	17.4	17.7	15.7	13.0
8. Home economics	3,292	3,228	3,228	3,378	3,458	3,453	3,676	5,089
% Women	99.9	99.9	99.9	99.9	99.7	99.6	99.6	99.8
% Grand total	2.0	1.6	1.4	1.4	1.3	1.2	1.2	1.1
9. Law	13,298	13,859	14,420	14,861	15,708	16,842	222,522	18,945
% Women	5.7	5.5	5.8	4.5	4.7	3.9	3.4	4.4
% Grand total	8.0	7.1	6.5	6.2	6.1	6.0	7.3	4.3
10. Total	165,934	195,963	223,151	238,719	257,139	278,987	308,730	444,578
% Women	27.2	28.3	28.1	27.8	26.9	25.6	25.1	24.1

Note: Higher education includes two-year junior colleges, colleges and universities, and graduate schools.
Source: Ministry of Education, *Statistical Yearbook of Education,* 1969-1979

Table 16. Breakdown of graduates in higher education by discipline and by sex, 1969-79

Discipline	1969	1972	1974	1977	1979
1. Natural science	2,255	2,807	3,022	3,533	4,432
% Women	41.9	31.0	38.2	43.2	41.9
% Grand total	6.5	6.8	7.2	7.5	8.4
2. Technology	4,214	6,264	6,873	8,129	10,600
% Women	2.2	0.5	1.9	1.7	1.3
% Grand total	12.2	15.2	16.4	17.2	20.2
3. Medical science	3,088	4,402	4,165	4,043	4,401
% Women	44.2	65.2	58.5	44.4	38.8
% Grand total	8.9	10.7	9.9	8.5	8.4
4. Agricultural science	2,274	2,545	1,980	2,469	2,770
% Women	12.6	7.9	11.9	12.2	13.2
% Grand total	6.6	6.2	4.7	5.2	5.3
5. Social science & humanities	7,152	6,886	7,195	9,779	11,152
% Women	51.5	51.3	51.4	52.9	51.2
% Grand total	20,7	16.7	17.2	20.7	21.2
6. Business & commerce	5,255	5,727	4,678	4,751	5,170
% Women	16.0	7.0	8.7	8.4	7.6
% Grand total	15.2	13.9	11.2	10.0	9.8
7. Education	5,856	8,577	10,035	10,648	9,960
% Women	53.0	56.8	51.6	56.7	58.7
% Grand total	17.0	20.9	23.9	22.5	18.9
8. Home economics	1,067	793	763	853	940
% Women	98.6	100.0	100.0	100.0	99.8
% Grand total	3.1	1.9	1.8	1.8	1.8
9. Law	3,357	3,111	3,201	3,108	3,159
% Women	4.8	5.6	7.9	5.8	4.8
% Grand total	9.7	7.6	7.6	6.6	6.0
10. Total	34,518	41,112	41,917	47,313	52,584
% Women	33.4	30.4	34.4	34.4	32.5

Note: Higher education includes two-year junior colleges, colleges and universities, and graduate schools.

Source: Ministry of Education, *Statistical Yearbook of Education,* 1969-1979

Table 17. Breakdown of first-year students in higher education by discipline and by sex, 1969-79

Discipline	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1. Natural science	4,587	4,207	4,228	4,788	4,791	12,655	16,201	9,955	10,250	14,433	24,523
% Women	31.9	31.5	32.5	31.9	36.3	23.8	25.9	37.7	33.1	30.9	42.3
% Grand total	9.3	8.2	7.9	8.3	8.0	20.3	24.7	14.3	13.5	16.5	12.8
2. Technology	8,593	10,160	10,505	10,281	10,640	9,035	8,941	14,227	15,011	19,070	74,593
% Women	0.8	1.0	1.5	2.3	1.4	1.4	1.2	1.1	0.5	1.5	3.1
% Grand total	17.5	19.7	19.5	17.9	17.7	14.5	13.6	20.5	19.7	21.8	39.0
3. Medical science	5,803	6,680	6,587	6,331	6,057	5,837	5,806	6,417	6,305	6,348	13,815
% Women	54.2	53.1	49.7	48.6	40.9	36.4	34.2	35.7	30.2	29.4	45.1
% Grand total	11.8	13.0	12.3	11.0	10.1	9.4	8.9	9.2	8.3	7.3	7.2
4. Agricultural science	3,056	2,895	2,871	3,451	3,518	2,775	2,824	4,553	5,220	5,605	10,073
% Women	7.2	9.1	9.8	11.6	10.1	10.1	11.5	11.0	9.7	9.3	12.2
% Grand total	6.2	5.6	5.3	6.0	5.9	4.5	4.3	6.6	6.9	6.4	5.3
5. Social science & humanities	8,971	9,068	9,461	11,033	12,091	10,346	10,996	13,007	17,019	20,425	35,089
% Women	43.3	46.0	50.2	49.0	45.3	44.6	46.4	40.8	32.8	20.9	40.9
% Grand total	18.2	17.6	17.6	19.2	20.2	16.6	16.8	18.7	22.3	23.4	18.3
6. Business & commerce	4,323	4,377	4,546	4,891	4,471	4,228	4,255	4,331	4,012	3,561	11,944
% Women	9.4	10.1	9.3	9.9	9.4	10.6	6.8	7.3	5.7	12.9	9.6
% Grand total	8.8	8.5	8.5	8.5	7.5	6.8	6.5	6.2	5.3	4.1	6.2
7. Education	9,824	10,702	11,384	12,303	14,145	13,524	12,551	13,010	14,410	14,467	18,233
% Women	49.9	51.8	49.1	50.8	50.9	54.4	57.0	53.2	48.5	55.5	58.1
% Grand total	20.0	20.8	21.2	21.4	23.6	21.7	19.2	18.7	18.9	16.6	9.5
8. Home economics	1,001	884	916	1,122	1,006	843	868	937	900	907	556
% Women	100.0	100,0	100.0	100.0	100.0	100.0	100.0	100.0	98.4	99.1	100.0
% Grand total	2.0	1.7	1.7	1.9	1.7	1.4	1.3	1.3	1.2	1.0	0.3
9. Law	3,011	3,055	3,273	3,373	3,282	3,007	3,085	3,036	3,067	2,608	2,554
% Women	5.2	5.4	5.7	6.3	5.8	6.3	2.0	1.5	1.2	2.0	4.8
% Grand total	6.1	5.9	6.1	5.9	5.5	4.8	4.7	4.4	4.0	3.0	1.3
10. Total	49,169	51,528	53,771	57,573	60,001	62,250	65,527	69,473	76,194	87,424	191,380
% Women	31.0	31.9	31.5	32.5	31.7	30.5	30.7	29.1	25.7	26.2	24.5

Note: Higher education includes two-year junior colleges, colleges and universities, and graduate schools.

Source: Ministry of Education, *Statistical Yearbook of Education,* 1969-1979

Table 18. Breakdown, by disciplines, of the number of doctorates conferred annually, 1970-79

Discipline	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1. Natural science	9	7	14	9	15	34	29	23	40	59
% Grand total	5.2	3.5	8.5	5.5	4.8	9.0	6.7	8.3	12.5	15.29
2. Technology	5	6	7	5	10	38	20	14	25	32
% Grand total	2.9	3.0	4.3	3.1	3.2	10.1	4.6	5.1	7.8	8.29
3. Medical science	135	152	117	110	153	200	211	129	140	176
% Grand total	78.5	75.3	71.3	67.1	48.6	53.2	49.0	46.6	43.6	45.6
4. Agricultural science	4	14	10	10	6	22	48	39	25	29
% Grand total	2.3	6.9	6.1	6.1	1.9	5.9	11.1	14.1	7.8	7.5
5. Social science & humanities	6	9	6	8	20	28	57	35	38	39
% Grand total	3.5	4.5	3.7	4.9	6.4	7.5	13.2	12.6	11.8	10.1
6. Business & commerce	6	7	2	6	39	19	23	11	23	22
% Grand total	3.5	3.5	1.2	3.7	12.4	5.1	5.3	4.0	7.2	5.7
7. Education	—	—	—	—	20	1	2	1	2	—
% Grand total					6.4	0.3	0.5	0.4	0.6	
8. Home economics	—	—	—	—	—	—	2	—	1	—
% Grand total							0.5		0.3	
9. Law	7	7	8	16	52	34	39	25	27	29
% Grand total	4.1	3.5	4.9	9.8	16.5	9.0	9.1	9.0	8.4	7.5
10. Total	172	202	164	164	315	376	431	277	321	386

Note: Only doctorates conferred by higher education establishments within the country are tabulated here. Doctorates conferred abroad are not included.

Sources: Ministry of Education, *Statistical Yearbook of Education,* 1969-1979
Economic Planning Board, *Korean Statistics,* 1970-1979

Table 19. Distribution of scientists and engineers, employed and engaged in research, by sector of performance, 1978

	Public		Industry		Higher education		Total	
	Employed	Engaged in research	Employed	Engaged in research	Employed	Engaged in research	Employed	Engaged in research
Natural scientists	112	41	...	518	1,622	985	....	1,544
% of total	0.94	0.86		12.03	18.86	17.21		10.47
Engineers	5,993	2,374	...	3,262	3,881	2,631	...	8,267
% of total	50.54	50.25		75.78	45.13	45.98		56.05
Medical scientists	668	336	...	152	944	648	...	1,136
% of total	5.63	7.11		3.53	10.97	11.32		7.70
Agriculturists	4,546	1,760	...	332	1,684	1,211	...	3,303
% of total	38.34	37.25		7.71	19.58	21.16		22.39
Others	538	213	...	40	467	246	...	499
% of total	4.53	4.50		0.93	5.43	4.61		3.51
Total	11,857	4,724	9,759	4,304	8,598	5,721	30,214	14,749

Source: Ministry of Science and Technology, *Science and Technology Annual,* 1979.

