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european space agency

The European Space Agency was formed out of, and took over the rights and obligations of, the two earlier European Space Organisations: the European Space Research Organisation (ESRO) and the European Organisation for the Development and Construction of Space Vehicle Launchers (ELDO). The Member States are Austria, Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom. Finland is an Associate Member of the Agency. Canada is a Cooperating State.

In the words of the Convention: The purpose of the Agency shall be to provide for and to promote, for exclusively peaceful purposes, co-operation among European States 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.

(a) by elaborating and implementing a long-term European space policy, by recommending space objectives to the Member States, and by concerting the policies of the Member States with respect to other national and international organisations and institutions;
(b) by elaborating and implementing activities and programmes in the space field;
(c) by co-ordinating the European space programme and national programmes, and by integrating the latter progressively and as completely as possible into the European space programme, in particular as regards the development of applications satellites;
(d) by elaborating and implementing the industrial policy appropriate to its programme and by recommending a coherent industrial policy to the Member States.

The Agency is directed by a Council composed of representatives of Member States. The Director General is the chief executive of the Agency and its legal representative.

The Directorate of the Agency consists of the Director General; the Inspector General; the Director of Scientific Programmes; the Director of the Earth Observation and Microgravity Programme; the Director of the Telecommunications Programme; the Director of Space Transportation Systems; the Director of the Space Station and Platforms Programme; the Director of ESTEC; the Director of Operations and the Director of Administration.

The ESA HEADQUARTERS are in Paris.

The major establishments of ESA are:

THE EUROPEAN SPACE RESEARCH AND TECHNOLOGY CENTRE (ESTEC), Noordwijk, Netherlands.

THE EUROPEAN SPACE OPERATIONS CENTRE (ESOC), Darmstadt, Germany

ESRIN, Frascati, Italy.

Chairman of the Council: Mr H. Grage.

Director General: Prof. R. Lüst.

agence spatiale européenne

L'Agence Spatiale Européenne est issue des deux Organisations spatiales européennes qui l'ont précédée — l'Organisation européenne de recherches spatiales (CERS) et l'Organisation européenne pour la mise au point et la construction de lanceurs d'engins spatiaux (CECLES) — dont elle a repris les droits et obligations. Les Etats membres en sont: l'Allemagne, l'Autriche, la Belgique, le Danemark, l'Espagne, la France, l'Irlande, l'Italie, la Norvège, les Pays-Bas, le Royaume-Uni, la Suède et la Suisse. Finlande est membre associé de l'Agence. Le Canada beneficie d'un statut d'Etat coopérant.

Selon les termes de la Convention: L'Agence a pour mission d'assurer et de développer, à des fins exclusivement pacifiques, la coopération entre Etats européens dans les domaines de la recherche et de la technologie spatiales et de leurs applications spatiales, en vue de leur utilisation à des fins scientifiques et pour des systèmes spatiaux opérationnels d'applications:

(a) en élaborant et en mettant en oeuvre une politique spatiale européenne à long terme, en recommandant aux Etats membres des objectifs en matière spatiale et en concertant les politiques des Etats membres à l'égard d'autres organisations et institutions nationales et internationales;
(b) en élaborant et en mettant en oeuvre des activités et des programmes dans le domaine spatial;
(c) en coordonnant le programme spatial européen et les programmes nationaux, et en intégrant ces derniers progressivement et aussi complètement que possible dans le programme spatial européen, notamment en ce qui concerne le développement de satellite d'applications.
(d) en élaborant et en mettant en oeuvre la politique industrielle appropriée à son programme et en recommandant aux Etats membres une politique industrielle cohérente.

L'Agence est dirigée par un Conseil, composé de représentants des Etats membres. Le Directeur général est le fonctionnaire exécutif supérieur de l'Agence et la représente dans tous ses actes.

Le Directoire de l'Agence est composé du Directeur général; de l'Inspecteur général; du Directeur des Programmes scientifiques; du Directeur des Programmes d'Observation de la Terre et de Microgravité; du Directeur du Programme de Télécommunications; du Directeur des Systèmes de Transport spatial; du Directeur du Programme Station spatiale et Plates-formes; du Directeur de l'ESTEC, du Directeur des Opérations et du Directeur de l'Administration.

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LE CENTRE EUROPEEN D'OPERATIONS SPATIALES (ESOC), Darmstadt, Allemagne.

ESRIN, Frascati, Italie

Président du Conseil: M H. Grage.

Directeur général: Prof. R. Lüst.

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Editorial/Circulation Office
ESA Publications Division
c/o ESTEC, Noordwijk, The Netherlands

Publication Manager
Bruce Battrick

Editors
Bruce Battrick, Duc Guyenne

Assistant Editor
Erica Rolfe

Layout
Carel Haakman

Montage
Keith Briddon

Advertising Agent
La Presse Technique SA
3a rue du Vieux-Billard
CH-1211 Geneva 4

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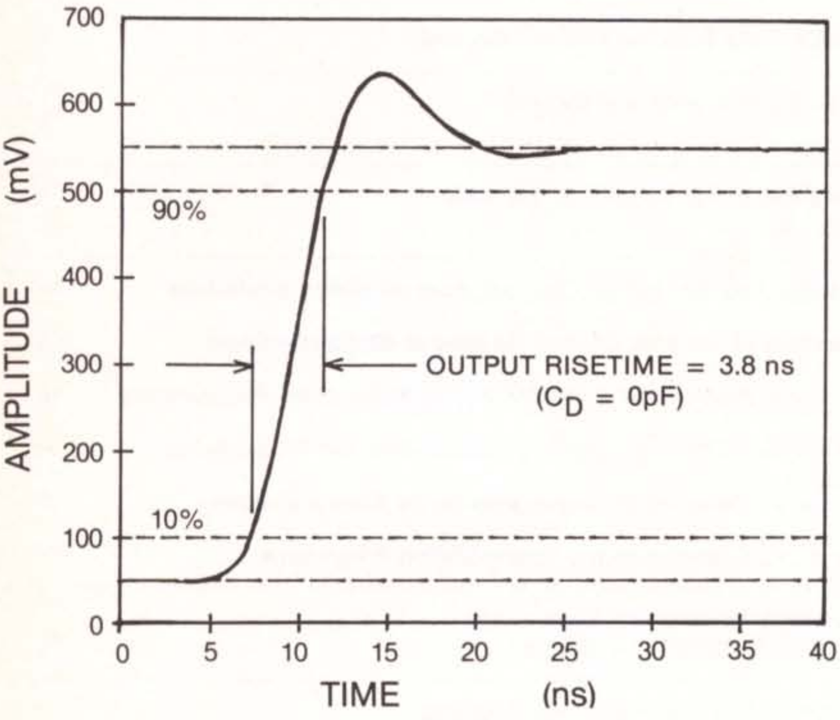
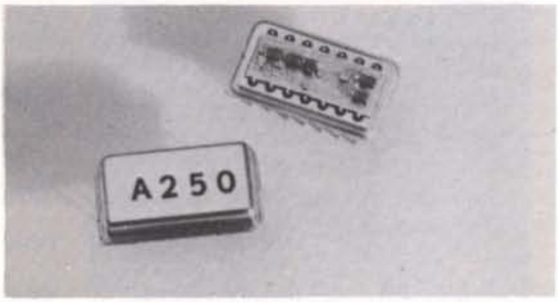


A NEW STATE-OF-THE-ART



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New Year's Message from the Director General

Nineteen eighty seven was a particularly fruitful year for all of us working in the Agency and indeed for European space activities as a whole, a year that we can look back on with much satisfaction.

The 'major event of the year' was of course the Ministerial Council Meeting in The Hague in November when the Ministers of our Member States took important decisions on our Long-Term Space Plan (see pages 9—30 of this issue), the implications of which go far beyond earlier European Space Conferences and will affect European space activities for decades to come. For the first time in the history of the Agency, we have a coherent and balanced Long-Term Space Plan which will ensure that, in future, Europe will be able to play an autonomous role in the exploration of space.

Naturally, the decisions taken by the Ministers will refocus our objectives and priorities for our work during 1988. This year and the coming years will be a tremendous challenge for us all and much energy and enthusiasm will be needed to carry out the ambitious programme adopted by the Ministers.

As a result of these decisions, and after adoption of the complementary Resolutions by the December Council, the development work on the three major programmes Ariane-5, Columbus and Hermes has started at the beginning of the year. Furthermore, we have resumed formal talks with the United States on the International Space Station. I trust that we can solve the outstanding issues to our mutual benefit and reach an agreement in the very near future.

With the spotlight being focussed on the new large programmes, we must not underestimate the importance of the user programmes, the support establishments and the administration. I am confident that, in conjunction with the other Directorates, we will be able to strike the right balance.

In early March we will see the launch of Ariane-V21, with one American and one French satellite on board. This will be followed by the first test flight of Ariane-4 with Meteosat-P2 as its main passenger. In the other programmes also — Science, Earth Observation, Microgravity and Telecommunications — important tasks lie ahead, the launch of ECS-5 and, in mid-1989, that of the Hubble Space Telescope being just two examples.

We have a well-defined and ambitious programme ahead of us and I know that I can count on your hard work and support to enable us to carry out this challenging task, which will shape the future of European space activities into the next century.

With this in mind, I wish you all a happy and prosperous 1988.

R. Lüst

Council Meeting at Ministerial Level in progress at the Ministry of Foreign Affairs, in The Hague

The Ministerial Conference and Beyond

Prof. Reimar Lüst, Director General, ESA

Introduction

On 9 and 10 November 1987, the ESA Council, meeting at Ministerial Level in The Hague, approved a Resolution which will ensure that Europe has a cogent and influential space policy, and programmes that will keep it in the forefront of space exploration and exploitation well into the next century.

The Meeting was the culmination of nearly three years of preparatory work which had been advancing steadily since the ESA Council Meeting at Ministerial Level in Rome in January 1985 had laid down its guidelines for the future. As a result it was possible to put forward in The Hague a proposal which had, as its strategic aim, a coherent, complete and balanced set of programmes.

The objectives in drawing up the proposals were as follows:

- Coherence should be achieved not only between the different programmes, but also between the different elements within the space infrastructure, and between the space and ground segments.
- The programmes should aim at completeness, in the sense that all major space disciplines should be represented, and the specialisations within these disciplines given a fair portion of the programmes.

In this way a balanced set of programmes was arrived at, this being especially so in the relationship worked out between the infrastructure and the user programmes that it must serve.

Coherence, completeness and balance are reflected not only in the technical content, but also in the scheduling and funding conceived for the programmes.

On this basis, the underlying political will that had been in such evidence at the Rome meeting, and was seen again in The Hague, could be turned into reality, so that:

a. Europe's autonomous capability in space could be expanded.
b. Europe's competitiveness in all sectors of space activity could be enhanced.
c. Europe's standing as a competent partner for international cooperation, in particular with the United States, could be strengthened.

In this review, I wish to focus on the major points that play a part in deciding the role Europe will play on the world stage of space exploration and exploitation during the coming decades.

The texts of the two Resolutions and the Final Declaration from the Ministers are included in extenso on pages 16 – 30 of this Bulletin.

The World scene

During the past few years we have seen the steady progress of the USSR towards the establishment of a permanent space station, the tragedy of the 'Challenger' disaster, and its crippling effect on the United States' space programme, and the emergence of 'new' space nations, such as Japan, China and India with the potential to increase their shares of the space market. There is no doubt that the USA will recover and forge ahead with its space programmes again, but this will take time, and the relationship between the military and peaceful uses of space has still to be resolved by the US Administration.

It is clear that Europe cannot allow itself to be reduced to a subordinate or subsidiary role in space ventures if it is to maintain its current hard-won position. Not only political credibility but also high-technology industrial growth depends on the degree to which Europe fulfills the potential it has built up in the last two decades. It is fitting at this point to recall the definition of 'autonomy' that we have developed over the last three years. The need for international collaboration on major space undertakings is not disputed, but Europe wishes to enter such undertakings on an 'equal partnership' basis, this concept applying at all levels including operational control. In other areas, such as launcher development, a more precise autonomy exists and this needs to be nurtured further.

To sustain this pattern of development, Europe will need to work as an entity during the coming decades, and to harness still more of its resources if it is to remain among the leading space powers at the turn of the century.

The ESA Programmes

Science

It is now accepted that space science is an integral and essential part of the mainstream of scientific advancement. Its findings and activities have substantial

Dr. R.W. de Korte (right), Deputy Prime Minister and Minister of Economic Affairs, The Netherlands, in discussion with Prof. Reimar Lüst, ESA's Director General

Assembled Ministers and Secretaries of State of the Agency's member countries, with H.R.H. Prince Claus of The Netherlands (front row, fourth from left) and Prof. Reimar Lüst (front row, second from left)

Models of Giotto and Ariane-5 on display outside the Dutch Ministry of Foreign Affairs

repercussions on other scientific disciplines. At the same time, it is the 'test bed' for many space systems and items of instrumentation that are subsequently incorporated in the longer-life applications satellite systems.

Space science has championed the cause of peaceful international cooperation in space in spectacular fashion, with outstanding successes in the encounters with Halley's Comet, and with the International Ultraviolet Explorer (IUE) and the International Sun—Earth Explorer (ISEE) Programmes. This policy is being continued with the Solar-Terrestrial Science Programme.

There is a tendency however to think of space science as serving only one community. This is not so. There are several different space-science communities within Europe, and ESA has therefore been careful to present a balanced programme. This it has been able to do through the 'Horizon 2000' Programme, which has recently been updated. A start has already been made on the first of the major Horizon 2000 Cornerstone Missions, namely the Solar-Terrestrial Science Programme mentioned above.

A successfully executed Horizon 2000 Programme would be the mainspring for much innovative work within the Agency, within European scientific institutes, and within European industry.

Earth Observation

The popular acceptance of nightly Meteosat images on TV screens should not be allowed to mask the great advances made in other areas of Earth observation in Europe over the last decade and a half. The unique all-weather capabilities of the European Remote-Sensing satellite (ERS-1) will provide much-needed insight into coastal, ocean, and ice processes from the early 1990s onwards. At the same time, new missions will be developed which will lead to the economic exploitation of remote-sensing data.

We know that before full exploitation can be realised, ESA must conduct the essential basic research into the underlying physical mechanisms and the related surface phenomena of the Earth and make these findings widely available.

There is now a growing awareness in political, industrial, and potential user communities of the exciting and, eventually, profitable future for the European Earth-Observation Programme.

Microgravity

The 'youngest' of the space generic groupings encompasses those disciplines that make specific use of the microgravity environment found in low Earth orbit — mainly the life and materials sciences. The European-built Spacelab opened the way for these disciplines to profit from the ability to return experiments to Earth, and also the possibility of human intervention and participation in experiments conducted in space.

Telecommunications

The demand for more and improved telecommunications satellite links is a fair reflection of the way in which ESA's successful satellite systems have proved themselves in practice and helped change attitudes by example. Telecommunications is also the discipline that has led the way in demonstrating the advantages of users of application systems having a representative voice – in this case Eutelsat.

European industry has realised the potential of the worldwide satellite communications market, and has benefitted substantially from ESA's research and development role. However, there can be no slackening of effort if Europe is to remain a market force. New and more powerful systems are demanded; mobile air, sea and land systems have lucrative futures, while innovative ideas in the domains of teleconferencing and navigation systems could pay large dividends.

In addition, Europe needs a means of relaying the data from other satellites and space systems to ground stations. A data-relay satellite is therefore an essential element not only in the development of space technology, but also in terms of much-needed support to many other programmes.

The ESA Telecommunications Programme is well-established, well-proven and much-respected around the World.

Space-Transportation Systems

The political will to seek European autonomy in space has rested in part on the success of the early Ariane flights. As with all launcher systems, there has been a period of reappraisal following setbacks, but that is hopefully behind us. With the lessons learnt, we can be confident for the future. One thing is certain; unless we continue to develop launchers capable of carrying satellites and other space systems into low Earth orbit and geostationary transfer orbits at competitive prices, and with comparable safety, Europe will lose not only the chance of autonomy, but also its existing

Press Briefing on the last afternoon of the Conference, hosted by Minister Heinz Riesenhuber (Fed. Republic of Germany), Chairman of the Conference (above right), and Prof. Reimar Lüst (above left)

right to be numbered amongst the major space powers.

Ariane-5 will be developed, qualified and put into production to satisfy market demand. Launchers are ordered during the design and early development phases of a satellite project, and much has to be taken on trust. Europe can only hold its market position if it is seen to exhibit a positive drive behind its programmes and a firm belief in its capabilities.

