THE ETHICS OF SPACE POLICY

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FOREWORD

Progress in science and technology endows us today with unprecedented powers that depend by and large on our aims and the way we intend to shape our future. On a balance, the extent to which we wield these powers is inextricably linked with humanity's mastery over its own destiny. The questions thus raised by scientific progress are critical and manifold. Who, and on the basis of which collective project, defines the priorities and the choices to be made when it comes to scientific research and technological development? When risks are involved, where do we draw the line between what is socially acceptable and what is not, given the wide range of differing cultural perceptions and attitudes toward a specific technology? What degree of responsibility and solidarity toward present and future generations can we rightfully expect from the individual and the community?

The answers to these questions largely exceed the bounds of established professional codes of ethics and national boundaries. In today's multi-faceted world, where viewpoints are splintering as never before, it is all the more crucial to strive for the emergence of values that can make our coexistence technologically, ecologically and socially sustainable.

Intrinsically bound with the future of society and democracy is their ability to foster in their midst, and in the face of irrational wanderings and scientistic pressures alike, the exercise of critical judgement, a genuine culture in which scientific and technological knowledge goes hand in hand with unflagging ethical stamina. The twenty-first century citizen must thus be prepared to knowledgeably participate, on the strength of ethical reflection, in the making of strategic decisions bearing upon technology and the environment.

Such are the considerations which led the governing bodies of UNESCO to create the World Commission on Scientific Knowledge and Technology (COMEST), taking a further step toward the fulfilment of the ethical mandate assigned to the Organization, by virtue of its Constitution, which envisions, in its preamble, that "peace must ... be founded upon the intellectual and moral solidarity of mankind".

As "globalization" progresses, we must move to greater awareness of our collective responsibilities, which are, in essence, ethical. The criteria used for making decisions cannot be governed by economic purposes alone, but must be extended to embrace fundamental commitments to human rights and freedoms and to the cultural identity of each nation. This need is particularly felt in the area of space technology, owing to the considerable imbalances that its use can generate in relations between countries, as well as between the private sector and the public at large.

On October 4, 1957, the world watched with wonder a tiny sphere called Sputnik weighing no more than 84 kilograms that went spinning and beeping around the Earth. The space era had begun.

In an effort to shed more light on a growing and increasingly complex domain, particularly in regard to the many social and moral issues surrounding the applications of space technology, a fruitful collaboration has been established between the European Space Agency (ESA), competent bodies of the United Nations System, representatives from national space agencies and private industry and UNESCO.

If all those who have contributed to this publication on “The Ethics of Space Policy” share one sole aim, it is that of preventing future generations from the possible harms of space technology applications. Indeed, we can no longer afford to systematically favour our immediate interests, regardless of their direct, indirect, shorter or longer term, more or less detrimental consequences. I wish to take this opportunity to express my sincere thanks to the COMEST Working Group, and especially to Professor Alain Pompidou, to the European Space Agency, and to all the experts who gave generously of their time and energy in this endeavour.

The time to come harbours space for freedom, provided that we know to look ahead and refrain from recklessly mortgaging our future. Vast as this time may be, may its every moment count - whatever is said for the quickening pace of transformations - in the building of a viable and sustainable world for future generations.

Earth and Space are not ours. They are treasures, real and symbolic, which we owe to ourselves to safeguard for our descendants.

Vigdís Finnbogadóttir

Reykjavik, 20 April 2000

Contents

Pages

INTRODUCTION 1

THE COMEST CONTEXT 1

I CONSIDERATION OF THE ETHICS OF OUTER SPACE – PREPARATORY REMARKS 6

II THE ETHICS OF OUTER SPACE 8

II.1 Space as an Ethical Issue 8

II.2 Life in Space 9

II.3 Space as a Dimension 11

II.4 Space as a Tool 12

II.5 Space as a Perception 16

III DISCUSSION 17

III.1 From Bioethics to the Ethics of Technology 17

III.2 Space, an Instrument of Power or Sovereignty 18

III.3 Special Aspects of Dual Technologies 21

III.4 Sustainable Management of Outer Space 21

III.5 Special Aspects Associated with Crisis Management 22

III.6 Balance between Collective Protection (Combating the Mafia, Terrorism, Paedophilia) and Protection of the Individual (Individual Freedoms and Electronic Surveillance) 23

III.7 New Information and Communication Technologies and New Social Ties 23

III.8 Training in Mediation 24

IV RECOMMENDATIONS 24

IV.1 Space as an Ethical Issue 25

IV.2 Space as a Dimension 25

IV.3 Space as an Instrument 26

IV.4 Space as a Perception 28

CONCLUSION 29

BIBLIOGRAPHY 30

ABBREVIATIONS 31

GLOSSARY 32

ADDITIONAL DOCUMENTS 35

ADDITIONAL DOCUMENT I 37

Members of the Working Group of COMEST
on "The Ethics of Outer Space" 37

ADDITIONAL DOCUMENT II 39

Contributions by the Members of the Working Group of COMEST
on "The Ethics of Outer Space" 39

The Development of Science and Space Technology 41

Use of Space Technology 45

Man in Space 49

Manned Space Flight as a Cultural Mission 51

Space and Protection of the Environment 61

ADDITIONAL DOCUMENT III 65

Meeting Reports of the Working Group of COMEST
on "The Ethics of Outer Space" 65

ADDITIONAL DOCUMENT IV 81

Final report of the Paris Seminar on "The Ethics of Outer Space" 81

ADDITIONAL DOCUMENT V 109

Summary Record of the Paris Seminar on "The Ethics of Outer Space" 109

TECHNICAL ANNEXES 137

Technical Annex I - *Launchers: the Example of Ariane*

Technical Annex II - *Earth Watch Satellites*

Technical Annex III - *Communications Satellites*

Technical Annex IV - *Distribution of the Market for Satellite Navigation Equipment and Services*

Technical Annex V - *Space Systems for Observation of the Universe*

Technical Annex VI - *Manned Flights*

Technical Annex VII - *Space Stations*

Technical Annex VIII - *Space Debris*

TECHNICAL ANNEX IX - *Space Budgets*

TECHNICAL ANNEX X - *General Presentation of the European Space Agency (ESA)*

Technical Annex XI - *Scientific Missions and Long Term Programmes of the European Space Agency (ESA)*

INTRODUCTION

The COMEST Context

Growing awareness of the human and social implications of scientific research, its technological applications and their exploitation, has given rise to a new phenomenon: the world of scientific and technical research now regards ethical reflection as an integral part of the development of its own domain. Never have scientific progress and technological innovations fashioned the modes of economic production, social relations and life styles as much as they do today. Never perhaps has the general public been so aware of the transformations of daily life brought about by the progress of knowledge and technology. A real "need for ethics" has come to light in societies.

Founded on ethical reflection, this approach calls for perpetual renewal and constant questioning of the foundations of our own acts. The ethical approach encompasses the definition of a simple deontology, but goes much further. It presupposes a public debate with the enlightened participation of citizens and political decision-makers. In that sense, it is a vital feature of democracy.

Ethical reflection must be approached by a "proactive" logic. Pursued internationally, it must adopt a broad vision and anticipate problems. To that end, its work will be founded on the great systems of thought and the intellectual community all over the world will have an opportunity to participate. Ethical reflection requires an exchange of ideas and experience conducted in total freedom and independence between specialists in the various disciplines, political leaders and actors in civil society in all its diversity. It must define points of reference, outline perspectives, envisage alternatives and propose innovative options, permanently adjusted to the advances of science and technology.

The internationalization and interpenetration of problems at global level place the action of international organizations at the heart of the construction of tomorrow's society. In this context, and through its spheres of competency, the United Nations Educational, Scientific and Cultural Organization (UNESCO) is the body responsible for intellectual co-operation par excellence. It has a duty to strengthen individual rights and freedoms by drawing on the very latest developments of knowledge and on a precise inventory of practices in the different socio-cultural contexts, which constitute the specific character of our globalized society.

In its Preamble, the Constituent Act of UNESCO states that peace must be founded on the intellectual and moral solidarity of mankind. It therefore ascribes an ethical mandate to the Organization. From its inception, UNESCO has been described as the *"conscience of the United Nations".* On the eve of the 21st century, the mission incumbent upon UNESCO in a world undergoing fundamental change appears equally, or still more important, than it was when the Organization was founded in the aftermath of the Second World War. Under the terms of its Constituent Act, ethics remains its essential function, because the objective of the Organization is to contribute to the maintenance of peace and security by establishing closer co-operation between nations through education, science and culture. The underlying aim is to ensure universal respect for justice, the rule of law, the rights of man and fundamental freedoms without distinction of race, sex, language or religion, which the United Nations Charter recognizes for all peoples.

In 1993, The UNESCO General Conference already called attention to the fact that changes brought about in the past fifty years by scientific discoveries and technological progress raised questions, which opened up new perspectives for ethical reflection. The medium-term strategy of the Organization for 1996-2001 points out that *“in face of the upheavals experienced by contemporary societies and their difficulty in assimilating harmoniously the extraordinary achievements of technological progress, and confronted with the weakening of traditional moral principles and the decline in the sense of solidarity, the appeal for ethics is becoming increasingly widespread”.*

In recognition of the growing importance of ethical reflection in face of the cultural and social repercussions of the faster pace of development of scientific and technological knowledge - which is a precondition for the future development of mankind - the UNESCO General Conference, at its 29th session (autumn 1997), called upon the Director-General to promote ethical multi-disciplinary and pluri-cultural reflection on a number of situations liable to present a risk to society because of the progress of science and technology. With that end in view, the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) was created. The Director-General appointed Her Excellency, Mrs Vigdís Finnbogadóttir, President of Iceland from 1980 to 1996, to chair this Commission.

In virtue of its statutes, COMEST is a consultative body with eighteen members acting in a personal capacity and appointed by the Director-General. The members of the Commission are drawn from the ranks of prominent figures in scientific, technological, legal, philosophical, cultural and political worlds, having the expertise and the authority needed to perform the duties incumbent upon the Commission. Its membership also takes account of geographical representation and seeks to cover the different disciplines and currents of thought.

To the extent that the opinions and assistance of the professional organizations directly concerned are imperative, the presence of *ex officio* members on the Commission was decided. The Chairmen of the five intergovernmental scientific programmes of UNESCO[1] and those of the International Council for Philosophy and Human Sciences (ICPHS), the International Social Sciences Council (ISSC), the International Science Council (ICSU) and the Pugwash Conferences on Science and International Problems were invited to attend the work of COMEST in an *ex officio* capacity.

The mandate of COMEST is to act as an intellectual forum for the exchange of ideas and experience; to detect, on that basis, the signals which are precursors of risk situations; to perform in that capacity an advisory role for the decision-makers; and, finally, to promote dialogue between scientific communities, decision-makers and the general public. It advises the steering bodies of the Organization on specialized questions submitted for its consideration or which it may itself decide to examine. It also has the right to make proposals to decision-makers in the public or private sector, based on detailed pluridisciplinary studies and dealing with questions which it decides to consider or which are referred to it by the Director-General of UNESCO, more particularly matters that are of immediate or urgent concern.

1. The Intergovernmental Oceanographic Commission of UNESCO (IOC); Programme on Man and the Biosphere (MAB); International Social Sciences Programme on the “Management of Social Transformations” (MOST); International Hydrological Programme (IHP) and the International Programme for Geological Correlation (IPGC).

COMEST must be one of the pillars underpinning restoration of a balance of resources through better international co-operation in the scientific field, notably between the developing and industrialized countries. It is called upon to contribute to the circulation of discoveries and major innovations in science and technology today in order to reduce the inequalities, which exist between countries or groups of countries and within many individual countries.

The creation of COMEST reflects the growing importance of ethical reflection from the standpoint of the cultural and social repercussions of accelerated development of scientific and technological knowledge as a condition for the future development of mankind. It is the task of COMEST, as a forum of reflection, to define, on an objective scientific basis, principles which can provide decision-makers in sensitive areas with criteria, other than strictly economical, for making choices. In the exercise of its mandate, the Commission endeavours to adopt a concrete approach to the problems which arise, founded on ethical reflection. As a privileged centre for debate, exchanges of views and information, COMEST acts as an observatory of “signs”, which are precursors of risk situations and liable to generate dangers to society.

As to its working procedures the Commission has an open membership. It has adopted a flexible and transparent structure, which is both pluri-cultural and trans-disciplinary. The creation of a network of correspondent members enable specialists and scientific institutions to co-operate in the work of COMEST. In addition, COMEST establishes, as a function of the domains which it decides to examine, sub-committees consisting of members of COMEST and experts to deal with specific subjects. It may call upon specialists, depending on the particular subjects dealt with, and create working groups on specific subjects as the need arises. They meet between the sessions and consist of experts whose professional competency is consulted on an ad hoc basis. These procedures imply that the work of the Commission is not confined to its sessions alone, but continues permanently. Two working groups, dealing respectively with the ethics of energy and the ethics of soft water resources, have accordingly been set up and already report to COMEST.

1) Scientific Progress and Political Decision-Making

By reason of scientific progress and the emergence of new technologies, which have both direct and indirect consequences for society, the political decision-makers, elected by the citizens, must have at their disposal means for the democratic control of scientific and technological policy.

Confronted with the risks of abuse, which are aggravated as economic pressure grows, and with the risks of misuse of the application of science and technology, politicians too must adopt an ethical approach. The ethical approach has become a political responsibility, which must be fully assumed by decision-makers to impose respect for the dignity, identity and integrity of man confronted with the progress of scientific and technological research.

That ethical approach seeks, in particular, to provide objective information for the political decision-makers and adequate training of elected representatives to enable them to take their decisions more effectively. Ethics are at one and the same time the moral standard for action and a reflection on risk.

The politicians, whose task is to take the final decision to settle ethical problems, must therefore take into consideration the precautionary principle which seeks to avoid all irremediable consequences to present and future generations; the principle of feedback which is vital to the experimental approach: it proceeds step by step drawing on the results of successive experiments; and the principle of vigilance which consists in identifying weak signals that are genuine alert systems, liable to anticipate the appearance of possible risks. These three principles are themselves founded on moral commitments of equity and solidarity, which condition the efficacy of technological choices. These choices are made in an ethical context, which implies confrontation and interaction between three different but complementary players, i.e. the expert, the politician and the citizen. To safeguard the effectiveness of this approach, the roles of these different players must be defined. Thus, the expert is not necessarily a scientist but his expertise is drawn from a scientific approach. For the scientist, the ethical approach is based on the quality of knowledge, the refusal of falsification or malpractice: without honesty, the freedom of knowledge cannot be justified. The scientist is not necessarily concerned with the consequences of his work. Although the scientist is inspired, in Albert Einstein's words, by "the pleasure of knowledge", "science does not think", as Martin Heidegger pointed out: it advances blindfold. So the scientist must posit an assumption and then analyze this assumption to find out whether it is justified. By doing so, he passes from a product of the imagination and abstract reasoning to concrete reality. The expert explains knowledge and integrates it into the socio-economic field. In parallel, he must define the main objectives and identify the ethical problems relating to the financing of research, the presentation, management and use of scientific discoveries and technological progress. In addition, the expert formulates the stakes and challenges of knowledge by specifying the risks, which its application involves. He highlights, in total objectivity and independence, the future orientations and answers the questions put by the politician and the citizen by furnishing the necessary explanations in an interactive framework which enables misunderstandings to be avoided and doubts dispelled. In a context of scientific and technical progress, confronted with new risks the expert must throw the necessary light on the facts for the benefit of the political decision-maker. The expert and the politician are intermediaries between science and public opinion.

Among the political decision-makers, the elected representative is the person closest to public opinion and the public at large. He holds a form of knowledge about his citizens and his country in a particular socio-cultural context. He must therefore be kept informed of the main objectives of science and technological policies in terms of investments and their consequences for society.

Despite the absence of direct communication between scientists and political decision-makers, they are both working towards the same end - namely the improvement of the citizen's condition through better management of knowledge and know-how. They are each in the service of progress for mankind and supported by the same intermediary, namely the expert. They use the same opinion multiplier, i.e. the media.

The citizen for his part, as a representative of public opinion, is now directly involved in the decision-making process. He must therefore bring his critical spirit to bear in the debate associated with the ethical approach to technological choices. This debate leads to a dialogue between experts, politicians and public opinion.

In this context, the interactions between science, ethics and politics provide an opportunity to define technological options, which will shape the future of our society. Founded on an approach of moral reasoning, social, legal and ethical preoccupations seek to put the human being squarely back in the centre of the debate.

2) Creation of a Working Group on the Ethics of Outer Space by COMEST in the UNESCO Framework

At the initiative of the Director-General of UNESCO, Mr Federico Mayor, and acting on a proposal by the Director-General of the European Space Agency (ESA), Mr Antonio Rodotá, a new working group was set up to consider the ethics of outer space in December 1998 on the basis of a partnership between UNESCO and ESA. The co-ordination of this group was entrusted to Professor **Alain POMPIDOU**, a former Member of the European Parliament who also sits on the French Economic and Social Council. Its members were Mr **Jean AUDOUZE**, astrophysicist, Research Director at the CNRS, Director of the Palais de la découverte, Mr **Ezio BUSSOLETTI**, Professor at the Naval University of Naples, Director of the Experimental Physics Institute; **Dr Carl Friedrich GETHMANN**, Professor at the Institute of Philosophy of Essen University, Director of the European Academy for Study of the Consequences of Scientific and Technological Progress; **Mr André LEBEAU**, Member of the National Air and Space Academy, Professor at the Conservatoire National des Arts et Métiers (CNAM), former Deputy Director-General of the European Space Agency, former President of the National Space Research Centre (CNES) and **Sir Geoffrey PATTIE**, Director of Communications of The General Electric Company, plc.

This Working Group, in a context of transparency, objectivity, and exhaustivity, was given the task of preparing a report on the ethical implication of space activities. Its task was to identify the difficulties and fears, opportunities and promises associated with the conquest of space, while providing the necessary explanations in the clearest and most comprehensive manner possible, taking account of the needs of the populations in their specific socio-cultural context. The group endeavoured to define the outcomes of human activities in the conquest of space and exploration of the Universe; the consequences of this space conquest in the shape, firstly, of the MIR space station with the questions arising over its future status and possible return to Earth, and, secondly, all aspects of debris circulating in space which raise environmental concerns; the problems of man in space and inhabited flight which require the ability to sustain human beings in space; the exploration of other planets and of the Universe and, last but not least, the future of space policy as such, i.e. the implications of space activities in terms of costs and the cost-benefit ratio.

3) The Ethics of Space Policy

Since Icarus melted his wings by flying too close to the sun, the progress of astronomy, then of astrophysics and more recently of ballistic and propulsion technologies and advances in optics, electronics and computer software, have enabled man not only to fly, but also to walk on the Moon, send out probes to explore the Universe and even colonize near planetary space. Man has been able to build orbital stations, communication and earth watch satellites, to say nothing of positioning satellites for air and land vehicles.

These rapid scientific and technological developments generate new benefits but also new risks. Space technologies, at one and the same time promising and disturbing, mobilize substantial volumes of capital and represent a power game between the nations. Mankind, and more specifically the integrity and dignity of man, must therefore be protected by making allowance for social, legal and ethical concerns. Ethical reflection enables us to embark upon a path of moral reasoning.

Thus, the ethics of space policy must raise questions over the motivations underlying access to outer space by human beings and the exploration of the Universe. The degree of acceptability to public opinion and, lastly, aspects of equity must also be considered. The issue here is equality of access to the space instrument, or at least to the applications resulting from its use. Moreover, the consequences of the conquest of space make it necessary for this ethical reflection to be pursued in an international context, especially as outer space has been acknowledged as the common heritage of mankind.

The main objective of the ethics of space policy is to keep in mind the place of human beings and answer the anxieties of public opinion through an objective, independent and transparent approach, which avoids all emotional overtones. This in turn requires interaction between the scientists and experts in different disciplines, elected representatives, political decision-makers at government level and the media to highlight the necessary explanations. This approach, specific to the ethics of decision-making, leads to an evaluation of the degree of freedom of the human being confronted with progress of knowledge and know-how in space.

I CONSIDERATION OF THE ETHICS OF OUTER SPACE – PREPARATORY REMARKS

I.1 TWO PRELIMINARY MEETINGS

The Working Group on the Ethics of Outer Space met twice to define its working methods and identify the themes of its reflection founded on an analysis of the ethical and societal consequences of progress associated with space technologies. The Group decided to focus its attention on questions of the presence of man in space and manned flights, the development of science and space technology, the use of space technologies, protection of the environment and protection of public freedoms and cultural identities. Each of the subjects was envisaged, at one and the same time from the ethical, governmental and inter-governmental, economic, scientific and technical aspects and from the angle of perception by public opinion. Moreover, the Group excluded from its field of competence the specifically military dimension of the conquest of space and referred only to the twofold (civilian and military) use of space technologies.

Each member of the Group took a more particular interest in one of the themes on which he outlined the ethical problems in a factual note. These contributions were then examined by the Group as a whole, which formulated its observations.

The presence of man in space and manned flights, which are not justified by scientific research alone, have a strong philosophical dimension and economic aspects that cannot be disregarded. This presence makes it necessary for us to consider the spatial limits of human action because of the “inhospitable” nature of space in relation to human beings whose activities in space do not necessarily require his physical presence. In addition, the motivations, often of a cultural nature, underlying space exploration, scientific and technical research and commercial utilization of space were all evoked, more particularly from the angle of the specific problem of the ownership of the knowledge and know-how acquired by space missions.

In the field of the development of science and space technology, the Working Group examined firstly the question of access to space programmes, which require substantial resources and whose extremely high costs put them out of reach of the developing countries. Secondly, the motivations underlying space missions were approached, to the extent that science must not be used as an alibi. Mention was also made of the inalienability of space as a scientific territory. This notion must guarantee free access and protection against pollution of all kinds. The impact of space technologies on the daily life of citizens also gives rise to ethical reflection because the operators who have access to space are able to penetrate the private sphere of citizens, notably through “electronic surveillance”.

The study of the use of space technologies enables the members of the Group to develop, firstly, the environmental impact by stressing the need for management of risks in space, notably those associated with debris and the use of nuclear propulsion reactors. Secondly, the economic impact was considered through the question of the participation of the nations in space activities. Finally, the military dimension was envisaged from the angle of dual use, having regard to the specific problem of systems developed by the military on which civilians are totally dependent: the Global Positioning System (GPS), controlled exclusively by the United States of America, is a good example.

As to the protection of the environment, space technology was found to represent a factor of damage to the circumsterrestrial, terrestrial and planetary environments. Space debris and the question of its limitation by preventive measures, which must be imposed equally on all users of the instrument of space, were given particular attention by the Working Group. In parallel, space technology can be used for the protection of the terrestrial environment by permitting in particular the forecasting, prevention and monitoring of natural disasters and, more generally, better global management of our planet.

As to the protection of individual liberties and cultural identities, the Working Group gave its consideration to the ethical aspects of electronic surveillance, satellite communications and satellite positioning systems. They pose a problem of infringement of individual liberties which is all the more serious as there is as yet no legislation to regulate access to, and use of, data processed on board satellites.

The maintenance of cultural diversity for its part is threatened by a risk of standardization of the means of expression derived from the globalization of communication while benefiting from the appearance of new cultural identities, which must be combined with those that already exist.

The meetings also enabled the Working Group to organize the programme of the seminar held in September 1999.

I.2 THE PARIS SEMINAR

The Paris Seminar on the Ethics of Outer Space, organized jointly by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and by the European Space Agency (ESA) enabled, firstly, specialists to share their thoughts and experience on the ethical implications of the use of science and space technologies and, secondly, to establish a constructive dialogue with the different players in the space field: representatives of space agencies and industrial companies.

This seminar took place in two phases. The reflections on the first day sought to identify and analyze the ethical problems, which arise from the use of outer space. This process of reflection took place on several different levels. Space was envisaged successively

- as an ethical issue;
- as a dimension, envisaging outer space and the Universe in their totality;
- as an instrument, which implies the protection of the near-planetary environment and secondly that of public liberties and cultural identities;
- and as a perception, with analysis of the benefits and risks associated with the progress of space technologies, including communication and the role of the media.

The aim of the second day was to define the content of the ethical approach to space policy by allowing industrialists and heads of the different space agencies to explain their concerns in this field and to answer the questions put by experts.

II THE ETHICS OF OUTER SPACE

II.1 SPACE AS AN ETHICAL ISSUE

One distinctive feature of mankind is his ability to reflect and question the justification, motivation, contents, significance and repercussions of his actions. By constantly pushing back his limits, they have enabled him to become, as Descartes put it, the “master and possessor of nature”. This reflection and process of questioning are particularly necessary in the space field now that space has become accessible to human beings. These new activities of man pursued, in what is essentially an inhospitable environment for him, raise increasingly important ethical questions:

What is the role of human beings in the Universe?

How can the links between the earth and outer space be organized?

Who is to determine the priorities and choices of science and space technologies and on the basis of which objectives for society?

How can the risks engendered by the space technologies be defined democratically and what risks can be regarded as “acceptable”?

What is the level of responsibility and solidarity to which individuals and groups must aspire for present and future generations?

Ethical questions condition the acceptability of space technologies. They must lead up to the best solution, founded on moral arguments, against the background of the comparison of risks and benefits engendered by these technologies in a spirit of respect for the rights of man and, more particularly, respect for the integrity and dignity of human beings.

II.2 LIFE IN SPACE

II.2.1 Man in Space

Many centuries passed before Icarus' dream of overcoming the Earth's gravity became a reality. In 1783, Pilâtre de Rozier made the first human flight in the atmosphere in his Montgolfier. But it took another two centuries, with the progress of civil and military aviation, before man became present in outer space. In April 1961, the cosmonaut, Yuri Gagarin, became the first man to orbit the earth. Then in July 1969, Neil Armstrong and Edwin "Buzz" Aldrin walked on the Moon. Since then, man's space flights have multiplied and their length has become longer. The Russian MIR space station, placed in orbit in February 1986, was inhabited almost continuously and enabled astronauts to spend several months at a time in space.

The presence of human beings in space today raises a number of philosophical, cultural and ethical questions as well as the economic and political issues. Man's ability to intervene in space does not necessarily require his physical presence in outer space. Space technology using probes, satellites and automatic devices, can in most cases be equally efficient and often costs less than a manned mission. Moreover, man's need for air, water and food, his relative physical fragility, and the risk of damage caused by his exposure to cosmic radiation, are all factors which do not necessarily militate in favour of his presence in space. In addition, satellites and space probes are becoming increasingly effective because of the spectacular progress of micro-electronics. A debate has opened between the advocates of manned space flights and those who are more reticent and even opposed to this type of mission. But manned flights are clearly complementary to the other space projects. Where artificial intelligence is limited or too costly, man has the ability to manage complex and unforeseen situations. However, we must avoid instrumentalization of the astronaut who would then be relegated to the status of a mere robot or tool in the service of space technology. It is here that his capacity of analysis, judgement and decision-making, and also his courage and determination, are the key to his human condition. Consideration of these aspects enables ethical reflection to be taken further.

This debate poses in substance the question of the motivation of manned flights which cannot be reduced to purely economic arguments based on a cost-benefit analysis. The motivations underlying the presence of man in space are more complex and of several types. They can serve scientific interests by permitting research in the absence of gravity (in particular into the physics of materials). Experiments in the absence of gravity on human beings have enabled progress to be made with our knowledge of physiological regulation mechanisms.

Over and above the technical, economic or scientific arguments, there is another justification, which may be termed "trans-utilitarian", of man's conquest of space. Human beings are inspired by a permanent desire to push back the boundaries of possibility and cross new frontiers. President John Fitzgerald

Kennedy's determination to conquer the "new frontier" was, for example, taken over in the Report of the National Space Commission[2], *Pioneering the Space Frontier* written in 1986, which states that *"the pioneering spirit is part of the heritage of mankind … In recent decades, a new frontier has opened to us, confronting mankind with its biggest and most promising challenge of all: the frontier of space".*

More generally, knowledge of the Universe - the infinitely large - and of its origins and the atom - the infinitely small – are part of man's pursuit of a dream and his imagination. In parallel with the thirst for knowledge and discovery, technology gives the human being an impression of power, which is symbolized by the myth of Prometheus, but has now moved on significantly.

Moreover, the conquest of space contributes to the dissemination of scientific and technical culture. It favours the appropriation of space activities by public opinion by maintaining an imaginative horizon and the determination to make new discoveries. These are the driving forces in human society.

Man's exploration of outer space will in future start out from space stations, which may be defined as base camps on the road to the planets of the solar system. They can also be used to observe the earth and celestial bodies, for biological and medical studies in the absence of gravity, for physical and chemical experiments in the space environment and for the maintenance and repair of satellites. Space stations have familiarized man with prolonged stays without gravity in preparation for long journeys into space.

II.2.2 Life on Other Planets

a) Search for Signs of Life

The search for signs of life in the solar system or in other galaxies, which seemed to belong to the realm of science fiction just a few decades ago, is now a fundamental theme in the activities of the space agencies. In practical terms by exploring the solar system and then the Universe, the aim is to find signs of life, so enabling a universal principle of life to be identified through the progress of contemporary biology. Science is seeking an answer to questions associated with the great myth and, in particular, the mystery of man's origins. The search for new forms of life in space generates the creation of new links between human beings and outer space. Scientific knowledge is not sufficient to enable reference to the myths or imagination to be surpassed. On a subject with such emotional overtones as the perception by public opinion of the consequences of the existence of living beings in space, an ethical approach has become essential. It seeks to envisage the place of the human being in relation to possible forms of detectable or accessible life thanks to space technologies. Without excluding spirituality, that approach poses the question of the attitude to be adopted to different models of life and may necessitate the exploration of new methods of objective perception.

Pursuant to Art. 5 of the "Treaty on the principles governing the activities of States in exploration and use of outer space of 1967" more commonly referred to us as the "Space treaty", astronauts are regarded as envoys of mankind in space. In that capacity, they might be seen as the best intermediaries between life on earth and other forms of life.

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2. This Commission, consisting of independent NASA experts, was set up by President Ronald Reagan to prepare the United States fifty-year space programme.

b) Bringing Back Samples

The return to earth of samples taken from the Moon or projects for missions to take samples from other planets, such as Mars, raise many questions of an ethical nature. These touch on the scientific value of such missions and the benefits that mankind may derive from them. The management of the risks inherent in such missions requires the creation of precautionary and protective systems to avoid any potential contamination of planet Earth. Such missions require information for public opinion which, in the present context, is particularly sensitive to the problems of contamination, while remaining fascinated by exploration of the Universe.

II.3 SPACE AS A DIMENSION

II.3.1 Exploration of the Universe

From the moment in 1957 when the USSR launched its first satellite, the Sputnik, space exploration had developed rapidly and taken the form of inhabited missions and the despatch of probes to land on Mars or overfly other planets in the solar system. It provides information on the formation of the Universe, the planetary system, the sun and the earth. Scientists have developed and used increasingly powerful telescopes giving access to the outer confines of the Universe.

Space technology therefore appears to be an instrument in the service of knowledge as a value in its own right. The ultimate purpose of all exploration of space is to broaden human experience and knowledge.

At the same time it has become possible to study the earth from space from many different angles with a precision never achieved by other technologies: analysis of the characteristics of its ionosphere, meteorological missions which permit unprecedented monitoring of climates and their evolutions, a study of the level of the oceans and their interactions with the atmosphere (Franco-American Topex-Poseidon mission); infrared observation of the earth's surface (soil, modifications of the vegetable covering and conurbations by the Spot image programmes). Satellite observations enabled the ozone hole to be revealed in the stratosphere above the South Pole and measures were taken internationally to prohibit the use of chlorofluorocarbons (CFCs).

Other missions, which have achieved real scientific success, include the Hubble space telescope, which provides a good illustration of the advantages of space technology. Despite its astigmatism which lasted for three years, Hubble has for seven years been supplying the finest images of the near Universe and above all of its outer confines.

II.3.2 Consequences of Exploitation of Circum-terrestrial Space

a) Damage to the Circum-terrestrial Environment

Space technology has caused damage to the circum-terrestrial environment by becoming a source of pollution. Each launch has repercussions on the terrestrial environment.

Space launchers may have effects on the ozone layer and risk causing partial changes in air quality. However, this atmospheric pollution is negligible at the level at which space activity occurs today. Moreover, the generalization of cryogenic propulsion – which also emits water – will help to reduce the level.

b) Space Debris

The circum-terrestrial environment is also being polluted by space debris, consisting of fragments of previous launchers and failed missions. Their presence is liable to prove an obstacle to the success of future missions. Satellites, which have become non-operational in the terrestrial orbit and debris from missions sent out towards other planets and interstellar space, contribute to the pollution of outer space.

In just forty years, over 20,000 tons of materials have been placed in orbit round the earth. 4,500 tons are still there today. 5% of this mass represent the totality of satellites still operational today (around 500 in all), while the rest may be regarded as a field of debris. 9,000 objects measuring more than 10 cm are estimated to be present today with 110,000 between 1 and 10 cm in size and 35 million measuring between 0.1 and 1 cm.

The time at which uncontrollable objects were deliberately placed in space belongs to the past, but the sources of this pollution remain and they are considerable: they may be accidental or chronic, such as paint flakes from satellites or launchers. Moreover, space debris represents a kind of waste material that is very special, to the extent that the number of pieces increases as a result of collisions. Most space debris cannot be detected at present other than through the impact of collisions with objects in space. Only objects measuring more than 10 cm are individually monitored by observation and ballistic detection systems using optical appliances and radars.

Space debris pose a risk in orbit to vehicles and crews through the threat of collision. Risks on the ground cannot be ruled out either in the event of uncontrolled re-entry of debris into the atmosphere. Moreover, space debris make a growing contribution to the luminous pollution of space. Electromagnetic pollution for its part is hampering astronomic observations from the earth.

II.4 SPACE AS A TOOL

Alongside the drawbacks generated by the use of space, it also has undeniable advantages. Space technology and its applications have provided a formidable system for observation of the earth and knowledge of global effects of human activities on the planetary environment.

From the beginning of the spatial era, the exploration and exploitation of space have had considerable spin-off effects for mankind at both scientific and economic and social levels. Space technologies, through satellites, provide a profusion of information, which enables man, by observing the planet, to understand his environment and manage natural resources. They also enable him to assure almost instant communications, regardless of the distances or positions involved.

Earth observation satellites are therefore an increasingly precious source of information. They allow the development of precision agriculture by giving farmers a series of data about various parameters (nature and composition of the soil, meteorology, agricultural practices etc.) enabling them to optimize their yields.

Communication satellites bring human beings closer together and facilitate exchanges.

Alongside these advantages, space does, however, have drawbacks and risks, which must be taken into account in order to permit their most effective possible management.

II.4.1 Benefits

a) Observation of the Earth and Climatic Phenomena by Satellite

Space is an irreplaceable source of information in fields such as weather forecasting, prevention and management of natural disasters, which each year cause damage running into billions of dollars and cost countless human lives. Space techniques for observation of the Earth by satellite contribute to the management of terrestrial resources. They will therefore enable living conditions to be improved and sustainable development achieved.

Many meteorological phenomena have direct consequences for the economy, smooth working and well being of society. Meteorological forecasting is therefore vitally important to human activities, particularly in agriculture where it enables crops to be monitored and water resources managed more effectively. In parallel, space techniques can play an important role, enabling an early warning to be given of hurricanes, typhoons, cyclones and storms and the consequences of natural disasters controlled. However, and this is where the ethical dimension arises: all the countries, and more particularly the developing countries which are heavily exposed to natural disasters and for which this type of information is vital to their development, must have access to this data at the earliest opportunity by application of the principle of equity.

b) Position Finding and Navigation Technologies

Space has also permitted the spectacular development of position finding in navigation technologies. Satellites can now guide and determine the position of boats, aircraft or land vehicles. GPS, developed for the American military, has been made available to civil users and is proving immensely successful because of its impact on daily life by giving precise real time data, which can be associated with other types of information. According to the European Commission, the world market for civilian applications of GPS, which was worth less than 1 billion euros in 1994, is likely to reach 8 billion in the year 2000 and 50 billion in 2005 (including 10 for space segments and 40 for the terrestrial sector including, in particular, on-board equipment). Because of its precision, this system permits control of air navigation, air traffic and soon take off and landing, even without visibility. However, despite the falling costs of the systems and equipment for GPS, which are becoming routine consumer goods, their cost still makes them inaccessible to the least wealthy countries.

c) Creation of a “Planetary Village”

The rapid development of space science and technologies has had a significant impact on the economic, social and cultural life of human beings and contributed, by reducing times and distances, to the establishment of a “planetary village”, so permitting better links between human beings, notably through the explosion of new information and communication technologies (NTICs), generated by space activities. But the village still lacks a hierarchical structure and is more in the nature of a jungle.

The emergence of multi-media services, digital television, direct satellite television, the Internet, the Intranet and systems for mobile personal communication, have led to the dream of establishing planetary human relations anywhere, regardless of the constraints of terrestrial air and maritime space. The interaction between computers, communication technologies and digital compression techniques has brought the development of sophisticated information structures with immediate access, regardless of the location of the users, so facilitating planetary exchanges of opinions and information on economic, social and cultural subjects.

NTICs now offer the possibility for different cultural identities to be expressed by giving access for immigrant communities or members of a diaspora to the cultural messages of their communities of origin. In addition, the communication instrument is becoming a personalized tool, which goes much further than the levelling out of expression. In this regard, space technologies may favour the maintenance of cultural identities and the preservation of their diversity; these technologies may also engender the appearance of new identities which must be combined with existing cultural identities in order to maintain a necessary balance for the coexistence of different cultures.

On the margins of this phenomenon, the NTICs permit the development of communication forums bringing together individuals who are interested in a particular subject and can hold discussions, regardless of the distance separating them physically. In the field of science and space technologies, these forums, which are spaces of freedom, communication and information are particularly important to ensure a genuine dialogue. Such forums can be effective only if they are regularly updated and led by qualified persons.

II.4.2 Risks

The exploration of space brings a number of risks resulting from the techniques used and the applications made of them.

a) Use of Nuclear Energy Sources

In the 1960s, the United States of America and the USSR sent into space objects containing nuclear reactors designed to generate the energy necessary for their operation. At present, several space vehicles with nuclear reactors are in orbit. As mankind explores the Universe more deeply, the need to develop permanent systems of controlled power is becoming increasingly urgent. That is why the use of nuclear energy in outer space appears inevitable in the present state of our knowledge. The use of nuclear energy for missions to interstellar space was the subject of Resolution 47/68 adopted by the UN General Assembly on 14 December 1992 and entitled “Principles for the use of nuclear energy sources in space”. But the fact remains that the use of such a source of energy, although permitted, is controversial because of the risks incurred on earth when the vehicle is launched or returns and in terms of potential damage to the space environment. In this regard, the fall in 1978 of the Cosmos 954 satellite with radioactive debris created an awareness of the risks involved. The time has come to ask whether nuclear energy is the only viable alternative and whether there is not a source of energy with less risk, which would attract greater support from public opinion.

b) Electronic Surveillance

Among the risks deriving from the use of space technology, those associated with electronic surveillance are particularly disturbing because they may encroach upon individual freedoms. The computer hardware carried on satellites permits interactive, instant and planetary exchanges through interconnection. Secondly, the capability of information systems enables digitized data to be collected, sorted, processed, recombined and circulated. The computer support also engenders the processing and transmission of virtual and anonymous data. These functions performed by the computer hardware on board satellites may be particularly intrusive. They make planetary electronic surveillance possible in at least three fields: communication through new information and communication technologies (NTIC), positioning of vehicles through the global satellite navigation system (GNSS) and observation of the earth through high resolution imaging.

c) Encroachment on Individual Freedoms

The performance of electronic surveillance is making the problem of the encroachment on individual freedoms increasingly acute. Thus, the use of space technology enables private communications by telephone, fax and electronic mail to be intercepted. It also enables the behaviour patterns of individuals to be identified through the transactions effected by them with their bank cards in order to locate, through a positioning system, not only communications between mobile telephones but also the position of vehicles. Satellite positioning systems, such as the US global positioning system (GPS) or the world satellite navigation system (GLONASS) of the Russian Federation, enable the position of moving objects on land, air or at sea to be determined with very high precision. In some cases the position of individuals can even be detected without their knowledge. These techniques, which were formally the domain of the military alone, are now within reach of anyone who has the necessary technical resources and their inappropriate use is liable to encroach upon individual liberties.

d) Encroachment on Identity and Cultural Diversity

An inappropriate use of space technologies can have a considerable impact not just on social life and individual freedoms, but also on cultural identity and diversity. The relationship which exists between space technologies and cultural diversity also entails some risks for the latter. Because of their planetary nature, space resources contribute to the globalization of culture and therefore to the standardization of means of expression. Such globalization may in future lead to greater uniformity in the behaviour of peoples, standardization of languages, cultures and behaviours, and consequently to the disappearance of the cultural diversity which is an inestimable part of our heritage. Some vulnerable societies might then be the victims of a perverse form of cultural alienation.

The problem which arises in this area can be summarized by a single question: how can the dissemination of information technologies worldwide be assured while permitting the best possible communication and assuring the personalization of communication and respect for cultural identities?

e) Acceptability of Messages Transmitted by the NTIC

Alongside the problem of cultural diversity, the question of the acceptability of the messages, which may be circulated in every country via the NTICs and satellite instruments, without regard to terrestrial frontiers, arises. However, the acceptability of the messages remains relative to the extent that it can only be judged with reference to a system of values that varies from one country and culture to another. Messages, such as an apology for violence, paedophilia or “soft pornography”, may well be unacceptable, but their control or supervision is not easy and raises the more general question of the right of individual access to information and that of individual or collective moral regulations.

II.5 SPACE AS A PERCEPTION

Space as a perception refers to the image of outer space in public opinion. The emotional connotations of the conquest of space must be disregarded and attention focused on the role of the media and communication organs and that of the political decision-makers who are in contact with public opinion.

II.5.1 Escaping from the Emotional Context

For hundred of years, the heavens were a source of myths: man projected his image as though in a mirror and imagined in the heavens the presence of gods with human forms. But today that mirror has been shattered. To the extent that space has now become accessible to human beings, the perception of space has passed from myth to dream and then from dream to reality. In this context, this perception of space has a high emotional charge.

The emotional context in which space exploration takes place admittedly has a positive aspect in that it stimulates a form of constructive and mobilizing imagination. But it may also give rise to unfounded fears fed by disinformation deliberately put about by the media. Therefore, we must escape from this emotional context using a rational, objective, independent, transparent and complete analysis of the benefits and also of the risks engendered by space activities. Our examination of the situation must be as comprehensive as possible, leaving no shadow zones.

II.5.2 Role of the Media

The media have an important role to play in passing on information, but they must not appropriate an exclusive right to communication. Another pitfall to avoid is the appropriation of explanations by scientists. Scientists must intervene to give explanations in a language, which is sufficiently accessible to be understood by public opinion and avoid misunderstandings and doubts. In order to share knowledge, an interactive approach involving both the media and the scientific world confronted with the concerns of public opinion has become necessary.

II.5.3 Interaction between Experts, Politicians and Citizens

As we saw in our introduction, interaction between experts, politicians and citizens must be organized. The debate arising from the ethical approach to the technological choices of space policy leads on to a dialogue between these three categories.

II.5.4 What Strategy for Communication with Public Opinion?

The ethical approach is founded on a strategy of communication with public opinion. This strategy seeks to pass from an emotional context to a rational, objective, independent and detailed analysis, leading on to a credible explanation. The knowledge sharing which flows from this approach reveals the role of concertation between scientists who are the artisans of knowledge and expertise and the experts who have the ability to explain science and technology. The function of the "scientific mediator" will emerge at the interface between the world of scientists and that of experts.

Appropriate communication is founded on the accuracy of the information without seeking to play on the credulity of individuals or populations and on a concerted effort of education, which must be assured first in school and then on a life-long basis. This initial training must permit the acquisition of a basic scientific culture to enable the citizen to understand the information presented to him. The higher the citizen's level of education, the less inclined he will be to accept disinformation. In this regard, teaching assumes particular importance because it must lead on to active and interactive training with a view to a process of shared discovery and understanding. The practice intended to lead to an understanding of facts will result in a "mediation pedagogy" in the service of the goals of space policy.

Responsible communication is based on the right to precise information, which may admittedly have uncertainties but must not hide the real and potential risks. We must demystify the problem of risk by highlighting the difference between the potential risk and certain damage in order to avoid panic reactions. Moreover, the public must be kept informed of the real risks. This can be done only through an anticipative strategy founded on the objective explanation and identification of risks. Risk is inherent in every human activity and zero risk does not exist. That is why a prospective and organized management of risk is the only way of avoiding rumours, fears and discredit.

III DISCUSSION

III.1 FROM BIOETHICS TO THE ETHICS OF TECHNOLOGY

The movement of bioethics, which emerged in the 70s in the United States, has gradually given way to a wider movement of ethical reflection in the fields of science and technology. This movement originated in the observation of some excesses of science, such as the atrocities perpetrated by doctors and scientists on prisoners and deportees in the nazi concentration camps, and the repercussions of certain scientific discoveries or technological development, e.g. nuclear fission or reproductive cloning. These situations have shown the need to raise clearly the question of the limits to research by laying down ethical principles and defining the responsibility of researchers. The ethical committees formed in this way concerned the life sciences at the outset but have progressively expanded their scope to encompass the sciences in general and their technological applications.

The need for an international approach has become apparent because the future of mankind is now defined on a planetary scale. An ethical committee for science and technology was therefore established within the European Union and in the United Nations system. In 1998, UNESCO set up the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) as a separate body from its International Committee on Bioethics (IBC).

III.2 SPACE, AN INSTRUMENT OF POWER OR SOVEREIGNTY

In the early days of the space adventure, space was regarded as a new field of confrontation between the super-powers. But the geopolitical changes that have occurred since the end of the cold war have partially changed the way in which space is perceived. In future, because of the enormous cost of space programmes, these can no longer see the light of day and develop except through international co-operation. However, space is engendering a growing number of commercial activities financed in large measure by private operators and in a few years time the turnover of commercial space activities will exceed the public space budgets of all the nations engaged in space research.

So power has shifted from State level to a level of trade which is increasingly difficult to control by the States, but dominated by the manufacturers of terminals or software and by access providers. This tendency has been strengthened by a new phenomenon bound up with the complexity of our society: the State is today no longer the sole guarantor of moral integrity, because of a growing interaction between countries and a degree of relativization of the role of the State whose essential mission is to manage social policy.

This crisis of the nation state, reflected in the fact that the State is no longer the only actor on the scene, is liable to result in situations of abuse of dominant positions. For a company or a group of companies enjoying a preponderant position in the space field, such abuses consist in their profiting from the situation to adopt certain forms of behaviour, which are prejudicial to the competition. In this regard, the system of “steering” economic activities through space technologies is significant.

Space is a source of major development in particular because of the forecasts, which can be made in respect of a climate or agricultural production and crops. Substantial economic benefits result from the use of space resources for forecasting purposes. And we may well ask who will really benefit from these advantages – the producers, consumers or intermediaries. Clearly, the increase in our forecasting capacity has as its corollary a higher speculative capacity with, in the long run, the risk of the already profound inequalities in this field becoming wider than ever. For example, the artificial fixing of prices to make quick profits, the destabilization of societies in transition and any political interference with networks can create grave imbalances.

III.2.1 Resources Allocation

Because of the competition, which it engenders, the determination of the distribution of resources between different scientific disciplines comprises a new ethical dimension founded on the emergence not only of scientific values and principles but also of ethical principles that preside over the equitable allocation of these resources. The definition of these principles must be the outcome of a balance between the general interest and particular interest of the various players involved in space activity. The allocation of resources presupposes interaction between the scientific and industrial worlds and political decision-makers. The States, through their political leaders, decide on the allocation of resources having regard to the dialectic established between their interests and those of the industrialists who have to fill their order books. Thus the allocation of resources necessitates strategic choices, which in substance raise the question of the motivations put forward to justify space programmes.

This question is all the more important as space activities involve the allocation of colossal budgets. To secure the necessary credits, the persons in charge of space programmes may sometimes be tempted to hide the true motivations of their projects behind the alibi of science. Consequently, there is an ethical requirement to present clearly and honestly the motivations underlying decisions on space programmes, whether they be cultural, economic, scientific or political.

III.2.2 Sharing Knowledge and Resources

Despite the provisions of Art. 1, paragraph 1 of the 1967 Treaty which stipulates that exploration and use of outer space “must be effected for the good and in the interest of all countries, regardless of their state of economic and scientific development, being the attribute of all mankind”, the space adventure is in fact the preserve of a few powers because of its cost and the use of advanced technologies. However, the resulting knowledge and information on space must be available to all countries and more particularly to the developing countries, which are unable to access space directly. In fact a number of items of information are used to take decisions in such key areas as agriculture, natural resources, the environment, prevention or intervention in the event of natural disasters. The developing countries therefore have a particular need for this type of data to which access depends on price and on information-sharing policy.

To arrive at an equitable sharing of information, a distinction can be drawn between three types of data generated by space missions:

- scientific data which are the preserve of fundamental research and must be accessible to researchers and university staff in every country;
- environmental data, which should be placed at the disposal of the less-favoured countries for which access to such data is a major contributory factor to balanced development. In this regard, the practice followed by Eumetsat towards non-member countries, which are expected to pay for data if they are rich but enjoy free access if they are poor, could also apply to environmental data;
- commercial data in the strict sense of the term (telecommunications), which might alone be governed by a strictly “commercial logic”.

When it comes to the sharing of resources, the question arises as to the equitable distribution of frequencies and orbital positions in the geostationary orbit which are scarce and limited resources. The geostationary orbit has the particularity that satellites appear to be motionless in relation to the Earth and therefore permanently situated above the same point. For technical reasons, in order to avoid interference between satellites, the number which can operate simultaneously on this orbit is limited. This therefore presupposes efficient and equitable management, notably in relation to the developing countries. In this regard, the International Telecommunications Union (ITU), a specialized United Nations Agency, has been working since the start of the space era to promote equitable access and rational and effective utilization of radio frequencies and orbital positions. However, more recently we have seen a progressive questioning of the status of the geostationary orbit with some authors going so far as to envisage a “stock exchange” to trade in orbital positions and their corresponding frequencies. This would call into question the principle of equal access for all to space activities, which is enshrined in the principle embodied in the 1967 Space Treaty of freedom of exploration and use of outer space and celestial bodies.

III.2.3 Appropriation of Space and Free Access to Space

The 1967 Space Treaty sets out in its Art. 1, paragraph 2, the principle of freedom of exploration and use of outer space.[3] This freedom has as its corollary the non-appropriation by the States of outer space. That fundamental principle is embodied in Art. 2 of the 1967 Treaty[4].

Since 1961, the United National General Assembly has repeatedly adopted resolutions stating that outer space and the celestial bodies cannot be the subject of national appropriation of any kind (Resolutions 1721 (XVI) and 1884 (XVIII)).

Today, the threat exists that this principle may be weakened, for example through the sale by certain private companies of land on the Moon. Even if this type of initiative elicits smiles today, it is nevertheless in complete contradiction with the principle of non-appropriation and any encroachment on this principle is liable not only to deprive of all content one of the foundations of the space law but is also inherently dangerous. Space must remain at the service of all mankind.