PART V

Principal Aims of the National Science and Technology Policy

I. POLICY DIRECTIONS FOR DEVELOPING SCIENCE AND TECHNOLOGY

From the very beginning of economic development planning, the importance of the development of science and technology has been recognized as an indispensable moving force for the industrialization and economic development processes. As a result the setting-up of policies both explicit and implicit for the development of science and technology has evolved in conjunction with, or as an integral part of, the consecutive five-year economic development plans. Up until the Third Five-Year Plan, the predominant thrust was the building-up of infrastructures involving a great variety of institutions and legal measures for the promotion of science and technology development, and this ranged from the establishment of the Ministry of Science and Technology in 1967 to more recent measures to promote engineering companies.

One of the first major tasks which the Ministry of Science and Technology (MOST) undertook upon its establishment in 1967 was the formulation of the Long-Term Plan for Science and Technology Development, covering twenty years, in recognitin of the fact that if national economic goals for the eighties were to be reached "Korea must telescope the one hundred years or so of the development of the advanced nations into twenty years for its own development." The following summary outline of the plan presents the main features of the development strategy.

	Industrialization Strategy	Science & Technology Strategy
1960s	1. Develop import-substitute industries 2. Expand export-oriented light industries 3. Support producer goods industries	1. Strengthen science & technology education 2. Build scientific & technological infrastructure 3. Promote foreign technology imports
1970s	1. Expand heavy and chemical industries 2. Shift emphasis from capital import to technology import 3. Strengthen export-oriented industry competitiveness	1. Expand strategically important skill training 2. Improve institutional 2. mechanism for adapting imported technology 3. Promote research applied to industrial needs
1980s	1. Promote international confidence in Korean industrial products 2. Develop export of technology-intensive products 3. Expand knowledge-intensive industries	1. Expand facilities for advanced scientific and engineering manpower 2. Develop export of technology and engineering know-how 3. Promote long-term advanced research and strengthen development of system research

In addition, the Science and Technology Promotion Law was enacted in 1967 to promote and co-ordinate matters pertaining to: (a) overall science and technology policies and plans, including manpower policies and plans, (b) establishment of systems and policy instruments for implementing such policies and plans, and (c) budget allocation. MOST draws up a policy draft reflecting the opinion of those in economic and scientific fields, and this draft is reviewed and evaluated by various science and technology-relevant ministries. These ministries formulate annual plans and implement them in line with the long-term plan and in accordance with the Science and Technology Promotion Law.

A series of laws enacted for the promotion of science and technology are of major importance in the implementation of development plans:

1. The Science and Technology Promotion Law of 1967 provides the basic commitment of the Government to support science and technology and to provide policy leadership.
2. The Technology Promotion Law of 1972 supports private and public corporate enterprises in their scientific and technological development efforts through tax privileges and other incentives.
3. The Engineering Services Promotion Law of 1973 provides for the strengthening of the capabilities of local engineering firms and for using them.
4. The National Technical Qualification Law of 1973, through a system of examinations and certifications, promotes the status of engineers and craftsmen and insures their proper recognition in society.
5. The 1973 Law for Assistance to Special Research Institutes provides incentives in legal and financial terms for research institutes in specialized fields of high priority such as shipbuilding, electronics, communication, mechanical and materials engineering, and energy.
6. The 1976 Law for the Korea Science and Engineering Foundation provides a legal basis for the establishment of a foundation to support basic research in pure and applied sciences, mostly at academic institutions.

Major program goals for the advancement of science and technology are:

1. the development and maintenance of manpower of a quality and quantity to meet national science and technology needs,
2. the build-up of the infrastructure for science and technology including research and development institutes,
3. the development of industrial technology with special attention to the strategic industrial technology required by the heavy and chemical industries,
4. establishment of a climate of public understanding, participation and commitment in support of science and technology, and

5. emphasis on basic technology for farming, fishing and reforestation, and continuing research on available natural resources.

Most of these goals represent the basic requirements for building up scientific and technological bases to support the country's overall economic development, and many of them are now in the process of being achieved.

The overall science and technology effort has aimed at effecting a structural change in the economy by shifting it from a simple labor-intensive structure to a more viable, technology-intensive one, to be followed by a brain and knowledge-intensive structure. The role of science and technology will shift from one of supporting national economic development to leading such development on the foundation of a technologically self-reliant economy planned for the early 1980s. Appropriate technologies may initially have been labor-intensive but as industrialization proceeds they are becoming highly advanced.

The Fourth Five-Year Economic Development Plan (1977-1981) calls for investment in research and development at the rate of at least 1.5 per cent of GNP in 1981, as compared to 0.6 per cent (of which the government's share was 70 per cent) in 1976.

In view of Korea's poor resource endowment, increased productivity through technological innovation and improved efficiency are the keys to its continued high rate of economic growth. To catalyze technological innovation requires increased indigenous R & D efforts and the accelerated introduction and adaptatin of imported, often advanced, technologies from abroad as well. These two seemingly contradictory elements are the main policy pillars so long as export-led economic growth remains the economic development strategy.

To this end, the Korean government has already taken a set of measures designed to relax the screening functions on the part of the government for technoogy 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 round of measures for technology import liberation and is working towards gradually broadening it.

II. CREATING A CLIMATE FOR SCIENCE AND TECHNOLOGY

A country's science and technology can strike deep roots when soil and climate are favourable to their growth, and only with such roots can they grow enough to contribute to national development and up-graded living standards.

A climate favourable to the development of science and technology has been a major policy goal for laying a solid foundation for science and technology. As a result, the climate has greatly improved in the past few years, so that the public's understanding of science has increased and the importance of scientific and technological development for the achievement of economic development plan goals, including the promotion of the heavy and chemical industries, has been increasingly recognized.

The government, with the co-operation of the academic and industrial communities and the mass media, has launched a nation-wide Science Movement *(Kwahakhwa Undong)* designed to apply scientific principles to all levels of national life. The Ministry of Science and Technology has incorporated this nation-wide movement into its annual programme to create a favourable science/technology climate. It provides basic guidelines for scientific programmes for all government ministries and agencies, and co-ordinates them within the framework of the science movement.

The main objective of the movement is to create an environment in which the general public can apply scientific principles to daily living, and develop a scientific approach to thinking and living with increased recognition and understanding of science and technology. It also aims at promoting a rational, efficient and creative national characteristic which is easily adaptable to an industrial society. The movement is organized to enable scientists and technologists to contribute their knowledge and skill to rural development and to the diffusion and popularization of science and technology throughout the country.

III. DEVELOPMENT OF INDUSTRIAL TECHNOLOGY

In addition to its efforts to establish the institutional infrastructure and to develop manpower, the Korean government has emphasized the development of appropriate industrial technology.

Technology development has been an integral part of the overall Korean national economic development plans, and it has been made clear that the development of science and technology *per se* is not the objective but a primary medium of industrialization through which national economic and welfare goals can be reached. The approaches that the Korean government has pursued simultaneously are worth emphasizing here: the transfer of technology, the development of local R & D capability, and the choice of technologies relevant to the current development stage.

Some development theorists criticize the transfer of capital and technology from foreign countries arguing that it may make a national economy dependent upon foreign countries. Countries in the early industrialization stage, like Korea, however, have few alternatives to importing foreign technology and capital. Korea was convinced that questions concerning the transfer of technology should concentrate not on the appropriateness of the transfer itself but rather on its ability as a developing country to select relevant technologies and to ensure a proper control system within the overall economic development framework.

In Korea the import of technology started in a formal fashion with the enactment of the Foreign Capital Inducement Law in 1962, and the foreign capital and technology importation that took place in the 1960s during the process of industrialization played a vital role in Korea's industrial development.

During the laying of the foundation for industrialization, the country was deficient in both capital and technology, and as a result, the import of technology was made in most cases as an integral part of investment financing involving turn-key projects, that is the import of all necessary equipment, technology, and technological services in the construction of an industrial factory. In addition, foreign technology was imported in the form of direct foreign investment or joint ventures.

The situation has, however, changed and the explicit need for technology, as distinguished from capital, to meet the rising demand for technology in the nation's socio-economic development has been recognized. Because of the ambitiousness of our socio-economic goals,

the quantity of technology required is huge and the quality so high that it would be unwise, if not impossible, to rely on indigenously generated technology alone. To encourage the inflow of foreign technology, the Korean government has been according some favourable fiscal incentives to the import of technology, in the form of tax exemptions followed by tax reductions. Since the Foreign Capital Inducement Law went into effect in 1962, there have been 1,726 cases of technology import approval, which entailed royalty payments of about US$457 thousand.

For the last few years technology importation has shown a strikingly sharp rise, almost doubling each year. In terms of sources, Japan has been the primary one, but its total share is gradually declining. In 1977, Japan was the source of 45 per cent as compared with over 51 per cent in previous years. Next comes the United States of America, which is registering an increase, 28 per cent in 1977 as compared with 22 per cent previously. The balance comes mainly from European countries. Worthy of mention is the fact that Korea has had very productive arrangements with several other developing countries in importing technology from them for use in very modern plant operations.

The government strives to see more diversification of technology supply sources, as well as capital inducement. To help the potential end-users of foreign technology, the government assisted in the establishment of the Technology Transfer Center at the Korea Institute of Science and Technology and the technology transfer data bank at the Korea Scientific and Technological Information Center. The Technology Center was given the mandate of assisting industry by acting as a window for technology import, where necessary, and as an information clearinghouse in technology transfer.

A great deal of significance is attached by the government to the building-up of domestic R & D capability, which ultimately is the chief conditioning agent for the proper selection and the timely inflow and digestion of foreign technologies on equitable terms to both supplier and receiver.

Industry's demand for, and expectations from, R & D are on the increase in parallel with rapid industrialization. Accordingly, R & D oriented toward supporting economic development has had to be increased and strengthened. Until fairly recently, government and private research organizations, the mainstay of the R & D system, were organized in a manner similar to government, and public agencies and consequently could not operate in accordance with such principles of research organization as research autonomy and creativity and support flexibility. Activities were therefore limited to simple testing, examination, inspection and surveying without sophisticated laboratory research.

