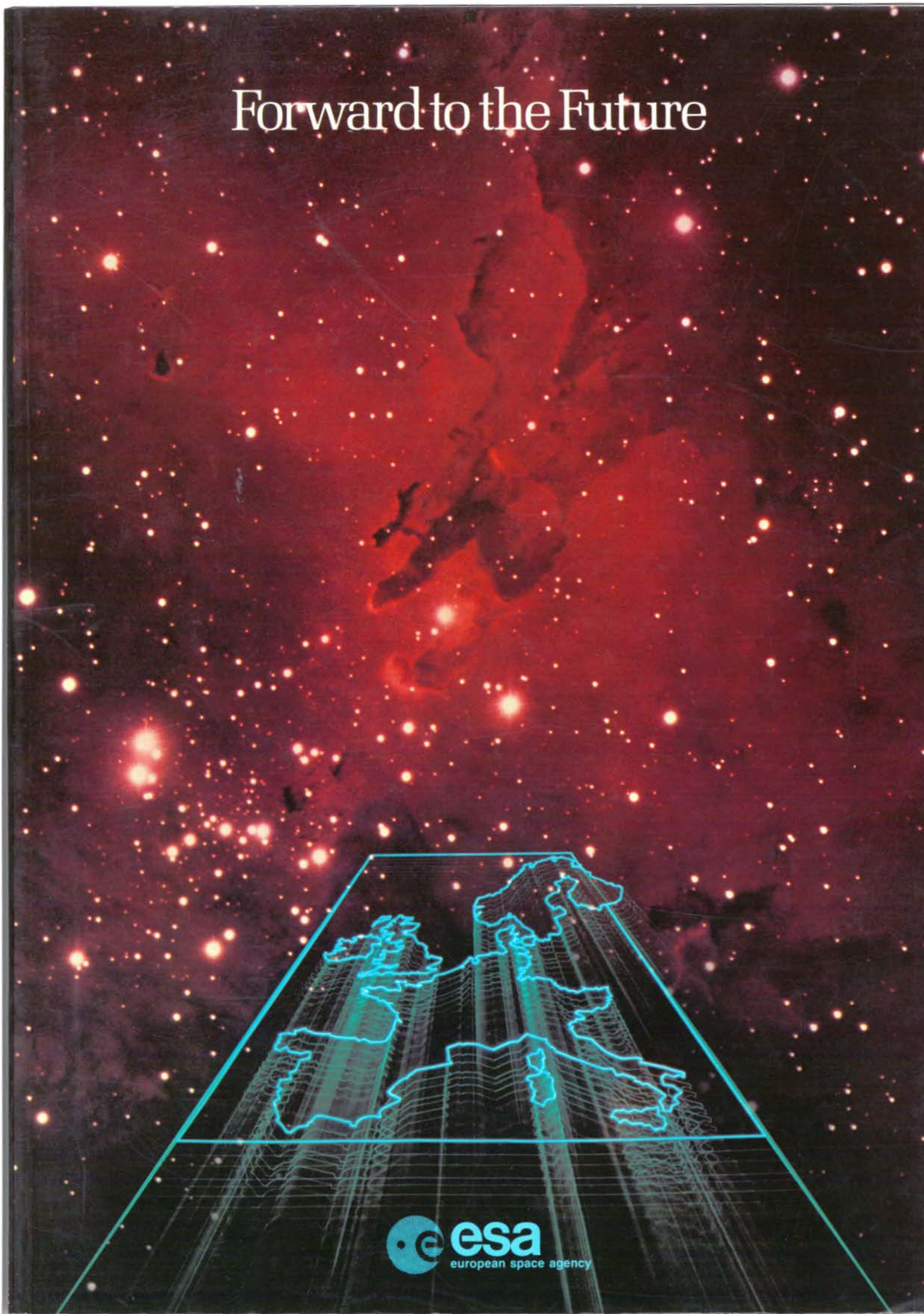
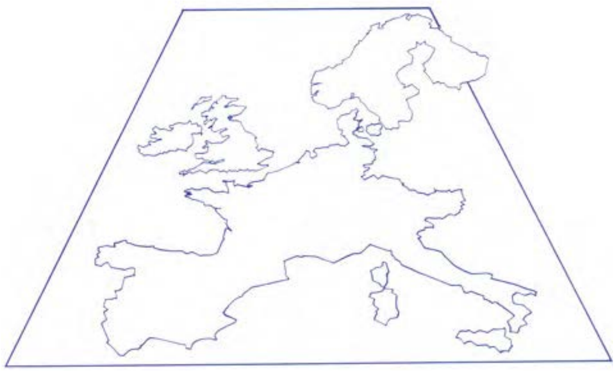
Forward to the Future



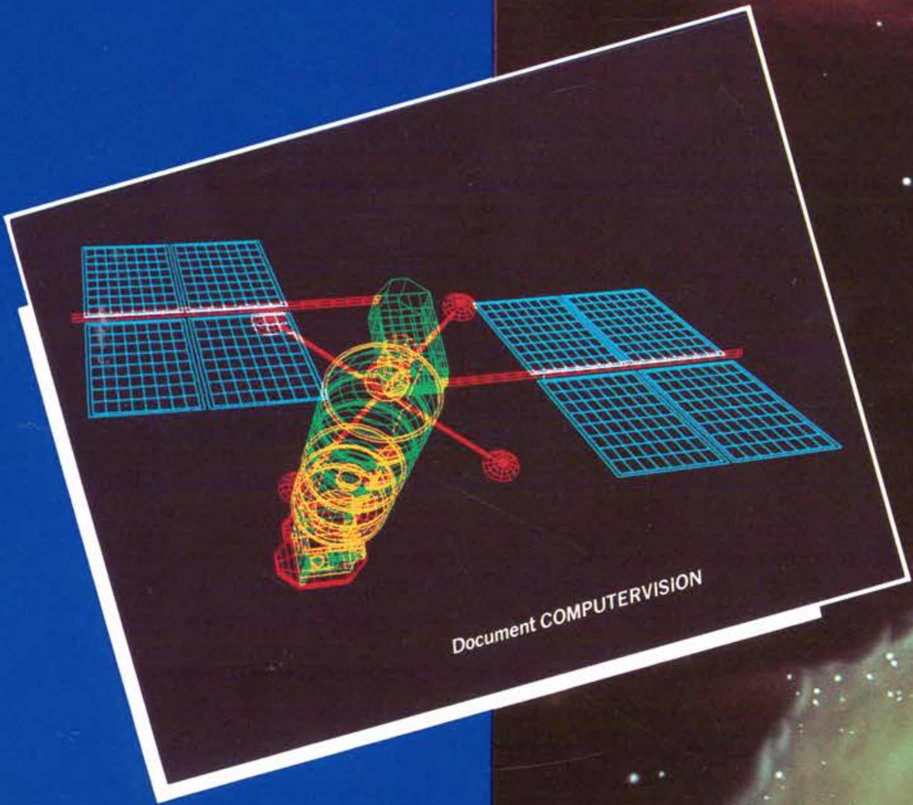
esa
european space agency

Forward to the Future



SUMMARY

FURTHERING OUR KNOWLEDGE



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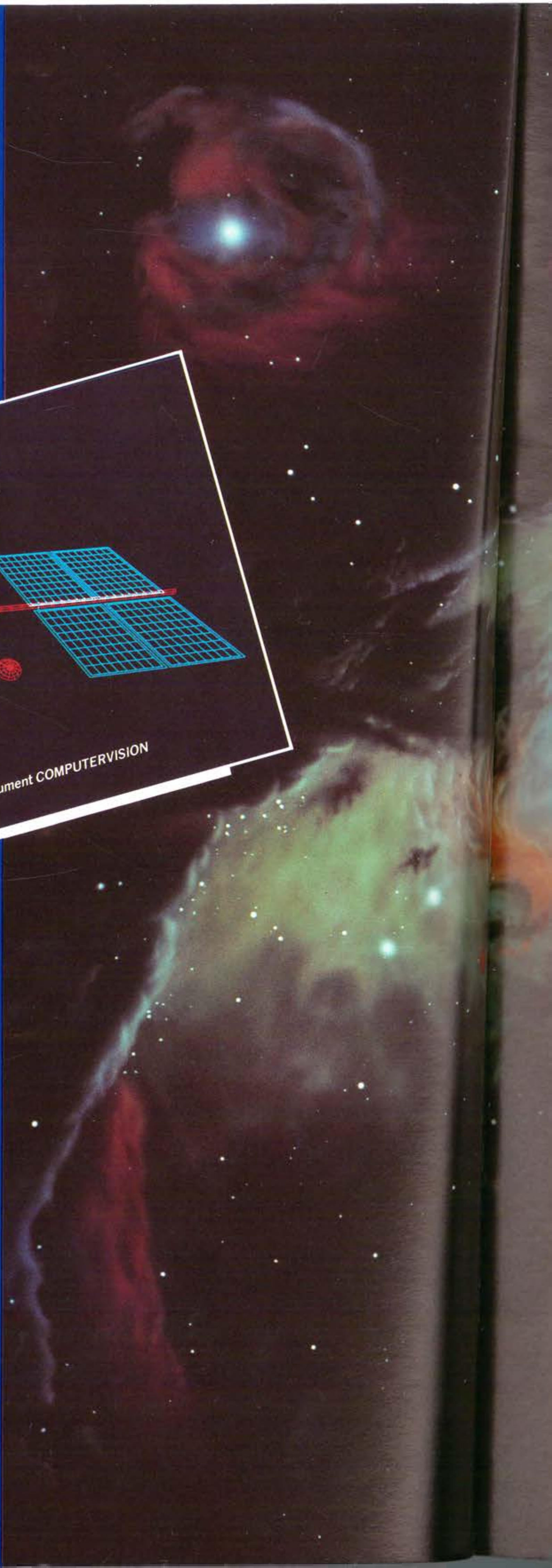
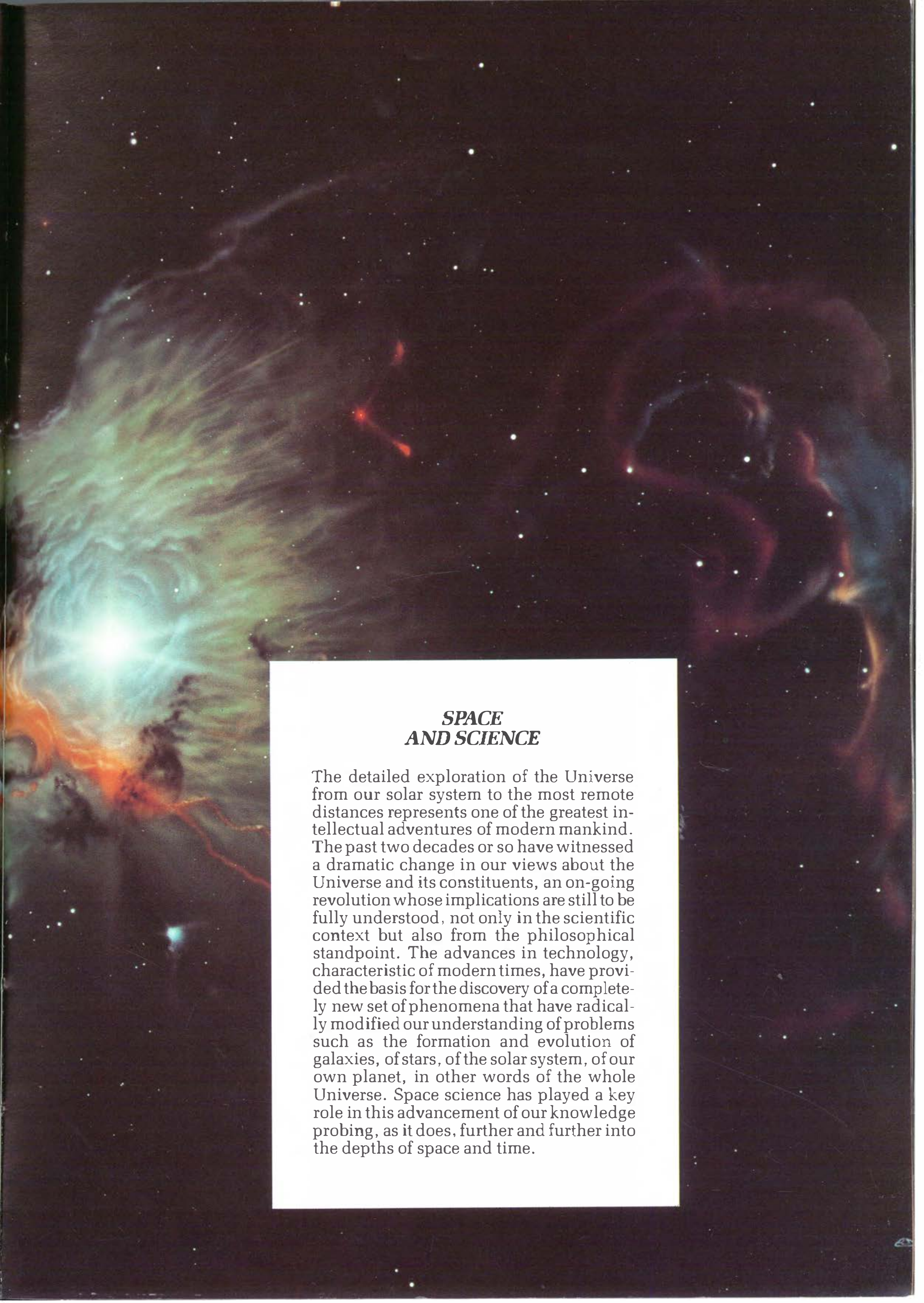
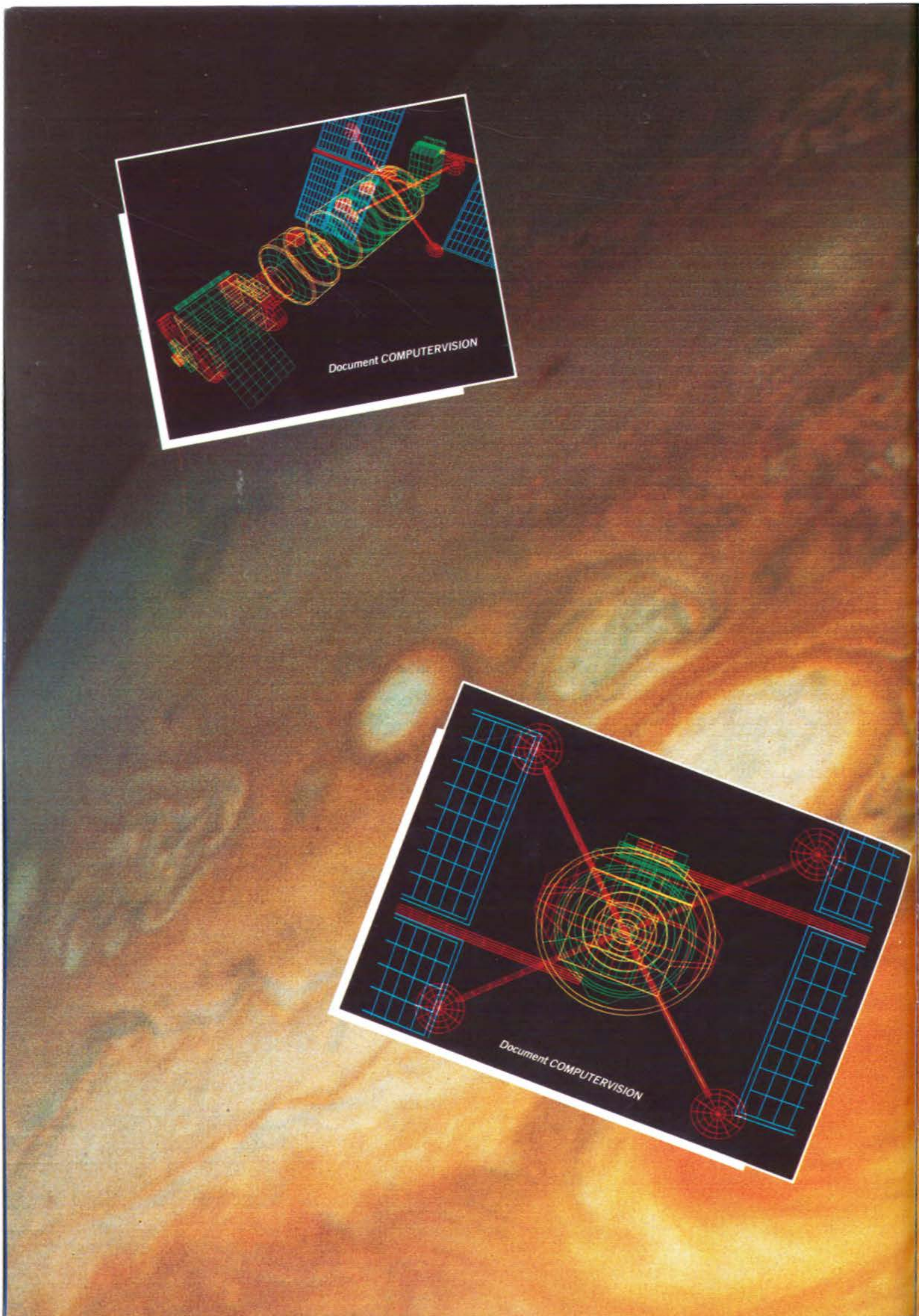


It is in the nature of scientific quest that successive projects always strive for the as yet unattainable and push technologies to their ultimate performance.