However, we must not interpret the principle of non-appropriation as excluding any filing of patents or more generally protection of intellectual property. Space technologies, and the expertise required by them, must be eligible for protection as intellectual property. Indeed, it seems justified for the countries or space industries, which invest considerable sums to be paid for their inventions. Moreover, this whole issue of intellectual property is all the more pressing as the international space station will be a kind of experimental laboratory that may have spectacular repercussions in various fields. Industrialists will no longer be inclined to pursue extremely costly research in space unless they have a legal guarantee that any discoveries made will be properly protected.

A problem of the modalities for appropriation of space technologies clearly arises here because at present the United States of America alone hold a monopoly on the filing of patents for inventions or devices carried on board satellites.

Moreover, if a discovery may bring universal benefits, should it be patented on a strictly commercial basis or should legal provisions be enacted to grant free access?

The protection of intellectual property may have proved a threat to the development of subsequent research, especially in the case of intelligent orbits for which the necessary technology has been patented. These orbits are elliptical and quasi-geostationary, but located outside the equatorial zone. This means that they do not require limited frequencies. The consequence of a patent registration is that people who would wish to use these orbits for commercial or research purposes will have to pay royalties. This practice has the effect of limiting access to space and is hard to justify. Detailed work in this field must be encouraged.

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3. Art. 1, para. 2: “Outer space, including the Moon and other celestial bodies, may be explored and used freely by all States without discrimination under conditions of equality and in compliance with international law, all regions of the celestial bodies to be freely accessible.”

4. Art. 2: “Outer space, including the Moon and other celestial bodies, cannot be appropriated by any nation by proclamation of sovereignty, use or occupation, or by any other means.”

III.3 SPECIAL ASPECTS OF DUAL TECHNOLOGIES

The use of space is a strategic challenge and a key factor in the defence policy of the leading nations. Space can for instance contain weapon systems. It also enables terrestrial armament systems to be jammed.

Space has a military component, which is inseparable from its civilian side. Thus, although the international treaties on space generally refer to concepts such as the shared interest of mankind and the use of space for peaceful ends, most space applications are dual in nature, i.e. they can be used for both civilian and military purposes. Military space technology and civilian space technology have shared bases. In this regard a distinction must be drawn between:

- the civilian technologies which are capable of military applications, such as optronics applied to observation of the Earth;
- and military technologies with civilian applications such as GPS.

The first category seems less problematic from the ethical standpoint. We must not forget that systems originally created for civilian use may also benefit the military, e.g. by enabling cruise missiles to be guided.

In the other case, commercial applications are increasingly subject to systems developed for military purposes. This question becomes critical when a State is liable to become dependent on the systems. Although technology should benefit from the dual use of military techniques, reduced development and production costs, a complete separation of the uses of technology as such should exist, taking independent account of the needs of the different civilian users and the military aspects.

In this context of dual use, observation of the Earth can lead to surveillance and even espionage. Communication satellites facilitate the projection of armed forces beyond national frontiers. The same technologies also permit the deployment of observation and surveillance systems. Positioning systems (GPS and GLONASS) were developed for military ends and give a dominant advantage to the authorities that control them. However, the availability of their signals for civilian users has resulted in a growing dependence of commercial applications, which are important for civil society, on these military systems.

Under what circumstances could the proprietors of these systems refuse their use by others? This dependence poses questions, which may have ethical implications because of the risk that civilian applications may be dependent upon the military authorities (notably GPS).

The civilian sector should have a system of recourse to enable it to defend its position in relation to the military. Military technologies, which have civilian applications, must be used in the civilian field and the situations that would justify the maintenance of use of these technologies in the civilian sector need to be clearly identified.

III.4 SUSTAINABLE MANAGEMENT OF OUTER SPACE

III.4.1 Debris in Orbit

In the present state of the technological art, no economically viable solution exists to rid space of the debris that has built up since the early days of space launches. Only preventive measures such as the diversion of geostationary satellites to a graveyard orbit at the end of their life or the reduction of the time spent in orbit or the immediate re-entry of the upper stages of launchers, might be envisaged to halt the increase in their numbers. But because of their high cost, these measures have a significant impact on the competitiveness of commercial systems and are liable to distort competition, especially in regard to launchers. Consequently, in order to maintain equitable competition in this field:

- rules seeking to prevent the propagation of debris must be uniformly imposed on all users of space technology;
- and embodied in international law.

Rules of good conduct have been established and implemented by some space agencies and under the terms of existing international law the States bear sole responsibility for the harmful consequences of their launches. But there is as yet no binding legal framework with a universal scope specifically regulating the problem of space debris. Therefore, there is also no institutional structure to watch over its implementation by analogy with the system which manages the allocation of radio frequencies to space vehicles. For some years, several countries have been considering this problem in the Committee on the Peaceful Use of Outer Space (COPUOS) of the United Nations Organization. This Committee has put in hand studies seeking to establish a plan for observation and counting of objects circulating in space and for the development of models permitting forecasting and prevention.

The nationality of space debris generally cannot be identified. Most potentially dangerous debris is not individually tracked: determination of its origin is therefore impossible. So far only one satellite has been damaged in orbit by a collision. This was the French military satellite “Cerise” which collided with the upper stage of the launcher that placed it in orbit. In that case the nationality of the debris was known and the collision was national in character. But what would happen if elements of different nationality collided? What would be the nationality of the debris generated by that collision or what would happen on the assumption of damage caused by debris whose nationality is impossible to determine, which applies in the immense majority of cases? Because of the complexity of these questions, they can only be dealt with at international level to the extent that no initiative can be effective unless it is pursued jointly by the countries which are active in space and by those which are mere users of space. Consequently co-operation in this field is essential.

III.4.2 Waste Products Generated by Human Activity

In the medium term, there are other potential uses of space technology, but they would first require substantial progress, notably in respect of transport from Earth into orbit. The most immediately accessible possibility is the use of the space transport system to rid the surface of the planet of the most dangerous waste caused by human activity, notably nuclear industrial waste. In this respect, circum-solar space at a great distance from the Earth offers unlimited storage capacities for indefinite duration. However, in the present state of technology, this approach is impeded by the inadequate security of the means of transport from the Earth into orbit. It will only become feasible if major progress is made in the cost and reliability of space launchers.

III.5 SPECIAL ASPECTS ASSOCIATED WITH CRISIS MANAGEMENT

Crisis management presupposes detailed study of the aspects of communication, scientific mediation and explanation of risk management to prepare and inform public opinion in a transparent manner of the occurrence of possible incidents. In this respect, the programmed return of the MIR station requires the creation of a detailed communication strategy to explain the different stages of the process as effectively as possible.

This crisis management entails risk management, which must take account of the perception in public opinion of these risks and their subjective character. In this regard, a clear and transparent dialogue must be established between the public and the various players in the space field.

Moreover, at organizational level, to ensure that risk management to be as objective as possible, it must be handled within the bodies involved in space activities by an independent authority responsible for the protection of safety.

Control of the GPS positioning system by the US military raises anxieties in the event of a conflict. What would happen if the interests of the USA led them to suspend the availability of this system for civilian users? To avoid this situation of dependence, the development of a civilian system is highly desirable. Europe has therefore decided to set up a specifically European civilian system for satellite navigation control, the GALILEO Programme, which might supplement and even replace the GPS system.

III.6 Balance between Collective Protection (Combating the Mafia, Terrorism, Paedophilia) and Protection of the Individual (Individual Freedoms and Electronic Surveillance)

As pointed out earlier, space technologies can be used for surveillance purposes, sometimes of dubious legality. It is understandable that the States may wish to use this electronic surveillance to ensure the security and defence of public order, but it must not serve to systematically and arbitrarily control individuals and interfere with their private lives. Therefore a balance must be struck between the protection of society and protection of the individual.

The use of satellite networks must not promote the proliferation of illegal activities. But, in parallel, observation and electronic surveillance systems may be used to identify criminal or terrorist networks. However, this electronic surveillance raises problems pertaining to individual liberties. Today, it is possible to intercept communication data conveyed by satellite and to locate by a positioning system mobile phone communications and even to identify the behaviour of individuals. These techniques, which used to be employed solely by the military, are today within reach of everyone who has appropriate technical resources. Their diverted use is liable to encroach upon individual freedoms. In this respect, determination of the frontier between legal surveillance and illegal actions, such as the monitoring of personal communications, is no easy matter and requires international consultations at an early date.

III.7 New Information and Communication Technologies and New Social Ties

The new information and communication technologies have abolished barriers of space and time and turned the world into a “planetary village” where information and communication circulate at the speed of light. The NTICs have resulted in the emergency of an open, decentralized, personalized, interactive and dematerialized communication forum, which gives the citizen a new space of freedom while posing a threat to individual freedoms and cultural identities.

The appearance of NTICs in our daily lives and at all stages of life lies at the origin of new products and new services: teleteaching, teleworking, telemedicine, electronic commerce and teleleisure. Then there are new professions, new services and new activities, which are factors of new economic and social challenges. For example, the impact of the Internet is increasingly apparent on the social fabric, which it modifies and remodels in depth. Society will have to adjust to this new situation. A long road remains to be covered to bring about an evolution of mentalities and pass from information to knowledge and from communication to understanding.

Today, with television, the emergence of new information and communication technologies and satellites, man is also endowed with a telepresence: this happens through different means of sensation and perception than those enjoyed by his immediate ancestors. We must therefore examine the new kind of human being who is being created and the new relations that will emerge. Globalization of trade and respect for socio-cultural identities are at one and the same time a consequence and a perspective of the NTICs. At the economic level, the information society permits a reorganization of professional activities, a new industrial strategy, new relations between customers and companies or services, especially in the context of electronic commerce. At sociological level, the habitual hierarchies and purely operational relations linked to professional life are progressively being replaced by a new relational system between the authorities and economic players.

III.8 Training in Mediation

Decisions concerning space programmes are taken by a handful of politicians, heads of major public agencies and engineers. A problem of the democratic deficit therefore arises. This deficit must be filled by putting in place an enlightened democratic dialogue involving experts, scientists, political decision-makers and citizens. That dialogue may take the form of public debates organized to permit active public participation.

Steps must be taken to ensure adequate scientific training of the media to avoid any risk of disinformation or propagation of superficial or even erroneous information. This training might be envisaged through the institutionalization of an international training structure of the scientific journalists. Moreover a function of training for the media might be performed by space agencies, just as scientific mediators may be trained through the services of an international training centre.

It is essential for the scientific and industrial world to organize this mediation training to enable people to live harmoniously with space policy. The aim must be to put man back at the heart of the debate by ensuring that he has in his possession all the elements necessary for a space culture.

IV RECOMMENDATIONS

After identifying a number of problems or questions relating to the ethics of science and space technologies, our Working Group proposes several recommendations to COMEST which may, as appropriate, use our work as the basis for defining guiding principles for the development and use of space technologies.

IV.1 SPACE AS AN ETHICAL ISSUE

Elaboration of Ethical Norms:

- If ethical considerations must help to resolve conflicts that are liable to occur from applications of space technologies, criteria or norms must be established to support the relevant arguments.
- Ethics must precede and guide the law and not vice versa. Ethics represents a permanent movement, which is destined to enlighten regulations.
- Space activities require a precise legal framework subtended by an ethic, which is designed and clearly accepted by all players in the field. For instance, within the United Nations system, general principles must be drafted and adopted in respect of the legal concept of the launcher country and the status of low orbits.
- But even before this, most countries should ratify the legal instruments that already exist in the space sector to enable them to be brought into force.
- The ethical principles should be applied to every phase of development of the space instrument and they should underlie the strategic plans of the space agencies.
- Where appropriate, the establishment of an ethical code should flow from international consultation to harmonize practices and possible legislation in order to avoid the proliferation of norms specific to each country.
- To avoid any shadow zone and permit better understanding and the support of public opinion, the greatest possible clarity and independence must be ensured in putting forward motivations which, regardless of their foundations, underlie decisions on space programmes. This presupposes genuine transparency on the part of the space agencies and governments which take the decisions and also of the media which are their relays in society.
- Definition of the basis of a space culture has become imperative today.

IV.2 SPACE AS A DIMENSION

- Space as a factor of enlargement of knowledge presupposes the absence of any obstacle to observation of the Universe by astrophysicists, especially the barrier created by electromagnetic pollution.
- To allow scientific work to be pursued under sound conditions, space must be the subject of special protection.
- Space should be proclaimed a scientific territory available to mankind.

Allocation of Resources:

- Principles must be defined. They should result from the balance to be struck between the general interest of mankind and the particular interest of the various players involved.
- The notion of equity should apply to the distribution of resources to alleviate the competition engendered between different scientific disciplines.

IV.3 SPACE AS AN INSTRUMENT

Limitation of Pollution Generated by Space Activities: Space Debris:

- With a view to limitation of pollution induced by space activities, preventive measures in respect of space debris should be defined and imposed uniformly on all users of space technology to avoid the risks of distortion of competition.
- These preventive measures should be entered in international law.
- The elaboration of an international legal instrument is a matter of priority.
- The notion of space debris should be the subject of a detailed definition.
- The creation of ethical and juridical frameworks presupposes the development of a symbiosis between scientists, lawyers and ethical committees.

Access to Data:

- Environmental data should be made available to the least prosperous countries. Giving them access is a vital feature of their development.
- Legislation should be developed to regulate access and use of data processed by satellites.
- In the event of natural disasters, the rapid and quasi-free circulation of information must be possible without reference to other more commercial activities by analogy with the procedure in meteorology where, although meteorological data has a commercial value, the different weather forecasting services worldwide permanently exchange on a daily basis their global observation data on the terrestrial environment.

Space and the Environment:

- In the short term, space technology must enable a system for management of the global environment to be set up.
- The establishment of a permanent source of knowledge based on observation of the planetary environment should be a major objective for the space nations.
- In the long run, the intervention of space technology could help to rid the Earth's surface of the most dangerous waste material generated by human activity, in particular nuclear waste by putting this material in a circum-solar orbit where storage capacity is unlimited. Nevertheless this implies the attainment of conditions of absolute safety.

Protection of Public Freedoms and Cultural Identities:

- Satellite broadcasting must be sufficiently diverse to enable minority cultures to express themselves by reaching the populations concerned wherever they may be.
- A balance must be struck between the maintenance of cultural identities, which already exist and the appearance of new identities created by electronic forums.

- We must make sure that the phenomenon of globalization does not lead to the standardization of cultures.
- This circulation of information technologies at world level must guarantee respect for cultural identities and freedom of expression.

Electronic Surveillance:

- Since electronic surveillance is inevitable, management and control of data must be regulated while protecting the confidentiality of information and individuals.
- Legislation on access and use of data processed by satellite should be developed.
- The techniques of space communication must not be used to circulate subversive messages or pursue unlawful activities.

Commercial and Industrial Exploitation of Space:

- The use of data flowing from the development of forecasting capacities must be managed in such a way that inequalities do not widen and coercitive economic practices are not allowed to emerge.
- It is essential to avoid the adoption of a reproving attitude towards commercial and industrial use of space. As long as private funds are used, a commercial logic is justified.
- The advantages specific to space systems must be preserved and care taken, when defining ethical standards, to weigh up their consequences for the different systems and different players.
- The question of commercial practices should be considered in the framework of commercial discussions between countries and in the World Trade Organization (WTO).

Acquisition and Protection of Space Data:

- To benefit from the same rights and opportunities, all countries should have access to space data; at the very least a distinction in respect of the cost of access to data might be made as a function of the use that the countries intend to make of it.
- A distinction might also be drawn between three types of data produced by space missions:
    - data with a scientific character which belong to the sphere of fundamental research and must be accessible to researchers and university staff in every country.
    - environmental data which should be placed at the disposal of the less-favoured countries for which access to such data is a major contributory factor to balanced development. In this regard, the practice followed by Eumetsat towards non-member countries, which are expected to pay for data if they are rich but enjoy free access if they are poor, could also apply to environmental data.
    - commercial data in the strict sense of the term (telecommunications), which might alone be governed by a strictly “commercial logic”.

- Although outer space is the shared territory of mankind, space technologies and expertise must be eligible for protection of intellectual property.
- The desirability of drawing up European or international law on space matters must be envisaged, notably in the field of protection of intellectual property in on-board equipment which is currently governed by the legal provisions of a single country.
- However, there is no need to define specific rules for space relating to the protection of intellectual property since the same rules of intellectual property might be applied to space as are applicable to other forms of creation.

IV.4 SPACE AS A PERCEPTION

Risk Management:

- An independent authority is needed to protect safety; this implies a separation between safeguard instruments and those used to apply the technology involved.
- At the risk of prejudicing the immediate development of the space industry, we cannot afford to wait for damage to occur before placing limits on the use of knowledge: a long-term development policy must be adopted, based on a proportionate precautionary principle.
- The management of risks in relation to society implies not only allowance for the subjective nature of the risk but also its demystification by keeping the public informed of the real risks and establishing a clear and transparent dialogue between society and the different players in space activities to avoid all shadow zones.
- Supranational bodies must be identified with authority to propose rules for balanced risk management and assure monitoring and effective application, notably for protection of the space environment.
- This risk management must also be translated into legal terms at the same time, however, avoiding the risk of over-regulation. Public opinion must be reassured by stressing the notion of responsibility, which must apply in this area.
- Where damage is caused by space vehicle, the possibility of unlimited liability should be envisaged.

Communication:

- An ethic of information on aspects of space exploration must be developed in the media.
- Specifications might be envisaged for information about space policy.
- Adequate scientific training must be ensured for journalists to avoid all disinformation. That being so, the space agencies might have a pedagogical role in relation to the media.
- It would be desirable to give the general public better information on space activities. Good information for the public can help to legitimize space exploration.

- Information alone is not enough. Public opinion must be able to understand. Therefore an adequate basic scientific culture must be created to enable the public at large to understand the aims and challenges, as well as the risks of space exploration.
- Programmes to train trainers and scientific mediators should be drawn up and assured by specialized international institutions.
- Better understanding and support by the public could be developed through public debates or hybrid forums bringing together experts, scientists and citizens.
- All these communication efforts must lead to the development of a "**Culture of Space"** based on the training in mediation which has become imperative today.

CONCLUSION

Outer space is part of the shared heritage of mankind and as such its exploration and exploitation must be freely accessible for the benefit of all mankind.

The ethical approach to space is a moral principle for action, with due attention to the risks involved and recognition of the rights of others. It must be founded on a new strategy of communication. As part of that strategy, it is imperative to leave room for a dream, as a source of creative imagination and to give fiction its rightful place, while bearing in mind the reality of the future of space policy for the benefit of all mankind.

The work undertaken by the Working Group on the Ethics of Outer Space has enabled ethical problems which arise in this matter to be identified. This report is no more than a preliminary phase. The Group will be submitting its conclusions to COMEST which will then have the task of defining the basis of the **Ethics of Space** as a first stage to worldwide consultations.

Paris, 23 December 1999

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ABBREVIATIONS

CNAM	Conservatoire national des arts et métiers *(French National Conservatory of Arts and Crafts)*
CNES	Centre national d'études spatiales *(French National Space Research Centre)*
CNRS	Centre national de la recherche scientifique *(French National Scientific Research Centre)*
COMEST	World Commission on the Ethics of Scientific Knowledge and Technology
COPUOS	Committee on the Peaceful Use of Outer Space
ESA	European Space Agency
EUMETSAT	European Organization for Meteorological Satellites
GLONASS	Global Navigation Satellite
GPS	Global Positioning System
IBC	International Bioethics Committee
ITU	International Telecommunications Union
NASA	National Aeronautics and Space Administration
NTIC	New Technologies of Information and Communication
UNESCO	United Nations Educational, Scientific and Cultural Organization

GLOSSARY

Ariane: European space launcher.

Astronaut: Occupant of a space vessel.

Atmosphere: The gaseous envelope surrounding a planet or natural satellite.

Common heritage of mankind: A formula for the internationalization of certain spaces, justified by their interest for mankind in its entirety. This term is used for the seabed, outer space and even the Antarctic. Its purpose is to avoid national appropriation.

COPUOS (Committee on the Peaceful Uses of Outer Space): Created in 1959 by the United Nations General Assembly, one of the main international agencies within which legal norms destined to regulate the peaceful uses of space are drawn up. It has two sub-committees, one scientific and the other legal, which work either in plenary session or in working groups devoted to specific subjects based on proposals made by a State or group of States. The annual report forwarded to it by each of the sub-committees is used as a basis for its proposals to the United Nations General Assembly. This may also adopt recommendations or resolutions containing texts of international conventions laid open for signature by the States.

Cosmonaut: Occupant of a space vehicle in the former USSR.

COSPAR (Committee on Space Research): Committee created in 1958 within the International Council of Scientific Unions to promote, at international level, the progress of all kinds of scientific research using rockets, satellites and balloons.

Data gathering (by satellite): Technique using artificial satellites to bring together, in a matter of hours and perhaps in a single place, a considerable volume of information taken from a large number of sites in geographically dispersed locations.

EUMETSAT (European Organization for Meteorological Satellites): Intergovernmental agency officially set up on 19 June 1986 by sixteen European States and their meteorological services. Its main objective is to put in place, maintain and operate European operational meteorological satellite systems having regard, as far as possible, to the recommendations of the World Meteorological Organization.

European Space Agency (ESA): The European Space Organization which ensures and develops for exclusively peaceful purposes co-operation between the European States in the field of research and technology of space and their spatial applications, with a view to their use for scientific purposes and for applied operational space systems.

Galaxy: Vast group of stars, dust and interstellar gas whose cohesion is ensured by gravitation. The galaxy in which the solar system is located is a flattened disk with a diameter of around 100,000 light years and a thickness of 5,000 light years with a big central swelling known as the bulb.

Tens of thousands of galaxies are known today and they are regarded as the fundamental constituent of the Universe. They are classed in three major categories depending on their shape: elliptical, spiral (striated or not) and irregular. Finer sub-divisions in each category characterize their morphological type.

Geostationary orbit: Situated on the equator at an altitude of around 35,800 km. With a circumference of 270,000 km it can only accommodate a limited number of satellites. Satellites launched on this orbit maintain a fixed position in relation to the surface of the Earth, their period of revolution around the centre of the planet being the same as that of the Earth. Because of its altitude a satellite can, on its own, cover one third of the Earth's surface.

GLONASS (Global Navigation Satellite): System of satellite navigation developed in the 70s by the Ministry of Defence of the USSR and then of the Russian Federation. It consists of a constellation of 24 satellites distributed on 3 orbital planes inclined at 65° at an altitude of 19,000 km above the Earth. It uses two frequency bands, one reserved for the armed forces and the other intended for both civilian and military applications.

GPS (Global Positioning System): Positioning system designed and managed by the US Ministry of Defence (DOD) based on a constellation of 24 satellites distributed on four orbital planes inclined at 55° and situated at 20,000 km above the Earth. It emits two coded signals, one reserved for the US Armed Forces and the other freely accessible to civilians without charge.

Internet: The "network of networks" initially destined for the purposes of exchange and communication between army, research and university centres. The Internet is a worldwide network of servers such as computers capable of exchanging vast quantities of information.

Ionosphere: Zone in the high atmosphere of a planet characterized by the presence of charged particles (electrons and ions), formed by photo-ionization under the effect of solar radiation.

Launch pad: A zone on which the equipment needed for final preparation and launch of a space vehicle is brought together.

Launcher: This term designates any propulsion system capable of placing an object in orbit around the Earth or beyond.

MIR: The MIR orbital complex consists of a basic block or inhabited module placed in orbit by the Soviet Union in 1986 and specialized modules (Qvant, Qvant 2, Kristall). The Soyuz capsule transports crews between the Earth and MIR, while freight is carried by the Progress capsule, which removes waste for burning in the atmosphere. In Russian, MIR has two meanings: the globe and peace.

Orbit: Trajectory followed by an object in space. In a first approximation the orbit is defined in relation to the nearest space body with the greatest mass (for example the Earth, the Moon or the Sun). The orbit is then conical, more often than not closed (ellipse), sometimes open (parabola or hyperbola) if sufficient kinetic energy has been transmitted to the object.

Probe: An unmanned vehicle launched outside the earth’s atmosphere and designed to study a body in the solar system or interplanetary space.

Satellite: A vehicle placed in orbit around the Earth or any other celestial body by a space transport system (rocket, shuttle).

Shuttle: An inhabited space vehicle fitted with wings and capable of horizontal landing; reusable for several successive missions.

Software: Set of programs, processes, rules, and documentation, relating to the operation of an information processing system.

Solar system: The Sun and the stars gravitating around it.

Space:
1. Zone located beyond the part of the terrestrial atmosphere in which aircraft may fly (in international law, reference is made to outer space as opposed to air space);
2. All the industrial activities relating to this field.

Space (or orbital) debris: Solid waste material of artificial origin gravitating around the Earth.

Space cartography: Mapping on the basis of data collected by space vehicle supplemented by other information.

Space station: This term currently designates any inhabitable system placed in orbit around the Earth and visited by successive crews for stays of varying duration using a specific means of specific transport (capsule or shuttle).

Space vehicle: Object of human manufacture situated in space or intended for launch into space

Stage: Independent and separable part of a space vehicle generally equipped with a means of propulsion and designed to perform certain functions during a given phase of flight.

Stratosphere: The part of the atmosphere situated between the troposphere and the mesosphere with a thickness of 30 km, in which the temperature rises only slightly.

ADDITIONAL DOCUMENTS

1. List of members of the Working Group of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) on the "Ethics of Outer Space"

2. Contributions by the members of the Working Group

3. Reports of the meetings of the Working Group

4. Final report of the UNESCO-ESA Seminar on the "Ethics of Outer Space"

5. Summary record of the Seminar on the "Ethics of Outer Space".

ADDITIONAL DOCUMENT I

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ADDITIONAL DOCUMENT II

CONTRIBUTIONS BY THE MEMBERS OF THE WORKING GROUP OF THE WORLD COMMISSION ON THE ETHICS OF SCIENTIFIC KNOWLEDGE AND TECHNOLOGY (COMEST) ON "THE ETHICS OF OUTER SPACE"

THE DEVELOPMENT OF SCIENCE AND SPACE TECHNOLOGY

by Mr Jean Audouze (France)
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Access to space has brought about an unprecedented scientific revolution in astronomy and related fields. Not only did Man walk on the Moon in July 1969, thus confirming the dreams of Cyrano de Bergerac, Jules Verne and others, but he can now "contemplate" the sky in every wavelength from the weakest radio waves to radiation in the gamma wavelengths. Nor can we overlook his increased ability to receive cosmic rays and the future possibility (2017-2020) of detecting gravitational waves emitted during the formation of neutron stars and black holes in galaxies outside our own (under the LISA project of the European Space Agency). Among the most spectacular astronomical space missions, we might mention:

(i) the Hubble space telescope which, despite its three-year (1990-1993) astigmatism has, for more than seven years, been given us the best pictures yet of the near and especially the far regions of the Universe;

(ii) the Voyager I and II programmes which, between 1979 and 1989, explored the as yet unknown world of the giant planets from Jupiter to Neptune and, of course, the entire series of flights in which several American astronauts went to the Moon from July 1969 onwards and brought back many soil samples.

From space, it is now possible to study many aspects of the Earth with a degree of precision never achieved by other techniques. These aspects include the analysis of the characteristics of its ionosphere, meteorological missions that allow an unprecedented tracking of climates and their development, the study of the oceans and their interactions with the atmosphere (in the Franco-American Topex-Poseidon mission), infrared observation of the earth's surface - soils, modifications of plant cover and urban built-up areas - through the Spot-Image programmes etc.. It is satellite observations that brought to light the famous "hole in the ozone layer " in the stratosphere over the South Pole and led to steps at the international level to prohibit chlorofluorocarbon (CFC) emissions. The military programs of the great powers include of course satellites and space missions dedicated to monitoring events on Earth. The telecommunications revolution (covering telephone, television, Internet) owes a great deal to the array of satellites dedicated to the remote transmission of information. In addition, the major laws of physics such as those pertaining to relativity, the slowing down of time at speeds close to that of light, the curvature of space-time and the principles of the equivalence of gravity can henceforth be verified by means of space techniques.

Space stations (and satellites dedicated to these studies) make it possible to create the conditions of weightlessness. Two branches of science are drawing benefit from these features: certain laboratories are developing experiments in crystallography and solid state physics in the absence of gravity (crystal growth etc.), but it is above all doctors and biologists who are studying the behaviour of living beings (plant, animal or human) in these environments. These studies on plants and animals as well as on human beings, conducted with the active collaboration of astronauts on Russian and American spaceships, have made it possible especially to test the behaviour of living matter in weightlessness and, correlatively, to determine the role of gravity in the fundamental biological processes with greater precision.

Science has thus undergone an upheaval through access to space. This is also the case for technology where engineers and industrialists have achieved extraordinary progress in terms of the reliability of the equipment they install in satellites and other spaceships, the miniaturisation of their devices as well as every aspect related to data-processing and the development of increasingly complex and powerful software.

In spite of, or because of, these splendid achievements which not only increase our knowledge of the Universe but are also of benefit with respect to far more immediate concerns (such as meteorology, telecommunications etc.), there is no lack of ethical questions and concerns. We might mention some of the most important and most obvious of these concerns:

1. Space programs are a part of “heavy science” which mobilises colossal budgets, accessible only to the wealthiest countries. “The Utopia of the Future” (observation posts and scientific stations on the Moon, manned flights to Mars and more distant planets, second or third generation scientific space expeditions) will be even more expensive, even if NASA wishes to put up more modest missions according to the principle of “better, quicker, cheaper” alongside the huge operations that it has undertaken. Indeed, NASA wants to create an opening in which motivated users can develop highly target-oriented, shorter-term projects in which higher risks may be accepted as regards the reliability of the installed equipment.

Owing to the technological complexity and cost of most of these missions, access to space raises the same type of ethical problems as those encountered in energy production and consumption. To illustrate this observation, it may be recalled that, in both cases, care must be taken to establish a more equitable situation among all those whose appointed task is to implement these programmes. In both these fields, all the risks need to be taken into account and assessed in all their aspects. The duty to carry out research and achieve increases in profitability by adopting approaches that are as economical as possible in terms of human and material resources is also an imperative along with the need to provide more and better information on these matters to all the sections of the public.

As regards space science and technology, these observations immediately bring three concerns to mind:

a) the budgetary balance to be maintained between space and other fields;

b) the possibility for scientists and technicians from under-privileged countries to join these missions free of charge;

c) free access to the data on space relating, for example, to the protection of the environment, education and the dissemination of culture to financially deprived countries and communities.

It is indeed possible to distinguish between three types of data produced by these space missions:

a) data forming a part of fundamental research that must be accessible to researchers and university staff from all countries,

b) environmental data which the countries of the North should place at the disposal of under-privileged countries for whom access to this data is a major factor in their balance and development (for example data for drought-forecasting),

c) commercial data in the strict sense of the word (telecommunications etc.) which for its part (and its part alone) could be governed by a “business-oriented” logic.

2. Programmes entailing a human presence in space must be decided upon and assessed in the light of their scientific and/or technological value. They must be compared with the more modest “automatic” missions pursuing the same goals. At the celebrations last July of the 30th anniversary of Man’s landing on the Moon, it could be seen that the Apollo programme had played a role in the unrestrained competition between the USA and the USSR. From this point of view, the Mars mission, which the United States wants, seems to form part of a corresponding logic. The use of science as a pretext for this type of mission in which the only real issue at stake is the supremacy of a superpower, raises a genuine ethical problem.

3. Space can thus be seen as a “scientific territory” that must remain at the disposal of humanity as a whole. It is thus that its “inalienable character” must be proclaimed and that international laws must guarantee its protection against all kinds of pollution (from equipment, electromagnetic pollution etc.) and ensure free access.

4. Operators with access to space are able to penetrate “the private sphere” of the citizen in an uncontrolled manner. These intrusions must be prohibited or, at the very least, regulated.

In short, while the scientific and technological advances made in the field of space cannot be disputed, there are many political, social, and even philosophical - hence ethical - problems that must be faced and must lead to the preliminary analyses and debates needed to resolve them.

USE OF SPACE TECHNOLOGY

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INTRODUCTION

This paper seeks to raise issues in a number of areas concerning space technologies, where the ethical exploitation of current and future capability may be of concern. It also briefly considers the impact in three areas - on the environment, the economy and the consequences of military use.

The ethical discussion is stated repeatedly in all the United Nations Organization traditional principles on space.

I ENVIRONMENT IMPACT

As mankind has achieved the capability to access space, it has also started to pollute that environment. This pollution includes debris from previous launchers and failed missions, the presence of which may threaten the success of future missions; it also includes expended satellites in Earth’s orbit and the debris from missions - both manned and unmanned - sent to other planets and into deep space.

The subject of space debris in Earth’s orbit has received growing attention just recently, from a simple technical view, with respect to managing the volume of debris in the Earth’s orbit, in order to protect unmanned flying systems and manned missions. This becomes a particularly important matter as we move further towards the completion and eventual use of the International Space Station.

There has also been a growing awareness with respect to the need for some kind of harmonisation of practices, or regulation. This could be a code of practice to which all those involved - space agencies or industry - subscribe. As the debris from future missions increases there is an increasing need for the assessment, and a management of this debris. The extent of any adverse effects from the intrusion into other environments also requires international discussion.

As mankind seeks to explore deeper into the Universe, the requirement for self-contained power systems becomes more urgent. While we deal with the problem of the limited use of nuclear power in space missions, we should also ask whether it is the only viable alternative, and whether perhaps there is a more environmentally friendly and less dangerous source of power.

The recent controversy over the use of nuclear power units for deep space missions, both in terms of risk to the Earth on launch, or the risk of damage to the space environment during the mission, is evidence of the ongoing ethical debate. This debate should be an open one, including all the appropriate bodies, space agencies, industry and other interested parties. It should analyse and consider potential risks, the management of risks and consequences of this activity.

It should also be remembered that applications benefiting some members of society, impact adversely upon others. For example, use of the radio spectrum for communications and Earth observations may interfere with the needs of astronomers to observe the Universe.

II ECONOMIC IMPACT

As with the debate surrounding the development of nuclear weapons we are confronted with the question of a country's genuine need for technological development, and a company's need for revenues. Where is the line drawn? How can other nations (particularly those that are less well developed) participate in these developments when in some countries these industries have been created by government investment? Such industries have created applications that have a global impact which is either directly commercial, such as telecommunications, or indirectly through Earth observation. The questions are many.

Can the economic benefits of communication systems be shared rationally between the owners and the users of the infrastructure? How much control over content and services should be a country have over intrusive networks? It is the same as the nuclear dilemma. While the international community must guarantee the rights of a nation, more and more of those nations are being subsumed into wider supranational entities where the rights of single countries disappear within those of the larger community. It is these supranational bodies which are better suited to solve the problem and guarantee the interests of single nations.

This control of access to space by a small number of countries affects the ability of other countries to participate. Is the launch services business now so commercial that the question is simply one of wider economic development?

Earth observation applications raise the question of ownership of information, as well as intrusion (passive for optical systems, active for radar systems). If a commercial system identifies that a crop is failing in a particular country, who owns this information - those who observe it first, the country, the owner of the crop….?

III THE MILITARY DIMENSION

International treaties related to space generally refer to concepts such as “the common interest of all mankind” and the “use of outer space for peaceful use”. However, most space-based applications have the potential to be used for both civil and military purposes, “dual use” The military uses can be offensive or defensive. Increasingly, systems produced for military use produce an increasing dependence on their commercial applications. This issue becomes critical if there is a risk of a nation in some way being denied dependency on these systems. While technology should benefit from military technology's dual use, its reduced development costs and production, it may be that there has to be a complete separation between the “utilization” of the technology itself taking into account the different user needs that it has to serve, and its military side.

In the dual use context, Earth observation becomes surveillance. Satellite communications facilitate the projection of force beyond national boundaries. These same technologies enable the deployment of intelligence systems. Positioning systems (GPS and Glonass) were developed for military use and give commanding advantage to their owners. However, the availability of their signal to civilian users has lead to the increasing dependence of commercial applications important to civil society, upon these military systems. In what circumstances should be the owners of these systems deny their use to others? Space can support weapons systems, or the capability to disable terrestrial weapons systems. Is it the role of the United Nations Organization to consider and to police such use of space?

CONCLUSION

The space community is aware of the complexity of these issues, but it is doubtful as to how such consideration can be given to them when a space project is started, whether it be by public or private finance. Deciding how we do this is the new challenge which confronts us.

Man in Space

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This topic comprises aspects from anthropology, cultural history, ethics and a number of other disciplines. In the following, those aspects will be emphasized which are of particular relevance for the consideration of ethical questions and which have been pointed out by critics of manned space flight. Thus, the topic will be dealt with in a dialectic rather than in an encyclopaedic way.

1 The Spatial Limits of Human Action

Critics of manned space flight consider the boundaries of the earth to be the limits of human action at the same time. In other words, the atmosphere is seen as the skin of the human living space. The main argument supporting this view is the supposed hostility of space to human being. Furthermore, anthropological-structural or religious arguments are used to underline that humans are not supposed to be in space, as if they were intruding into a holy area.

These arguments are basically untenable. On formal grounds, they are caught up in a naturalistic fallacy because they try to derive prescriptions from (supposedly correct) descriptions (of the human). In their substance, these arguments are in part too strong since many areas of the earth itself are in some sense hostile to human being, and in part too weak because technical evolutions allow us to cope with this hostility. The refutation of these arguments does not imply, however, that every possible action of humans in space is morally legitimate. Rather, a differentiated argumentation is necessary just because the fundamental objections do not hold.

2 The Exploration of Space

With regards to the question of the purpose of manned space flight, it is important not to engage straightforwardly in cost-benefit-considerations. The interest of humans in exploring their environment is not oriented towards utility in a narrow sense, but is rather something like a basis cultural need. This need is not a merely scientific interest, but a general cultural achievement. Seen in this way, space flight stands in the continuity of the famous explorations and discoveries of the 19th and 20th centuries.

The interest in exploring the human living space does not only refer to the space of human perceptions but also to the space of human actions. The exploration of space also implies the possibility of inspecting and settling it (at least temporarily).

The results of such explorations are, despite the interest of the explorers of utilizing them, general human cultural achievements, which, in principle, should be available to all nations.

3 The Scientific Research of Space

The interest in the scientific research of space is made possible by exploration of space, but is not an inevitable consequence. Beyond exploration, the scientific research of space consists in the methodical organisation of cognition with a high technical effort. Scientific research is a trans-utilitarian purpose, even though there is a closer connection to an expected utility than in the case of exploration.

Scientific research is subject to its own societal rules. Claims of priority or copyrights of researchers are to be acknowledged, for example. To that extent, a primary claim on the utilization of knowledge is due to the institutions and individuals carrying out the research. However, the main goal of scientific research is common availability by publication, such that, in principle, all humans and nations have equal chances to access this knowledge.

4 The Commercial Utilization of Space

In the following, the commercial utilization of space stands as a representative for all utilitarian purposes of space flight. In principle, it is morally legitimate that commercial utilizations of space are limited to those who make the necessary investments. However, limitations of the commercial utilization are conceivable with regards to environmental protection, such as they have been agreed upon in the international treaty on the Antartic.

Since problems such as the treatment of space debris, the avoidance of pollution of space, the protection against dangers of, i.e., nuclear propulsion systems, the establishment and maintenance of emergency systems and others cannot reasonably be solved by individual parties, an international space convention is desirable. The basic features of such a convention should be formulated by the Working Group.

MANNED SPACE FLIGHT AS A CULTURAL MISSION

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In the current discussion with regard to the pros and cons of space flight, the benefit of *unmanned* space flight appears to be widely undisputed. Not each individual project but the technological option as such could well be the sole highly developed technology - apart from computer technology – which does not attract any strong societal opposition. The decisive reason for this general acceptance is to be found in the obvious benefit of unmanned space flight, which even extends to highly respected areas such as the transmission of educational programmes for the Third World or Earth observation in the service of environmental protection. In the shadow of attention of such undisputed economically and socially productive areas, some ventures, which are less benefit-oriented, such as the dispatch of space probes for purely scientific purposes meet with no appreciable levels of protest either.

For the discussion with regard to manning, however, the economic and social success of *unmanned* space is proving to be fatal. As it happens, manned space flight is consequently being caught up in a type of “argumentative whirlpool” which is culminating in the demand that manned space flight must at least in the long-term meet the same criteria for success as unmanned space flight. Criteria, by the way, which unmanned space flight would have failed to meet in the early phase of its development. As a result of this demand the discussion with regard to manning, especially in Germany, is proceeding solely along the lines of cost-benefit analyses.[1] Benefit here is understood as being either direct or at least indirect; scientific insights, for example, are viewed primarily in consideration of what must be at least indirect economic benefit, an approach which many scientist also favour themselves.

As a result of this orientation along the lines of (surplus) benefit, the opponents of manning feel they have an easy game to play with regard to their position. They are convinced that the functions of man in space can be compensated (at least with time) by unmanned space flights, maybe even over-compensated (“Man as an Interference Facto”). Consequently they declare manned space flight as superfluous because it generates high costs which outweigh the identifiable benefits. This is stated with the unmistakable undertone that other scientific or social projects are being deprived of these funds[2]. Incidentally, many proponents of manned space flight – especially in Germany – are also influenced by this argumentative whirlpool. Namely by searching for holes and uncertainties in the arguments of their opponents they already recognise the basic pre-suppositions of cost-benefit analysis.

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1. Cf. Deutsche Physikalische Gesellschaft (Publ.): Entschließung; *Der Spiegel*: “Milliarden für Schrott im All”; J. Weyer: “Subventionsruinen im erdnahen Orbit”.

2. Cf. Deutsche Physikalische Gesellschaft (Publ.): *Entschließung*; E. Keppler: “Keine neue Raumfahrt-Ideologie, bitte”; H. Krupp & J. Weyer: “Die gesellschaftliche Konstruktion einer neuen Technik”.

The “utilitarian” approach – as should be said in anticipation of terminology to be introduced in the following – clearly distinguishes the debate in the Federal Republic of Germany from the justification patterns used within the framework of American and Soviet, but also, for example of French discussions. In the above, altogether functional complexes are considered as self-evident, “non-utilitarian” points of view - such as international co-operation, national identity, human discovery, conception of the world function, colonisation etc. - even though this does not mean they are unproblematic in the least[3]. These discussion frameworks, which vary greatly internationally, are sufficient reason to also include in the discussion and to critically examine the “non-utilitarian purposes” of manned space flight.

For reason of the extremely varied patterns of argumentation alone, it is not intended to describe the pros and cons in detail here[4]. On the contrary, in the following it is intended to expose and examine the implicit pre-suppositions and premises shared by the opponents but also by many proponents of manned space flight in Germany. They express themselves in the conviction that man only has a place in space if this can be justified by a direct, or at least indirect, surplus of benefits. Therefore, any non-directly “utilitarian” – i.e. specifically *cultural* – mission on the part of man in connection with manning will implicitly not be recognised.

It is one of the tasks of philosophy to uncover implicit premises and pre-suppositions of this kind and to examine them with regard to their ability to be universalised. In traditional terms, this is the way of introducing reason into the discourse. In doing so, philosophical reconstruction and criticism must, above all, concentrate in the given context on two subject areas: on the one hand, on a cultural understanding which includes the trans-utilitarian purposes, and on the other, on the critical discussion with regard to an ethos of self-restraint, which is often the reason behind the position rejecting manned space flight. These are the topics which often give cause for emphatic enthusiasm or polemic complaint as part of the public debate. In contrast to this, it is philosophy’s contribution to process problems of this kind using the analytical sharpness of abstract reconstruction and stringent argumentation - a task which cannot be accomplished using coloured pictures or other types of entertainment. On the contrary, what is an effort of understanding in order to move closer to a rational debate.

1 Trans-utilitarian Purposes of Technological Activity.

Sometimes in connection with (manned) space flight – as in other contexts of technology assessment – the expressions “costs” and “benefits” are used in a colloquially broad and unclear sense and sometimes in a sense which is terminologically standardised. Whilst the colloquial notion of benefit also encompasses “trans-utilitarian” expedience, the standardised concept of benefit use in economics relates exclusively to “utilitarian advantages”. This ambiguity in terms is the reason for a whole series of misunderstandings and apparent problems in the

3. Cf. amongst others, Committee on Space Policy: “Towards a new era in space”; W. Gluschko: *Die sowjetische Raumfahrt*; M. Harrison: “Has Manned Space Flight a Future?”; A. Ladwig: “U.S. Space Leadership”; National Commission on Space: *Pioneering the space frontier*.

4. A detailed analysis of the discourse with regard to manned space flight was conducted in: Deutsche Forschungsanstalt für Luft- und Raumfahrt e.V. (Publ.): SAPHIR. Technikfolgenbeurteilung der bemannten Raumfahrt. See also C.F.Gethmann, P. Janich & H. Sax: “Bemannte Raumfahrt im Widerstreit”.

current debate on manned space flight. In order to avoid these, a terminological framework should first be formulated, within which a rough differentiation between various notions pertaining to benefit is possible[5].

A "pragmatic terminology" of this kind is of course not neutral, relative to all philosophical positions within the theory of actions. Consequently, the terminology suggested in the following determines a *finalistic* interpretation from the very outset: In the context of technology assessment it must be assumed namely that people act in order to reach certain ends. If, in contrast, one were to assume that man brings forth technical instruments quasi-naturally, just as ants build their anthill (*causalistic* understanding of action), there would be nothing more to evaluate with regard to the consequences of technological activities. At least not in the sense that evaluation could be based on considerations concerning the choice of options.

In this connection a *purpose* is understood as a condition which is planned as a consequence (of consequences). The *consequence* (of an action) is the condition, which arises as (supposed) effect, if the action is reconstructed as the cause. *Objectives* are those attributes of a purpose, which allow the purpose to appear to be a desired condition. We understand the *means* to be an action, which must supposedly be carried out so that the purpose results as its consequence (of consequences). It is possible to speak of a *higher (or lesser) purpose* because a purpose can in turn be the basis for another purpose; the action performed in the framework of any such purpose is in turn a means. *Goods* (instruments) are those "objects" in the broad sense of the word, which are required for the realisation of means or which are suited for that purpose. Incidentally, the word "technology" is often used equivocally, namely on the one hand to refer to a certain class of means, and on the other to refer to a collection of certain goods (instruments).

One of the fundamental experiences of human life are those that others have the property than one needs oneself in order to employ means to an end or purpose. Goods (instruments) can therefore be scarce, relative to individual or collective need. Accordingly, the institution of barter was invented in all known civilisations. Through barter the subjective evaluations of goods are made comparable, either implicitly or explicitly.

Barter, therefore requires that goods can at least be placed in an ordinal (comparative) relation. The logical conditions for ordinal measurability are inner consistency (i.e. that which is performed in the internal sphere of an agent) and inner transitivity of the subjective exchange values. The employment of goods needed for the exchange determines the costs, whereas the expected yield of goods determines the *benefit* of the corresponding goods.

If a certain type of good is employed as a medium of exchange, one speaks of *money*. One additional logical condition of rationality of money is the linear transformability of the benefit onto a scale so that in the transformation an external (inter-subjective) consistency and transitivity comes about for all agents involved. Any good which is evaluated with regard to its economic benefit or its cost, is referred to as *utilitarian*. In so far as goods show usefulness, which cannot be evaluated as utilitarian, it is possible to speak of trans-utilitarian usefulness.

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5. See here in particular: O. Schwemmer, *Philosophie der Praxis*; C.F. Gethmann, "Proto-Ethik".

In some situations people forgo an achievable benefit, or some objectives are estimated as being de facto non-exchangeable, in some societies the exchange of certain goods is even forbidden in a legal sense. These simple phenomena already show that a terminological equation of purpose and benefit would be inadequate. Whoever consequently had justified that an action brings with it fewer benefits than costs, had in doing so not yet proven this action to be pointless. On the contrary, a trans-utilitarian purpose could even justify this action.

Utilitarian evaluation is a necessary basis for the monetary evaluation of a good; in contrast to this trans-utilitarian evaluation for analytical reasons is necessarily non-monetary . Purposes can be striven for because of utilitarian or trans-utilitarian objectives. Accordingly we should speak of utilitarian and/or trans-utilitarian purposes.

The system of utilitarian and trans-utilitarian purposes and the means allocated thereto, go to make up the *"culture"* of a society in the broadest sense of the word.

A certain form of rationality is established via utilitarian evaluation, namely economic rationality. However, even trans-utilitarian evaluations can be rational, to be precise, if a justified general value can be claimed for them. Economic rationality is therefore, from a terminological point of view, only *one particular species* of rationality whilst the general notion of rationality is determined by the accessibility of argumentation and the argumentative redeemability of varying types of claims for value recognition.

Economic rationality is the leading rationality paradigm in economic and very often also in other social sciences.[6] In this respect, these disciplines are only concerned with what is admittedly an essential yet limited form of rationality. Consequently with regard to the task of technology assessment they only possess limited competence, which essentially ends where the discussion with regard to the justification of trans-utilitarian purposes begins.

If, in contrast, technology assessment is merely related to utilitarian purposes it is possible to speak of an economically reduced technical utilitarianism of the relevant sciences[7]. A broadened technical utilitarianism is to be established particularly in the discussion with regard to manned space flight.

It is a central task of philosophical criticism of technology vis-à-vis technical utilitarianism to indicate the validity of establishing trans-utilitarian purposes and to be aware of or invent forms of rationality for the discursive evaluation thereof. The task of technology ethics is, amongst others, to criticise improper reduction of the purposes under consideration. It fulfils this objective by virtue of its general task of examining the ability to universalise the claims for recognition contained within actual systems for regulating societal actions (morals, ethos). As far as moral systems of this kind function in a manner free from conflict, they are not to be criticised from an

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6. It consequently results that the currently dominating "Technology Assessment", which has its orientation in social science, primarily considers utilitarian evaluational points of view; cf. in this regard: C.F. Gethmann: "Die Ethik technischen Handelns".

7. This utilitarianism is to be differentiated from ethical utilitarianism which is characterised by the fact judgements are to be made with regard to moral obligations within the framework of utilitarian points of view. – With regard to fundamental criticism of technical utilitarianism, also see F. Kambartel: "Ist rationale Ökonomie als empirisch-quantitative Wissenschaft möglich?"; the same: Article "Nutzen".

ethical point of view. Sometimes, however, people pursue purposes which cannot be realised simultaneously. Then the problem arises as to whose set purpose deserves priority - and with what right. In the interest of overcoming (avoiding or eliminating) such conflicts the question is asked as to which rules can make a claim with regard to their ability to be universalised. If one wishes to achieve a maximum level of conflict avoidance the uttermost ability to universalise must be asked for, i.e. validity for all must be striven for. The sole principle of ethics with which it approaches moral systems is therefore a principle of practical universalism ("categorical imperative").

Before this theoretical backdrop it becomes clear that the central task of technology ethics with regard to manned space flight is to critically examine its trans-utilitarian purposes with regard to the ability to universalise the same.

2 On Ethical Criticism of Manned Space Flight

The ethical reconstruction of the actual attempts at justification presented with regard to manned space flight shows that by no means all of the trans-utilitarian purposes meet the requirements of practical universalism. There are definitely justification strategies for manned space flight which are explicitly or implicitly anti-universalistic (particularistic). The following two examples are to substantiate this.

One precise example of particularity is the use of manned space flight for the trans-utilitarian purpose of demonstrating the superiority of one particular societal system. Because the class standpoint is expressly part of the agenda here, it is obvious that this establishment of purpose could potentially generate conflict and is consequently to be ethically rejected. The existence of particularity can also be proven in the purpose of generating and maintaining the political leadership of *one* nation. In so far as the establishment of this trans-utilitarian purpose generates conflict, it is also to be rejected. However, global-political constructions can be found in which the "leadership"-notion can be upheld (cf. comments below on polycentric world order).