Industries in a developing country are often incapable of choosing appropriate technologies because of the lack of information on foreign technology and of limited staff capabilities. Accordingly, the government of such a country must develop industrial technology to support the development of science and technology and it must also guide, counsel and encourage industries in the import of technology.

To accomplish this the Korean government has established a strategic industrial research institute, the Korea Institute of Science and Technology (KIST). It is the central technical organization for the development of industrial technology and the window through which the transfer of foreign technology to domestic industry can be made.

KIST was established in 1966 as an independent contract research organization to satisfy Korea's industrial R & D needs. If industrial research was to be successful when society's awareness of R & D had not yet reached a sufficiently sophisticated level, it was of the utmost importance that a positive attitude toward contract research be accepted to induce industry's positive involvement on one hand and on the other to obligate researchers to engage in relevant work.

KIST had to cover a broad sprectrum of activities in applied research including project feasibility studies, technical services for small and medium industries, and engineering studies on a pilot-plant scale. With the economy's ever-increasing technological demands, KIST alone is no longer capable of meeting all of industry's technical needs. As a result, five strategic industrial research institutes are being set up to absorb some of KIST's research and development functions.

KIST and a dozen other strategic industrial research institutes mentioned earlier in Part IV are the realization of the government's stretegy for the development of industrial technology on the basis of the import and adaptation of advanced technology. The goals and operating programs of these organizations are in accordance with this strategy.

Among the services KIST has rendered to industry and deserving of special attention are: general technical services on both a periodic and ad-hoc crash basis to diagnose operations and provide such assistance as may be necessary in adapting imported technologies for small and medium industries, the production of prototype products or the operation of pilot-scale plants to determine the commercial feasibility of research results, and information analysis services to keep individual industries abreast of technology development in their respective fields. During its formative years, attention was directed toward building up a scientific base of research investigators, and also initiating production and marketing services to industry.

KIST's R & D in the 1960s was directed toward the solution of simple practical in-the-field problems arising in the course of technology transfer or production processes. The 1970s have added higher level technological problems such as productivity improvement, cost reduction, domestic raw material development and imported technology improvement to serve large industrial firms which have accumulated considerable technological capability.

The present state of, and prospects for, industrial technology confront KIST with new demands and an evolution in role. Many large corporations have achieved a great degree of self-reliance in technology as related to their established product lines and production methods. Medium and small industries require continuing assistance for technological development. This situation represents a stabilization and a maturing of industrial growth in the past decade.

Recognizing the greatly increased technological needs of industry during the next decade, two major developments will occur. These will be the establishment of the strategic industry research institutes at Daeduk Science Town, either as direct spin-offs from KIST, or new establishments, and a substantial increase in R & D capability within private enterprise.

PART VI

The Economic and Political Background

I. RECENT ECONOMIC GROWTH

In recent years Korea has often been cited as a model of economic development for less developed countries. Beginning in 1962 with the initiation of Korea's First Five-Year Development Plan (1962-1966) through 1978, Korea's real gross national product increased at an annual average rate of nearly 10 per cent in real terms. This was one of the highest average annual growth rates in the world. In 1961 the gross national product of Korea stood at US$2.1 billion at current prices. This figure rose to US$9.1 billion in 1971 and further increased to US$60.1 billion in 1978. Moreover, during this same period the rate of increase in population declined by nearly one half from 3.0 per cent in 1961 to 1.6 per cent in 1978.

Thus, the rapid growth in aggregate income and the reduction in the rate of population growth combined to produce a rapid rise in the per-capita gross national product which grew from a mere US$82 in 1961 to US$1,597 in 1979 at current prices. At the same time, the unemployment rate steadily declined from 8.2 per cent in 1963 to 3.8 per cent in 1979.

This long period of sustained economic development has transformed the structure of the Korean economy from that of a typical developing country to that of a moderately industrialized nation. The share of income derived from agriculture, forestry, and fisheries has been gradually reduced from 38.7 per cent of the total GNP in 1961 to 20.5 per cent in 1979. On the other hand, the share of the mining and manufacturing sector has grown from 15.4 per cent to 28.0 per cent during the same period. Meanwhile, the social overhead capital and services sector has roughly maintained a constant share, 45.9 - 51.5 per cent, during the same period. This structural change was brought about by rapid growth in the manufacturing sector. During the period referred to, the annual rate of growth of the manufacturing sector was 18 per cent, while that of the primary sector was only 3.4 per cent and that of the service sector grew at the annual rate of 10.2 per cent.

As the economic performance in terms of overall growth and changes in the industrial structure toward that of the already developed countries showed stable development, there were other economic issues which showed a less sterling performance. Firstly, inflation was a serious problem throughout the 1960s and 1970s. During the 1960s the annual average change in the consumer price index was 12.5 per cent and during the 1970s it was 14.9 per cent, which was very high relative to the industrial countries. Secondly, income distribution, which had improved in the 1960s, showed signs of worsening in the 1970s as economic development matured. Specifically, analysis based on the distribution ratio showed that as the lower 40 per cent of the income group took 19.3 per cent of the total income in 1965, this percentage rose slightly to 19.6 per cent in 1970 but by 1976 it had declined to 16.8 per cent.

The assassination of President Park in 1979 was followed by political and social unrest, and the economy was put under serious strain. For the first time in 20 years it recorded -5 per cent growth rate in 1980. However, the advent of the Fifth Republic in early 1981 re-instituted political and social stability and signs of stable economic recovery and acceleration toward rapid economic growth have become evident.

II. GENERAL AND POLITICAL BACKGROUND TO DEVELOPMENT

The Republic of Korea is a medium-sized country in terms of area and population. The area is approximately 98,966 km^2 with a population of 38 million people as of 1979. Population density in Korea is over 360 people per km^2, one of the highest in the world.

Korea is relatively poor in natural resource endowment. Arable land comprises less than 20 per cent of the total area. Under these circumstances Korea had no other choice but to specialize in manufacturing industry based on human resources initially labor-intensive and gradually becoming skill- and technology-intensive.

In order to understand the rapid economic development of the 1960s and 1970s and concomitant changes that took place in policy we should review Korea's performance in the 1950s. The Korean war of 1950 which ended in 1953 left a big scar on Korean economy and policy. The reconstruction of war damages was almost completed by 1957, but the Rhee government did not have strong leadership nor a comprehensive plan for economic development. It relied heavily on foreign aid to finance imports and government revenue. The economy was characterized by chronic inflation, low growth rate, over-valued exchange rates, negative interest rates and thus, low savings ratio and tax-revenues, all of which are symptoms of an inefficiently managed developing country.

The Park government, which came into power in 1961, put major emphasis on economic development by initiating a comprehensive economic development plan, adopting policies to stimulate an export-drive, and relying on the import of foreign capital and technology. The new government had to respond to serious economic problems arising from significant reduction in United States aid. Without a substantial increase in exports, imports, which had been financed mainly through US aid, would have to be curtailed drastically. Furtermore, as a country poor in natural resources and limited in economic size, an outward looking growth strategy based on the export of labor-intensive manufactured goods for which Korea had a comparative advantage was the only reasonable choice to make. Why was this policy possible in the 1960s, and not in the 1950s?

A number of economic and non-economic factors explain this phenomenon. Firstly, industrial recovery from the Korean War was almost completed by 1957 and Korea's infrastructure had been rebuilt. Industrializa-

tion based on import substitution in the light manufacturing sector, especially textiles, and requiring simple technology and labor-intensive methods, was also well established by the early 1960s, thanks to Korea's relatively low-salaried but well-educated labor force. Thus turning to the export development strategy merely required putting the proper incentives into place.

Secondly, institutional changes were important. The new government adopted economic growth as its main goal. Since the improvement of economic welfare was the overriding concern of the public, the new government realized that the best way to establish political legitimacy was by adopting economic growth as its prime objective. With a strong government, unpopular policies could be pursued if they were widely regarded as being necessary for economic development. For instance, the normalization treaty between Korea and Japan, negotiated in 1965, received little popular support but it was not widely decried since it was deemed necessary for economic reasons.

By the mid 1970s, Korea, along with other advanced developing countries, became one of the 'newly industrializing countries' in terms of per-capita income, industrial structure and the level of education.

Korea's level of education in the 1970s almost reached that of the industrial countries. The share of manufactured goods in the total exports was 82.4 per cent by 1975, and the heavy and chemical industry products such as ships, machinery, equipment and petro-chemical products also comprised 38.5 per cent of the total exports of 1979.

Since the late 1940s Korea has maintained a government based on the presidential system whereby a President is elected by the public either directly, or indirectly through an electoral college system. As the leader of the government, the President has always played a central role in the government. Technically, the Parliament wields considerable power and is able to check the power of the President and the administration, but in reality the President, through controlling the government party in the Parliament, has been able to minimize intervention by the Parliament.

The government in Korea is highly centralized and local governments are not allowed to play any major independent role in the administration. The government had been extensively involved in economic affairs and played an important role in rapid economic development.

When the private sector economy was relatively small in the 1960s, the forceful role which the government played in the economic area was appreciated, but at present the private government intervention is now generally viewed as hindering the initiatives of the private sector. The new government of the Fifth Republic made the reduction of the role of government in the economy one of its primary concerns.

The following tables (Tables 20-28) give some relevant statistics on the economic and political background in Korea.