SPACE AND SCIENCE

The detailed exploration of the Universe from our solar system to the most remote distances represents one of the greatest intellectual adventures of modern mankind. The past two decades or so have witnessed a dramatic change in our views about the Universe and its constituents, an on-going revolution whose implications are still to be fully understood, not only in the scientific context but also from the philosophical standpoint. The advances in technology, characteristic of modern times, have provided the basis for the discovery of a completely new set of phenomena that have radically modified our understanding of problems such as the formation and evolution of galaxies, of stars, of the solar system, of our own planet, in other words of the whole Universe. Space science has played a key role in this advancement of our knowledge probing, as it does, further and further into the depths of space and time.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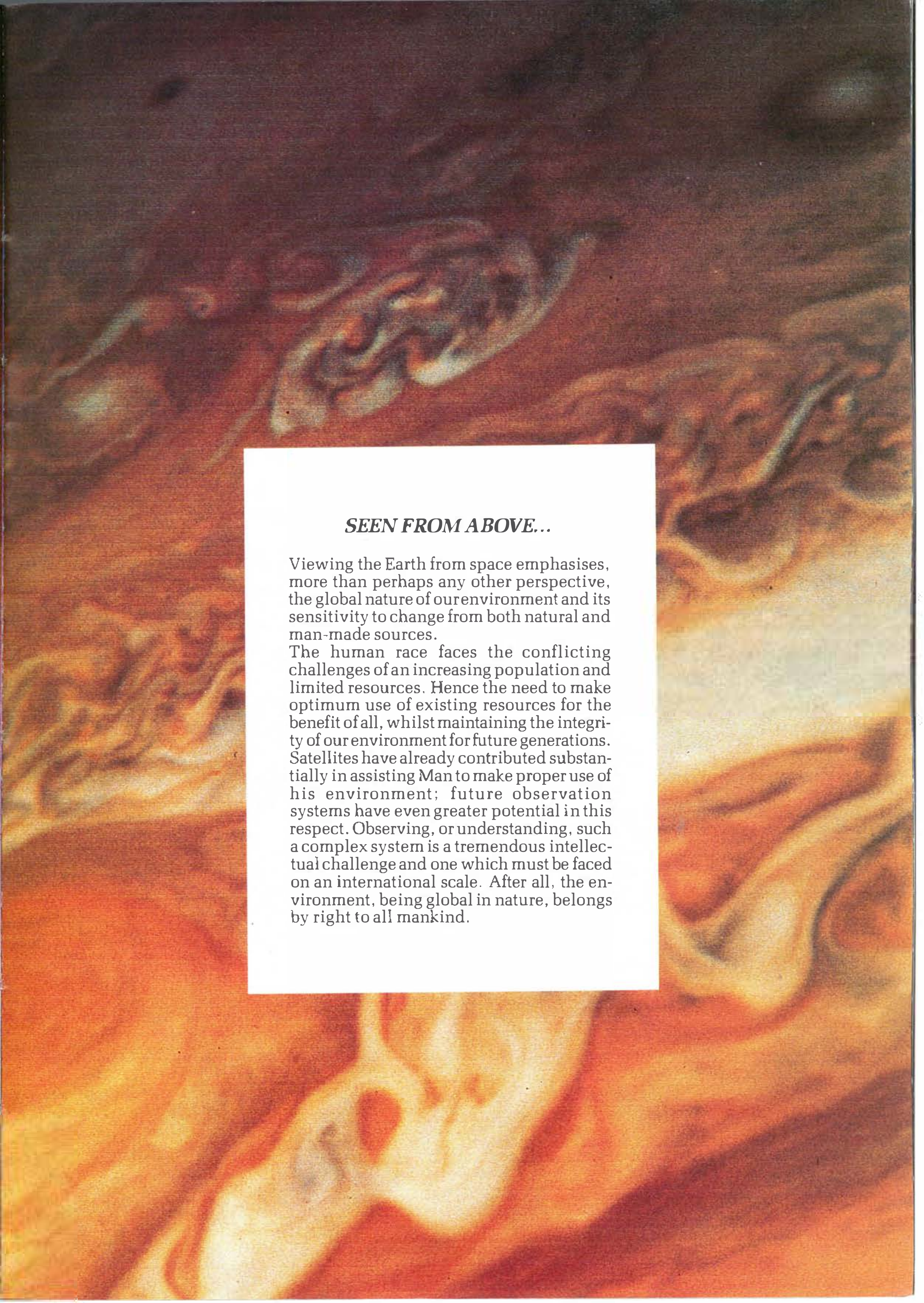
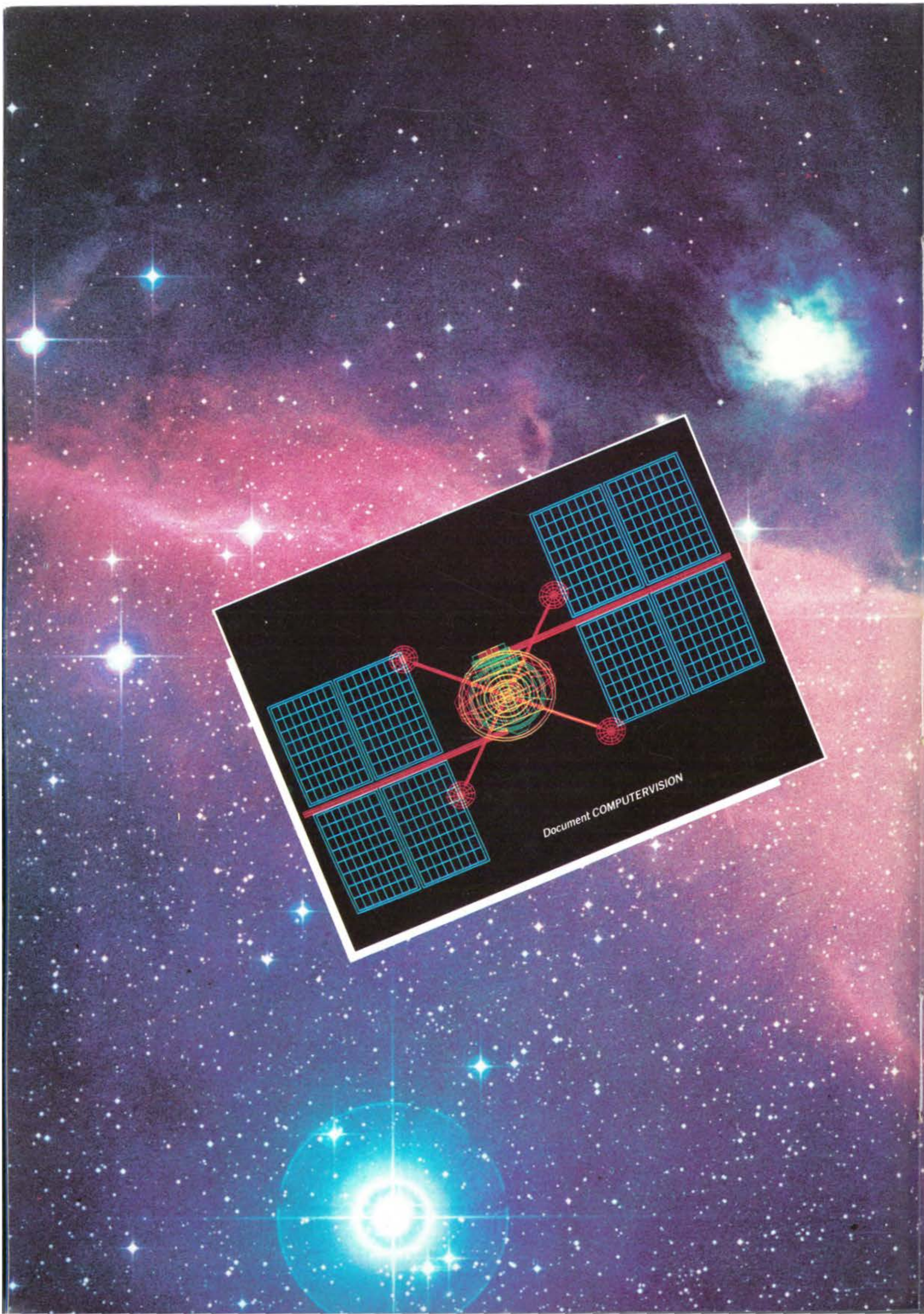


SEEN FROM ABOVE...

Viewing the Earth from space emphasises, more than perhaps any other perspective, the global nature of our environment and its sensitivity to change from both natural and man-made sources.
The human race faces the conflicting challenges of an increasing population and limited resources. Hence the need to make optimum use of existing resources for the benefit of all, whilst maintaining the integrity of our environment for future generations. Satellites have already contributed substantially in assisting Man to make proper use of his environment; future observation systems have even greater potential in this respect. Observing, or understanding, such a complex system is a tremendous intellectual challenge and one which must be faced on an international scale. After all, the environment, being global in nature, belongs by right to all mankind.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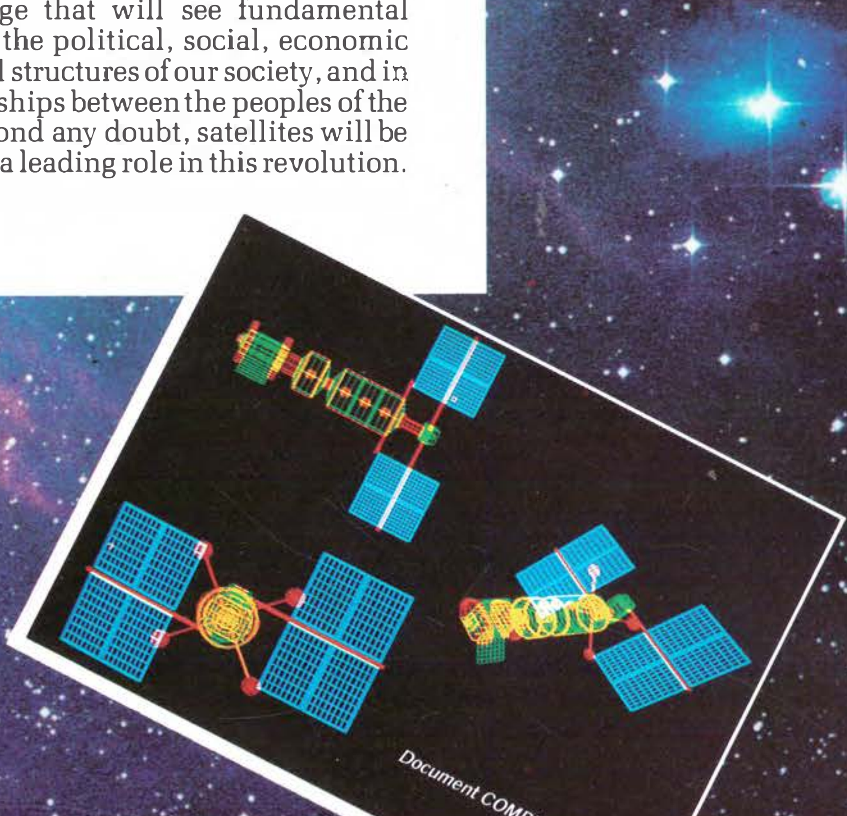
SATELLITE TELECOMMUNICATIONS FOR ALL

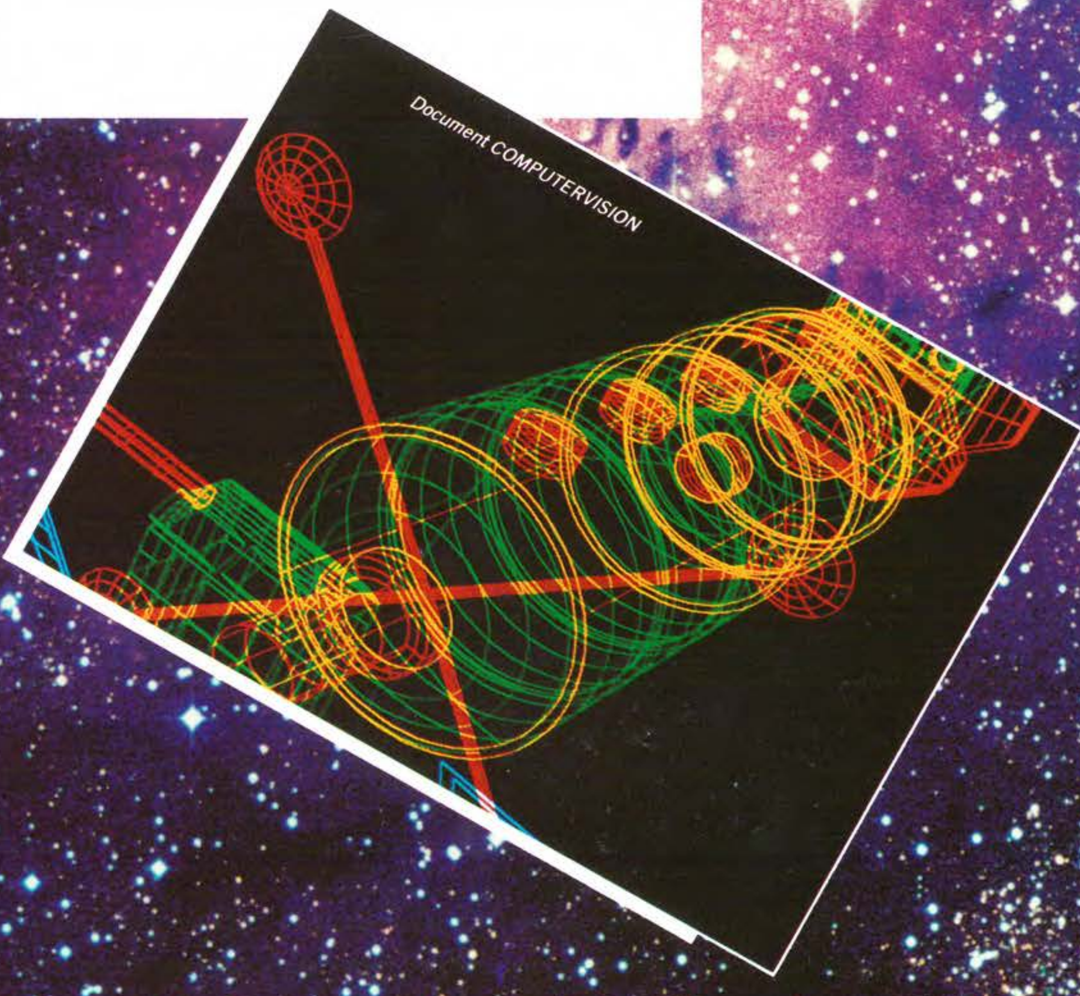
Orbiting the Earth at a distance three times its diameter, geostationary telecommunication satellites relay messages from continent to continent, taking the oceans in their stride. When the first of them came into service in 1964, enormous ground stations were needed to transmit and receive the signals; over the years, the satellites have grown more and more powerful, and the ground stations have become smaller and smaller.

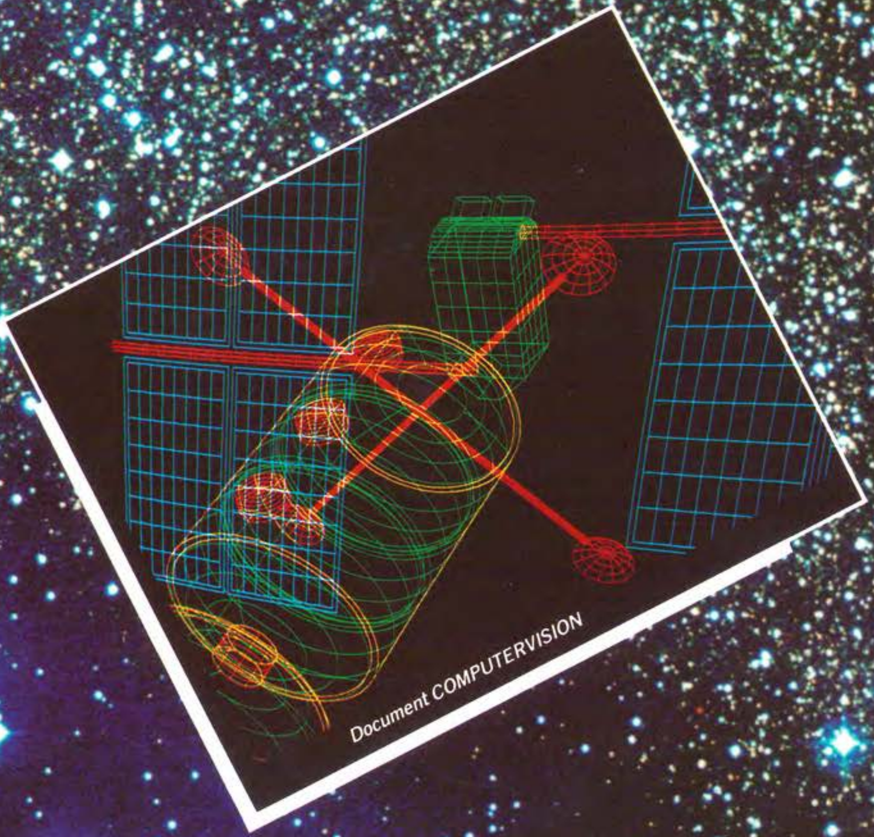
The age of all-purpose telecommunications, available to everyone, is just beginning. It will be an age of tele-data processing and of a revolution in the way information is handled, an age that will see fundamental changes in the political, social, economic and cultural structures of our society, and in the relationships between the peoples of the world. Beyond any doubt, satellites will be able to play a leading role in this revolution.



LAUNCHING - THE FUTURE

The worldwide psychological and political shock occasioned by Man's entry into the space age with the launch of the first artificial satellites in the late fifties could not fail to have major repercussions in Europe. The two key words here are "launch" and "satellite". While Europe very quickly undertook the development of its own satellites, it entered the launcher field at a much later date. Since the first Ariane-1 launch in 1979, it has however progressed very rapidly and is now preparing to take another stride forward with the development of Ariane-5 which could well lead to the launch of manned vehicles before the end of the century. Europe is thus on the way to achieving autonomy in yet another field of space research and technology.





MAN IN SPACE

Until very recently, Man's development has taken place on the surface of planet Earth. He has now shaken off the shackles of gravity and is beginning to learn to live and work in the hostile environment of space where his presence guarantees an adaptable human interpretation of events and subsequent reasoned action. Sometime next century, space travel will probably no longer be a great pioneering adventure but may well become as routine as taking a plane today. In fact, the novelty is already disappearing and other factors are taking pride of place. The first ESA astronaut was a scientist trained to operate experiments in orbit. Without doubt he will be followed by others and the years to come will see not only the further exploration of this vast environment but also its commercial exploitation.

TECHNOLOGY : AN ESSENTIAL FACTOR

The capability to perform any space mission is, in the end, dependent on the capability of spacecraft, and the technological state-of-the-art determines whether mission ideas can be turned into reality. The preparation of new technological capabilities is therefore the pacing item in satisfying Man's desire for new adventures in space exploration. From the beginning of European space activities this need for technological advance has been recognised; the obvious increase in the complexity, reliability and overall capability of today's spacecraft compared to their early predecessors provides ample evidence of success in this field. In addition, the success of the European space industry in the competition for the valuable and rapidly expanding world market for commercial spacecraft relies heavily on this technological preparation.


Document COMPUTERVISION

FORWARD TO THE FUTURE

"The purpose of the Agency shall be to provide for and to promote, for exclusively peaceful purposes, cooperation among European States...

In the past twenty years, European cooperation in space has produced outstanding results and placed Europe in third place, immediately behind the two superpowers, the United States and the USSR, in a field that has tremendous potential not only scientifically but also economically. Space has now entered a commercial phase, the fiercely competitive launcher market alone being a striking example of this.

1984 was a turning point for Europe in space. It saw the end of the first two decades of cooperative effort and, at the same time, the successful completion of the major programmes — Spacelab, Ariane and the Telecommunications Programme in particular — approved over ten years earlier, in 1973. It was also a year of preparation, of putting the final touches to a long-term plan of activities designed to bring Europe to the brink of the 21st century. This preparatory effort was crowned with success at the end of January 1985, when the Ministers responsible for space matters in ESA Member States approved an ambitious and far-seeing programme of activities designed to reinforce Europe's position at the forefront of advanced scientific and technological activities.

What objectives did the Ministers set the European Space Agency ? First and foremost, to expand Europe's autonomous capability and its competitiveness in all sectors of space activity by building on the past successes of the Agency.

Autonomy and competitiveness are, in fact, the keynotes behind the whole of the ESA long-term plan. The two are closely linked; Europe can only achieve autonomy in all fields of space research if its industry is also at the forefront of progress and can thus compete on equal terms, for a share of the world market. In this respect, the ESA long-term plan implements the ESA Convention which, in its Article VII, lays down that "The industrial policy which the Agency is to elaborate and apply shall be designed in particular... to improve the worldwide competitiveness of European industry by maintaining and developing space technology and by encouraging the rationalisation and development of an industrial structure appropriate to market requirements, making use, in the first place, of the existing industrial potential of all Member States."

Over the years, the space industry throughout Europe has, thanks to ESA, built up a considerable fund of expertise. To mention but two programmes, over forty European industrial firms were involved in the development of Spacelab and over 50 in the development of Ariane. It is a truism that space costs money — the development of the Ariane-1 launcher alone cost over 960 million accounting units (at 1984 price levels) — but the economic spin-offs are considerable. Also the European Ministers specifically recommended that the Agency should make every effort to ensure that the overall return coefficient should be as close as possible to the ideal value of 1 for all countries. In other words, the contribution of each country to a specific programme should ideally bring it industrial contracts of an equivalent value.

The Ministers also approved the specific programme proposals put forward in the long-term plan and which are described in some detail in the following chapters.

The scientific programme is one of the foundation stones of European cooperation in space. Between 1968 and 1984, 13 scientific spacecraft were launched, ranging from simple payloads for studies of the magnetosphere, just beyond the Earth's atmosphere, to ESA's X-ray observatory satellite, EXOSAT, a highly sophisticated tool for the observation of X-ray sources in our own and other galaxies. The next fifteen years will see not only an increase in the number of missions but also in their complexity and interest.

Another area of great potential is telecommunications. In spite of the tremendous strides in this area over the last ten to fifteen years, new and unexpected applications are already appearing on the horizon and it is essential that European industry should keep its leading edge if it is to continue to play a role in yet another keenly competitive market. ESA's programme in this field includes the development of advanced communication satellites of a type which will become operational in the last decade of this century.

The development of Earth observation satellites whether for meteorological purposes, the exploration and evalua tion of natural resources or for scientific purposes, have completely modified Man's attitude to his environment and here again, the scientist, closely followed by the businessman, sees new vistas opening up in the future. In the years ahead, ESA will be playing the role of pathfinder in this area. With the development of new systems for ocean and land applications and for meteorology, the Agency will be laying the foundations for future operational systems which will mean that Europe will cease to depend on other sources for the information it will need not only to manage its own resources but also, and this is of capital importance, to help developing countries with which it has traditional links to manage theirs.