The development of Hermes as Europe's independent spaceplane takes us a step further towards autonomy but, more than that, it is a step forward in the more general and lucrative field of aerospace technology. There is evidence of mounting interest in hypersonic flight in the Far East as well as in the USA and the USSR. There can be no certainty as to where this road leads, but other nations are venturing along it, and Europe should find itself in a more advantageous position in the longer term after the decision to begin the first phase of the Hermes Programme.

Columbus

Spacelab proved a very successful first venture by Europe into the realms of manned spaceflight. Even so, the Columbus Programme is breaking new ground, with many aspects needing to be studied in considerable depth. It has been decided that the development of Columbus will take a phased approach. The first phase of the Programme will therefore last three years, during which the initial development will confirm technical feasibility.

The Attached Pressurised Module (APM) will be designed as an integral part of an international Space Station, with facilities for carrying out experiments primarily requiring a microgravity environment. The Man-Tended Free Flyer (MTFF) will carry similar experiments, together with others of a technological nature. It will be capable of co-orbiting with a Space Station, and be serviced once every six months by Hermes. The third element, the Polar Platform (PPF), will be dedicated to Earth-observation missions.

The decision to commence the first phases of Hermes and Columbus gives both programmes a promising start, while providing Member States with an opportunity after three years to examine progress made and assess the prevailing situation before approving the second phases.

Support Programmes

No high-technology programmes are possible without a considerable degree of basic research, especially on long-lead-time items. At the same time, the economic advantages of testing and check-out are well proven, but testing methods and hardware must be kept abreast of the sophistication of the satellite and launcher systems they serve. The ground control and operational systems are as essential as the space systems, and must reflect the degree and type of satellite control that needs to be exercised.

These are areas in which European industry has realised that expertise can give it an edge in a growing market, and that in supporting ESA it increases its own standing in other allied markets.

Industrial and financial policy

The concern of Member States regarding an equitable sharing of the industrial return is well understood, and Resolution No. 1 from The Hague Meeting makes clear the importance that Governments attach to this question. The position has improved over the last few years, but this topic remains in the forefront of our planning. At the same time, the Member States are inviting greater participation from the private sector and a wider role for industry. With the very firm basis of the ESA Long-Term Plan now extending so far into the future, one can indeed foresee a rise in the degree of interest shown by the private sector, and the Agency will pursue this policy with determination.

Conclusion

Although it abstained during the vote on the first Resolution, the other Member States expressed their wish and belief that the United Kingdom, which played so prominent a role from the beginning of the European space venture, should remain a major force in securing the future of European space activities. The hope was therefore expressed that, during the coming period, events might be such that the United Kingdom would be able to review its position on several programmes.

Emerging from the discussions between Ministers, there is a clear determination that Europe should have a programme for the peaceful exploration and exploitation of space which places it in a strong position in the councils of the space powers. The importance of space activities to economic, technical, and cultural cooperation in Europe is well understood, and the Ministers showed a strong confidence in ESA's ability to carry through the series of programmes with which it has been entrusted.

We now embark on a decade and more of exciting, fulfilling research and development work unparalleled in our history, both in terms of the number of nations participating and the effect this could have on Europe's future prosperity and influence on World events.

Opening Address to the Council of Ministers of the European Space Agency

by His Royal Highness Prince Claus of The Netherlands

Excellencies, Ladies and Gentlemen,

May I first offer you a warm welcome to the Netherlands, and to The Hague in particular, on the occasion of this Third Meeting of the Council of Ministers of the European Space Agency.

The Hague, as you know, has a long tradition as a centre for international conferences which have played a key role in the history of our continent.

Ladies and Gentlemen, I hope that you will regard the words I am about to say as more than a simple formality. Please be assured of my firm conviction that the exchange of views you will be conducting today and tomorrow is of exceptional importance, not only for European space research, but for the future of Europe as a whole.

The history of European space research prompts me to make a number of remarks.

The first is that scientists, more than anyone else, are the fathers of European space research. It is they who in fact defined, and who continue to define, the high standards of quality demanded in technology.

As we are gathered in the country which gave birth to Christian Huygens and other leading astronomers, I hope you will forgive me if I emphasise — with a certain degree of pride — that the achievements of the smaller European powers in the field of fundamental space research have been far from negligible. I would hasten to add, however, that European space research could never have reached its current level of advancement without a number of decisive initiatives taken by the four major West European nations.

In the past, the Federal Republic of Germany, Italy and the United Kingdom have each in their own way contributed to the scope, the diversity and the quality that characterise space research in Western Europe. I hope that no-one will take exception if I pay particular tribute today to the perspicacity, courage and perseverance with which France has worked to realise many major technological projects and, in the specific context which is the subject of your conference, to develop carrier rockets and the Hermes space plane.

Today, when we speak in general terms about European cooperation and integration in the fields of politics, economics and culture, we can state, not without satisfaction, that this involves a process that is definitely irreversible. But in all honesty we must recognise that, for all sorts of reasons, the pursuit of this process is slow and is not particularly inspiring.

European space research, by contrast, has impressive performances to its credit; it is a field which appeals to the imagination, particularly of younger generations. Space research is also a sector in which Europe has raised itself to take third place in the World, after the Soviet Union and the United States of America.

His Royal Highness Prince Claus of The Netherlands delivering his address. Seated, Dr. R.W. de Korte, Deputy Prime Minister and Minister of Economic Affairs, The Netherlands

It seems to me that there are three reasons which can explain this success. The first is that ESA has been able, as the organisation responsible for the execution and the coordination of space research, to gain a great deal of confidence from the Member States, and in this way has come to obtain the freedom of action which is essential for the planning, implementation and administration of wide-ranging projects.

Secondly, the Governments of the Member States have been willing — some, unfortunately, less than others — to release funds not only for the scientific space-research programmes governed by the compulsory financial agreements on which the ESA is based, but also for optional programmes, which have progressively come to occupy a more important position than the programmes provided for in the Agency's mandate.

Thirdly, one can say that today, specialists and laymen alike have become convinced that space research, at least if it is to be pursued seriously, surpasses the capacity of any individual country.

In other words, there can be no real progress in this area without international cooperation.

Now, real progress and political energy in matters of space research are of vital interest to our part of the World.

The development of increasingly advanced space technologies enables Europe to revitalise its industry, to modernise its economies and to create the employment that is so necessary for both current and future generations. If we are not to miss our connection with the computerised society of the 21st Century, it is important that we master fully all the applications of space technology in telecommunications. Europe can make a vital contribution to enriching the cultural life of our planet and does not have the right to ignore the possibilities offered by space technologies in this respect.

Today, satellites already enable us to help developing nations find solutions to the economic and social problems with which they are confronted.

For Europe, the joint utilisation of space constitutes a unique opportunity to create a common identity for itself. In this way, two of Europe's main aspirations could be combined in space: its own unification and the promotion of spearhead technologies.

While I am well aware of the importance of space for peace and security, even at the European level, you will understand that, respecting the spirit and letter of the Convention on which the European Space Agency is based, I shall not enter into any discussion of this question here this morning.

You may have had an opportunity to acquaint yourselves with a recent report published jointly by five West European international relations institutes. The report confirms that in future, the standing and influence of countries or groups of countries in the World will depend increasingly on their ability to explore and to exploit space.

If we consider the extraordinary efforts made in this field by other countries — and I have in mind here not only the major powers in space, the Soviet Union and the United States, but also countries such as China, Japan and India — we must say that the grounds for this confirmation have already long been recognised in other parts of the World.

The Ministerial Conference of the European Space Agency held in Rome in January 1985 has already allowed a very serious and sober discussion of the task facing Europe in this field. The definition of this task gave rise to a policy with two components. On the one hand, the Ministers declared their support for continued cooperation with other countries, in particular with the United States.

They gave concrete form to this desire with their positive response to the invitation of the President of the United States to participate in the international Space Station Programme.

But at the same time, the Ministers strongly supported the objective of European autonomy in space. The five international relations institutes I have just mentioned defined this autonomy as: 'the ability of Europe to reach space, to carry out activities there and to return to Earth in a way that does not require the consent of either its friends or its enemies, but which enables it to do so in accordance with its own ideas, will benefit everyone'.

Since January 1985 the costs of achieving this objective have risen considerably. At this moment, you are facing a difficult choice. Either you must decide to effectively free the necessary capital, which is certainly no easy matter in this period of budgetary constraints, or you must renounce, at least temporarily, European autonomy in space.

It is sometimes said that Cretan civilisation contributed more towards history than it was itself able to absorb. To return to what I said at the beginning, I would like to conclude by drawing your attention to the fact that at this time, it is all of Europe which must absorb the pages of history that you will be writing today and tomorrow here in The Hague.

I would therefore like to voice the hope that your conference will be a complete success.

Thank you for your attention.

Déclaration finale du Conseil de l'ESA siégeant au niveau ministériel

(adoptée le 10 novembre 1987)

Le Conseil de l'Agence spatiale européenne, siégeant au niveau ministériel à La Haye les 9 et 10 novembre 1987 sous la présidence du Dr Heinz Riesenhuber, Ministre de la Recherche et de la Technologie de la République fédérale d'Allemagne, a examiné les propositions présentées par le Directeur général pour la mise en oeuvre du Plan spatial à long terme faisant suite à la réunion ministérielle tenue à Rome en janvier 1985, ainsi que la situation des négociations multilatérales sur le programme de station spatiale internationale.

Les Ministres, représentant les treize Etats membres de l'Agence, le Canada et la Finlande — la Commission des Communautés européennes s'étant vu accorder le statut d'observateur — ont pris note avec satisfaction de l'élargissement de l'Agence et des progrès réalisés dans l'exécution des programmes en cours.

Le Conseil a adopté deux Résolutions: la Résolution No. 1 sur le Plan spatial européen à long terme et les programmes, et la Résolution No. 2 sur la participation au programme de station spatiale.

Dans le cadre de la Résolution No. 1 et sur la base des propositions du Directeur général, les Ministres ont à nouveau marqué la nécessité de poursuivre une politique spatiale complète, cohérente et équilibrée, conformément aux principes approuvés à l'unanimité en janvier 1985.

Dans cet esprit, le Conseil siégeant au niveau ministériel s'est déclaré d'accord pour entreprendre dans le cadre de l'Agence la réalisation d'Ariane-5, de Columbus et d'Hermès ainsi que, à compter de 1989, celle d'un système de satellites de relais de données.

Pour des raisons de technique et de programmation, le Conseil a décidé de procéder en deux phases à la réalisation de Columbus et d'Hermès, conformément à la Convention de l'Agence.

Les Ministres ont fait part des intentions de participation de leurs gouvernements et ont annoncé leurs taux de contribution aux programmes de développement Ariane-5, Columbus et Hermès.

La Résolution No. 1 fait en outre état d'une augmentation du Budget général et du Budget du Programme scientifique.

Les Ministres ont également approuvé la poursuite et le développement des programmes et activités utilisateurs selon les lignes définies dans les propositions de programmes présentées par le Directeur général en ce qui concerne en particulier les télécommunications, la microgravité, l'observation de la Terre et la science spatiale.

Le Conseil a en outre examiné les problèmes de politique industrielle et adopté des directives de nature à satisfaire les besoins des programmes spatiaux avec un bon rapport coût/efficacité, à améliorer la compétitivité de l'industrie européenne, à assurer à tous les Etats une participation équitable aux travaux présentant un intérêt technologique et à exploiter dans toute la mesure possible les avantages de la libre concurrence.

Les Ministres ont souligné que le secteur privé devrait être encouragé à faire usage du potentiel disponible et à participer à ces efforts. Une attention particulière a été portée à la possibilité d'obtenir des fonds du secteur privé pour les programmes, chaque fois que ce sera possible.

Le Conseil est convenu que la réalisation des programmes spatiaux exigera la création d'une infrastructure au sol appropriée, laquelle devra dans toute la mesure du possible utiliser des installations existant en Europe, et a approuvé les propositions que le Directeur général a faites en ce sens.

Le Ministre du Royaume-Uni s'est abstenu de donner son aval à la Résolution No. 1, ne pouvant approuver certains aspects de la stratégie à long terme de l'Agence.

La Résolution No. 2 sur la participation au programme de station spatiale a été adoptée à l'unanimité.

Les Ministres ont pris note du fait que les négociations multilatérales sur la station spatiale internationale n'ont pas encore abouti à un résultat final et que de nouveaux efforts seront nécessaires pour résoudre des problèmes essentiels pour l'ESA et ses Etats membres.

Ils ont confirmé l'intérêt qu'ils portent à cette coopération et, dans la ligne des objectifs fixés au Conseil ministériel de Rome, ont défini les conditions qui devraient figurer dans les Accords relatifs à cette coopération. Dans l'éventualité où ces négociations ne permettraient pas de satisfaire à ces conditions dans des délais compatibles avec le programme de réalisation Columbus, les Ministres sont tombés d'accord sur la nécessité d'adapter le contenu du programme Columbus approuvé tout en continuant à rechercher d'autres formes de coopération avec les Etats-Unis.

Final Declaration of the ESA Council Meeting at Ministerial Level

(adopted on 10 November 1987)

The Council of the European Space Agency, meeting at Ministerial Level in The Hague on 9 and 10 November 1987, under the chairmanship of Dr Heinz Riesenhuber, Minister of Research and Technology of the Federal Republic of Germany, considered the proposals put forward by the Director General for the implementation of the Long-Term Space Plan, following up the Ministerial Meeting in Rome in January 1985, and the status of the multilateral negotiations regarding the international Space-Station programme.

The Ministers, representing the thirteen Member States of the Agency, Canada and Finland — the Commission of the European Communities having been granted observer status — noted with satisfaction the enlargement of the Agency and the progress made in carrying out the current programmes.

The Council adopted two Resolutions, Resolution No. 1 on the European Long-Term Space Plan and programmes, and Resolution No. 2 on participation in the Space-Station programme.

In Resolution No. 1, and on the basis of the Director General's proposal, the Ministers reiterated the need to pursue a comprehensive, coherent and balanced space policy in accordance with the principles unanimously approved in January 1985.

In this spirit, the Council at Ministerial Level expressed its agreement to undertake within the Agency the development of Ariane-5, Columbus, Hermes and, starting in 1989, the Data-Relay Satellite.

For technical and programmatic reasons, and in accordance with the ESA Convention, the Council adopted a two-phase approach for the development of Columbus and Hermes.

The Ministers stated their Government's intention on participation and their rate of contribution to the Ariane-5, Columbus and Hermes development programmes.

Resolution No. 1 further stated an increase in the scientific and general budgets.

Ministers also approved continuation and development of the users' programmes and activities along the lines of the programme proposals put forward by the Director General, concerning in particular telecommunications, microgravity, Earth observation and space science.

Council also considered industrial policy and adopted guidelines which will meet the requirements of the space programmes in a cost-effective manner, improve the world-wide competitiveness of European industry, ensure an equitable participation for all States in the work of technological interest, and exploit as much as possible the advantages of free competition.

Ministers underlined that the private sector should be encouraged to make use of the available capacity and to participate in these efforts. Particular attention was given to the possibility for the private sector to provide funds for the programmes whenever possible.

Council agreed that the development of the space programmes will require the setting up of an appropriate ground infrastructure which should make maximum use of existing facilities in Europe and approved the proposals of the Director General to that end.

The Minister of the United Kingdom abstained from endorsing Resolution No. 1, because he could not agree with certain aspects of the long-term strategy of the Agency.

Resolution No. 2 on participation in the Space-Station programme was adopted unanimously.

Ministers noted that the multilateral negotiations on the international Space Station had not yet produced a final result and that new effort would be necessary to solve issues essential for ESA and its Member States. They confirmed their interest in this cooperation and, in line with the objectives stated at the Rome Ministerial Meeting, defined the conditions that should appear in the Agreements concerning this cooperation. In the event that these negotiations do not succeed in fulfilling these conditions in a timeframe compatible with the Columbus development programme, the Ministers agreed on the need to adapt the content of the agreed Columbus programme while continuing to seek other forms of cooperation with the United States.