Table 20. Basic economic and demographic aggregates

	1974	1975	1976	1977	1978	1979
State Budget (Expenditure)						
In thousand million wons	1,014	1,535	2,142	2,740	3,539	5,032
In million US dollars	2,086.8	3,171.6	4,425.7	5,661.2	7,312.0	10,396.8
National income or net material product						
In thousand million wons	6,185	8,056	10,747	13,739	18,647	23,414
In million US dollars	12,778.9	16,664.6	22,264.5	28,386.4	38,526.7	48,377.0
Gross national product at factor cost						
In thousand million wons	7,333	9,793	13,273	17,021	22,918	29,072
In million US dollars	18,127	20,233	27,423	35,168	47,350	60,066
Number of inhabitants (in thousands)	34,692	34,679	35,860	36,436	37,019	37,605

Source: Economic Planning Board

Table 21. Distribution of population by age group
(in thousands)

Age group	1960		1966		1970		1975	
	Population	Ratio	Population	Ratio	Population	Ratio	Population	Ratio
0- 4 years	3,550	14.2	4,481	15.4	4,316	13.7	4,227	12.2
5- 9	3,782	15.1	4,613	15.8	4,532	14.4	4,454	12.8
10-14	2,822	11.3	3,590	12.3	4,393	14.0	4,527	13.0
15-19	2,283	9.5	2,708	9.3	3,088	9.8	4,147	12.0
20-24	2,279	9.1	2,299	7.9	2,523	8.0	3,123	9.0
25-29	1,913	7.7	2,244	7.7	2,204	7.0	2,507	7.2
30-34	1,556	6.2	1,960	6.7	2,193	7.0	2,224	6.4
35-39	1,417	5.7	1,553	5.3	1,854	5.9	2,189	6.3
40-44	1,187	4.8	1,347	4.6	1,462	4.7	1,800	5.2
45-49	1,034	4.1	1,117	3.8	1,249	4.0	1,399	4.0
50-54	885	3.5	948	3.3	1,025	3.3	1,197	3.4
55-59	665	2.7	789	2.7	855	2.7	939	2.7
60-64	567	2.3	551	1.9	665	2.1	738	2.1
65-69	405	1.6	437	1.5	435	1.4	543	1.6
70-74	297	1.2	267	0.9	315	1.0	325	0.6
75-79	141	0.6	172	0.6	175	0.6	204	0.6
Over 80 years	93	0.4	85	0.3	114	0.4	134	0.4
Unspecified	15	—	8	—	37	—	2	—
Total	24,989	100.0	29,169	100.0	31,435	100.0	34,679	100.0

Source: Economic Planning Board

Table 22. Distribution of the active population by sex
(in thousands)

	1965	1972	1977	1978	1979	1980
Men	5,080	7,064	8,518	8,671	8,820	9,020
Women	3,051	3,994	4,922	5,261	5,368	5,435
Total	8,859	11,058	13,440	13,932	14,206	14,455

Source: Economic Planning Board

Table 23. Geographical distribution of the population in 1975 by administrative areas
(in thousands)

Areas	Numbers of inhabitants
Seoul	6,890
Busan	2,453
Gyeonggi Do	4,039
Gangweon Do	1,862
Chungcheong Bug Do	1,522
Chungcheong Nam Do	2,949
Jeonra Bug Do	2,456
Jeonra Nam Do	3,984
Gyeongsang Bug Do	4,859
Gyeongsang Nam Do	3,280
Jeju Do	412
Total for country	34,707

Source: Economic Planning Board

Table 24. Structure of foreign trade, 1979
(in million US dollars)

Commodity	Exports	Imports
Food & live animals	1,082	1,432
Beverages & tobacco	118	71
Crude materials, inedible (except fuels)	361	3,260
Mineral fuels, lubricants and related materials	18	3,779
Animal & vegetable oils & fats	27	152
Chemicals	532	2,009
Manufactured goods classified by material	4,815	2,722
Machinery & transport equipment	3,101	6,125
Miscellaneous goods	4,980	718
Not classifiable	21	71
Total	15,055	20,339

Source: Economic Planning Board

Table 25. Origin of the gross domestic product by sector of activity
(breakdown by percentage)

Sector of activity	1974	1975	1976	1977	1978	1979
Agriculture, forestry and fisheries	26.3	27.0	26.5	25.6	24.5	22.9
Mines	1.4	1.7	1.4	1.7	1.6	1.3
Manufacturing industries	23.2	23.0	24.5	23.6	23.9	22.8
Construction	4.9	5.4	5.5	7.0	9.2	10.4
Transport and communications	6.4	6.3	6.1	6.3	6.4	6.2
Commerce						
Public administration; defense						
Other	37.8	36.5	36.0	35.7	34.5	36.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: The Bank of Korea

Table 26. Gross investment in the economy as a whole, by sector of activity
(in percentages)

	1974	1975	1976	1977	1978	1979
Agriculture, forestry and fishing	9.7	7.9	8.8	8.6	8.0	6.0
Mining and quarrying	0.7	1.1	1.1	0.8	0.8	0.5
Manufacturing	18.5	18.6	21.2	19.9	22.6	20.5
Electricity, gas and water	5.5	6.0	9.8	9.1	8.4	9.8
Construction	0.8	1.2	1.1	1.7	1.4	0.8
Wholesale and retail trade; restaurants and hotels	6.2	6.2	7.3	9.0	7.4	8.9
Transport, storage and communication	19.1	24.4	21.6	20.9	22.5	18.5
Financing, insurance, real estate and business service	0.9	1.4	1.2	0.8	0.9	0.6
Ownership of dwellings	14.4	15.4	13.4	15.6	19.1	14.3
Public administration	1.3	1.4	1.8	2.0	2.6	3.2
Community, social and personal services	5.1	4.7	6.0	6.8	4.7	5.1
Increase in stocks	17.8	11.7	6.7	4.8	1.6	11.8
Gross domestic capital formation	100.0	100.0	100.0	100.0	100.0	100.0

Source: The Bank of Korea

Table 27. Development of the national production of commodities and in the manufacturing industries
(percentage indices)

Products and industries	1975	1976	1977	1978	1979
Food, beverages & tobacco	100.0	120.2	149.4	180.8	212.8
Textiles, clothing & leather	100.0	133.8	148.0	173.3	182.1
Wood & wood products including furniture	100.0	130.4	149.7	177.7	169.2
Paper & paper products; printing & publishing	100.0	118.8	140.8	164.4	185.9
Chemicals, petroleum, coal, rubber & plastic products	100.0	127.7	157.2	191.6	219.7
Non-metallic mineral products	100.0	115.5	146.4	169.3	186.6
Basic metals	100.0	141.6	172.4	228.3	295.4
Fabricated metal equipment	100.0	151.4	191.5	270.1	301.7
Miscellaneous	100.0	124.1	151.2	128.3	124.1
Total	100.0	131.8	158.7	196.4	220.1

Source: Economic Planning Board, unpublished data for Fourth Economic Plan (1977-1981)

Table 28. Changes in the cost of living index
(rural and urban)

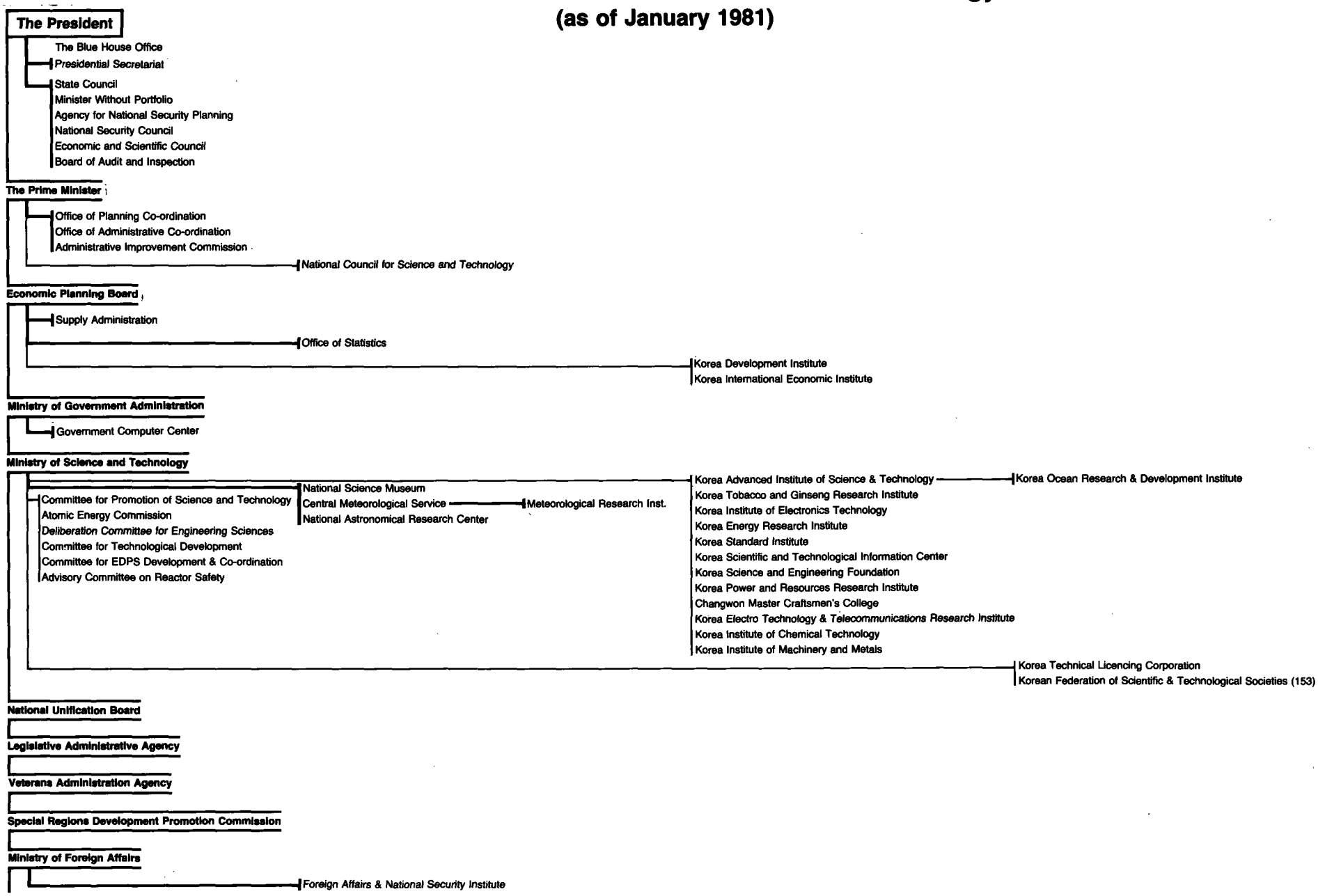
	1974	1975	1976	1977	1978
Urban	79.8	100.0	115.3	127.0	145.3
Rural	80.9	100.0	124.9	146.2	190.1