ESA's Spacelab mission in November 1983 clearly demonstrated that two relative newcomers to the field of space research — life sciences and material sciences — have great potential for the future to the extent that factories in space are perhaps not just a pipe dream but could rapidly become reality. The first step in this direction is the space station. Europe plans to take up the invitation made by the President of the United States and to participate in the US Space Station project. It also intends to work towards autonomy in this area too and could well have its own space station during the first decades of the 21st century. Closely linked to this is the launcher programme which, in its early stages, will continue to develop expendable launch vehicles designed to place ever heavier payloads in orbit. The logical follow-on — which is already being studied — is the development of a European spaceplane which could carry Man and materials to and from the space station.

Last, but by no means least, is the space technology programme which forms the common bedrock on which all other programmes rest. The centralisation of research ar d development work on new technologies under this programme avoids duplication of effort and ensures that all ESA projects benefit from breakthroughs. The fact that ESA closely coordinates its activities in this field with those carried out at national level in its Member States contributes greatly to the build-up of a unified European technology effort.

The changes which can be expected over the next twenty years of European space cooperation will undoubtedly be as great if not greater than those made during the pioneering years between 1964 and 1984. ESA is proof that where the will exists, as it clearly does for space activities, European countries can pool their efforts and achieve their goals.

...in space research and technology and their space applications with a view to their being used for scientific purposes and for operational space applications systems." (ESA Convention)

ESA-EUROPEAN SPACE AGENCY

"Desiring, in order to achieve these aims, to establish a single European space organisation to increase the efficiency of the total of European space efforts ...

With the ratification of its Convention on 30 th October 1980, the European Space Agency, which de facto came into being in May 1975, acquired its legal existence. The Agency groups in a single body the complete range of European space activities previously conducted by ESRO and ELDO in their respective fields of satellite development and launcher construction.
The eleven Member States of ESA are Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom. Three other states are closely associated with the Agency: Austria and Norway are associate members with the status defined in the Convention, and Canada has an agreement for close cooperation.
The Agency's purpose, as described in its Convention, is to provide for and to promote, for exclusively peaceful purposes, cooperation among European states in space research and technology, and their space applications, with a view to their being used for scientific purposes and for space applications systems. To fulfil its mission the Agency:

- elaborates and implements a long-term space policy, recommends space objectives to its Member States, concerts the policies of the Member States with respect to other national and international organisations and institutions;
- elaborates and implements activities and programmes in the space field;
- coordinates the European space programme and national programmes, integrating the latter progressively and as completely as possible into the European space programme, in particular as regards the development of application satellites;
- elaborates and implements the industrial policy appropriate to its programme, and recommends a coherent industrial policy to the Member States.

To help in achieving these goals, and in promoting European space products, the Agency maintains relations with a large number of non-member States and international organisations.
It cooperates with States and organisations that are building up space programmes, and helps in encouraging the developing countries to make use of space techniques.

Organisation and functioning

The Agency's policy-making body is the ESA Council, composed of representatives of the Member States. The Council takes decisions on the policy to be followed by the Agency, and on scientific, technical, administrative, and financial matters, each State having one vote except in the case of an optional programme in which only participating States have a vote. The level of the Agency's resources for its mandatory activities is determined for a period of five years in advance by a unanimous decision of all Member States. Other decisions are taken on a simple, or two-thirds, majority vote.
The Convention established a Science Programme Committee, to which are referred matters relating to the mandatory science programme; the Committee is authorised to take decisions relating to that programme. The Council may also establish such other subordinate bodies as may be necessary for the purposes of the Agency. Delegations from the Member States sit on all such committees and programme boards.
The chief executive and legal representative of the Agency is the Director General, who is appointed by the Council for a defined period. He is assisted by six directors who are responsible for the following directorates: Administration, Application Programmes, Spacecraft Operations, Scientific Programmes, Space Transportation Systems, and the Technical Directorate.

ESA Council Meeting at Ministerial Level. Rome, January 1985

...by making better use of the resources at present devoted to space and to define a European space programme for exclusively peaceful purposes." (ESA Convention)

EUROPA-II
ESRO-4
ESRO-1
HEOS-A2
IUE
ISEE-2
OTS
GEOS-2
HIPPARCOS
METEOSAT
EXOSAT
GIOTTO
SPACE TELESCOPE
OLYMPUS
SPACELAB
ULYSSES
ISO
ERS-1
EURECA
ARIANE-5
ARIANE-3

Establishments and their staff

ESA's total staff at the end of 1984 amounted to some 1360 persons, drawn from the Member States and located at the Headquarters and the various Establishments.

- The ESA Headquarters is situated in Paris and has a staff of some 250;
- ESTEC (European Space Research and Technology Centre) is located at Noordwijk in the Netherlands and has a staff of about 810. It is responsible, with the Programme Directors who are in charge of the various projects, for the study, design, development and testing of spacecraft in collaboration with industry and the scientific community. ESTEC is also responsible for applied research in space technology.
- ESOC (European Space Operations Centre) is located at Darmstadt in Germany and has a staff of about 220. It is in charge of all satellite operations and of the corresponding ground facilities and communications networks. The ESOC-controlled network includes a central control centre in Darmstadt and telemetry, tracking and control facilities at the ground stations. Such stations are either Agency-owned or are national facilities and include the following: Michelstadt (Germany), Redu (Belgium), Villafranca (Spain), Kourou (French Guiana), Carnarvon (Australia), Ibaraki (Japan), Malindi (Kenya), Fucino (Italy). Individual satellite missions are generally supported by a subset of these stations depending on data acquisition and control requirements.
- ESRIN (previously European Space Research Institute) is located in Frascati, near Rome, Italy, and has a staff of 65. Two programmes are on site: IRS (Information Retrieval Service), responsible for the operation of the most powerful automated documentation retrieval system in Europe, with a file of more than 35 million bibliographic references; and Earthnet, which collects, preprocesses and distributes images and data from remote-sensing satellites.

Several technical teams are located in national establishments for the conduct of specific programmes. About 20 people work in the Earth Observation Programme Department at Toulouse (France). A few staff members are stationed at Porz-Wahn (Germany) and others are at the Ariane launch site at Kourou (French Guiana). The Agency also has a liaison office in Washington.

"Considering that the magnitude of the human, technical and financial resources required for activities in the space field is such that these resources lie beyond the means of a single European country..."
(ESA Convention)

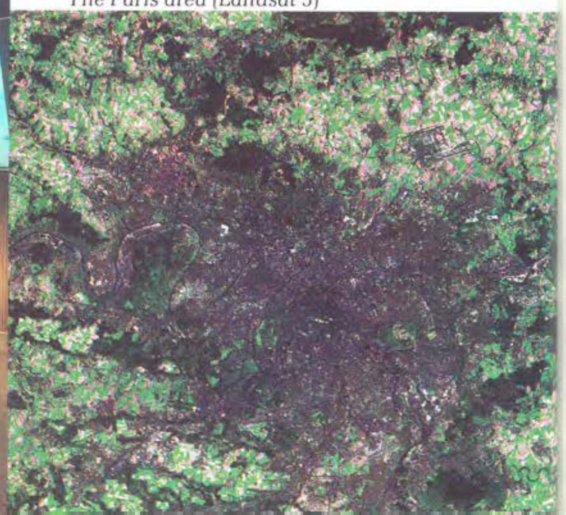
Finance

The Agency is financed by the Member States who contribute to the budgets for its mandatory activities (i.e. the general budget and the scientific programme budget) on the basis of their average national income calculated over the past three years.

Additionally, many of the Agency's major programmes are optional and Member States contribute to these to the extent that they are interested. They may be joined in these programmes by other states who may select the level of their participation and are permitted to vote in Council on

Control Room, ESOC

The Paris area (Landsat 5)



the programmes to which they contribute, e.g. Austria, Canada and Norway in the ERS-1 programme.

Contracts and industrial relations

Some 85 % of the Agency's resources are devoted to outside procurements in the form of industrial contracts, which have the purpose both of procuring for the Agency the necessary services and hardware for its programmes at an optimum combination of technical quality and price, and of promoting the technological and managerial skill of European industry in order to increase its competitive strength on the world market.

The Agency's procurement programme is carried out under the provisions of the Contract Regulations, laid down by the Council, and is supervised by the Council's Industrial Policy Committee, where national delegations are represented.

The Executive is responsible for carrying out the agreed procurement policy; in accordance with the Regulations this is, as far as possible, based on the issue of competitive invitations to tender, with a process of evaluation and selection of offers received. There are some exceptions to the rule of open competition, in order to take account of:

- the policy of technological specialisation which the Agency intends to pursue,
- the need to ensure an equitable industrial return to all countries participating in the ESA programmes.

Contracts are, in principle, placed in the countries participating in the ESA programmes; this rule may only be waived in special and defined cases.

An indication of the scale of the programme, and the work involved on the side of industry and of the Agency, is given by the following figures:

- ESA awards between 500 and 600 contracts per year;
- the number of invitations to tender per year lies between 100 and 150;
- the average number of submissions by industry for each contract awarded falls between 3 and 4, but 10 or 20 offers for a particular topic are not uncommon.

In terms of relations between ESA and industry, as a result of 20 years of a procurement policy based on the above principles, what has been achieved is:

- the generation of multi-national groups of firms working together in cooperation (consortia) and capable of taking the responsibility for the development and manufacture of spacecraft;
- a distribution of technological work of an advanced nature between all ESA Member States, and to firms and institutes of all sizes, providing a broad basis of skills and capacities.
- a degree of mutual familiarity and understanding that greatly facilitates the process of procurement through all its phases.

The international nature of the Agency imposes a further constraint on the procurement policy, namely the need to ensure not only the quality and cost-effectiveness of the work, but also an equitable distribution of the contracts between the participating States. This is measured by the "return coefficient" (essentially the ratio between a country's percentage share of the total value of contracts placed, and its percentage contribution). The value of the coefficient is evaluated regularly and if it falls below a "danger limit", corrective measures are taken.

During the last few years, all countries have (with a few temporary exceptions) had a return coefficient above 0.8; at the end of 1984 the coefficient for all countries was around 0.9 and special measures are being studied to bring the minimum return coefficient for all countries to above 0.95.

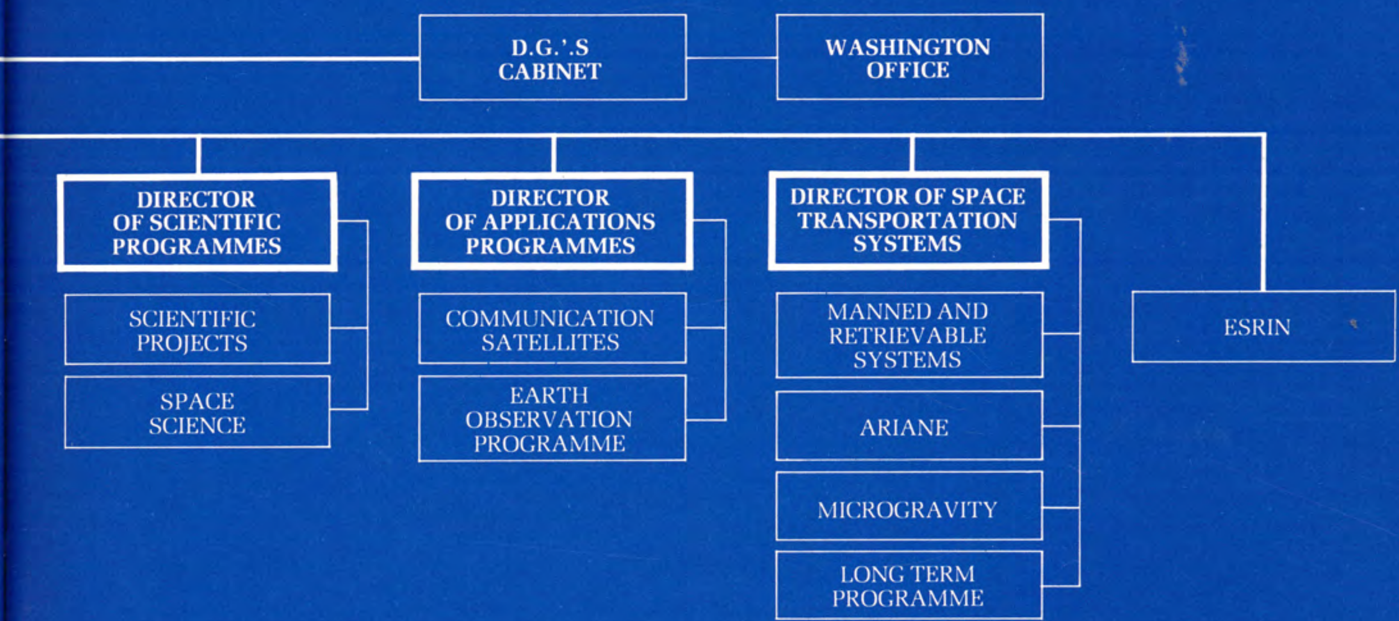
"The Agency's industrial policy shall be designed in particular to ...improve the world wide competitiveness of European industry ...by encouraging the rationalisation and development of an industrial structure appropriate to market requirements ..." (ESA Convention)

DIRECTOR GENERAL

- CO-ORDINATION AND MONITORING OFFICE

- **DIRECTOR OF ADMINISTRATION**
  - PERSONNEL AND GENERAL SERVICES
  - FINANCE AND BUDGET
  - LEGAL AFFAIRS AND INTELLECTUAL PROPERTY
  - CONTRACTS AND INDUSTRIAL POLICY
- **TECHNICAL DIRECTOR AND DIRECTOR OF ESTEC**
  - PAYLOAD TECHNOLOGY
  - SPACECRAFT TECHNOLOGY
  - ASSURANCE TESTING AND MATHEMATICS
  - SYSTEMS ENGINEERING
  - ESTABLISHMENT GENERAL SERVICES
  - PARIS OFFICE
- **DIRECTOR OF OPERATIONS (ESOC)**
  - ESA COMPUTERS
  - OPERATIONS
  - METEOSAT EXPLOITATION
  - GROUND SYSTEM ENGINEERING
  - ADMINISTRATION


esa


D.G.'.S CABINET
WASHINGTON OFFICE
DIRECTOR OF SCIENTIFIC PROGRAMMES
SCIENTIFIC PROJECTS
SPACE SCIENCE
DIRECTOR OF APPLICATIONS PROGRAMMES
COMMUNICATION SATELLITES
EARTH OBSERVATION PROGRAMME
DIRECTOR OF SPACE TRANSPORTATION SYSTEMS
MANNED AND RETRIEVABLE SYSTEMS
ARIANE
MICROGRAVITY
LONG TERM PROGRAMME
ESRIN

ESA BUDGET

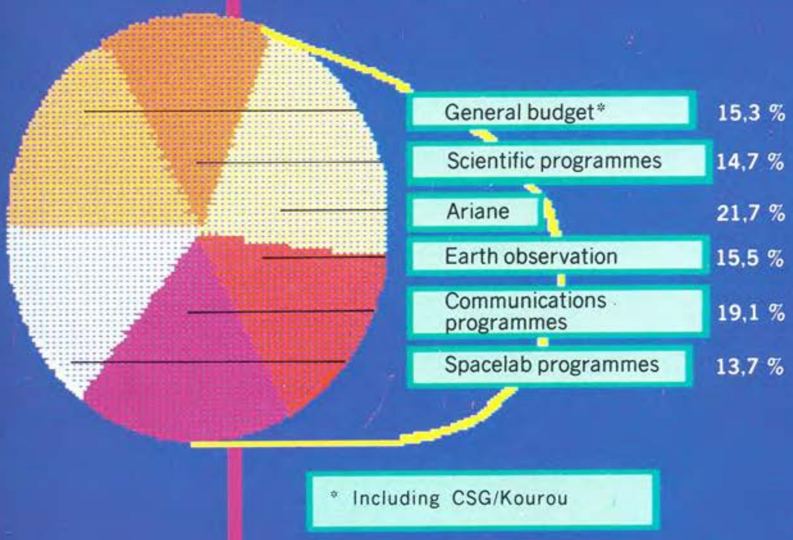
(in millions of accounting units - MAU) 1 AU = 0.82 $

	1983 Actual	1984 Actual	1985 Proposed
General budget	104	121	140
Scientific programmes	118	127	143
Meteosat programmes	10	71	96
ERS-1	30	91	51
Earth Observation Preparatory Programmes	8	1	—
Communications programmes	64	66	42
MARECS A & B	12	41	4
Olympus	113	147	108
Other communications programmes	20	34	19
Spacelab programmes (including Microgravity and STS-Long Term Preparatory Programme)	61	126	95
Ariane programmes	154	271	179
TOTAL AGENCY PROGRAMMES	694	1096	877
Programmes financed by third parties	117	60	77
GRAND TOTAL	811	1156	954

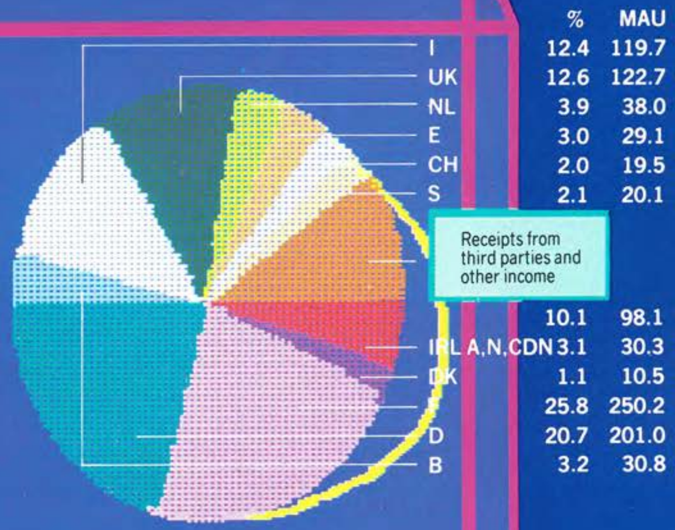
Cost-to-completion of the principal going programmes (mid-1984 price levels)

PROGRAMMES	MUC
Space telescope	169.7
Ulysses	121.3
Hipparcos	274.4
Giotto	150.6
ECS 3,4,5	221.3
Olympus	615.3
Meteosat operational	424.7
ERS-1 - phases C/D/E	584.2
Spacelab including IPS	759.4
Eureca	258.9
Microgravity	46.0
Ariane development	962.2
Ariane (promotion series)	426.7
Ariane 2-3	142.4
Ariane 4	417.4
Second Ariane launch site (ELA-2)	153.8

ESA budget 1985
approximately 970 MAU (791 M$)
(in percentages)



ESA Budget 1985
Income from Member States
and other sources



Contributions of Member States to the principal ESA programmes in 1985 (in percentages)

Member States	General budget + ESA Kourou	Ariane User Support	Science	Meteosat* Operational	ERS-1 Phase C/D	ECS 3,4,5	Olympus Phase C/D	Spacelab FOD	Microgravity	Ariane 4
Belgium	3.54	3.73	3.61	4.00	3.62	1.94	3.18	3.68	4.49	2.80
Denmark	1.64	0.65	1.98	0.19	1.52	0.45	1.17	0.62	2.51	0.15
France	25.21	68.65	20.23	22.00	21.51	16.11	—	17.31	15.50	52.90
Germany	22.68	15.95	24.90	21.00	26.60	18.48	—	53.66	27.57	20.79
Ireland	0.52	0.16	0.60	—	—	—	—	—	—	0.04
italy	11.26	1.28	13.56	11.00	11.32	8.41	31.49	17.33	7.50	7.75
Netherlands	4.53	1.06	5.39	3.00	5.18	1.08	10.40	1.50	4.00	2.00
Spain	4.41	1.19	4.94	4.50	2.50	0.32	2.69	2.80	1.00	2.50
Sweden	3.59	1.40	4.01	0.33	3.30	2.41	—	—	4.25	1.39
Switzerland	3.59	1.68	3.87	2.60	1.70	0.33	—	1.00	4.06	1.60
United Kingdom	13.98	4.25	16.91	14.40	13.88	11.22	39.13	2.10	1.35	3.55
Other Participants										
Austria	0.36	—	—	—	0.71	—	0.92	—	—	—
Norway	0.51	—	—	0.50	1.26	—	—	—	—	—
Canada	1.76	—	—	—	6.10	—	11.02	—	—	—
Other income	2.42	—	—	15.73	0.80	39.25	—	—	27.77	4.53

* The following countries also participate in the Meteosat Operational Programme: Portugal (0.13 %), Turkey (0.5 %) and Finland (0.13 %)

Space science

The Council agrees to reinforce space science activities in Europe during the next decade with a view to enabling the scientific community to remain in the vanguard of space research. *

In the coming decades ESA intends to develop its efforts in keeping and increasing the European space science community's role at the forefront of scientific research on the world scale. To this end, ESA has developed a long-term plan for missions to be launched in the mid- to late- nineties and the early years of the next century. ESA's long-term plan for space science was conceived by a committee of leading scientists supported by teams of experts in the various scientific disciplines, and is based upon the inputs of the scientific community which intensively responded to a call for mission concepts issued by ESA's Scientific Directorate.