Résolution sur le Plan spatial européen à long terme et les Programmes

(adoptée le 10 novembre 1987)

Le Conseil, siégeant au niveau ministériel,

RAPPELANT la Résolution ESA/C-M/LXVII/Rés. 1 (Final) sur le plan spatial européen à long terme et la Résolution ESA/C-M/LXVII/Rés. 2 (Final) relative à la participation au programme de Station spatiale adoptées le 31 janvier 1985,

CONSIDERANT l'évolution continue des activités spatiales et l'expansion rapide de leur champ d'application et de leur volume dans le monde entier,

CONSIDERANT les événements intervenus depuis la réunion de Rome au niveau ministériel et les travaux entrepris, en ce qui concerne notamment le développement d'une infrastructure orbitale européenne et son utilisation,

RECONNAISSANT que les activités spatiales constituent un élément important de la coopération économique, technique et culturelle en Europe et que l'Agence spatiale européenne joue à cet égard un rôle essentiel en liaison avec d'autres organisations ou institutions européennes, contribuant ainsi à l'établissement d'une politique européenne d'ensemble dans le domaine de la technologie,

SE FELICITANT de l'extension de l'Agence du fait de l'adhésion de l'Autriche et de la Norvège, de l'association de la Finlande et de la poursuite de la coopération avec le Canada, ainsi que du renforcement de ses relations internationales,

VU le document relatif à l'évolution des négociations avec les Etats-Unis sur le développement, l'assemblage, l'exploitation et l'utilisation d'un complexe international de Station spatiale (ESA/C-M(87)3),

VU la proposition du Directeur général concernant les programmes futurs de l'Agence spatiale européenne (ESA/C-M(87)2) et le plan spatial européen à long terme (LTP) couvrant la période 1987–2000 (ESA/C(87)3),

I. Objectifs

1. *REAFFIRME les objectifs approuvés tels qu'ils sont décrits au premier chapitre de la Résolution ESA/C-M/LXVII/Rés. 1 (Final) adoptée le 31 janvier 1985, et qui consistent plus spécifiquement:*
   - *à poursuivre un programme spatial européen qui soit un ensemble cohérent dans lequel les dépenses entre les instruments nécessaires aux activités spatiales et ces activités elles-mêmes soient correctement équilibrées;*
   - *à élargir les horizons de la recherche et de l'exploitation spatiales en Europe;*
   - *à permettre à la communauté scientifique européenne, par le biais d'un élargissement du programme scientifique, de rester à l'avant-garde de la recherche spatiale;*
   - *à renforcer le potentiel spatial dans les domaines des télécommunications et de la météorologie;*
   - *à prévoir un apport substantiel des techniques spatiales et terrestres aux sciences de l'observation de la Terre et à leurs applications, et à préparer en tant que de besoin la mise sur pied de systèmes opérationnels et d'organisations axées sur les utilisateurs pour l'exploitation de ces systèmes;*
   - *à améliorer la compétitivité de l'industrie européenne dans les secteurs des applications par des développements de pointe dans le domaine des systèmes spatiaux et de la technologie correspondante;*
   - *à promouvoir, par le biais d'un important programme de recherche en microgravité (par exemple sciences des matériaux, sciences de la vie et physique des fluides), des applications pratiques dans l'espace;*
   - *à renforcer le potentiel européen en matière de transport spatial pour que celui-ci réponde aux besoins prévisibles des utilisateurs en Europe et hors d'Europe et demeure compétitif par rapport aux systèmes de transport spatial existants ou prévus ailleurs;*
   - *à préparer des moyens européens autonomes pour le soutien de l'homme dans l'espace, pour le transport des équipements et des équipages et pour l'utilisation des orbites terrestres basses;*
   - *à intensifier la coopération internationale et en particulier à rechercher une association avec les Etats-Unis sous forme d'une participation importante à une Station spatiale internationale.*

2. *NOTE l'émergence de nouvelles possibilités spatiales, de nouvelles techniques et de nouvelles applications prometteuses.*

3. *CONSIDERE qu'un effort supplémentaire est nécessaire pour faire en sorte que l'Europe se maintienne au niveau des autres puissances spatiales au-delà de l'an 2000 et qu'elle soit en mesure de maîtriser toutes les applications spatiales.*

4. *APPROUVE l'objectif visant à renforcer le potentiel actuel de l'Europe pour qu'elle acquière dans toute la mesure possible d'ici la fin du siècle les moyens voulus d'accès à l'espace et de retour pour des missions de type habité, le service de charges utiles et la vie et le travail de l'homme dans l'espace; NOTE l'importance que revêt*

Resolution on the European Long-Term Space Plan and Programmes

(adopted on 10 November 1987)

The Council, meeting at Ministerial Level,

RECALLING Resolution ESA/C-M/LXVII/Res. 1 (Final) on the Long-Term European Space Plan and Resolution ESA/C-M/LXVII Res. 2 (Final) on participation in the Space Station programme adopted on 31 January 1985,

CONSIDERING the continuing evolution in space activities and their fast expansion in both scope and volume throughout the World,

CONSIDERING the events that have taken place since the Rome ministerial meeting and the work that has been undertaken, in particular that related to the development of a European In-Orbit Infrastructure and to its utilisation,

RECOGNISING that space activities are an important aspect of economic, technical and cultural cooperation in Europe, and that the European Space Agency plays an important role to that effect in liaison with other European Organisations or Institutions, thus contributing to the establishment of an overall European policy in the field of technology,

WELCOMING the enlargement of the Agency through the accession of Austria and Norway, Finland's Associate Membership and continued cooperation with Canada, and the growth of the Agency's international relations,

HAVING REGARD to the document on the progress of the negotiations with the United States on the development, assembly, operation and utilisation of an international Space Station complex (ESA/C-M(87)3),

HAVING REGARD to the Director General's proposal on the future programmes of the European Space Agency (ESA/C-M(87)2), and the European Long-Term Space Plan covering the period 1987–2000 (ESA/C(87)3),

I. Objectives

1. REAFFIRMS the agreed objectives as described in Chapter I of the Resolution ESA/C-M/LXVII/Res. 1 (Final) adopted on 31 January 1985, these being in particular:
   - to pursue a European space programme as a coherent whole, with the spending on the tools needed for space activities and on the activities themselves appropriately balanced;
   - to expand the horizons of space research and exploitation in Europe;
   - to enable the European scientific community, via an expansion of the scientific programme, to remain in the vanguard of space research;
   - to develop further the potential of space in the areas of telecommunications and meteorology;
   - to prepare a substantial contribution of space and ground techniques to Earth observation sciences and applications and, if so required, prepare for the setting-up of operational systems and of user-oriented organisations to operate them;
   - to improve the competitiveness of European industry in applications areas by means of advanced development of space systems and technology;
   - to promote, via a substantial microgravity research programme (e.g. materials sciences, life sciences and fluid physics), practical applications in space;
   - to strengthen the European space transportation capability, meeting foreseeable future user requirements both inside and outside Europe, and remaining competitive with space transportation systems that exist or are planned elsewhere;
   - to prepare autonomous European facilities for the support of man in space, for the transport of equipment and crews and for making use of low earth orbits;
   - to enhance international cooperation and in particular aim at a partnership with the United States through a significant participation in an international Space Station;

2. NOTES the advent of new space capabilities and new techniques and the emergence of further promising applications;

3. CONSIDERS that an additional effort is needed to ensure that Europe keeps up with other space powers beyond the year 2000 and to ensure that Europe is capable of all space applications;

4. APPROVES the objective of reinforcing the current European capability in order to achieve as far as possible by the end of this century the capability needed for access to and return from space for manned missions and for servicing payloads, and in order to provide for men living and working in space; NOTES the importance of continuing studies and technology programmes concerning future European space transportation systems which will take into account studies carried out *in* Member States nationally and concerning the expansion of the European In-Orbit Infrastructure in order to render it fully autonomous;

la poursuite de programmes d'étude et de technologie portant d'une part sur les futurs systèmes européens de transport spatial, qui tiendront compte des études effectuées au plan national dans les Etats membres, et d'autre part sur l'expansion de l'infrastructure orbitale européenne pour la rendre pleinement autonome.

5. *ESTIME important que l'Europe soit capable d'exploiter les nouvelles perspectives de la science et des applications dans l'espace, d'acquérir de nouvelles connaissances dans le domaine de la science et de la haute technologie, de rester compétitive sur de nouveaux marchés et de s'affirmer encore davantage comme partenaire valable dans la coopération internationale pour l'exploration et l'utilisation de l'espace.*

6. *VOIT dans ces efforts une source de possibilités nouvelles pour le secteur privé qui devrait être incité à utiliser le potentiel disponible, à participer aux investissements et à prendre des responsabilités en matière d'exploitation. SE FELICITE que le Directeur général poursuive activement les études portant notamment sur la possibilité d'associer le secteur privé au financement du satellite de relais de données.*

II. Plan spatial européen à long terme

COMPTE TENU des objectifs susmentionnés,

1. *ACCUEILLE FAVORABLEMENT la proposition du Directeur général concernant le plan spatial européen à long terme visée au préambule;*

   l'ENTERINE comme cadre stratégique et comme base pour les décisions successives concernant les activités et programmes spatiaux de l'Europe jusqu'à la fin du siècle, en prenant en considération les contraintes budgétaires des Etats membres;

   SOULIGNE que tous les éléments de ce plan contribuent à sa cohérence et sont importants pour atteindre les objectifs susmentionnés.

2. *CONSIDERE que la réalisation des programmes exige également un renforcement du rôle de l'Agence en tant qu'autorité chargée de la coordination, de la stratégie et de l'exécution, en ce qui concerne notamment la sécurité, la cohérence et l'application de ses procédures contractuelles et de sa politique industrielle lorsque les programmes sont gérés à l'extérieur.*

3. *PREND NOTE de la proposition du Directeur général visant à étudier la modification du Règlement financier compte dûment tenu de la tendance accrue à l'utilisation de l'ECU sur le marché monétaire et de présenter les résultats à l'examen du Conseil.*

4. *INVITE le Directeur général*
   - *à identifier chaque fois que cela est possible des sources potentielles de financement des programmes dans le secteur privé,*
   - *à considérer, lorsqu'un financement anticipé du secteur privé n'est pas possible, les moyens d'une implication de l'industrie et des utilisateurs dans les décisions sur la conception et le calendrier,*
   - *à rechercher, en l'absence de tout financement de source privée, si les utilisateurs sont prêts à prendre en charge les coûts d'exploitation ou de fonctionnement à l'issue du développement,*
   - *à établir projet par projet des étapes dans lesquelles seraient spécifiquement mentionnés les cas d'accroissement de la participation existante du secteur privé.*

III. Programmes*

CONSIDERANT les progrès accomplis dans les programmes préparatoires liés à l'infrastructure orbitale européenne comprenant Ariane-5, Hermès et Columbus,

* *Tous les chiffres sont exprimés aux conditions économiques de 1986*

CONSIDERANT l'état d'avancement du programme préparatoire d'un système de satellites de relais de données,

CONSIDERANT les propositions de programmes relatives aux phases de développement d'Ariane-5, de Columbus et d'Hermès, et prenant dûment en compte les différentes conditions de leur mise en oeuvre,

CONSIDERANT la volonté d'utiliser pleinement cette infrastructure par la mise en route et le soutien de programmes utilisateurs dans les domaines des sciences et des applications,

A. Transport spatial et infrastructure orbitale

1. *MARQUE son accord de principe sur la mise en route des programmes facultatifs suivants:*
   - *le programme de développement Ariane-5,*
   - *le programme de développement Columbus,*
   - *le programme de développement Hermès,*
   - *le programme de développement de satellites de relais de données (DRS) en tant qu'élément de soutien de base de l'infrastructure orbitale, commençant en 1989.*

2. *VU les articles V.1.b. et XI.5.c. de la Convention et son Annexe III,*

   a) *APPROUVE l'exécution dans le cadre de l'Agence du programme de développement du lanceur Ariane-5 à compter du 1er janvier 1988 sur la base de la proposition de programme visée ci-dessus; NOTE que le coût de ce programme est estimé à 3496 MUC, y compris trois vols de qualification;*

   b) *APPROUVE l'exécution dans le cadre de l'Agence du programme de développement Columbus selon un déroulement en phases, à compter du 1er janvier 1988, sur la base de la proposition de programme visée ci-dessus et dans les conditions suivantes:*

5. SEES it as important for Europe to be able to respond to new scientific and applications prospects of space, to acquire new scientific and high technology knowledge and to be able to remain competitive in new markets and to increase its ability as a valuable partner in international cooperation in exploring and making use of space;

6. SEES these efforts as a source of new opportunities offered to the private sector, which should be encouraged to make use of the available capacity, participate in the investment and take over operating responsibilities; WELCOMES the fact that the Director General is actively pursuing in particular the studies on the possibility of the private sector taking part in the funding of Data Relay Satellite.

II. European Long-Term Space Plan
TAKING INTO ACCOUNT the above-mentioned objectives,

1. WELCOMES the Director General's proposal on the European Long-Term Space Plan referred to in the preamble;

   ENDORSES it as the strategic framework and as the basis for the successive decisions regarding Europe's space activities and programmes up to the end of this century, taking into account budgetary constraints of the Member States;

   UNDERLINES that all the elements of this plan contribute to its coherence and are important for reaching the above-mentioned objectives;

2. CONSIDERS that the carrying out of the programmes also requires a reinforcement of the Agency's role as a coordinating, strategic and executive authority, especially in relation to safety, coherence and the implementation of Agency contract procedures and industrial policy when programmes are managed externally;

3. NOTES the Director General's proposal to study the modification of the Financial Regulations with due consideration to the growing tendency towards the use of the ECU on the monetary market and to present the results for examination by the Council;

4. INVITES the Director General
   - to identify potential private sector funding sources for programmes whenever possible,
   - where early private sector funding is not possible, to consider means of industrial and user involvement in design and timing decisions,
   - where no private sector money is involved, to identify whether users are prepared to take over operational or recurring cost following development,
   - to set milestones project-by-project where the case for increasing the existing private sector involvement would be specifically addressed.

III. Programmes*
CONSIDERING the progress achieved in the preparatory programmes related to the European In-Orbit Infrastructure encompassing Ariane-5, Hermes and Columbus,

CONSIDERING the status of the preparatory programme for a Data Relay Satellite system,

CONSIDERING the programme proposals for the development phases of the Ariane-5, Columbus and Hermes programmes and taking due account of their different conditions of implementation,

CONSIDERING the will to make full use of such an infrastructure by undertaking and supporting users' scientific and applications programmes,

A. Space Transportation and In-Orbit Infrastructure

1. EXPRESSES its agreement in principle with the undertaking of the following optional programmes:
   - the Ariane-5 development programme,
   - the Columbus development programme,
   - the Hermes development programme,
   - the Data Relay Satellite (DRS) programme, as a basic supporting element of the space infrastructure, starting in 1989.