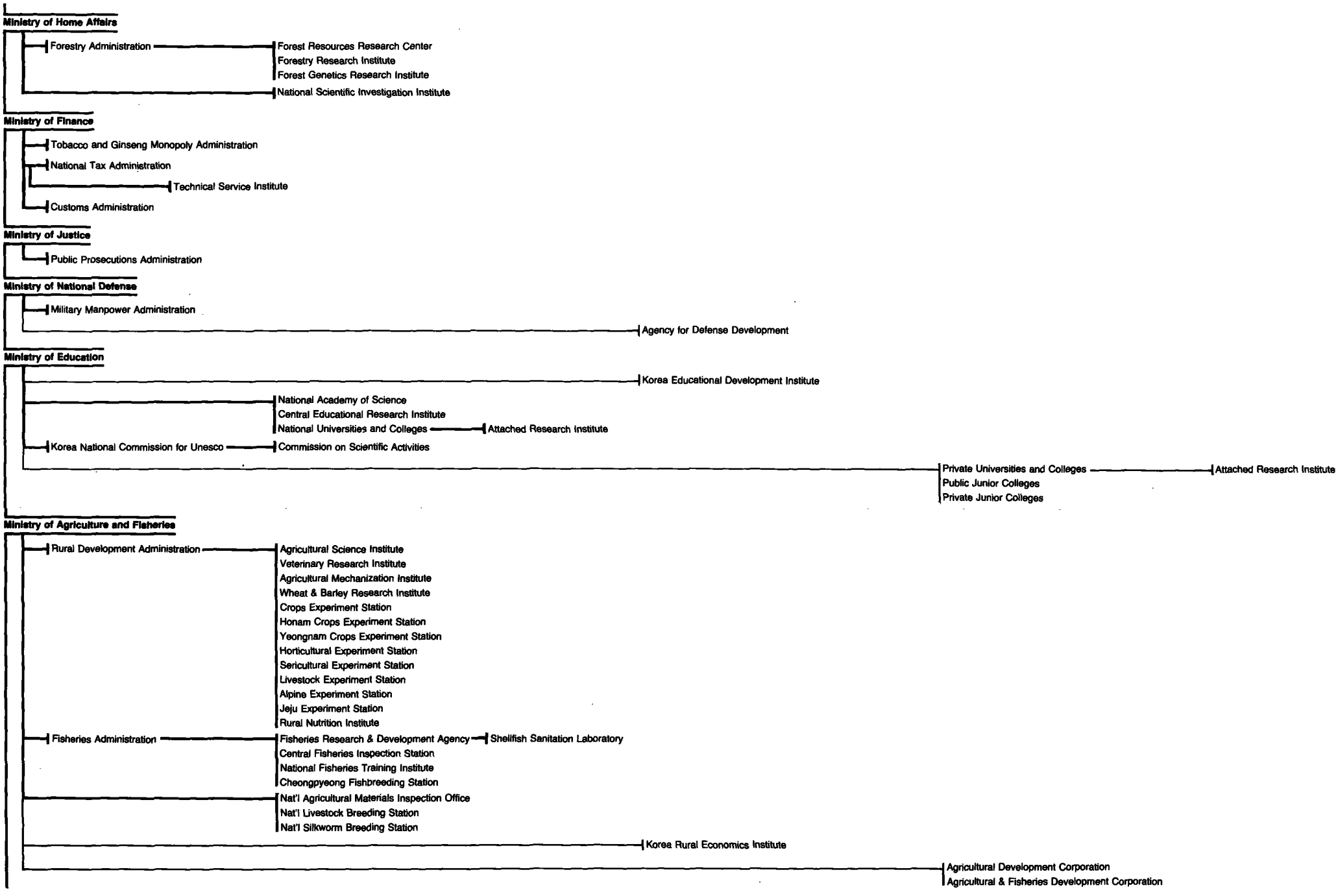
Source: Economic Planning Board, unpublished data for Fourth Economic Plan (1977-1981)

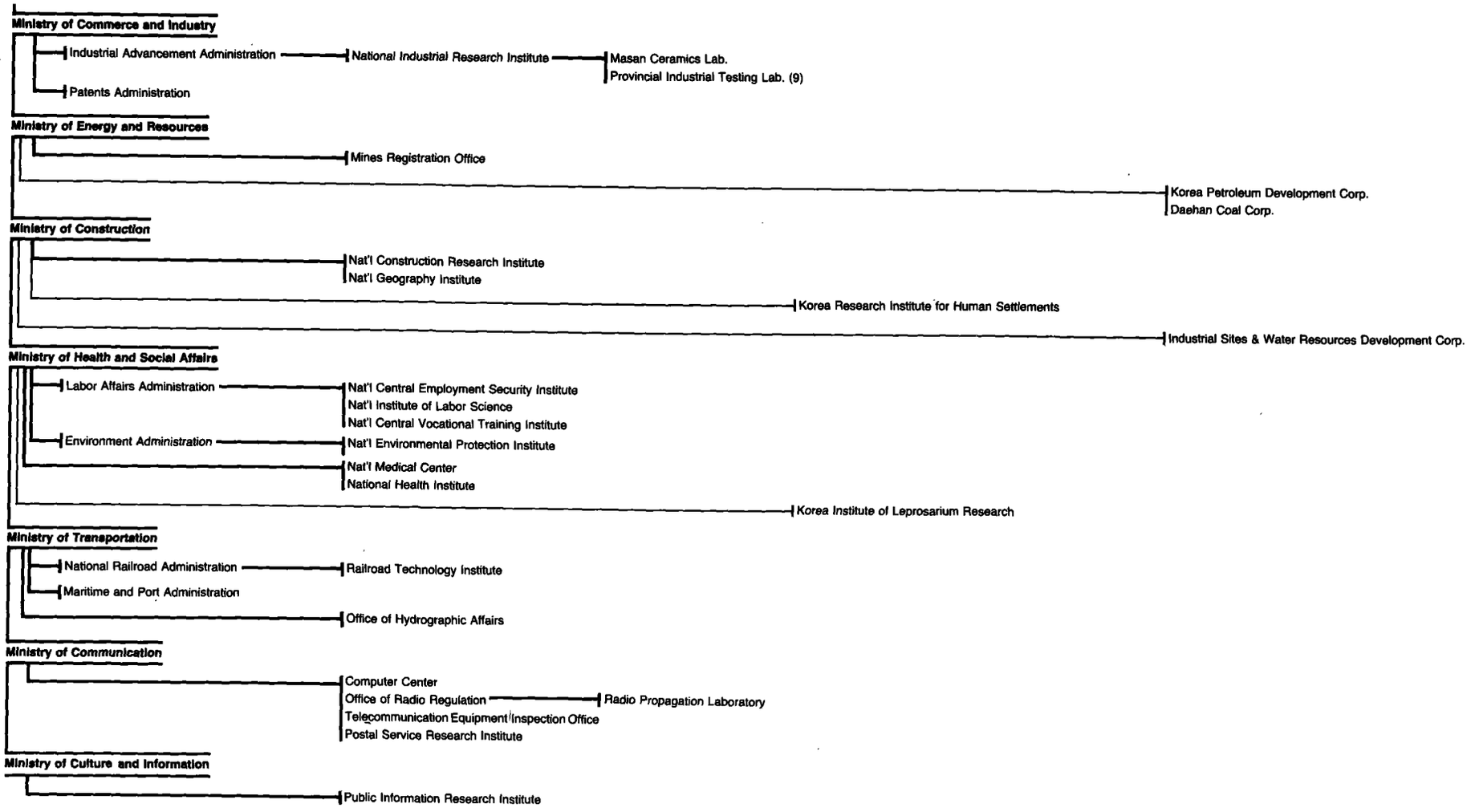
Annexes

ANNEX I

Administrative Structure for Science and Technology
(as of January 1981)