The proposed programme is shown in fig. 1. It is founded on four major cornerstones which introduce a crucial solidity in the construction of the overall programme and which satisfy the highest priorities in the domains of solar system sciences and astronomy, with a view to ensuring that Europe continues to play a dominant role in these areas. Of the four cornerstones, two are in the solar system sciences: planetary science and solar terrestrial physics. The other two are in astronomy, in the X-ray and submillimeter domains (X-ray spectroscopy and heterodyne spectroscopy).

The four cornerstones are:

The Solar Terrestrial Physics Programme (STP)

The STP programme builds on the extensive European experience in solar, heliospheric and space plasma physics. It will attack the outstanding scientific problems in these fields in a unified and well-coordinated approach.

A Mission to Primordial Bodies including Return of Pristine Materials

Within planetary exploration, this is an area where Europe could take the lead, following on the Giotto mission. The return of primordial material from primitive bodies, namely from asteroids and comets, constitutes a major theme in future planetary science.

A High Throughput X-Ray Mission for Spectroscopic Studies between 0.1-20 keV

An observatory comprising multiple telescopes will provide the required sensitivity to perform detailed spectral diagnostics of many classes of objects with low surface brightness. This is particularly important for studying the evolution of the large and small scale structures of the universe.

A High Throughput Heterodyne Spectroscopy Mission

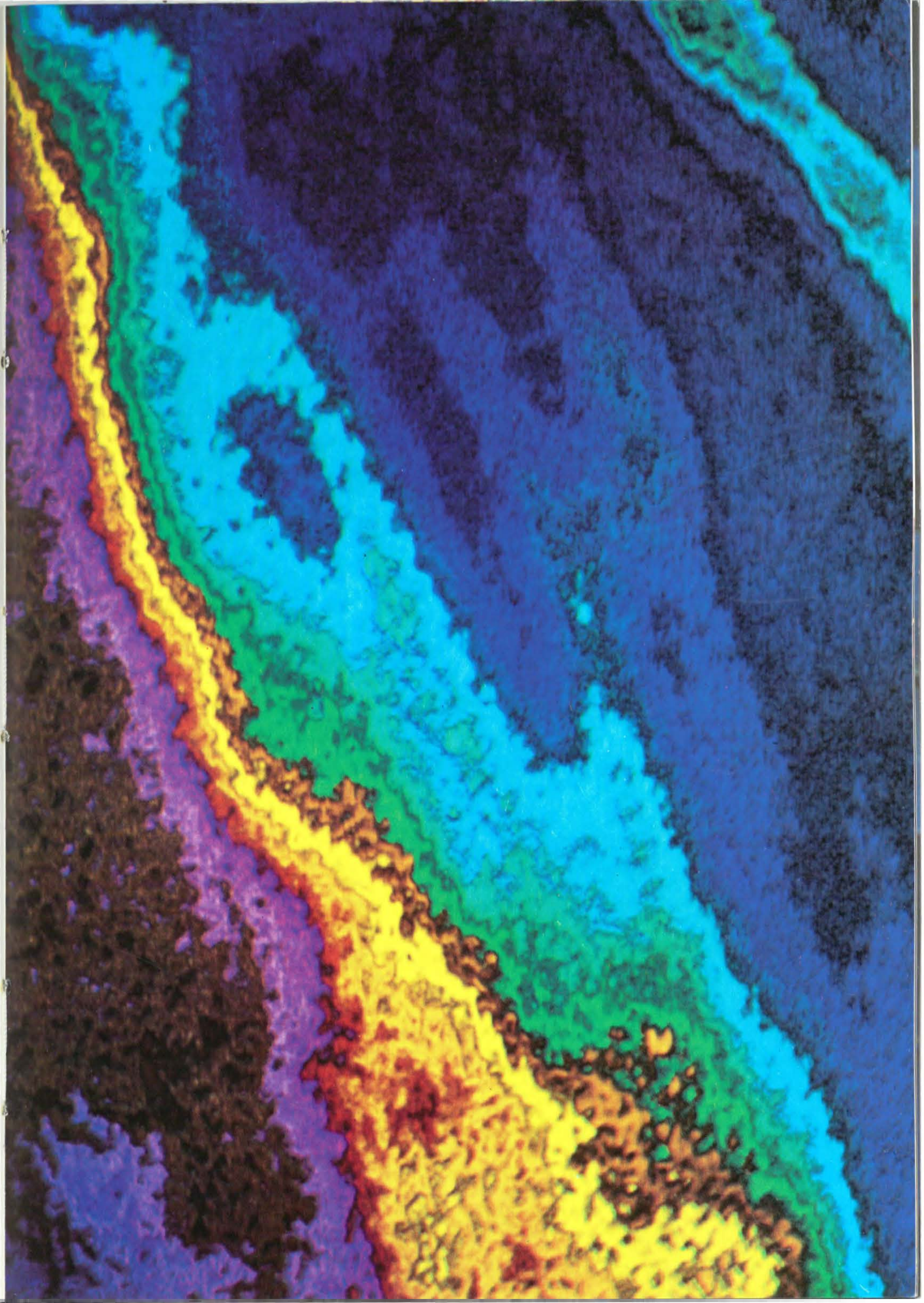
The sub-mm domain is the last remaining gap in the electromagnetic spectrum left unexplored. Apart from the continuum radiation from cosmic dust, this range also contains a large number of very important atomic and molecular transitions which provide a direct probe for stuyding the physics and chemistry of the cool universe in the range 3-1000K.

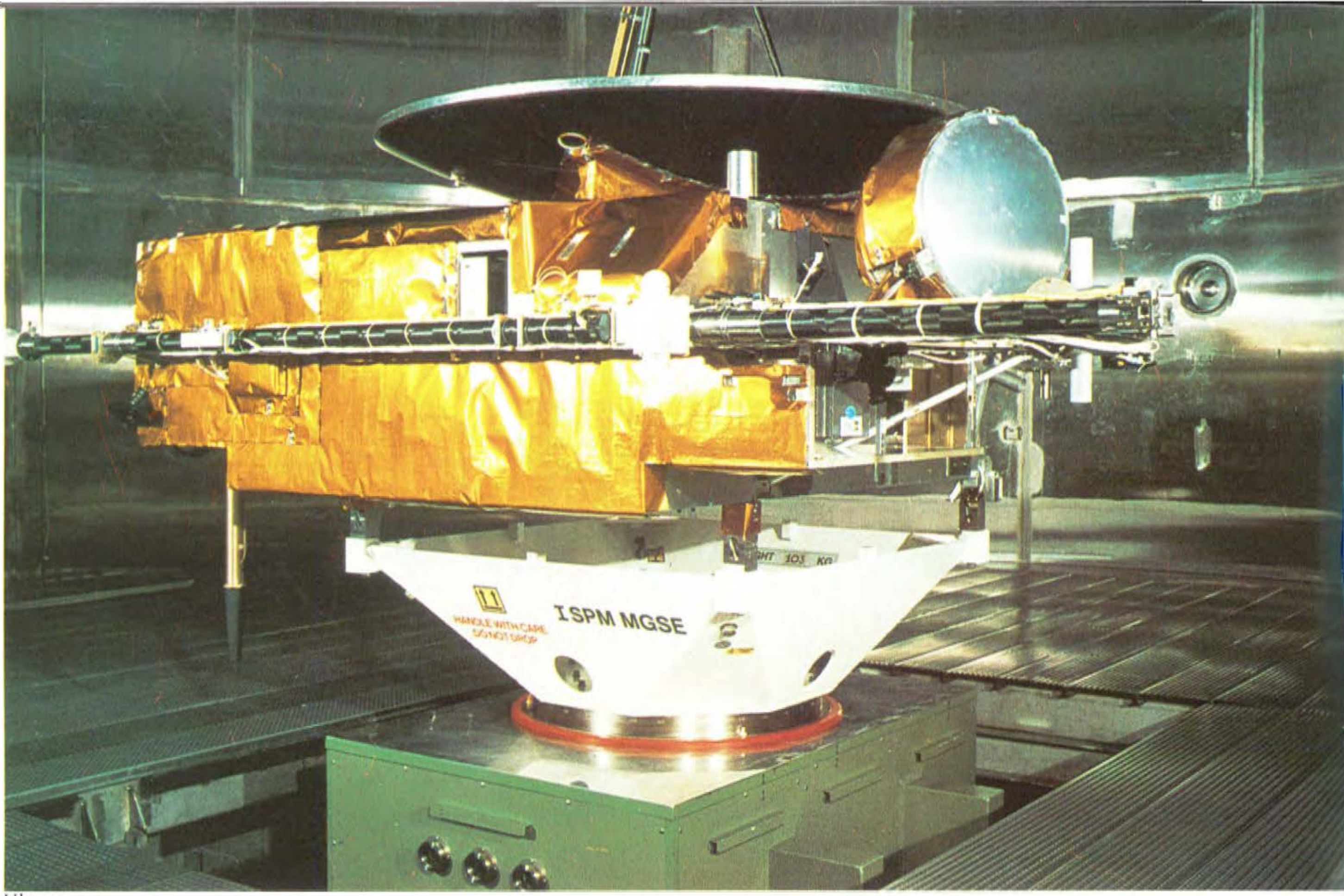
Following these four cornerstones, on which the future programme of ESA is based in the next 15 to 20 years, it is already possible to identify beyond the horizon other major thrusts: these are the Solar Probe and the Heliosynchronous Out of Ecliptic Mission in solar terrestrial physics, the Mars Rover in the planetary area, and, in astronomy, two-dimensional interferometry for high spatial resolution in the visible, IR and mm range.

On a smaller scale, a number of conventional medium-size projects, will be carried out in the same time frame. They include projects already approved and about five other new projects.

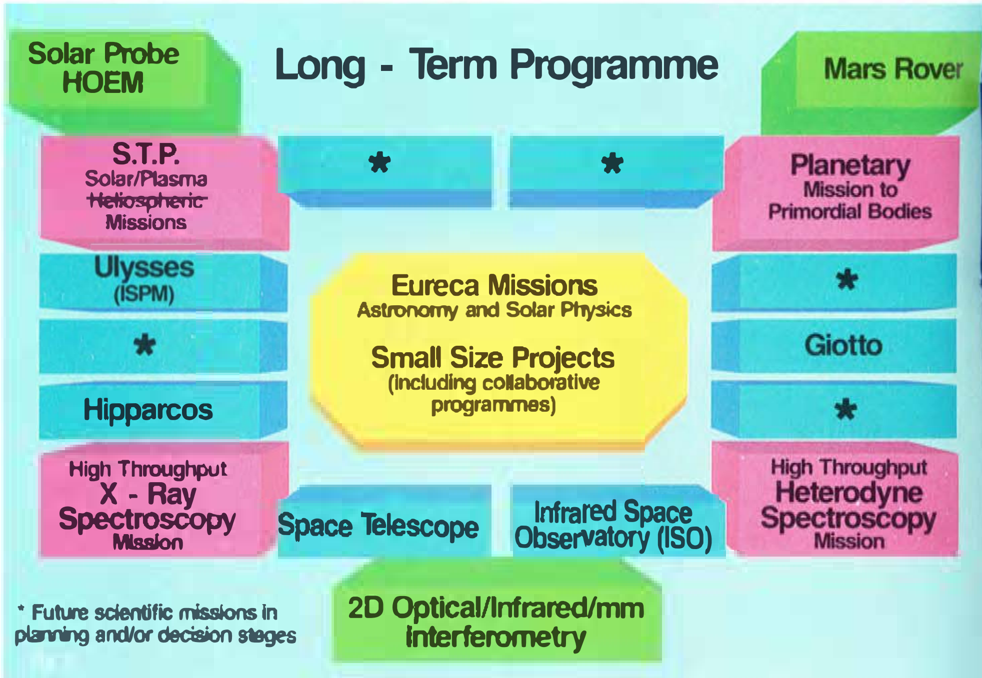
These projects will be selected according to the ESA science programme's standard procedure, i.e. through an open competitive selection. Through this procedure, the overall programme maintains the required flexibility and its capability to meet the shifting needs of science.

* *(Resolution on the long term European plan, adopted on 31 January 1985 by the ESA Council meeting at Ministerial level)*





Ulysses



A number of still smaller projects are included in the programme. They respond to the need for frequent flight opportunities, for quick reaction to missions of opportunity and for minor participation in projects of other Agencies. Prominent in this class is a programme of utilisation of retrievable platforms such as the Eureca platform, suitably modified to meet the requirements of astronomical and solar-physics payloads.

Also included in the programme is the development of the technologies which are needed for the cornerstones and future missions.

The scientific programme of ESA has always offered challenges which have stimulated the development of technical and managerial skills in industry and within the Agency itself.

A few of the technical developments stimulated by the demands of the scientific programme are, of course, highly specialised and esoteric. Many, on the other hand, are of great benefit to other space programmes. Developments in data-handling systems, attitude control systems, lightweight and other materials and space tribology have been applied in other programmes.

At the time of writing, data is still being received from three satellites which have greatly exceeded their originally planned lifetimes:

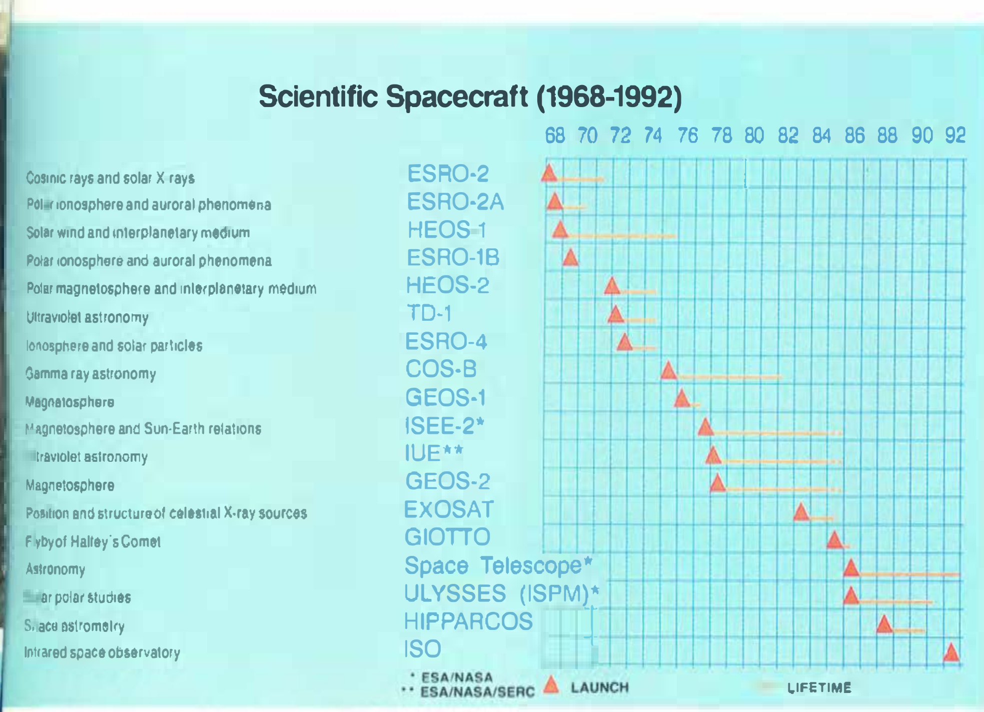
ISEE

A closely spaced pair of satellites, one provided by ESA and one by NASA, is still being operated and is giving new insights into small scale structures and dynamical processes in the Earth's magnetosphere. A third spacecraft, provided by NASA, has been re-routed on a new mission to intercept comet Giacobini Zinner.

GEOS-2

This spacecraft has been moved from its original geostationary posi-

The scientific programme of ESA has always offered challenges which have stimulated the development of technical and managerial skills in industry and within the Agency itself.



tion in order to avoid congestion in this region of space but is still being operated intermittently by ESOC to provide valuable data over a time scale of more than half a solar cycle. Operations are now funded only by Germany and Switzerland.

IUE
The International Ultraviolet Explorer, a joint project of ESA, NASA and the SERC* is a highly successful observatory which is operated 8 hours out of every 24 by the ESA station at Villafranca for the benefit of European astronomers.

A second astronomical observatory is also in operation:

EXOSAT
The European X-ray Observatory Satellite is, like IUE, over subscribed. Data is received at the Villafranca station and routed to ESOC where the control centre and observatory facilities are located.

The hardware development phase of two deep-space missions is nearing completion:

GIOTTO
This spacecraft will take a "close-up" look at comet Halley which it will fly-by at a distance of 500 km from the nucleus in March 1986.

ULYSSES
This cooperative ESA/NASA mission will explore for the first time the third dimension of the solar system by flying high over the poles of the sun.

The development of two further astronomical facilities is well under way:

HUBBLE SPACE TELESCOPE
ESA's contribution to this NASA project consists of the Faint Object Camera, the solar arrays and support to the Space Telescope Institute in the USA as well as the European Coordinating Facility located at the European Southern Observatory, ESO, Garching, Germany.

HIPPARCOS
The scientific goals of the space astrometry mission Hipparcos are the accurate measurement of the positions, proper motions and trignometric parallaxes of about 100 000 selected stars. Hipparcos will provide a ten-fold improvement in the precision of existing observations.

Finally, early technical work is in progress in preparation for:

ISO
The Infra-red Space Observatory will be offering high-sensitivity observing facilities for a large region of the electro-magnetic spectrum which is relatively unexplored.

* UK Science & Engineering Research Council.

Earth observation

*The Council welcomes and endorses the proposal to pursue vigorously the Agency's activities in the fields of Earth observation.**

The development, over the last twenty-five years of Earth observation from space has provided mankind with a new global perspective of its environment. Scientists now have a much better understanding of the complex interactions between the atmosphere, oceans, ice regions and land surfaces which control our planet's climate and environment. Remote sensing of the Earth from space has a wide variety of applications, all of which have, and will continue to have, a substantial economic impact.

ESA's plans in the Earth Observation Field over the coming decade cover both scientific and applications aspects in four main areas, namely:

- Ocean and ice observations, with a programme following on to ERS-1 which will comprise both research and development as well as operational elements.
- Land observations, with a mission designed for all-weather microwave and optical observations.
- Meteorology, with the continuation of European involvement in geostationary satellites for meteorological applications through the implementation of the Meteosat Operational Programme, and the development of a second-generation Meteosat system.
- Missions initially of scientific interest which in some cases lead to applications in the field of solid-earth physics which will exploit very precise measurement techniques for Earth-oriented research. Other missions will address the problems of the upper atmosphere and climatology.

The First ESA Remote Sensing Satellite (ERS-1) and follow-on missions

ERS-1 is expected to be the forerunner of a series of European remote sensing satellites to become operational in the 1990's. Its mission objectives, of both an economic and scientific nature, are as follows:

- to establish, develop and exploit the coastal ocean and ice applications of remote sensing data with a view to improving our knowledge of ocean parameters and sea state conditions. These applications are particularly important due to the increasing development of coastal and off-shore activities and the adoption of the 200 nautical mile economic zone ;
- to obtain high-resolution images of land surfaces in all weather conditions, which will be possible thanks to the on-board Synthetic Aperture Radar (SAR) ;
- to increase the scientific understanding of coastal zones and global ocean processes which, together with the monitoring of polar regions will provide a major contribution to the World Climate Research Programme.

Priority in the payload has been given to a comprehensive set of radar instruments designed to observe the surface wind and wave structure over the oceans.