These examples show how the method of ethical criticism works. In the *first* step, the trans-utilitarian purposes being striven for are to be reconstructed with regard to their pre-suppositions. In the *second*, the pre-suppositions found are examined along the lines of the principle of practical universalism. In the *third* step, any set purposes which fail because of this principle are to be examined with regard to the manner in which they must be modified in order that they may become acceptable. In certain cases, this is a complicated task, one which consequently demands professionalism from a certain degree of complexity onward. As is true elsewhere in the sciences, it is also true in ethics that insights, which in principle must be comprehensible to all, may in fact demand extensive specialisation and professionalisation .

Two groups of trans-utilitarian purposes – unlike the examples mentioned - are valid vis-à-vis ethical criticism, though they are listed without any claim to completeness. Included in the *first group* are purposes which provide a contribution towards *political culture on earth:* for example, the realisation of a "polycentric world order", "European integration" and contributions towards forming "national identity". The *second group* encompasses those contributions which have the realisation of a cosmic culture/civilisation as their aim; these include "exploration of the Universe" and the extension of man's conception of life brought about by the same, the "improvement of the general technological standard", as well as the "colonisation" of space stations and the planet Mars.

Two of these examples are to be explained in greater detail here, namely the realisation of a polycentric world order and the purpose of colonising space stations and the planet Mars.

(a) The criticism of the establishment of the trans-utilitarian purpose "Leadership in the world by one nation" shows that this cannot be universalised. Which image of international politics – in the sense of a just inner-political world structure – should replace it then? Any such notion is undeniably merely a political "vision", but it is unavoidable that within the framework of considering large-scale technological options their significance for major political structures must also be borne in mind[8].

A "just" world order cannot be held to mean that every nation has the same rank. Justice is not equality but justified inequality. Allow me to clarify this using a comparison from the world of sports: the usual understanding of "leadership" would correspond to an Olympic Games where all sportsmen appear in *one* discipline and one nation is so dominant that only one of *its* sportsmen has the chance of winning the gold medal. In this kind of situation, there would be no more Olympic Games (at best national championships). In actual fact, however, Olympic Games are held with a great number of sporting disciplines. More disciplines in fact than there are nations. Essentially any nation could be awarded a gold medal. Analogous to this it can therefore be observed that, alongside manned space flight, there are also many significant utilitarian and trans-utilitarian large-scale technological undertakings. Therefore it would not be desirable if one nation were to lead in all areas (sectoral plurality).

In addition it is not desirable – for reasons of competition alone – that precisely one nation always assumes leadership in every "discipline". Thus, for example, in sport there are nations which lead in sprinting, fencing, synchronised swimming etc., and mostly several for each discipline, whose sportsmen compete with each other for first place (*structural plurality*).

A polycentric world order is one in which nations compete with each other within the framework of a sectoral and structural plurality. With regard to manned space flight, structural plurality implies that it is not appropriate to have only *one* space flight nation in the world. Currently, alongside the United States of America, it is the European Nations which seem predestined to be a centre for manned space flight due to their economic potential, their technological experience and their attitude towards technological advance.

This argumentation by no means logically indicates that manned space flight does indeed have to be. However, it does hypothetically show that with regard to the purpose it could make good sense to keep space flight as a large-scale technological option. On the other hand the argumentation allows us to see that it is problematic, though of course not out of the question, to reduce the number of disciplines within which nations compete.

Whilst manned space flight represents a possible means of realising a polycentric world order, colonisation represents the sole means for realising the purpose. Regardless of utilitarian points of view (maintenance of unmanned systems, obtaining solar energy in space, etc.) one must ask whether the colonisation of

8. Cf. in this regard in particular: K. Kaiser, S. von Welck (Eds.): *Deutsche Weltraumpolitik*; K. Kaiser: "Eine deutsche Weltraumpolitik für Europa".

artificial or natural space bodies should be viewed as a distant technical purpose. On earth it would at any rate be strange if people were to fundamentally declare certain territories as being untouchable zones. At best there are pragmatic reasons for not colonising certain regions.

The question then arises in this regard as to why the geosphere should represent such a territorial frontier. Here too there could of course be pragmatic reasons for giving up the purpose for colonisation. It could, for example, become obvious that excessively high levels of inescapable cosmic radiation appear to make the project inappropriate. The researching of possible barriers of this kind and the discovery of possibilities to overcome them does, however, make it necessary to conduct manned undertakings to a certain extent.

Criticism of colonisation should therefore also not be permitted using the hostility of space to man as an argument. The earth too would be hostile to a technically inexperienced person. There would have to be reasons in principle to reject intentions to explore and colonise the geosphere. Such reasons, in principle, are also being stated in the current debate and these are to be discussed separately under the heading “Ethos of Self Restraint”.

3 Plea for an Ethos of Transcendence

An ethos of self moderation of man, currently being announced with great response, is connected with the implicit limitation with regard to utilitarian purposes. At first glance, however, this connection is unclear. It results in the demand that man should be satisfied with the status of technology development that has already been attained and should even accept a retrogression in certain sectors. H. Jonas made this attitude the basis of a new “Ethics of Responsibility”[9] the central imperative of which demands if in doubt (i.e. almost always), man should decide against a technological innovation[10]. If one relates this principle to manned space flight, it says that humanity should content itself with Earth as a habitat and should not strive beyond it.

It is the mostly tacit ethos of self-restraint which is behind the aforementioned argument with regard to the hostility of space to man. The topos of hostility of space namely assumes that Earth is humane and adapted to man. If the Earth is a humane place and space hostile – the premises can be dovetailed in this way – then everything speaks in favour of being content with the available habitat or lebensraum.

However, the premise of life-friendly Earth is definitely to be looked at critically. Regarding man as a friendly natural being harmoniously adapted in a friendly Earth-environment is a pure “construction” . In reality, man is the least adapted living being, who cannot create for himself an environment favourable to life until evolutionary mechanisms are invalidated in part (e.g. via science, technology and medicine).

It has above all been pointed out in the philosophical anthropology of the twentieth century that man, if for once viewed fictitiously as a purely natural being, must appear rather less able to survive in comparison with other animals. Technology and other cultural achievements are vital necessities for ensuring survival[11]. There is a

9. Cf. H. Jonas: *Das Prinzip Verantwortung*.

10. On the “Heuristik der Furcht” cf. ibid. p. 63 ff.

11. See here in particular: A. Gehlen: *Der Mensch*; ders.: *Urmensch und Spätkultur*; H. Plessner: *Die Stufen des Organischen und der Mensch*; ders.: *Conditio humana*; M. Scheler:

natural structural adaptation deficit on the part of man which “naturally” forces him to his respective situational transcendency because of an interest in survival. This pressure to adapt and the accomplishment thereof may not be described as “warfare against nature”, provided that by war one understands a war as being a phenomenon caused by unfounded and avoidable actions due to contingent interests. Consequently the programme of a “peace with nature” [12] is also misleading since it is primarily the environment that threatens man and not vice versa (which does not rule out that one should avoid “exploiting” nature in an counterproductive manner).

However, the ethos of self-restraint can be understood in another, non-structural sense, which is rather more historical: according to this, with *the current* state of civilisation a situation has been reached at which the permanent conflict between man and an environment hostile to life should come to a standstill. However, this point of view also contains a problematic assumption, namely that the cultural process of adaptation leads to an approximation to perfect conformism and that this process has at least in part been concluded; consequently people could at least at the current position in the history of civilisation be satisfied with what they have.

Admittedly, philosophy cannot now say apodictically whether the colonisation of artificial or natural space bodies should be realised. However, it can show whether the ethos of self-restraint is adequate from an anthropological point of view. In addition it must be asked whether man’s structural deficits in adaptation compared to nature can be compensated through a certain level of cultural development to such an extent that the attitude of self-restraint corresponds with the will to survive. However, no environment is stable either diachronically or synchronically for any living being*. Consequently, even the person who wishes to survive must be prepared to go beyond the status-quo of his conquest of nature*. Accordingly, he is well advised in the interest of survival to develop an ethos of transcendency, according to which he permanently attempts – with consideration and moderation - to instrumentalise nature.

Often the criticism of manned space flight – not unlike a whole series of other large-scale technological innovations as well – has its basis in an unspoken ethos of self-restraint. However, this ethos is a luxury which only a few highly-technicalised nations can afford for a short period of time. Generally speaking, man must be constantly prepared to cross the given boundaries of his environment using utilitarian and trans-utilitarian cultural achievements. In this regard, the stratosphere does represent a natural barrier to human living space to the same extent, as was the Alps or the Atlantic in the past.

4 Manned Space Flight as a Cultural Option

The starting point for a final consideration of the arguments pro and contra manned space flight should be a schematic critical examination of the current discussion. In the case of disputes of such magnitude the evaluation of the discursive situation depends considerably on the question with regard to which side has to bear the burden of justification for which actions. In the current debate, above all in

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Die Stellung des Menschen im Kosmos. – The methodical status of the theory of structural non-adaptation, however, has not been consistently clarified in philosophical anthropology; occasionally it is understood as being an empirical and then again as an aprioristic insight. To provide further clarification it would be a question of clearly presenting the consciousness of non-adaptability as a condition of the possibility of equipment-supported (technical) world conquest.

12. K. M. Meyer-Abich: *Wege zum Frieden mit der Natur.*

Germany, justification is being sought for the demand that manned space flight should be conducted. To check the justifiability cost-benefit analyses – as discussed in the above – are then carried out. It is the prevailing conviction here that there is sufficient justification if benefits on the whole outweigh the costs. However, a *minority* regards the situation as unclear and warns of hasty, short-winded decisions, and desires to keep options open.

Since the material assumption of technological utilitarianism has been criticised, we must consequently in closing look at the methodical problem with regard to burdens of justification. As everybody knows, Germany is not faced with the decision of whether to start manned space flight programmes but whether co-operation in the same should be terminated. Consequently, it is not the demand to conduct, but the demand to cease which should first be examined with regard to justifiability. Consequently, the opponents of manned space flight must show that the realisation of certain purposes compels or urges that any further co-operation in manned space flight programmes be stopped.

That, in fact, the argumentative situation presents itself differently may be demonstrated by the following example: whoever wishes to justify that a city should establish an orchestra in order to improve income via the surplus of benefits, is as things stand, in a difficult argumentative situation. Whoever in contrast is to justify disbanding an orchestra which is admittedly making a loss, but nevertheless is popular and regarded with high esteem, is also in a difficult situation. Generally speaking this means that the burdens of justification which come about as a result of a demand to carry out a particular action or to stop it are not normally converse. Whoever demands that an option be refrained from, has to present different arguments from those in favour of taking up an option.

In addition, there is now also the point of view with regard to content, that the burdens of justification for technological options are ultimately always in the sphere of trans-utilitarian purposes. Consequently, the fundamental approach in *ethics of technology* is not, in the first place, to ask whether benefits outweigh costs in the case of every technological innovation but rather to question the purpose to which the instruments being under debate (machines, large-scale technical plant) are to be used.

Machines are a means in the technical conflict with nature, and the nature which is conquered through use thereof is a fundamental part of human “culture”. Therefore in the ethics of technology one should not primarily question to the benefits of, but the cultural function of technology. From this point of view economic benefit proves to be a possible and important aspect of the cultural function. However, the cultural function does not become absorbed in the benefit function.

It is informative here to cast an eye on former cultural options which have structural similarities with manned space flight, such as the great voyages of discovery and pioneering inventions. Here too it was not the beneficial aspects *ex ante* which tipped the scales (although there were often also motivating expectations with regard to benefits); and often they were not decisive *ex post* either. Nobody speaks of the benefits of the invention of the art of printing books, for example with regard to the improvement in the labour market situation for writers in the city of Mainz in the 15th century, or of the benefit of the discovery of America, for example with regard to the improvements in the Spanish state budget in the 16th century (in both cases the surplus benefits had few encouraging results).

In the context explained above, the large-scale technological option of manned space flight is also a cultural achievement. Of course this does not mean in this case, as in others, that this option will be put into effect whatever happens. The term "culture" is not yet used to refer to an argument but merely to an argumentative level. One should realise a cultural option to the extent that one would like to see the objectives associated with it realised. In addition one should be able to afford to do so after weighing it up with other cultural options. However, he who demands that an option which has already been realised should be dispensed with, is saddling himself with considerably greater burdens of justification.

5 Closing Remarks

Can we and should we therefore indulge in manned space flight? This question cannot be answered with arguments which are compelling in the utilitarian sense. There are no compelling utilitarian justifications either for the upkeep of orchestras or museums, for equipping expeditions or for work on brilliant inventions. In addition, it must be borne in mind that although manned space flight contributes towards the realisation of certain purposes, these contributions can nevertheless be achieved more or less to the same degree by other technological and different cultural options. As seldom as exclusivity of means is a criteria of justifiability, the existence of alternatives is equally seldom a convincing objection. One exception here is the colonisation of space bodies, which trivially can only be realised through manned space flight itself. Here, however, the price of the stringency of exclusivity of means is paid by the problematic nature of the purpose. Generally speaking, it is sufficient for the justification of an action option that a purpose can be realised via a certain means, even if alternative, suitable means are imaginable. The correct level of argumentation is then the weighing of alternative means against each other. The introductory investments required for alternative options generally speak in favour of options which have already been realised – an entirely utilitarian point of view.

Fundamentally, however, when considering the pros and cons one should bear the following in mind: if one were only to give utilitarian reasons a chance in the debate concerning technological achievement, there would be no justified cultural options in the history of mankind. Incidentally, this is also valid with regard to the temporal variation of deferring cultural options until certain problems (for example world famine or dying of forests) have been solved. As for the rest, it is not conceivable that large-scale technological options can be held, so to speak, in a state of pure potentiality until Day X. Ability in contrast to knowledge cannot be preserved. One can conserve a dictionary and use it later but the ability of an orchestra cannot be preserved.

In summary, the following can therefore be established: if one were only to permit utilitarian arguments in the debate with regard to cultural options, humanity would be reduced to a great horde of (possibly) contented apes; presumably they would, however, already have died out long ago due to self-restraint.

SPACE AND PROTECTION OF THE ENVIRONMENT

by Mr André LEBEAU (France)
Professor at the "Conservatoire national des Arts et Métiers", former Director of METEOSAT, former Chairman of the National Center of Spatial Sudies

An ambiguous relationship exists between space technology and the environment. As with most major technologies, it is the cause of changes in the natural environment. The most serious consequences mainly concern the extra-terrestrial field that space technologies have in fact opened up to human activity.

But on the other hand, it provides the best means available to man to deal with the warming of the climate induced by the accumulation of gases giving the greenhouse effect. More generally, it is an irreplaceable tool for the study of all aspects of global change brought about by human activity on the terrestrial environment: changes in the ozone layer, a rise in sea levels, melting of polar ice caps, etc., and for the management of major risks. In the long term, it offers an unprecedented means to rid the Earth of its most dangerous waste from technical activity.

CHANGES IN THE ENVIRONMENT BROUGHT ABOUT BY SPACE TECHNIQUE

Circum-terrestrial Environment

Creating waste in orbit in circum-terrestrial space is a matter of most immediate concern. It calls for the implementation of a defined deontology, accepted on an international level, by all users of space.

The main elements of the problem are the following:

- at the present stage of technology, the way to rid space of waste accumulated since the beginning of space launches is unknown. Therefore, in practice, only preventive measures are foreseeable to put a stop to the accumulation of this waste. Objects of more than 10 cms are tracked individually; as for the others, which are however likely to cause damage, only a statistical knowledge concerning them is available (35.10^6 objects between 0.1 and 1 cm).
- all the preventive means identified: putting end-of-life geo-stationary satellites on a graveyard orbit, controlled re-entry of satellites on low orbit, reduction in the length of stay in orbit or immediate re-entry of the upper stages of launchers are quite costly which alter the commercial competition of the systems concerned. *The maintenance of equitable competition requires therefore that rules imposed on users be universally adopted.*
- existing international law renders States solely responsible for harmful consequences of launchings. Rules for competent supervision have been developed and implemented by some space agencies and, more generally, the absolutely necessary steps to be taken to avoid the creation of spatial waste have been clearly identified. Nevertheless, no specific and binding legal instrument, with worldwide influence, aiming to limit the creation of space waste yet exists and, because of this, an institutional purview responsible for its implementation, on the model of the one that directs the assigning of radio frequencies to space vehicles.

The creation by States of an international legal framework to be imposed in particular on commercial activities is a necessary priority. It could be a pact that would complete the existing pacts that govern the use of extra-atmospheric space and a means of implementation. An adequate framework could be provided either by the UNO or, because of the commercial aspects implicated and the importance of maintaining equitable competition, the World Trade Organization (WTO).

In addition to the material pollution of susceptible space that will slow down the development of space activities in the short term, there is electromagnetic pollution which impedes observation by astronomers of the outer Universe. There is therefore also a need to pay attention so that space activities do not perturb uncontrollably the transparency of the Earth's environment to outside radiation.

Changes in the Terrestrial Environment and the Planetary Environment

With regard to the problem of pollution of space by orbital waste, the consequences on the terrestrial environment and the risks generated by space activities are of lesser importance and urgency. It concerns mainly:

- risks to populations concerning the re-entry of massive objects, e.g. the station MIR (120 tonnes). The risk exists only if the object goes out of control, as was the case with Skylab. In the case of MIR it would be desirable that a controlled re-entry be made towards an unfrequented oceanic zone before the station becomes uncontrollable. In any case, the risk to populations is limited; it has no relation to the mediatic activity that such an event will certainly produce and is very much less than the risks run by the unobtrusive presence of nuclear reactors on military satellites in very low orbit. The precautions to take in this domain are more concerned with the nature rather than the mass of what is put in orbits likely to give rise to uncontrollable re-entries. *It seems sufficient to forbid the use of such orbits with carrying capacities likely to spread radioactive matter during re-entry.*

- atmospheric pollution generated by space launchers. This pollution is negligible at the present level of activity and the generalisation of cryogenic propulsion - which releases only water - will contribute to reducing the level.

As far as planetary environments are concerned, the question of pollution is raised, particularly by the forms of life and by organic molecules of terrestrial origin in planetary environments that have until now remained untouched. This problem was identified from the very first planetary missions. As these activities are undertaken by public authorities and do not have, in the foreseeable future, a commercial stake, they easily accommodate the constraining measures taken spontaneously by their initiators. On this subject, the COSPAR has established a systematic data base which could be used as a base for the drawing up and adoption of international rules of conduct.

USE OF SPACE TECHNOLOGY FOR THE PROTECTION OF THE TERRESTRIAL ENVIRONMENT

The change in climate induced by human activity and the other global effects of this activity on the Earth's environment - changes in the ozone layer, rise of sea levels, etc. - calls for the global management of the planet.

A thorough knowledge of the environment and its evolution is the basis for difficult political decisions needed for this management and space technique is the key tool for this knowledge. In the same way, it provides a powerful tool for the control of international pacts concerning the environment.

In the short term, a major objective of space programmes carried out by public authorities should therefore be the creation of a global system of observation of the terrestrial environment and its implementation on a permanent basis.

The use of space technique in the control of major risks - prevention and management of catastrophies - is another domain which should be given serious attention by the authorities which control governmental space programmes.

In the medium term, there are other means of intervention of space technology, which presume that major progress intervenes, notably concerning space transport from the Earth towards orbit. The most immediately accessible is the utilisation of a system of space transport to rid the planet's surface of the most dangerous wastes of human activity and specially nuclear industry waste. In this respect, circum-solar space at a very great distance from the Earth offers an unlimited capacity for stockage for an undefined period. Nevertheless, at the present level of technology, this undertaking comes up against the insufficiency of the means of transport from Earth towards orbit. It can only be realised if major progress is made in the cost and viability of space launchers. It would be sufficient if access to the orbit did not carry a greater risk of accident than maritime transport or transoceanic flights and that the cost is coherent in relation to the cost price of recycling operations for the solution to become practical and give access to a capacity for unlimited stockage. This stage is far from being achieved but nothing excludes that the impetus of progress will lead there one day.

CONCLUSION

From this general study of the relation between space and the environment, two aspects emerge, both of them important and urgent:

- the problem of space waste which underlies a conflict between commercial competition and measures of control. It calls for the drawing up of an international agreement establishing deontological rules that everyone must adhere to;
- the systematic use of space in the knowledge of the terrestrial environment and its evolution which calls for an international effort to create a system of global observation of the planet Earth.

ADDITIONAL DOCUMENT III

MEETING REPORTS OF THE WORKING GROUP OF THE WORLD COMMISSION ON THE ETHICS OF SCIENTIFIC KNOWLEDGE AND TECHNOLOGY (COMEST) ON "THE ETHICS OF OUTER SPACE"

United Nations Educational, Scientific and Cultural Organization
Organisation des Nations Unies pour l'éducation, la science et la culture

World Commission on the Ethics of Scientific Knowledge and Technology

Commission mondiale de l'éthique des connaissances scientifiques et des technologies

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WORKING GROUP ON "THE ETHICS OF OUTER SPACE"

UNESCO Headquarters, Paris
28 January 1999

REPORT OF THE FIRST MEETING

Division of the Ethics of Science and Technology

I INTRODUCTION

The Co-ordinator of the Working Group on the Ethics of Outer Space, Prof. Alain Pompidou, opened the meeting and welcomed the participants. In particular, he welcomed the presence of H. E. Mrs Vigdís Finnbogadóttir, Chairperson of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST). He expressed his pleasure that the Working Group was meeting in UNESCO which as the guarantor of humanity's heritage, is the ideal forum for treating this subject.

The purpose of the meeting of 28 January was to define the working methods of the group. It therefore dealt with the basis for the programme activities. The Group then tried to identify high level personalities (philosophers, economists and jurists) who would be susceptible to join it. Lastly, a timetable for the work was decided upon.

II OBJECTIVES OF THE GROUP

Regarding the basis for the programme, Mr Alain Pompidou presented a certain number of themes to be considered such as, on the one hand, man's place in the Universe - not on a philosophical level but in the framework of the conquest of space - and, on the other hand, the exploration of the Universe. This means attempting to define where human activity will lead to in the conquest of space; the consequences of the conquest of space which are, on the one hand, the MIR station with the problems of its future activity, its status and its eventual return to Earth and, on the other hand, everything concerning waste matter circulating in space, which brings us back to environmental concerns. The problem of man in space and manned flights which imply our capacity to maintain humankind in space; the future of space policies, strictly speaking, that is to say what space activities represent where consideration of costs and the relation between cost and benefits; lastly, the exploration of other planets and, in particular, the planet Mars, which poses problems relative to the possibility of setting up activities and sending men there.

These themes were then summed up in four points: the conquest of space, the exploration of the Universe, the problems, and the costs and commitments.

Mr Alain Pompidou also spoke of the necessity of eventually taking into consideration the military aspects of the conquest of space. He then recalled that ethics signified respect for the dignity, autonomy, and responsibility of the human being, as well as his identity.

Mr Jean-Jacques Dordain then presented a working method organized a little differently on three themes: the first concerned the motivation of space activities, the second centred on the equity of these activities, and the last concerning the risks and, especially, the risks linked to electronic surveillance, high resolution imagery or nuclear energy being taken into space. He also took the opportunity to draw the attention of the participants to the necessity of establishing relations between the Working Group and the work already undertaken by other bodies such as the COPUOS (Committee for the Peaceful Use of Space) and UNISPACE III.

In his intervention, Mr Georges B. Kutukdjian recalled that in April 1996, when Mr Federico Mayor, Director-General of UNESCO, envisaged the possibility of creating a World Commission on the Ethics of Scientific Knowledge and Technology, space was already one of the six priorities to be studied in the framework of this Commission. Mr Kutukdjian mentioned the idea of a common heritage for humanity by recalling the United Nations Agreement Governing the Activities of States on the Moon and Other Celestial Bodies. He also mentioned the level of acceptance of technology by society. This last remark was made to underline the importance of promoting access by developing countries to knowledge and to scientific and spatial technology.

III DISCUSSION

While insisting on certain points which they considered to be particularly important, the members of the Group subscribed in general to the aims outlined by the Co-ordinator. Thus, all the participants raised the problem of the military aspect of the conquest of space which cannot be ignored, as space presents a military component that is inseparable from the civil component and on which the Group must make decisions. In fact, certain civil systems that are inadequate for the development of activities of the civil society have military implications. The most obvious example is that of the American GPS positioning system which is basically a military system but which has fundamental civilian applications and, particularly, in the field of commercial air traffic.

In addition, some participants underlined the importance of envisaging the problem of media implication and the diffusion of information by appropriate means. Several members of the Group referred to the use of nuclear energy in space.

After everyone had spoken in turn, the Co-ordinator summarized the suggestions emanating from the various interventions and noted the following four categories:

(i) military problems;

(ii) problems of motivation, equity and free access, that he regrouped under the term efficiency;

(iii) the risks to environmental protection and the use of nuclear energy; and

(iv) the aspects linked more specifically to the development of knowledge and technology and their consequences for humanity.

Regarding the military aspect, Mr Pompidou made a proposal that received unanimous agreement. He suggested excluding from the Working Group's discussions everything specifically military, unless a specific military operation menaced humanity, because this enters into the realm of decision and the strategic sovereignty of States. However, everything that could have a dual use and menaces public freedom, on the one hand, and cultural identity, on the other, would be within the competence of the Group.

IV STRUCTURE OF THE REPORT

At the end of the discussion between the members to define the suggestions for a programme proposed by the Co-ordinator, five themes resulted:

- Man in space
- Development of science and space technology
- Use of space technology and efficiency
- Protection of the environment
- Public freedoms and cultural identities.

For each of these themes, the approach would be fourfold: the Group would take into account the ethical aspects, governmental and intergovernmental aspects, economic aspects and scientific aspects, as well as the aspects linked to the perception of public opinion. In addition, all members of the Group would work on all the themes, but each one would concentrate more particularly on one of the subjects. Thus, Mr André Lebeau will cover the protection of the environment; Sir Geoffrey Pattie and Mr Ezio Bussoletti, the use of spatial technology and efficiency; Mr Gethmann, man in space; Messrs Audouze and Gethmann, the development of science and space technology; and Mr Alain Pompidou, public freedoms and cultural identities.

Messrs Dordain and Kutukdjian will ensure the articulation between the Working Group, COSPAR, UNISPACE III and COPUOS.

V SEMINAR FOR REFLECTION

Concerning the high level personalities who could work with the Group, the idea of the Director-General of UNESCO is to implicate people of a very high level of thought, including philosophers, economists, scientists and humanists and, to ensure a geographic and cultural balance, from different parts of the world .

For the working paper, a preliminary list including Mr Heinz Riesenhuber, Sir Herman Bondi, Mr Cheikh Modibo Diarra, Mr Freeman Dyson, Mr Umberto Eco, Mr Luc Ferry, Mr Elie Wiesel and Mr Joseph Ki-Zerbo, has been drawn up. The ESA, UNESCO and members of the Group should make suggestions, together with short curriculum vitae, and the final decision will be taken by the Group as a whole.

With regard to the actors in the field of space, which can be space as well as industrial agencies, or economic agents and who will be asked to intervene in the framework of the seminar in September, ESA and UNESCO will also submit proposals bearing in mind a balanced geographical and professional repartition.

VI TIMETABLE OF WORK

With regard to the timetable for the work of the Working Group on the Ethics of Outer Space, it was decided that for each of the five themes, those who were responsible would prepare a short factual note, of two pages maximum, identifying all the ethical problems involved, which would be circulated among all the members before Wednesday, 3 March 1999.

In addition, the seminar, bringing together well-known personalities from outside the field of space, as well as the actors of this discipline, will take place on Friday and Saturday, 10 and 11 September 1999.

The interim meeting foreseen on Tuesday, 13 April, has been postponed to Thursday, 22 April, in the afternoon, due to Professor Gethmann's teaching schedule.

United Nations Educational, Scientific and Cultural Organization
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WORKING GROUP ON "THE ETHICS OF OUTER SPACE"

UNESCO Headquarters, Paris
10 May 1999

REPORT OF THE SECOND MEETING

Division of the Ethics of Science and Technology

I INTRODUCTION

Opening the meeting, Prof. Alain Pompidou, Co-ordinator of the Working Group on the Ethics of Outer Space welcomed Prof. U. R. Rao, President of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) and UNISPACE III as well as Prof. Stan Grzedzjelski, Executive Director of the Committee on Space Research (COSPAR).

Mr Alain Pompidou told the members of the Group that he had given a talk on Friday 30 April at the first session of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) in Oslo, in which he had explained the preliminary ideas of the Working Group.

He recalled the five working themes defined during the first meeting of the Group, on which each member had prepared a fact sheet identifying ethical issues. The agenda of this meeting had two items:

- presentation by each member of his contribution, after which all the other participants were called upon to make comments and observations;
- organization of the seminar to be held on 10 and 11 September 1999.

II PARTICIPANTS' CONTRIBUTIONS

A. Man in Space

Prof. Gethmann's contribution was based on four points, namely: the limits of human action in space, space exploration, scientific research and the commercial use of space. Prof. Gethmann began by asking if it is permissible for man to go into space. He then looked at the problem of the ownership of knowledge and know-how obtained from space missions, making a distinction between exploration the results of which belong to all of mankind, research that benefits scientists and researchers and the commercial use of technology which should belong primarily to investors.

During the discussion, the concept of a "misanthropy of space" raised questions, and it was felt that it would be preferable to replace it by that of the inhospitable or unsuitable nature of space for human beings.

It was pointed out that the presence of man in space should not be confused with the limits of his perimeter of activity. In fact, man is already acting in outer space every day, without its requiring a human presence.

Furthermore, it was pointed out that man's presence in space is not warranted by the needs of scientific research. Certain members wanted Prof. Gethmann to go further into the issue of limits on the acceptability of a human presence in space in the exploration of the Universe far beyond the Moon.

Certain participants also asked if there was not a philosophical dimension to the human presence in space.

The exclusive use of space for peaceful purposes and the need to look at the long-term prospects of sustainable development was also evoked along with the question of maintaining the possibility of permanent access to space for all scientific missions seeking to increase knowledge.

B. The Development of Science and Space Technology

By way of a preliminary observation, Mr Jean Audouze[1]. explained that he had focused his speech mainly on access to space, and added that the question of the development of space technology, especially with regard to telecommunications or access to automatic observatories, needs to be studied in greater depth. He attached particular importance to astronomy and to gathering knowledge about the earth from space. He then proposed four topics of ethical reflection:

- space programmes, which come under “heavy science”, are very costly. This makes it necessary to reflect on access to these programmes, especially for the developing countries, as well as the nature of their beneficiaries (entailing questions about research for what purpose, for whom, and with what means);
- programmes involving man’s presence in space should be assessed in philosophical as well as economic terms;
- space is a territory of science that should remain at the disposal of all of mankind, but is being increasingly polluted not only by solid objects but also by electromagnetic waves and radiation. Space therefore should be declared to be inalienable. Man should appropriate space technology but has no right whatsoever to appropriate space itself;
- the impact of technology on daily life. Mr Audouze raised the issues of the rights of citizens to have access to space and that of the development of space technology.

Some participants felt that it would be artificial to set up an excessively close link between human behaviour in micro-gravity and the possibility of carrying out planetary flights that go far beyond the difficulties related to weightlessness.

Certain members were pleased to see space being referred to as part of the field of “heavy science” because this implies major social and political consequences that may last for decades and have ethical repercussions. The question of energy was referred to as an example of a project in the field of “heavy science”.

In this respect, it was suggested that Mr Jean Audouze, who is also the Co-ordinator of a Working Group on the “Ethics of Energy” within the framework of COMEST, should draw a parallel between energy and the evolution of space technologies in order to prevent the errors and difficulties of energy policy from being repeated in space policy.

Furthermore, certain members wanted further reflection on the NASA slogan “better, quicker, cheaper” as well as on the topics of risk management in space, energy in space and energy from space.

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1. As part of the celebration of the year 2000, Mr Jean Audouze announced that a forum would be organized on the 29 May 1999 in Toulouse in the *Théâtre de la Cité* called *L’avenir est-il dans le ciel?* (Is the Future in the Heavens?). Four Round Table meetings will be organized on the following subjects respectively: *Le cosmos ou l’invention d’un rêve* (“The Cosmos or the Invention of a Dream”), *La Terre dans tous ses états* (“The Earth in a State”), *La conquête spatiale, dernière frontière du progrès* (“The Conquest of Space, the Last Frontier of Progress”) and *Liberté de l’espace, espace de liberté* (“Freedom of Space and the Space of Freedom”) in which Professors André Lebeau and Alain Pompidou will take part.

With respect to space as a scientific territory at mankind's disposal, it is necessary to raise the question of its commercial exploitation which will very probably not be available to all nor will it be obtained freely. Furthermore, such exploitation calls for protection and guarantees, and these too must be envisaged.

The Group then looked at the motives that underlie space missions, and asked whether science might not be a pretext for such missions, especially in the case of the Mars mission. The fact that the motives being put forward to justify a public project are spurious and that science is being used as a pretext raises an ethical problem.

At the end of the discussion, Mr Jean Audouze said that he would take account of the different observations and make a distinction in his fact sheet between:

- the data that can be collected from space and pertains to fundamental research;
- the environmental data that the countries of the North must place at the disposal of the less fortunate countries for which access to this data is a very major factor (for example in drought forecasting) of development;
- commercial data in the strict sense of the term, which can be governed by commercial rules and regulations.

C. The Use of Space Technologies

Mr Bussoletti, in the absence of Sir Geoffrey Pattie, presented a joint document based in the following three points: the environmental impact, the economic impact and finally the military dimension.

With regard to the environmental impact, he stressed the problem of debris and the question of the exploitation of energy in space and especially nuclear energy. He referred to the need to bring practices and legislation into line with each other. He also emphasized the question of risk management in space. Certain members wanted the topic of nuclear wastes in space and low orbital waste to be dealt with more extensively (see also paragraph D on the protection of the environment).

With regard to the economic impact, the essential question is that of the participation of the various nations in the development and use of technologies.

Reference was also made to the importance of identifying supranational entities that could suggest rules and see to their follow-up and effective application, especially in the protection of the space environment.

The military dimension was envisaged from the viewpoint of dual use. In this respect, Mr Pompidou recalled that, at its first meeting, the Group had decided to exclude purely military questions from its deliberations and consider only dual-use technology, namely military technology having civilian applications.

The Group recognized the fact military space technology and civilian space technology have common industrial bases and that practically all space technology is dual-use technology. The situation that was deemed to pose the greatest problem was that of systems, developed by the military, on which civilians are totally dependent, such as, for example, the American GPS positioning system. Indeed, the use of the GPS for air navigation control, from take-off to landing, means that commercial flights throughout the planet will be governed by this system[2]. It was proposed to make a distinction between civilian technologies liable to military applications such as optronics applied to earth observation and military technologies having civilian applications such as the GPS.

D. The Protection of the Environment

Prof. André Lebeau pointed out that space technology has an ambiguous relationship with the environment because it can be both a cause of degradation in the natural environment and a tool for the control of this degradation. He drew a distinction between the degradation of the extraterrestrial environment and degradation of the terrestrial environment and of planetary environments. In the first case, Prof. Lebeau stressed the fact that, at present, there is no way of eliminating orbital debris. Consequently, only preventive measures can be implemented. He then pointed out that the commercial applications of near-earth space, given their number, are the most pollution-creating applications. Since the imposition of preventive measures has a cost, it will affect the competitivity of commercial systems., Prof. Lebeau therefore emphasized the fact that it was indispensable for these measures to be imposed on all undertakings, especially business undertakings, without exception and that these measures should form part of international law, although there is no international legal framework at present laying down rules in this field.

As regards the degradation of the terrestrial and planetary environments, Prof. Lebeau said that the re-entry of massive objects and the atmospheric pollution caused by space objects were negligible phenomena. With respect more particularly to planetary environments, Prof. Lebeau referred to pollution by life forms and organic molecules while pointing out that this problem was being controlled by the application of heavy and costly protocols. As for the use of space technology for the protection of the earth's environment, Prof. Lebeau identified two aspects. Firstly, there is the short-term aspect of the use of space programmes as tools of knowledge for the development of the earth's environment. Secondly, there is a long-term aspect corresponding to the development of reliable space transport at reasonable cost, enabling the surface of the planet to be rid of the most dangerous wastes resulting from human activity, especially nuclear wastes, by placing them in solar orbit.

In conclusion, Prof. Lebeau recalled two major points of his presentation, namely control of space debris and the use of space for obtaining knowledge about the earth's environment. He also acknowledged that he had omitted to deal with the question of electromagnetic pollution.

During the general discussion, the Group stressed the fact that there are no ways, at present, to eliminate debris. Certain participants were concerned about the solution in which wastes are sent into solar orbit and drew the members' attention to the risks of the irreversible pollution of space. In this respect, Mr Grzedzjelski informed the Group of the creation, within COSPAR, of a panel on planetary protection aimed at studying the situation as well as the political measures and regulations laid down by the space agencies. This panel would set up a database, that could be at the disposal of UNESCO, on the protection of the planetary environment.

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2. On 12 May 1999, the Ministerial Council of the ESA decided on the participation of the ESA in the European Union project of setting up a specific European system of satellite navigation (the GALILEO programme). This project will be the subject of a decision by the European Ministers on 17 June 1999.

Finally, certain members sought further examination of all matters concerning other environmental aspects such as the carbonizing of the atmosphere, nuclear wastes and monitoring of the climate.

With regard to the need for international legislation on the control of space debris, applicable imperatively to business entities, it was suggested that such regulations could take the form of a treaty within the framework of the United Nations, involving also the World Trade Organization (WTO).

Three levels of the possible use of space technology were identified. These were, firstly, the prevention and even the forecasting and management of catastrophes, secondly the monitoring of compliance with treaties and conventions on the environment and thirdly possible changes in the climate. It was proposed to integrate these points into Prof. Lebeau's text.

At the end of the discussion, Prof. Lebeau summed up the modifications in his document and the further points that he was going to develop in it. These relate to the emergence of the overall effects of human activity, the control of the climate, electromagnetic pollution, nuclear installations in earth orbit, debris and the COSPAR database on the protection of planetary environments.

E. Public Freedoms and Cultural Identities

Mr Alain Pompidou concentrated his talk on electronic surveillance and maintaining cultural diversity. He felt that electronic surveillance raised a problem of the infringement of individual freedom since it is now possible to record communications data routed through satellites. This will ultimately make it all the easier to obtain knowledge about the behaviour of an individual, a group of individuals, an undertaking or a group of consumers as there is currently no legislation regulating access to data and the use thereof.

On maintaining cultural diversity, Mr Pompidou noted that owing to the globalization of communications, there was a risk of the uniformization of languages, cultures and behaviour. He identified the problem: how to ensure the world-wide dissemination of information technology with the utmost possible efficiency while ensuring the personalizing of communications and respect for cultural identities[3]

With respect to the proposal to have an electronic space reserved for the maintaining of cultural diversity, it was suggested that there should be free, self-managed slots on satellite transponders.

Furthermore, on the fringes of the phenomenon of uniformization, certain members referred to the creation of new forms of cultural diversity, which should not be carried to excess. Otherwise, there is a risk of losing a heritage based on prior identity. The need to strike a balance between the maintenance of existing cultural identities and the appearance of new identities was emphasized.

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3. Mr Alain Pompidou mentioned the electronic address for accessing the English-language and French-language report of a seminar that he had organized on information ethics in February 1998: *http://pacte.tethys-software.fr*

The Group also discussed the right of access by individuals to information, an issue that has been the subject of world-wide discussion for fifteen years and ultimately relates to the working of democracy. One particular example referred to was that of municipal decrees prohibiting the installation of television reception antennas. The members of the Group pointed out that any attempt to manipulate public opinion by prohibiting access to information was unacceptable. They proposed a democratic debate in various countries on the problem of maintaining cultural diversity.

F. Conclusion

Mr Alain Pompidou pointed out that all the members had to take account in their respective documents of the various observations made during the meeting and submit new versions of their presentation by 1 June at the latest to the UNESCO Secretariat. The Secretariat would forward them to all the members of the Working Group.

III ORGANIZATION OF THE SEMINAR

Mr Alain Pompidou reminded the participants that the seminar would take place on 10 and 11 September 1999 in the Paris region at a place yet to be determined, and that the first day would be devoted to brainstorming between the members of the Group and philosophers, writers, communicators, etc. from all horizons.

On the second day, the Group would hear the principal actors of space policy (leading officials of national space agencies, industrialists, etc.).

In order to determine the framework of reflection of the seminar, Mr Pompidou said that he would prepare a document for the presentation and identification of ethical problems by 1 June at the latest. He would submit this document first of all to Prof. Gethmann and Mr Kutukdjian and then to the other members.

With regard to the subjects to be discussed during this seminar, the Group agreed on the following three points:

- **space as a dimension**, covering man in space, the exploration of the Universe, the development of space science and technology;
- **space as a tool**, covering economic issues and the protection of the environment, space technology and the risks related to the use of space;
- **space perceived**, namely the perception of space in the media, the role of the media and of communication organs, and that of political decision-makers.

The Group then examined the list, prepared by the UNESCO Secretariat, of persons likely to be invited to the seminar while leaving it to ESA and UNESCO to draw up the list of representatives of national space agencies and industrialists. Mr Johnston, Secretary General of the OECD as well as Mr Ashpal (India), Mr Sagdiev (Russian Federation/United States of America) and Mr Haerendal (Germany), President of COSPAR, were added to the list. It was also decided to invite the COPUOS, UNISPACE III, COSPAR, the International Aeronautical Association and the International Astronomical Union.

ADDITIONAL DOCUMENT IV

FINAL REPORT OF THE SEMINAR OF PARIS ON "THE ETHICS OF OUTER SPACE"

UNESCO - ESA

(10-11 September 1999, Roissy-Charles de Gaulle, France)

United Nations Educational, Scientific and Cultural Organization
Organisation des Nations Unies pour l'éducation, la science et la culture

World Commission on the Ethics
of Scientific Knowledge and Technology
Commission mondiale de l'éthique
des connaissances scientifiques et des technologies

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SEMINAR OF PARIS ON "THE ETHICS OF OUTER SPACE"
UNESCO - ESA

(10-11 September 1999, Roissy-Charles de Gaulle, France)

FINAL REPORT

Division of the Ethics of Science and Technology

PART ONE: SITTING OF 10 SEPTEMBER 1999

I INTRODUCTION

1. Space is a new challenge for mankind because it involves a definition of man's role in the Universe. The issue is at one and the same time philosophical and scientific: man wants to conquer space, to get to know and explore it. But before doing so, he must question his aims and scientists must seek to better sound out public opinion in all its cultural diversity. This question must be approached equally from the scientific and cultural points of view. In addition, the consequences of the conquest of space require ethical reflection on this subject in an international framework, especially as outer space has been acknowledged as an integral part of the shared heritage of mankind. In that spirit, the Director General of UNESCO, in co-operation with Mr Antonio Rodotá, Director General of the European Space Agency (ESA), created, in December 1998, a Working Group on the Ethics of Outer Space whose co-ordination he entrusted to Prof. Alain Pompidou. This Group, with a pluridisciplinary membership, has been asked to prepare a report on the ethical implications of space activities.

2. This report will be put forward for examination by the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) because the ethics of outer space are one of the domains which fall within the remit of this Commission. In this regard, at the first meeting of COMEST held in Oslo in April 1999, the Co-ordinator of the Working Group had occasion to present the initial proceedings of the Group and the framework for its reflections. He pointed out that, while space technologies often touch upon both civilian and military activities, the Working Group had decided not to deal with matters of an exclusively military nature without, however, systematically disregarding them.

3. As the highlight of the proceedings of the Working Group, the seminar was organized firstly to enable specialists to share their reflections and experience in this area and secondly to interest operators in the field of space, the representative of space agencies and of industry. The list of participants will be found in Annex 1 to this report.

II OPENING SESSION

4. Presenting the terms of reference and the workings of COMEST which provided the framework for the seminar, H. E. Mrs Vigdís Finnbogadóttir, Chairperson of the Commission, pointed out that the increasing awareness of the human and social implications of scientific research and the resulting technological applications had given rise to a new phenomenon. Never in the past had scientific progress and technological innovation shaped the modes of economic production, social relations and life styles as much as they did today. While the world of scientific research now took the view that ethical reflection was an integral part of development in this area, the general public was equally aware of the fact that sciences and their applications had transformed daily life. The ethics of scientific and technological knowledge must now figure in the forefront of decision-making in every area. Ethics must therefore become a system of reference, just as the world dialogue on topical issues now also took account of social and cultural concerns. Ethical reflection

involved the constant questioning of our acts and a process of perpetual renewal. This reflection goes far beyond the definition of a deontology and presupposes that the debate is conducted in public with the enlightened participation of citizens and decision-makers. In that sense, it is a democratic requirement. Moreover, it must anticipate problems by working on scientific bases and assuring the participation of the intellectual community from all parts of the world.

5. Referring more specifically to COMEST, Mrs Vigdís Finnbogadóttir said that the Commission must formulate, on a scientific basis, principles which were capable of providing the decision-makers with criteria for choice in sensitive areas other than those of a strictly economic nature and of fixing the boundaries between what is possible and acceptable. Moreover, by helping to improve risk management, it must become the cornerstone of a culture of responsibility and solidarity. Finally, at a time when scientists are endeavouring to break down the barriers between disciplines to open more stimulating lines of research, COMEST can offer the entire world community new points of reference to exercise a specific influence on the evolution of science and radically modify the very foundations of human nature.

6. Prof. Alain Pompidou for his part clarified the conceptual framework of the seminar. He pointed out that mankind's entry into the 21st century would be marked by faster population growth, disparities between the industrialized and emerging countries and technological breakthroughs which would make scientific progress part of daily life. The combination of these three factors creates ambiguities and paradoxes which are particularly sensitive in the case of activities associated with the development of space technologies. Nowadays, the perception of outer space has progressed successively from myth to dream and then from dream to reality; so much so that space has become accessible to human beings. This association of the conquest of space with our everyday life is accompanied by financial constraints and power games involving space, which is a new terrain for the power struggle. This in turn is creating new challenges that involve the assessment of the balance of benefits and risks to justify the allocation of resources. Benefits include the victory represented by successful manned space flights, the enlargement of our field of knowledge, the use of space technologies for meteorological observation purposes and the development of satellite communication. However, those benefits do not diminish the importance of the risk factor. In this regard, the importance of defining a forward-looking strategy founded on objective explanation and identification of risks is evident.

7. Ethics are now an integral part of harmonious development and of scientific and technical progress; they entail at one and the same time the morality of action and the idea of risk. In the more specific field of outer space, three postulates can therefore be formulated: space regarded as a common heritage of mankind implies the need to respect free access to space; space as a factor for the enlargement of scientific knowledge presupposes that nothing must prevent astrophysicists from observing the Universe and, in particular, the risks of electromagnetic pollution; finally, as a support for communication between human beings, the use of space must respect human liberties and basic rights. In terms of management of the risks involved in the use of space technologies, three principles must be applied: the principle of precaution, the principle of a return on experimentation and the principle of vigilance which themselves rest on the principles of equity and solidarity. The practice of an ethic of space must be founded at one and the same time on reflection and on a communication strategy because of the emotional context which surrounds

matters associated with space exploration. What counts is to avoid disinformation and fraud, to undertake not to play upon the credulity of individuals or populations. It is important to avoid all unjustified alarmism and the mercantile attitude to information, which represents a sales argument for the media, an argument for the allocation of resources for the research world and sometimes even for certain industrial companies. The public debate must of necessity be organized with a view to creating a democratic approach to space policy. This discussion might eventually emerge onto a "culture of space" which would seek to create a cultural link between tradition and innovative breakthroughs.

III GENERAL DISCUSSION

8. The discussions focussed on four topics of reflection: the ethics of outer space; space as a dimension; space as a tool and space as a perception (see Annex 2).

A. THE ETHICS OF OUTER SPACE

9. In his presentation, Prof. Carl Friedrich Gethmann laid emphasis on the opposition existing between a utilitarian approach and a cultural approach to manned space flight. When examining the goals of manned space flight, cost-benefit considerations must not be uppermost. The consequences for the progress of scientific research are self-evident, just as the commercial use of space may legitimize manned flights. Man's interest in exploring his environment is not guided by utility in the strict sense of the term, but also corresponds to a fundamental cultural need reflecting the continuity of the great explorations and discoveries of past centuries. It is therefore important to examine the cultural foundations of space exploration and to make sure that the resulting benefits are shared as widely as possible.

10. The ensuing discussion showed that it was difficult to make a radical separation between the utilitarian approach and the cultural approach; there can in fact be no culture without economic or political aspects. When the question of space flights is approached from the ethical angle, simultaneous account must be taken of the two approaches. Since the economic and cultural aspects are closely bound up, it is also essential to respect maximum transparency in explaining the motivations underlying manned flight and commercial use of space. In the same spirit, it would be desirable to give the general public access to better information. Some experiments with a pedagogical slant have in fact shown that good information for the general public can help to legitimize space exploration. As outer space is regarded as a common heritage of mankind, any exploration or use of space must be for the benefit of all. That would not be the case if the economic approach prevailed.

11. Some speakers pointed out that ethics must be understood as the moral principles for action, the thinking about risk and recognition of others; at the same time, the relationship between ethics and law must be taken into account. While ethical considerations must permit the resolution of conflicts that are liable to occur because of space exploration, criteria or norms must be established to underpin all arguments; law must be a consequence of ethical reflection and not the opposite. Ethics should also lie at the basis of political decisions on space exploration. Last but not least, it is imperative for citizens to be able to play their part in decision-making, drawing on rational arguments to avoid possible protest movements when the inevitable accidents occur.

B. *Space as a Dimension : Man in Space and Exploration of the Universe*

12. Introducing his remarks, Prof. Jean Audouze pointed out that political decisions at the origin of scientific progress have often been based on dubious motivations. There are areas in which ethical arguments can easily be invoked and outer space is one of them, because it is perceived positively by the public, unlike nuclear energy which is often regarded as a menace. He highlighted the importance of the time factor in space experimentation because projects involving outer space are often long-term ventures. Space programmes fall within the zone of “heavy science” which mobilizes colossal budgets accessible only to the richest countries even if the NASA slogan is to organize modest missions on the principle “better, quicker, cheaper”. Space is a scientific territory, which must remain at the disposal of all mankind but is increasingly polluted. The right of citizens to have access to space must be asserted and sustained by an effort to create awareness and education. He also called attention to the importance of the environmental data being made available by the Northern countries to their less fortunate counterparts for whom access to such data is an important factor in their future development.

13. In the ensuing exchange of views, space was recognized as being an effective territory for scientific research but it nevertheless contributes to the development of commercial applications which oblige the scientific community to take account of the space agencies and industries that allocate the necessary funds to research. These considerations create the need for an ethical basis for all action in the field of exploration of outer space to be rethought since ethical reflection seeks the general well being of all mankind. The ultimate objective of space exploration was considered at length from the angle of the search for other forms of life – as a possible response to the great founding myths of societies and also from the angle of the scientific progress which it induces, to say nothing of the possible economic benefits. The discussion revealed the respective interest of these different motivations, but also the need to reflect on the best ways of informing and training the public.