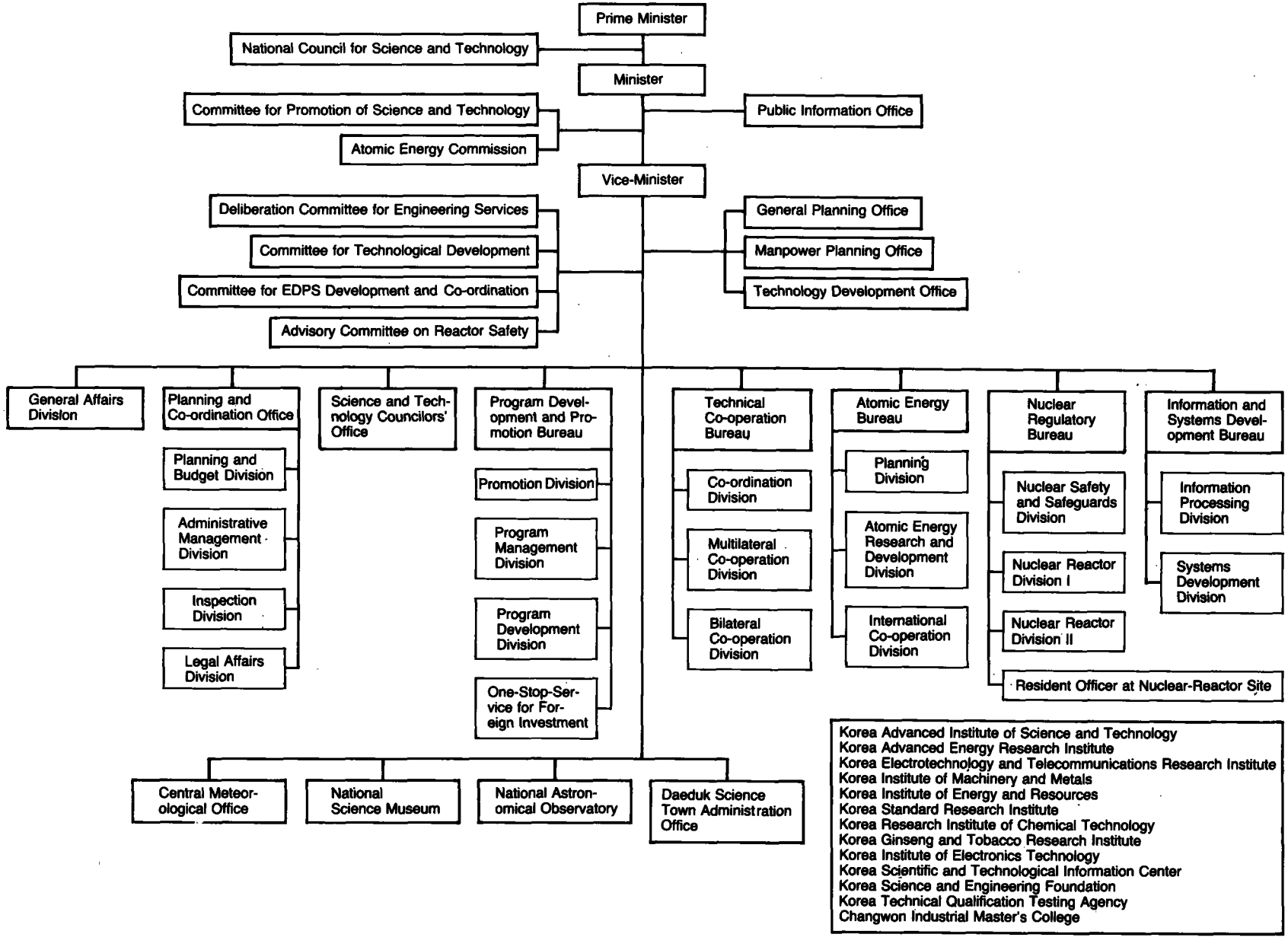



Ministry of Home Affairs
Forestry Administration
Forest Resources Research Center
Forestry Research Institute
Forest Genetics Research Institute
National Scientific Investigation Institute
Ministry of Finance
Tobacco and Ginseng Monopoly Administration
National Tax Administration
Technical Service Institute
Customs Administration
Ministry of Justice
Public Prosecutions Administration
Ministry of National Defense
Military Manpower Administration
Agency for Defense Development
Ministry of Education
Korea Educational Development Institute
National Academy of Science
Central Educational Research Institute
National Universities and Colleges
Attached Research Institute
Korea National Commission for Unesco
Commission on Scientific Activities
Private Universities and Colleges
Attached Research Institute
Public Junior Colleges
Private Junior Colleges
Ministry of Agriculture and Fisheries
Rural Development Administration
Agricultural Science Institute
Veterinary Research Institute
Agricultural Mechanization Institute
Wheat & Barley Research Institute
Crops Experiment Station
Honam Crops Experiment Station
Yeongnam Crops Experiment Station
Horticultural Experiment Station
Sericultural Experiment Station
Livestock Experiment Station
Alpine Experiment Station
Jeju Experiment Station
Rural Nutrition Institute
Fisheries Administration
Fisheries Research & Development Agency
Shellfish Sanitation Laboratory
Central Fisheries Inspection Station
National Fisheries Training Institute
Cheongpyeong Fishbreeding Station
Nat'l Agricultural Materials Inspection Office
Nat'l Livestock Breeding Station
Nat'l Silkworm Breeding Station
Korea Rural Economics Institute
Agricultural Development Corporation
Agricultural & Fisheries Development Corporation


Ministry of Commerce and Industry
Industrial Advancement Administration
National Industrial Research Institute
Masan Ceramics Lab.
Provincial Industrial Testing Lab. (9)
Patents Administration
Ministry of Energy and Resources
Mines Registration Office
Korea Petroleum Development Corp.
Daehan Coal Corp.
Ministry of Construction
Nat'l Construction Research Institute
Nat'l Geography Institute
Korea Research Institute for Human Settlements
Industrial Sites & Water Resources Development Corp.
Ministry of Health and Social Affairs
Labor Affairs Administration
Nat'l Central Employment Security Institute
Nat'l Institute of Labor Science
Nat'l Central Vocational Training Institute
Environment Administration
Nat'l Environmental Protection Institute
Nat'l Medical Center
National Health Institute
Korea Institute of Leprosarium Research
Ministry of Transportation
National Railroad Administration
Railroad Technology Institute
Maritime and Port Administration
Office of Hydrographic Affairs
Ministry of Communication
Computer Center
Office of Radio Regulation
Radio Propagation Laboratory
Telecommunication Equipment Inspection Office
Postal Service Research Institute
Ministry of Culture and Information
Public Information Research Institute

ANNEX II

Organization of the Ministry of Science and Technology
(as of 31 January 1981)



ANNEX III

Higher education institutions (1979)

Gangweon National University
San 32, Hyoja-Dong, Chuncheon-si, Gangweon-Do

Busan National University
San-30, Jangieon-Dong, Dongrae-Gu, Busan

Chungnam National University
San-1 Munhwa-Dong, Daejeon, Chungnam

Chungbuk National University
48 Gaesin-Dong, Cheongju, Chungbuk

Jeonbug National University
287-1 Deogjin-Dong, Jeonju, Jeonbug

Jeonnam National University
318 Yang-Dong, Kwangju, Jeonnam

Gyeongbug National University
San 1370 Gyog-Dong, Daegu, Gyongbug

Seoul National University
San 56-1, Shinlim-Dong, Kwanak-ku,
Seoul (Headquarters)

Chungang University
221 Huksuk-Dong, Gwanak-Gu, Seoul

Gyeongsang National University
92 Chilam-Dong, Chinju, Gyeongnam

Chosun University
375 Seoseog-Dong, Gwanak-Gu, Seoul

Dan-Kook University
San 8 Hannam-Dong, Gwanak-Gu, Seoul

Dong-A University
1, 3-Ga, Dongdaesin-Dong, Seo-Gu, Busan

Dongguk University
26, 3-Ga, Pil-Dong, Jung-Gu, Seoul

Ewha Women's University
11 Daehyun-Dong, Seodaemun-Gu, Seoul

Hanyang University
San 8 Hangdang-Dong, Seongdong-Gu, Seoul

Hongik University
1 Sangsu-Dong, Mapo-Gu, Seoul

Inha University
Inchon, Gyeonggi-do

Keimyung University
2139, Daemyung-Dong, Nam-Gu, Daegu

Kon-Kuk University
93 Mojin-Dong, Seongdong-Gu, Seoul

Korea University
1 Anam-Dong, Seongbug-Gu, Seoul

Kyung Hee University
San 4, Heogi-Dong, Dongdaemun-Gu, Seoul

Sogang University
1 Sinsu-Dong, Mapo-Gu, Seoul

Sookmyung Women's University
2-1 Cheongpa-Dong, Yongsan-Gu, Seoul

Soongjun University
135, Sangdo-Dong, Youngdeungpo-Ku, Seoul

Sung Kyun Kwan University
53, 3-Ga, Myeongryun-Dong, Jongro-Gu, Seoul

Yeung Nam University
214-1 Dae-dong, Gyeongsan-Up, Gyongsan-Gun
Gyeongsang Buk Do