ERS-1, which will be placed in a quasi-polar circular orbit at an altitude of about 780 km, will give worldwide coverage with a three-day repeat cycle. Data from the payload will be transmitted directly to a number of ground stations where it will be processed and delivered in near-real time (less than three hours) to users interested in monitoring rapidly changing phenomena.

All ESA Member States, with the exception of Ireland, its two Associate Member States (Austria and Norway) and Canada, participate in the ERS-1 programme which moved into its development and manufacturing phase (Phase C/D) in January 1985. The industrial activities are carried out by a consortium of European and Canadian companies. ERS-1 is scheduled for launch in mid-1989 by an Ariane-4 launcher.

ERS-1 will be the first step towards an operational satellite system. ESA plans to propose to its Member States the launch of a nearly identical second flight unit, ERS-2, two or three years after ERS-1, thereby providing the user community with five to six years of continuous data.

* *(Resolution on the long term European plan, adopted on 31 January 1985 by the ESA Council meeting at Ministerial level)*

The potential for further development and exploitation of Earth observations from space is very large indeed and will undoubtedly have a major impact on our lives during the coming years.

Advanced land application satellite

In spite of the mainly experimental or pre-operational nature of most land remote sensing satellite missions to date, spaceborne imagery has contributed substantially to a better scientific understanding of the influence of land masses on our environment. These scientific observations have been of considerable benefit to such areas as agriculture, forestry and water resources management, to environmental fields such as land-transformation (desertification and erosion), water-pollution and disaster damage assessment and finally, to domains such as cartography and land-use planning and the study of geological, mineral, soil and geothermal resources.

Much remains to be done in this area. ESA's Earth Observation Programme can be expected to contribute largely to the improvement of land observations. This high priority mission, which also constitutes a considerable technical challenge, is now under definition with a view to a launch in 1994/1995 at the latest.

Meteosat 2000

The Meteosat Operational Programme is designed to provide data for the meteorological community up to the end of 1995. Consequently, the time has come to start thinking of its successor.

A meeting of top European meteorologists was held in Avignon (France) in mid-1984 to give the future programme a general orientation to meet the users' needs and desires. This meeting was just the beginning of a long phase of studies which will have to be carried out before the second generation spacecraft can be fully defined.

The Meteosat Pre-Operational Programme

As well as meeting the needs of the European meteorological services, the Meteosat System is Europe's contribution to two programmes of the World Meteorological Organisation, i.e. the continuous World Weather Watch Programme and the Global Atmospheric Research Programme. Meteosat forms part, for this purpose, of a network of five geostationary meteorological satellites providing full global coverage (except for the polar regions).

Meteosat 1 was launched in November 1977, and Meteosat 2 in June 1981, both into geostationary orbit. Both spacecraft are still carrying out some of their functions in spite of the fact that they have long outlived their design lifetime of 3 years.

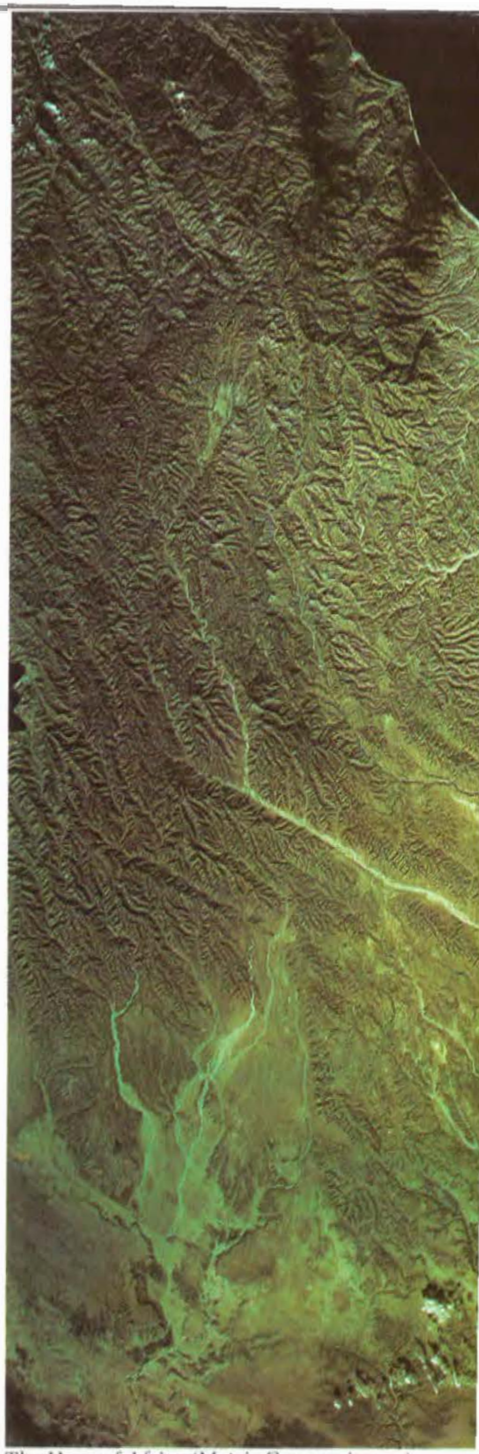
The Meteosat Operational System

On 24 May 1983, the Convention for the creation of an international organisation called EUMETSAT was signed by twelve countries. The main purpose of EUMETSAT is to establish, maintain and operate European operational meteorological satellite systems. Pending formal ratification of the EUMETSAT Convention, it was considered appropriate to bridge the legal gap by carrying out the early stages of the operational programme — which is in fact a continuation of the Meteosat pre-operational programme — within the framework of the ESA Convention.

The Meteosat Operational Programme which is now one of the Agency's optional programmes, foresees, first and foremost, the launch of the refurbished engineering model of the preoperational Meteosat series, now known as Meteosat P2, by the first Ariane-4 flight in mid-1986. This will be followed by the launch of three operational satellites in August 1987 (MO 1), mid-1988 (MO 2) and in 1990 (MO 3) and their subsequent operation up until 1995.

Solid Earth Observations

ESA is well aware of the need to enter into this field and is already planning a programme designed to improve our understanding of the physical forces and processes active below the Earth's crust and which



The Horn of Africa (Metric Camera image)

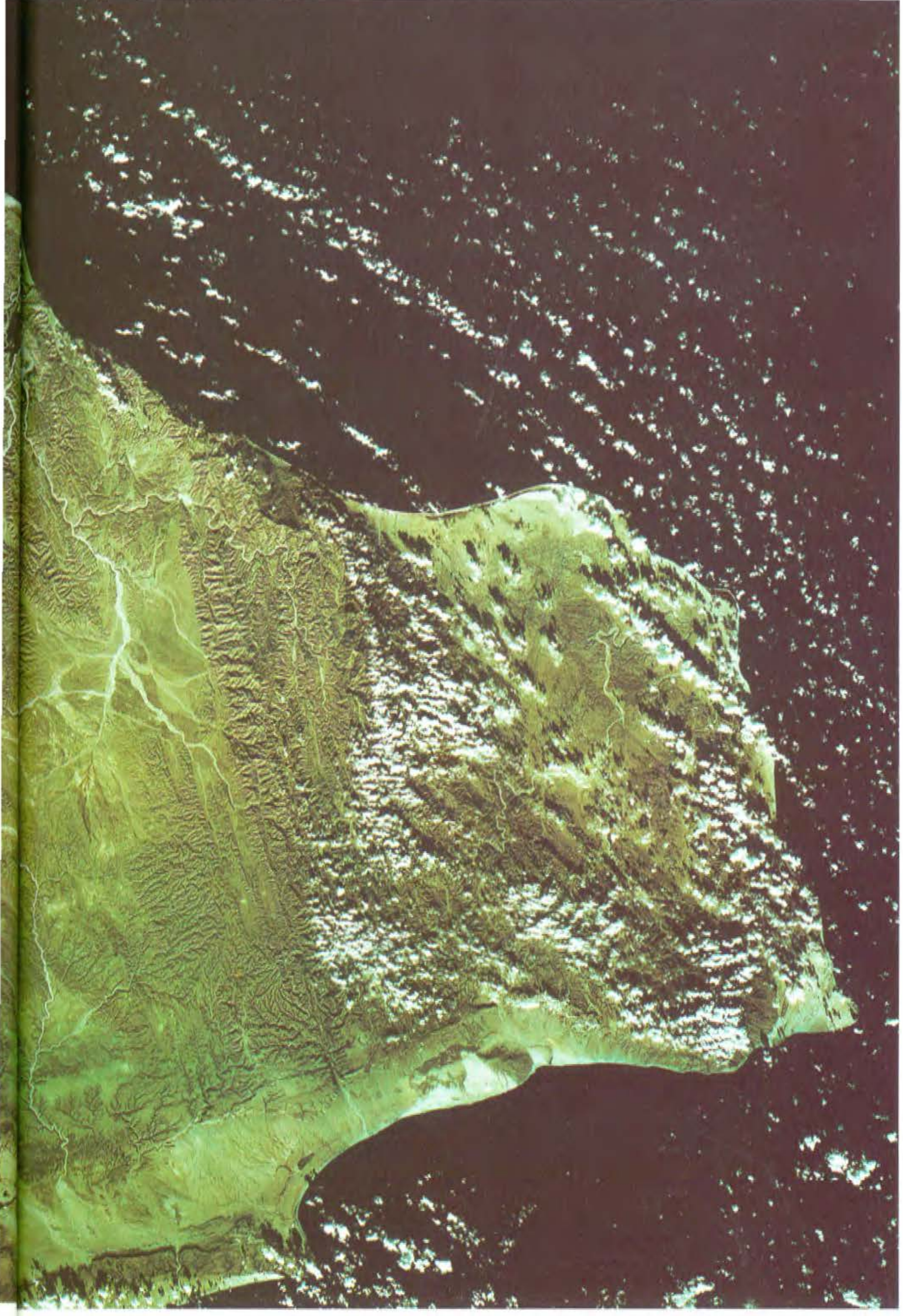
are responsible for such catastrophic events as earthquakes and volcanic eruptions.

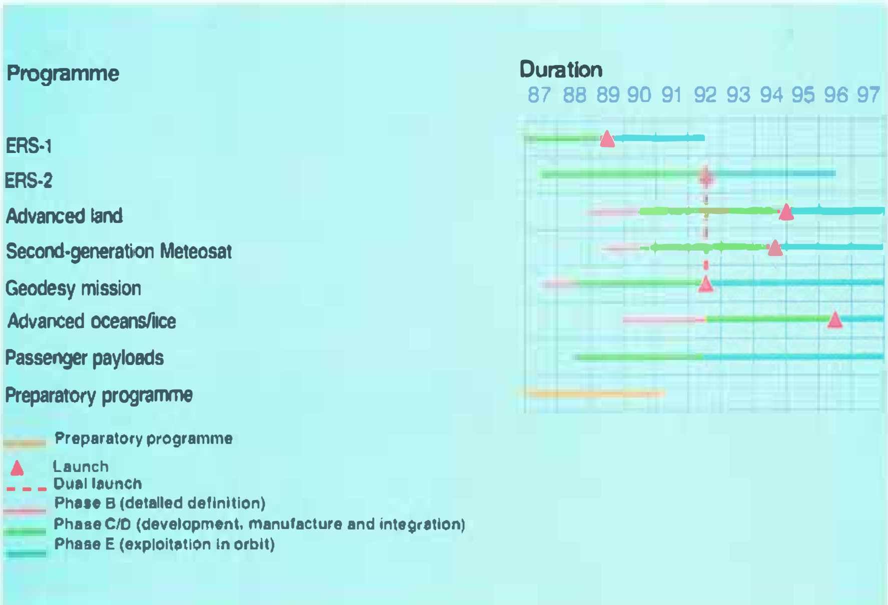
The key technique for observing geophysical phenomena and for monitoring their dynamic behaviour in earthquake prediction research is to determine, with the highest possible accuracy, positions of points on the Earth's surface and to measure, precisely, day-by-day, horizontal and vertical motions.

A first satellite designed for this purpose could be launched in 1992/1993.

Earthnet

The Earthnet programme is part of the mandatory activities of ESA. It is





the European network for the acquisition, pre-processing, archiving and distribution of remote sensing data.

To meet the ever-growing user community requirements for data from as many sensors and platforms as possible, Earthnet disseminates the information collected from the various US satellite missions, namely the Landsat series, HCMM (Heat Capacity Mapping Mission), Seasat-1 and Nimbus-7. Data is acquired and pre-processed at the four ground stations operated by Earthnet in Italy (Fucino), France (Lannion), Sweden (Kiruna) and the Canary Islands (Maspalomas).

The inclusion in the Earthnet network of a Landsat MSS data acquisition and recording capability at the Maspalomas station in the Canary Islands (Spain) is of particular interest to scientists working on development aid projects in West Africa.

Data from the Metric Camera Experiment, flown on the first Spacelab mission, is distributed by Earthnet and by the German Aerospace Establishment (DFVLR). A complete catalogue, together with a set of microfiches showing South, Central and North America, central and southern Europe, Africa, the Middle East, North India, the Himalayas and East China is now available.

Earthnet's experience in handling data from a wide variety of sensors, including Synthetic Aperture Radar data, will be of particular value once ERS-1 becomes operational. The Earthnet Programme Office has been involved in the programme definition from the outset and it will play a preponderant role in the acquisition, archival, retrieval and distribution of data to users.

Telecommunications Programmes

The Council welcomes and endorses the proposal to pursue vigorously the Agency's activities in the field of space telecommunications. *

Prospects for the future

Because of their geostationary position 36 000 km above the Equator, telecommunication satellites have special characteristics that distinguish them from other transmission media such as coaxial cables, optical fibres and radio links. When communicating between fixed points, they make it possible to establish wide-band links across considerable distances, and the fact that they allow both multiple access at the transmitting end and multiple destinations at the receiving end makes switching of these links easy without the need for switching centres. Moreover, they lend themselves perfectly to handling mobile-service transmissions, e.g. for communicating with ships on the high seas, and for links that are temporary or with inaccessible locations. In short, the satellite is an ideal vehicle for distributing and disseminating information — the most commonplace example of this is the broadcasting of radio and television programmes. The potential of satellites for direct broadcasting is and will remain considerable for a long time to come; where innovation is concerned, direct broadcasting offers virtually unlimited opportunities for improvement and expansion in the areas of higher image definition, large-screen projection, sound-channel and multilingual sub-title selection, stereophonic music, high-capacity video-text, electronically printed newspapers, and the distribution of software and data files to home computers.

The prospects are no less attractive in the domain of mobile communications. There is a large, unsatisfied demand in this area; this is felt by everyone travelling in commercial or private vehicles who wishes to have access to the public telephone network during his journey, or simply to be able to receive specific items of information such as notification of telephone calls that have come in or instructions on what route to follow. Such services are certainly available currently in some parts of Europe; however, they suffer from being very limited geographically and, in the case of the radiotelephone, from being of mediocre quality.

This is where the satellite can be used both to serve all the regions of Europe not covered by the land-based networks and to reconcile the different national systems by acting as an interface. Under the Prosat programme, ESA has embarked on a campaign of measures aimed at defining the characteristics of satellite links with small terminals mounted on all types of vehicle.

At present, the public has benefited only indirectly from the advantages of satellites, which have led to cheaper and better-quality long-distance communications and to the daily exchange of television programmes across the world. These advantages will soon become more tangible, and the year 2000 will usher in the era in which the man-in-the-street will have a direct line to Space, the era of the satellite at the service of everyone.

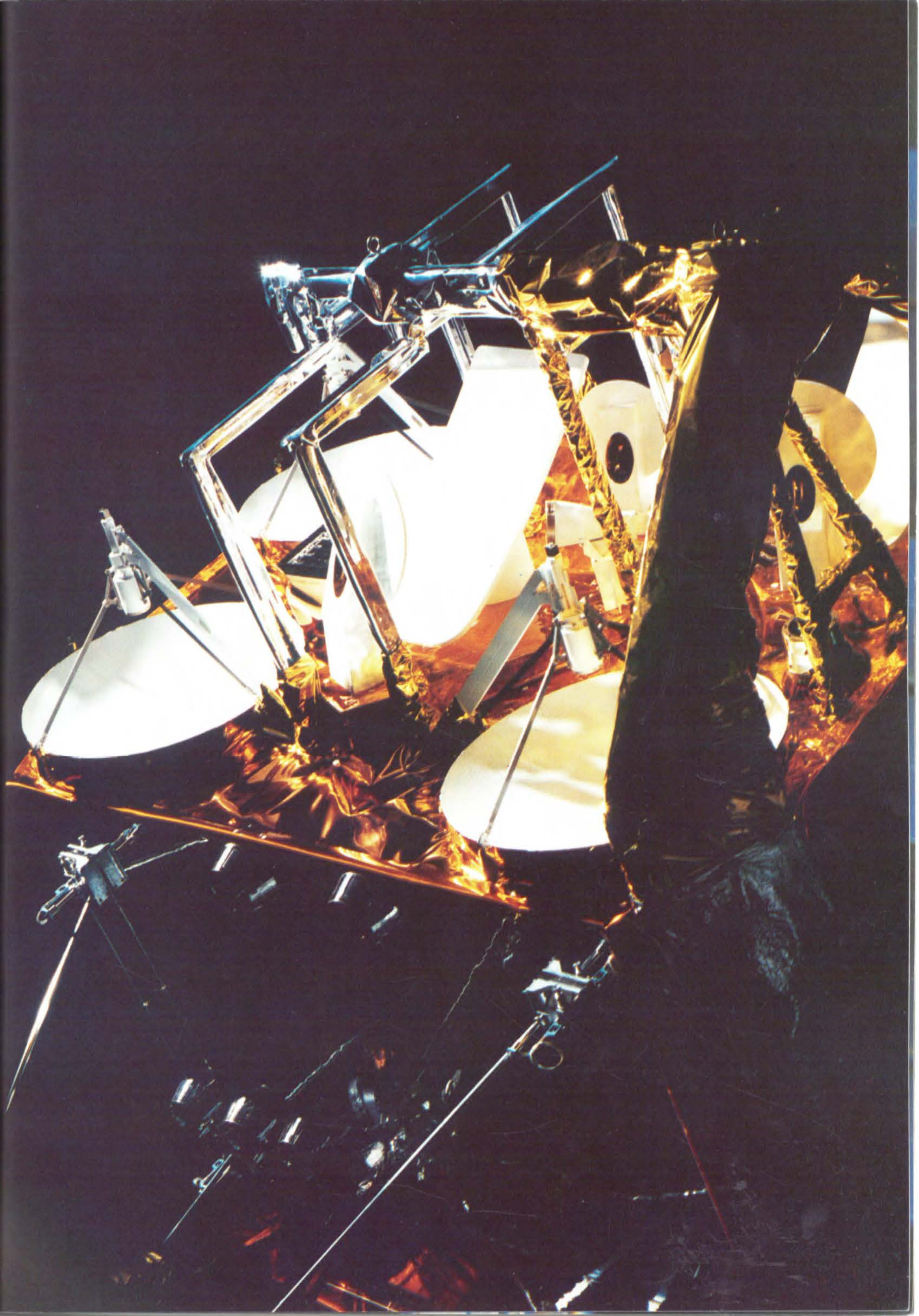
ESA prepares for the future

When it was decided in 1970 to set up a European telecommunication satellite programme, the objective assigned to ESA was the setting up of a satellite network to meet the requirements both of the PTT administrations for international telephone traffic in Europe and of the European Broadcasting Union for Eurovision, its TV programme exchange network. To make up for lost time, it was also decided to make a firm commitment to developing advanced technologies, and from the outset to use frequencies higher than 10 GHz in order to avoid the overcrowding problems encountered in the usal 6/4 GHz band.