14. Having regard to the allocation of funds earmarked for space exploration, the possibility and procedures for pooling all the resources allocated to purely scientific purposes were evoked. Such purposes might be regarded as serving the general interest. As to the economic goals, it would be desirable for the fund providers to be able to justify the legitimization of the projects financed by them and the principles, perhaps of an ethical nature, which underlie the distribution of funds. So far, scientific applications placed in the service of space exploration have not yet been called into question but an urgent need is developing to envisage the definition of principles presiding over the allocation of resources and respect of responsibilities at national or international level. In this regard, the role of ethics in the decision-making circuits and the notion of equity were evoked. Equity is important to alleviate the competition that exists between scientific disciplines. Moreover, sound management of space is a condition for the survival of mankind and the well being of future generations. The definition of relevant ethical principles therefore assumes full importance in this regard.

C. *Space as an Instrument*

i) Protection of the peri-planetary environment

15. Prof. André Lebeau pointed out that space technology had an ambiguous relationship with the environment because it might at one and the same time lie at the origin of damage to the natural environment, while also serving as a tool to verify

such damage. He drew a distinction between damage to the extraterrestrial environment and damage to earth and planetary environment. In the first assumption, he called attention to the fact that no procedure existed at present for the destruction of orbital debris and that only preventive measures could be applied. He said that the commercial applications of outer space caused the greatest pollution because of their large number; preventive measures were expensive and therefore influenced the competitiveness of commercial systems. He stressed the vital need for all the companies concerned to take these measures without exception and for them to be embodied in international law. Referring to the use of space technology for protection of the earth's environment, Prof. Lebeau identified two aspects: firstly, a short-term aspect represented by the use of space programmes to better understand the evolution of the earth's environment, and secondly, a long-term aspect which consisted in ridding the surface of the planet of the most dangerous waste products of human activity and, in particular, nuclear waste by putting them into solar orbit. In this regard, he stressed the need to establish a system for management of the global environment, as had already been done in meteorology.

16. As to the notion of space debris, it was essential to provide a detailed technical definition accompanied by ethical and juridical frameworks, which would enable the dangerous practices that were liable to mortgage the life of future generations to be avoided. The creation of "second generation" debris with a serious destructive power must be feared in this respect. The definition of ethical and juridical frameworks presupposes a symbiosis between scientists and lawyers. Work is already in progress in the United Nations Organization with studies to set up a monitoring plan to count objects in circulation in space and develop models of forecasting and prevention. All solutions in this regard imply the recognition by decision-makers of potential dangers while ethical principles must be applied to each phase of development of the space tool.

17. The principle of sharing environmental data was described as a corollary to sound management of the planet and outer space, given the fact that this data has an economic value and hence a political impact. In the meteorological sphere, this system has been put in place because of the immediacy of demand recognized by all States; however, in the case of space, the time scale is longer and does not militate in favour of rapid decision-making. Moreover, there is no certainty that the creation of a system to monitor the terrestrial environment would be unanimously accepted given the diversity of interests involved and the fact that space is still largely managed by the military.

18. As to the elimination of space debris, the question of the high cost of the necessary measures was raised and also that of the responsibilities shared by all concerned in the political, economic and technical spheres. While the use of space as a climate management instrument is widely acknowledged, the fact remains that an ethical problem arises as to its legitimacy because of the remaining uncertainties.

ii) Public freedoms and cultural identities

19. Prof. Rao laid emphasis on the development of means of communication using space technologies. He deplored the imbalance that exist between the countries of the North and those of the South and pointed out that the application of ethical principles might offset these differences. While the development of space technology was certainly liable to improve the quality of life in years to come, incorrect uses might have negative impacts on life in society and on the exercise of individual

freedoms. Vulnerable societies might in fact be the victims of a perverse form of cultural alienation. Globalization must under no circumstances lead to cultural standardization. It is therefore imperative to make sure that ethical principles are applied to the use of space to guarantee individual freedoms and respect for cultural identities. Through appropriate protection of access to information, action must be taken to ensure that the techniques of space communication are not placed in the service of any form of propaganda or criminal activities. While the emergence of what is known as the "global village" has brought human beings closer together in virtual terms, it has not by the same token developed friendship between peoples. Public education must be developed to facilitate the attainment of that goal.

20. The risks of inappropriate use being made of satellite networks was widely discussed. The ability of the States to maintain order in this rapidly expanding domain and to protect individuals was questioned at length. However, the positive impact on cultural development was stressed because the variety of methods of transmission leads to the supposition that minority cultures can nevertheless express their views and reach the populations concerned by the use of satellites, so favouring the protection of cultural identities. The bodies which define ethical principles must therefore point out that the worldwide circulation of information technologies, while permitting the most effective possible communication, must also guarantee respect for cultural identities and freedom of expression. The need to strike a balance between the preservation of existing cultural identities and the appearance of new identities was underlined. These new tools must be placed in the service of justice, equity and sustainable development. Moreover, space techniques placed in the service of education and tele-medicine must be developed.

21. The use of space surveillance techniques can also help to monitor economic activities. The example of the surveillance of agricultural production was mentioned. In this particular case, the question arises as to which category derives the greatest benefit: producers, consumers or intermediaries. The possibilities opened for speculation through the development of forecasting capacities must be limited to prevent growing inequalities or the emergence of economic practices that are both coercitive and suspect. Electronic surveillance also poses a problem of encroachment on individual liberties because communication data transmitted by satellites can now be intercepted or mobile telephone communications pinpointed. These techniques which used to be the preserve of the military are today available to anyone who has the appropriate technical resources. Their abusive use could encroach seriously on fundamental human rights. Attention was nevertheless called to the fact that this question of surveillance of individuals exceeds the framework of space and is in fact a more general problem. Finally, while it must be conceded that surveillance is inevitable, the management and verification of data must be regulated.

E. Space as a Perception

i) Benefits and risks associated with the advances of space technology

22. Prof. Ezio Bussoletti structured his presentation around three points: environmental impact, economic impact and, finally, the military dimension because of the dual use of space technologies, i.e. military technologies which may have civil applications. On the subject of environmental impact, the problem of debris and the utilization of energy, notably nuclear energy, in space were highlighted. Prof. Bussoletti spoke of the need for harmonization of practices and legislation. He also stressed the need for risk management and the development of information and education on a

preventive basis as well as the role of the media. He referred to the importance of identifying the supra-national bodies, which could propose rules of balanced management and assure their monitoring and effective application, notably in terms of protection of the space environment.

23. As to risk management, the acquisition of data on a free or fee-paying basis and the management of this data was given attention by the participants. The ethical aspect of these issues was stressed. It is in fact vital to ensure the proper use of scientific knowledge about space. The juridical notion of responsibility arising from risk arose in the space domain, perhaps more than in any other. Clearly, we must not wait until the damage has occurred to impose limits on the use of knowledge, otherwise the development of the space industry may be adversely affected. In this regard, we must make sure to take account of the subjectivity of the perception of risks which varies from one society to another. A clear and transparent dialogue must be opened between the parties involved in space policy and the different types of society.

24. While the acquisition of data is an important matter, its safeguarding through the rules for the protection of intellectual property cannot be disregarded. Despite the fact that outer space is recognized as being the “common heritage of mankind”, today patents filed for a process or inventions carried on board a satellite are registered in a single country only. From the point of view of equity, this aspect therefore deserves to be examined. Legislation must be drawn up to regulate access to, and use of, information processed by satellite.

ii) Communication and the media

25. Prof. Alain Pompidou felt that ethics had a major role to play, notably in relation to the creation of communication strategies. The emotional relationship with space exploration was a positive aspect in that it stimulated a form of creative imagination. However, poor information must not be allowed to cause the public to develop unjustified anxieties. The credulity of individuals or societies must not be played upon in a field in which the transition from rationality to the emotional is all too easy. In this regard, an ethic of information on matters involved in space exploration must be developed in the media. We must avoid the mercantilism which is inherent in the circulation of information, often subject to pressure from fund providers and denounce any perverse interaction between the media and the world of politics which has a much greater power of persuasion than the scientific world. Although the State is no longer the only player in space technology and has ceased to be the sole guarantor of moral integrity, it does play an important part in the management of society. Specifications applicable to information about space might be envisaged to avoid any distortion of the information provided and make sure that the risks are not kept secret. Knowledge must be made available through language that is accessible to the general public in order to avoid misunderstandings. Last but not least, Prof. Pompidou stressed the need to develop the public debate on all matters pertaining to space.

26. The discussion revealed the importance of the phase of definition and analysis of space matters outside the media context, through an organized dialogue in the form of hybrid forums between experts, scientists, politicians and the public at large. The inadequate scientific training of certain journalists was called into question as being a possible element of disinformation. The space agencies could perform a pedagogical function in relation to the media. They might develop a pedagogy of mediation within their own organization. This would be the necessary preliminary to

the creation of a culture of space. As we have already seen, space must be presented in such a way that it is comprehensible to the largest number of persons, to avoid an overabundant supply of information and ensure the circulation of elementary scientific culture while preserving the dream factor involved in the use of space technologies. Pedagogical actions intended for young people should be organized on the model of those already set up by NASA; the resources of television should also be widely used for this purpose, just as programmes to "train the trainer" and scientific mediators should be developed.

IV CONCLUSION OF THE FIRST PART OF THE SEMINAR

27. To achieve the objectives pursued by the definition of ethical principles for outer space, which had been the subject of discussion, the participants called attention to a number of key points and questions which are still awaiting a reply:

i) the ethical arguments to be deployed to avoid conflicts presuppose the organization of an interactive debate between two groups consisting, firstly, of scientists and industrialists and, secondly, of political decision-makers and public opinion;

ii) the decision-making process presupposes the definition of forms of co-operation with the national space agencies;

iii) the role of ethical filter in dealing with the parameters used in the decision-making strategy such as technological feasibility, the cost-benefit ratio and the application of international law;

iv) since outer space is the common heritage of mankind, is there a specificity of space as an inalienable protected domain?

v) how can unnecessary duplication be avoided with a view to the creation of an integrated planetary system for observation of the Earth?

vi) can areas be identified in which space technologies could be beneficial to all mankind, for instance by using them for the disposal of nuclear waste in the solar system?

vii) if space technologies pollute the space around the Earth, cannot space research contribute to a reduction of pollution of the planet by surveillance of its environment?

viii) to create a system of management of the risks involved in the use of space techniques and space exploration, what limitations are imposed by public acceptability and the cost which the States and the industrial sector are willing to assume?

ix) in the context of the use of space technologies, what procedures should be adopted for access to data and should they be based on equity and profit sharing?

x) how can the definition of a law on space and its application with a view to better protection of intellectual property and respect for human rights be promoted?

PART TWO: SITTING OF 11 SEPTEMBER

28. The purpose of this day's sitting was to define the content of the ethical approach to space policy by enabling industrialists and the heads of space agencies to explain their concerns in this area.

A. European Space Agency (ESA)

29. The Director-General of the European Space Agency (ESA), Mr Antonio Rodotá called attention to the growing importance of the role of ethics in the field of outer space which, by its very nature, is an area in which activities are pursued on a long-term basis so necessitating long-term planning. Mr Rodotá then turned to the three major topics of the seminar, namely space as a dimension, space as a tool and space as a perception. Envisaging space as a dimension, Mr Rodotá turned his attention to the motivations of space exploration and its consequences, particularly in environmental terms with electromagnetic pollution of space or the use of nuclear sources. Space as a tool creates data for which access and availability in all countries are problematic. Finally, perception of space by public opinion presupposes effective information and explanation of the limits, benefits and risks of space to enable the public to make choices with a full knowledge of the facts and to better understand what is at stake in space policy.

30. In the ensuing discussion, the role of ethics in the development of the agencies' strategies was touched upon in the sense that guidelines should underlie the strategic plans of the agencies concerned. Some participants also examined the relationship between ethics and politics. They felt that these two concepts should be separated. Ethics permits the definition of limits that must not be exceeded, but politics sometimes does not take account of ethical considerations. The implications of politics in space involve the issue of sharing data obtained from space. It was felt that all countries should benefit so as to enjoy the same rights and opportunities. The difference between the exploration and exploitation of space was also highlighted.

B. Centre national d'études spatiales (CNES) [French National Space Research Center]

31. Mr Gérard Brachet Director-General of the CNES, took the view that research and space activities posed certain ethical questions which must be identified and to which an attempt must be made to find satisfactory answers. In this regard, his agency had for some years now begun to promote ethical questioning by creating a working group to reflect on different topics. These included the project of a mission to bring back samples from the planet Mars. That project was particularly important to the CNES at present and raised many ethical questions concerning, in particular, the creation of systems of precaution and protection to prevent any possible contamination of the Earth or Mars. Missions of this kind require thorough information of the general public, in particular to explain their scientific value. Mr Brachet went on to outline the decision-making and space programme management process within the CNES which, to avoid authoritarian decisions taken by technocrats, was founded on a structured and detailed dialogue with the scientific community with a view to defining the priorities for scientific programmes. Programmes with a major commercial dimension did not lend themselves to the same approach as the financing initiative came from the industry and the markets, while the CNES focused its intervention on upstream technical research. As far as space systems meeting public service imperatives, such as meteorology or navigation, were concerned, the process consisted in making sure that the needs were properly expressed by the community of public operators. The same mechanism for decision-making and management of space programmes also applied to defence programmes, even if transparency was less effective in such cases.

32. During the ensuing discussion, the question of risk management was raised with the example of the decision to launch the Ariane space rocket. The management of a project presupposes that the space agencies must consider the acceptable level of risk, allowing for the extremely strong market pressure to which they are exposed. However, in the field of planetary exploration or scientific research, where the commercial dimension did not play a preponderant role, the question arose somewhat differently, i.e. in terms of the potential loss of the scientific mission. But in every case, sound risk management entailed a separation between the “safeguard” bodies and those responsible for implementation of the technological instrument. An independent safety protection authority must exist. Moreover, the wish for closer ties between space agencies and various institutions whose aim is to call attention to scientific information for the public, was expressed – the aim being to permit scientific mediation. As to the link between ethical reflection within the CNES and the formulation of international law, no such link had yet been established because of the fairly recent and insufficiently advanced nature of this reflection.

C. EUROPEAN COMMISSION

33. By way of introduction, Mr Hamelin, the Delegate responsible for Space Coordination, pointed out that the Commission was not a space agency but that it dealt with the field of space from the angle of its applications and strategic economic and cultural consequences for a society at large and for Europe in particular. As a regulatory player in the conduct of space policies, the Commission was deeply involved in the debate on the ethics of outer space. It was convinced that space activities could only be developed in a precise legal framework underpinned by an ethic that was clearly accepted by all the players in this field. The concerns of the Working Group on the ethics of outer space involved a number of fields to which the Commission subscribed, namely damage of the environment caused by space technologies, the use of space technologies to protect the environment and the prevention of major risks, the use of space technology to guarantee the safety of means of transport and protection of the private sphere and preservation of cultural identities.

34. Discussion touched on the relationship between the European Space Agency and the Commission; this relationship was gradually being established and presupposed a definition of the respective competencies of these two bodies. Some participants questioned the desirability of defining a European body of law on space, taking as an example the protection of intellectual property in on-board equipment, which was covered only by US legal provisions. Among the different subjects considered by the Commission, the matter of environmental data and, more particularly their use for environmental monitoring purposes, was tending to become one of its strategic objectives because the policy on information added a new dimension to observation of the earth.

D. GERMAN SPACE AGENCY

35. Mr Kai-Uwe Schrogl, Delegate of the German Space Agency to the United Nations Committee on the Peaceful Use of Outer Space (COPUOS), concentrated in his presentation on the current status and future development of space law. He took as his starting point the Treaty on Space drawn up at the beginning of the space age in 1967 which was the fundamental charter of space law. He stressed the principle of non-discrimination and equity embodied in this treaty. He felt that in future the drafting of new treaties could not be envisaged but that space law would focus on

specific matters such as space debris, the legal concept of the launch country or the statute for low orbits on the basis of which the general principles would be drafted and adopted within the United Nations system. On this basis, the implementation and more detailed definition of technical specifications would be forwarded to the international agencies concerned.

36. The importance of the key principle of non-appropriation of space was stressed because of the threat that it might be weakened, e.g. through the sale of plots of lunar land by certain companies. Space must exist for the benefit of all mankind. Some participants raised the issue of the determination of the bodies responsible if damage occurred: the principle of the liability of the launch country might not be appropriate to the present situation because of the existence of consortiums. The possibility of unlimited liability must therefore be envisaged. More generally, the key to orderly conduct in space in future was that national laws must be drafted in every country which engaged in space activities. Familiarity with the law on space was a matter for education and training of public opinion and its application presupposed the ratification by the largest possible number of countries of appropriate legal instruments. Moreover, the point was made that ethics must precede and guide the law and not the opposite. Ethics cannot be regulated.

37. One of the participants called attention to the dichotomy which sometimes existed between what the law allowed and the way in which space agencies acted. One example was the use of sources of nuclear energy.

E. Arianespace

38. The Chief Executive of this venture, Mr Jean-Marie Luton, outlined the activities of Arianespace which were guided by certain criteria such as their peaceful nature and the general principle of protecting persons and property whenever a launch took place. The judgement on protection was a matter for an independent authority and this separation between the supervisory and operational bodies was important. Mr Luton explained the policy of his undertaking in respect of space debris, which was to limit the debris of each launch to one single piece. This position was not neutral because it entailed a reduction of performance and encroached upon economic benefits. He also called attention to the permanent competition, which existed between the development of terrestrial means and space satellites. It was important not to destroy the specific advantages of space systems. Care must be taken when drawing up ethical norms to weigh up their consequences on the different systems and not to privilege certain players in competition.

39. The discussion highlighted the need for industrialists to have universally applicable norms and standards. They must themselves take part in the definition of these standards to avoid any risk of distortion of competition. However, the risk of over-regulation in an attempt to reassure public opinion must also be avoided. That in turn presupposed education of public opinion by explanation and scientific mediation. As to commercial practice, some participants felt that it was in the interest of industrialists to leave this matter to commercial discussions between the countries and the World Trade Organization (WTO).

F. Alenia Aerospazio

40. Mr Franco Malerba, representing this company, took the view that industrialists should work closely with the other players in the space field and should not themselves be charged with the task of defining or drawing up rules of ethics. These

rules must come from society itself. There was a point in time at which business ethics and the ethics of society coincided. Moreover, the definition of an ethical code should be the outcome of international concertation to avoid the creation of a proliferation of codes in different countries. Mr Malerba stressed the importance of equal access to space and equal opportunity in competition. He referred to the appropriation of space and the commercial motivations, which underlay the exploitation of space. He then turned to the links between sustainable development and space. Alenia was concerned with protection of the environment because the international space station was liable to be threatened by space debris. Questions of culture and education were then raised in the sense that, through space activities, a clear dynamic had emerged with the opening of many local television stations. Moreover, the public took a keen interest in the space adventure. Space agencies therefore had an excellent opportunity to take greater account of this interest and favour a stronger public awareness.

41. The ensuing discussion focused on the question of the appropriation of space and intellectual property rights which must not be allowed to become a threat to the development of further space research. Some participants felt that the same rules of intellectual property should apply to space as to other forms of creation. The case of intelligent “orbits” was taken as an example. Moreover, as far as imaging was concerned, not everything that is photographed or recorded in space is available without charge. If private funding is involved, a commercial logic appeared justified. The reasoning behind the international space station, which would enable the community of space users to be broadened, was also the subject of some consideration. Up to now the station belonged to the sphere of scientific information that was more or less confidential and the public was not necessarily particularly aware of it. That is why publicity and information work would be needed in future. As to the definition of a framework, some commentators felt that it was first necessary to make a detailed review of space activities, which would then be placed in a moral or ethical framework. This must be done in a positive manner and no bans or prohibitions must be imposed. All this was part of a space culture, which would tend to shape “tomorrow’s man”.

G. AEROSPATIALE MATRA

42. In the very nature of its activities, Aérospatiale Matra was confronted with choices which in some instances posed ethical problems. Mr Frédéric d’Allest, Advisor to the Executive Board on Space Matters, felt that industrialists had a contribution to make, in their own interest, to the definition and implementation of an ethics of space by identifying and managing the risks and problems which may result from the equipment built by them and by defining, in co-operation with the space agencies that had a major role to play in this sphere, codes of good conduct or international regulatory provisions. At the same time, they must bear in mind the need for transparency and communication and take account of the major concerns of industrialists. Mr d’Allest also felt that a definition of ethics should be seen as a positive step and that the commercial and industrial exploitation of space must not be criticized; like science, this was a driving force behind space exploration. In the absence of reasonable commercial activity, civilian observation of the Earth was liable to lack sufficient resources for development.

43. The importance of defining a positive approach and avoiding all condemnation of the commercialization of activities in space was taken up again during the discussion. On this matter some participants felt that if certain events such as natural disasters occurred, the rapid circulation of information at practically no cost could be effected without reference to other more commercial activities, such as agriculture. Other participants raised the possibility of compensation to arrive at equitable concepts for the reduction of disparities between countries. The practice adopted by Eumetsat towards non-member countries of charging rich nations for data while making information available free of charge to their poorer counterparts was cited as an example.

PRACTICAL CASE

44. Before closing the seminar, a "practical case" simulating the questioning of an industry by the media on the occasion of an imaginary accident enabled the participants to reflect on the communication strategy that would have to be adopted in relation to public opinion and the media if the debris from a space station caused victims when it fell back to earth. An event of that kind would raise in particular the problem of responsibility for risk management and that of the stakes involved in space activities. It appeared that detailed study of the aspects of communication, scientific mediation and explanation of risk management was more than necessary to prepare public opinion for incidents of this kind before they actually occurred.

GENERAL CONCLUSION

45. Winding up the meeting, H. E. Mrs Vigdís Finnbogadóttir, Chairperson of COMEST, welcomed the interest shown by the participants in human rights and in the future role of the citizen. She pointed out that one task of COMEST was to define "good practices". It was essential at this juncture for COMEST to be able to communicate with the public and provide fuller information on these activities so as to create a sense of responsibility and an awareness of the issues at stake. This awareness creation was all the more urgent in the case of young people as in the decades to come people under the age of twenty would be the largest segment of the world population. The people concerned would not necessarily be sufficiently well-equipped to take decisions. That being so, Mrs Vigdís Finnbogadóttir advanced the idea of developing a concept of "ethical guides" who might play the role of "Socrates of our modern times" by encouraging public opinion to find answers to the questions facing it. On an optimistic and poetic note, the Chairperson of the World Commission on the Ethics of Scientific Knowledge and Technology closed the seminar on the ethics of outer space. She pointed out that the beginning of every century was always a dynamic period and that science and poetry were inherently linked because they both represented visions and hopes for the future.

United Nations Educational, Scientific and Cultural Organization
Organisation des Nations Unies pour l'éducation, la science et la culture

*World Commission on the Ethics
of Scientific Knowledge and Technology*
*Commission mondiale de l'éthique
des connaissances scientifiques et des technologies*

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Annex / Annexe 1

Paris, 11 September / septembre 1999

SEMINAR OF PARIS ON "THE ETHICS OF OUTER SPACE"
SÉMINAIRE DE PARIS SUR "L'ÉTHIQUE DE L'ESPACE EXTRA-ATMOSPHÉRIQUE"

UNESCO - ESA
10-11 September / septembre 1999, Roissy -Charles de Gaulle (France)

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United Nations Educational, Scientific and Cultural Organization
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World Commission on the Ethics
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Commission mondiale de l'éthique
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Annex 2

SEMINAR OF PARIS ON "THE ETHICS OF OUTER SPACE"
UNESCO - ESA

10-11 September 1999, Roissy-Charles de Gaulle (France)

PROGRAMME

FRIDAY 10 SEPTEMBER 1999

I. Presentation of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) by H. E. Mrs Vigdís Finnbogadóttir

II. Introduction by Professor Alain Pompidou

III. The Ethics of Outer Space
led by: Prof. Carl Friedrich Gethmann

IV. Space as a Dimension: Man in Space and Exploration of the Universe
led by: Prof. Jean Audouze

V. Space as an Instrument:
- A - Protection of the Peri-planetary Environment
  led by: Prof. André Lebeau
- B – Public Freedoms and Cultural Identity
  led by: Prof. U. R. Rao

VI. Space as a Perception:
- A - Benefits and Risks Linked to Advances in Space Technology
  led by: Prof. Ezio Bussoletti
- B - Communication and Media
  led by: Prof. Alain Pompidou

VII. Summary and Conclusions

SATURDAY 11 SEPTEMBER 1999

VIII. Introduction by Mr Antonio Rodotà, Director-General of ESA

IX. Hearing of Representatives of Space Agencies

X. Hearing of Representatives of Industries

XI. Summary and Conclusions

United Nations Educational, Scientific and Cultural Organization
Organisation des Nations Unies pour l'éducation, la science et la culture

World Commission on the Ethics
of Scientific Knowledge and Technology

Commission mondiale de l'éthique
des connaissances scientifiques et des technologies

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Annex 3
Original English

SEMINAR OF PARIS ON "THE ETHICS OF OUTER SPACE"

UNESCO - ESA

10-11 September 1999, Roissy-Charles de Gaulle (France)

Presentation of the World Commission on the Ethics of
Scientific Knowledge and Technology (COMEST)
by H. E. Mrs Vigdís Finnbogadóttir

Ladies and Gentlemen,

I am pleased to be able to participate in this Seminar, organized jointly by UNESCO and the European Space Agency, to whom we owe our thanks for having organized this gathering in such pleasant surroundings, and whose Director-General, Mr Antonio Rodotá, will join us tomorrow.

For those who are taking part for the first time in a gathering within the framework of the work of the World Commission on the Ethics of Scientific Knowledge and Technology, I should like to say a few words about this Commission.

Just as the nations of the world are co-operating positively on scientific projects, international dialogue on the implications of these projects should also be initiated. International scientific collaborations should open the eyes of the public to ethical problems that science has already raised and will do so even more with the increasingly rapid advances that are certain to be made during the new millennium. This can be achieved not only through the long-term educational goal of wider scientific literacy, but also by including an ethical element in the general presentation of scientific issues. Ethics should become one of our frames of reference in exactly the same way that we have incorporated social and cultural elements into so many of today's global dialogue.

Growing awareness of the human and social implications of scientific research, its technological applications and their exploitation has engendered a new phenomenon: the scientific research community now considers that ethical reflection is part and parcel of development in this field. Probably never before have scientific progress and technological innovation shaped economic modes of production, social relations and lifestyles as they do today. Probably never before has the public at large been so keenly aware of the changes wrought in daily life by science and its applications.

Ethical reflection is a perpetually renewed process, a constant questioning of the whys and wherefores of our acts. It means more than defining codes of ethical practices - it implies that the debate should be conducted in public with the informed participation of citizens and decision-makers, and should thus be regarded as a matter of democratic necessity. Ethical reflection must be seen in a proactive perspective. Carried out at the international level, it calls for broad vision and foresight with, as its basis, the major ethical systems and the participation of the intellectual community of all regions of the world.

How could the creation, under the aegis of UNESCO, of a World Commission on the Ethics of Scientific Knowledge and Technology provide a response to these issues? Globalization and the interpenetration of the problems facing the world place the action of international organizations at the very heart of the process of building the society of the future. In this context and through its fields of competence, UNESCO has a special position as the intellectual co-operation organization with a duty to reinforce individual rights and freedoms on the basis of the most up-to-date knowledge and a clear appraisal of accepted practice.

While there is undeniably a growing international awareness of the magnitude and topicality of certain issues, it is now for the international community to make sure that it has at its disposal the necessary means for identifying the ethical implications of the issues raised and determining the scope for in-depth action. In a perspective of greater humanism, the World Commission will in this respect serve to mobilize the scientific community and give advice on issues of vital importance to both societies and individuals.

It was on the initiative of the Director-General of UNESCO, Federico Mayor, that the World Commission on the Ethics of Scientific Knowledge and Technology was established. His ideas and vision became reality with the resolution passed at the twenty-ninth session of UNESCO's General Conference and the appointment of all the members to the Commission in September 1998. It was gratifying and a genuine inspiration to see the way that everyone who was approached about contributing to the Commission was immediately prepared to join in its work.

It is the task of the World Commission on the Ethics of Scientific Knowledge and Technology, as a forum for reflection, to formulate on a scientific basis principles that could provide decision-makers in sensitive areas with selection criteria that are other than purely economic. Furthermore, the Commission will advise UNESCO on questions which are submitted to it or which it may take up. While the Commission must preserve the memory of the gains of science and technology, it must rigorously delineate the challenges of the future because ethics, quite apart from scientific knowledge and technology know-how, must set the limits between what is possible and what is acceptable. The Commission will help to improve risk management. In doing so, it will be the keystone of a culture of responsibility and solidarity.

As to the general functioning of the COMEST, it is composed of 18 members from scientific, legal, philosophical, cultural and political circles, designated on their personal capacity, appointed by the Director-General, taking due account of geographical distribution and ensuring coverage of the various disciplines and schools of thought. I am delighted to see Professor Jens Erik Fenstad, a member of the COMEST, here with us today.

In so far as it is essential to have the benefit of the views and assistance of the professional organizations directly concerned, the Presidents of UNESCO's five intergovernmental scientific programmes[1] (IOC, MAB, MOST, IGCP and IHP), of the International Bioethics Committee (IBC) and the Intergovernmental Committee who is to be elected next October at the 1st session of this body, and those of the International Council of Philosophy and Human Sciences (ICPHS), the International Social Science Council (ISSC), the International Council of Scientific Unions (ICSU) and the Pugwash Conferences on Science and World Affairs, are *ex officio* members of the Commission.

Furthermore, the Commission will conduct its work with the utmost flexibility keeping open the possibility of recourse, as necessary to public hearings of leading figures representing different philosophical schools of thought. With its large measure of flexibility, the Commission will thus be able to dispense with the usual constraints and compartmentalization between disciplines and institutions, while taking account of the plurality of cultures.

The first session of the COMEST was held in Oslo in April of this year. Among others topics, this first session was devoted to an analysis of the ethical challenges posed by the use of energy sources, on the basis of the excellent report presented by Mr Jean Audouze, Co-ordinator of the Working Group on this subject, by the use of fresh-water resources and by the information society. During one of the plenary meetings at this first session, an outline was given of the initial elements identified by the COMEST Working Group on the Ethics of Outer Space. The Director-General has entrusted Dr Alain Pompidou with the co-ordination of this Working Group.

The spectacular advances in science and technology in the realm of space have provided man with the capability of not only reaching into the skies, but of walking on the Moon, of exploring the Universe and even colonising near-earth space. The repercussions, for the entire human race, of such activities is even more reason for reflection, on an international level, on the ethical and societal implications of progress linked to science and space technology since near-earth space is part of the common heritage of mankind. In this respect, COMEST, through its Working Group on the Ethics of Outer Space, could play the role of a preventive body. In a few moments Dr Pompidou will present in further detail the context in which our present meeting is placed and the objectives pursued.

Before giving the floor to Dr Pompidou, I would like to conclude by saying that COMEST has a role to play in providing guidelines and moral leadership, with inputs into the work of scientists who are working on defining these issues for UNESCO. Moreover, UNESCO offers an ideal cultural platform with its assurance of multilingual presentation of both science and ethical issues - a truly international body and supremely equipped to meet this great challenge.

What is special about COMEST is its potential to examine the ethics of human relationships to water, energy, information society or the role of science in general. Just as many scientists are attempting to break down narrow disciplinary focuses in order to give added depth to their work and break exciting new ground, COMEST

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1. Intergovernmental Oceanographic Commission of UNESCO (IOC); Programme on Man and the Biosphere (MAB); International social sciences programme on Management of Social Transformations (MOST); International Hydrological Programme (IHP) and International Geological Correlation Programme (IGCP).

gives not only those who are involved in its work, but also the *entire* global community, new dimensions and contexts for actively shaping the course of science which has now reached the stage where it can fundamentally change the very physical nature of human existence.

My steadfast belief is that ethics in scientific knowledge and technology need to be in the forefront of all decision-making. To many citizens of the world, science and technology are giants that they watch marching blindly forwards, towering over everything, taking control, creating a world so complex that few people understand where its momentum derives from. It is vital that these same citizens of the world should know that such issues are actually being discussed by people who are pondering what is right and wrong about them, how they can either enrich our life or degrade it. This is a case we in COMEST must do from today onwards, for the governments of the world and for the general public that elects them.

10 September 1999

ADDITIONAL DOCUMENT V

SUMMARY RECORD OF THE PARIS SEMINAR ON "THE ETHICS OF OUTER SPACE"

UNESCO – ESA

(10-11 September 1999, Roissy-Charles de Gaulle, France)

Paris, 15 December 1999

Editorial Assistant

Valérie Zinck

Transparency, objectivity and exhaustivity

The Paris Seminar on the Ethics of Outer Space, organized jointly by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the European Space Agency (ESA), enabled the questions and problems relating to the ethics of science and space technologies to be put in perspective. These questions are being studied by the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) of UNESCO, and more particularly by its Working Group on the Ethics of Outer Space. This Group has a duty of transparency, objectivity and exhaustivity and its role is to identify the difficulties and fears, opportunities and promises associated with the conquest of space, while furnishing the necessary explanations, which must be as clear and complete as possible having regard to the needs of the populations in their specific socio-cultural context.

INTRODUCTION

Mandate and workings of COMEST

In her introduction, H. E. Mrs Vigdís Finnbogadóttir (President of Iceland, 1980-1996), President of COMEST, presented the mandate and workings of this body. This Commission seeks dynamic growth of awareness by the scientific community of the human and social implications of scientific research and its technological applications and their commercial exploitation. Never before have scientific progress and technological innovation fashioned the modes of economic production, social relations and life styles as they do today. This growing awareness presupposes the inclusion of an ethical dimension in the general presentation of scientific questions and their applications. In this regard, ethical reflection is now an integral part of the development of science and technologies, which are in a state of perpetual renewal. It represents a constant questioning of the foundation of our acts, which goes beyond the definition of a deontology. Increasingly regarded as a criterion of democracy, ethical reflection implies an internal approach in each country with the organization of public debates presupposing the enlightened participation of political decision-makers and the general public who are increasingly aware of the transformations of daily life brought about by scientific knowledge and its applications. The international approach must secure participation by the intellectual community in every part of the world.

Ethical dimension in the general presentation of scientific questions

The twofold role of COMEST

While stressing her deep attachment to the primacy of ethics of scientific and technological knowledge in all decision-taking, H. E. Mrs Vigdís Finnbogadóttir felt that the creation of COMEST could provide an answer to these ethical questions by performing the twofold role of mobilization of the scientific community and giving advice on vital subjects for the benefit of society and individuals. As a forum for reflection, the

Commission must formulate on a scientific basis principles capable of giving the decision-makers, in sensitive areas, criteria other than strictly economic for their choices. It must also set the limits between what is feasible and acceptable. By preserving the memory of the benefits of science and technology and improving risk management, COMEST will be the keystone of a culture of responsibility and solidarity. Finally, in order to give a different dimension to their work, many scientists are endeavouring to break down the tight partitions between their respective disciplines. In a concrete approach, COMEST can therefore offer the entire world community new references to highlight the evolution of science and technology which are now capable of radically changing the very foundations of human nature.

Setting the limits between feasible and acceptable

In the field of the ethics of outer space, H. E. Mrs Vigdís Finnbogadóttir suggested that COMEST should play the role of a preventive body. The extraordinary advances of science and technology in the space sector had not only enabled man to travel out into space but also to walk on the Moon, to explore the Universe and even to colonize near-planetary space. The repercussions of such activities for all mankind created a still greater need for reflection on the ethical and societal implications of progress associated with science and technology of space, in that outer space is part of common heritage of mankind.

Outer space: common heritage of mankind

Professor Alain Pompidou, Co-ordinator of the Working Group on the Ethics of Outer Space and a Member of the French *Conseil économique et social* clarified the conceptual framework of the seminar.

Professor Alain Pompidou felt that the 21st century would be marked by three factors:

- fast population growth and the rising importance of young people in some regions of the planet;
- economic pressure affecting not only the industrialized countries but also the emerging economies from now on;
- technological breakthroughs which will make scientific progress a feature of everyday life.

Ambiguities and paradoxes

The combination of these three phenomena determines the ambiguities and paradoxes that are particularly clear in the field of space, understood in its widest sense, namely as an enterprise involved in the conquest of space.

For a long time the heavens had suggested myths: human beings projected their image into space as though in a mirror and imagined the presence of gods with human forms in the sky. Today, on the other hand, the perception of space has

Myth, dreams and reality

Complexity and banality

Challenges of space technologies

moved successively from myth to dreams and from dream to reality now that space is becoming accessible to mankind. Technical prowesses have become routine since they are now part of our daily reality. Moreover new knowledge is creating new powers and space, essentially as a place of transit, is becoming a domain which some would seek to appropriate. The power stakes are generating new risks, which are not acceptable without sufficient motivation and are themselves factors of fresh constraints. So it is that new challenges are emerging. These require an objective assessment of the balances of benefits and risks to justify the allocation of resources. This objective analysis enables us to emerge from the emotional context of the space adventure.

Risks of the conquest of space

The conquest of space brings many benefits. They include manned space flights, which bring a victory of man over man himself; the enlargement of knowledge through exploration of the Universe and the use of space technologies for observation of the environment and development of communications.

However, such benefits are not without risks, which include the return of samples to be taken from Mars, the management of space debris, protection of individual liberties against electronic satellite surveillance or respect for the socio-cultural identities threatened by the unifying character of the new information and communication technologies. <u>In this regard, an anticipative strategy founded on objective explanation and identification of risks, must be drawn up to prevent rumours and fears and maintain or restore confidence in space</u>.

Ethical dimension of space: principles of action and reflection on risk

Ethics are now part of the harmonious and integrated development of scientific and technical progress. They constitute at one and the same time the principles of action and a reflection on risk. And they lead to the formulation of three postulates founded on respect for the freedom of choice and dignity of human beings:

Space as common heritage of mankind

- space is common heritage of mankind. As such, free access to space must be respected, although this does not exclude protection of intellectual property;

Space as factor of enlargement of knowledge

- space envisaged as a factor of enlargement of knowledge implies that nothing must prevent astrophysicists from observing the Universe, notably the risks of electro-magnetic pollution;

Space as support for communication between men

- space envisaged as a support for communication between men is a factor for the improvement of life and development of human societies.

Principle of precaution

In terms of risk management, three principles must apply, namely the principle of precaution which seeks to avoid all

Principle of experienced feedback

Principle of vigilance

irremediable consequences for present and future generations; the principle of experienced feedback which is one of the main principles of the experimental approach: it moves ahead step by step and is nourished by the results of successive experiments. And the principle of vigilance, which consists in the identification of signals, however weak, that can alert us to the possible appearance of risks.

These three postulates themselves rest on respect for the principles of equity and solidarity.

Bases for reflection

Communication strategy

The ethical approach is founded on reflection, which envisages space on several levels (space as an ethical issue, space as a dimension, space as an instrument and space as a perception) and on a communication strategy. What counts is to prevent disinformation and fraud, to make sure that we are not playing on the credulity of individuals or populations. This leads to avoidance of the unjustified alarmism and mercantilism in information used by the media as a sales argument or as a resource allocation argument for research establishments and sometimes even for certain industrial companies.

It is therefore without emotional overtones, but leaving the human mind free to dream and deploy the creative imagination typical of mankind, that the response to possible anxieties of public opinion must be found through a rational, objective, independent and sophisticated analysis.

Developing a culture of space

The examination of the situation must be complete, seeking to be exhaustive, to hide nothing and leave no grey areas, while rejecting any culture of secrecy. This implies permitting the acquisition of sufficient information to better define the true advantages and risks. This communication strategy requires the development of a culture of space with the creation of new links between men.

Man in movement

Thus space policy and ethics of space are addressed to a “man in movement” capable of developing in parallel his spirit and his appetite for knowledge, together with human relations, and the ability to participate in the present while preparing for the future.

PART ONE: SITTING OF 10 SEPTEMBER 1999

The discussions focused on four topics, namely the ethics of outer space; space as a dimension, envisaging man in space and exploration of the Universe; space as a tool which implies protection of the periplanetary environment and also of the public freedoms and cultural identities and, finally, space as a perception, comprising analysis of the benefits and risks associated with the advances of space technology.

I. THE ETHICS OF OUTER SPACE

Professor Carl Friedrich Gethmann, Professor at the Institute of Philosophy of Essen University, Director of the European Academy for the Study of the Consequences of Scientific and Technological Progress, dealt with the subject of the ethics of space on three levels, namely human exploration, scientific research and the commercial use of space. Considering that the problems raised by scientific research and the commercial use of space would be the subject of further examination by other participants, he focussed his comments on the cultural aspect of manned flights, calling attention to the opposition between the utilitarian approach and the cultural or trans-utilitarian approach underlying inhabited space flights. The trans-utilitarian argument did not lend itself to quantitative assessment in terms of costs and benefits.

Manned flights: utilitarian and cultural approach

Manned flights were inevitably the subject of a "spiral of argument" by which they were expected to satisfy the same long-term success criteria as unmanned flights. Because of this demand, the debate over manned space flights remained confined to the cost-benefit analysis, because the advantages of manned space flights are tending increasingly to be justified by commercial approaches. Among the selection criteria for technological choices, Professor Gethmann regretted the primacy of the utilitarian argument to the detriment of the cultural component, including the trans-utilitarian dimensions of such choices. From this point of view, the economic benefit was a major element of the cultural function. But that function was generally disregarded in assessing the benefit.

Cost-benefit analysis

Professor Gethmann felt that the primary task of an ethic of technologies, faced with the question of manned space flight, must be the critical examination of its trans-utilitarian goals with a view to their universal applicability. Moreover, he pointed out that all the utilitarian and trans-utilitarian goals, together with the resources assigned to them, constitute the culture of a society in the broadest sense of the term.

Interdependency of the cultural and utilitarian aspects

During the ensuing discussion, some participants felt that it was artificial to make a radical distinction between cultural and utilitarian or economic aspects, which were interdependent. Culture and the economy are intrinsically linked because cultural aspects have often been developed as a function of, or thanks to, economic and political aspects, notably in the field of information technologies. Nevertheless the scientific disciplines, such as astronomy, cannot be approached solely from the angle of a cost-benefit analysis: the role which this plays must not be disregarded or exaggerated. But it may be overtaken by the questions which arise and to which the economy cannot give an answer.

Nevertheless this distinction between culture and utilitarianism may prove useful to highlight criteria as a basis for arguments on which ethics is founded. This goes beyond purely economic aspects.

Meaning of ethics

This approach presupposes preliminary questions about the meaning of ethics, which can be regarded as moral principles of action, concepts of risk and acknowledgement of other people based on the respect for all mankind. Starting out from the etymological sense of the term "ethics", which represents all the habits of society, some participants defined ethics as a "critical examination consisting of moral reasoning" within a society. Sometimes, this moral reasoning came into conflict with other forms of reasoning, making it necessary to have criteria and codify them in a set of super-institutional rules, which must reflect the evolution of society. In that sense ethics precede law, which becomes in a sense the consequence of the ethical argument and not vice versa.

Ethics preceding law

Outer space being regarded as common heritage of mankind, all exploration or use made of it must be for our universal benefit, which will not be the case if the economic approach prevails. However, we must be conscious of the fact that one motivation of manned flight is the commercial exploitation of space. It is more often than not in that perspective that the necessary capital is raised.

Motivation of manned flights

The presence of human beings in space and more generally of space flight makes a unique cultural and ethical contribution. However, the motivations underlying the decisions on space programmes – be they cultural, economic, scientific or political – must be clearly and honestly put forward to avoid any grey areas. This presupposes real transparency on the part of the space agencies and governments, which take decisions and also of the media which convey them within society. The general public is increasingly expressing a wish to follow the progress of space flights, although "space tourism" is still a remote prospect. It is therefore imperative for the citizen, on the basis of a rational discourse, to be associated with decision-making or made aware in a first phase of the challenges of manned flight. Today space experimentation must be shared with the general public, which must be sufficiently well educated for that purpose. In order to permit understanding and support by public opinion for space exploration, pedagogical programmes must be developed.

Participation of the general public to manned flights

II. SPACE AS A DIMENSION: MAN IN SPACE AND EXPLORATION OF THE UNIVERSE

"Man is neither an angel nor a beast". With that quotation from Blaise Pascal, **Professor Jean Audouze**, Director of the Palais de la Découverte, reminded the many political decisions taken with a view to scientific progress were underpinned by dubious motivations. He pointed out also that it was relatively easy to invoke ethical arguments in certain areas like outer space, which enjoyed a positive image in public opinion and therefore a rather favourable position. On the contrary, nuclear energy was perceived more as a threat. Professor Jean Audouze went on to stress the dimension of time in space experimentation and activities. A space experiment lasts on average for fifty years: space projects have a long-time scale, which presupposes and requires long-term thinking. Moreover in order to promote public participation in space experiments, the space agencies are trying to create public awareness and educate the public to participate in the space programmes, which they are conducting by making information available to them.

Dimension of time in space adventure

Professor Jean Audouze also underlined the importance of space for a number of scientific disciplines, in particular, astronomy. This scientific discipline has had been revolutionized by the possibility of escaping from the difficulties which the atmosphere places in the way of observation of the Universe. That is why space must benefit from special protection and therefore be proclaimed as a “scientific territory” to permit science to continue its investigations under good conditions. Referring to the acquisition of scientific data, he made a distinction between scientific data, which must be available to the whole of mankind and environmental information. On the basis of the equity principle, the different countries, foremost among them the developing countries, must have access on a non-economic basis. Scientific data is an important factor for their future and their development.

Space as a scientific territory

Nature of spatial data

The discussion which ensued enabled attention to be drawn to the need for an ethical approach alongside the technological and political justifications of space exploration. Space is a scientific territory even if it generates the development of commercial applications. Moreover attention was drawn to the fact that this ethical approach is oriented towards the general well being of mankind and founded on respect for life. As Jeffrey Hoffman, himself a former astronaut, pointed out in his capacity as a representative of the National Aeronautics and Space Administration (NASA), the search for extraterrestrial life is also a fundamental theme in the activities of space agencies, notably NASA. It involves exploration of the solar system to begin with and then of the Universe to find signs of life so enabling a universal principle of life to be identified through biology.

Search for new forms of life in space

The search for new forms of life in space creates new links between human beings and outer space. This presupposes a form of ethics going beyond myth or spirituality and therefore incorporating scientific knowledge. Moreover this research poses the question of the attitude to be adopted in relation to different life models. Pursuant to Art. 5 of the 1967 Treaty on the principles governing State activities in exploration and use of outer space, more commonly known as the "Space Treaty", astronauts are regarded as the "envoys of mankind in space".

Moon, a window onto space

Alongside this search for traces of life in space, two other great adventures in space astronomy were also mentioned, namely the development of gravitational astronomy and the project of making the Moon a big observatory by building a telescope base there to constitute an exceptional window onto space.

Space and sustainable development

The exploration of space and its ultimate objectives were also approached. Emphasis was placed on the fact that space activities are an integral part of sustainable development because they concern management of the planet, its environment and resources. In this regard, sound management of outer space is a precondition for the long-term survival of mankind and the well being of future generations at the economic, cultural and intellectual levels. Moreover, exploration was regarded as a driving force in terms of the presence of human beings in space. However, some participants criticized the risk of instrumentalization of human beings. They would become mere instruments in the service of space technology which itself appeared as a tool in the service of knowledge itself.

Instrumentalization of human beings

Allocation of resources

As to the allocation of resources some participants wondered which organization would be best able to determine the scale for the distribution of scientific funds. In this regard, and by analogy with the arrangements made for sequencing the human genome, with the HUGO[1] programme, the eventuality and procedures for pooling funds destined for purely scientific programmes within an international system were evoked. Because of the competition engendered by it, determination of the distribution of resources between the different scientific disciplines had an important ethical dimension. It necessitated the emergence of values and principles, at one and the same time scientific and ethical, to preside over the equitable allocation of these resources. The definition of these principles must result from a balance between the general interest of mankind and the particular interest of the different players involved in the space domain.

Emergence of scientifc ethical values and principles

Ethics in decision-making circuits

Emphasis was also placed on the need to situate the position of ethics in decision-making circuits with a view not only to the risk of abuse or the adverse consequences of the use of space technologies but also to determining the strategic approach to the necessary decisions.

1. HUGO: Human Genome Organisation

III. SPACE AS AN INSTRUMENT

A. Protection of the Periplanetary Environment

Space technology and the environment: cause of damage and tool of control

Space debris

Graveyard orbit solution

Absence of international legal framework

Professor André Lebeau, former President of the French *Centre national d'études spatiales* (CNES) and a member of the French *Académie nationale de l'air et de l'espace*, referred to the ambivalent relationship between space technology and the environment; space technology may at one and the same time cause damage to the earth's environment and be used as a tool to control changes brought about by human activities on the terrestrial environment. In the first assumption, Professor André Lebeau considered the problem of space debris orbiting in circumterrestrial space. He pointed out that some 4,500 tons of objects had been placed in orbit by man. Five per cent of this total represented all the satellites operational at present, while the remainder could be regarded as a field of debris. The age in which uncontrollable objects were disseminated at random in space was now past, but the sources of this pollution remained and were considerable. They could be accidental or chronic, such as paint flakes from satellites or launchers. These space debris most of which could not be detected at present except by the impacts of the collisions between them and space objects, posed all the more problems as in the present state of technology there was no way of cleaning space to remove the debris that had built up there since the beginning of space launches. Only preventive measures such as the despatch of geostationary satellites at the end of their life into a graveyard orbit could be envisaged to interrupt the growth of their numbers. But because of their high cost <u>these measures had a significant impact on the competitiveness of commercial systems</u>. Consequently, to maintain equitable competition in this area preventive rules must be uniformly imposed on all the users of space technology without exception and must be embodied in international law. Rules of good conduct had been established by the space agencies but no binding legal framework with universal scope existed at this juncture. In this regard, Professor André Lebeau called attention to the priority need for the creation by the States of an international legal instrument in this area. In parallel with material pollution, he also raised the subject of electromagnetic pollution which was relatively well-controlled by the bodies responsible for determining the use of the ectromagnetic spectrum.

Co-ordination of all the nations active in space to establishing a permanent source of knowledge

The fact of envisaging space as a tool to monitor environmental pollution on earth presupposed observation of this environment using space techniques. Professor André Lebeau felt that co-ordination of all the nations active in space with a view to establishing a permanent source of knowledge founded on the observation of the planetary environment was a major target with an ethical content. Moreover, in the medium-term, the intervention of space technology could serve to remove from the surface of the Earth the most dangerous waste material generated by human activity, in particular nuclear waste by placing this in a circum-solar orbit with an unlimited and indefinite storage capacity.

Need to define space debris

On the subject of space debris, it appeared essential to put forward a detailed technical and legal definition, which necessitated a symbiosis between scientists and lawyers. Moreover space debris were multiplied by collisions which further increased their destructive power. In view of the need for international legislation in this area, the suggestion had been made that such regulatory provisions might take the form of a United Nations Treaty also involving the World Trade Organization (WTO).

The basis for international legislation was currently emerging with work in progress in the United Nations Organization and more particularly in its **Committee on the Peaceful Use of Outer Space (COPUOS)**. This Committee had begun studies seeking to put in place a plan for the observation and counting of objects orbiting in space and for the definition of models enabling forecasting and prevention to be effected. However, because of the considerable financial implications and the different interests at stake, this work was not unanimously approved by the users of space and pressure had been exerted. It was therefore imperative for ethical principles to be universally applied after a wide-ranging debate. Clear explanations of debris would enable public opinion to exert pressure on the decision-makers. In parallel with the preparation of a legal and ethical framework relating to space debris the question of responsibility was mentioned, because the origin and nationality of the debris cannot always be identified.

Origin and nationality of the debris cannot always be identified

The solution of graveyard orbits for its part raised a number of fears and questions on the part of certain participants who wondered whether this was not a way of avoiding the problem of pollution of the circum-terrestrial environment.