2. HAVING REGARD to Articles V.1.b. and XI.5.c. of the Convention and Annex III thereof,

   a) APPROVES the execution within the Agency of the Ariane-5 launcher development programme starting on 1 January 1988 on the basis of the programme proposal referred to above; NOTES that the cost of this programme is estimated at 3496 MAU, including three qualification flights;

   b) APPROVES the execution within the Agency of the Columbus development programme according to a phased approach, starting on 1 January 1988 on the basis of the programme proposal referred to above and under the following conditions:
      - the overall cost of this programme as proposed is estimated at 3713 MAU, including the cost of launching the Columbus elements and of the Columbus utilisation preparation;
      - Phase 1 of this programme shall consist of a three year period of initial development within a financial sub-envelope of 669 MAU at the end of which the results of Phase 1 will be reviewed to determine whether the programme objectives can be attained within the overall financial envelope mentioned above and in conformity with the Resolution ESA/C-M/LXXX/Res. 2, taking into account the results of the

* All figures are expressed at 1986 economic conditions

– *le coût global de ce programme, tel que proposé, est estimé à 3713 MUC, y compris le coût du lancement des éléments de Columbus et de la préparation de l'utilisation de Columbus;*
– *la phase 1 de ce programme consistera en une période de développement initial d'une durée de trois ans dans les limites d'une sous-enveloppe financière de 669 MUC, à l'issue de laquelle les résultats de la phase 1 seront examinés pour déterminer si les objectifs du programme peuvent être atteints à l'intérieur de l'enveloppe financière globale mentionnée ci-dessus et en conformité avec la Résolution ESA/C-M/LXXX/Rés. 2, compte tenu du résultat des négociations avec les Etats-Unis; la décision d'entreprendre la phase 2 portant sur les travaux de développement complet sera prise avant la fin de cette période de trois ans par les Etats participants, conformément aux dispositions de l'Article II.2 de l'Annexe III de la Convention, étant entendu que les dispositions de l'Article III.1 de cette Annexe s'appliqueront en cas de dépassement de coût;*
– *tout en soulignant le caractère souhaitable de la mission polaire, des études seront entreprises au cours de la phase 1 afin d'obtenir un co-financement par les utilisateurs ou par le secteur privé du matériel de vol et de son exploitation, et afin d'étudier des variantes de conception permettant d'atteindre les objectifs de mission avec un bon rapport coût/efficacité;*

c) *APPROUVE l'exécution dans le cadre de l'Agence du programme de développement Hermès selon un déroulement en phases, à compter du 1er janvier 1988, sur la base de la proposition de programme visée ci-dessus et dans les conditions suivantes:*
– *le coût global de ce programme est estimé à 4429,4 MUC, y compris deux vols de qualification;*
– *la phase 1 de ce programme consistera en une période de développement initial d'une durée de trois ans dans les limites d'une sous-enveloppe financière de 530 MUC, à l'issue de laquelle les résultats de la phase 1 seront examinés pour déterminer si les objectifs du programme peuvent être atteints à l'intérieur de l'enveloppe financière globale mentionnée ci-dessus; la décision d'entreprendre la phase 2 portant sur les travaux de développement complet sera prise avant la fin de cette période de trois ans par les Etats participants, conformément aux dispositions de l'Article II.2 de l'Annexe III de la Convention, étant entendu que les dispositions de l'Article III.1 de cette Annexe s'appliqueront en cas de dépassement de coût.*

3. *SOULIGNE qu'il est particulièrement important de mettre en place des mécanismes qui assurent une pleine information et un strict contrôle sur l'avancement technique, la situation du calendrier, l'évolution des coûts et les engagements financiers annuels des Etats participants aux programmes de développement susmentionnés.*

4. *SE FELICITE des déclarations faites par les Délégations à la présente réunion du Conseil annonçant leur participation aux programmes visés au point A.1.a) ci-dessus selon les barèmes de contributions figurant au tableau 1 ci-joint; PREND NOTE des Déclarations faites par les délégations au cours de la réunion du Conseil concernant les questions sur lesquelles elles souhaitent recevoir des assurances avant de participer au programme; INVITE tous les Etats membres à faire connaître leurs vues définitives sur les Déclarations correspondantes avant le 31 décembre 1987.*

5. *SOULIGNE qu'il est important d'obtenir des Etats membres une indication officielle de leur position concernant leur participation à ces programmes de développement sans attendre l'expiration du délai prévu à l'Article 1, para. 2 de l'Annexe III de la Convention.*

6. *INVITE le Directeur général à continuer d'affiner les études des coûts d'exploitation de l'infrastructure orbitale actuellement estimés dans le plan spatial européen à long terme à 800 MUC par an pour la période 1998–2000, et à poursuivre la préparation de l'exploitation et de l'utilisation de cette infrastructure orbitale, y compris la question de son financement et de sa gestion, en vue d'une décision ultérieure.*

B. Infrastructure au sol

1. *CONVIENT que l'exécution du programme spatial européen à long terme nécessite une infrastructure au sol appropriée et une coordination plus étroite entre les activités de l'Agence et celles des Etats membres.*

2. *PREND NOTE de l'accord* auquel est parvenu le Conseil sur les propositions du Directeur général relatives à la mise sur pied d'une infrastructure au sol appropriée faisant le plus large usage des installations existantes, l'Agence conservant l'autorité d'ensemble sur la conception, l'approvisionnement et la gestion.*

C. Programmes utilisateurs

1. *Se félicitant des progrès réalisés à ce jour, ACCUEILLE FAVORABLEMENT, et DONNE SON AVAL A, la poursuite des activités et programmes de l'Agence dans les domaines suivants:*
   – *observation de la Terre, axée sur le projet ERS-1 déjà approuvé et la*

* *Cf. ESA/C/LXXIX/Rés. 1 du 5 novembre 1987*

negotiations with the United States; the decision to embark on Phase 2 related to full development work shall be taken before the end of this three-year period by the Participating States in accordance with the provisions of Article II.2 of Annex III of the Convention, it being understood that the stipulations of Article III.1 of this Annex will apply in case of a cost overrun;
- while stressing the desirability in principle of the Polar Mission, studies will be undertaken at the beginning of Phase 1 with the aim of securing user or private sector co-funding for the flight hardware and its operations and to evaluate modified design approaches for ensuring the mission objectives in a cost-effective manner;

c) APPROVES the execution within the Agency of the Hermes development programme according to a phased approach, starting on 1 January 1988 on the basis of the programme proposal referred to above and under the following conditions:
- the overall cost of this programme is estimated at 4429.4 MAU, including two qualification flights;
- Phase 1 of this programme shall consist of a three year period of initial development within a financial sub-envelope of 530 MAU, at the end of which the results of Phase 1 will be reviewed to determine whether the programme objectives can be attained within the overall financial envelope mentioned above; the decision to embark on Phase 2 related to full development work shall be taken before the end of this three-year period by the Participating States in accordance with the provisions of Article II.2 of Annex III of the Convention, it being understood that the stipulations of Article III.1 of this Annex will apply in the case of a cost overrun;

3. STRESSES the particular importance of implementing mechanisms ensuring full information and strict control on technical progress, schedule situation, cost development and annual financial commitments of Participating States to the above-mentioned development programmes;

4. EXPRESSES its satisfaction with the statements made by Delegations in the present Council meeting declaring their participation in the programmes referred to in A.1 a) above together with the scale of contributions reflected in Table 1 attached hereto; TAKES NOTE of the statements by the Delegations during the Council meeting on matters on which they would need to be assured before participating in the programmes; INVITES all Member States to make their definitive views known on acceptance of the corresponding Declarations before 31 December 1987;

5. STRESSES the importance of obtaining from Member States a formal indication of their position regarding participation in these development programmes, without waiting for the expiry of the time limit provided for in Article 1, paragraph 2 to Annex III to the Convention;

6. INVITES the Director General to continue to refine the studies of the operating costs of the In-Orbit Infrastructure, which are currently estimated in the European Long-Term Space Plan at 800 MAU per year over the period 1998–2000, and to pursue the preparation of the operation and utilisation of this In-Orbit Infrastructure, including the question of its funding and management, with a view to a decision later.

B. Ground Infrastructure

1. AGREES that carrying out the European Long-Term Space Programme requires an appropriate ground infrastructure and closer coordination between the Agency's activities and those of Member States;

2. NOTES the agreement* reached by Council on the Director General's proposals on setting up an appropriate ground infrastructure making maximum use of existing facilities, with the Agency retaining the overall design, procurement and management authority.

C. Users' Programmes

1. Appreciating the progress achieved so far, WELCOMES and ENDORSES the pursuance of the Agency's activities and programmes in the fields of:
   - Earth observation, centred around the ERS-1 project already agreed and the proposal for an ERS-2 programme, the continuation of research and development work on a new generation of meteorological satellites, and preparation for the development of a Solid Earth Mission and of the Earth observation payloads for the Polar Platform;
   - microgravity, with the expansion of microgravity activities in space, centred around an enhanced programme of utilisation of Spacelab, Eureca and new elements of the space transportation and In-Orbit Infrastructure;
   - space telecommunications, with the undertaking of the Payload and Spacecraft Development and Experimentation (PSDE) programme and the continuation of an advanced systems and technology programme;

2. ENDORSES the decision to carry out the long-term scientific programme on

* ESA/C/LXXIX/Res. 1, dated 5 November 1987

proposition de programme ERS-2, la poursuite des travaux de recherche et de développement portant sur une nouvelle génération de satellites météorologiques, et la préparation du développement d'une mission de physique du globe solide et de charges utiles d'observation de la Terre pour la plate-forme polaire;
- *microgravité, axée, avec l'extension des activités de recherche en microgravité dans l'espace, sur une utilisation poussée du Spacelab, d'Eureca et de nouveaux éléments de transport spatial et d'infrastructure orbitale;*
- *télécommunications spatiales, avec le démarrage du programme de développement et d'expérimentation de charges utiles et de véhicules spatiaux (PSDE) et la poursuite d'un programme de systèmes et de technologies de pointe.*

2. *FAIT SIENNE la décision d'exécuter le programme scientifique à long terme sur la base du programme 'Horizon 2000', et d'entreprendre à titre de première étape le programme sur la Physique des relations Soleil–Terre.*

RAPPELANT qu'il avait décidé, pour renforcer au cours de la prochaine décennie les activités de science spatiale en Europe, d'augmenter progressivement le niveau de financement du programme scientifique obligatoire pour atteindre 177 MUC en 1989, CONVIENT d'augmenter progressivement le budget du programme scientifique pour atteindre un niveau de 216,7 MUC à la fin de la période couverte par le prochain niveau de ressources (1992).*

D. Budget général

RAPPELANT qu'il avait décidé que l'accroissement du budget général devait aboutir à un niveau de contributions de 98 MUC par an en 1989,

1. *CONVIENT que l'accroissement du budget général nécessaire compte tenu de l'expansion prévue du volume des activités de l'Agence conduira progressivement à un niveau de contributions de 112,6 MUC par an en 1992; cette augmentation sera affectée par priorité à la technologie, tout en prenant en compte les investissements nécessaires dans les établissements de l'ESA;*

2. *DEMANDE au Directeur général de présenter au Conseil sa proposition de niveau de ressources pour la période 1988–1992 établie en conséquence.*

IV. Politique industrielle

1. *SOULIGNE que la politique industrielle de l'Agence, conformément aux objectifs définis à l'Article VII et dans l'Annexe V de la Convention, vise en particulier:*
   - *à répondre aux besoins du programme spatial européen et des programmes spatiaux nationaux coordonnés d'une manière économiquement efficiente,*
   - *à améliorer la compétitivité de l'industrie européenne dans le monde,*
   - *à améliorer le niveau technologique et le potentiel industriel de tous les Etats membres en matière spatiale, ceux-ci se voyant offrir le maximum de possibilités de participer aux travaux d'intérêt technologique entrepris pour le compte de l'Agence,*
   - *à bénéficier des avantages de l'appel à la concurrence, sauf lorsque cela est incompatible avec les autres objectifs définis de la politique industrielle.*

2. *RAPPELANT l'objectif de la répartition des contrats visé à l'Annexe V de la Convention, qui est d'atteindre un coefficient de retour global aussi proche que possible de la valeur idéale de 1 pour tous les pays,*

   REAFFIRME que cet objectif doit être atteint sur la base de l'ensemble des programmes de l'Agence, et

   RECOMMANDE que l'objectif d'un coefficient de retour global atteignant la valeur idéale de 1 soit dûment pris en considération lors de l'attribution des contrats.

3. *RECONNAISSANT que cet objectif ne pourra à l'avenir être atteint sans un retour géographique appréciable dans le cadre de chaque programme facultatif pour chaque Etat participant,*

   RECOMMANDE que soit garanti dans chaque programme facultatif un coefficient de retour supérieur à 0,9 pour tous les Etats participants, la marge de flexibilité subsistante étant laissée à la disposition du Directeur général pour qu'il assure, conformément aux règles et procédures en vigueur à l'Agence, le retour global susmentionné; et, en conséquence,

   INVITE les Etats participants aux grands programmes facultatifs, et en particulier aux programmes de développement Ariane-5, Columbus et Hermès, à insérer, dans les Déclarations pertinentes, des dispositions types complétant les procédures décrites dans la présente Résolution et comprenant, dans les limites de la marge de flexibilité, des mesures de compensation a priori en faveur des Etats dont les industries n'assument ni responsabilité de maîtrice d'oeuvre ni responsabilité majeure pour une partie notable du programme, et prévoyant un réexamen de la répartition géographique des travaux lorsque la structure industrielle sera clairement définie ou, au plus tard, après 24 mois, examen dont les conclusions amèneront à redresser la situation par une redistribution des travaux, ou bien par une révision des barèmes de contributions; cet examen sera

* *Le chiffre de 216,7 MUC correspond à une augmentation annuelle de 5%.*

the basis of the 'Horizon 2000' programme, and as a first step to undertaking the Solar Terrestrial Science Programme.

RECALLING that it agreed, in order to reinforce space science activities in Europe over the next decade, progressively to increase the level of funding of the mandatory science programme to reach 177 MAU by 1989, AGREES progressively to increase the science programme budget to reach a level of 216.7* MAU at the end of the next period of the level of resources (1992).

D. General Budget

RECALLING that it agreed that the rise in the general budget shall lead to a level of contributions of 98 MAU per year by 1989,

1. AGREES that the rise in the general budget needed in view of the foreseen expansion in the volume of the Agency's activities will progressively lead to a level of contributions of 112.6 MAU per year by 1992; this increase will be assigned, by priority, to technology, while giving due consideration to necessary investments in ESA establishments;

2. REQUESTS the Director General to submit to Council his proposal for the 1988–1992 level of resources accordingly.

IV. Industrial Policy

1. STRESSES that the Agency's industrial policy, in line with the objectives defined in Article VII of the Convention and its Annex V, shall aim in particular to:

   - meet the requirements of the European space programme and the coordinated national space programmes in a cost-effective manner,
   - improve the worldwide competitiveness of European industry,
   - improve the technological level and industrial capacity related to the space field of all Member States, who shall be given maximum opportunity to participate in the work of technological interest undertaken for the Agency,
   - exploit the advantage of free competitive bidding, except when this is incompatible with other defined objectives of industrial policy.

2. RECALLING the objective in distributing contracts, referred to in Annex V to the Convention, of reaching an overall return coefficient as near as possible to the ideal value of 1 for all countries,

   REAFFIRMS that this must be achieved on the basis of all the Agency's programmes, and

   RECOMMENDS that due consideration be paid to the objective of reaching the ideal value of 1 for the overall return coefficient when awarding the contracts.

3. RECOGNISING that this objective cannot in future be achieved without a significant geographical return for each participating State in each optional programme,

   RECOMMENDS that a return coefficient above 0.9 within each optional programme be guaranteed for all Participating States, the resulting flexibility being at the Director General's disposal to ensure, in accordance with the applicable rules and procedures of the Agency, the achievement of that overall return mentioned above; and therefore

   INVITES the States participating in major optional programmes, and in particular the Ariane-5, Columbus and Hermes development programmes, to insert in the relevant Declarations a standard clause to complement the procedures described in the present Resolution, including, within the limits of flexibility, anticipatory compensation measures in favour of States whose industries do not assume prime-contractor responsibilities or major responsibility for a significant part of the programme, and providing for a review of the geographical distribution of work once the industrial structure is clearly defined or, at the latest, after 24 months, the conclusion of which will lead to a correction of the situation through a redistribution of work, otherwise through revision of the contribution scale; this review will be conducted subject to negotiations with the Participating States concerned in order to determine how a better work distribution over all the programmes could as far as possible prevent a revision of the contribution scales,

4. REQUESTS the Director General to ensure that the industrial participation of the Member States in the science programme contributes to achieving the ideal value of 1 for the overall return coefficient,

5. TAKES NOTE of the results of the measures that have been implemented during the last three-year period (1985–1987) in order to bring the overall return coefficients of all States above 0.95 by the end of 1987,

   INVITES the Director General to pursue these efforts to absorb the imbalances of the geographical distribution of contracts resulting from the past; and

   DECIDES that the initial scale of contributions of the In-Orbit Infrastructure optional programmes Ariane-5, Columbus and Hermes shall reflect specific measures to be applied during the first three-year period (1988–1990), to compensate for the imbalances recorded at the end of 1987 and defined by the amounts required at that time to bring each return coefficient to 1,

* The 216.7 MAU corresponds to a yearly increase of 5%.

effectué sous réserve de négociations avec les Etats participants en cause pour déterminer comment une meilleure répartition des travaux sur tous les programmes pourrait autant que possible éviter une révision des barèmes de contributions.

4. *DEMANDE au Directeur général de veiller à ce que la participation industrielle des Etats membres au programme scientifique contribue à la réalisation de l'objectif qui est d'atteindre la valeur idéale de 1 pour le coefficient de retour global.*

5. *PREND NOTE des résultats des mesures appliquées au cours de la dernière période triennale (1985–1987) pour porter les coefficients de retour globaux de tous les Etats à plus de 0,95 d'ici la fin de 1987;*

INVITE le Directeur général à poursuivre ces efforts pour résorber les déséquilibres de la répartition géographique des contrats résultant du passé; et

DECIDE que le barème initial de contributions aux programmes facultatifs d'infrastructure orbitale Ariane-5, Columbus et Hermès tiendra compte des mesures spécifiques qui seront appliquées au cours de la première période triennale (1988–1990) pour compenser les déséquilibres enregistrés à la fin de 1987 et définis par les montants nécessaires à cette date pour porter chaque coefficient de retour à 1.