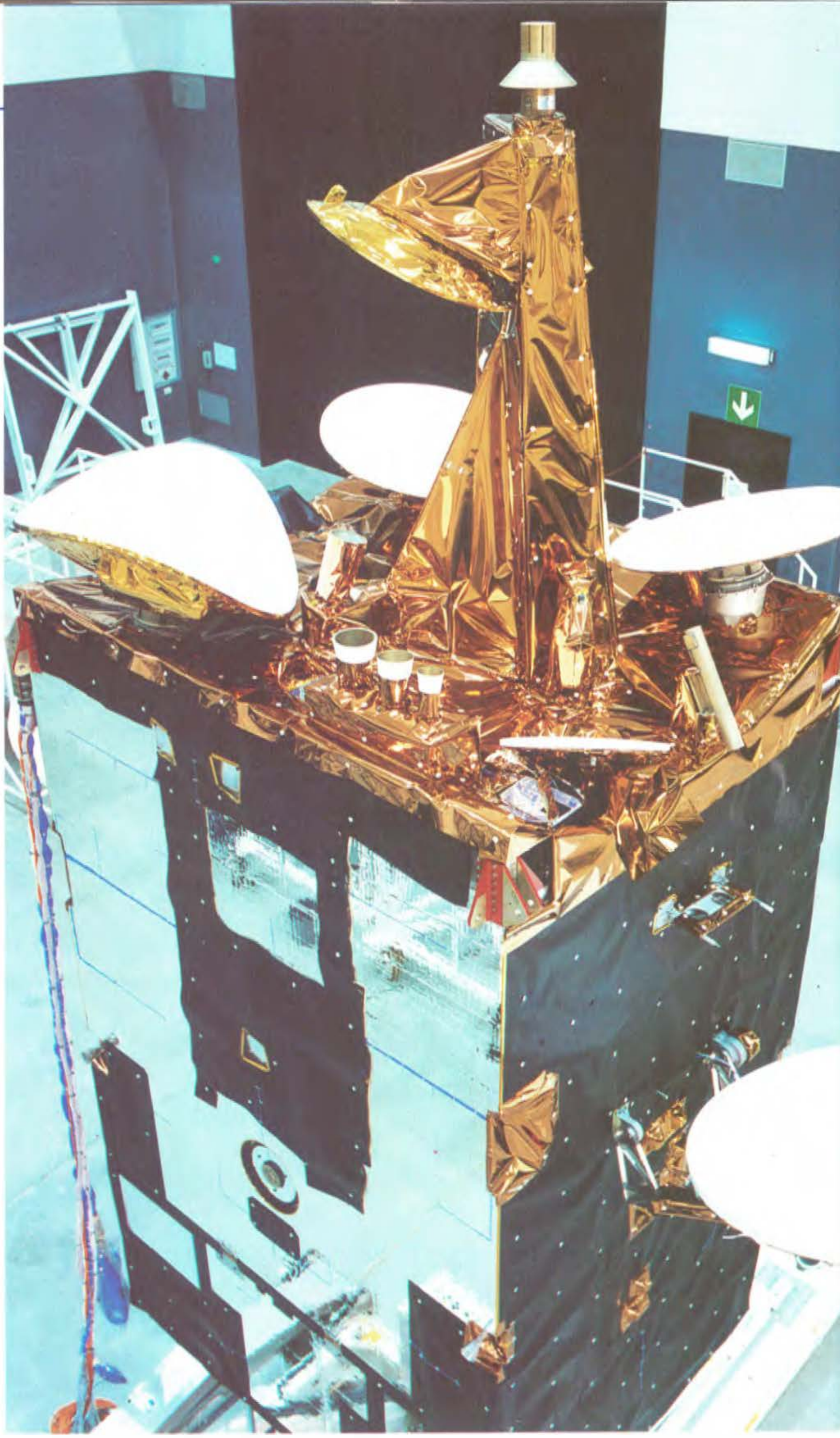
Today, several first-generation satellites are already in service for Inmarsat and Eutelsat, the latter forming part of a series of five, intended to ensure a continuous service until 1990. In the meantime, a new satellite, Olympus, is being constructed; this satellite is twice as heavy as ECS and Marecs and is capable of meeting the requirements

* (Resolution on the long term European plan, adopted on 31 January 1985 by the ESA Council meeting at Ministerial level)

ECS-3



Because of their geostationary position 36 000 km above the Equator, telecommunications satellites have special characteristics that distinguish them from other transmission media.



of future missions that will be much more exacting in terms of transmission capacity and on-board power. The prospects opening up for satellites, and the future role they will play in the European telecommunications infrastructure, highlight the need to push technology ahead more vigorously than in the past, in particular with regard to payloads and, more precisely, to antennae and on-board signal processing. This is the purpose of the ASTP (Advanced Systems and Technology Programme), which provides continuous development activity in a very wide range of space technologies and earth stations.

With the experience gained in the OTS, ECS and Marecs programmes, combined with current activities under the Olympus, Prosat and ASTP programmes, ESA is well placed to confront the future. Precise identification of new missions and definition of the facilities to be developed is currently under way in what is known as the Telecommunication Preparatory Programme (TPP).

Growing interest is also being shown in two new satellite applications - the relaying of data from spacecraft in low orbit, and aid to navigation.

Although these applications are not part of the telecommunications domain in the usual sense, they can easily be associated with it, given the similarity of the transmission support role that such satellites are called upon to play. The geostationary relay satellite will be an essential and virtually irreplaceable element in Europe's space infrastructure, and in particular will make it possible to handle in real time the enormous volume of data collected by Earth observation satellites and space stations. Navigational assistance is a service that, like normal telecommunications, could interest a great many users in the world of shipping and aviation.

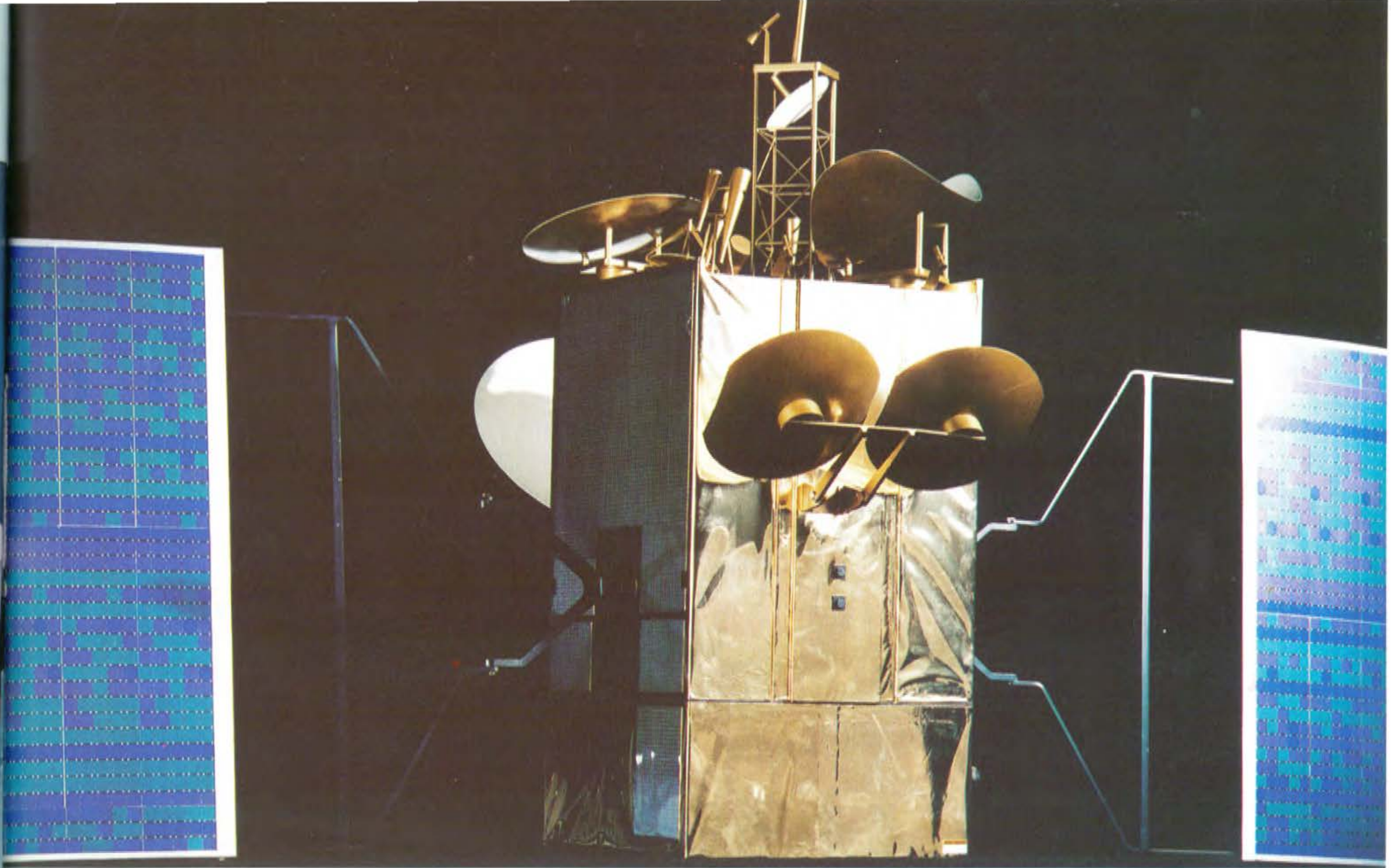
Long-term plans

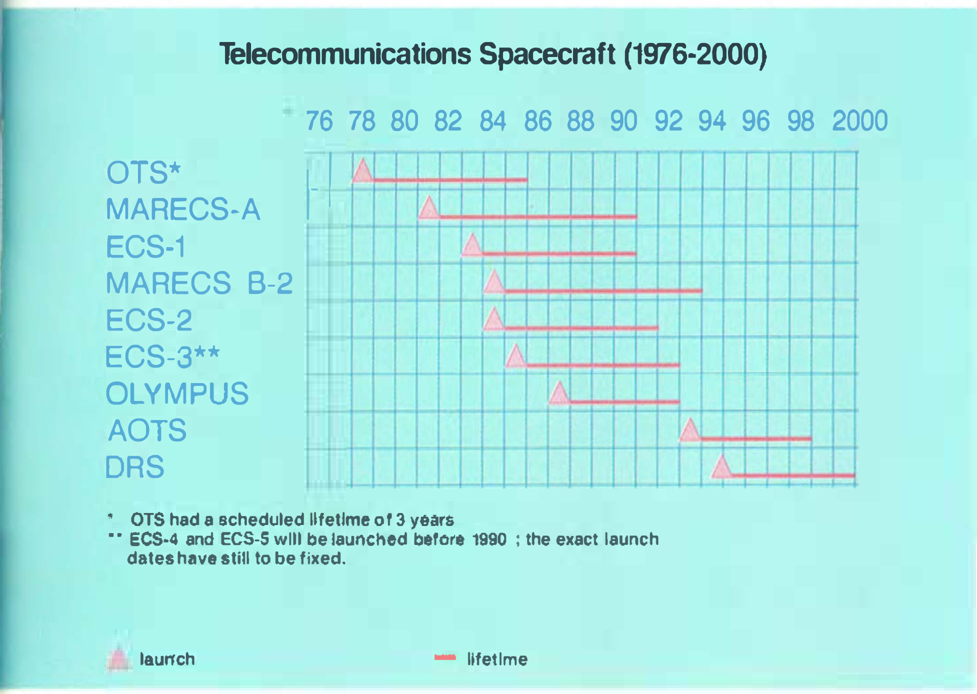
In practical terms, the various ideas for future applications in telecommunications will give rise to a new programme of activities extending over a period of ten years (1985-1995).

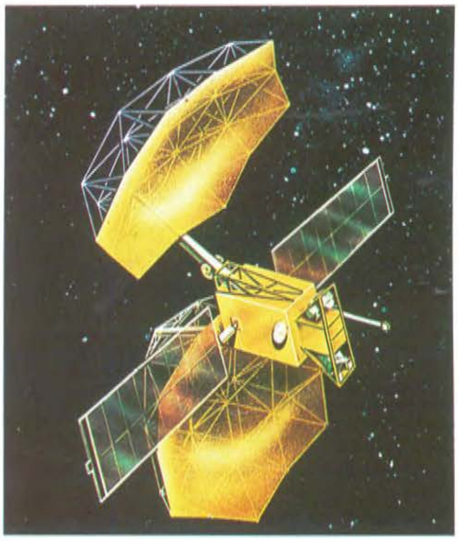
Mission studies, identification of the requirements and definition of the global architecture of the various systems seen as candidates for future development will be pursued, carrying on work already started under the TPP.

The ASTP, which provides constant technological support for all future applications, will also be pursued beyond the second phase currently under way.

A number of particularly promising concepts will emerge from the definition studies mentioned above, and will require intensive development work and experiments in the laboratory and in the field. These activities will be accomodated in separate projects entrusted to industry. In a majority of cases, the most







important results will be given concrete form by the development and qualification of very advanced payloads and satellite systems forming the core of future telecommunication systems and on which it will be possible to carry out verification tests.

Lastly, the final phase of the programme will include a number of tests and demonstrations on orbital systems. This phase will concentrate above all on the development of a large project known as AOTS (Advanced Orbital Test System). The first in-orbit demonstrations are planned to start in 1990, though deployment of the AOTS system itself is not foreseen before 1993.

The development of the data relay satellite programme (DRS) will follow the normal sequence of the Agency's major projects, passing through Phases A, B, C and D. Its launch is currently planned for the period 1994/1995.

Europe's Ariane Launchers

The Council welcomes and endorses the proposal to undertake the development of the Ariane 5 launcher and takes note with interest of the French decision to undertake the Hermes manned spaceplane programme with a view to including this programme, as soon as feasible, in the optional programmes of the Agency. *

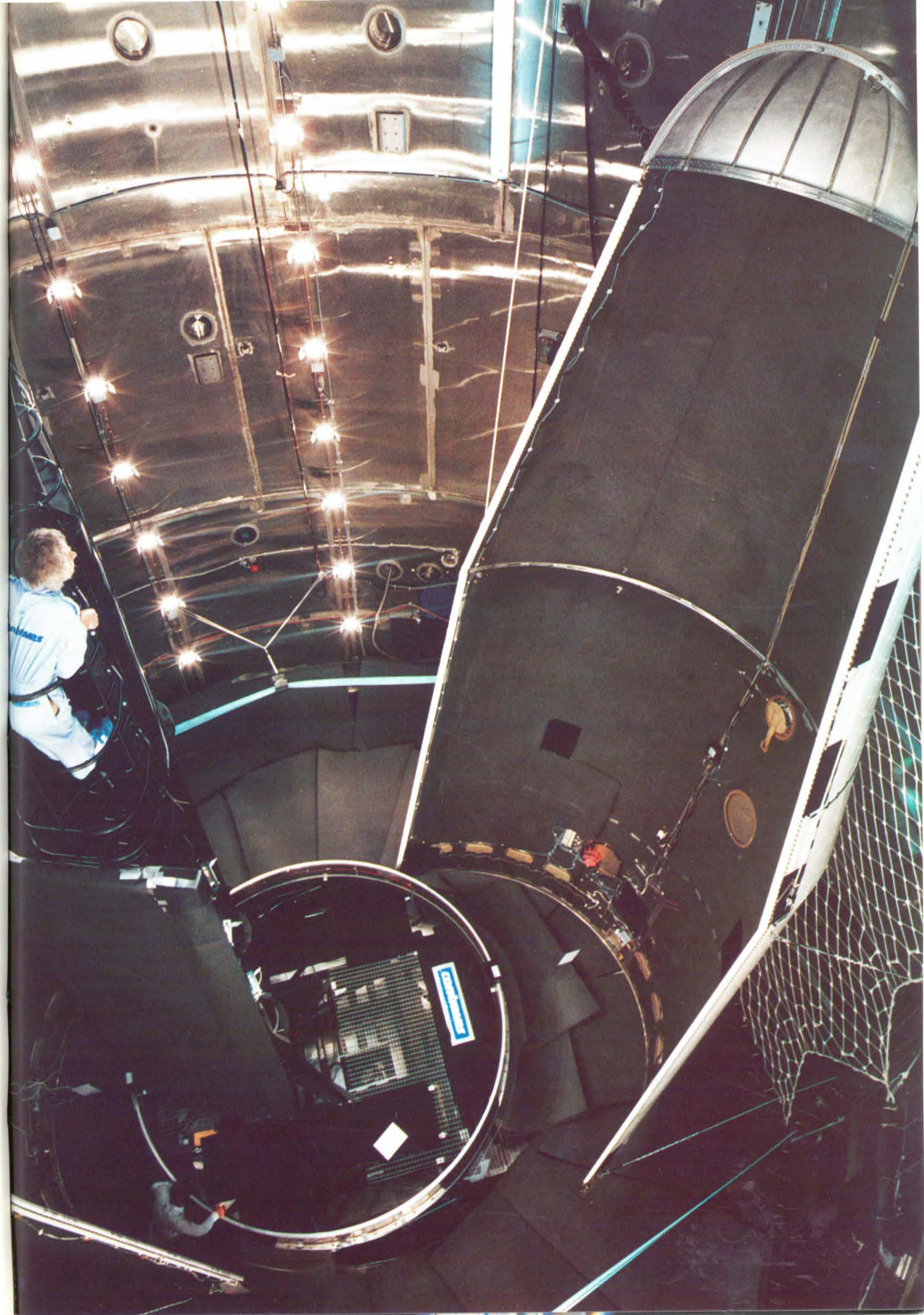
To secure its future, Europe has to prepare here and now for the new era of the exploitation and commercialisation of space.
With regard to launch vehicles, if Europe wishes to keep and improve its current status on the world market, its future efforts will have to match the following requirements:
- the ability to launch satellites of ever-increasing size and mass,
- a reduction in launch costs compared with Ariane 4,
- reliability equal to that of the Shuttle.

These are the development programme criteria for the European launcher, Ariane 5, which will form part of ESA's activities over the next fifteen years, with a first operational launch scheduled in 1995.
Ariane 5 is a three-stage launcher consisting of a lower composite comprising two strap-on solid boosters and a main stage, and an upper composite comprising a final stage, the vehicle equipment bay and an upper section adaptable to each mission.
The strap-on boosters, which are 25 m long and have a diameter of 3.10 m, each carry 170 tonnes of solid propellant and each develop a thrust of 500 tonnes for 2 minutes.
The main stage is a cryogenic one, powered by a single engine (HM 60); it contains 120 tonnes of propellant and measures 5.40 m in diameter with a total length of 25 m. Its engine delivers a thrust of 100 tonnes for about 9 minutes.
Two different versions of the upper composite are planned for automatic missions ; one with cryogenic propulsion derived from the third stage of Ariane 3 for placing in geostationary transfer orbit payloads with a mass of up to 8 tonnes, the other with storable-propellant propulsion for placing in transfer orbit payloads with a mass of up to 5.3 tonnes.
A set of fairings and adaptors for payloads of different sizes is planned to meet user requirements. The usable diameter within the fairing is 4.55 m (as for the Shuttle) with a usable length of between 4 m and 10.5 m. Bearing structures of a design similar to that planned for Ariane 4 will allow launches of two and even three satellites simultaneously.
Finally, the upper composite planned for automatic missions may be replaced by a "spaceplane", such as Hermes, for the manned missions that may be expected in connection with the space station programme towards the end of the century, thus enabling Europe to acquire autonomy in all aspects of space transportation.
These prospects, which are rapidly approaching, cannot however materialise without intermediate phases. Since July 1973, when ten European States (*) decided to undertake within the framework of ESA the development of a European launcher, the pace of technological advance has been such that progress can now be envisaged beyond the launching of satellites to manned spaceflight systems. A relative latecomer to the launcher market, Europe can now hope to move closer to the two major world space powers.
The first step towards this future was Ariane 1. Development of this initial version of the launcher was decided in 1973 in order to meet two needs. First, to give Europe an independent launch capability for its own satellites, whether for scientific or applications purposes and, second, to enable Europe to acquire a commensurate share of the very large international satellite launch market.

(*) Belgium, Denmark, Spain, France, Italy, Netherlands, Federal Republic of Germany, United Kingdom, Sweden and Switzerland.

* *(Resolution on the long term European plan, adopted on 31 January 1985 by the ESA Council meeting at Ministerial level).*

Ariane 4 fairing



Ariane 1 is a three-stage launcher designed for a wide range of missions, from missions in low orbit to missions for exploring deep space. It is used more particularly for the placing in orbit of geostationary satellites. It is capable of placing in orbit masses of the following order:

- 1 825 kg in geostationary transfer orbit (perigee of 200 km/apogee of 35 800 km);
- 4 850 kg in low circular Earth orbit (altitude of 200 km);
- 2 400 kg in sun-synchronous circular Earth orbit;
- lower masses in hyperbolic trajectory.