The debates also enabled the question of the use of space technologies for planet and natural resource management purposes to be highlighted. This question was all the more important for the developing countries as they did not systematically have access to these technologies or to the resulting data, although these were crucial to their development. Any information relating to the Earth inevitably had an economic and political dimension. Consequently, the equitable sharing of data, notably on the environment, posed a problem. In this regard, it was suggested that environmental data should be made available to all countries by isolating such data from the commercial circuit. The example of the

Access to and equitable sharing of space data

system of permanent data exchange in the meteorological field could serve as the basis for a solution to the problem of knowledge and control of global pollution of the terrestrial environment. However, in meteorology demand was immediate, whereas in the global environment the implications were much more remote and rapid decision-making was not facilitated.

Acceptability and uncertainties

Space technology also lent itself to other applications such as control of compliance with international treaties for environmental management and also the modification of complex balances relating to the climate, thanks to the experience of local lighting by space reflectors or in the environmental area a possible restoration of the ozone layer using space vehicles. Such possibilities nevertheless raised questions of ethical acceptability because of the many uncertainties, which still remain.

B. Public Freedoms and Cultural Identities

Professor U.R. Rao, President of the United Nations Committee on the Peaceful Use of Outer Space (COPUOS) and UNISPACE III, began by pointing out that spectacular development of science and space technology had had a significant impact on economic, social and cultural life and contributed to the creation of a “global village”. However, despite all these technological breakthroughs the world was still divided between North and South, the developed countries and the developing countries.

Cultural alienation and reduction of freedoms

Poor use of space could have a harmful effect on public freedoms and cultural identities. Vulnerable societies might undergo a perverse form of cultural alienation and suffer a reduction of freedoms. Globalization must not lead to the standardization of peoples and the disappearance of cultural diversities, which were an inestimable part of our heritage. That is why all the countries were encouraged to adopt a much more humane and equitable approach to development and to reflect in global terms, even if they went on to act locally.

Reflecting in global terms and acting locally

Drawing up a code of deontology

To avoid all risk of deviation, a code of deontology must be drawn up.

The technological revolution had permitted rapid access to a mass of information, which depended on the technical capacity of each country. Thus, rapid provision of data, notably on natural disasters, could be very useful and should be integrated into this code of deontology. Moreover, although the emergence of the “planetary village” should enable societies to be improved by strengthening friendship between peoples it did present a real threat. Poor use of information for the commercial, social and political exploitation of vulnerable societies was a real danger. Thus the artificial fixing of prices to make a quick profit, the destabilization of societies in a state of transition and all political interference with existing networks could create very serious imbalances. The confidentiality of information must be protected and suitable rules laid down for access to information and its use. This meant that space communication techniques must on no account be used to propagate subversive ideas and messages or for the development of terrorist and criminal activities.

Professor U.R. Rao concluded his presentation by pointing out that science and technology had not made societies more intelligent or more reasonable. With all the knowledge and information at our disposal today, the ethical issue that still remained was to know how the egoistic interest of each individual could be surmounted for the greater benefit of all mankind.

Electronic surveillance

The risk of misuse of satellite networks attracted the attention of participants to the extent that illegal activities must not be allowed to proliferate through these networks. Observation and electronic surveillance systems can be used to identify criminal or terrorist networks.

Misuse of surveillance technics encroaches upon individual freedoms

But this electronic surveillance is bound to pose problems for individual freedoms. It is now possible to intercept communication data transmitted by satellite to locate, by means of a positioning system, mobile telephone communications and even to identify the behaviour of individuals. These techniques formerly used by the military alone were today within reach of everyone with access to appropriate technical resources. Their misuse was liable to encroach upon individual freedoms. In this respect the determination of the frontier between legal and illegal surveillance, such as that of personal communications or those between businesses, was not easy. Everything must be done to avoid excessive controls in this matter, while allowing the States to ensure their security and maintain public order. However, emphasis was placed on the fact that surveillance of individuals was not a problem specific to space but inherent in modern society in the broader sense. Surveillance being inevitable, the management and control of data must be regulated by giving access in particular to cryptography.

Maintenance of cultural identities and preservation of cultural diversity

The use of space technologies did imply a risk of standardization of cultures but had a positive impact on cultural identities. Space technologies favoured the maintenance of cultural identities and the preservation of cultural diversity by giving access for immigrant communities or members of diaspora to the cultural messages of their communities of origin. But they also engendered the appearance of new identities, which must be combined with existing cultural identities. The bodies responsible for defining ethical principles must therefore make it clear that the distribution of information technologies at world level must guarantee respect for cultural identities and freedom of expression. However, problems may arise, not so much from the interaction between cultures as from the acceptability of the messages circulated: some of these messages, such as an apology for violence, paedophilia or even "soft pornography", were not acceptable but they were not easy to control or monitor and this raised a question of the right of individuals to have access to information.

Question of acceptability of messages

Space technologies and economic activities

Use of space resources for forecasting purposes

The system of monitoring economic activities by space technologies was also mentioned. Space is a major source of development through the forecasts which it enables to be made of the climate or agricultural productions and crops. Very significant benefits accrue from the use of space resources for forecasting purposes. The question arose as to who would benefit most from these advantages: the producers, consumers or intermediaries. Clearly the growth of forecasting capacity had as its corollary an increase in speculative capacity with the risk in turn that the already severe inequalities in this sphere would be further aggravated.

IV. SPACE AS A PERCEPTION

A. Benefits and Risks Associated with the Advances of Space Technology

Environmental impact of space technologies

Professor Ezio Bussoletti, Professor at the University of Naples and Director of the Institute of Experimental Physics, envisaged the impact of space technologies in three domains namely the environment, the economy and the consequences of their military use. As to the environmental impact, the consequences of man's intrusion into the Universe were raised. Professor Ezio Bussoletti also felt that the use of nuclear energy in outer space was the most important question arising in this area. As this use was inevitable the emphasis must be placed on risk management, which implied allowance for the sometimes negative role of the media as in the case of the Cassini probe. To avoid the harmful effects of media "scoops", information and education of public opinion and the media must be developed for preventive purposes.

Economic impact

From the angle of economic impact, the question of the true needs of a country in technological development with the financial consequences arose, as did that of the participation of the least favoured countries in this development. Control of access to space by a small number of countries affected the possibility of other countries to take part. In that sense, supranational bodies like the United Nations were able to find balanced solutions satisfying the interest of each State.

Military dimension of the use of space technologies

The military dimension of the use of space technologies was also evoked, to the extent that practically all space technology has two possible uses. The emphasis was placed on the need to define clearly the frontiers in this domain at a time when commercial applications are increasingly dependent on systems developed for military purposes.

Management of space data

In the course of the discussion, the management of space data, i.e. their acquisition, qualification and cost, was raised. In terms of the cost of access to data, the possibility of discrimination on the basis of use, as was the case in meteorology, was advanced again: depending on whether data acquisition took place for research or commercial purposes, access to the data would be free or against payment. While the acquisition of data is an important question, their protection through rules of intellectual property cannot be overlooked. Although outer space is common heritage of mankind, all the space technologies and the resulting expertise must be eligible for intellectual property protection. Here a problem of the method of appropriating space technologies arose, because at present one single country held a monopoly on the registration of patents for inventions or devices carried on board a satellite.

Protecting intellectual property

Risk management

Risk management, for its part, involved questioning the perception of risk and its subjective character, because this varied from one individual and society to another. In this regard, the role of the media was essential because of the risk that an event might be amplified. The problem of risk must therefore be demystified by making a difference between potential risk and certain damage to avoid panic reactions. Moreover, it was imperative to keep the public informed of the real risks and to open a clear and transparent dialogue between society and its different actors, each of whom has his own motivations. As to the legal qualification of responsibility, a distinction was made between risk and prejudice and the principle of responsibility for the risk was chosen; this is because, in the space sector, we clearly cannot wait for damage to occur before defining limits.

Role of media

Legal qualification of responsibility for risk

B. Communication and the Media

Ethics, a basis for reflection and a communication strategy

Professor Alain Pompidou reminded the meeting in his introduction that ethics were a basis for reflection and a communication strategy. The emotional context in which space exploration took place could not be disregarded to the extent that it was positive by stimulating a form of constructive and mobilizing imagination. However, it could also have a negative aspect if it generated unnecessary fears fuelled by disinformation. Ethics commanded us not to play on the credulity of individuals or societies and to avoid all mercantilism in the way in which data specific to science and technology, especially in the space domain, are presented. The perverse interaction between the media and the political world, because of their shared interests, was unacceptable. This interaction is all the more dangerous as the media and the political world by definition have a far greater ability to convince than the scientific community at large. Moreover, this phenomenon is aggravated by the absence of any reference to the State, which is no longer the only player today in space and is not the sole guarantor of moral integrity.

Interaction between the media and the political world

Professor Alain Pompidou felt that the response to the anxieties of public opinion required a particular approach because of the recent relativization of the reliability of the media, politicians and scientists. In this regard, he proposed a kind of specification for communication, permitting the transition from an emotional context to a rational and objective analysis based on explanation. This analytical phase must be a preliminary without media attention. Risks will then not be kept secret - quite the contrary. In the field of space, unlike the nuclear sector, the cult of secrecy must be avoided and a context of transparency created. To avoid all doubts and misunderstanding the provision of knowledge to the whole of society must be assured after this first phase in which agreement between the experts is sought, <u>through language accessible to the general public</u>. To that end, public debates or hybrid forums grouping together scientists, specialists in communication and public opinion should be organized via the media, which will then exercise their influence on a sounder basis because they will be more objective. <u>A culture of space based on a pedagogy of mediation</u> will then develop with the participation of the scientific community in the industrial world. It would enable men to enjoy the dream which is their rightful due in <u>an evolving context where we pass from immediate acceptance to accessibility over an extended period of time</u>.

From an emotional context to a rational analysis

Context of transparency

Culture of space and pedagogy of mediation

While supporting the observations made by Professor Alain Pompidou, some participants stressed the complexity of communication in space matters because of the component of dream and myth induced by space activities. It was therefore suggested that this communication should be effected through <u>scientific mediators</u> whose training could be assured by space agencies and who would have as their particular task the conduct of pluridisciplinary, or even hybrid forums, involving experts, politicians and citizens regardless of their form (televised debate, electronic networks etc.).

Scientific mediators

In parallel, the inadequate level of scientific training of some journalists had been criticized as a possible source of disinformation. That is why the idea of institutionalizing <u>an international training structure for scientific journalists was put forward</u>. Moreover a media training function could be performed by space agencies in the same way as the training

Training for scientific journalists

Education of public opinion

Television, teaching actions and electronic forums

of scientific mediators. More generally the promotion of a "space culture", presupposing a basic scientific culture, necessarily involved the education of public opinion. The important need here was for a pedagogic system. It is a well-known fact that being a teacher is not enough to play a pedagogical role. Indeed, pedagogy must lead to active and interactive training with a view to the discovery and understanding of phenomena that have been unexplained up to now. On the model of the work done by NASA, a television channel could be created and teaching actions and programmes for the benefit of young people in particular should be introduced. This would no doubt be rapidly supplemented by electronic forums.

V. CONCLUSIONS OF THE FIRST PART OF THE SEMINAR

Ethics consist in placing man at the centre of the debate

Man in movement

Before moving on to recommendations and ethical questions in the field of outer space, the meeting was reminded that ethics consisted in placing man squarely at the centre of the debate. Which kind of man was involved? The revolution of Copernicus followed by those of Darwin and Freud, all shared the feature that they had called into question man and anthropocentrism. Man had not been rejected but he had been set in motion. Space was, in a sense, a source of movement to the extent that astronauts had walked on the Moon and been sent out into space stations. Moreover with television, the emergence of new information and communication technologies and satellites, man has also acquired a telepresence: he exists through other means of perception than his immediate ancestors. We must therefore question this new nature of the human being, which is being created. People today must choose to become "human beings". No definitive definition of the human being exists. This creative humanism presupposes agreement on a number of points which are common to "man in motion".

Definition of ethical principles

For an interactive debate

Cooperation between space agencies and industrialists

Ethical filter

At the end of the discussions, the participants highlighted a number of key points and formulated questions with a view to the definition of ethical principles in the field of space:

1. the ethical arguments to be developed to avoid conflicts of society required the organization of an interactive debate between two groups, consisting firstly of scientists and industrialists and secondly of political decision-makers and public opinion;
2. the decision-making process presupposes the definition of procedures for co-operation between space agencies and industrialists;
3. the "ethical filter" was one of the parameters used in the strategy for decision-making such as technological feasibility, the cost-benefit ratio and the application of international law;

Space as a sanctuary?

4. as outer space was part of the common heritage of mankind, is there a specific character of space as a protected and inalienable sanctuary?

How to avoid duplication?

5. how can unnecessary duplication be avoided, with a view to the creation of an integrated planetary system for observation of the earth?

Which benefits for mankind?

6. can areas be identified in which space techniques can prove beneficial to mankind, such as the disposal of nuclear waste by transporting it into the solar system?

Ambiguous aspect of space technologies for environment

7. if space technologies pollute circum-terrestrial space, space research can perhaps contribute, by monitoring the environment, to a reduction of planetary pollution;

Limit of acceptability to public opinion and cost evaluation

8. to put in place the management of risks arising from the use of space techniques and space exploration, what is the limit of acceptability to public opinion and the maximum cost that the States and the industrial sector are willing to assume?

Procedures for access to data

9. in the framework of the use of space technologies, what procedures should be used for access to data and should they be based on equity and profit sharing?

Elaboration of space law

10. how can the elaboration of space law be taken further and knowledge improved with a view to better protection of intellectual property and respect for human rights?

PART TWO: SITTING OF 11 SEPTEMBER 1999

The aim of this sitting was to define the content of the ethical approach to space policy by giving industrialists and space agency managers an opportunity to explain their concerns in this area and respond to the questions put by the experts meeting on the previous day on the ethics of outer space.

I. THE EUROPEAN SPACE AGENCY (ESA)

Growing importance of the role of ethics in the field of outer space

The Director General of the European Space Agency (ESA), **Mr Antonio Rodotà**, first laid emphasis on the growing importance of the role of ethics in the field of outer space to the extent that space and the applications resulting from its use were involved in our daily life. He envisaged ethics as the emphasis on moral and spiritual values leading to equitable and harmonious actions. Ethics were an integral part of our life and must guide all human activities including those in the area of space where they have implications for future generations.

Necessity of a long-term planning

Outer space by its very nature is a field in which activities are pursued for the long-term, so necessitating long-term planning. Mr Rodotà went on to refer to the three main themes of the seminar, i.e. space as a dimension, space as an instrument and space as a perception. By envisaging space as

Space as a dimension

a dimension, Mr Rodotà stressed the need to define universally accepted rules for exploration. He then turned to the motivations underlying space exploration and manned space flights and the consequences of these missions, notably for the environment with electromagnetic pollution of space or the use of nuclear sources. Economic considerations alone were not enough; the cultural aspect must also be integrated into decision- making. Moreover the exploration of space must be for the benefit of all mankind; this means sharing the benefits of this exploration between all countries, regardless of their particular degree of development.

Space as a tool

Space is a tool whose applications are many faceted and daily. Mr Rodotà placed particular emphasis on the twofold impact of this instrument on cultural diversity, which it tended to standardize and also to enrich. Moreover space as an instrument engendered data for which access and availability in all countries were problematic because of the divergent interests involved.

Space as a perception

Finally the perception of space by public opinion presupposed effective information and explanation of the limits, the benefits and risks associated with space to enable the public to make informed choices and understand the issues of space policy. In this regard, democratic debates should be organized more often in society.

Ethics and strategy of space agencies

In the ensuing discussion, the role of ethics in the strategic work of the agencies was evoked in the sense that guidelines should underpin the strategic plans of the agencies and the allocation of resources. Moreover, some participants took an interest in the relationship between ethics and politics, considering that these two notions should be treated separately. Ethics allowed the limits, which must not be exceeded, to be defined. But politics sometimes failed to take account of ethical considerations.

Ethics and politics

The growing involvement of politics in the space domain raised the question of the sharing of data and information obtained from space.

Data sharing

It is not sufficient to have information: all the countries must have access to it and to the resulting benefits so that they share the same rights and opportunities. In this respect, UNISPACE III, the CNES and ESA had formulated proposals open to all with a view to sharing data obtained in space.

Difference between exploration and exploitation of space

Moreover, the difference between exploration and exploitation of space was highlighted in the sense that exploration which satisfied a need of human knowledge was subject to much less stringent limits than exploitation. The question of the pedagogic and educational action of ESA, notably in relation to young people, was also raised.

II. THE *CENTRE NATIONAL D'ÉTUDES SPATIALES* (CNES)

Working group on the ethics of outer space

Mr Gérard Brachet, Director General of CNES, felt that research and space activities raised a number of ethical questions, which must be identified in an endeavour to achieve satisfactory results. In this regard, the CNES had for several years begun to promote these ethical questions within its own bodies. It had created a working group to reflect on various subjects. They included the project for a mission to bring samples back from the planet Mars, which was of particular importance at present for the CNES. It raised many ethical questions relating in particular to the creation of precautionary and protective systems to avoid all contamination of the Earth or Mars. Such missions required information for the public, notably on their scientific interest. Mr Brachet also raised the question of space debris, which was dealt with by the Inter Agency Debris Committee, an organization bringing together practically all world space agencies in an endeavour to define rules of good conduct in the design of launchers or satellites themselves.

Decision-making and management process for space programmes

Mr Brachet also presented the decision-making and management process for space programmes at CNES. To avoid authoritarian decisions taken by technocrats, it was based on an interactive process calling for a deep and structured dialogue with the scientific community with a view to definition of the priorities for research and scientific programmes. Programmes with a strong commercial dimension did not lend themselves to the same approach as the initiative for their financing came from industry and the markets. The CNES concentrated its intervention on upstream technical research. In the area of space systems meeting public service imperatives such as meteorology or navigation, the process consisted in ensuring a good expression of needs by the community of public operators. The same mechanism for space programme decision-making and management applied to defence programmes, even if this field was less transparent. It was therefore up to the CNES to make sure that its decision-making and mission selection process was as scientific as possible. This implied a structured approach in which the objective of the mission was sufficiently well defined to build, on that objective, the initial concept of the system which appeared best adapted and most economical. In conclusion, Mr Brachet underlined the special attention, which must be permanently given to the programme decision-making process through a debate which must be rich and organized with the communities of users whoever they may be.

Special attention given to the programme decision-making process

Risk management

In the course of the discussion, the question of risk management was raised, with particular reference to the example of the decision to launch the Ariane rocket. The management of a project presupposed that the space agencies must question the acceptable level of risk, having regard to the extremely strong pressure from the market to which they were exposed. However, in the field of planetary exploration and scientific research in which the commercial dimension was not the main imperative, this question arose differently, i.e. from the angle of the notion of potential loss of the scientific mission. Be that as it may sound risk management implied a separation between the "safeguard" bodies and those responsible for implementing the technological instrument: the safety protection authority must be independent.

Separation between the safeguard bodies and those responsible for implementing the technological instrument

Moreover, the wish for closer ties between space agencies and various institutions whose purpose is to make scientific information known to the public was expressed, with a view to opening the process of scientific mediation.

Scientific mediation training

No links between the ethical approach of the CNES and the formulation of international law had yet been established because of the recent and insufficiently developed character of the reflection necessitated by them.

III. THE EUROPEAN COMMISSION

As a preliminary remark, **Mr Joël Hamelin**, the Delegate for Space Co-ordination, pointed that the Commission was not a space agency. It approached space from the angle of applications and strategic economic and cultural consequences for society and the European Union in particular. As a regulatory body and for the conduct of its policies, the Commission was fully concerned by the debate on ethics of outer space. It was convinced that space activities could only be developed in a precise legal framework underpinned by an ethic that was clearly accepted by everyone concerned.

A precise legal framework for an ethic accepted by everyone concerned

Among the concerns expressed by the Working Group on the Ethics of Outer Space, the Commission was itself involved in a number of fields, namely the use of space techniques to protect the environment and prevent major risks – this involved the definition of minimum global monitoring of the environment and major risks and an ethic of access to data; the use of space techniques to guarantee security of means of transport, damage to the environment caused by space techniques for the circum-terrestrial environment (waste) and protection of the private sphere and preservation of cultural identities.

Protecting the environment and preventing major risks

Securing data and protecting private sphere

The discussion enabled relations between the European Space Agency (ESA) and the Commission to be raised. This was being established gradually and presupposed a definition of their respective competencies.

Some of the participants spoke of the desirability of drafting a body of European Law on space, taking as an example the protection of intellectual property in on-board equipment which was covered exclusively by an American legal provision. More generally, it was suggested that the European

Opportunity of an European law on space

Commission should consider a more comprehensive body of law on space and the improvement of its knowledge with a view to better protection of intellectual property and respect for human rights.

Environmental data

Among the subjects dealt with by the European Commission, the question of environmental data and more particularly their use for environmental control purposes was becoming a strategic objective. Through the policy on data, the implications of observation of the Earth were being approached in a new way.

IV. THE GERMAN SPACE AGENCY

Current state and future development of space law

Principles of non-discrimination and equity

Mr Kai-Uwe Schrogl, Delegate for the German Space Agency to the United Nations Committee on the Peaceful Use of Outer Space (COPUOS), focussed his address on the current state and future development of space law. He took as his starting point the Treaty on Space drawn up in 1967 at the start of the space era, which remained the fundamental charter of space law. He laid emphasis on the principles of non-discrimination and equity embodied in that treaty and he felt that in future new treaties could not be drafted because they would risk calling into question existing principles. But it would be desirable for space law to focus on specific matters such as space debris, the legal concept of the launcher country or the status of low orbits from which general principles will then be drafted and put to the vote within the United Nations Organization. On that basis the implementation and further definition of technical specifications could be entrusted to the international bodies concerned.

Non-appropriation of space

Space for the benefit for all mankind

The importance of the key principle of non-appropriation of space embodied in Art. 2 of the Space Treaty of 1967 was underlined, because of the threat of weakening of this principle that existed today, for example through the sale of plots of land on the Moon by certain companies. Even if this type of initiative caused us to smile rather than eliciting any other reaction, it was in complete contradiction with the principle of non-appropriation. Any infringement of that principle was liable not only to deprive of all content one of the foundations of space law but was also dangerous. Space must be and must remain a benefit for all mankind.

Responsability: towards an unlimited liability

Some speakers raised the question of the determination of the bodies responsible for damage: the principle of responsibility of the launch country might no longer be appropriate to the situation prevailing today because of the existence of consortiums. This posed the problem of the identification after the event of the companies or businesses responsible. That is why the possibility of having unlimited liability must be envisaged. More generally in future the key to orderly behaviour in space rested on the fact that all the countries pursuing space activities must have coherent legislation.

Education and training of public opinion to space law

Knowledge of space law involved the education and training of public opinion. Its application presupposed the ratification by the largest possible number of countries of the relevant legal instruments. Space agencies must play a leading role in this field. Moreover, attention was called to the need for ethics to precede and guide law so as to avoid any regulation of ethics. Moreover, the dichotomy which sometimes exists between the actions that are permitted by law and the way in which the space agencies act was raised, taking as an example the use of nuclear energy sources.

V. ARIANESPACE

Principle of safeguarding persons and assets whenever a launch takes place

Mr Jean-Marie Luton, Chairman and Chief Executive of Arianespace, outlined the activities of this organization briefly. They are guided by certain criteria such as that of their peaceful aspect and to the general principle of safeguarding persons and assets whenever a launch takes place. The judgement on this safeguarding is taken by an independent authority and the separation between the supervisory bodies and those responsible for operations is essential.

Pollution management and technical as well as economical performances

Mr Luton outlined his industry's policy on space debris. The principle was to generate no more than one piece of debris per launch and to reduce the life cycle of debris. This was not a neutral position because it resulted in reductions of technical performance and an adverse trend of economic performance which caused competitive distortions.

Competition between the development of terrestrial and space resources

Mr Luton also stressed the permanent competition between the development of terrestrial and space resources. In this regard, the specific benefits of space systems must not be destroyed. The elaboration of ethical norms led to the weighing up of their consequences on the different systems by avoiding any privilege for certain players in increasingly stringent international competition. Moreover in Europe financing from the military market was very limited because the military now drew upon technological progress in civilian industry to implement their projects. The situation in the United States was the exact opposite, as it was for other space powers.

Norms and standards applicable to all concerned

Risk of distortion of competition

The discussion revealed the need for industrialists exposed to very keen competition to have norms and standards applicable to all concerned in whose drafting they would play their part to avoid any risk of distortion of competition. However, the risk of over-regulation to reassure public opinion must be avoided. This presupposed education of public opinion by explanation and scientific mediation.

Turning to commercial practices, some participants felt that it was in the interest of industrialists to leave this matter to the framework of the commercial discussions between countries and the World Trade Organization (WTO).

VI. ALENIA AEROSPAZIO

Mr Franco Malerba, an astronaut and former Member of the European Parliament, representing Alenia Aerospazio, felt that industrialists should work in close co-operation with the different players in the space industry. They must not themselves be charged with the definition of ethical rules, which must come from society. The ethics of the business and the ethics of society come together at a given point in time. Every space venture can legitimately question the desirability of its activities, which admittedly represent a market but also enable greater knowledge to be gathered on the environment and the development of telecommunications promoted. Space systems know no frontiers, unlike terrestrial systems. Nevertheless they all tend towards universal solutions. That is why space must be a domain for all mankind. In this connection, Mr Malerba stressed the importance of equality of access to space and equality of opportunities in competition. He evoked the appropriation of space and commercial motivations, which underlay the exploitation of space. This economic aspect must not be overlooked because it is necessary to attract investments enabling new scientific or technical experiments to be launched. He then turned to the links between sustainable development and space. Alenia is concerned with the protection of outer space to the extent that the international space station is liable to be endangered by space debris. That is why the logistic module built in Italy for the station was equipped with a shield. This had an impact on its weight and on the whole concept of the project.

Ethics of business and ethics of society

Space, a domain for all mankind

Sustainable development, environment and space

Culture and education

The questions of culture and education were raised. Space activities had created a manifest dynamic, accompanied by the appearance of many local television stations. This dynamic must not be hampered by the development of excessively extensive and even contradictory legislation notably for reasons of territorial protection.

The public is interested in the space adventure and the space agencies have an excellent opportunity to make greater allowance for that interest and promote greater awareness. Space has made public opinion more aware of the fragility of our environment.

Elaborating an ethical code

Moreover the definition of an ethical code would be useful and must flow from international consultations to avoid all the drawbacks associated with the proliferation of different codes from one country to another.

Appropriation of space and intellectual property rights

The discussion focussed primarily on the question of the appropriation of space and intellectual property rights, which must be modulated if the risk creates an obstacle to the development of further space research. Some participants felt that the same rules of intellectual property should be applied to space as those, which are applied to other forms of creation, although perhaps with still greater vigilance. The case of intelligent orbits for which the technique had been patented was quoted as an example. Turning to imaging, attention was drawn to the fact that everything that is photographed or captured in space is not available free of charge and that a commercial logic seems justified if private funds are used.

Moreover the strategy underlying the construction of international space stations which would enable the community of space users to be broadened was also the subject of some further consideration. So far this station fell within the domain of more or less confidential scientific information, and the public was not necessarily very sensitive to it. That is why in future an effort of advertising information and explanation would be necessary.

A culture of space to shape the "man of tomorrow"

Some commentators felt that it was necessary first to take stock of activities in space to fit them into a moral or ethical frame. This must be done constructively by making sure not to impose prohibitions only. This is all part of a "culture of space", which tends to shape the "man of tomorrow".

VII. AEROSPATIALE MATRA

Industrialists and the ethics of space

Industrialists' concerns

Equitable competition and keeping in a reasonable proportion technical or economic constraints

Given the civilian and military nature of its activities, Aerospatiale Matra is faced with choices of technology design and architecture which pose ethical problems in some cases. **Mr Frédéric d'Allest,** Advisor to the Supervisory Committee for Space Affairs, felt that industrialists had in their own interest a contribution to make to the definition and implementation of an ethic of space. Industrialists had a duty and a responsibility to contribute, alongside all the space agencies and their clients, to the identification and management of the risks and problems that might result from the equipment built by them. They must also draw up, in co-operation with the space agencies, codes of conduct or even international regulations. This meant keeping in mind the need for transparency and communication with society while having regard also to the concerns of industrialists. These concerns sought to maintain conditions of equitable competition and to keep in a reasonable proportion the technical or economic constraints, which are or would be imposed because of a real objectively evaluated risk. Mr d'Allest also felt that the space agencies had a major role to play in encouraging reflection by

Role of space agencies

the States. They must advise and enlighten States on their space policy. Moreover, they may serve as relays for the industrialists to develop and implement codes of conduct. He also stressed the fact that a definition of ethics should be part of a positive approach and that a purely reproving attitude towards commercial and industrial exploitation of space must not be adopted. Like science, this was a motor of space exploration. The fact is that without reasonable commercial activity civilian observation of the Earth was unlikely to develop much further.

A definition of ethics within a positive approach

Rapid access to space data on the occurrence of certain events such as natural disasters

The importance of developing a positive approach, while avoiding all criticisms of the commercialization of space activities, was taken up by others during the discussion. In this respect, some participants hoped that on the occurrence of certain events such as natural disasters, rapid and quasi-free circulation of information would be possible. Other more commercial activities such as the surveillance of crops did not necessarily obey the same political approach. Other participants imagined the possibility of having compensatory mechanisms by which the most privileged players would pay for those who were more deprived: this would permit the implementation of the principle of equity going beyond commercial aspects to reduce disparities between countries. The practice followed by Eumetsat towards non-member countries which have to pay for data if they are rich, while enjoying free access if they are poor, was quoted as an example.

VIII. Case Study

Elaboration of a communication strategy

Risk management

Space activities challenge

Scientific mediation

Before closing the seminar, a case study enabled the participants to reflect on the communication strategy to be adopted in relation to public opinion and the media if the debris from a space station claimed victims when it fell back to Earth. Such an event would pose the problem of responsibility for risk management and that of the issues involved in space activities. It would require the creation of a committee of enquiry to elucidate the causes of this incident and to propose actions to reduce risks and ensure that space activities no longer presented an objective danger. The exceptional character of such an event should also be highlighted and the initial challenge recalled. It was found that further consideration of the aspects of communication, scientific mediation and explanation of risk management was vital to prepare and provide transparent and objective information for public opinion on the occurrence of incidents or accidents.

Conclusion

In conclusion, H. E. Mrs Vigdís Finnbogadóttir, welcomed the interest shown by the participants in the rights of man and in the role of the citizen in future. She pointed out that the work

Defining good practices

of COMEST was in part to define good practices and that it was vital for COMEST to be able to communicate with the public from now on. It must be able to supply public opinion with broader information about its activities to create a sense of responsibility and an awareness of the issues involved. This awareness was particularly important in relation to young people since in the next decades people under the age of 20 would represent the biggest segment of the world population and they would not necessarily be sufficiently mature to take decisions on the ethics of technologies. In that perspective, Mrs Vigdís Finnbogadóttir advanced the idea of developing the concept of ethical guides who could be the "Socrates of modern times" and encourage public opinion to find the answers to its questions.

Concept of ethical guides

Mrs Vigdís Finnbogadóttir concluded the Seminar on the Ethics of Outer Space on an optimistic and poetic note by pointing out that the early years of each century were always a highly dynamic period and that science and poetry were related because, each in their own way, they presented visions and hopes for the future.

TECHNICAL ANNEXES

1. Launchers: the example of Ariane
2. Earth watch satellites
3. Communications satellites
4. Distribution of the market for satellite navigation equipment and services
5. Space systems for observation of the Universe
6. Manned flights
7. Space stations
8. Space debris
9. Space budgets
10. General presentation of the European Space Agency (ESA)
11. Scientific missions and long term programmes of the European Space Agency

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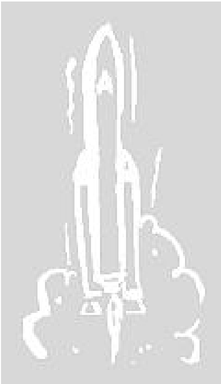
TECHNICAL ANNEX I

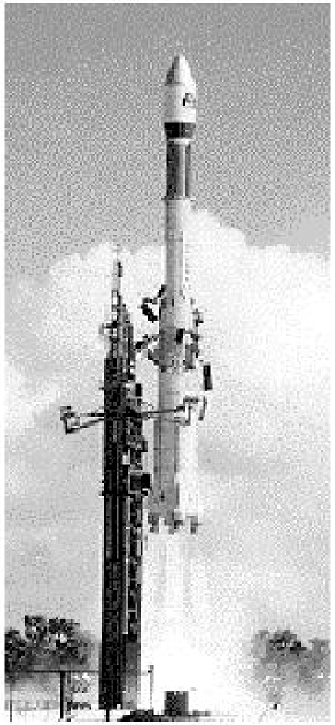
LAUNCHERS: THE EXAMPLE OF ARIANE

Ariane success story

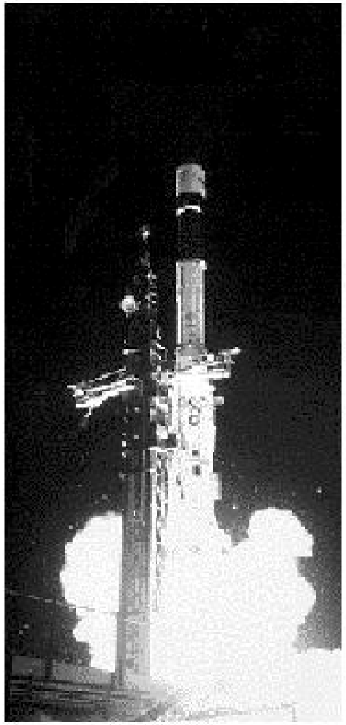


- ESA is responsible for development of all Ariane launchers and for the production and testing facilities.
- Ariane maiden launch on Christmas Eve 1979
  To date (02/2000) 126 Ariane flights have launched 216 satellites, successfully placing 199 in orbit.
- Ariane 4
  • modular concept
  • up to four liquid or solid propellant strap-on boosters
  • ideal for today's communications, Earth observation and scientific satellite launch market.

Ariane sucess story

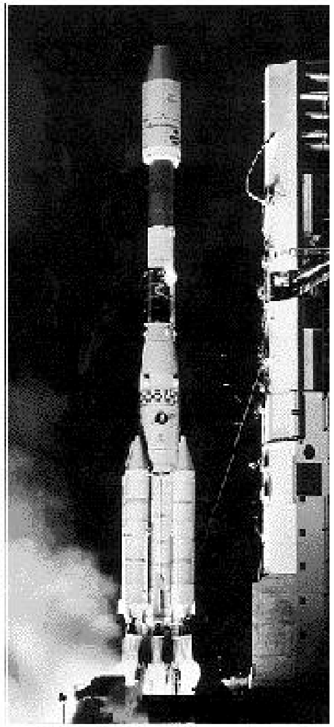


AR1 . LO6

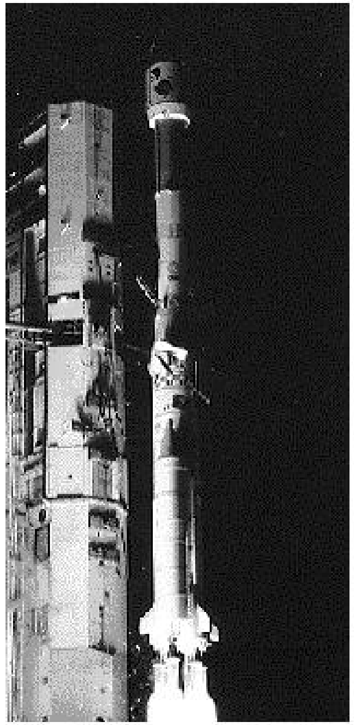


AR2 . V26

AR3 . V10



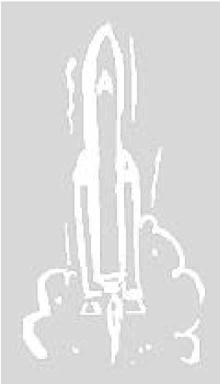
AR4 . V50



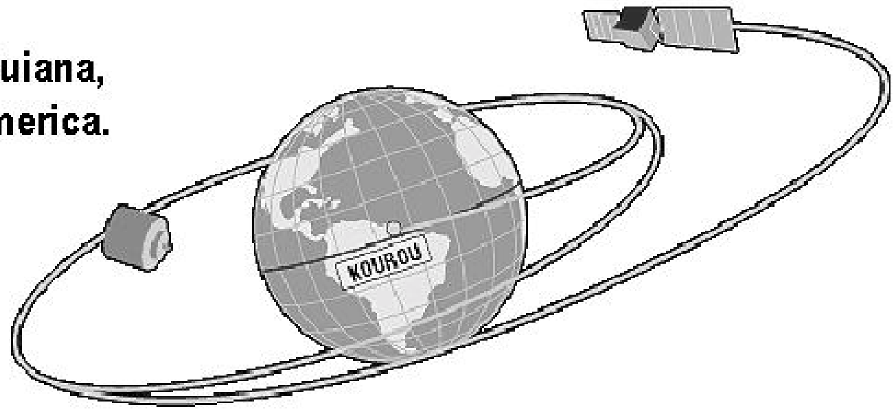
AR4 . V100

Europe's spaceport

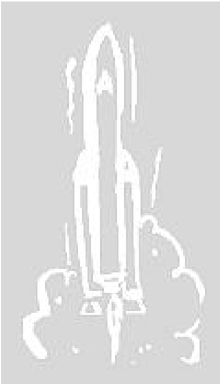
(Centre Spatial Guyanais - CSG)



- **Location : French Guiana, South America.**
- **Sites :**
  ELA 2 - Ariane 4
  ELA 3 - Ariane 5
- **Launch capacity :**
  12 per year from ELA 2
  8-12 per year from ELA 3
- **Proximity to the equator gives :**
  - **Payload mass gain**
  - **Increased satellite lifetime.**



Ariane launch log - 1



ARIANE-1

LO1 24.12.79
LO2* 23.05.80
LO3 19.06.81 / METEOSAT-2
LO4 20.12.81 / MARECS-A
L5* 10.09.82 / MARECS-B1
L6 16.06.83 / ECS-1
L7 18.10.83
V8 04.03.84
V9 23.05.84
V14 02.07.85 / GIOTTO

ARIANE-2

V20 21.11.87
V23 17.05.88
V26 28.10.88
V28 17.01.89
V30 02.04.89

ARIANE-3

V10 04.08.84 / ECS-2
V11 09.11.84 / MARECS-B2
V12 08.02.85
V13 08.05.85
V15* 13.09.85 / ECS-3
V16 22.02.86
V17 28.03.86
V18* 30.05.86
V19 16.09.87 / ECS-4
V21 12.03.88
V24 22.07.88 / ECS-5
V25 08.09.88
V32 12.07.89 / OLYMPUS

216 Satellites have been carried on 126 ARIANE flights
***Launch failure**

Ariane launch log - 2

ARIANE-4

V22 15.06.88 / METEOSAT-3
V27 11.12.88
V29 06.03.89 / METEOSAT-4
V31 05.06.89
V33 08.08.89 / HIPPARCOS
V34 21.10.89
V35 22.01.90
V36* 22.02.90
V37 24.07.90
V38 31.08.90
V39 12.10.90
V40 20.11.90
V41 15.01.91
V42 02.03.91 / METEOSAT-5
V43 04.04.91
V44 17.07.91 / ERS-1
V45 14.08.91
V46 26.09.91
V47 29.10.91
V48 16.12.91
V49 26.02.92
V50 15.04.92
V51 09.07.92

V52 10.08.92
V53 11.09.92
V54 28.10.92
V55 01.12.92
V56 12.05.92
V57 24.06.93
V58 22.07.93
V59 26.09.93
V60 22.10.93
V61 20.11.93 / METEOSAT-6
V62 18.12.93
V63* 24.01.94
V64 17.06.94
V65 08.07.94
V66 10.08.94
V67 09.09.94
V68 08.10.94
V69 01.11.94
V70* 01.12.94
V71 28.03.95
V72 21.04.95 / ERS-2
V73 17.05.95
V74 10.06.95

V75 07.07.95
V76 03.08.95
V77 29.08.95
V78 24.09.95
V79 19.10.95
V80 17.11.95 / ISO
V81 06.12.95
V82 12.01.96
V83 03.02.96
V84 14.03.96
V85 20.04.96
V86 16.05.96
V87 15.06.96
V89 09.07.96
V90 08.08.96
V91 11.09.96
V92 13.11.96
V93 30.01.97
V94 01.03.97
V95 16.04.97
V96 03.06.97
V97 25.06.97
V98 08.08.97
V99 02.09.97 / METEOSAT-7

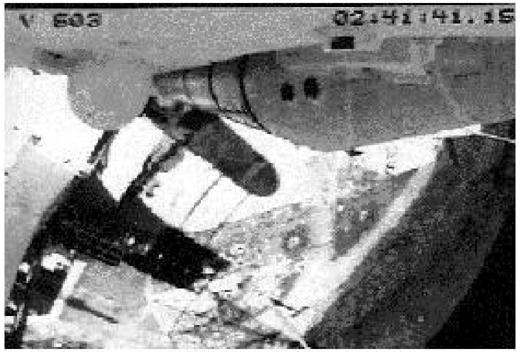
V100 23.09.97
V102 12.11.97
V103 02.12.97
V104 22.12.97
V105 04.02.98
V106 27.02.98
V107 24.03.98
V108 28.04.98
V109 25.08.98
V110 16.09.98
V111 05.10.98
V113 28.10.98
V114 06.12.98
V115 22.12.98
V116 26.02.99
V117 02.04.99
V118 12.08.99
V120 04.09.99
V121 25.09.99
V122 19.10.99
V123 13.11.99
V124 03.12.99
V125 22.12.99
V126 24.01.2000

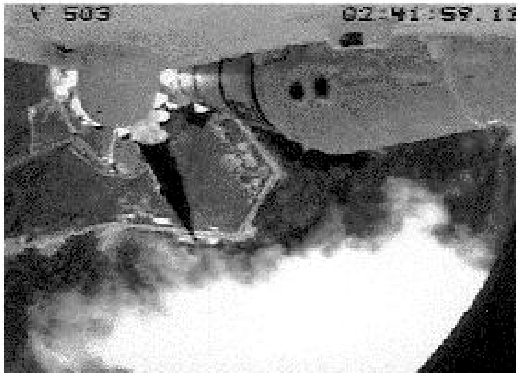
*Launch failure

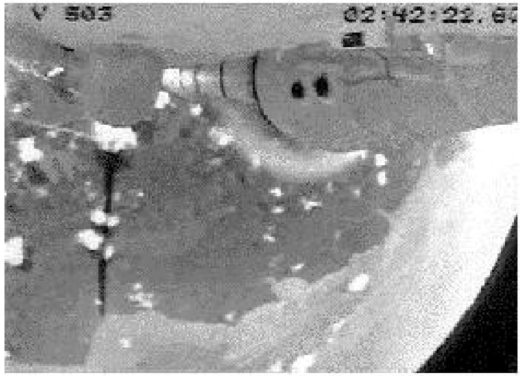
Ariane launch log - 3

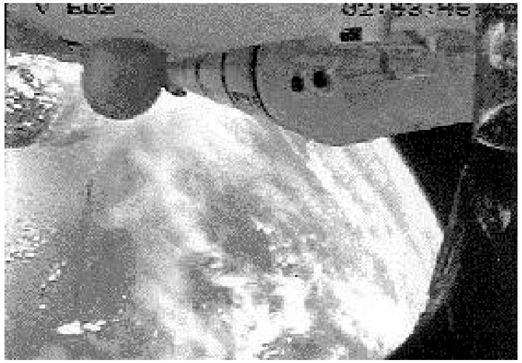
ARIANE-5

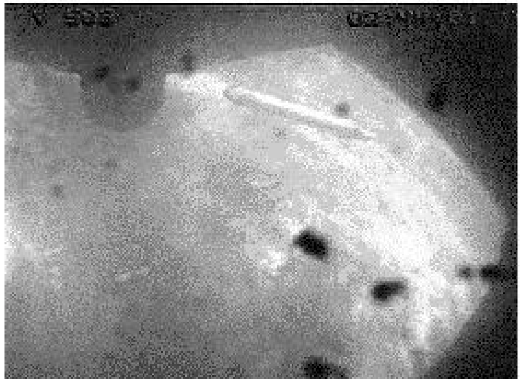
V88* 04.06.96 / CLUSTER
V101 30.10.97 / TEAMSAT
V112 21.10.98 / ARD-MAQSAT
V119 10.12.99 / XMM

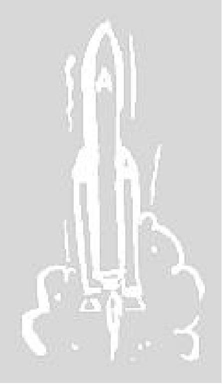




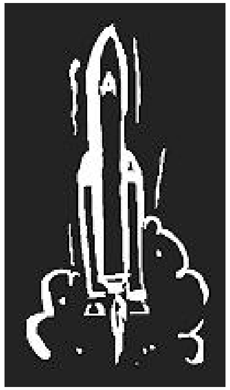






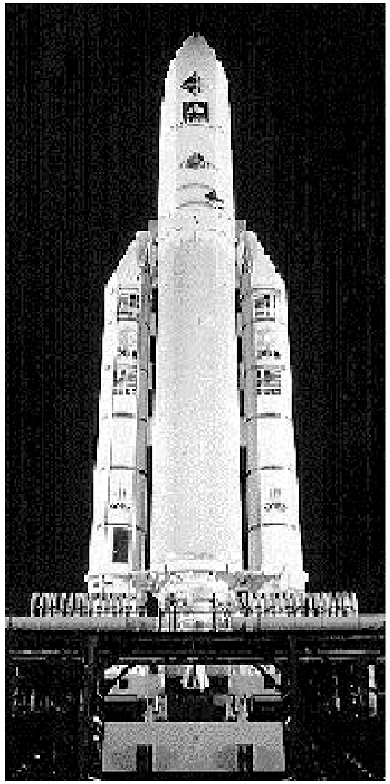


Ariane 5 : a new launcher designed for the 21st century



Ariane 5 designed from the outset to meet the needs of the future launch market:

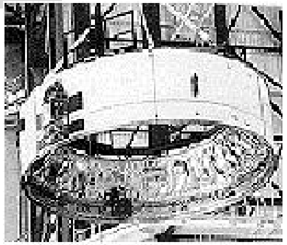
- Increased GTO mission payload list capability
- Cost-effective dual launch of three tonne class satellites
- High reliability
- More economic



First qualification flight (501): 4 June 1996 (failure)
Second (502): 30 October 97
Third (503): 21 October 98
Production/exploitation phase started by Arianespace in 1999 with first commercial flight (504).

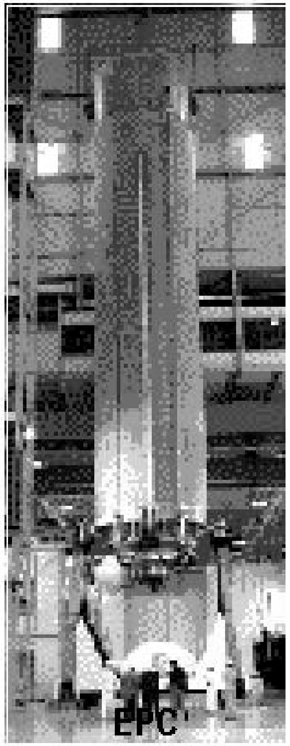
Ariane 5 : a new launcher designed for the 21stcentury

VEHICULE EQUIPMENT BAY

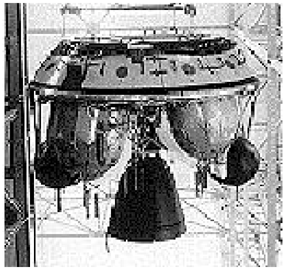


SOLID BOOSTER

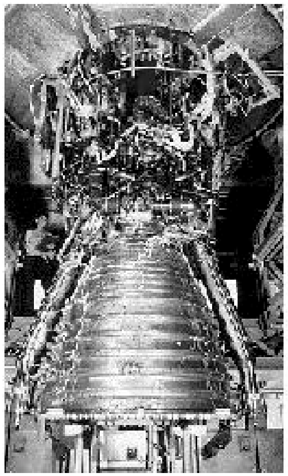
CRYOGENIC MAIN STAGE

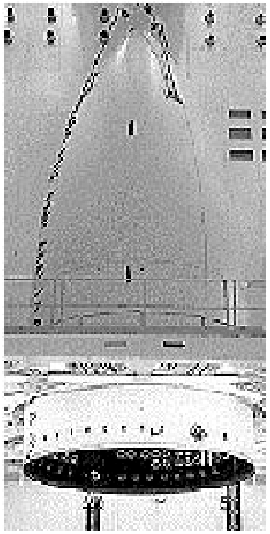


STORABLE PROPELLANT STAGE



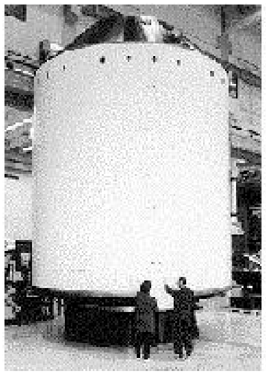
VULCAIN ENGINE

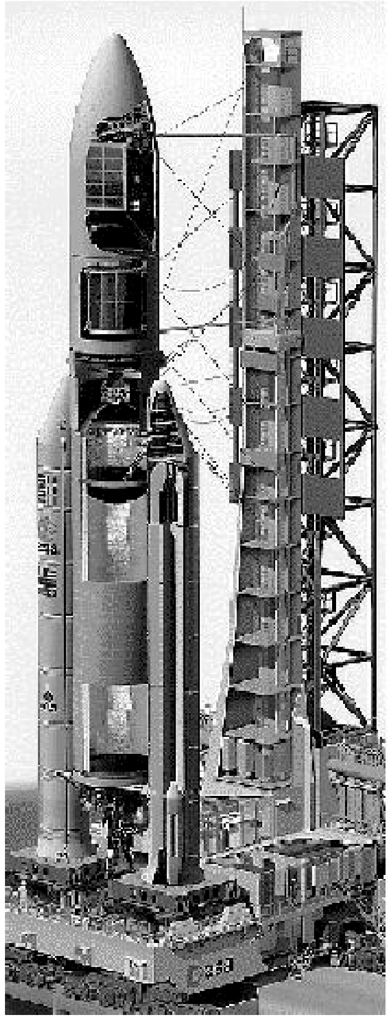




FAIRING

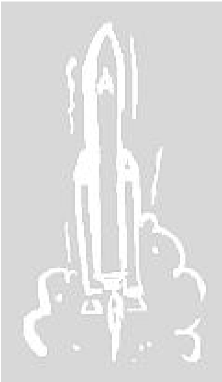
EXTERNAL BEARING STRUCTURE





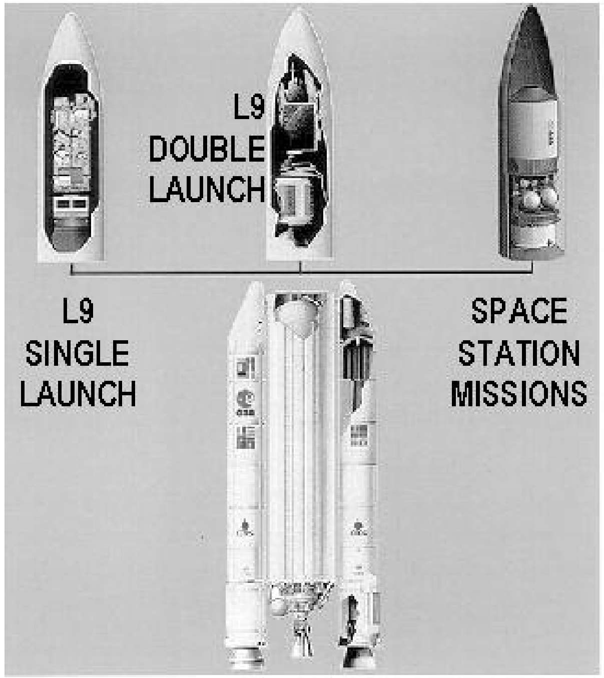
ARIANE 5

Ariane 5 : missions



Main Ariane 5 missions :

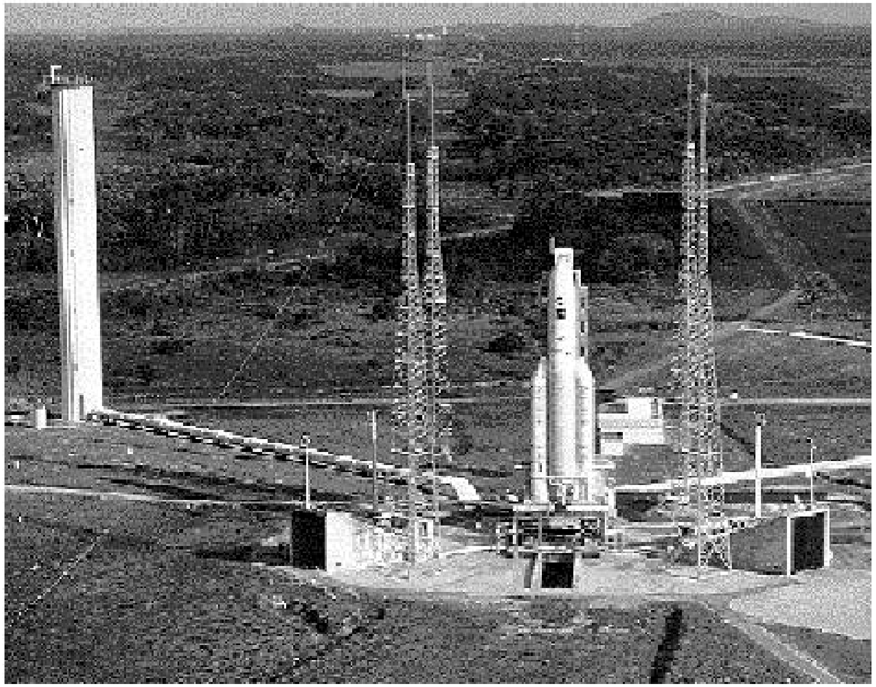
- Launch of communications, Earth observation and scientific satellites into geostationary and sun-synchronous orbits
- Launch of ATVs (automated transfer vehicles) to service the international space station



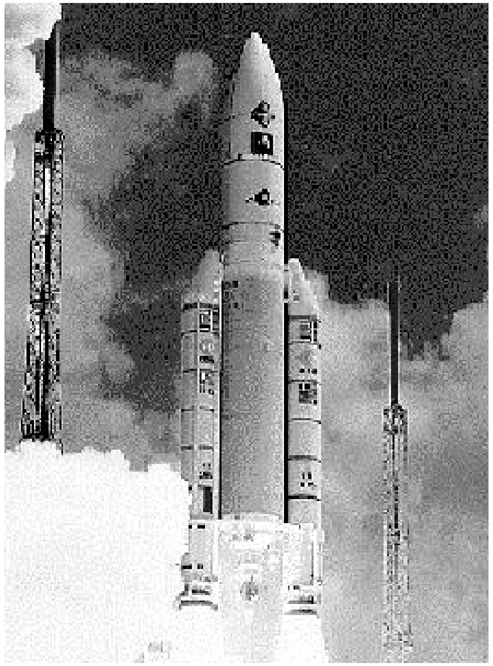
Development of the Ariane 5 launcher, its production facilities and new launch site (ELA-3) in Kourou were financed by ESA.