6. *DONNE SON AVAL aux décisions concernant les coefficients de pondération des services de lancement prises à la réunion du Conseil des 22 et 23 juin 1987.*

7. *DEMANDE au Directeur général de prendre les mesures nécessaires pour porter les coefficients de retour cumulés de tous les Etats à plus de 0,95 d'ici la fin de 1990;*

ACCEPTE DE CONSIDERER que pour la période suivante (1991–1993), la limite inférieure visée à l'Article IV, para. 6 de l'Annexe V de la Convention, au-dessous de laquelle des mesures spéciales doivent être prises, soit fixée au minimum à 0,96.

8. *RAPPELANT la nécessité de procéder tous les trois ans à des examens formels de la répartition géographique des contrats, comme le prévoient l'Article IV, para. 5 et l'Article V de l'Annexe V de la Convention, le prochain examen étant fixé au début de 1988 comme l'avait décidé le Conseil siégeant au niveau ministériel à Rome;*

DEMANDE au Directeur général de soumettre au Comité de la Politique industrielle des propositions de mesures correctives si, à l'occasion de l'un des examens formels, le coefficient de retour global d'un Etat se situe au-dessous de 0,95. Ces propositions pourraient concerner la répartition des travaux (clause de préférence, redéfinition de la structure industrielle) ou, si ces mesures ne suffisaient pas à atteindre les objectifs fixés, une révision des barèmes de contributions aux programmes facultatifs.

9. *RAPPELANT les principes directeurs de la politique industrielle de l'Agence visés plus haut, en particulier l'objectif d'une répartition géographique équitable des contrats, ainsi que la nécessité de prendre en compte la qualité du retour industriel,*

PRENANT NOTE du fait que l'un des principaux résultats de la politique spatiale européenne commune est le développement d'industries et de laboratoires employant directement quelque 35 000 personnes,

RECOMMANDE, en vue d'améliorer la compétitivité de l'industrie spatiale européenne et d'accroître sa part du marché commercial mondial, qu'un maximum de concurrence entre firmes européennes soit assurée aux différents niveaux de responsabilité dans le cadre des programmes de l'Agence, sauf lorsque d'autres objectifs de politique industrielle prévaudront.

Tableau 1

Les Délégations ont marqué leur intention de participer aux programmes de développement Ariane-5, Columbus et Hermès et à souscrire aux Déclarations correspondantes selon les barèmes suivants (en pourcentage):

Etats	Ariane-5	Columbus	Hermès
Allemagne	22,0	38,0	30,0
Autriche	0,4	–	0,5
Belgique	6,0	5,0	6,4
Danemark	0,5	1,0	0,5
Espagne	3,0	6,0	5,0
France	45,0	13,8	45,0
Irlande	0,2	–	–
Italie	15,0	25,0	12,0 – 15,0
Norvège	0,4	0,4	–
Pays-Bas	2,0 – 2,5	1,0 – 1,5	1,5 – 3,0
Royaume-Uni	–	–	–
Suède	2,0	–	–
Suisse	2,0	–	1,5
Canada	–	–	–

6. ENDORSES the decision concerning the weighting factors for launching services taken at the 78th Meeting of the Council held on 22 and 23 June 1987,

7. REQUESTS the Director General to take the necessary measures to bring the cumulative return coefficients of all States above 0.95 by the end of 1990,

   ACCEPTS TO CONSIDER that, for the following period (1991–1993), the lower limit, referred to in Article IV, paragraph 6 of Annex V to the Convention, below which special measures are to be taken, be fixed at the minimum of 0.96.

8. RECALLING the need for formal reviews of the situation of geographical distribution of contracts to take place every three years, as provided for in Article IV, paragraph 5 and Article V of Annex V to the Convention, the next such review being scheduled in early 1988, as decided by the Council meeting at Ministerial Level in Rome,

   REQUESTS the Director General to submit corrective proposals to the Industrial Policy Committee if, at one of the formal reviews, the overall return coefficient of any State is found to be below 0.95. These proposals could concern the distribution of work (preference clause, redefinition of the industrial structure) or, if such measures would not suffice to achieve the fixed objectives, a revision of the contribution scales in optional programmes.

9. RECALLING the guiding principles of the industrial policy of the Agency mentioned above, in particular the objective of a fair geographical distribution of contracts, as well as the need to take into account the quality of the industrial return,

   TAKING note that one of the main results of the common European space policy is the development of industries and laboratories employing directly about 35 000 persons,

   RECOMMENDS that, to improve the competitiveness of the European space industry and to increase its participation in the world commercial market, a maximum of competition between European firms be ensured at the various levels of responsibility within the Agency's programmes, except where other industrial policy objectives take precedence.

Table 1

The Delegations have declared their intention to participate in the Ariane-5, Columbus and Hermes development programmes and to subscribe to the corresponding Declarations as follows:

States	Ariane-5 (%)	Columbus (%)	Hermes (%)
Austria	0.4	–	0.5
Belgium	6.0	5.0	6.4
Denmark	0.5	1.0	0.5
France	45.0	13.8	45.0
Germany	22.0	38.0	30.0
Ireland	0.2	–	–
Italy	15.0	25.0	12.0 – 15.0
Netherlands	2.0 – 2.5	1.0 – 1.5	1.5 – 3.0
Norway	0.4	0.4	–
Spain	3.0	6.0	5.0
Sweden	2.0	–	–
Switzerland	2.0	–	1.5
United Kingdom	–	–	–
Canada	–	–	–

Résolution sur la participation au programme de Station spatiale

(adoptée le 10 novembre 1987)

Le Conseil, siégeant au niveau ministériel,

RAPPELANT la Résolution ESA/C-M/LXVII/Rés. 2 (Final) adoptée le 31 janvier 1985 par laquelle il accepte l'offre faite par le Président des Etats-Unis en janvier 1984, sous réserve que soient atteints les objectifs fondamentaux énoncés dans ladite Résolution, laquelle a été transmise au Président des Etats-Unis qui en a accusé réception,

RAPPELANT la lettre de l'Administration de la NASA au Directeur général, en date du 6 avril 1984,

CONSIDERANT le Mémorandum d'Accord entre la NASA et l'ESA pour la conduite d'études parallèles de définition détaillée et de conception préliminaire (phase B) conduisant à une coopération ultérieure au développement, à l'exploitation et à l'utilisation d'une Station spatiale habitée en permanence, entré en vigueur le 3 juin 1985,

CONSIDERANT les progrès réalisés dans le cadre du programme préparatoire Columbus ainsi que la proposition relative à l'exécution du programme de développement Columbus,

CONSIDERANT le rapport sur les négociations concernant, d'une part, le projet d'Accord intergouvernemental entre le Gouvernement des Etats-Unis d'Amérique, des Gouvernements membres de l'Agence spatiale européenne, le Gouvernement du Japon et le Gouvernement du Canada relatif à la coopération portant sur la conception détaillée, le développement, l'exploitation et l'utilisation de la Station spatiale habitée en permanence et, d'autre part, le projet de Mémorandum d'Accord entre la NASA et l'ESA pour la mise en oeuvre dudit Accord intergouvernemental,

VU son accord pour que soit entrepris le programme de développement Columbus (ESA/C-M/LXXX/Rés. 1 – Chapitre III),

CONSIDERANT que la Déclaration sur le programme de développement Columbus a été établie dans l'hypothèse que les négociations s'achèveront de manière satisfaisante et en vue de servir de cadre au développement de la contribution de l'Europe au complexe de Station spatiale internationale,

CONSIDERANT que les progrès accomplis au cours des négociations n'ont pas encore permis la présentation de projets d'Accord intergovernemental et de Mémorandum d'Accord complets et satisfaisants et que des questions de fond essentielles restent à résoudre,

I. CONFIRME son intérêt pour une participation avec les Etats-Unis à la Station spatiale internationale sous réserve que, à la lumière de la Résolution ESA/C-M/LXVII/Rés. 2 du 31 janvier 1985, soient au minimum remplies les conditions fondamentales suivantes:

1. que la responsabilité de l'ESA pour la conception, le développement, l'exploitation et l'utilisation des éléments que l'Europe fournira soit reconnue dans l'Accord intergouvernemental et le Mémorandum d'Accord, tout en acceptant que la NASA assure la coordination et la direction d'ensemble de programme pour la base habitée, l'ESA conservera l'entier contrôle de la conception, du développement, de l'exploitation et de l'utilisation du module autonome visitable et de la plate-forme polaire européenne, tout en respectant la documentation technique d'interface convenue entre la NASA et l'ESA et les contraintes de sécurité d'ensemble de la Station spatiale;

2. qu'une solution satisfaisante, dans la ligne de la Convention de l'ESA, soit trouvée au problème soulevé par le fait que les Etats-Unis exigent que les autres Partenaires leur reconnaissent le droit d'interpréter la notion de fins pacifiques pour l'utilisation par eux-même des éléments qu'ils auront fournis, alors que les dispositions du présent projet d'Accord intergouvernemental concernant le caractère civil et les objectifs pacifiques de la Station spatiale ainsi que le droit de chaque Partenaire de définir l'application de ces dispositions à ses propres éléments sont considérées comme adéquates et que leur substance ne doit pas être compromise;

3. que soient établies des dispositions adéquates pour le règlement des différends concernant, le cas échéant, l'interprétation ou la mise en oeuvre de l'Accord intergouvernemental ou du Mémorandum d'Accord;

4. que soit établi un régime juridique sauvegardant les intérêts des Etats participants et des utilisateurs européens.

II. CONVIENT, au cas où les négociations ne permettraient pas de satisfaire aux conditions énoncées ci-dessus dans un délai compatible avec le programme de développement Columbus,

voir suite

Resolution on Participation in the Space Station Programme

(adopted on 10 November 1987)

The Council, meeting at Ministerial Level,

RECALLING the Resolution ESA/C-M/LXVII/Res. 2 (Final) adopted on 31 January 1985 by which it accepts the offer made by the President of the United States in January 1984, subject to the achievement of fundamental objectives listed in that Resolution, and which was transmitted to and acknowledged by the President of the United States,

RECALLING the NASA Administrator's letter of 6 April 1984 to the Director General,

CONSIDERING the Memorandum of Understanding between NASA and ESA for the conduct of parallel detailed definition and preliminary design studies (Phase B) leading toward further cooperation in the development, operation and utilisation of a permanently manned Space Station which entered into force on 3 June 1985,

CONSIDERING the progress achieved within the framework of the Columbus Preparatory Programme as well as the proposal for undertaking the Columbus development programme,

CONSIDERING the report on the negotiations of the draft Intergovernmental Agreement between the Government of the United States of America, Government Members of the European Space Agency, the Government of Japan and the Government of Canada on cooperation in the detailed design, development, operation and utilisation of the permanently manned Space Station and on the draft Memorandum of Understanding between NASA and ESA for the implementation of the said Intergovernmental Agreement,

HAVING REGARD to its agreement with undertaking the Columbus development programme (ESA/C-M/LXXX/Res. 1 Chapter III),

CONSIDERING that the Declaration on the Columbus development programme has been drawn up on the assumption that a satisfactory completion of the negotiations will be reached and with a view to forming the framework for the development of Europe's contribution to the international Space Station complex,

CONSIDERING that the progress made during the negotiations has not yet allowed the presentation of a complete and satisfactory draft Intergovernmental Agreement and Memorandum of Understanding and that essential issues remain to be resolved,

I. CONFIRMS its interest in participating with the United States in the international Space Station, provided that in the light of Resolution ESA/C-M/LXVII/Res. 2 of 31 January 1985, as a minimum the following essentials are met:

1. that the responsibility of ESA in the design, development, operation and utilisation of the elements Europe will provide be recognised in the Intergovernmental Agreement and the Memorandum of Understanding, while accepting NASA's overall programme co-ordination and direction regarding the manned base. ESA will remain in full control of the design, development, operation and utilisation of the Man-Tended Free Flyer and of the European Polar Platform while respecting jointly agreed NASA/ESA technical interface documentation and overall Space Station safety requirements;

2. that, whereas the present draft Intergovernmental Agreement's provisions concerning the civil nature and the peaceful purposes of the Space Station and each Partner's right to determine the application of these provisions to its elements are considered adequate and their substance must not be compromised, a satisfactory solution in line with the ESA Convention be found to the problem raised by the United States' requirement for recognition by the other Partners of the United States' right to interpret the notion of peaceful purposes in relation to the US utilisation of the elements they provide;

3. that adequate provisions be made for settlement of disputes concerning, as the case may be, the interpretation or implementation of the Intergovernmental Agreement or the Memorandum of Understanding;

4. that a legal regime safeguarding the interests of the Participating States and of European users be achieved;

II. AGREES, in the event that the negotiations do not succeed in fulfilling the above-mentioned conditions within a time frame compatible with the Columbus development programme,

– to adapt the content of the Columbus development programme referred to in Resolution ESA/C-M/LXXX/Res. 1 to the new situation, as quickly as possible and in line with the

continued overleaf

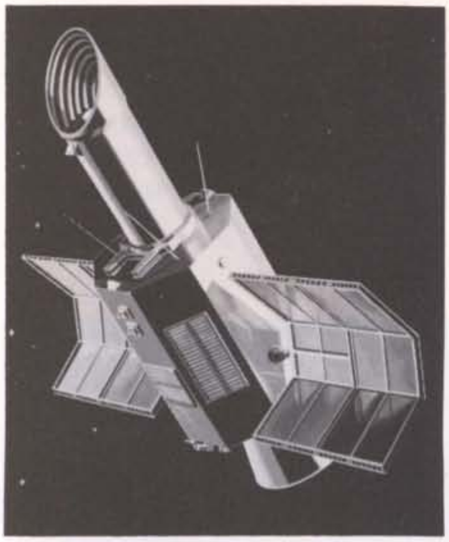
suite

- *d'adapter à la situation nouvelle, aussi rapidement que possible et dans la ligne des objectifs convenus lors de la réunion du Conseil tenue au niveau ministériel à Rome (ESA/C-M/LXVII/Rés. 1 du 31 janvier 1985), le contenu du programme de développement Columbus visé dans la Résolution ESA/C-M/LXXX/Rés. 1, tout en recherchant d'autres formes de coopération avec les Etats-Unis concernant les programmes respectifs de vols spatiaux habités;*
- *d'assurer, également dans le cas visé ci-dessus, la cohérence entre les éléments de l'infrastructure orbitale européenne, et de s'efforcer de maintenir, de façon compatible avec les engagements financiers des Etats Membres en cause, le niveau actuel de leurs responsabilités ainsi que leur participation industrielle dans le programme de développement.*

continued from previous page

objectives agreed at the Rome Ministerial Council Meeting (ESA/C-M/LXVII/Res. 1 of 31 January 1985), while seeking other forms of cooperation with the United States regarding the respective manned spaceflight programmes,

- to ensure also in this event coherence between the elements of the European In-Orbit Infrastructure and to strive to maintain, in line with the financial commitment of Member States concerned, the present level of their responsibilities and industrial involvement in the development programme.



Supernova 1987A Through the Eyes of IUE

W. Wamsteker, A. Cassatella & R. Gilmozzi,
ESA IUE Observatory, Villafranca, Spain

In this article, the ESA IUE Observatory staff working with the 'Supernova Team' describe the results obtained during the first six months of SN 1987A observations with IUE. A striking feature of these results is that SN 1987A is the first supernova bright enough to allow observations of the same high quality possible for normal stars. It has provided a number of new data which make the IUE observations all the more important, as they now constitute a rather strict test bench for stellar evolution theory.

Apart from the exciting results concerning SN 1987A itself, which are described below, these observations have provided an unprecedented set of high-quality data on the interstellar matter between the supernova and the Earth, including the gas in our Galaxy and the gas in the Large Magellanic Cloud where the supernova was located (Fig 1).

When news of the discovery of a new supernova visible with the naked eye — the first such occurrence in 383 years! — was received from the remote astronomical observatory of Las Campanas in Chile, a flurry of activity ensued at many other observing facilities around the World in an attempt to obtain unique observations.

The excitement among astronomers about the discovery of SN 1987A is easy to understand when one considers that supernovae are assumed to represent the last phase of stellar evolution, when the star's nuclear fuel is exhausted and it collapses under its own gravity. This collapse causes the interior density of the star to rise to 10^{10}g/cm^3 and its temperture to 10^8 K, leading to the initiation of rapid nuclear reactions, with spectacular consequences.
Important also was the fact that this discovery was accompanied by the first ever detection of the neutrino particles created in such a collapse. A total of 29 neutrino events were detected. Although these detections nicely confirmed theoretical predictions, there are still some difficulties in explaining the exact timing of the measurements.