The launcher has a total height of 47.7 m and weighs 210 tonnes at lift-off, 90% of this weight being propellant. The total flight time is about 15 minutes, from the time of leaving the Kourou launch pad to injection of the satellite into transfer orbit.

Since the V9 launch on 22 May 1984, all launches have been carried out under the responsibility of the Arianespace company on a purely commercial basis. The States participating in the Ariane production programme have entrusted Arianespace with the task of manufacturing, funding, marketing and launching Ariane vehicles. Its shareholders comprise 36 of the main European aerospace and electronics firms, 13 European banks and CNES.

Ariane Launches 1979-1984

24.12.79	LO 1	AR 1	Capsule Ariane Technologique (CAT)	Success
23.05.80	LO 2	AR 1	CAT – Firewheel – OSCAR 9	Launch failure
19.06.81	LO 3	AR 1	CAT – Météosat 2 – Apple	Success
20.12.81	LO 4	AR 1	CAT – MARECS-A	Success
09.09.82	L 5	AR 1	MARECS-B – SIRIO-2	Launch failure
16.06.83	L 6	AR 1	ECS-1 – AMSAT PHASE III B	Success
18.10.83	L 7	AR 1	Intelsat V FU 7	Success
04.03.84	L 8	AR 1	Intelsat V FU 8	Success
23.05.84	V 9*	AR 1	SPACENET F1	Success
04.08.84	V 10	AR 3	ECS-2 – TELECOM 1A	Success
09.11.84	V 11	AR 3	Spacenet F2 – MARECS B2	Success

* First commercial launch under Arianespace responsibility

Success — Launch failure

The next phase, whose object was to increase the lift capability of the launcher while reducing the price per kilo in orbit, was reached in 1980 when ESA decided to undertake a follow-on development programme. Two uprated versions of the vehicle, Ariane 2 and Ariane 3, were developed under this programme. Ariane 3 is able to place in geostationary transfer orbit a single satellite with a mass of 2 580 kg or to launch simultaneously two satellites of 1 195 kg, at a price some 25% less than that of Ariane 1.

The Ariane 3 launcher is 49 metres high and weighs 237 tonnes at lift-off. The Ariane 2 version is identical to Ariane 3 but has no strap-on boosters; it can place satellites of 2 175 kg in transfer orbit.

The utilisation of space is evolving so rapidly that launchers need to evolve at a similar pace. Only 18 months, therefore, after the decision to develop Ariane 2 and 3, ESA undertook the development of an even more powerful version of its launcher, Ariane 4, which offers a

To give Europe an independent launch capability for its own satellites and to enable it to acquire a commensurate share of the very large international satellite launch market.

Ariane 5

whole range of possible performances. Started early in 1982, this programme provides for the first launch on Ariane 4 in mid-1986.

Drawing on development work under previous programmes, Ariane 4 comprises 6 different versions whose performance in transfer orbit varies from 1 900 to 4 200 kg. The various versions differ with regard to the strap-on boosters :

- two or four solid boosters derived from those of Ariane 3.
- two or four liquid boosters with some 40 tonnes of propellant, using the Viking engine.
- a version with two solid boosters and two liquid boosters, and a version with no boosters.

This variety of Ariane 4 configurations will provide great flexibility and enable the performance of the launcher to be adjusted to payloads while maintaining a high load factor.

The launch base

At the same time that it decided to develop the first version of the vehicle, ESA started to build the Ariane launch site (ELA-1) within the precincts of the Guiana Space Centre near Kourou (French Guiana). The location of this Centre (5.1° North) is particularly favourable for launching geostationary satellites since its position near the equator means that advantage can be taken of the "sling" effect of the Earth's rotation.

The growth of the launcher family and the increasing number of prospective customers led ESA in 1981 to undertake construction at Kourou of a second Ariane launch site (ELA-2) designed for launches of the Ariane 2, 3, and 4 versions. The first flight from this new complex should take place in 1985. ELA-2 provides both redundancy of the present launch site and also increases operational flexibility by considerably reducing the interval between two launches.

ELA-2 consists essentially of two distinct areas:

- the launcher preparation area, where stages are erected and the first checkout operations on the launcher carried out; the launcher remains here for about a month.
- the launch area, where final vehicle checkout, the mating of the payload, assembly of the fairing and launch countdown take place. The launcher remains here for about two weeks.

The two ELA-2 areas are connected by a railway track on which the mobile launch tables move. For transfer from one area to the other, the launcher, assembled to the level of the equipment bay, is mounted vertically on its launch table, which moves on double railway tracks by means of special transporters.

ELA-1 (foreground) and ELA-2

Manned and retrievable systems

The Council welcomes and endorses the proposal to undertake in the field of in-orbit structures, the Columbus programme, as a significant part of an international space station programme. *

The Future

Europe stands at the threshold of manned space flight. The future presents golden opportunities to partake in the exciting adventure of manned exploration of the solar system. Through existing or planned projects such as Spacelab, Eureca and the Space Station, ESA can lead its Member States into the exciting new era of the discovery and commercialisation of space.

Europe's eventual goal is an autonomous Space Station which will provide European scientists and industrialists with a permanent platform for research and the processing of key materials. However, to attain this lofty goal, a gradual evolution is envisaged.

Immediately, the use of Spacelab will give ESA Member States basic experience in the optimum use of a manned space station. Applications in the fields of Earth Observations, Astronomy, Plasma Physics and Microgravity are foreseen as well as the use of Spacelab as a test bed for technology and system development. Although no ESA-only missions are planned, ESA participation with NASA (such as the Earth Observation Mission, EOM), its Member States (such as the German D-1 and D-2 missions) and international missions (such as the International Microgravity Laboratory, IML) are planned. Such missions will not only provide ESA with experience in the operation of manned systems but also the opportunity to build up a core of scientist-astronauts to perform the on-board duties.

The design and development of Eureca is now underway. It will exhibit the better qualities of Spacelab and unmanned conventional satellites. Any disturbing influences introduced by Man are avoided while still retaining the possibility of manned intervention during its Shuttle launch. This unmanned retrievable free-flyer ensures a 10^{-5}g environment for the duration of the mission which is nominally six months. While being an extremely useful tool in its own right for scientific and commercial use, Eureca represents a bridge between Spacelab and Space Station. In particular, it will be used to develop the rendez-vous and docking techniques so essential to Space Station operation. Its first flight is scheduled for early-1988 with retrieval some six months later. Launches of this reusable system will take place every 18 months to two years.

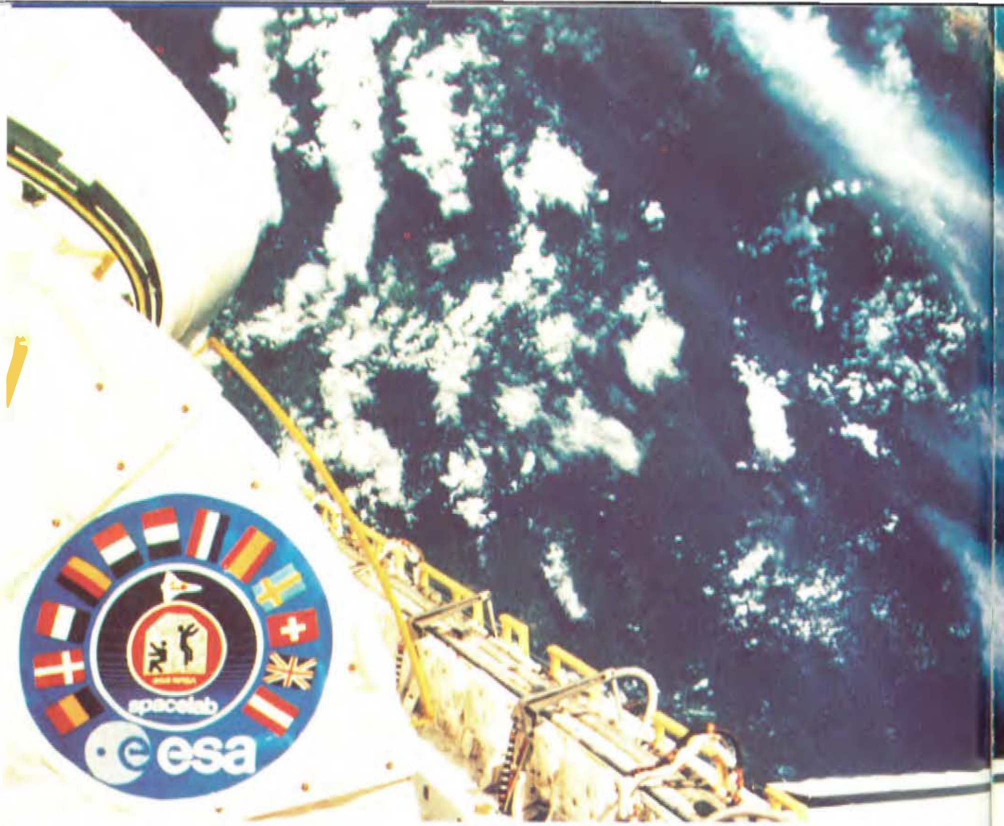
A possible European participation in the US space station could be a pressurised module for housing men or experiments, a platform for carrying unpressurised payloads, and a resources module. The module and platform could be used either attached to the Space Station or in a free-flying mode. A polar orbit version of the free-flyer has a particular attraction for science and remote sensing applications.

The US Space Station is expected to become operational in the period 1992/1993. The scenario of Space Station activities with resupply by the US Space Shuttle will extend to the end of the century. A greater degree of European autonomy might apply thereafter. Such a principle would involve a European Space Station, heavily dependent on robotic operations, but with manned intervention as required. The European supply and return capability would rely on a man-rated version of Ariane 5 for launch and a space plane such as Hermes.

The Experience

ESA entered the manned spaceflight field with the successful flight of Spacelab in the Orbiter Columbia over the period 28 November to 8 December 1983. The agreed follow-on to Spacelab is the retrievable carrier Eureca. Spacelab and Eureca represent solid investments for the future. Europe can build on the engineering and technical experience gained through its involvement with these two programmes. Spacelab, both

* *(Resolution on the long term European plan, adopted on 31 January 1985 by the ESA Council meeting at Ministerial level).*



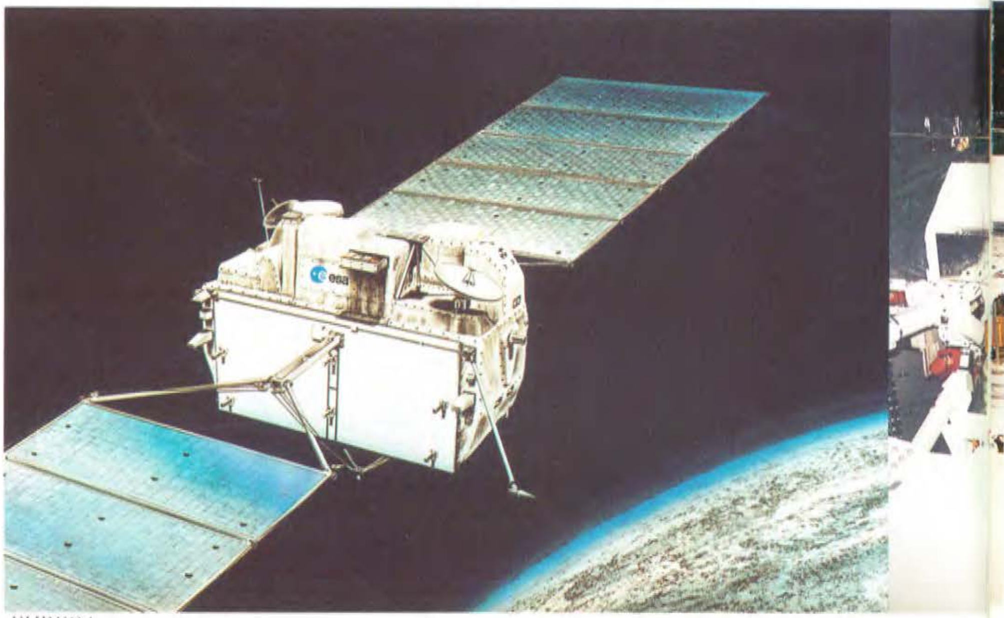
module and pallet, lends itself to being developed as an essential part of a permanently manned Space Station. The basic Eureca principles can lead to an unmanned platform which can be visited by Shuttle astronauts from time to time when free-flying or which can be serviced at the Space Station when docked.

In addition, a considerable knowledge of the design and operation of such facilities as Space Sled, Biorack, Anthrorack, Fluid Physics Module and Material Sciences Double Rack, has provided a fund of information on the expirement approach of the future.

To this experience must be added the "know-how" of how to conduct space operations. There is no doubt that Spacelab ushered in a new era of performing experiments in space. The SL-1 mission showed how a team composed of the onboard Payload Specialist and the Investigator-on-the-ground, using data, voice and video links, provide a powerful and revolutionary way of doing space experimentation. This concept embodied in the Payload Operations Control Centre will be further exercised in later missions, particularly the German D-1, and sets the stage for efficient operation of the European part of the Space Station.

Not only is this new way of operating experiments being exploited but competency in the personnel involved is being maintained and developed. This is ensured by the sharing of manned spaceflight experience with the new breed of experimenters and building up a core of trained and experienced scientist-astronauts. The latter are of Mission Specialist standard and are permanent staff members. In this way, ESA will have available trained astronauts, who together with those of its Member States, will ensure the success of future manned space activities.

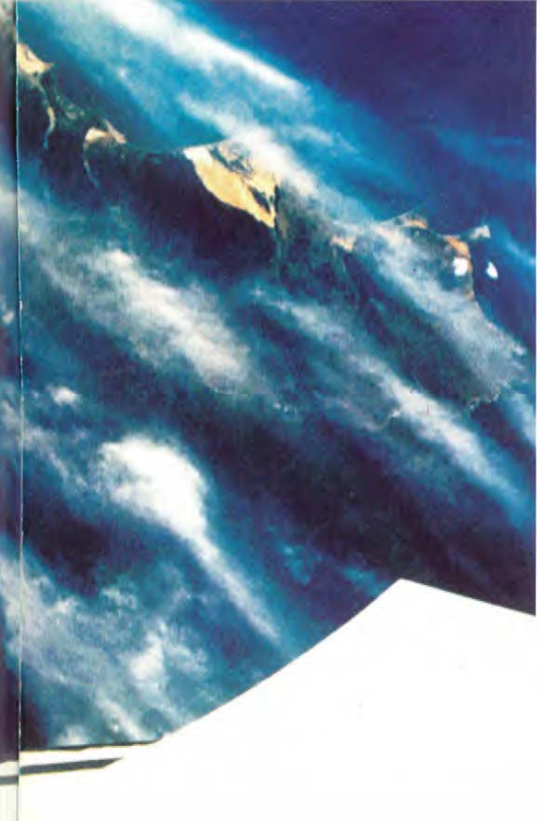
The continuing activities in Microgravity research are identifying the basic physics of processes that lay the basis for improved ground techniques and the industrialisation of space. This commercialisation of space experiments represents the key to ESA's Space Station activities.



EURECA

The Present

ESA's current activities in this area include continuation of the Spacelab Programme, the design and development of Eureca, the performance of the Microgravity Research Programme, the development of facilities for use on Spacelab and Eureca and preparation for future Space Station work.
The Spacelab Programme reached its climax with the space baptism of Spacelab, in the long module plus one pallet configuration, on the STS-9 flight of the Orbiter Columbia. As well as verifying the hardware the flight was memorable for many reasons. It not only returned extremely valuable scientific data and research results but it also marked ESA's entry into manned space activities with ESA's scientist-astronaut Dr. Ulf Merbold on-board.
Although the first Spacelab was given free to NASA, a second flight unit has been ordered at cost of about 200 MAU. The long module and five pallets have already been delivered and 1985 will see the completion of the order with the delivery of a second Instrument Pointing System, spares and additional rack/floor combinations.



Europe's eventual goal is an autonomous Space Station which will provide European scientists and industrialists with a permanent platform for research.

The Microgravity Research Programme is being carried out within the STS Directorate. Phase 1 of the programme has been under way since 1982 and has seen some 35 experiments flown on 8 Texus sounding rockets, the development of Biorack (for the study of cells and complex biological systems) and uprating of the existing Fluid Physics Module. Both the latter instruments along with the Space Sled will be part of the D-1 payload. Phase 2 of the Microgravity Research Programme will run over the period 1986 to 1989 and will include such activities as reflights of the Sled (D-2), Biorack (IML-1) and Fluid Physics Module (IML-1). New developments include the Anthrorack, for physiological measurements, and a Fluid Physics Double Rack which will include equipment for bubble and critical point investigations. These two facilities will fly on D-2, IML-2 and IML-3 and on IML-2 respectively. Also, short duration flight opportunities will be made available to experimenters such as on sounding rockets and Shuttle Get-Away Specials. Long duration investigations in the field of Microgravity Research will be carried out on Eureca.

Phase C/D (design and development) of Eureca and its automatic facilities has started. Eureca is a Shuttle-launched and Orbiter-recovered platform, mainly for Microgravity research but will also find ready applications in such fields as Astronomy, Earth Observations and Technology. Eureca can carry 1000 kg of payload and provides 1 kW of continuous power and 1.5 kW peak power to the experiments. Experiment cooling (active and passive) and on-board data recording are available with a continuous data rate available to the payloads of 2.5 kbs. It is solar pointing (with an accuracy of ± 1 deg) and uses ESA's S-band system for data transmission.

The first flight, scheduled for early 1988 will carry these facilities together with 26 experiments. In addition, three add-on Material Sciences experiments will be performed and another eight science and technology experiments will be carried. The latter includes the important In-Orbit-Communication (IOC) experiment and the RITA, a low-thrust ion engine using Argon as a working fluid.

A major on-going activity is the Columbus preparatory programme for Space Station participation. The Phase B will be completed by the end of 1986 and the phase C/D will commence in April 1987. The Space Station operational phase (E) will start in 1992/93 and continue until the end of the century and beyond.

The following table presents a summary of the programmes underway in the Directorate of Space Transportation Systems.

Programme	Main Elements	Duration
Spacelab Utilisation	Spacelab and Experiments	1983-1993
Spacelab FOP	Spacelab Flight Unit, IPS and Ground Support	1980-1985
Eureca (development and first flight)	Eureca Carrier + Core Facilities	1984-1988
Microgravity Phase 1	Biorack, Sled (flight), Fluid Physics Module, Opportunities on Spacelab and Texus	1982-1985
Microgravity Phase 2	Anthrorack, Fluid Physics Double Rack, Opportunities on Spacelab, Shuttle, Texus	1985-1988
Long Term Preparatory Programme	Ariane 5, Pressurised Module, Platform Elements, Advanced Technology	1982-1985
Columbus Preparatory Programme	Pressurised Modules, Platform Elements, Resources Module, Service Module, Space Station Ground Segment, Demonstration Missions	1985-1986

Space Technology

The Council agrees that the rise in the General Budget will be assigned, by priority, to the technology research programmes and investments. *

The ESA space technology R & D programme, which supports all the Agency's programmes, is an important factor in maintaining a high level of competence in space technology in Europe and in preparing for both the Agency's own space missions and international commercial space procurements. The Technological Programme is therefore focused around major "Themes" oriented to meet the future requirements of these two categories. These themes include at present:

- the optimisation of the Earth-Space telematic network for the 1990s;
- major technology infrastructure for space communications in the 1990s;
- global weather/climate/environmental monitoring;
- deep space and observatory facilities;
- microgravity utilisation;
- space platform technology;
- in-orbit operations.

In addition, ESA also closely coordinates its programme with Member States' national technonology research and development activities thus ensuring that European efforts in this field are both optimised and compatible. It also coordinates its activities with non-European organisations, such as INMARSAT and INTELSAT, thus ensuring that its programme produces technology which is competitive on a worldwide basis. The ESA Space Technology Research and Development Programme is implemented on the basis of 3 major programme elements:

The Basic Technology Programme advances the state of the art in the main domains of space technology. This programme aims at demonstrating, through the development of "working models", the feasibility of technology advances likely to be required for both medium and long-term future ESA missions. To this end, it focuses on a few major technology themes and is partially implemented in the form of multidisciplinary technology projects. By providing in good time, the essential knowledge on technology feasibility, risks and constraints, it helps to reduce cost both for the Agency and in industry. Furthermore, it provides continuity in specialised fields of activity and strengthens specific competence in industry.