Near ELA-3, ESA has built manufacturing facilities for the 230t solid boosters.

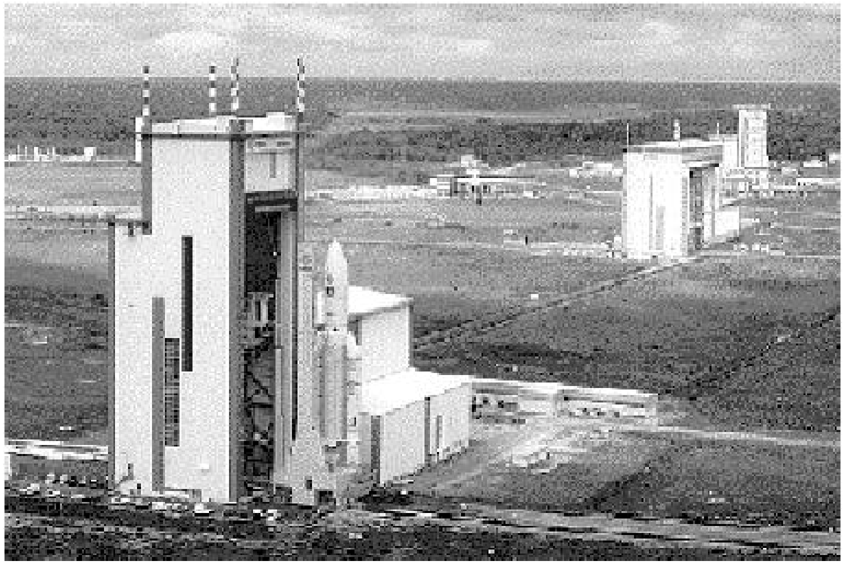
Ariane 5 : a new launcher designed for the 21st century



ZL 3

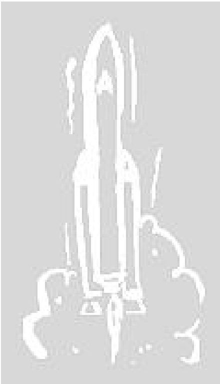


LAUNCH 503



BAF

Ariane 5 : complementary programmes

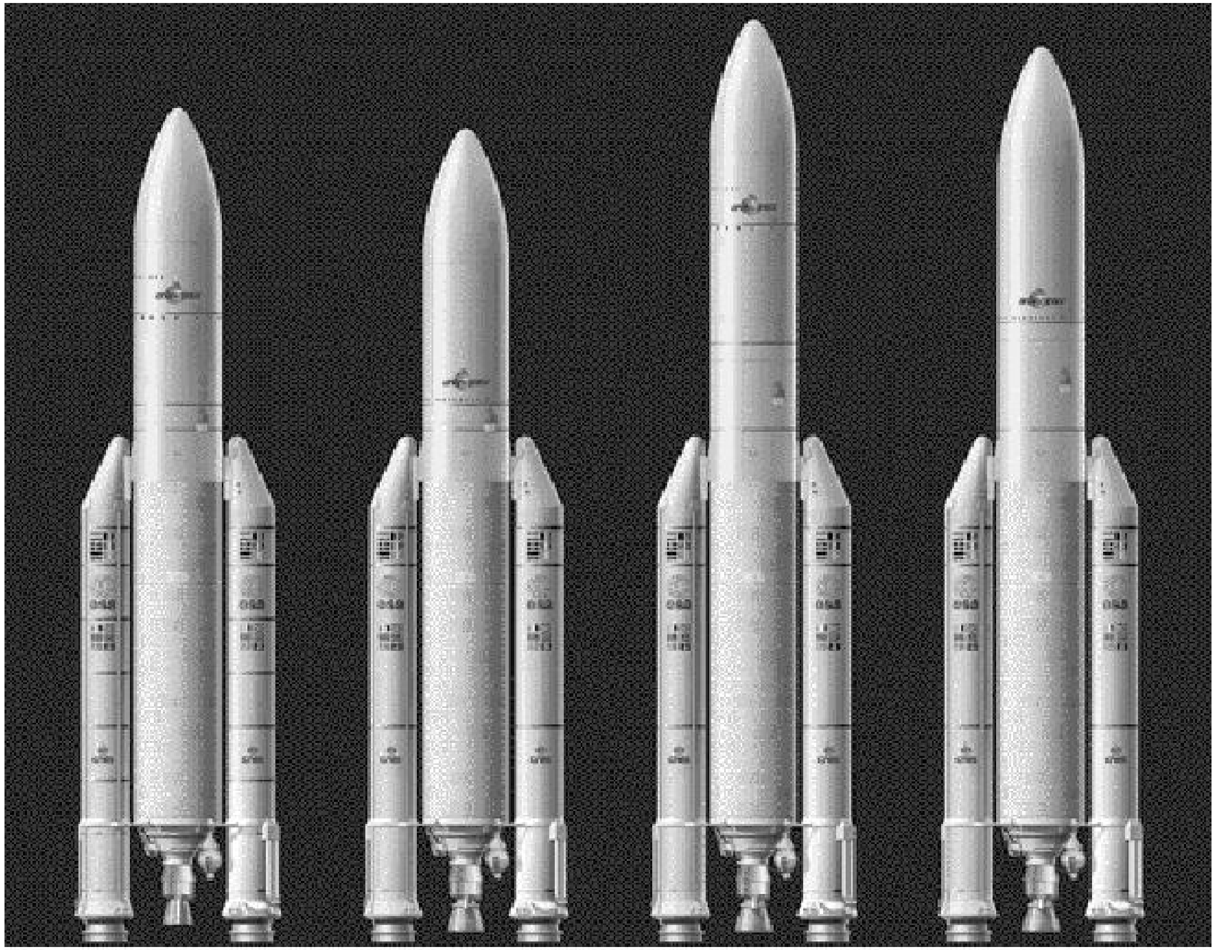


- Decided by ESA Council meeting at Ministerial level in October 1995 :
  AR5 - EVOLUTION
  - In order to cope with mass increase of sat coms and maintain dual launch possibility GTO performance increased from 5970 to 7400kg (1st launch 2002)

- ARTA - AR5
  - Based on 10 years of experience with similar AR4 programme
  - Aiming at guaranteeing launcher qualification through critical elements tests
  - Taking care of suppliers' obsolescence

- AR5 - INFRASTRUCTURE
  - Ensuring the maintenance of ESA-owned production and launch facilities

Ariane 5: Evolution



ARIANE 5	ARIANE 5 ES	ARIANE 5 ESC-A	ARIANE 5 ESC-B
Speltra - Short fairing	Long fairing	Long Speltra - Short fairing	Long fairing
Introduction: 2000	Introduction: 2002	Introduction: 2001	Introduction: 2005
Lift capability: 5970 Kg.	Lift capability: 7600 Kg.	Lift capability: 10 000 Kg.	Lift capability: 12 000 Kg.

TECHNICAL ANNEX II

EARTH WATCH SATELLITES

The quest for information about the earth

ESA has developed the Meteosat series of weather satellites, the environmental monitoring satellites ERS-1 & 2, and prepares for the future, ENVISAT, MSG and METOP to provide tools for :

- Meteorology
- Environmental & climate monitoring
- Earth resource management & other applications

Europe's first weather satellites

- The first Meteosat was launched in 1977. Five more followed and the seventh was launched in 1997.

- Placed in geostationary orbit they are designed to :
  • Take pictures of the Earth every 30 minutes
  • Distribute meteorology data
  • Collect environmental data recorded by automatic ground stations

- Eumetsat owns and exploits the Meteosat satellites.

Cooperation with EUMETSAT

ESA is cooperating with Eumetsat, the European Organization for the Exploitation of Meteorological Satellites on the development of two new series of meteorological satellites :

- MSG (Meteosat Seconde Generation) : will be a sequence of geostationary meteorological satellites with improved performance with respect to the current Meteosats, to be launched as from the year 2000.

- METOP (Meteorological Operational Polar Orbiting Satellites) : will be an European suite of polar orbiters embarking a very comprehensive meteorological payload provided by Europe and the USA. The first launch is foreseen in 2003.

A radar view of the Earth

ERS-1 (European Remote Sensing satellite) was launched in 1991. It uses radar instruments to survey the Earth's surface day & night and in all weather conditions.

A second ERS satellite (ERS-2), was launched in 1995.

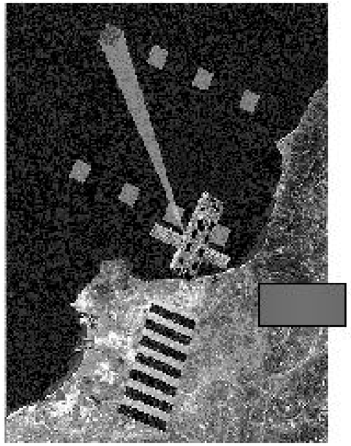
- Same missions as ERS-1
- Additional ozone monitoring instrument (GOME)

A constant flow of data provides information on status and changes of :

- Ocean currents & sea surface
- Polar ice caps & ice movementis foreseen in 2003.

ENVISAT: focusing on the environment

ENVISAT is the most ambitious Earth observation satellite ever designed in Europe and weighs in at over 8 tonnes.
It will be launched towards mid-2001 by an Ariane-5 in a quasi-polar orbit at an altitude of 800 km.
It will carry a payload weighing over 2 tonnes and consisting of 9 instruments of advanced design, which will provide:

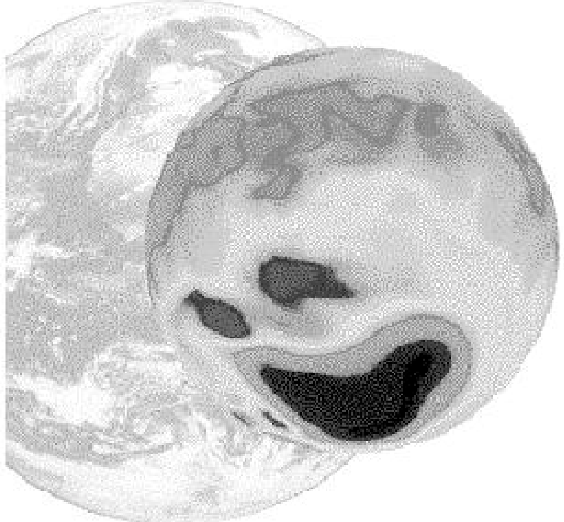


- a smooth transition from the measurements taken by ERS-1 and ERS-2 (radar in particular)
- new data on marine biology and atmospheric chemistry.

It will, along with ERS-1 and ERS-2, provide a continuous supply of services to scientists and operational users over a period of more than 15 years:

- Crop inventories and forest management
- Tropical deforestation
- Natural disasters / damage assessment (flooding, forest fires, earthquakes, volcanic eruptions, etc.)
- Generation of digital terrain models (DTMs)
- Ozone layer / monitoring of ozone layer depletion.

Looking at the Earth… …in a different way



What happens post-ENVISAT?
The future ESA Earth Observation Programme
The Living Planet Programme

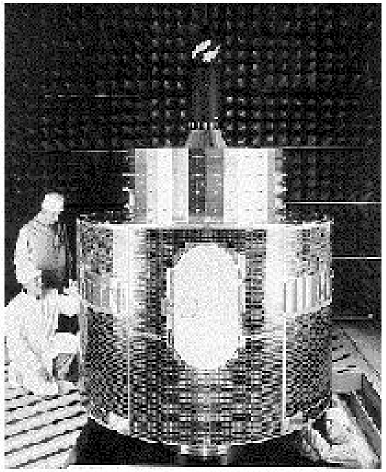
– Created in consultation with the key players
- Europe's scientists
- Industry
- European Commission
- EUMETSAT and many others

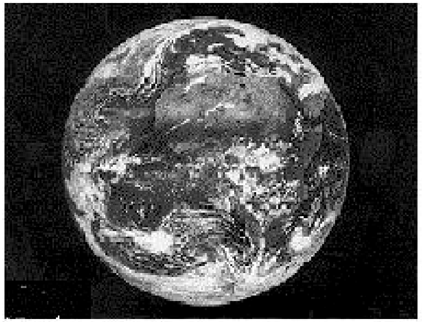
The first missions:

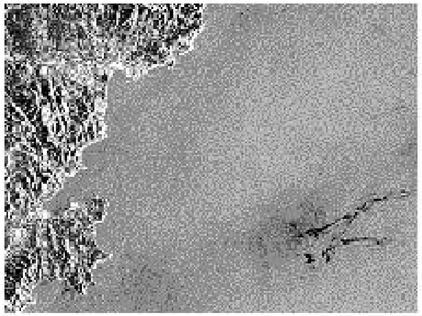
- Cryosat: Assessing the Polar Ice,
- GOCE: Gravity and Ocean Circulation,
- SMOS: Soil Moisture and Ocean Salinity,
- ADM-Aeolus: Measuring the winds at all altitudes.

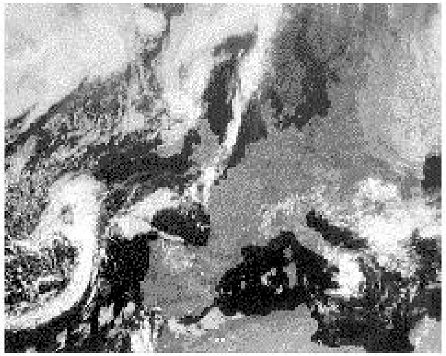
A view of the Earth

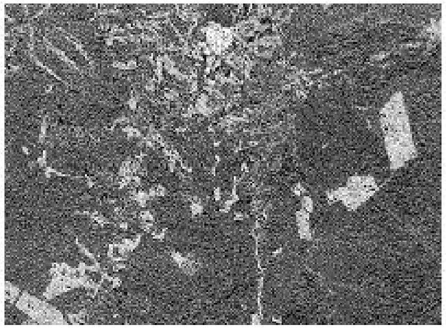
METEOSAT



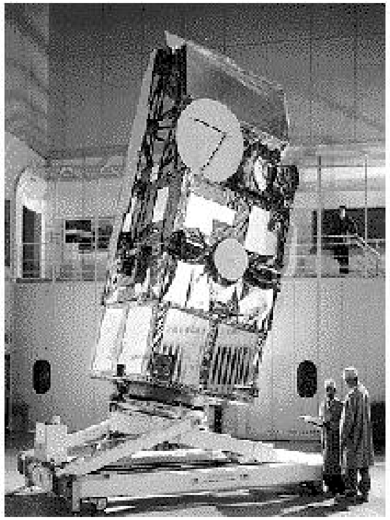




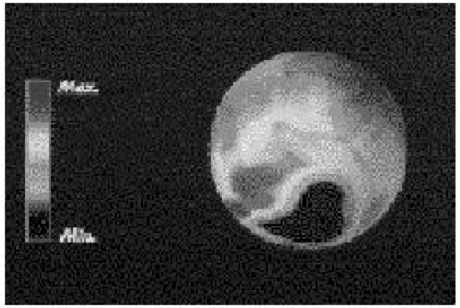


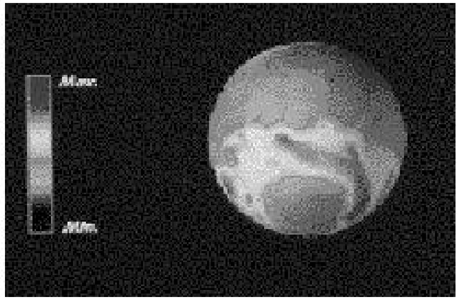


ERS-1



ERS-2
GOME - 3/09/95

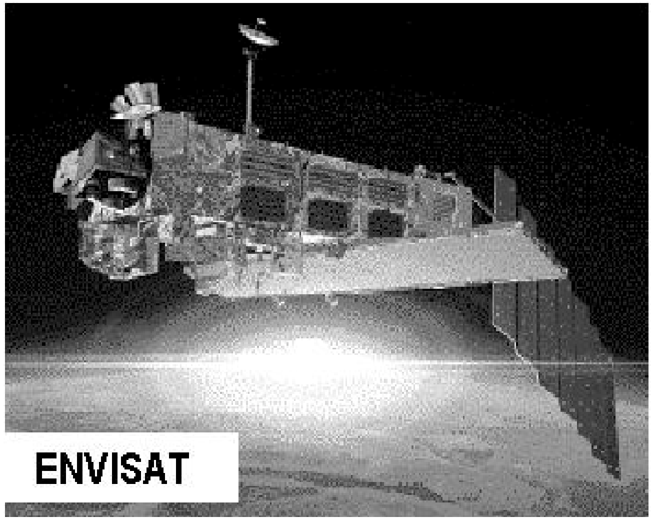




GOME - 7/10/95

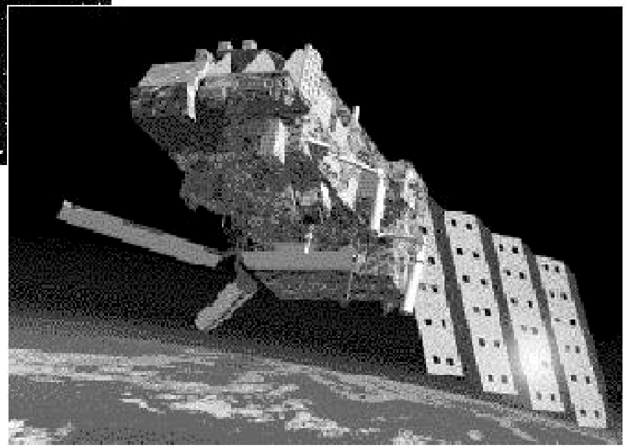
A view of the Earth

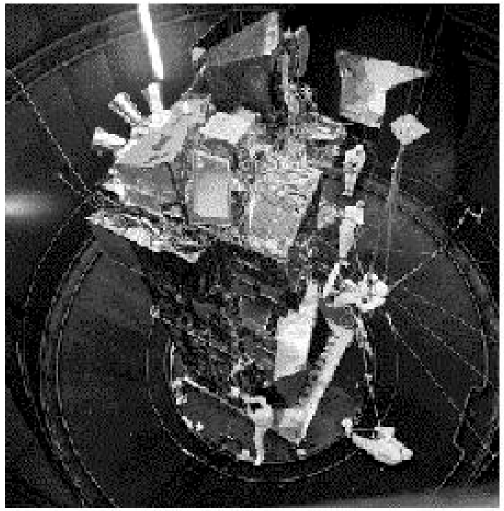
METEOSAT



ENVISAT

METOP





Focus for the distribution of environmental data

ESA's Earth Observation Data
Handling Centre ESRIN, Frascati

Acts as a focal point for distribution/archiving of data acquired via Earth stations from different satellites :
- ESA (ERS-1, ERS-2 and later ENVISAT)
- non-ESA (Landsat, Tiros, JERS, MOS, etc.)

Activities also include :
- planning ERS-1 payload use
- interfacing with users
- pre-processing of data and product control
- development of quick online access to data, catalogues...

TECHNICAL ANNEX III

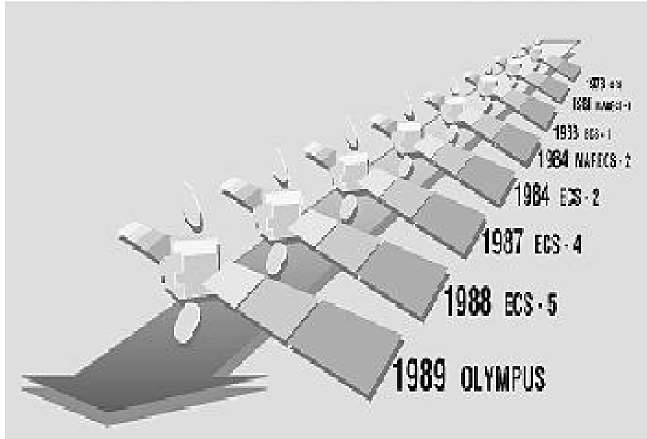
COMMUNICATIONS SATELLITES

Telecommunication : a commercial success

- Communications satellites represent the largest worldwide commercial space market.

- Key areas of interest to ESA are :
  - Fixed services
  - Broadcasting
  - Mobiles communications
  - Navigation
  - Data relay
  - Multimedia

From OTS to Olympus



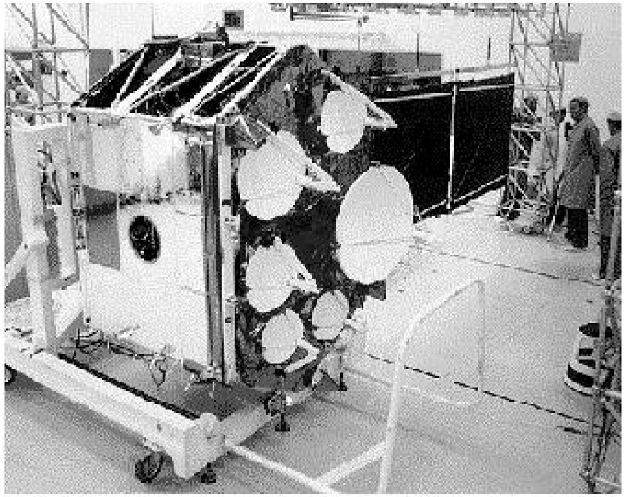
- **ESA began development of communications satellites in 1968 :**

- **OTS (Orbital Test Satellite) - (1978-1991)**
  - technology opened European market for broadcasting to cable feeds and television.

- **Four ECS (between 1983 and 1988) and two MARECS (1981,1984)**
  - consolidated Europe's position as a satellite builder.
    3 ECS and both MARECS are still operational.

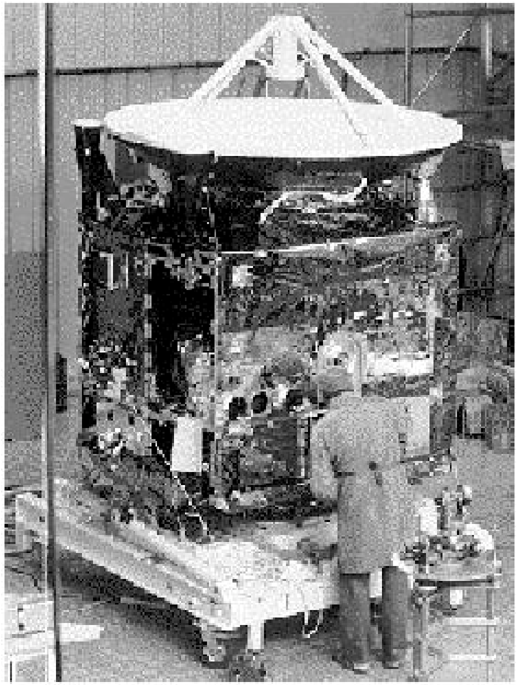
- **Olympus (1989-1993)**
  - redefined leading edge of advanced telecommunications services including direct-to-home TV and high definition TV.

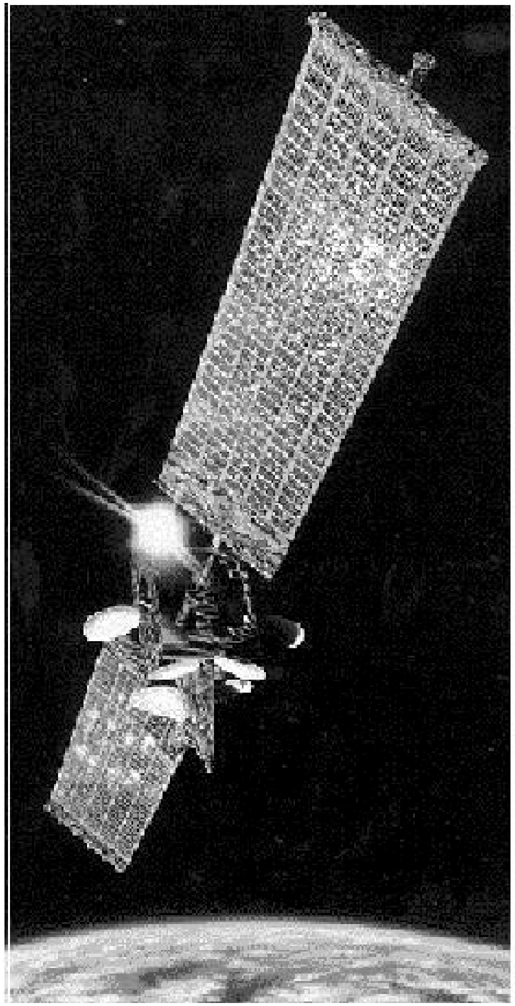
From OTS to Olympus

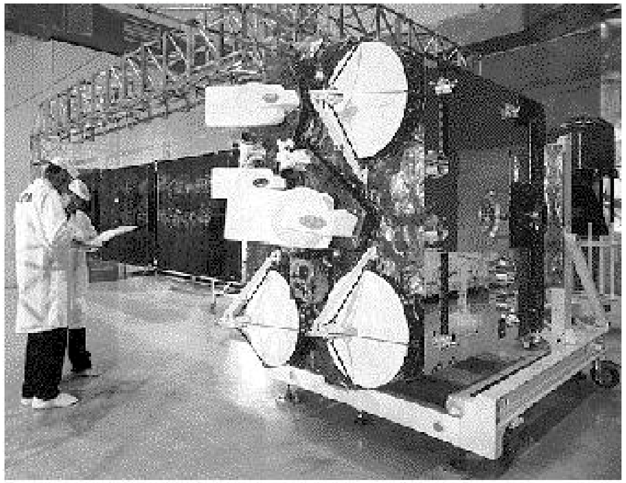


OTS

MARECS



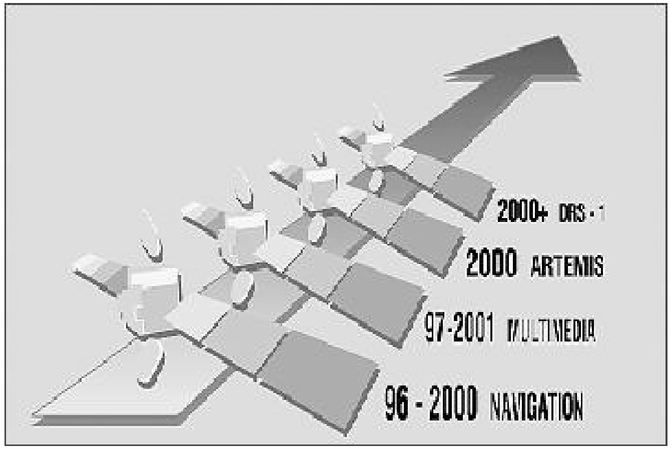




ECS

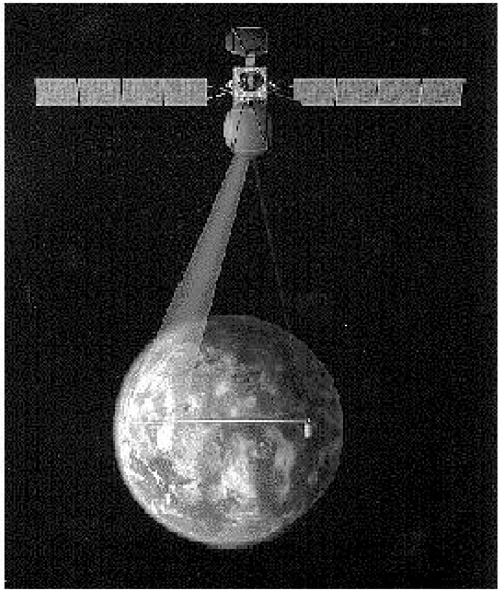
OLYMPUS

Advanced technologies from tomorrow



- **In the next five years, ESA will :**
  - **Develop and launch two advanced telecommunications satellites**
    - Artemis (2000)
    - Data relay satellite DRS-1 (2000+)
  - **Develop, deploy and test the first phase of the European Satellite Navigation System, based on GPS/GLONASS augmentation**
  - **Promote a large range of activities on multimedia, including technology developments, pilot projects and on-flight demonstrations**
- **These projects will expand the technological base of Europe's space industry and act as a foundation for new European services .**

European data relay



- Artemis will give Europe a data-relay capability and satellite-to-satellite communications

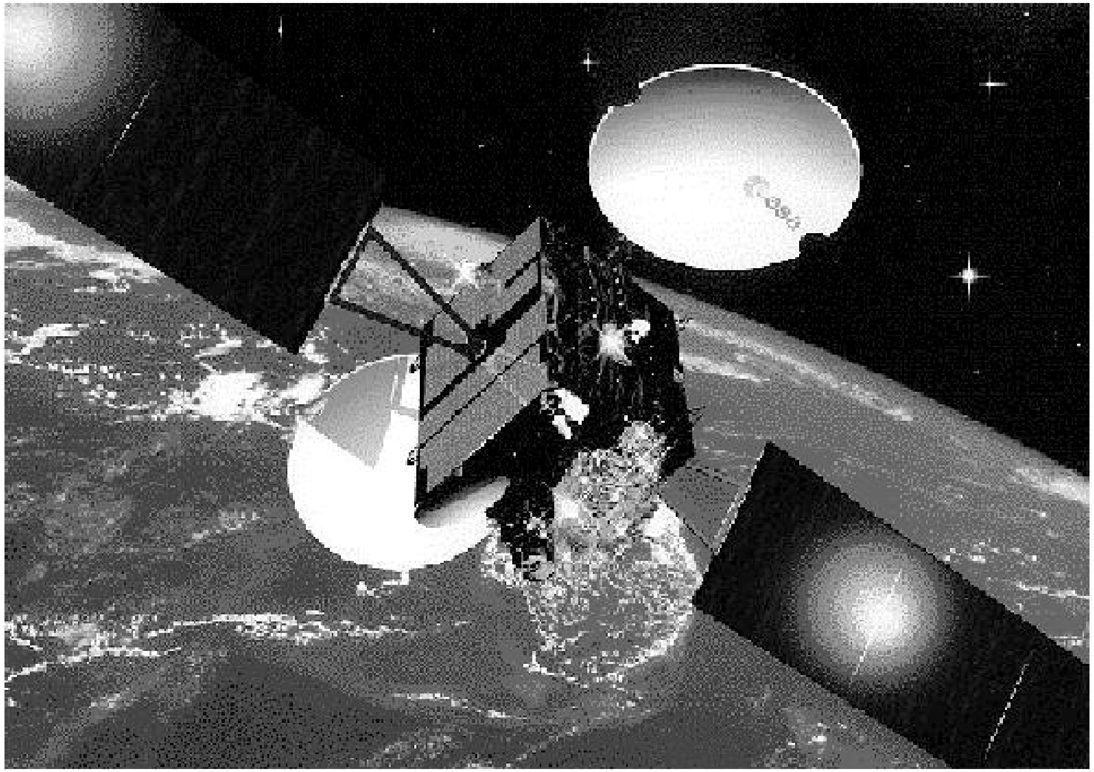
- Objectives :

  • Operational system by 2001

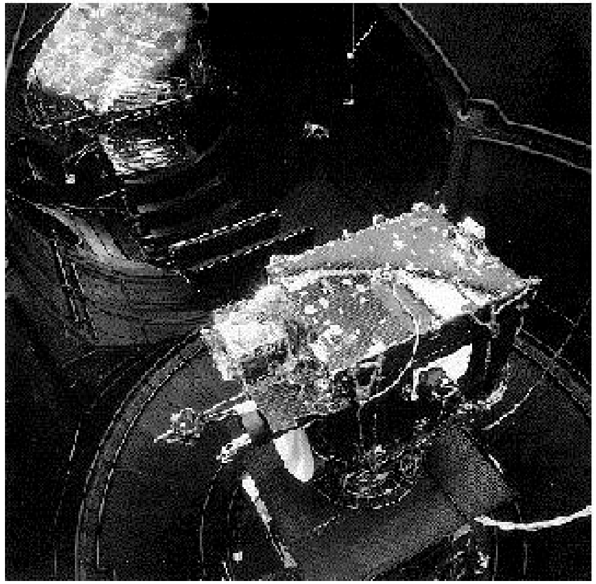
  • Inter-operability with TDRSS (US) & DRTS (Japan)

  • Introduce new & more powerful technologies (laser)

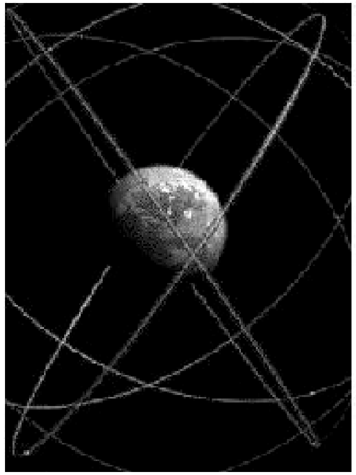
European data relay



ARTEMIS



Satellite Navigation: EGNOS, Galileo and Galileosat

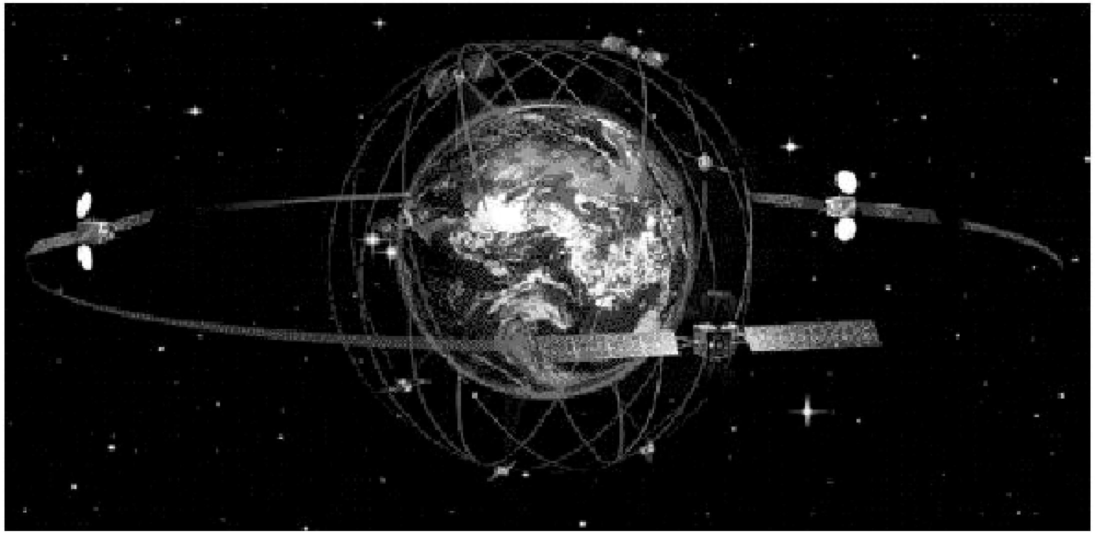


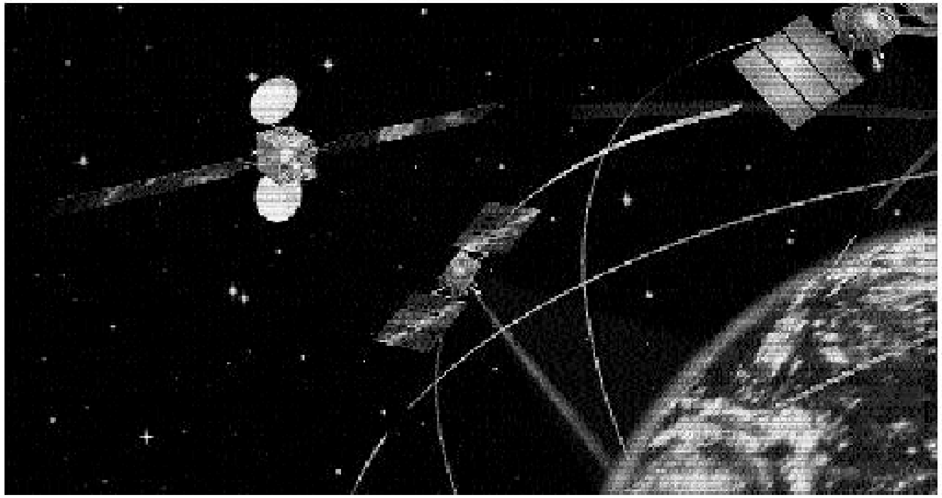
- EGNOS, the European satellite based augmentation service is the stepping stone for the European efforts towards GNSS-2/Galileo and represents an institutional, industrial and operational breakthrough in the field. It is a joint effort of the European Union, ESA and EUROCONTROL.

- Galileo is the major initiative of the European Union leading to fundamental strategic, political, economic and industrial benefits. Its definition phase is being carried out in cooperation with ESA.

- Galileosat is the programme of ESA to cover Galileo's space and related ground segment up to the in-orbit validation.

Satellite Navigation: Galileosat

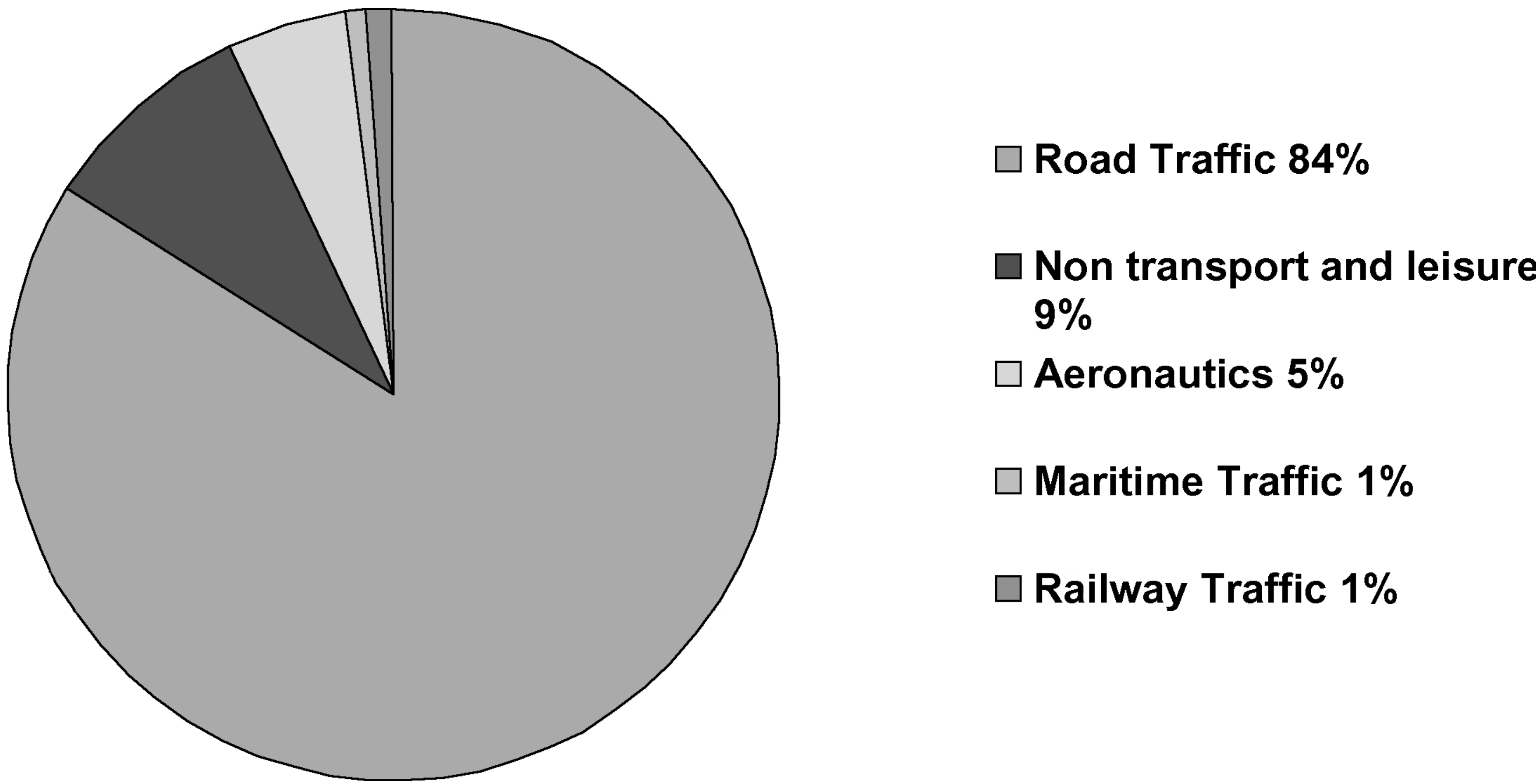




TECHNICAL ANNEX IV

DISTRIBUTION OF THE MARKET FOR SATELLITE NAVIGATION EQUIPMENT AND SERVICES

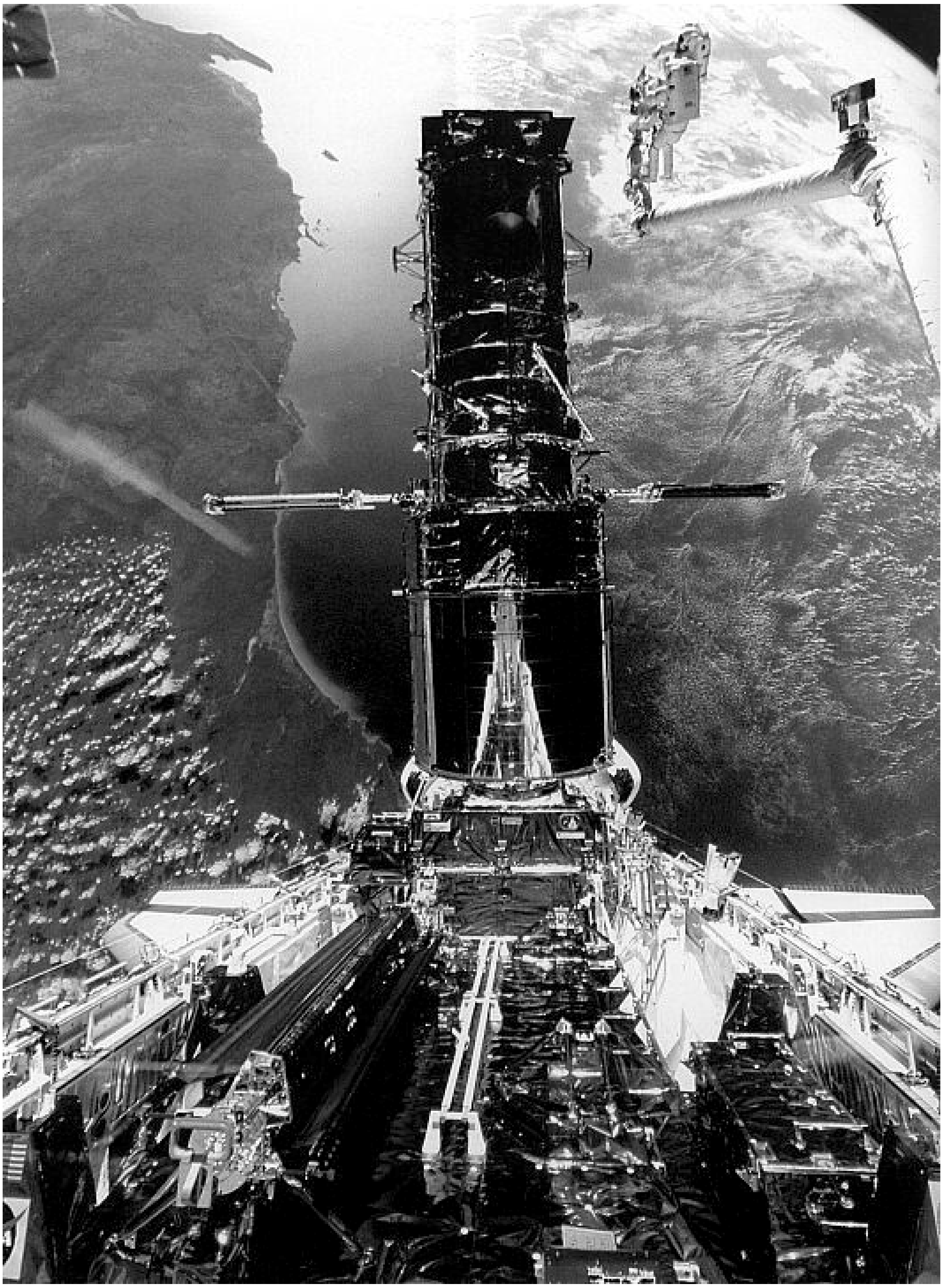
DISTRIBUTION OF THE MARKET FOR SATELLITE NAVIGATION EQUIPMENT AND SERVICES FORECAST FOR 2005-2010



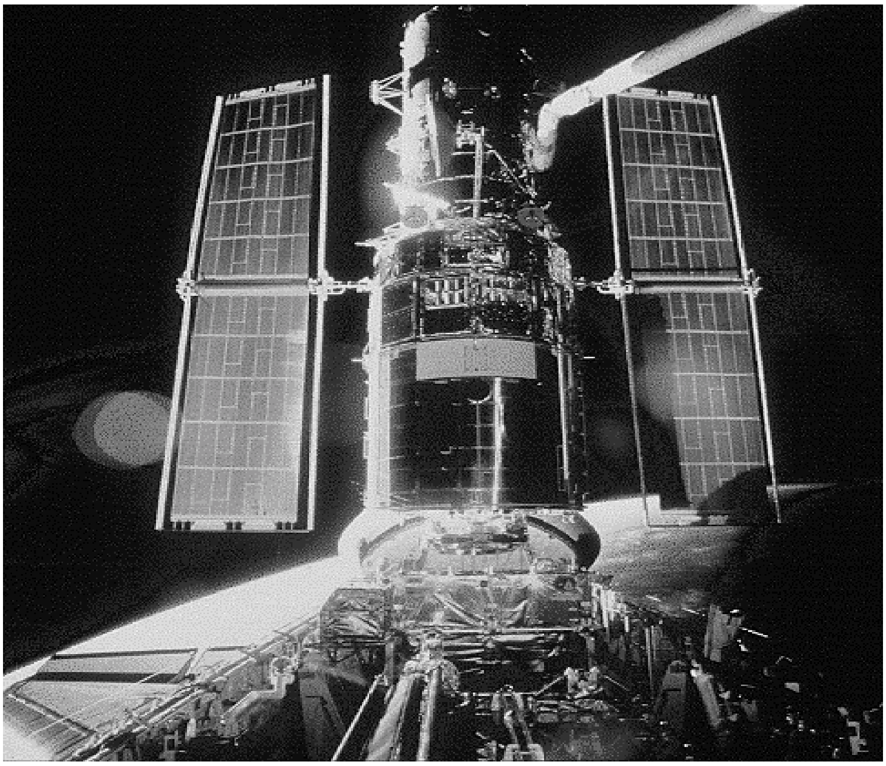
TECHNICAL ANNEX V

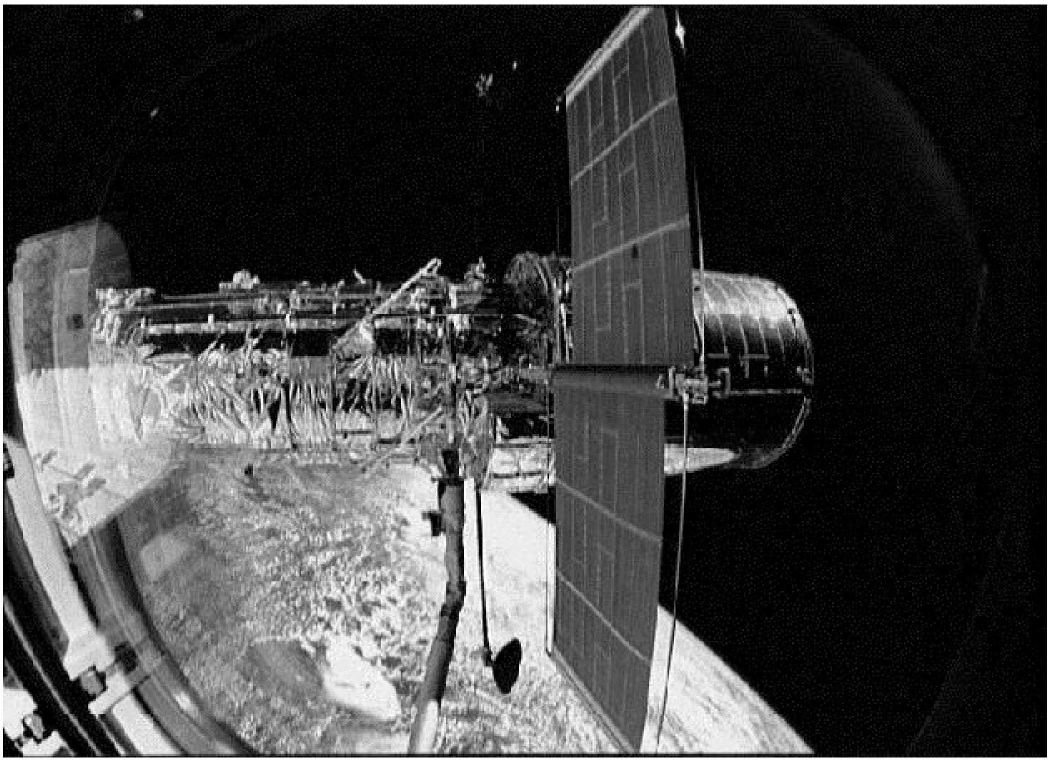
SPACE SYSTEMS FOR OBSERVATION OF THE UNIVERSE