There are two known types of supernova, known with typical astronomical originality as 'Type I' and 'Type II'. The Type I supernovae are associated with the total disintegration of a white dwarf star, while Type II are thought to be associated with massive stars and to result in the formation of a neutron star, which can occasionally be observed through its characteristic pulsar.

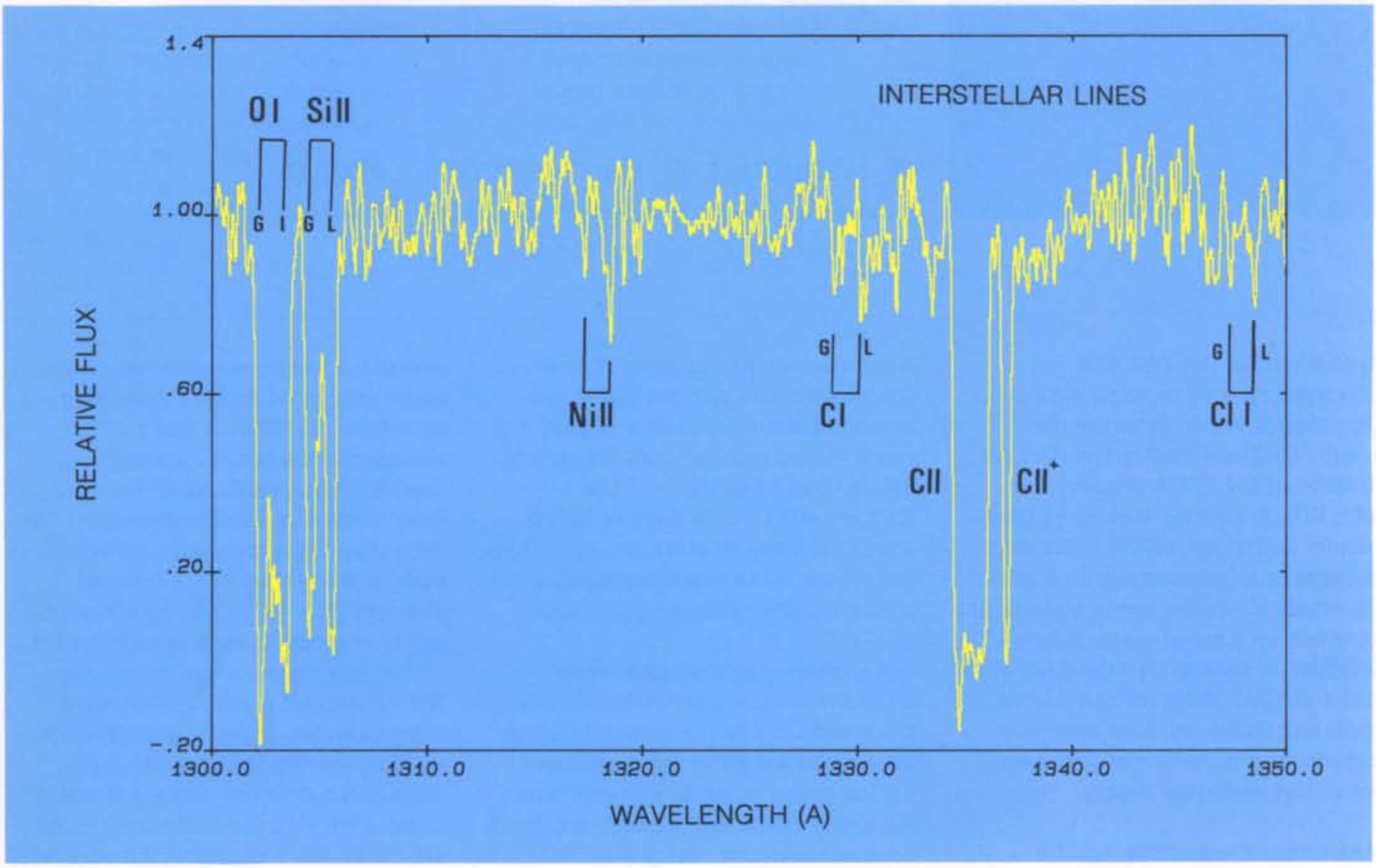
One of the instruments that has been contributing spectacularly to the study of supernova SN 1987A is ESA's International Ultraviolet Explorer (IUE) satellite. Through a Guest Observer Programme, this satellite observatory has been providing astronomers on both sides of the Atlantic with a powerful ultraviolet (1150—3200 Å) spectroscopic facility in space since its launch in 1978.

The IUE Project is a joint venture between NASA, ESA and the UK Science and Engineering Research Council (SERC). Two observatories are available to serve the scientific community: ESA's IUE Observatory located at the Agency's Villafranca del Castillo Tracking Station, near Madrid, and NASA's IUE Observatory at Goddard Space Flight Center in Greenbelt, Maryland in the USA. Observing time is distributed in the ratio one third/two thirds between the two observatories.

It was realised early in the IUE project that occurrences like the sudden appearance of SN 1987A would require a special approach to ensure the best use of the space-based facility. Teams of specialists were therefore formed in Europe, under the auspices of the IUE Project, charged with the task of planning the observations to be made and analysing the results. For the European Target-of-Opportunity Team, under the leadership of Prof. Nino Panagia, the explosion of SN 1987A was the culmination of 10 years of preparation.

Prior to the launch of IUE, our

Figure 1 — Spectrum of the interstellar medium towards SN 1987A. Components of both our Galaxy (G) and the Large Magellanic Cloud (L) can be detected. Due to the brightness of the supernova, it has been possible to detect several spectral lines usually unseen against the background of much fainter stars



knowledge about the ultraviolet spectra of supernovae was limited to the extrapolation of results obtained in the visible region of the spectrum. Many faint supernovae had already been observed with IUE prior to the SN 1987A event, sometimes with very interesting results. Some quite unexpected features had been discovered, the strong ultraviolet deficiency of Type I supernovae and the discovery of a new type of supernova, Type Ib, associated with stars more massive than white dwarfs, being two such examples.

The ESA IUE Observatory was therefore well prepared for the excitement created by Supernova 1987A (Fig 2). The normal ongoing observation programmes were interrupted for about a week to make the observations that had been carefully pre-planned by the Team for such an eventuality. The long lifetime of IUE proved especially fortunate here, because the various launcher failures that had been occurring meant that there was no possibility of a rapid launch if IUE had not still been available.

Spectral evolution in the ultraviolet
A first and most unexpected result from IUE which differentiates SN 1987A from other Type II supernovae, is its dramatic fading at ultraviolet wavelengths especially very early during the outburst. Other Type II supernovae observed previously, such as SN 1979C and SN 1980K, remained strong in the ultraviolet for several weeks after the initial outburst. Type II supernovae have in fact been found to show a wide variation in behaviour in the ultraviolet. It has been suggested that this can be explained in terms of different degrees of interaction between the supernova ejecta and the interstellar medium, i.e. the early mass-loss history of the progenitor star.

The rapid decline of SN 1987A in the ultraviolet (Fig. 3) was accompanied by a dramatic decrease in temperature. The IUE data, and simultaneous optical and infrared photometry, indicate a very rapid fall in temperature from about 13 500 K on February 25.2, to about 8800 K on February 27.4, and then to 5200 K on March 14.3. From mid-March onwards, its temperature remained almost constant at approximately 5000 K, at least until July/August 1987. One obvious consequence of these observations is the inherent confirmation that the temperature at the time of the outburst must have been high enough to produce the hard photons needed to ionise the circumstellar environment (see below also).

The IUE data are of such high quality that important progress has been possible in the interpretation of the complex ultraviolet spectra of

Figure 2 — Image of SN 1987A obtained with the Fine Error Sensor (FES) on board IUE. The FES is used both to obtain images of the sky region to be observed, and to track on a guide star during observations

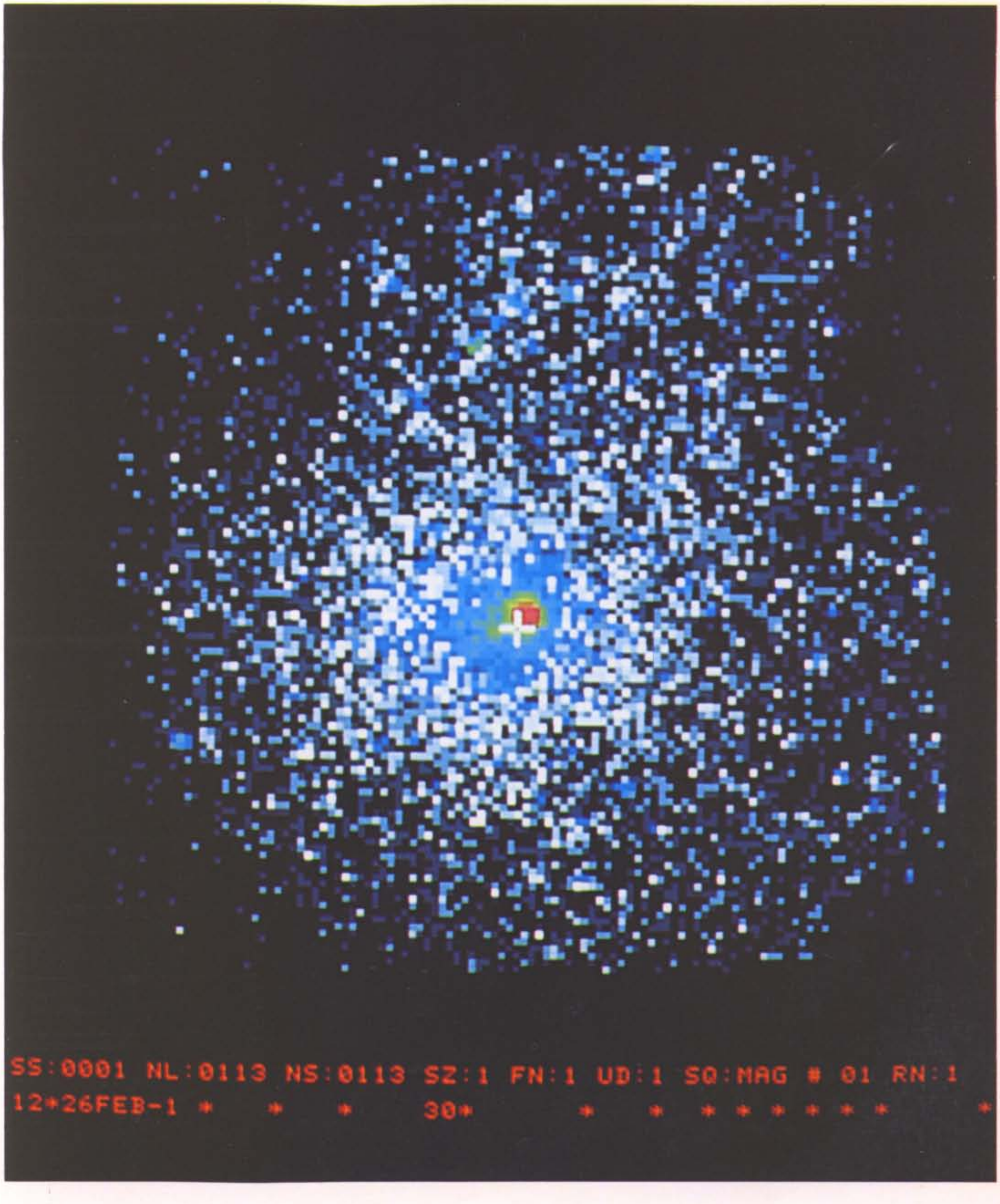
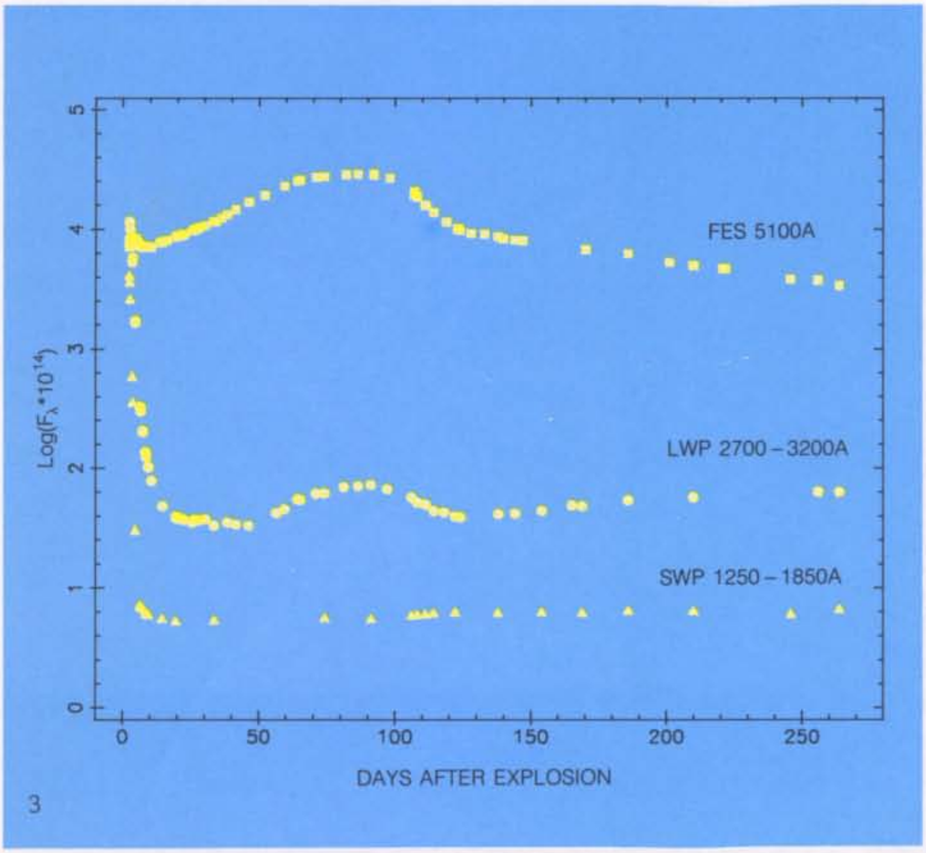


Figure 3 — Light curves of SN 1987A as measured by the IUE instruments. Note the different behaviours in the ultraviolet (SWP and LWP) and in the optical (FES), especially the initial dramatic fading (by a factor 1000) at the shortest wavelengths

Figure 4 — Bi-dimensional representation of the early time evolution of SN 1987A between 2500 and 3200 Å. The colours represent intensity levels. Note how the spectral features along the wavelength axis move towards the red (longer wavelengths) with time

Figure 5 — Light curve of the LMC supernova obtained with the Fine Error Sensor (FES), in the more usual astronomical units (magnitudes). The FES has produced the most reliable **optical** *light curve of SN 1987A*



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supernovae, which had hitherto presented something of an enigma.

The early IUE spectra obtained at Villafranca on 25 February show several very broad absorption features (20 000 —30 000 km/s wide). Their positions in wavelength are consistent with their being produced by the many resonance and low-excitation lines from doubly and singly ionised elements, especially Fe II, Fe III, Al III, etc.

Because of the expansion of the supernova's 'atmosphere', these lines are violet-shifted by about 15 000 km/s. Detailed model calculations tend to support this conclusion, but have not yet succeeded in producing a consistent model from 1200 Å all the way through to 6500 Å in the visible. The degree of ionisation decreases with time and the excited lines of Fe II become optically thick with time.