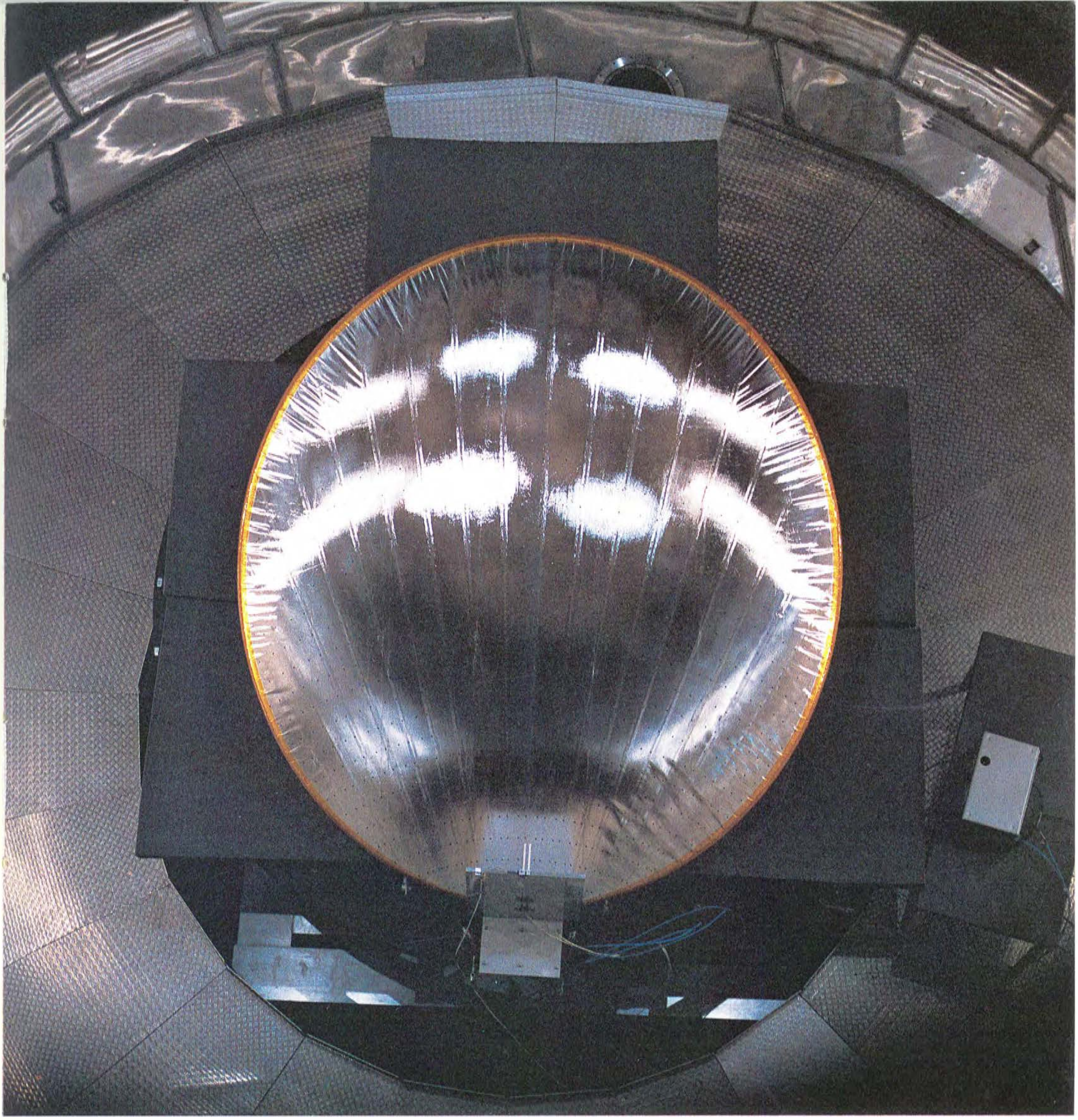
The Supporting Technology Programmes are directly linked to the Agency's major programmes and to clearly identified near- or medium-term requirements. They take the technology developments beyond the "working model" level to the point of demonstrated flightworthiness through the development and testing of engineering models, and thus significantly reduce the risks for flight equipment qualification.

Support (or preparatory) technology programmes have existed for several years for the Communications and Earth Observation Programmes, those for the Space Station/Columbus and Microgravity Programmes are in the final stages of detailed preparation and those to prepare for future Science and Launcher programmes will be defined later.

Communications: Emphasis is on the development of new payloads and system technologies and operating methods required for the next generation of communication systems. Emphasis is given to such advanced technologies as intersatellite links, multiple beams, onboard switching, the use of higher frequencies, large unfoldable and deployable antennas, reconfigurable systems and new ground segment technologies.

Earth Observation: Development of the complex technology required for the spacecraft and their payloads and for the advanced ground facilities and data handling systems needed for Earth Observation missions.

* *(Resolution on the long term European plan, adopted on 31 January 1985 by the ESA Council meeting at Ministerial level).*



Microgravity: Development of the instrumentation, facilities and critical mission support equipment for the utilisation of experiment carrier vehicles such as EURECA, SPACELAB and ultimately a Space Station.

Space Station/Columbus: Development of the critical unmanned platform and manned module technologies to support European participation in the Space Station and to prepare for ultimate European autonomy in all aspects of the future space infrastructure.

The In-Orbit Technology Demonstration Programme proposed for initiation in 1985 as an optional programme of the Agency, will provide frequent in-orbit demonstration opportunities for European technologies prior to their incorporation into the development phases of new projects.

The Agency's technology programme is carried out through many industrial companies and research institutes throughout Europe. It continuously challenges the frontiers of mankind's engineering know-how and produces new solutions to previously insoluble problems, thus allowing more ambitious space missions to be undertaken and providing impetus for new terrestrial applications.

The role of the establishments

For the execution of the programmes entrusted to it, the Agency shall establish and operate such establishments and facilities as are required for its activities. (ESA Convention).

ESTEC : The Space Research and Technology Centre of ESA

ESTEC (European Space Research and Technology Centre) was created in 1962 as the technical centre of the European Space Research Organisation, ESRO.

Originally located in Delft (The Netherlands), the establishment was transferred in 1967 to its present location in Noordwijk, approximately 35 km south of Amsterdam on the North Sea Coast.

ESTEC, its role in ESA

ESTEC is the largest technical establishment of ESA, it occupies a site of approximately 35 hectares, employs more than 1100 persons of which 800 are ESA international staff and offers a wide range of test and laboratory facilities.

The organisation of ESTEC is basically a matrix structure; the essential elements are represented by the dedicated project teams reporting to the Programme Directors located in ESA Head Office, Paris and the specialised Divisions of the Technical Directorate which has its home base at ESTEC. These Divisions cover virtually all technical space disciplines and comprise slightly less than 50 % of all ESA staff at ESTEC; their specialised engineers generally work in a task-sharing mode, i.e. they are involved in supporting project teams with the technical management of ongoing satellite projects as well as in managing advanced technology research and development work performed under contract to industry. Through this organisation, an effective cross-fertilization both between different projects as well as between projects and advanced technology is obtained whilst making efficient use of the available overall manpower resources.

This work implies the elaboration of the detailed technical specifications for the industrial procurements as well as the monitoring of the related contracts from a technical performance, cost and schedule point of view; through regular reviews, the design and development of the satellite project at box, sub-system and system level are supervised, problems of integration or interfaces between sub-systems resolved, test results verified, etc.

In addition to the technical management of on-going programmes, ESTEC specialised staff carry out studies for future space programmes in all domains of interest to ESA; through both in-house and industrial studies, new missions are defined and promising new concepts analysed.

From an establishment with as wide a range and complexity of activities as ESTEC, the administrative support Divisions also play an important role; whilst reporting to the Director of Administration, located in ESA Head Office, the ESTEC Contracts, Finance and Personnel Divisions provide direct support to all operational units of the establishment.

One of ESTEC's key activities is the Space Technology Research and Development Programme designed to ensure that the technology required by the Agency's programmes is available in due time to maintain a high level of competence in space technology in Europe. ESTEC's specialised staff are responsible for the programmation of this activity as well as its technical management, the execution proper being entrusted in most cases to industry so as to ensure that technology is developed where it will be required for later application to projects.

Past, present and future programmes managed by ESTEC

ESTEC has been so far associated with the development of almost all ESA and ESRO satellite programmes.

In the scientific field this comprises not less than 13 satellites from ESRO-II/Iris, launched on 17 May 1968 to EXOSAT, launched on 26 May 1983. Challenging new programmes in different stages of development under the responsibility of project teams at ESTEC include

Space Telescope, Ulysses, Hipparcos, Giotto and ISO. In addition, studies are being carried out on a number of Space Science projects in competition for selection in 1985 and beyond.

On the Applications side, 5 communications satellites have been developed so far under the responsibility of ESTEC's project teams, from OTS-2 launched on 11 May 1978 to ECS-2 launched on 4 August 1984. Programmes under development at ESTEC are the 3rd Flight Unit of ECS as well as the new large communications satellite Olympus. Work is further proceeding on the definition of a future telecommunications programme.

Another important domain of Space Applications, namely Earth observation and remote sensing, is also covered in ESTEC through the management of ESA's first Remote Sensing Satellite ERS-1, whilst studies are already being undertaken on satellites devoted to solid Earth physics, atmosphere/climate missions and remote sensing for land applications.

The programme which probably contributed most to ESTEC's reputation as the European centre for Space Research and Development is Spacelab; this project, representing Europe's entry into manned space flight, was managed through its different phases by a specialist team at ESTEC. The first mission of Spacelab took place between 28 November and 8 December 1983 and was an outstanding success, particularly from a technical point of view. ESTEC is now preparing to cope with the challenging new task of leading Europe into the Space Station era by assuming responsibility for technical management of the Columbus Project.

ESTEC also plays a role in a new domain of space activities, namely Microgravity Research; specialist staff are guiding European industry in the development of facilities for the two main research areas, life sciences and material sciences, which are to be flown on manned and unmanned spacecraft.

ESTEC's principal facilities and laboratories

ESTEC is not least known for its unique and wide range of testing installations and laboratory facilities which permit the verification of satellites from individual components to full system level.

As regards the system level test facilities, ESTEC is one of the three main Satellite Test Centres in Europe, the other two being located in France and West Germany respectively; the three centres are operated in a coordinated effort to maximize their utility for European spacecraft manufacturers which generally do not have extensive ground test capabilities of their own. ESTEC is presently expanding its test and integration facilities so as to cope with the new generation of spacecraft constituted by ARIANE 3/4 and shuttle class payloads; detailed plans have been elaborated for additional facilities so as to create at ESTEC an Integrated Test Centre, providing all necessary system level test facilities for full ARIANE 4 class satellites.

Among the different facilities are :

The environmental test facilities which support the development, qualification and acceptance of spacecraft and experimental payloads. They are used for sub-system and system level testing in the fields of vibration, solar simulation, thermal cycling, electro-magnetic compatibility, physical measurements and mechanism deployments. These facilities, complemented by adequate preparation and integration areas with high cleanliness conditions, are made available to the Agency's contractors responsible for the development and delivery of space hardware.

Recently an additional integration area and a large electrodynamic multishaker system were commissioned at ESTEC, whilst the conversion of the existing Dynamic Test Chamber into a Large Space Simulator is well underway; once completed, in 1986, this facility with a 6 m parallel solar beam will be one of the largest solar simulators in the world and will allow ESTEC to test ARIANE 3/4 and Shuttle class payloads.

The Check-out Reference Facility allows ESTEC to develop standards and basic software for operational check-out equipment owned and operated by industry and which are used for the functional testing of data handling sub-systems and satellites during integration and tests.

The laboratories and small technical facilities play an important role in ESTEC's mission to support both ESA and national programmes.

Included in this category is the ESTEC Battery Test Centre, a unique facility in Europe for testing the performance and degradation laws of batteries through continuous cycling under near-real conditions.

ESOC, The Space Operations Centre of ESA

ESOC (European Space Operations Centre) is located in Darmstadt, West Germany. It is responsible for all ESA satellite operations and for the operation of the corresponding ground facilities and communications networks. The ESOC controlled network includes an Operations Control Centre (OCC) in Darmstadt and telemetry, tracking and control facilities at the ESA network of ground stations.

Technical Facilities

The technical facilities of the Operations Control Centre in Darmstadt consist of :

- the Main Control Room
- Dedicated Control Rooms
- Computer Facilities
- Specialised Facilities for Ground System Engineering

The Main Control Room is used for the operation of all satellites during the "Launch and Early Orbit Phase" that is, for all manœuvres to be executed after separation of the spacecraft from the launcher until it has been placed into its final orbit.

Once the spacecraft is in its correct orbit and all preliminary manœuvres have been carried out, dedicated Control Rooms are used for its operation and maintenance throughout the "routine phase". Dedicated Control Rooms have been established for applications satellites such as METEOSAT-1 and 2, OTS, MARECS-A and B2 and for the scientific satellite EXOSAT.
Further facilities have been installed, for the exploitation of payload data from METEOSAT and EXOSAT.

The METEOSAT Operations Control Centre, besides controlling the satellites' position and health, supports the spacecraft's three missions namely the imaging mission (in three spectral bands), the data collection mission and the dissemination of the images and meteorological products. In addition a Meteosat Archive System, in which all satellite image data has been stored since 1977, is maintained at ESOC.
The EXOSAT Control Room and other facilities constitute an Observatory, where scientists can observe cosmic X-ray sources, monitor, in real-time, data from the satellite and carry out a thorough scientific analysis.
An extended network of real-time computers and three major Computer Facilities are used for the support of spacecraft operations, mission control and of payload monitoring, for off-line payload data processing, for flight dynamics support and for mission analysis.
In addition to the operational facilities, the Centre includes specialised facilities for ground system engineering. These are
- A test and reference station comprising a set of equipment of the type installed at the overseas ground stations and used to evaluate equipment modifications required for operations, to develop specialised software and to conduct tests using early models of the satellites in order to ensure compatibility between the in-orbit flight models and the ground station network.
- Electrical and mechanical workshops.
- Facilities for system integration. These allow major ground station elements to be integrated in Europe and tested prior to shipment to the operational site.

Tasks
ESOC participates in project studies and subsequent phases, covering all aspects of the ground segment including :
- mission analysis,
- operations concept,
- ground segment configuration and design,
- data handling configuration and design.

All operations after launch are executed by the Mission Control Team under the direction of the ESOC Flight Operations Director. This team comprises engineers and technicians responsible for spacecraft, ground station, and network control as well as computer experts and experts in flight dynamics responsible for Orbit and Attitude Determination and Control and Manœuvre strategy optimisation.
The operation of satellites in geostationary, polar and highly eccentric orbits has now become a routine matter for ESOC. However, among the forthcoming missions two deep space missions, ULYSSES and GIOTTO, will present a particular challenge for the ESOC team.
Ulysses because it will be the first spacecraft ever to fly out of the ecliptic plane over the poles of the sun using the Jovian gravtitational field to deflect it into a high-inclination orbit which will take it over one of the poles of the sun some 2 1/2 years after launch and over the other pole about 8 months later. The Operations Control Centre for the Ulysses mission will be located at the Jet Propulsion Laboratory (JPL) in Pasadena, California from where all operations will be conducted by a joint ESA/JPL team under ESA management.
The Giotto mission is also spectacular; not only is it the first European Deep Space Mission, it is also the first deep space mission to be launched with the European Ariane Launcher and, of the six spacecraft scheduled to rendezvous with the comet in March 1986, it is the one with the most rigid requirements with regard to navigation; the flight dynamics team from ESOC must navigate GIOTTO so accurately that it passes the comet's nucleus at a distance of about 500 km! The ESOC team will be helped in this task thanks to an unprecedented cooperation with NASA and Intercosmos. In particular, the two USSR spacecraft which will pass through the cometary coma a few days before the Giotto encounter, will provide information on the position of the comet's nucleus which will enable the ESOC team to make accurate final orbit correction manœuvres.
The GIOTTO encounter will last for only four hours, during which time data from the ten instruments on board will be transmitted in real-time down to Earth. To optimise the scientific results, a world-wide network of ground stations has been created. In Australia, at the Parkes Radio Telescope and in Weilheim in the Federal Republic of Germany, ESOC engineers have installed highly accurate tracking systems which have been developed by European industry under ESA contracts. These systems allow ESOC to follow and manœuvre the spacecraft with the necessary accuracy on its 700 million km voyage to meet the comet at a distance of almost 150 million km away from the Earth.

Staffing
In addition to a permanent staff of some 220 people from 13 European countries, about 375 staff provided by industry also work on ESOC premises, the latter being mainly employed for spacecraft and computer operations (shift work) and software development.

Budget
The investments made by ESA in the last 20 years in its Space Operations

Centre in Darmstadt and its ground stations result in a total amount of 150 million Accounting Units. ESOC's share of the ESA yearly budget is, on average, about 6 %.

With the expertise gained at ESOC over the past twenty years, the Agency is well equipped to handle the challenges of the future; spacecraft will need more and more complex operations and the corresponding ground support will also be more demanding. Support for operational activities in connection with the manned space station will be a new field for Europe which ESOC is already preparing to tackle.

ESRIN : IRS and EARTHNET

ESRIN, located in Frascati near Rome in Italy, houses two separate activities the Earthnet Programme Office (see page 32) and the Information Retrieval Service (IRS).

This Service traces its beginnings back to 1964, the year in which the ESRO/NASA Information Exchange Agreement was signed. The agreement, which initially provided for the exchange of scientific and technical aerospace literature, expanded into the online availability of the NASA database to European users and became the cornerstone of the present-day IRS. The spectacular growth of ESA's online Space Documentation Service turned a small in-house service with one database and a computer link to ESOC, Darmstadt, into a multi-million item databank loaded onto two mainframes at Frascati, accessible through national and international data transmission networks from all over the world.

This transformation was, and still is, the result of a strong demand from industrial and institutional users in ESA Member States for the provision of online information, coupled with selective R & D in software and hardware techniques and the continuous application of the latest technologies.

Among some of the many achievements to the credit of IRS in recent years are the construction of a bi-alphabet terminal, initially in an Arabic/Latin alphabet version, the implementation of a completely new information retrieval software, ESA-QUEST, considered the most "user-friendly" retrieval language available on the market of online database hosts, and the continuous development of new software commands to help searchers be more specific and quick in their research for bibliographic or factual information.

There are now around 90 databases and databanks, both of a public and private nature, available online covering most fields in science and technology. In the aerospace field, apart from the NASA and NTIS (National Technical Information Service) files, it is possible to get the latest news items in the world aerospace sector from the "Aerospace Daily" online databank, information on ESA satellite components, test reports, quality audits, etc. or a catalogue of Earthnet remote sensing images and so on. European industries involved in ESA programmes can now have immediate information on all ongoing ESA tenders and contract specifications at the push of a button and an Electronic Mail system provides ESA Directors daily with the latest world news in the aerospace sector.

Ongoing R & D projects include IRS development in the Apollo electronic document delivery programme. IRS provides a front-end interface with the CEC archives in Brussels, procures receiving terminals, tests the system at ESRIN and in general gives advice and support during the implementation period.

IRS also makes a major contribution to CEC and UNESCO funded programmes in developing countries. QUESTAR, an ESA-QUEST Arabic language retrieval software has been installed in Morocco at the Institut d'Études et de Recherches pour l'Arabisation to run their arabic databases, one of which — LEXAR, an Arabic/French language lexicographical database — was developed by IERA using IRS online infrastructures.

The European Host Operators' Group, of which IRS is a founder member, has initiated an interconnection programme between European database hosts, which will allow users to search all available files using the distributed database principle. A standard computer protocol has been specially developed, and IRS is participating in the project on an experimental basis.

Nobody expected the computer era, and with it the information industry, to make the tremendous progress it has made in recent years. In fact, the present day state-of-the-art in this field has already reached the level forecast, twenty years ago, for the end of the century, and who can say today what new developments will have been made by the year 2000 ? It is however obvious that the days of paper and pencil will disappear rapidly, and that electronic systems will soon be replacing today's means of communication. IRS will probably form part of a large European, or international, database network where each host will carry specialised files in its own field of competence.

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