HUBBLE



HUBBLE





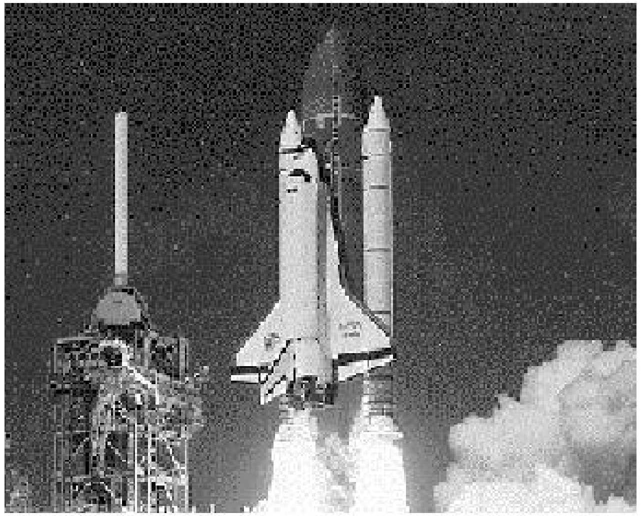
MARTIAN PROBES

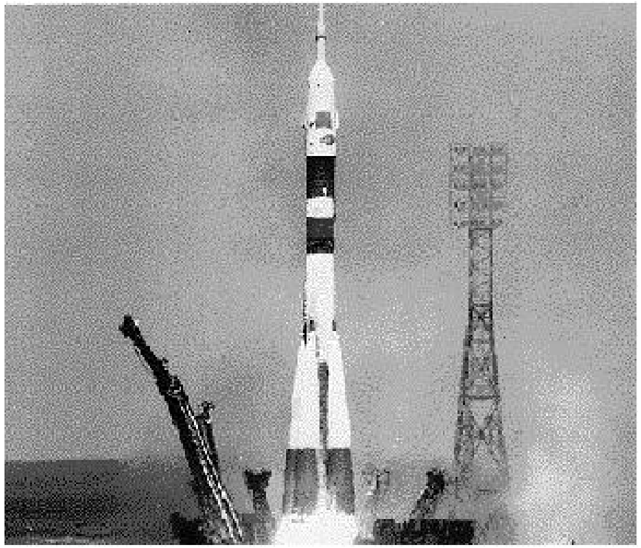
MARS 1	USSR	1962	FAILURE
MARINER 4	USA	1964	SUCCESS
MARINER 6	USA	1969	SUCCESS
MARINER 7	USA	1969	SUCCESS
MARS 2	USSR	1971	PARTIAL SUCCESS
MARS 3	USSR	1971	PARTIAL SUCCESS
MARINER 9	USA	1971	SUCCESS
MARS 4		1973	FAILURE
MARS 5	USSR	1973	SUCCESS
MARS 6	USSR	1973	PARTIAL SUCCESS
MARS 7	USSR	1973	FAILURE
VIKING 1	USA	1975	SUCCESS
VIKING 2	USA	1975	SUCCESS
PHOBOS 1	USSR	1988	FAILURE
PHOBOS 2	USSR	1988	PARTIAL SUCCESS
MARS OBSERVER	USA	1992	FAILURE
MARS GLOBAL SURVEYOR	USA	1996	SUCCESS
PATHFINDER	USA	1996	SUCCESS
MARS 96	CEI	1996	FAILURE
PLANET B	JAPAN	1998	
DEEP SPACE 2	USA		

TECHNICAL ANNEX VI

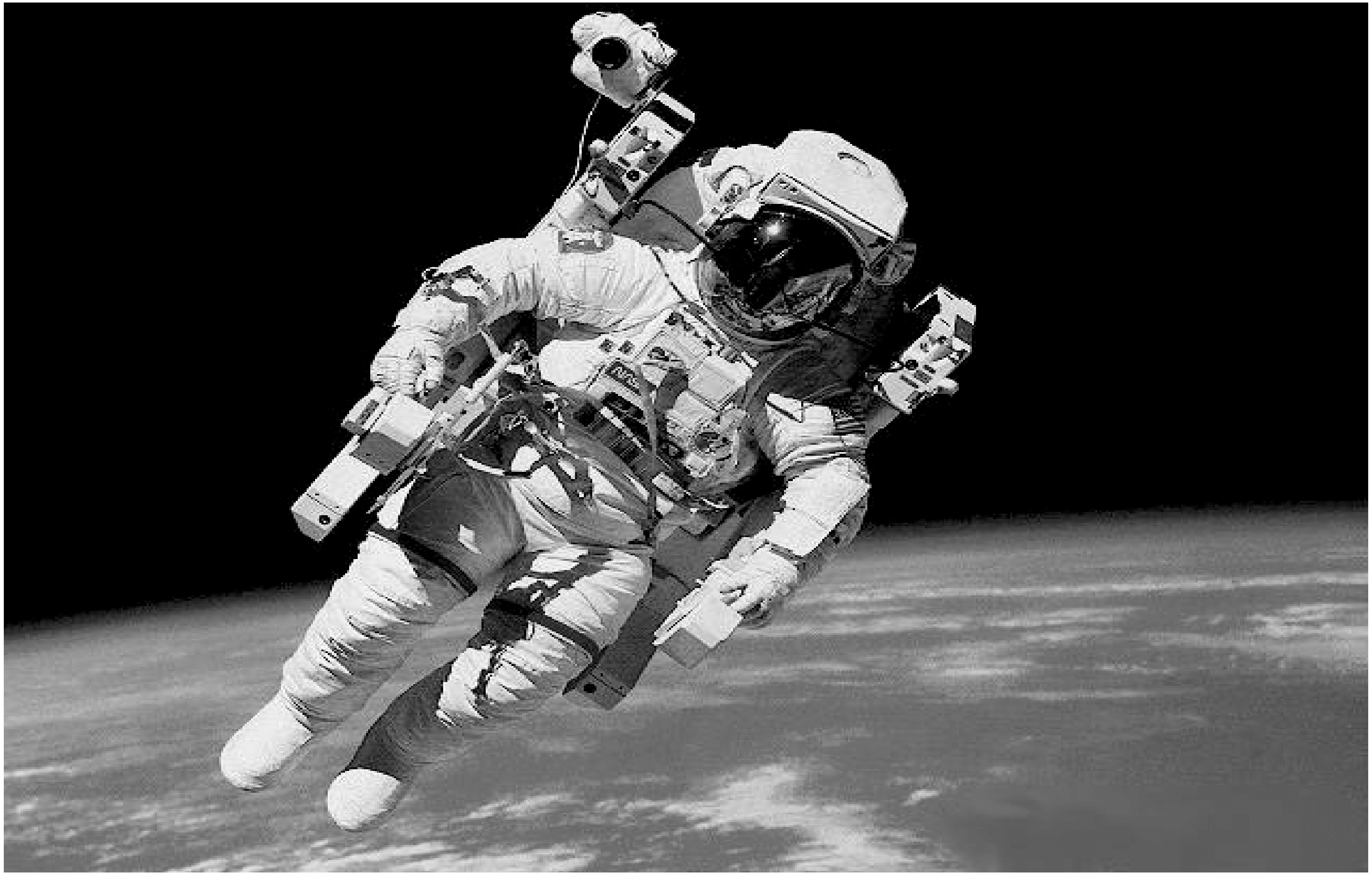
MANNED FLIGHTS

Manned Spaceflights, gaining experience

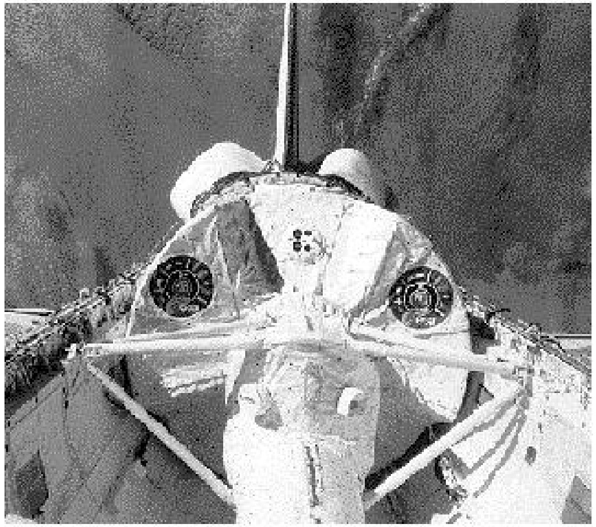




- **The ESA astronauts are preparing for work onboard the international space station.**
- **They have acquired experience on missions carried out jointly with the US and Russia :**
  - US Shuttle missions : (9)
  - 6th Shuttle/Mir station mission
  - Euromir 94, Euromir 95, Perseus

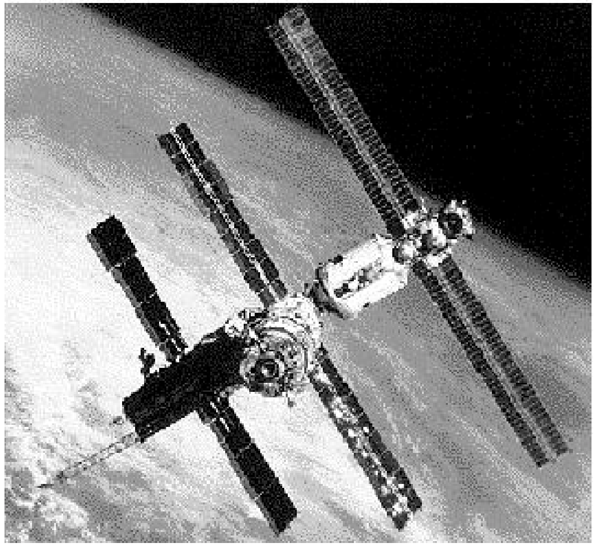


Spacelab and Euromir



Spacelab :

- A pressurised module designed and built by ESA where astronauts work in a shirt-sleeve environment.
- Carrier pallets added to this module in the Shuttle's cargo bay.
- Over 20 missions with ESA or other astronauts to date.



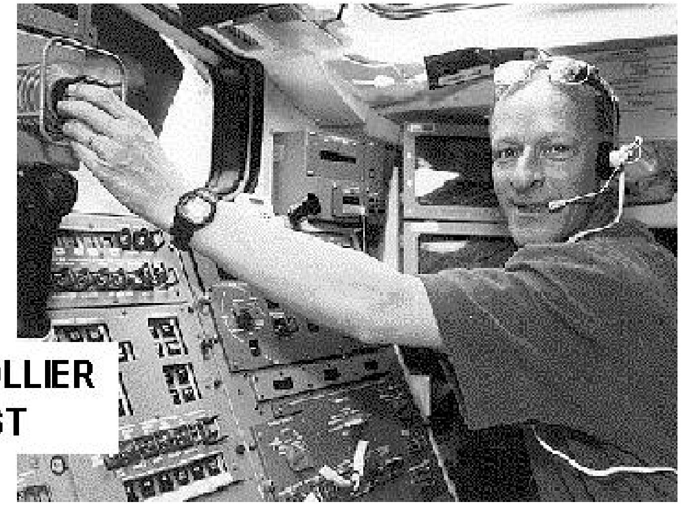
Euromir :

- Missions onboard Mir station :
  - Euromir 94 (31 days)
  - Euromir 95 (180 days)
- Benefits :
  - specific training and flight experience
  - know-how to conduct experiments onboard a space station.

Shuttle and Euromir

U.MERBOLD
EUROMIR-94

T.REITER
EUROMIR-95



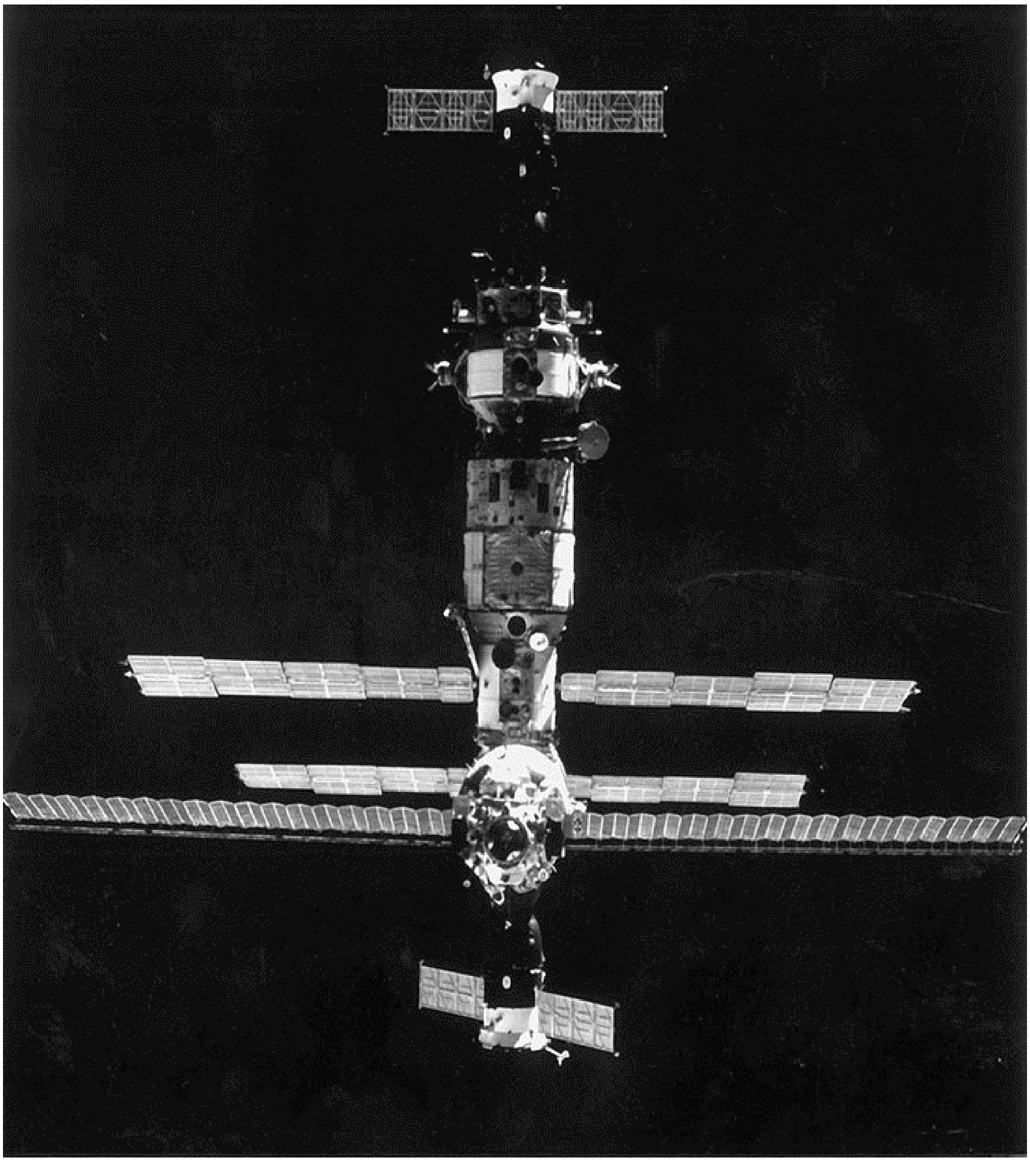
C.NICOLLIER
HST

P.DUQUE
STS-95

TECHNICAL ANNEX VII

SPACE STATIONS

MIR SPACE STATION

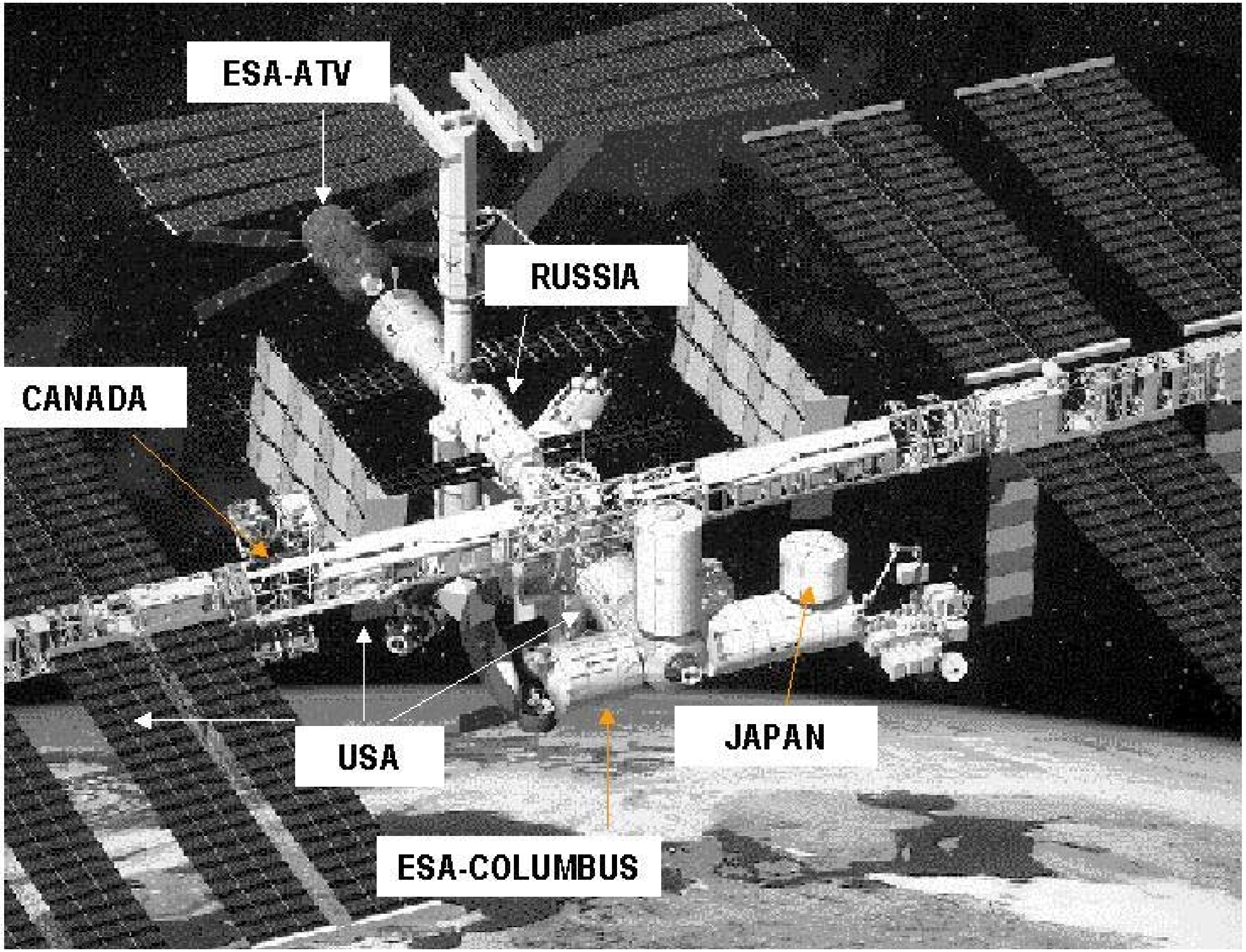


International space station
Elements of European participation

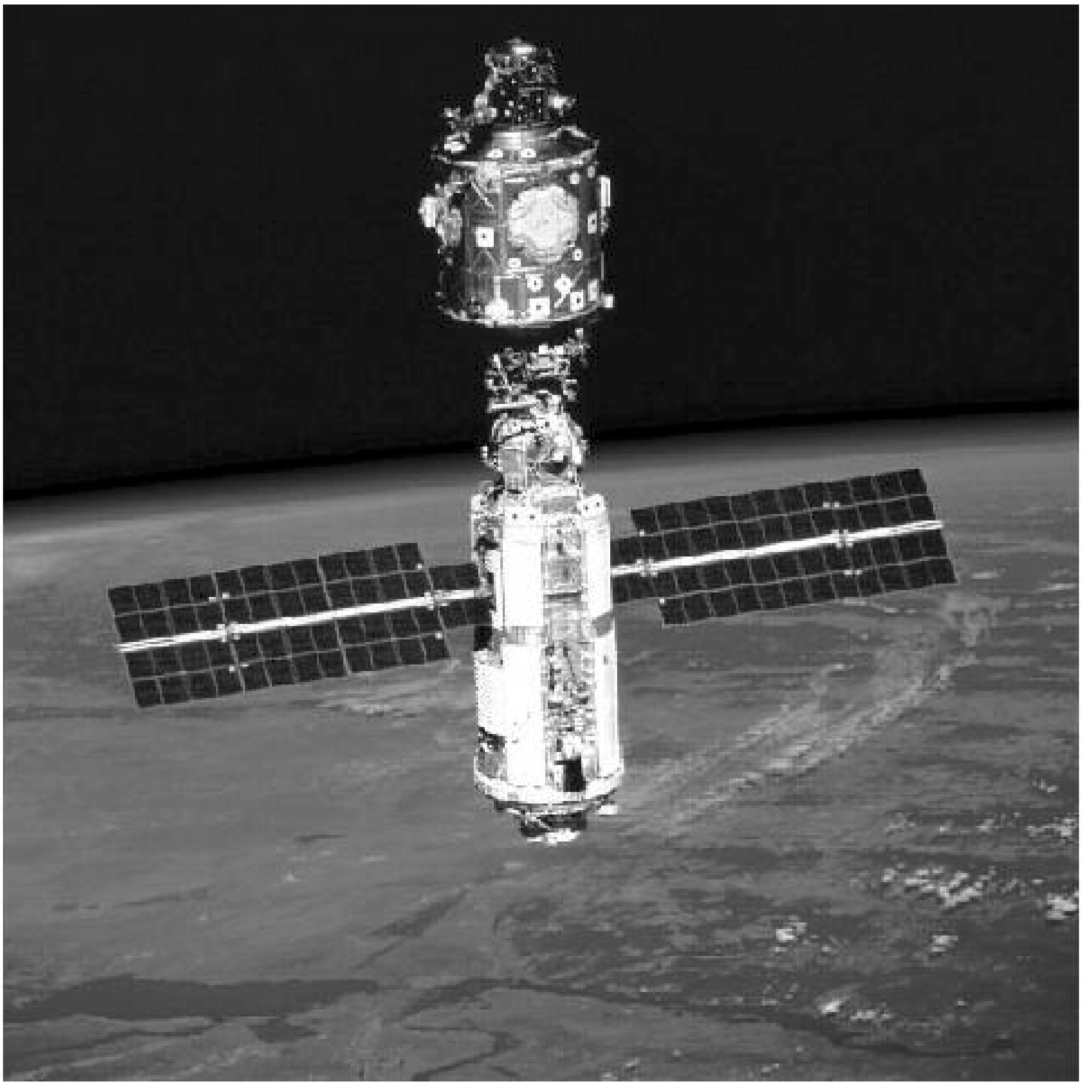
Europe is in the following :

- Development and operation of flight elements and their associated ground infrastructure :
  - Columbus Laboratory
  - Automated Transport Vehicle (ATV)
- Cooperation with NASA on a prototype crew return vehicule (X-38)
- Development and delivery of hardware and software to other partners through cooperation or barter arrangements : Node 2, Node 3, Data Management System for the Russian Service Module, European Robotic Arm, and other elements
- Development of multi-user experiment facilities on the International Space Station, in the framework of the Microgravity Facilities for Columbus (MFC) programme
- Preparation for the operation and utilisation of the Station
- Preparation for astronaut activities on the Station

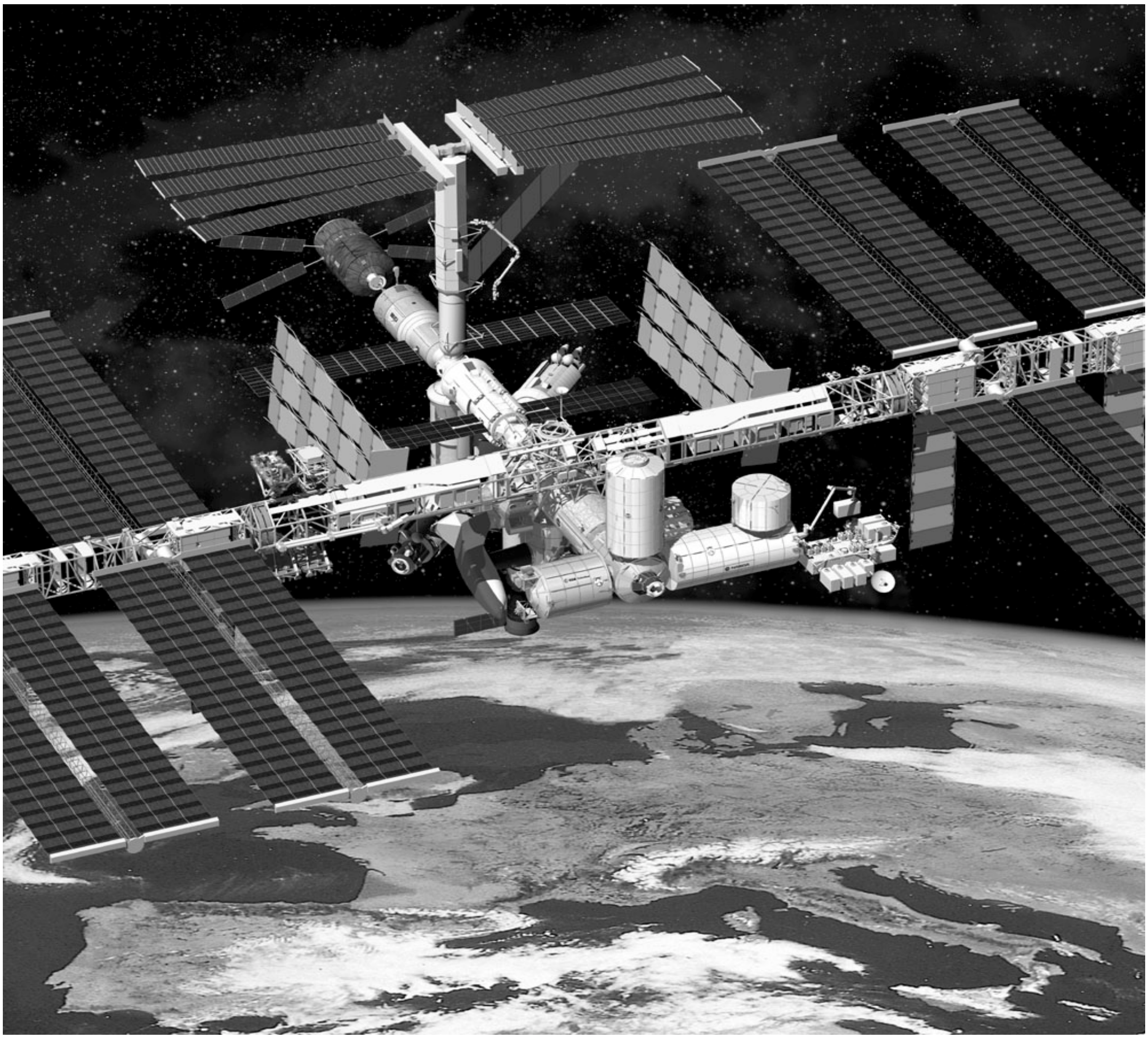
The International Space Station



INTERNATIONAL SPACE STATION
THE FIRST MODULE, ZARYA



INTERNATIONAL SPACE STATION



International space station
European participation programmes

- **European participation in the International Space Station formally agreed at ESA Council meeting at Ministerial level in Toulouse in October 1995.**

- **Two programmes :**
  - **European Participation in the International Space Station Development Programme, running from 1996 to 2004, with a total financial envelope of 2 651 million E (at the economic conditions of 1995), for development of space and ground infrastructure elements.**
  - **The Microgravity Facilities for Columbus (MFC) Programmewith a financial envelope of 207 million E (at 1995 economic conditions)**

- **Ten of 14 ESA Member States are contributing financially.**

	Development Programme	Microgravity Facilities for Columbus
	2651 ME	207 ME
D	41%	40%
F	27,6%	22,8%
I	18,9%	15,8%
B	3%	10%
CH	2,5%	4%
E	2%	2%
DK	1,17%	1,93%
NL	0,94%	1,5%
N	0,46%	-
S	0,4%	-
Total	97,97%	98,03%

Columbus Laboratory technical description

- **The Columbus Laboratory is a pressurised, habitable laboratory module which will be carried to the International space Station in the cargo bay of the US Space Shuttle and attached to Node 2 of the Station.**

- **Columbus has the external payload-carrying structures for four Express Pallet adapters for technology experiments, Earth observation and space science.**

Launch date : October 2002

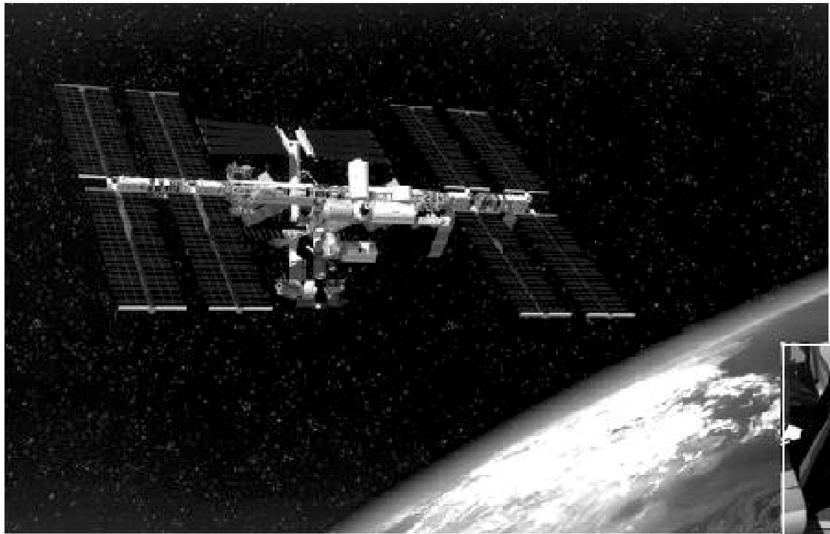
Launch mass of 12400 kg,
6,7m long, 4,5m diameter

Accomodation of external payloads :
attachment structures for
4 Express Pallet adapters

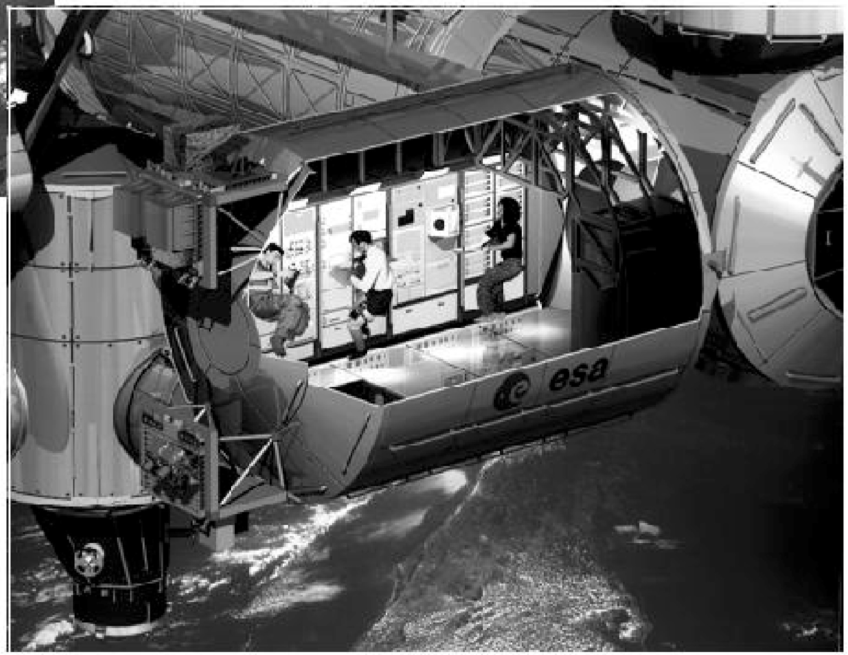
Sized for 20kW of power provided
by the station. 13.5kW available
for payload

Up to 15 years on-orbit lifetime
in maintenance and repair

The International Space Station



ISS



COLUMBUS LABORATORY

Automated transfer vehicle (ATV) technical description

- **Made up of a basic spacecraft, an unpressurised volume for propellant, water and gas, and a pressurised cargo carrier for dry cargo.**

- **To be launched by Ariane 5 from Kourou : after 2 days of autonomous transfer flight, arrives at the International Space Station and docks automatically to rear of Russian Service Module.**

- **Carries a total cargo of up to 9 t :**
  - up to 5.5 t of dry cargo (re-supply goods, scientific payload, etc)
  - up to 840 kg of water and gas
  - up to 860 kg of propellant for refuelling the Sation
  - up to 4 t of propellant for reboost manoeuvre

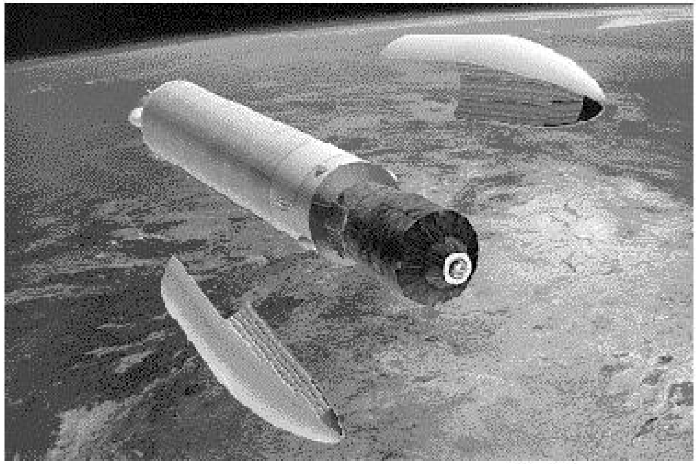
Qualification flight : end 2002,
First operational flight : early 2003

Operational flight rate :
approximately 1 flight/15 months

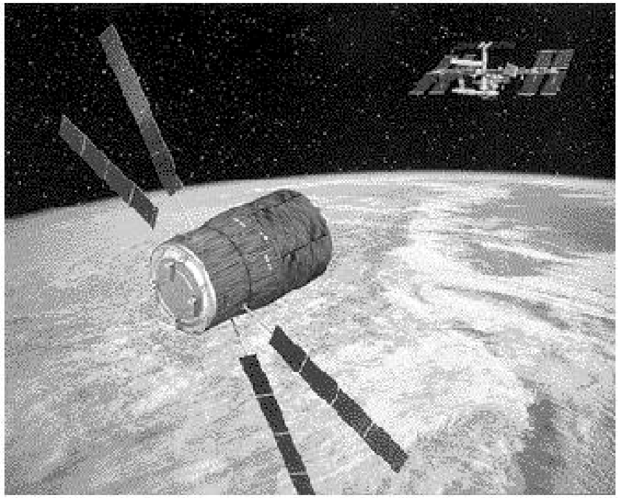
Overall length 8.5 m,
diameter 4,25 m,

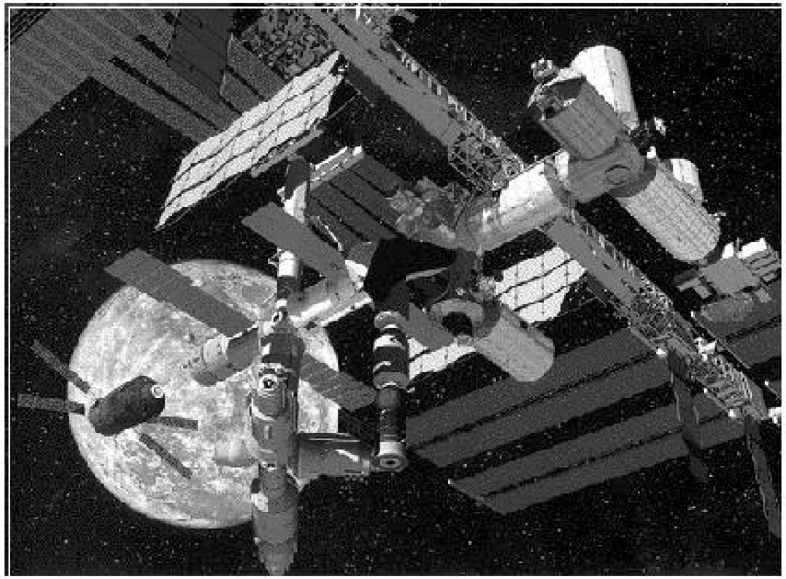
Total launch mass up to 20.5 t,
with up to 9 t of cargo.

Europeans in space and means to get there



ATV

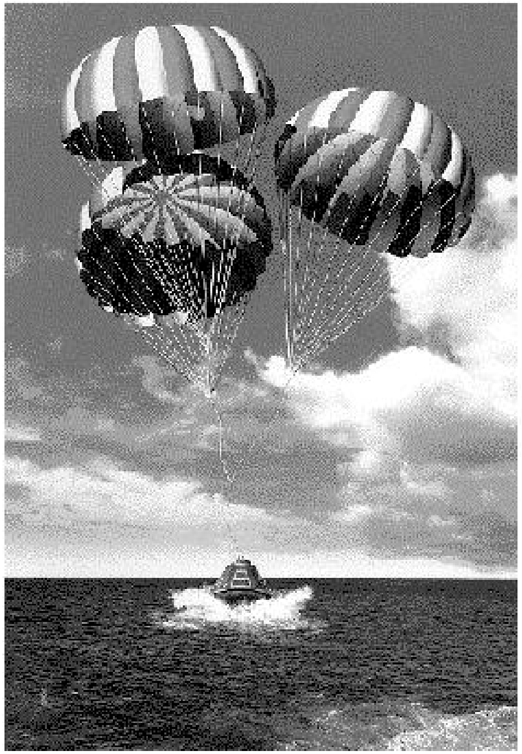


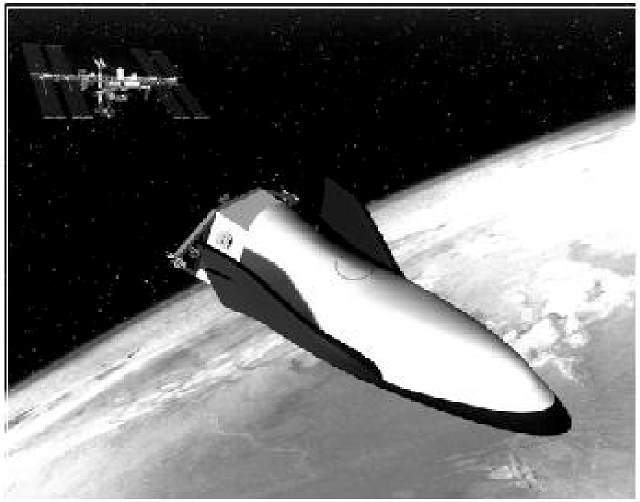


ISS

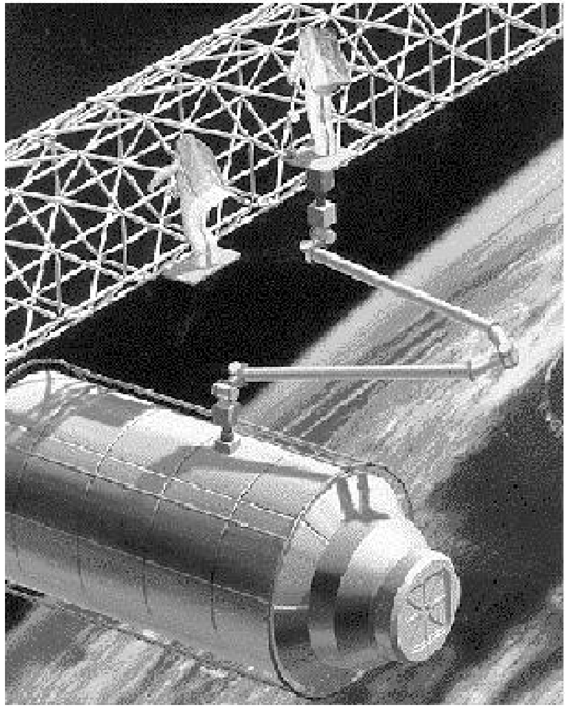
Europeans in space and means to get there

ARD





CRV



ERA

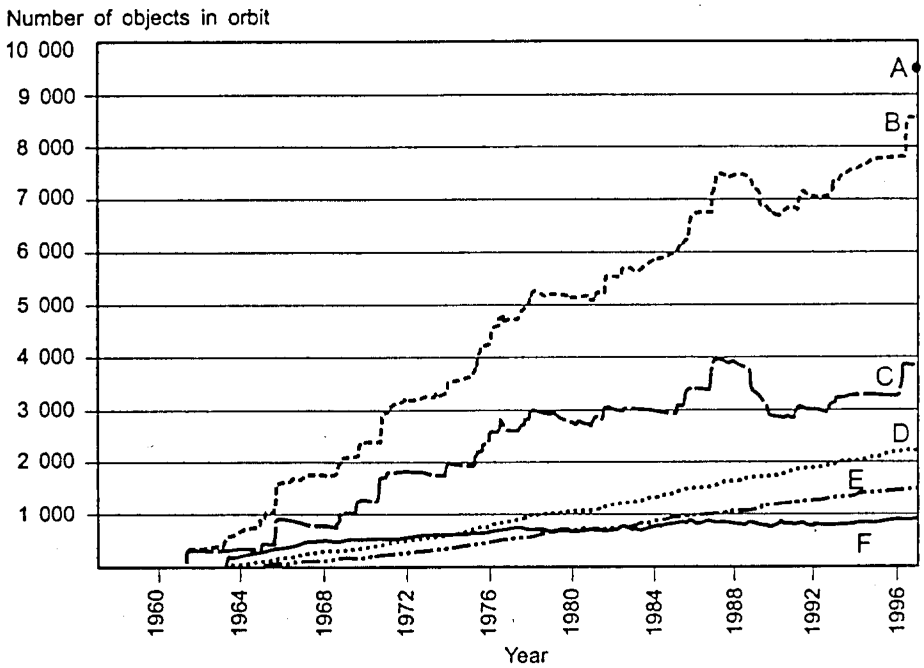
TECHNICAL ANNEX VIII

SPACE DEBRIS

Number of Artificial Objects in Space

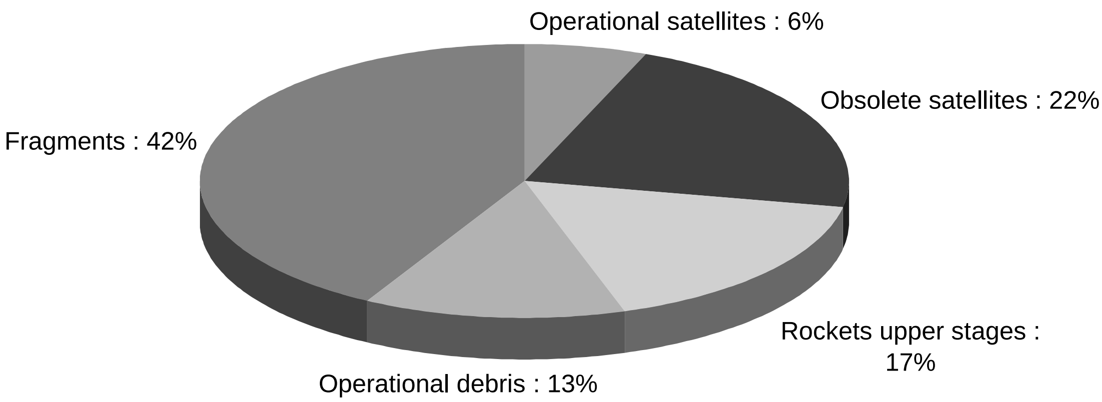
Size	Number	Number in %	Mass in %
> 10 cm	9,000	0.02 %	99.93 %
1 – 10 cm	110,000	0.31 %	0.035 %
0.1 – 1 cm	35,000,000	99.67 %	0.035 %
Total	= 35,100,000	100 %	2,000,000 kg

Number of objects in the United States catalogue, by type, 1959-1996



A: Total number of objects, including objects not contained in the official catalogue
B: Total number of objects, based on the official catalogue
C: Fragmentation debris; fragments are counted since the year of event; fragmentation parents are counted as intacts until the date of event; since the event date the parents are counted as fragments
D: Spacecraft
E: Rocket bodies
F: Operational debris; operational debris related to a launch are counted since the year of launch; Salyut 4, 5, 6, 7 and Mir operational debris are not counted since the date of launch of the parent but since a more realistic date

DISTRIBUTION OF OBJECTS IN OUTER SPACE

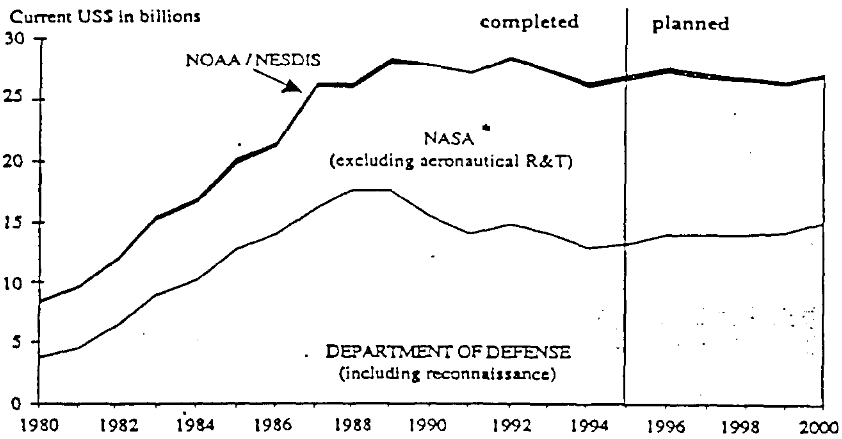


TECHNICAL ANNEX IX

SPACE BUDGETS

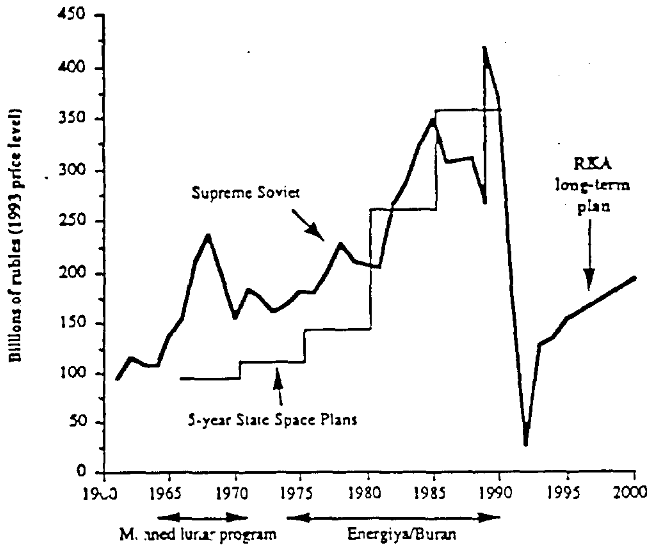
Evolution of American (1980-2000), Russian (1960-2000) and European (1972-1995) Space Budgets

United States

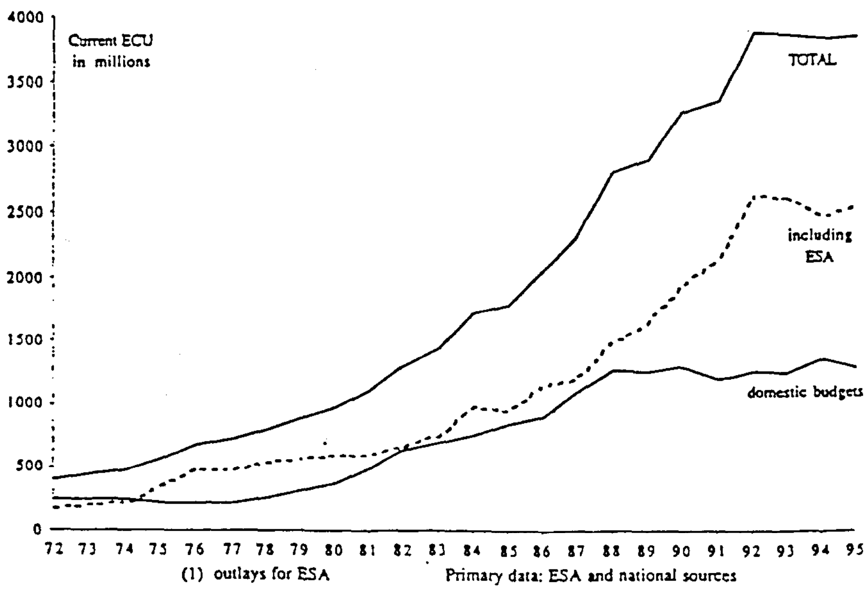


* including aeronautical R&T after 1997 (US$ 858 million in 1997)
primary data: NASA, DOD, GAO, AIAA

USSR / CEI



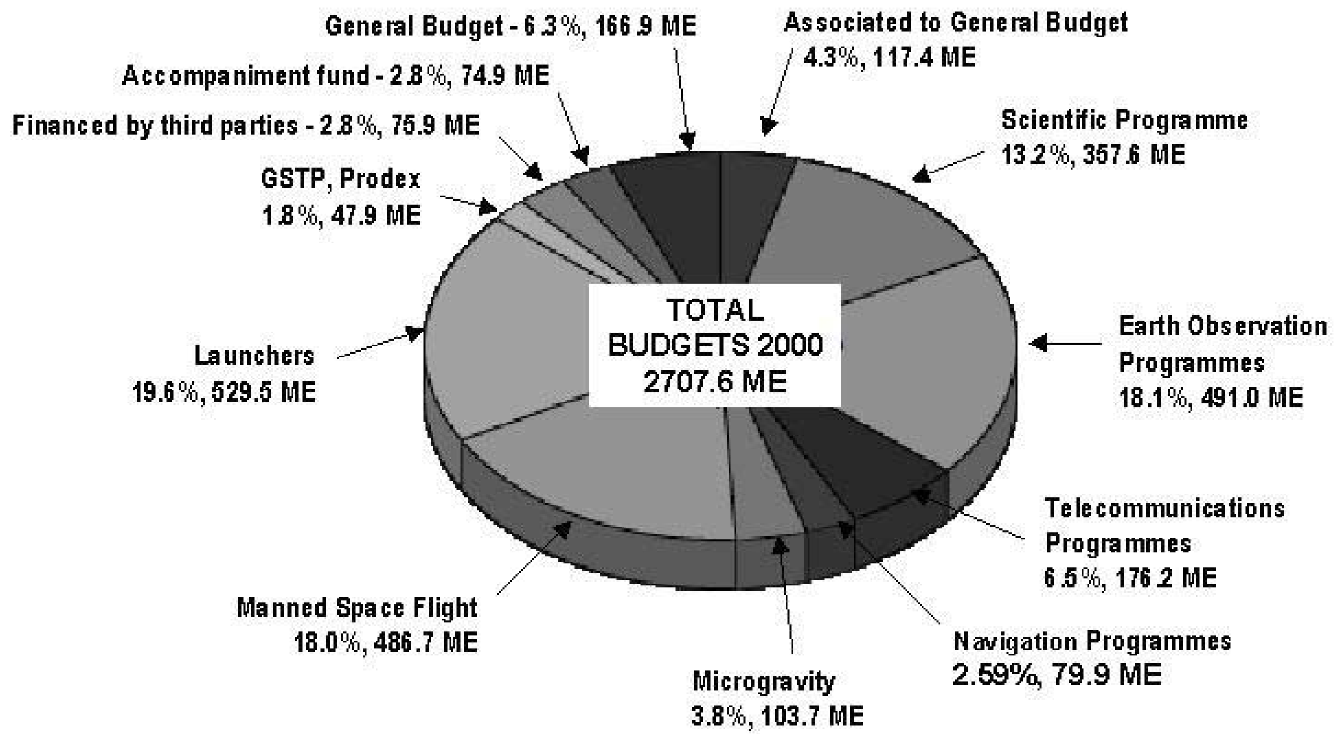
Europe



source : Euroconsult.