Particularly strong Fe II lines are easily recognisable in the spectra below about

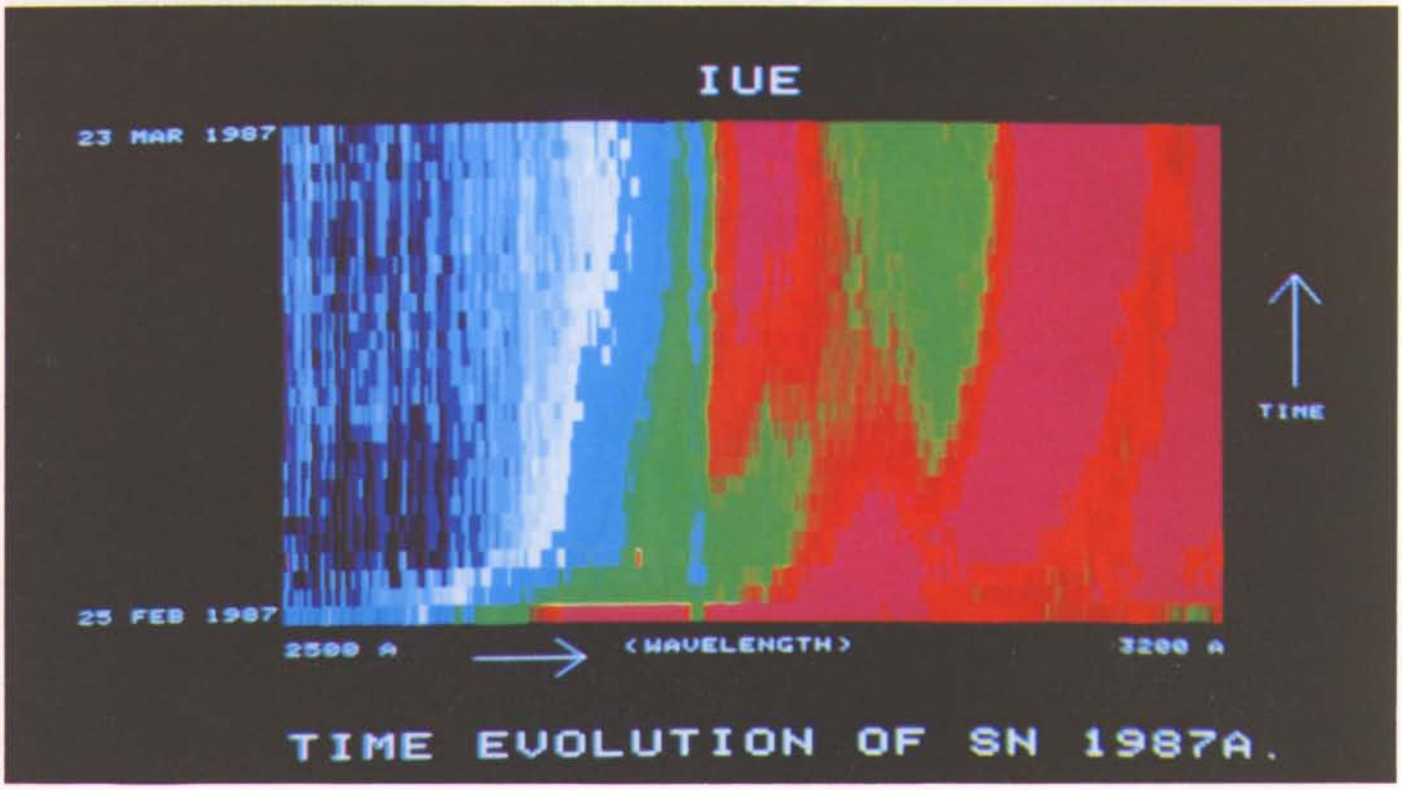

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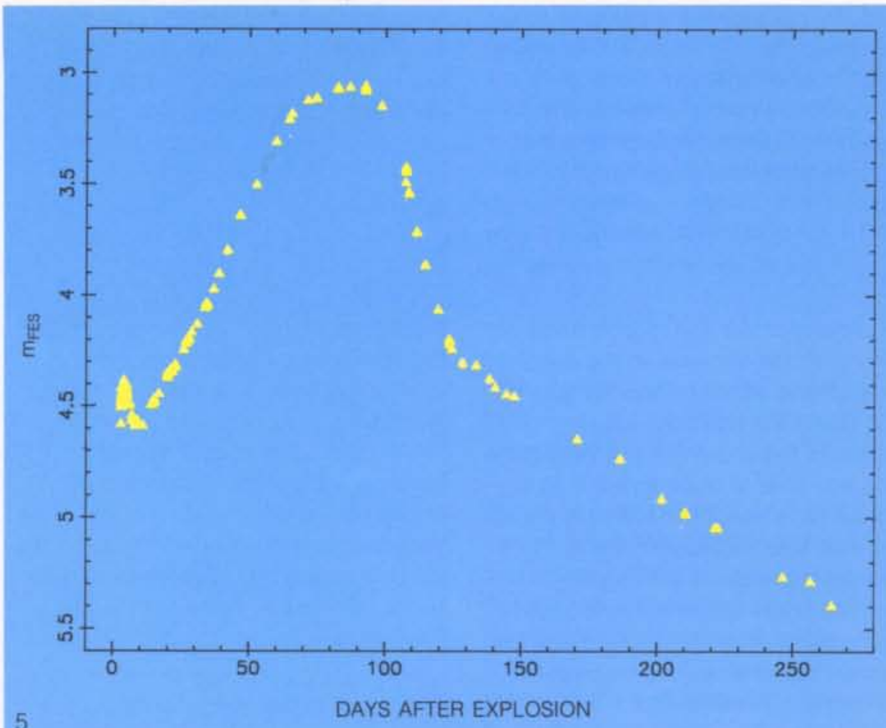
Figure 6 — Bolometric light curve of SN 1987A, i.e. the light curve of the **total** *flux of the supernova. Comparing with Figure 3, one can see how the very early epochs are dominated by the ultraviolet emission, while later it is the optical radiation that is dominant*



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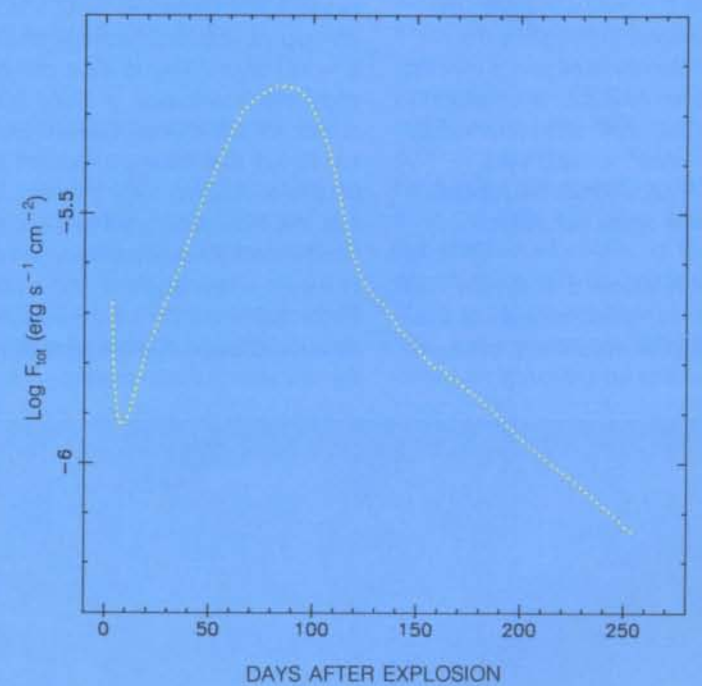

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2600 Å (Fig. 4). In the range 2850—2950 Å the spectrum is dominated by the excited lines from the Fe II. Longward of about 2950 Å, Ti II lines are important, and can explain the observed minima at approximately 3015, 3175 and 3290 Å.

From mid-March to mid-June, there are no spectroscopic changes apparent, except for the progressive narrowing of the absorption troughs and for the gradual shifting of the absorption minima towards longer wavelengths. A similar behaviour was also observed in the visible (hydrogen Balmer lines). This is a direct consequence of the gradual recession of the line-forming region into the inner, slower expanding parts of the envelope.

A specially interesting feature of SN 1987A is the puzzling emission-like peak seen around 1876 Å (on February 25.2), which has also been observed in SN 1983A, a Type Ib supernova. However, later spectra showed that this peak was shifting progressively towards the red, consistent with the behaviour of the absorption lines, confirming the suggestion made by the European supernova team that this feature is the result of a minimum in the selective opacity in the expanding 'atmospheric envelope'. Finally, in addition to line blocking, continuous opacity from iron-group elements can contribute to the extremely rapid fading of the ultraviolet flux observed below about 1800 Å.

The light curves and the progenitor star

An alternative means of analysing supernova observations is to examine the flux variation as a function of time. This approach is especially relevant because many of the definite predictions from theory refer to these 'light-curves'. Ultraviolet 'light-curves' provide information on the overall behaviour of the supernova without recourse to the spectral details.

Some light curves of this type are shown in Figure 3, together with the light curve in the optical as determined from the Fine Error Sensor (FES) onboard the IUE spacecraft (Fig. 5). Both similarities and differences in behaviour are apparent at the various wavelengths. Such curves can be combined into a bolometric light curve of the type shown in Figure 6.

After a very rapid decline in the ultraviolet, as a consequence of the very fast cooling of the ejecta, both the LWP (2000—3000 Å) and the SWP (1200—2000 Å) curves appear to reach a plateau. However, around day 60, the LWP light curve mimics the secondary luminosity maximum in the ultraviolet, whereas in the optical the secondary maximum is much less pronounced than the prime maximum. About 150 days after the explosion, when the optical light curve enters the exponential phase, driven by radioactive decay, the LWP curve starts increasing again.

Figure 7 — Line-by-line ultraviolet spectrum of the field of SN 1987A, giving spatial information in the direction perpendicular to the dispersion. The image of the supernova field after the initial ultraviolet decline (bottom) is compared with a single star spectrum. The multiplicity is evident, and it has been used to demonstrate that Sk-69 202, the star coinciding positionally with the supernova, was the progenitor

The explanation for this reverse trend can be found in the decrease in the metal line opacity at ultraviolet wavelengths, which allows the real continuous emission of the supernova underlying the absorption lines to shine through. In other words, it is not the flux from the supernova that increases in the ultraviolet, but rather the overlying absorbing layers become thinner and thinner, letting more and more of the flux escape. The net effect is an increase in the observed ultraviolet flux.

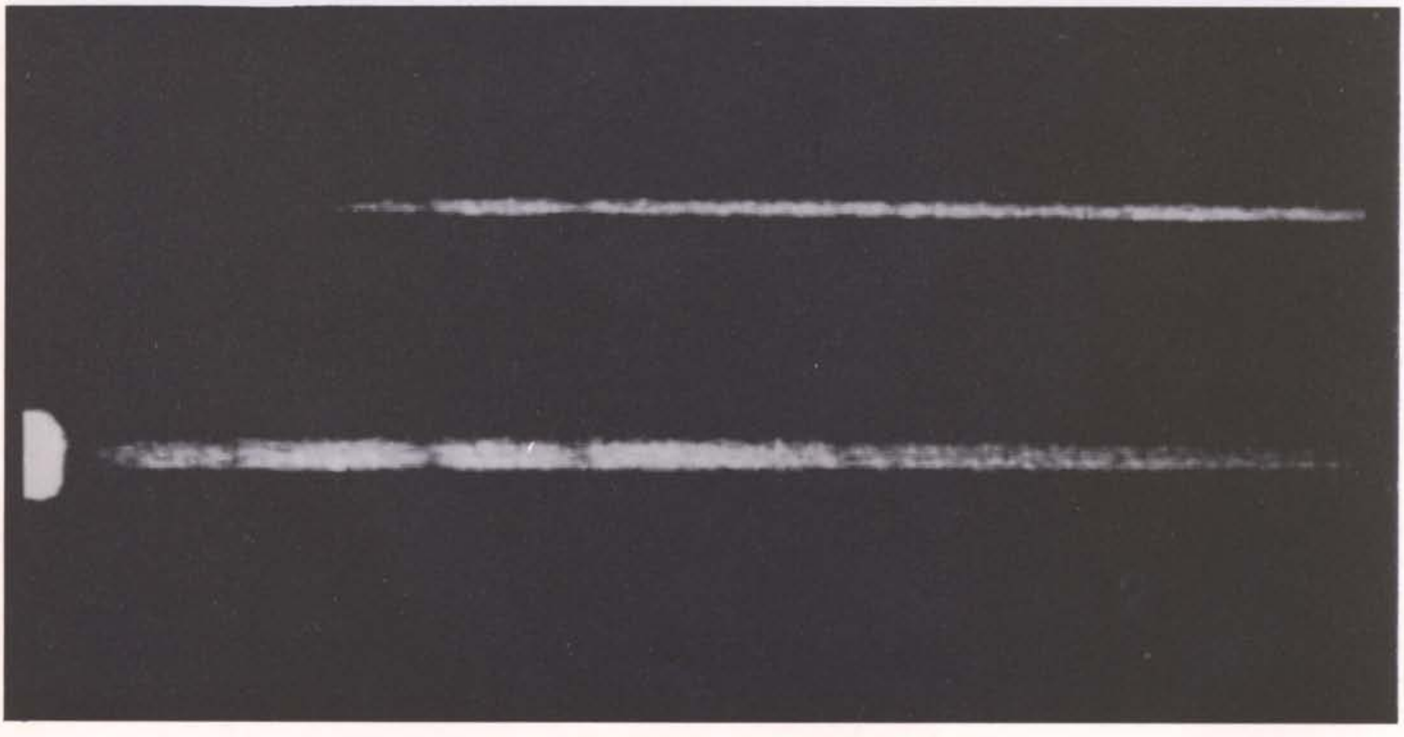
The SWP curve does not follow the LWP flux very closely. It stabilises to a constant value only four days after the explosion. However, in this case the asymptotic luminosity level is not intrinsic to the supernova itself, but is unrelated to it. Careful inspection of short-wavelength spectra taken after the rapid initial decline (Fig. 7) shows that the residual spectrum is of a stellar nature.

Re-analysis of historical data directly after the supernova explosion suggested that the close positional agreement between the supernova and an LMC blue supergiant (Sk-69 202) may indicate that this latter star is the progenitor of the supernova. Since it was always thought that Type II supernovae (to which SN 1987A belongs) evolved from red supergiant stars, this raises serious theoretical problems (even though theoreticians can now demonstrate that the case of the LMC supernova was an inescapable consequence of the old theories).

Analysis of the residual stellar spectrum in the ultraviolet led to it being classified as an early B-type star, i.e. with an ultraviolet spectrum very similar to that expected for a star like Sk-69 202, although it appeared somewhat too faint and too blue. Allowing for a possible slight misclassification of Sk-69 202 and/or for the effects of interstellar reddening (particularly important at ultraviolet wavelengths), it was concluded that this blue supergiant was still present, unaffected by the supernova explosion. However, a re-analysis of some plates of Sk-69 202 taken before the supernova's outburst showed that the optical image of the star was actually made up of three stars very close together. The spatially resolved IUE images of the residual stellar spectrum in fact showed two components.

Our own detailed re-analysis of the spatially resolved IUE images showed, however, that the separation between the two components (about 4.5 arcs) was not compatible with the continued presence of Sk-69 202, but rather with IUE seeing the two fainter stars (Fig. 7). This interpretation was also supported by the fact that the two spectra were of similar brightness and of similar spectral type, which is very difficult to reconcile with the continued presence of the supergiant, which was ten times brighter than the two companion stars.

The final confirmation of its disappearance was obtained from special observations made using the small aperture of the IUE telescope (3 arcs diameter). These proved beyond doubt that the supergiant Sk-69 202 was the progenitor of SN 1987A and that the two spectra observed in the short-wavelength ultraviolet were those of the two companion stars.