Yonsei University
134 Shinchon-Dong, Seodaemun-Gu, Seoul

Wonkwang University
344-2 Sinyong-Ri, Bugil-myon, Igsan-Gun, Jeonbuk

Civil Aviation College of Korea
200-1, Kwajeon-Ri, Goyang-Gun, Gyeonggi Do

Jeju College
Yongdam-Dong, Jeju-Si, Jeju-Do

Kongju National Teachers College
322-1 Banjuk-Dong, Kongju, Chung Nam

Busan Fisheries College
599-1 Daeyeon-Dong, Pusanjin-Gu, Busan

R.O.K. Merchant Marine College
618, Dongsame-Dong, Yungdo-Gu, Busan

Seoul Municipal College of Industry
8-3 Jeongong-Dong, Dongdaemun-Gu, Seoul

Catholic Medical College
90-2 Haehwa-Dong, Jongro-Gu, Seoul

Cheongju College
36 Naedeog-Dong, Cheongju, Chungbug

Dongduk Women's College
Dongdaemun-Gu, Seoul

Duk Sung Women's College
114 Uni-Dong, Jongro-Gu, Seoul

Hankuk University of Foreign Studies
272 Rimun-Dong, Dongdaemun-Gu, Seoul

Hyosung Women's College
1155 Bongdeog-Dong, Nam-Gu, Daegu, Gyongbug

Kuk Min College
861-1, Jeungreung-Dong, Sungbuk-Ku, Seoul

Kwangwoon Institute of Technology
447-1 Weolgyo-Dong, Seongbuk-Gu, Seoul

KyungKi College
70 Chungjeongro, Seodaemun-Gu, Seoul

Gangwon College
57-2 Chodangdong, Gangneung, Gangwondo

Kyungsang College
92 Chilamdong, Jinju, Kyungsangnamdo

Kwangdong College
72-1 Raigokdong, Gangneung, Gangwondo

Kukje College
2-2 Chungjungro, Seodaemungu, Seoul

Kunsan College
402-1 Dongheungnamdong, Kunsan, Chung Nam

Dong-eui College
24 Kayadong, Busanjingu, Busan

Masan College
1-11 Gopodong, Masan, Kyungsangnamdo

Mokwon College
24 Mokdong, Chunggu, Daechun

Mokpo College
43 Yonghaedong, Mokpo

Busan College of Industry
110-1 Daeyeungdong, Namgu, Busan

Busan Women's College
1528 Yeungsindong, Dongraegu, Busan

Sangji College
Woosandong, Wonju, Gangwondo

Sungshin Women's College
249-1 Dongsundong, Sungbukgu, Seoul

Sungsim Women's College
1 Okchundong, Choonchun, Gangwondo

Soonchunhyang Medical College
53-1 Uprairi, Sinchangmyun, Asangun, Chung Nam

Ajoo College of Engineering
5 Wonchungdong, Suwon, Kyunggido

Ulsan College of Engineering
29 Moogoedong, Ulsan, Kyungsangnamdo

Andong College
342 Myungyoondong, Andong, Kyungsangbukdo

Chungju College
36 Raeduckdong, Chungju, Chung Buk

Cheongju Woosuk Women's College
Wanjugun, Cheoung Buk

Hansung College
392-2 Samsungdong, Sungbukgu, Seoul

Kyungnam College
281-1, Wanwol-Dong, Masan, Kyeong-Nam

Myung Ji College
58-17, Seosomun-Dong, Seodaemun-Gu, Seoul

Samyook College
233, Gongleung-Dong, Seongbuk-Gu, Seoul

Sangmyung Women's Teachers College
7 Hongje-Dong, Seodaemun-Gu, Seoul

Seoul Women's College
228-32, Gongreung-Dong, Seoungbuk-Gu, Seoul

Source : Directory of Schools in Korea, 1979

ANNEX IV

List of Selective Laws Pertaining to the Development of Science and Technology

1. Law for the Promotion of Science and Technology
   (Law No. 1864, promulgated on 16 January 1967, and amended subsequently on 30 March 1967, and on 18 December 1972 as Law No. 1949 and 2377 respectively)

2. Law for the Acceleration of Technology Development
   (Law No. 2399, promulgated on 28 December 1972, and amended on 31 December 1977 as Law No. 3095)

3. Law for the Promotion of Engineering Services
   (Law No 2474, promulgated on 5 February 1973, and amended on 31 December 1976 as Law No. 2993)

4. Law for the National Techical Qualification
   (Law No. 2672, promulgated on 31 December 1973)

5. Atomic Energy Law
   (Law No. 483, promulgated on 11 March 1958, and amended subsequently on 2 October 1961, on 16 December 1963, on 3 August 1966, on 30 March 1967, on 24 January 1969, on 15 January 1973, and on 12 March 1973 as Law Nos. 735, 1537, 1615, 1883, 1948, 2093, 2444, and 2602 respectively)

6. Patent Law
   (Law No. 2505, promulgated on 8 February 1973, and amended subsequently on 31 December 1976, on 31 December 1978, and on 31 December 1980 as Law Nos. 2658, 2957 and 3325 respectively)

7. Law for the Development of Specially Designated Research Institutes
   (Law No. 2671, promulgated on 31 December 1973, and amended on 5 November 1976, and on 30 March 1981 as Law No. 2898 and 3404 respectively)

8. Korea Technology Development Corporation Act
   (Law No. 3312, promulgated on 31 December 1980)

9. Law for the Korea Advanced Institute of Science and Technology
   (Law No 3310, promulgated on 31 December 1980)

ANNEX V

Major engineering firms

Name of firm	Classification of service	Main areas of activity	Location
Steel Mill Engineering Consultant Co., Ltd.	Plant engineering	Industrial plant	658, Koedong-dong, Pohang-Si, Gyongbug, Korea Tel. (Pohang) 2-3740
Hyundai Engineering	1. Plant engineering	1. Chemical plant 2. Power plant 3. Industrial plant	230-5, Apgujeong-dong, Gangnam-gu, Seoul, Korea Tel. 52-1151
	2. Specialized eng.	Construction (a)Harbor and coastal eng. (b)Water supply and sewerage (c)Water resources (d)Irrigation drainage Farmland making (e)Highway and airports	
	3. Product control	Plant control	
Korea Engineering Co., Ltd.	1. Plant engineering	1. Chemical plant 2. Power Plant 3. Industrial Plant	1-620, Yeoeuido-dong, Yeongdeungpo-gu, Seoul, Korea Tel. 782-5088-5
	2. All Aspects of the Technological Category Concerned		
Cheil Engineering Co., Ltd.	1. Plant Engineering	1. Chemical Plant 2. Industrial Plant	1-510, Yeoeuido-dong, Yeongdeungpo-gu, Seoul, Korea Tel. 783-1930-9
	2. Specialized eng.	Construction (a)Water supply and sewerage (b)Water resources	
Daelim Engineering Co., Ltd.	1. Plant engineering	1. Chemical plant 2. Industrial plant 3. Power plant	1-423, Yeoeuido-dong, Yeongdeungpo-gu, Seoul, Korea Tel. 787-2781
	2. Specialized eng.	Construction (a)Harbor and coastal eng. (b)Highway and airports (c)Water resources	
Korea Nuclear Eng. Services Inc.	1. Plant engineering	Nuclear power plant	1-791 Yeoeuido-dong, Yeongdeungpo-gu, Seoul, Korea
Dae Woo Engineering Co., Ltd.	1. Plant engineering	1. Industrial plant 2. Power plant 3. Chemical plant	175-1, 2-ga, Eulji-ro, Jung-gu, Seoul, Korea Tel. 778-5231, 1361
	2. Specialized eng.	Construction (a)Highway and airports (b)Water supply and sewerage	
Hyo Sung Engineering Co., Ltd.	Plant engineering	Chemical plant	232-2, Seocho-dong, Gangnam-gu, Seoul, Korea Tel. 52-2191-4
ICC Engineering Co., Ltd.	1. Plant engineering	Chemical plant	123-1, Noryangjin-dong, Gwanag-gu, Seoul, Korea Tel. 829-7260
	2. Specialized eng.	Geology (applied geology)	
Amtai Co., Ltd.	Plant engineering	1. Power plant 2. Chemical plant 3. Industrial plant	194-151-ga Hoehyeon-dong, Jung-gu, Seoul, Korea
Dong Yang General Engineering Co., Ltd.	Specialized eng.	Architectural equipment and facilities	85-2 Nonhyeon-dong, Gangnam-gu, Seoul, Korea Tel. 58-4470

Name of firm	Classification of service	Main areas of activity	Location
Lucky Engineering Co., Ltd.	Plant engineering	Chemical plants	8, Yang-dong, Jung-gu, Seoul, Korea Tel. 782-0043
Yoo Shin Engineering Corporation	Specialized engineering	Construction (a)Civil structures eng. (b)Highway and airports (c)Water supply and sewerage (d)Urban & regional planning (e)Railways (f) Irrigation drainage and farmland making	7-54, Galweal-dong, Yongsan-gu, Seoul, Korea Tel. 793-7194-6
Woo Dai Engineering (a)Soil mechanics and	Specialized engineering Jung-gu, Seoul, Korea	Construction Consultants Co., Ltd. foundation engineering (b)Civil structures eng. (c)Highway and airports (d)Water supply and sewerage (e)Irrigation drainage and farmland making (f) Urban & regional planning	275-5, 5-ga, Eulji-ro, Yung-gu, Seoul, Korea Tel. 265-7228-9
Dae Ji Engineering Consultant Co., Ltd.	Specialized engineering	Construction (a)Civil structures eng. (b)Highway and airports (c)Water supply and sewerage (d)Urban & regional planning	340, 2-ga, Taepyeong-ro, Jung-gu, Seoul, Korea Tel. 712-2021, 0676
Korea Engineering Consultants Corporation	Specialized engineering	Construction (a)Water supply and sewerage (b)Urban & regional planning (c)Harbor and coastal eng. Electricity (a)Electric apparatus Machine (a)Hydraulic machinery	339-6, Huam-dong, Yongsan-gu, Seoul, Korea Tel. 793-0141-5
Sam An Engineering Consultants Co., Ltd.	Specialized engineering	Construction (a)Highway and airports (b)Water resources (c)Civil structures eng. (d)Urban & regional planning (e)Irrigation, drainage and farmland making (f) Energy civil engineering Electricity (a)Generation, transmission and distribution	139-3 Honggie, Seodae-mun-gu, Seoul, Korea Tel. 75-3077, 3938
Asia Aero Survey and Consulting Engineers Inc.	Specialized engineering	Geology (a)Geophysics	429, Shinsoo-dong, Mapo-gu, Seoul, Korea Tel. 34-7511-5
Pum Yang Co., Ltd.	Specialized eng.	Geology (a)Applied geology (b)Geophysics Machine (a)Machine manufacturing process and machine tools Construction (a)Energy civil engineering	18, 1-ga, Namdaemunro, Jung-gu, Seoul, Korea Tel. 74-7217-9

Source: List of registration of engineering services, prepared by Korea Engineering Services Association, 76-561, Yeogsam-dong, Gangnam-gu, Seoul

ANNEX VI

Major private industrial research institutes
(as of 31 December 1980)