Budgets for 2000, breakdown by programmes

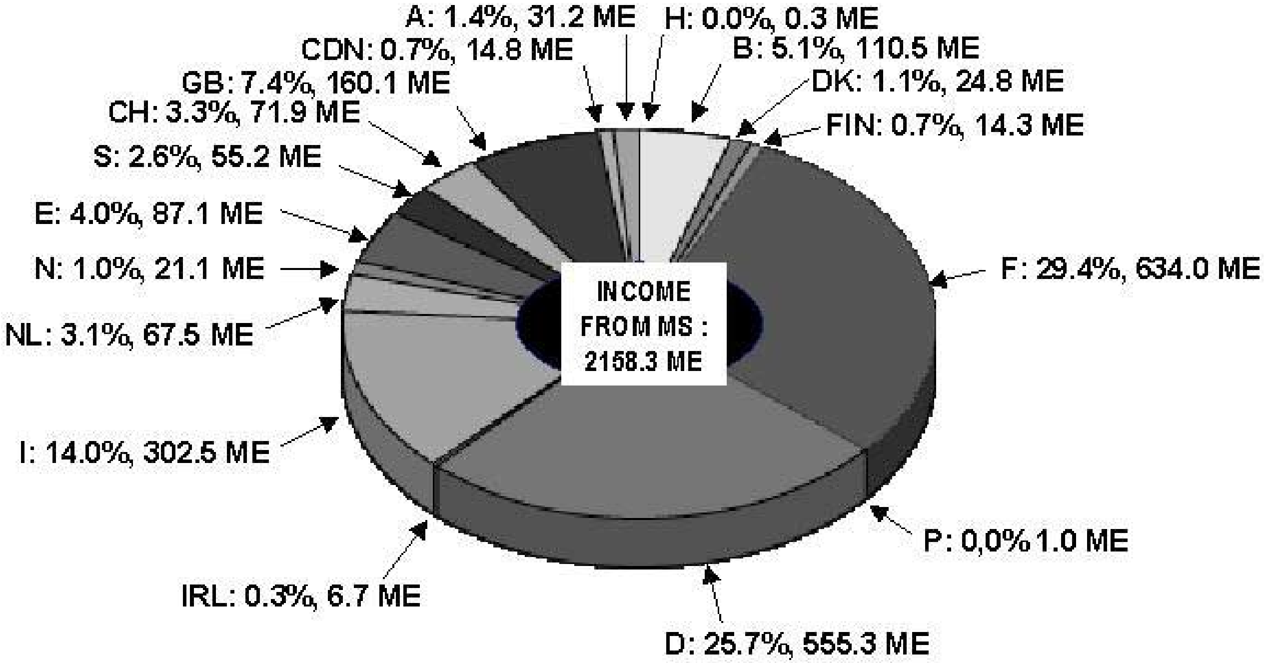
APPROVED PROGRAMMES	: 2556.8 ME
+ PROGRAMMES FINANCED BY THIRD PARTIES	: 75.9 ME
+ ACCOMPANIMENT FUND	: 74.9 ME
= TOTAL BUDGETS FOR 2000	: 2707.6 ME



ME : Million of Euro
ESA/AF (99) 55, rev2 - 12/99

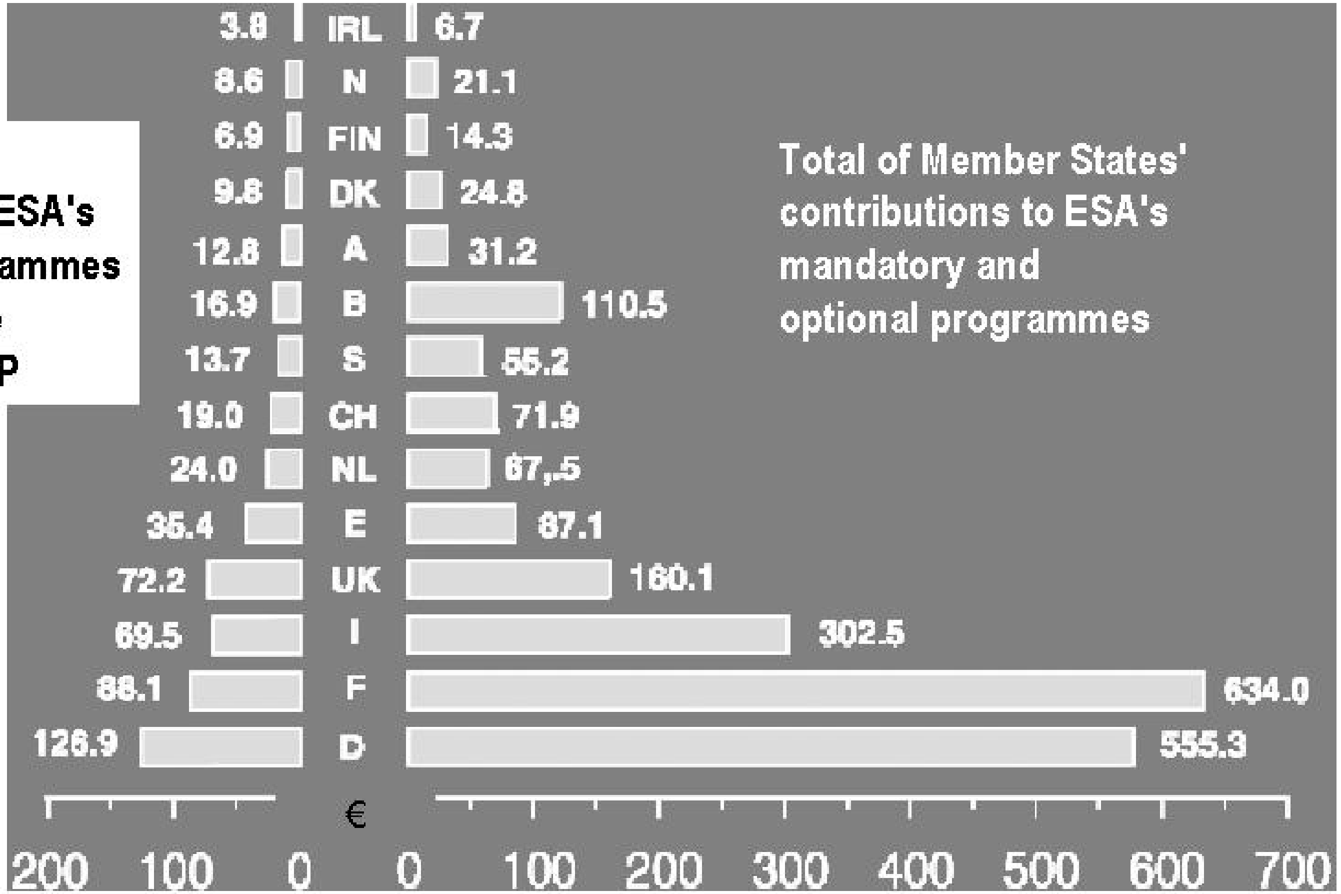
Budgets for 2000, income from Member States and Participating States

INCOME FROM MEMBERS STATES	: 2158.3 ME
+ OTHER INCOME	: 549.3 ME
= TOTAL BUDGETS FOR 2000	: 2707.6 ME



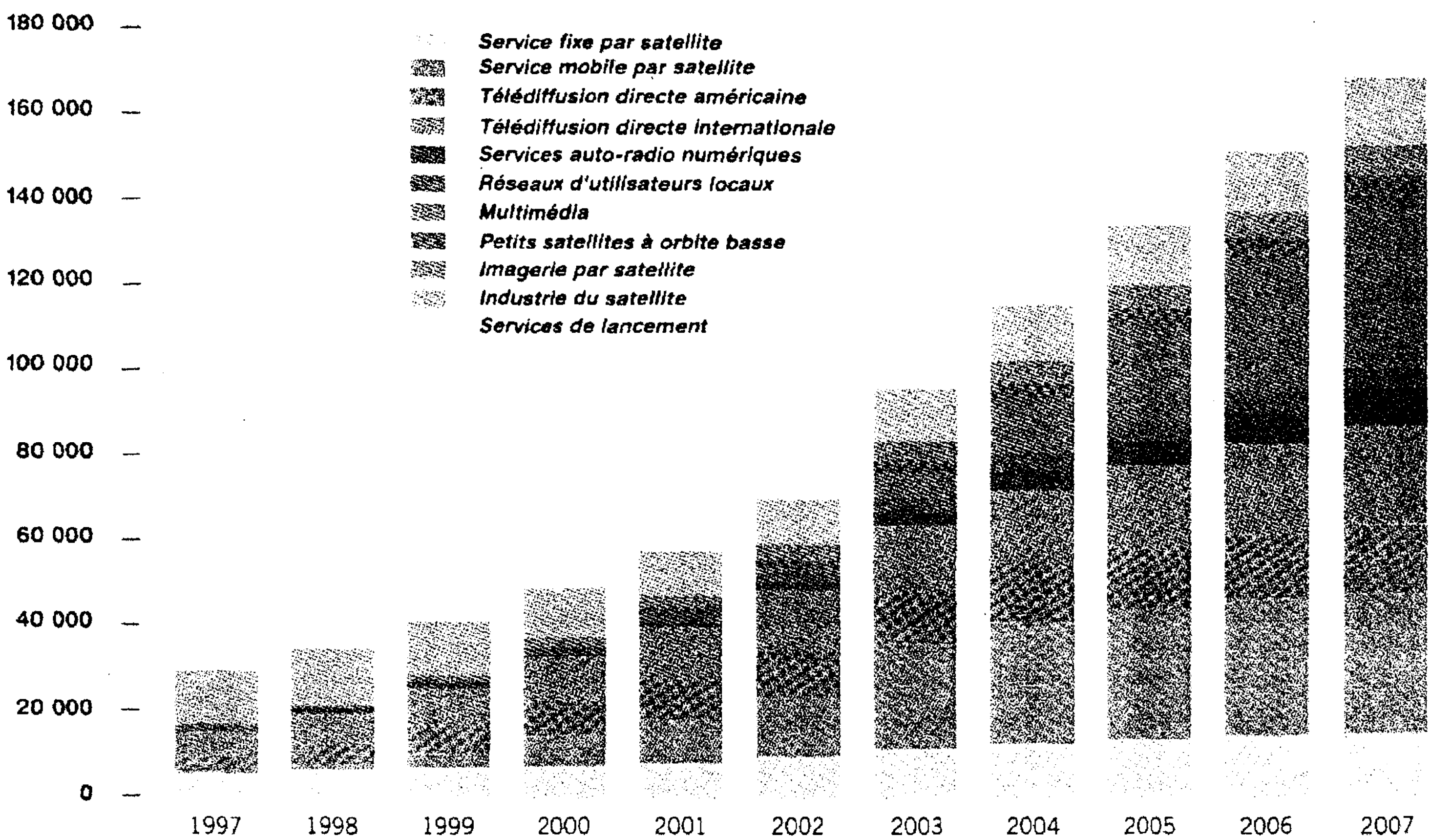
ME : Million of Euro
ESA/AF (99) 55, rev2 - 12/99

Comparison of Member States'mandatory contributions with total mandatory and optional contributions to ESA programmes



M € : Million of Euro
ESA/AF (99) 55, rev2 - 12/99

Prévision de croissance de l'industrie des satellites (million US $)



1997-2007 = moyenne annuelle 17 % • Source Merrill-Lynch

TECHNICAL ANNEX X

GENERAL PRESENTATION OF THE EUROPEAN SPACE AGENCY (ESA)

The European Space Agency

The idea of an independent European space organisation began in the early 1960's.

ESA was formed in 1975, replacing the ESRO satellite and ELDO launcher organisations.
It has 15 member states.

Issue 01/2000

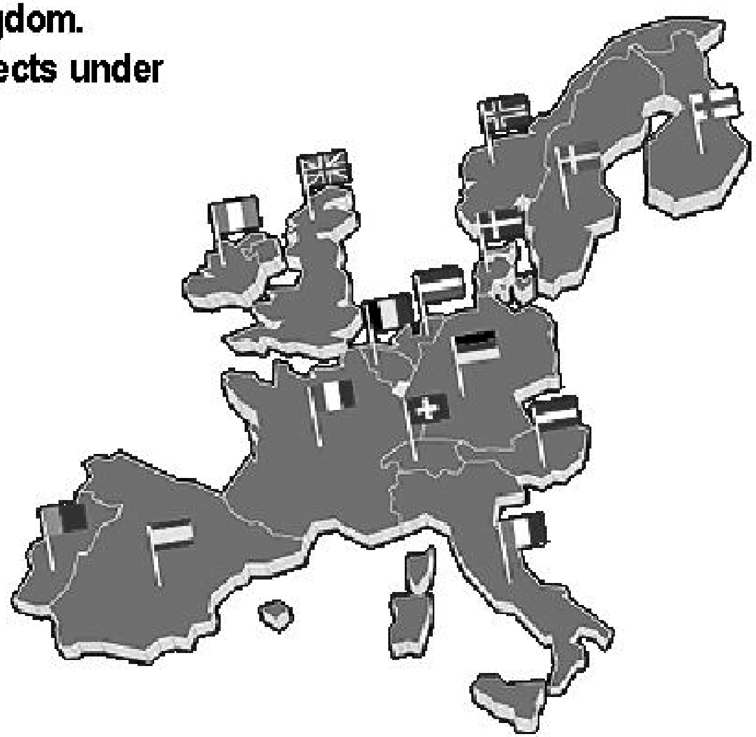
ESA Member States

ESA has 15 member States :

- Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Norway, the Netherlands, Portugal*, Spain, Sweden, Switzerland and the United Kingdom.
- Canada takes part in some projects under a cooperation agreement.

*By 1 July 2000 at the latest.

	D	B	F	I	NL	GB	DK	SP	S	CH	IRL	A	N	FIN	P	
2000																ESA
1995	•	•	•	•	•	•	•	•	•	•	•	•	•	•		ESA
1987	•	•	•	•	•	•	•	•	•	•	•	•	•			ESA
1975	•	•	•	•	•	•	•	•	•	•	•					ESA
1973	•	•	•	•	•	•	•	•	•	•						ESA
1962	•	•	•	•	•	•	•	•	•	•						ESRO
1962	•	•	•	•	•	•										ELDO



The purpose of ESA

An inter-governmental organisation with a mission to provide and promote – for exclusively peaceful purposes – the exploitation of :

- Space science, research & technology
- Space applications

ESA achiveves this through :

- Space activities and programmes
- Long term space policy
- A specific industrial policy
- Coordinating European with national space programmes

ESA programmes

- All member states participate in activities related to space science and in a common set of programmes (mandatory programmes).

- In addition, members chose the level of participation in optional programmes :

• Earth observation

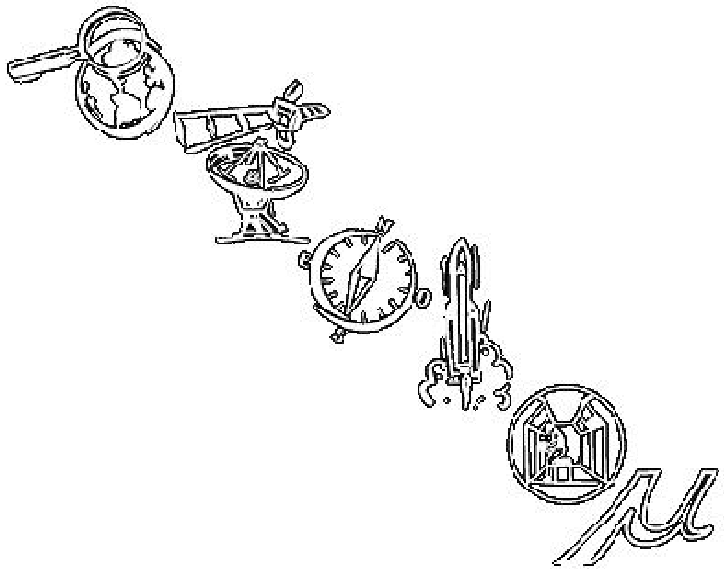
• Telecommunications

• Navigation

• Launcher development

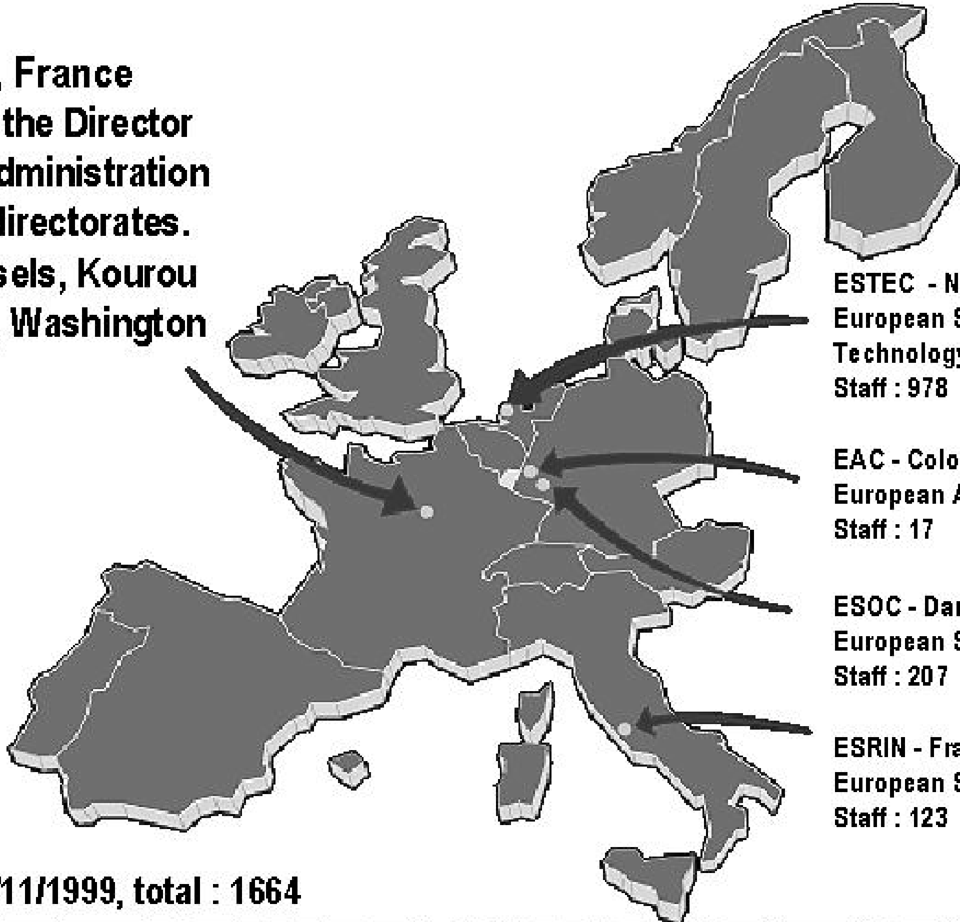
• Manned space flight

• Microgravity research



ESA headquarters and establishments

HEADQUARTERS - Paris, France
ESA headquarters houses the Director General's office, general administration and the main programme directorates.
Staff - 339 (including Brussels, Kourou liaison, Moscow,Toulouse, Washington and Houston offices).



ESTEC - Noordwijk, the Netherlands
European Space Research & Technology Centre
Staff : 978

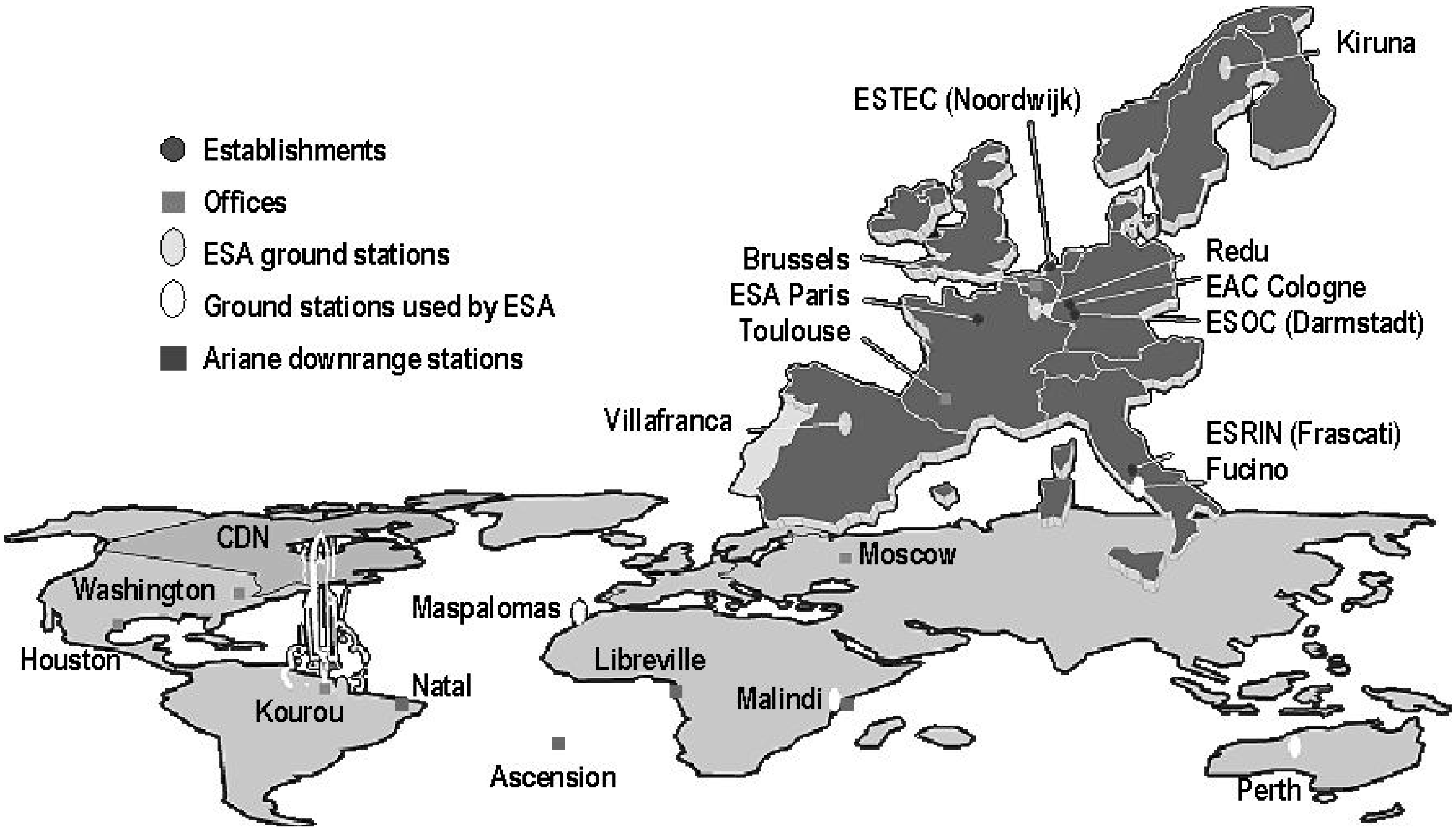
EAC - Cologne, Germany
European Astronaut Centre
Staff : 17

ESOC - Darmstadt, Germany
European Space Operations Centre
Staff : 207

ESRIN - Frascati, Italy
European Space Research Institute
Staff : 123

Staff in post at 30/11/1999, total : 1664

ESA locations worldwide



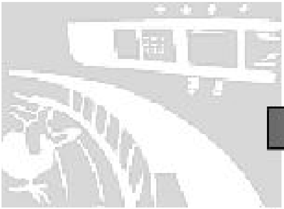
ESTEC - European space research & technology centre

ESA's largest establishment.

Principal functions :

- Project management
- Future studies
- Space science
- Conception & management of ESA's space technology programme
- Spacecraft testing
- Provision of technical expertise & laboratory facilities

ESOC - European space operations centre

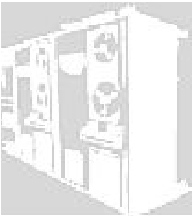


- **Ensures the smooth working of spacecraft in orbit.**

- **Principal functions :**
  - Operation of spacecraft
  - Satellite control & payload operations
  - Design & operation of ground facilities

- **Operations Control Centre :**
  - Main control room
  - Spacecraft dedicated control rooms
  - Computer & engineering facilities
  - Ground stations

ESRIN

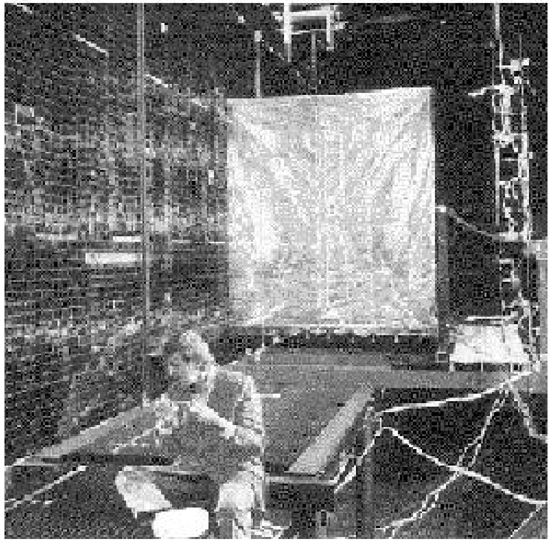


Principal functions :

- Acquisition, processing, archiving & distribution of remote sensing data from ERS-1/ERS-2 & other satellites such as Landsat, NOAA-Tiros, MOS, JERS, etc. And future missions such as ENVISAT (1999)

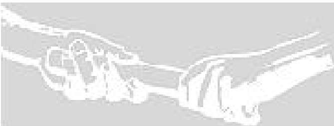
- Management of ESA's non-Operational Data Processing Activities, including development and operation of information systems.

Industrial policy

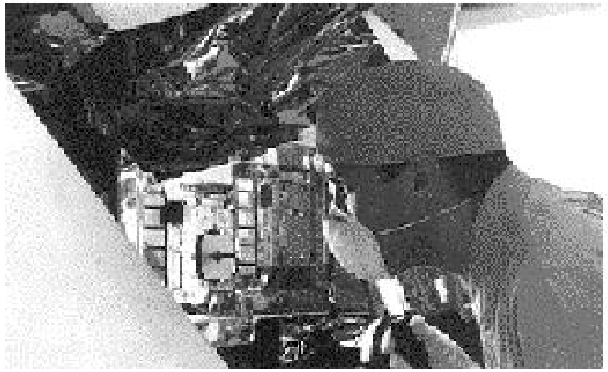


- About 90% of ESA's budget is spent on contracts with European industry, mainly for R&D.
- ESA's industrial policy ensures a guaranteed return for Member States on contributions, both financially and in terms of technical development activity.
- Aims :
  - Improve competitiveness of European industry
  - Conduct cost-effective R & D and operations
  - Ensure equitable participation for all Member States

Industrial policy



ESA is responsible for research and development of space projects. On completion of qualification, these Projects are harded over to outside bodies for the production/exploitation phase.



Operational systems are transferred to new or specially established organisations :

- Launchers :
  Arianespace - launcher production phase

- Communications :
  Eutelsat & Inmarsat - international communications services via ECS/MARECS

- Meteorology :
  Eumetsat - Meteosat weather satellites

TECHNICAL ANNEX XI

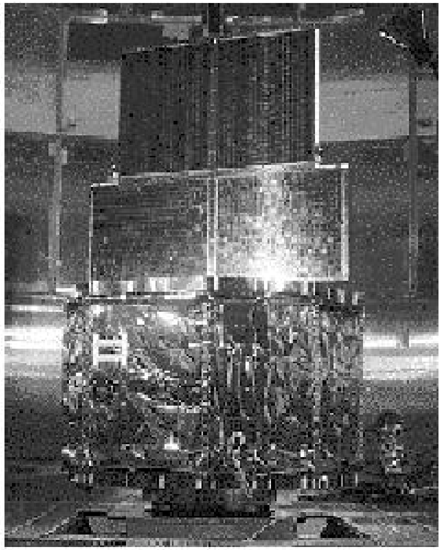
SCIENTIFIC MISSIONS AND LONG TERM PROGRAMMES OF THE EUROPEAN SPACE AGENCY (ESA)

The first science spacecraft

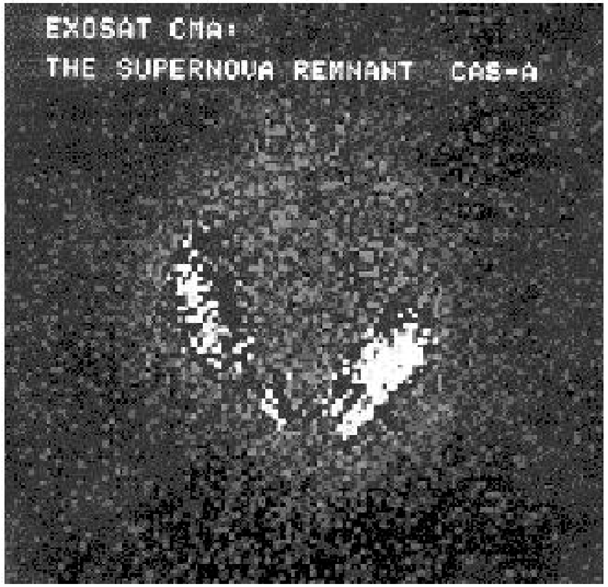
Between 1968 and 1983 some 13 European spacecraft were launched on scientific missions to study a vast array of disciplines :

- Cosmic rays and solar X-rays (ESRO 1B & 2B)
- Ionosphere and aurora (ESRO 1A)
- Solar wind (HEOS-1)
- Polar magnetosphere (HEOS-2)
- UV astronomy (TD-1)
- Ionosphere and solar particles (ESRO-4)
- Gamma ray astronomy (COS-B)
- Magnetosphere (GEOS-1 & 2)
- Magnetosphere and sun-Earth relations (ISEE-2)
- Ultraviolet astronomy (IUE)
- Cosmic x-rays (Exosat)

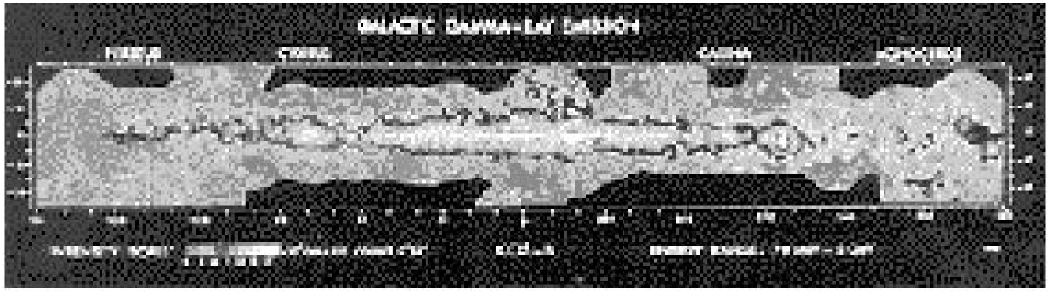
The first science spacecraft

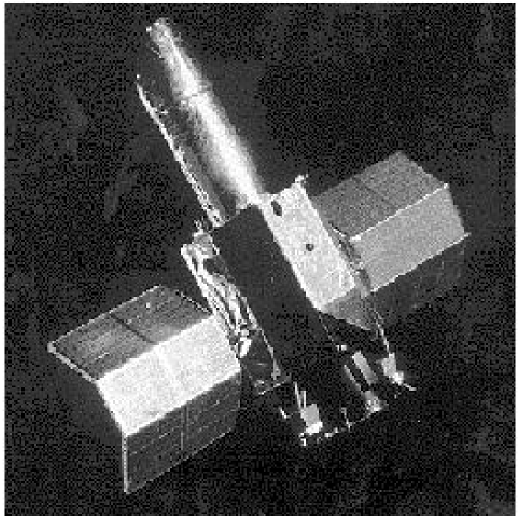


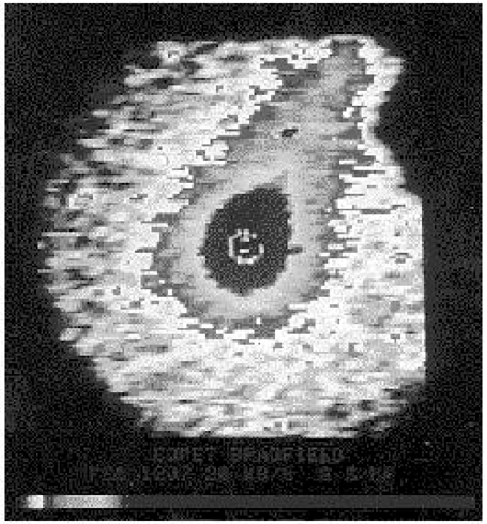
EXOSAT



COS B







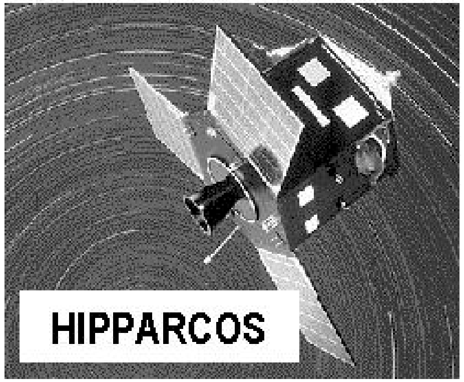
IUE

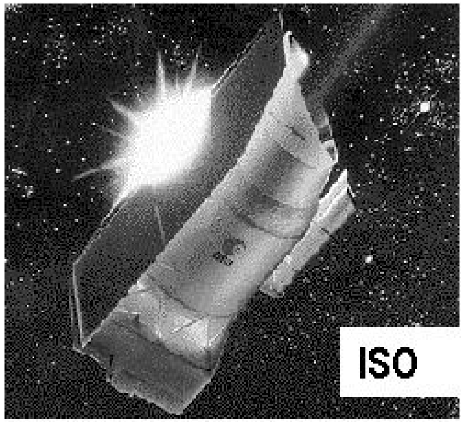
Science missions over recent years

- The ESA Giotto probe (launched in 1985) became the first spacecraft ever to meet two comets
  - Comet Halley, 1986
  - Comet Grigg-Skjellerup, 1992

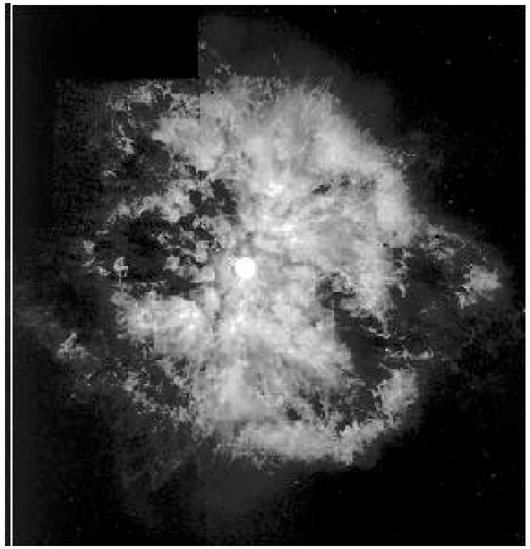
- Between 1989 and 1993 the Hipparcos satellite collected data on the positions and movements of a million stars. The catalogues are to be published in 1997

- The infrared space observatory (ISO) was launched in 1995 and concluded its operation in 1998, giving the first detailed view and spectra of infrared celestial objects





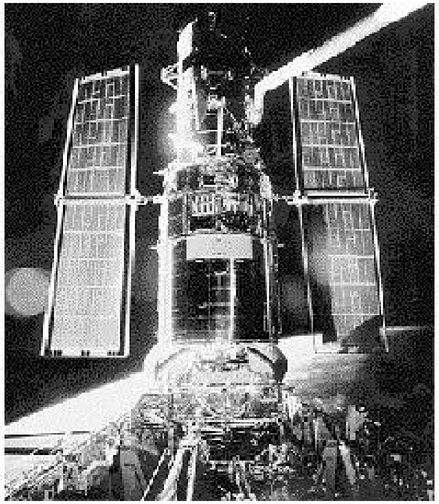
Science missions of today



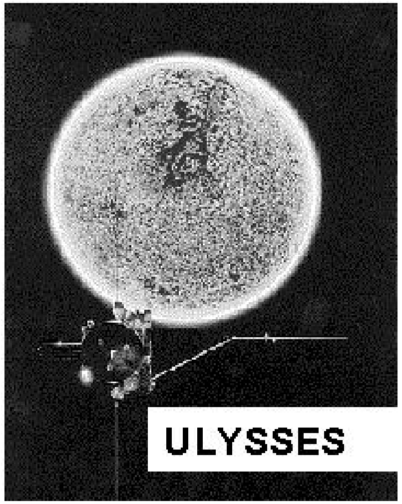
ESA science missions currently contributing to our understanding of the universe :

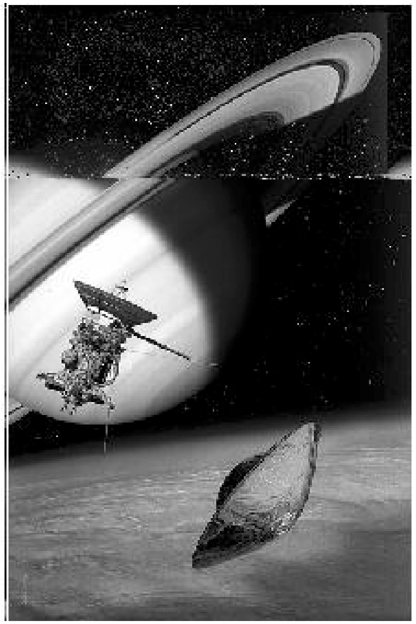
- Ulysses (1990-...) - (with NASA) heliospheric studies
- Hubble Space Telescope (1990-...) - (with NASA) space observatory
- SOHO - Sun-Earth environment (1995-...)
- Cassini - Huygens - probe to Saturn and Titan (1997-...)
- XMM - Multi Mirror Mission (1999-...)

Science missions of today

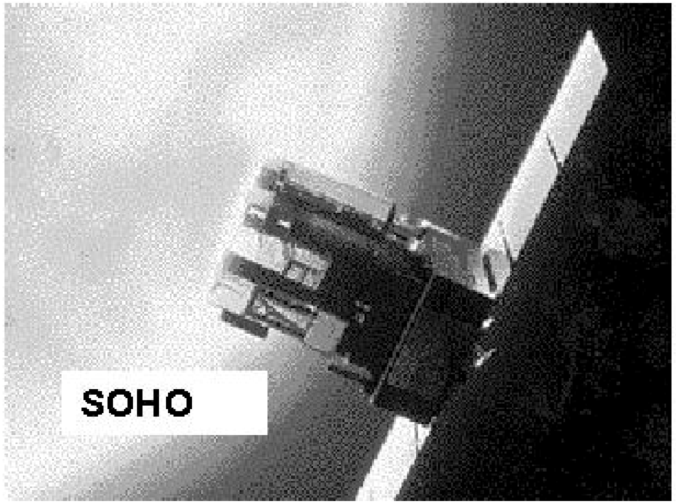


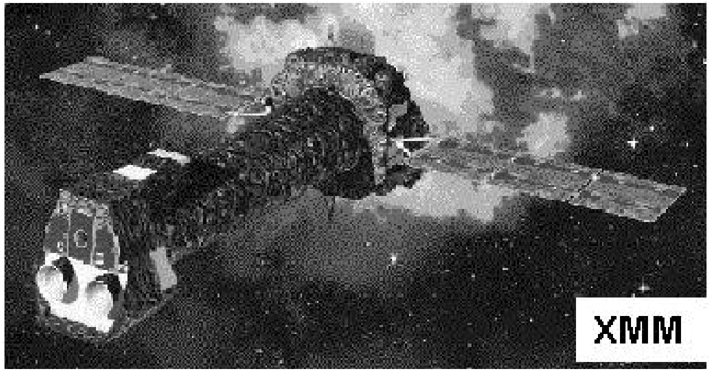
HUBBLE





CASSINI /
HUYGENS





The long term programmes - 1

In 1984 the Horizon 2000 plan was established.
It included four major projects (Cornerstones) and
a number of medium-size missions.

Cornerstones :

- STSP, consisting of two missions: SOHO (Solar and Heliospheric Observatory) and Cluster (the study of the terrestrial magnetosphere).
  SOHO was launched in 1995. Cluster was lost in 1996 on Ariane 501.
- XMM (X-ray Multi-Mirror mission), launched on 10 December 1999.
- Rosetta (in-situ analysis of cometary sample), to be launched in 2003.
- FIRST (Far Infrared Space Telescope), to be launched in 2007 with Planck.

The medium-size missions:

M1 : Cassini/Huygens (mission to Saturn and Titan), launched in 1997.
M2 : INTEGRAL (International Gamma-Ray Laboratory), to be launched in 2001.
M3 : Planck (observation of anisotropies of microwave diffuse background),
to be launched in 2007 with FIRST.

The long term programmes - 2

In 1995 the Programme Horizon 2000 Plus was approved,
which was designed to continue Horizons 2000.
The two programmes together are known as Horizons 2000.

The order of launch of the new Cornerstones is not yet fixed. They are :

• Mercury Cornerstone, for the study of the planet Mercury

• Interferometry Cornerstone, for which there are two major options :
- Infrared interferometry
- Astrometric interferometry, the successor of Hipparcos

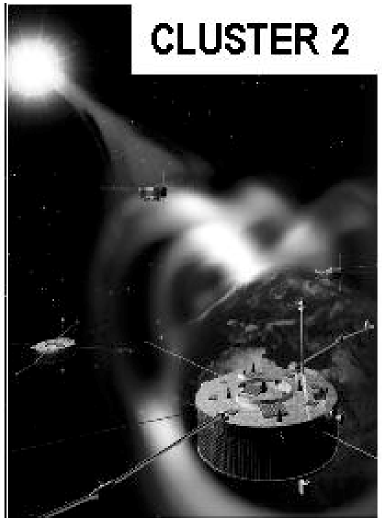
• LISA (Laser Interferometric Space Systems) for the detection of gravitational waves.

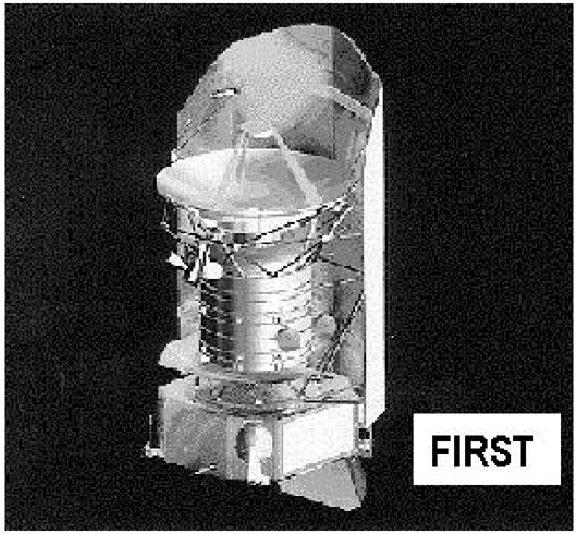
The long term programmes - 3

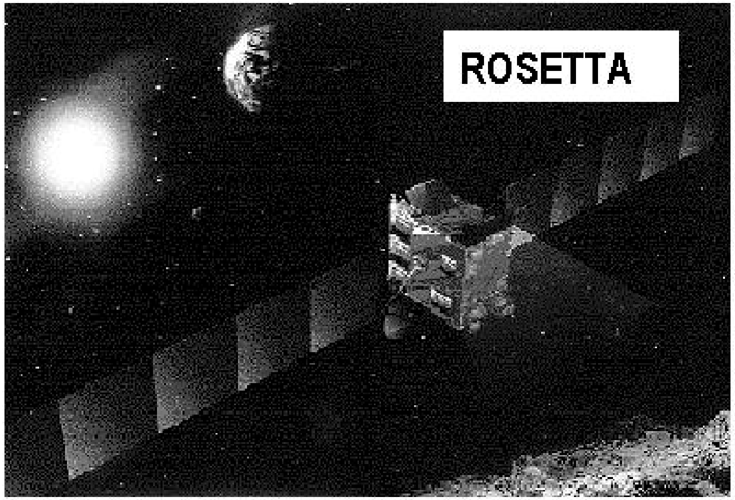
The new Horizons 2000 Implementation Plan (1997)
Foresees the following missions for the near future :

- Cluster II, Cluster replacement mission, (mid-2000)
- INTEGRAL (September 2001)
- Rosetta (January 2003)
- FIRST/Planck mission, combined, (2007)
- Cornerstone 5, to be selected among the Cornerstones of Horizon 2000 Plus (2009)

The long term programmes - 3







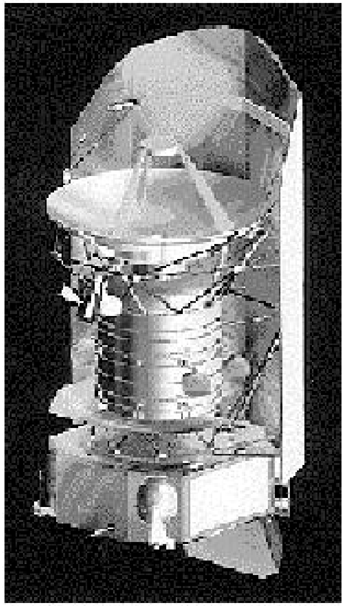
The long term programmes - 4

- The medium-size mission have been replaced by smaller, more frequent ''Flexi'' Missions.
  The first being :
  F1 Mars Express, to planet Mars (2003).

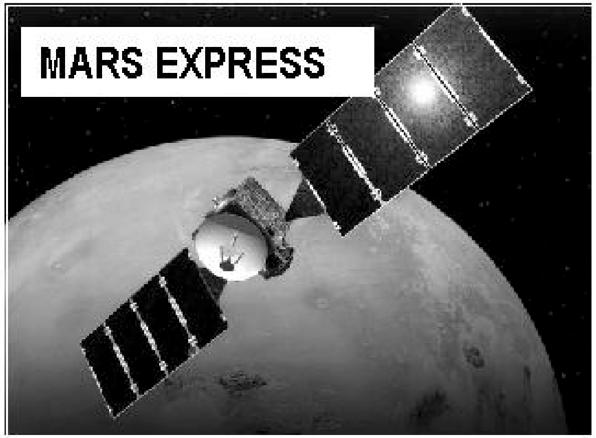
- In addition, Small Missions for Advanced Research in Technology (SMART) are planned.
  The first one will be :
  SMART-1 for the study of Solar Electric Propulsion (2001).

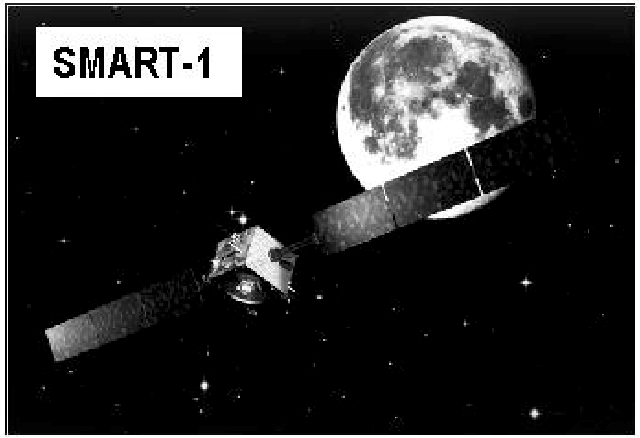
- A small mission is planned to test the Equivalence Principle in Space (MiniSTEP, 2004).

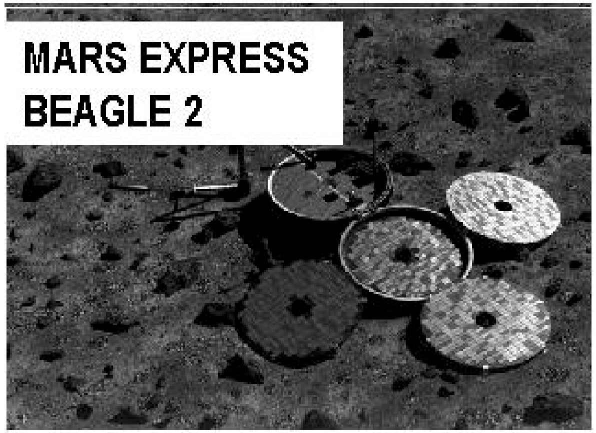
The long term programmes - 4

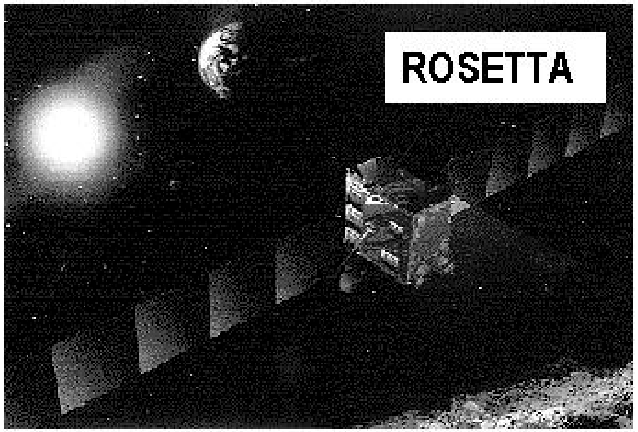


FIRST









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