Name of organization	Main areas of development activity	Year (& month) established	Parent organization	Location
Kang Won Industrial Co., Technical Research Laboratories	(a) Iron and steel plant (b) Hydro power plant (c) Cement plant (d) Environmental control equipment (e) Iron and steel castings (f) Rolling products	1978 (1)	Kang Won Industrial Co., Ltd.	444 Songnae-dong Pohang Kyungbuk, Korea Tel. (Pohang) 2-1701-9
Gold Star Central Research Laboratories	(a) Consumer electronics (b) Office equipment (c) Materials research	1976 (1)	Gold Star Co., Ltd.	327-23, Garibong-dong,Guro-gu, Seoul, Korea Tel. 856-5815-6
Gold Star Cable Co., Technical Research Institute	(a) Telecommunication and electricity cable and wire (b) Materials research	1979 (5)	Gold Star Cable Co., Ltd.	555, Hogye-dong, Anyang, Kyungki, Korea Tel. 23-2721
Gold Star Electric Co., Technical Research Laboratories	(a) Coaxial cable equipment (b) UHF carrier equipment (c) Tactical carrier equipment (d) Mine detector sets (e) Materials research	1978 (1)	Gold Star Electric Co., Ltd.	379, Gasuri, Osan, Hwasung, Kyungki, Korea Tel. (Osan) 3811-6
Gold Star Precision Industries Ltd., Central Research Institutes	(a) Precision electronics (b) Materials research	1976 (4)	Gold Star Precision Industries Ltd.	133, Gongdan-dong Gumi, Kyungbug, Korea Tel.(Gumi) 2-9109-10
Gold Star Tele-Electric Co., Research Institute	(a) Electronic switching equipment (b) Telecommunication terminal equipment (c) General telephone (d) Materials research (e) Training R&D engineers	1977 (3)	Gold Star Tele-Electric Co., Ltd.	600, Hogye-dong, Anyang, Kyung-ki, Korea Tel. (Anyang) 2-0085-6
Dae Dong Industry Co., Engineering Research Institute	(a) Agricultural machines and equipment (b) Diesel engines (c) Iron and steel castings (d) Materials research	1977 (11)	Dae Dong Industry Co., Ltd.	156 Juyak-dong, Jingu, Kyungnam, Korea Tel. (Jingu) 2-9311-9
Dae Woo Industrial Co., Research & Development Institute of Internal Combustion Engine	For diesel engines (a) Exhaust gas reduction (b) Performance improvement (c) New types of engine (d) Hydraulic and electrical control system	1978 (12)	Dae Woo Industrial Co., Ltd.	6, Manseog-dong, Donggu, Incheon. Kyungki, Korea Tel. 72-1011
Taihan Electric Wire Co., Central Research Institute	(a) Coaxial cable equipment (b) Telecommunication and electricity cable and wire (c) Consumer electronics	1978 (1)	Taihan Electric Wire Co., Ltd.	555 Siheung-dong, Guro-gu, Seoul, Korea Tel. 855-5111-20
Korea Institute of Aeronautical Technology	(a) Design and development of flight (b) New types of engine for flight	1978 (5)	Korean Airlines Co., Ltd.	132-4, 1-ga, Bongrae-dong, Jung-gu, Seoul, Korea Tel. 22-1192

Name of organization	Main areas of development activity	Year (& month) established	Parent organization	Location
Dong-A Pharmaceutical Co., Central Research Laboratories	(a) Quality improvement of pharmacy (b) New medicine	1977 (7)	Dong-A Pharmaceutical Co., Ltd.	252, Yongdoo-dong, Dongdaemun-gu, Seoul, Korea Tel. 95-6970
Tong Yang Nylon Co., Technical Research Laboratories	(a) Chemical fibers (b) Performance improvement of textile plant (c) Textile machinery and equipment	1971 (1)	Tong Yang Nylon Co., Ltd.	183 Mogye-dong Anyang, Kyungki, Korea Tel. (Anyang) 2-4171-6
Oriental Brewery Co., Research Institute	(a) Beer and wines (b) Quality improvement of products (c) Performance improvement of product equipment	1974 (6)	Oriental Brewery Co., Ltd.	582, Youngdeungpo-dong, Youngdeungpo-gu-, Seoul, Korea Tel. 833-6646
Oriental Precision Co., Engineering Research Center	(a) Various electronic communication equipment (b) Military communication equipment (c) Switching system	1978 (11)	Oriental Precision Co., Ltd.	146-1 Sangdaewon-dong Sungnam, Kyungki, Korea Tel. 253-4161-5
Lucky Central Research Institute	(a) Polymer chemicals and their application (b) Organic and fine chemicals (c) Petrochemicals (d) Chemical processes and technology	1979 (12)	Lucky Ltd.	84 Jangdongri, Tandongmyun, Daedukgun, Chungnam, Korea Tel. (Daejeon) 44-9981-3
Samsung Electronics Research and Development Center	(a) Electronic components and semi-conductors (b) Communication equipment (c) Electronic home appliances (d) Digital application products	1980 (4)	Sam Sung Electronics Co., Ltd.	416, Maetan-dong, Suwon, Kyungki, Korea Tel. (Suwon) 2-8711
Sam Yang Co., Central Research Institute	(a) Improvement of sugar quality (b) Foods (c) Polyester fibers	1979 (3)	Sam Yang Co., Ltd.	33, 2ga, Palbogdong, Jeonju, Cheonbuk, Korea Tel. (Jeonju) 3-5051-4
Ssang Yong Research Center	(a) Cement processes (b) Concrete products (c) Total management system of plants	1975 (11)	Ssang Yong Corporation	5-1, Sinsungri, Tandongmyun, Daeduk, Chungnam, Korea Tel. (Daejeon) 44-6801-5
Seoul Miwon Co., Technical Research Institute	(a) Glutamin acid and its application (b) Fertilizers (c) Animal feedstuffs	1980 (3)	Seoul Miwon Co., Ltd.	7 Banghak-dong, Dobong-gu, Seoul, Korea Tel. 992-3191-5
Sun Kyong Fibers Research Center	(a) Synthetic fibers (b) Various plastics (c) Fine chemicals and petrochemicals	1979 (5)	Sun Kyong Fibers Ltd.	600, Jungja-dong, Suwon, Kyungki, Korea Tel. (Suwon) 5-0121

Name of organization	Main areas of development activity	Year (& month) established	Parent organization	Location
Cheil Wool Textile Co., Technical Research Institute	(a) Wool fibers (b) Improvement of products quality	1979 (10)	Cheil Wool Textile Co., Ltd.	105, Jumsan-dong, Daegu,Kyungbuk, Korea Tel. (Daegu) 22-0123
Cheil Sugar Co., Food Research Institute	(a) Sugar processes (b) Wheat powder processes	1978 (3)	Cheil Sugar Co., Ltd.	92, Gayang-dong, Gangseo-gu, Seoul Korea Tel. 66-5173
Cheil Synthetic Textile Co., Technical Institute	(a) Synthetic fibers (b) Polymer chemicals	1979 (4)	Cheil Synthetic Textile Co., Ltd.	287 Gongdan-dong, Gumi, Kyungbuk, Korea Tel. (Gumi) 2-2825-9
Joong Ang Development Co., Environmental Research Institute	(a) Water resources (b) Environmental control equipment	1979 (12)	Joong Ang Development Corporation	529-5, Dogson-dong Youngdeungpo-gu, Seoul, Korea Tel. 854-4802
Chong Kun Dang Central Research Institute	(a) Improvement of pharmacy quality (b) Medicines	1972 (1)	Chong Kun Dang Corporation	410, Sinrim-dong Guro-gu, Seoul, Korea
Kolon Technical Research laboratory	(a) Synthetic fibers (b) Fiber processing and its application (c) Raw materials for plastics	1978 (3)	Jolon Incorporated	212 Kongdan-dong Gumi, Kyungbuk, Korea Tel. (Gumi) 2-2181-9
Pacific Chemical Industrial Co., Technical Research Institute	(a) Cosmetics (b) Medicines (c) Enzymes	1978 (10)	Pacific Chemical Indusrial Co., Ltd.	656-9 Sindaebang-dong, Donjag-gu, Seoul, Korea Tel. 832-7541
Pohang Iron and Steel Co., Technical Research Laboratories	(a) Iron and coke (b) Steel (c) Raw materials and refractories (d) Quality improvement of products	1977 (1)	Pohang Iron and Steel Co., Ltd.	5 Dongchon-dong Pohang, Kyungbuk, Korea Tel. (Pohang) 2-6501
Poong San Metal Co., Technical Research Institute	(a) Copper alloy (b) Powders (c) Quality improvement of products	1979 (4)	Poong San Metal Co., Ltd.	2222, Sandaeri Angang Eup, Wolsung, Kyungbuk, Korea
Korea Mining and Smelting Co., Technical Research Center	(a) Smelting (b) Refining (c) Anti-pollution research	1979 (7)	Korea Mining and Smelting Co., Ltd.	Jangam-dong, Janghang Seochon, Chungnam, Korea Tel. (Janghang) 1011-9
Han Kook Glass Industry Co., Technical Research Institute	(a) Glass fibers (b) Optical glass (c) Quality improvement of products	1979 (10)	Han Kook Glass Industry Co., Ltd.	San 14-5 Dongchon-dong, Nam-gu, Inchon, Kyungki, Korea Tel. (Incheon) 83-5401-3
Korea Integrated Special Steel Co., Central Research Institute	(a) Special steels (b) Quality improvement of products	1976	Korea Integrated Special Steel Co., Ltd.	25, Jeogjhyun-dong Changwon, Kyungnam, Korea

Name of organization	Main areas of development activity	Year (& month) established	Parent organization	Location
Korea Exposives Co.,	(a) Various explosives (b) Explosive processing (c) Anti-pollution technology	1979 (4)	Korea Explosives Co., Ltd.	805, Sinwol-dong Yosu, Jeonnam, Korea
Korea Pacific Petro-Chemical Research Institute	(a) New chemical products (b) Polymer chemicals (c) Quality improvement of products	1979 (4)	Korea Pacific Chemical Corporation	100, Jangdongri, Tandongmyon, Daeduk, Chungnam, Korea Tel. (Daejeon) 44-9911-3
Hyo Sung Heavy Industries Technical Research Institute	(a) Power and electrical equipment (motors, transformers) (b) Special motors	1979 (1)	Hyo Sung Heavy Industries, Ltd.	4, 5ga Dangsan-dong Youngdeungpo-gu, Seoul, Korea Tel. 634-6411-9
Hyundai Motor Co., Research & Development Institute of Automobile	(a) Diesel engines (b) New materials (c) New models	1978 (3)	Hyundai Motor Co., Ltd.	700 Yangjeong-dong Ulsan, Kyungnam, Korea Tel. (Ulsan) 2-4111-9
Korea Electric Co., Research & Development Laboratory	(a) Maintenance technology development of power plants (b) Super high voltage distribution systems		Korea Electric Co., Ltd.	140-90, Sindang-dong Junggu, Seoul, Korea Tel. 253-4121-4

ANNEX VII

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