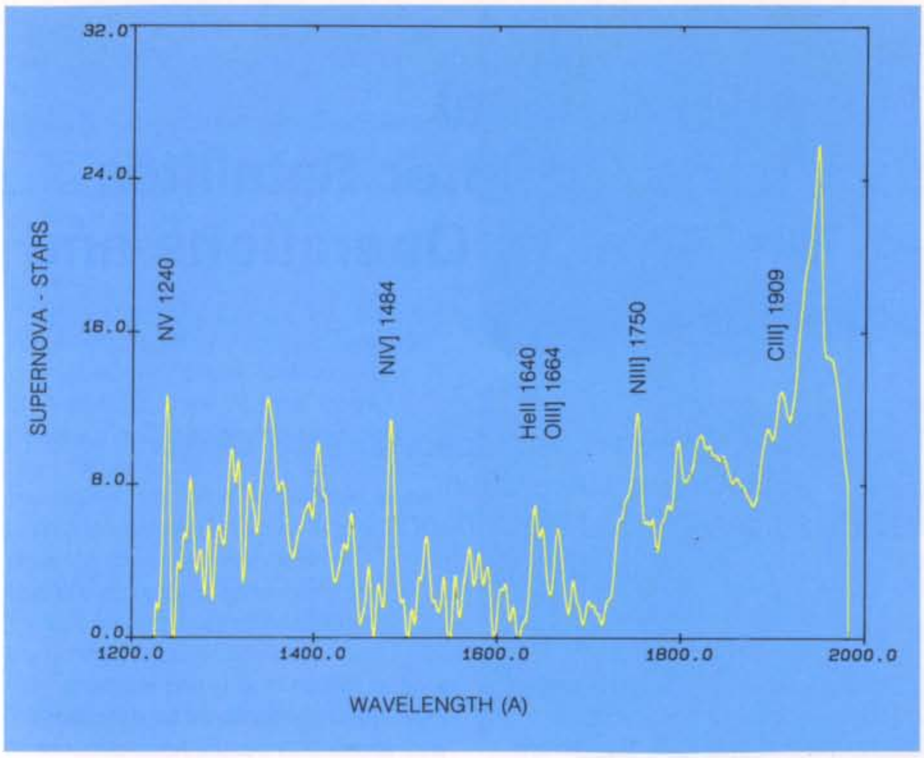


Figure 8 — The emission-line spectrum of the supernova between September and November. The contribution from stars 2 and 3 has been removed. These lines, indicating high ionisation stages of carbon, nitrogen and helium, arise from the circumstellar material, for which their accurate analysis provides composition, temperature and density data

The narrow emission lines

The European team first reported the detection of faint and narrow emission lines from NV 1240 Å, N IV] 1484 Å, He II 1640 Å and N III] 1750 Å in the spectra of the supernova taken on 9, 10 and 13 June. These emission lines were present earlier, but could only be detected with the benefit of hindsight. Further spectra obtained on 16 and 24 June, and on 10 July, confirmed the presence of the emission lines, and showed that their strength was slowly increasing with time.

As an example, Figure 8 shows the average spectrum (September — November 1987) after subtraction of the background stars. Important information can be derived from the strength of the emission lines, namely the chemical abundances of CNO elements emitting in the gas. To derive this data, one needs to estimate the electron density and the electron temperature of the emitting region. The former was estimated using the N IV] 1483.3—1486.5 Å doublet, whose line ratio is density-sensitive. From the measured position of this blended feature at 1483.7+/−1.2 Å, we conclude that the electron density in the N IV region is lower than $10^5 cm^{-3}$.

An estimate of the electron temperature can be obtained from the intensity ratio I(NV 1240)/I(N IV 1718). Analysis leads to electron temperatures in the range 11 000—14 000 K. Other mechanisms may, however, contribute to the N IV line, and such values should therefore be regarded as lower limits to the temperature.

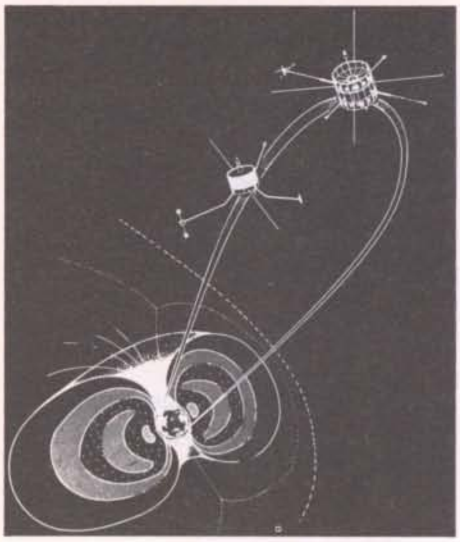
Given the low electron density, one can neglect collisional de-excitation effects and calculate the ionic densities using a simple two-level atom model. For the ionic fractions, such calculations lead to n(N III)/n(C III) ≃ 15 and n(N III)/n(O III) ≃ 0.3. Allowing for differences in the extents of the C, N and O ionisation zones, these translate into total abundance ratios of [N]/[C] ≃ 15 and [N]/[O] ≃ 0.8. These values are, respectively, 60 and 6 times greater than the solar abundances for nitrogen, carbon and oxygen. They confirm that the progenitor star has passed through a phase of heavy mass loss, with the subsequent dredging-up of processed materials. A similar scenario was suggested for the supernova 1979C.

One of the most crucial questions is: Why does one see emission lines and where do they form? Inside the expanding envelope of the supernova, in the interstellar medium, or in the circumstellar matter lost during the prior evolution of the progenitor? It is clear that the emission lines are too narrow to be formed inside the fast expanding envelope. In addition, the low density deduced from the N IV] doublet is inconsistent with the much higher densities that must exist in the supernova envelope. Formation in the interstellar medium is also unlikely, because of the anomalous N/C ratio.

The most likely possibility is therefore that the emission lines originate in the circumstellar matter accumulated, through the action of the stellar wind, during a red-supergiant phase before the last contraction to blue supergiant which precedes the supernova explosion. The ionising source powering the emission lines is then either the early and very short extreme-ultraviolet burst from the supernova breakout, or radiation from the expanding shock wave.

Preliminary calculations indicate that radiation from the shock cannot power such strong emission lines. On the other hand, the high colour temperature found from the early IUE data, together with the extremely rapid cooling of the envelope, seems to confirm the existence of a short, very-high-temperature flash at the time of the explosion, sufficient to be responsible for the ionisation of the material deposited around the star by the stellar wind.

Enhanced N/C ratios have already been observed for massive stars which are likely to have passed through the red-giant phase, and are also predicted from theory. Analysis of pre-discovery objective prism plates of the supernova at the ESA IUE Observatory show anomalies that could also indicate non-solar abundances even before the supernova explosion. An interesting aspect of all of this is that, at the present rate of fading of the supernova, it might take some three years before optical astronomers will be able to confirm the nature of the progenitor star, unless the Hubble Space Telescope, with its superior optical quality, is able to provide earlier confirmation.



The International Sun-Earth Explorer Satellites — Ten Years of Operations and Science

A. Pedersen, Planetary and Space Science Division, ESA Space Science Department, ESTEC, Noordwijk, The Netherlands

As early as the late nineteen sixties, scientists in Europe and the USA were discussing plans for a pair of spacecraft that would follow each other in the same orbit, a controllable distance apart, through regions of the Earth's magnetosphere. The aim was to be able to disentangle varations in space from variations in time in a system that expands, shrinks and changes topology sometimes in a matter of minutes.

The ISEE-1 spacecraft, developed by NASA, and ISEE-2, developed by ESA, were launched together by the same launch vehicle on 22 October 1977. The third spacecraft of the trio, ISEE-3, was launched less than one year later and placed in an orbit around the sunward Lagrangian point, 235 Earth radii sunward of our planet. There it was to provide reference measurements in the solar wind that would later impinge on the Earth's magnetosphere where ISEE-1 and ISEE-2 were orbiting.

European scientists have been involved in experiments on all three ISEE spacecraft, and the overall programme has been an outstanding success both operationally and in terms of the scientific results derived by the combined European and American scientific communities.

ISEE-3 has been exploited for two spectacular additional programmes that were not foreseen in the original plans. In mid-1982, this spacecraft was moved from its original position at the sunward Lagrangian point, and directed into a series of orbits in the Earth's extended, tail-like magnetosphere, taking it out to more than 200 Earth radii. Then, towards the end of 1983, ISEE-3 was dispatched, via a lunar gravity-assist manoeuvre, on a trajectory to rendezvous with Comet Giacobini-Zinner. This encounter took place in September 1985.

On 26 September 1987, ISEE-1 and ISEE-2 re-entered the atmosphere as predicted. This of course marked the end of operations, but the scientific results that they have provided will be analysed for several years to come.

This article briefly reviews the main results obtained so far from the three ISEE spacecraft.

Historical background

Between 1960 and 1970, spacecraft launched by the USA and the USSR had crossed the boundaries of the Earth's magnetic field and observed the charged-particle population trapped there. They had also explored the solar wind, a stream of ions and electrons moving radially outwards from the Sun with velocities of several hundred kilometres per second.

It became clear from these early results that the Earth's magnetic field assumes a comet-tail-like form under the influence of the solar wind. Given this exploratory knowledge of solar-terrestrial physics, further questions quickly arose about the physical processes involved and the mechanisms controlling the Earth's magnetosphere. The interaction between the solar wind and the Earth provides, it was decided, an unique opportunity to study, at close quarters, the fundamental processes that are at work both in the neighbourhood of the planets and comets in our own solar system and near other planetary systems in the Universe also.

The early years of space research had created an awareness of the space environment that was to prove extremely useful to the designers of the ISEE spacecraft. One of the first major discoveries had been the existence of the Van Allen radiation belts, shells of energetic electrons and ions trapped and mirroring within the Earth's magnetic field at a distance of a few Earth radii. This discovery led to the need to adopt protective measures for spacecraft solar cells as well as for the electronic components on board.

At the time of planning the ISEE mission, the European space-science community had gained considerable experience with the ESRO-I, ESRO-II and Heos

Figure 1 — The ISEE-1 and 2 spacecraft pair

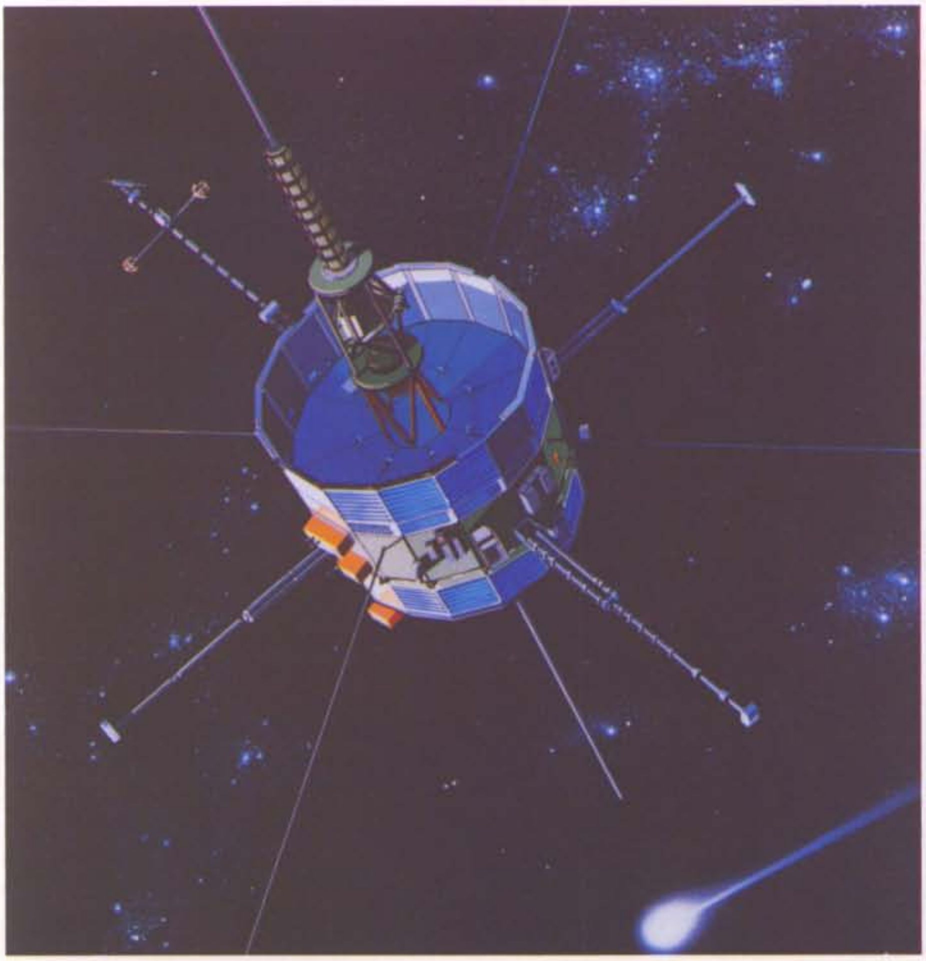


Figure 2 — The ISEE-3 spacecraft, which served first as a solar-wind monitor, later as a magnetotail explorer, and finally as a cometary explorer (rendezvous with Comet Giacobini-Zinner in September 1985)

spacecraft. Together with their American colleagues, they began a strong lobby, on both sides of the Atlantic, for the launching of a mission that would put two spacecraft (ISEE-1 and ISEE-2) into the same elliptic orbit, with an adjustable separation between the two. This would allow the observation of moving boundaries by both spacecraft, and thereby allow the velocities of these boundaries to be determined.

The rationale for the launch of a third spacecraft (ISEE-3) was that it would provide a reference for the two magnetospheric spacecraft and also furnish long, uninterrupted measurements of the solar wind, if it were stationed near the sunward Lagrangian point, 235 Earth radii (R_E) from our planet.

The Council of ESRO (ESA's forerunner) approved the joint ESRO—NASA ISEE programme in the spring of 1973, with ESRO being responsible for the development of the ISEE-2 spacecraft.

The spacecraft and their scientific instruments

Although, due to the limited finances available, there was a need to strive more for financial restraint than technical sophistication, each of the three spacecraft that finally flew had a number of features worth recalling (Figs. 1,2).

All had conductive surfaces to render the complete spacecraft uniformly charged, an important feature for the measurements that were to be made of low-energy particles and electric fields with boom-mounted probes. All three spacecraft carried radial wire antennas for electric-field measurements, these antennas being kept deployed by centrifugal force. The longest was on ISEE-1, extending 215 m tip-to-tip. ISEE-1 also carried two spherical electric-field sensors, 72 m apart, on radial booms.

ISEE-2, the smaller of the ISEE-1/ISEE-2 pair of spacecraft, was assigned the task

Figure 3 — The orbit of ISEE-1 and 2, showing the average front-side magnetospheric boundaries, and the variation in separation of the two spacecraft over the orbit (illustrated by distance vectors)

of controlling its separation relative to ISEE-1, by use of a freon cold-gas system. Figure 3 shows how the separation varied over the orbit. Typical separations near 10 R_E in the central part of the orbit were actively controlled to be in the range of a few hundred to a few thousand kilometres.

This orbit-control system functioned perfectly during its almost ten years of operation. It was, however, necessary to adopt a careful and inventive manoeuvring stategy towards the end of the unexpectedly long mission, because ISEE-2's gas supply was by then running very low.

The scientific instruments carried by the three ISEE spacecraft and the groups responsible for them are shown in Table 1. The instruments were of a 'new generation', based on the experience of the first decade of embarking scientific experiments on spacecraft launched into the Earth's magnetosphere. It can be

Table 1 — Scientific experiments on the ISEE-1, 2 and 3 spacecraft

Experiments	Spacecraft	Principal investigator	Affiliation	European collaborating institute
Electrons, protons	ISEE-1, ISEE-2	K.A. Anderson	Univ. Cal. Berkeley	Toulouse
Electrons, protons	,,	L.A. Frank	Univ. Iowa	
High-energy particles	,,	D.J. Williams/ E. Keppler	APL Maryland/ MPAe Lindau	Univ. Kiel
Magnetometer	,,	C.T. Russell	Univ. California Los Angeles	Imp. College London
Plasma waves	,,	D. Gurnett	Univ. Iowa	
Electron density	,,	C.C. Harvey	Meudon	CNET Issy les Moulineaux
Fast Plasma	ISEE-1	S. Bame	Los Alamos	MPI Garching
Electric fields	,,	J. Heppner	NASA/GSFC	
Electric fields	,,	F.S. Mozer	Univ. Cal. Berkeley	RIT Stockholm/ SSD ESTEC
Radio receiver	,,	R.A. Helliwell	Stanford Univ.	
Fast electrons	,,	K.W. Ogilvie	NASA/GSFC	
Ion composition	,,	R.D. Sharp	Lockheed	Univ. Berne
Cosmic rays	,,	D. Hovestadt	MPI Garching	
Solar-wind ions	ISEE-2	V. Formisano	CNR Rome	
Fast plasma	,,	G. Paschmann	MPI Garching	
X-rays, electrons	ISEE-3	K.A. Anderson	Univ. Cal. Berkeley	
Solar wind	,,	S.J. Bame	Los Alamos	
High en. cosmic rays	,,	M. Wiedenbeck	Univ. Chicago	
Low en. cosmic rays	,,	D. Hovestadt	MPI Garching	
Cosmic rays	,,	P. Meyer	Univ. Chicago	
Energetic protons	,,	R.J. Hynds	Imp. College London	SRC Utrecht, SSD ESTEC.
Ion composition	,,	K.W. Ogilvie	NASA/GSFC	Univ. Berne
Plasma waves	,,	F.L. Scarf	TRW Los Angeles	
Radio mapping	,,	J.L. Steinberg	Meudon	
Magnetometer	,,	E.J. Smith	JPL Pasadena	
High en. cosmic rays	,,	E.C. Stone	Cal. Inst. Tech.	
Cosmic rays	,,	T. von Rosenving	NASA/GSFC	

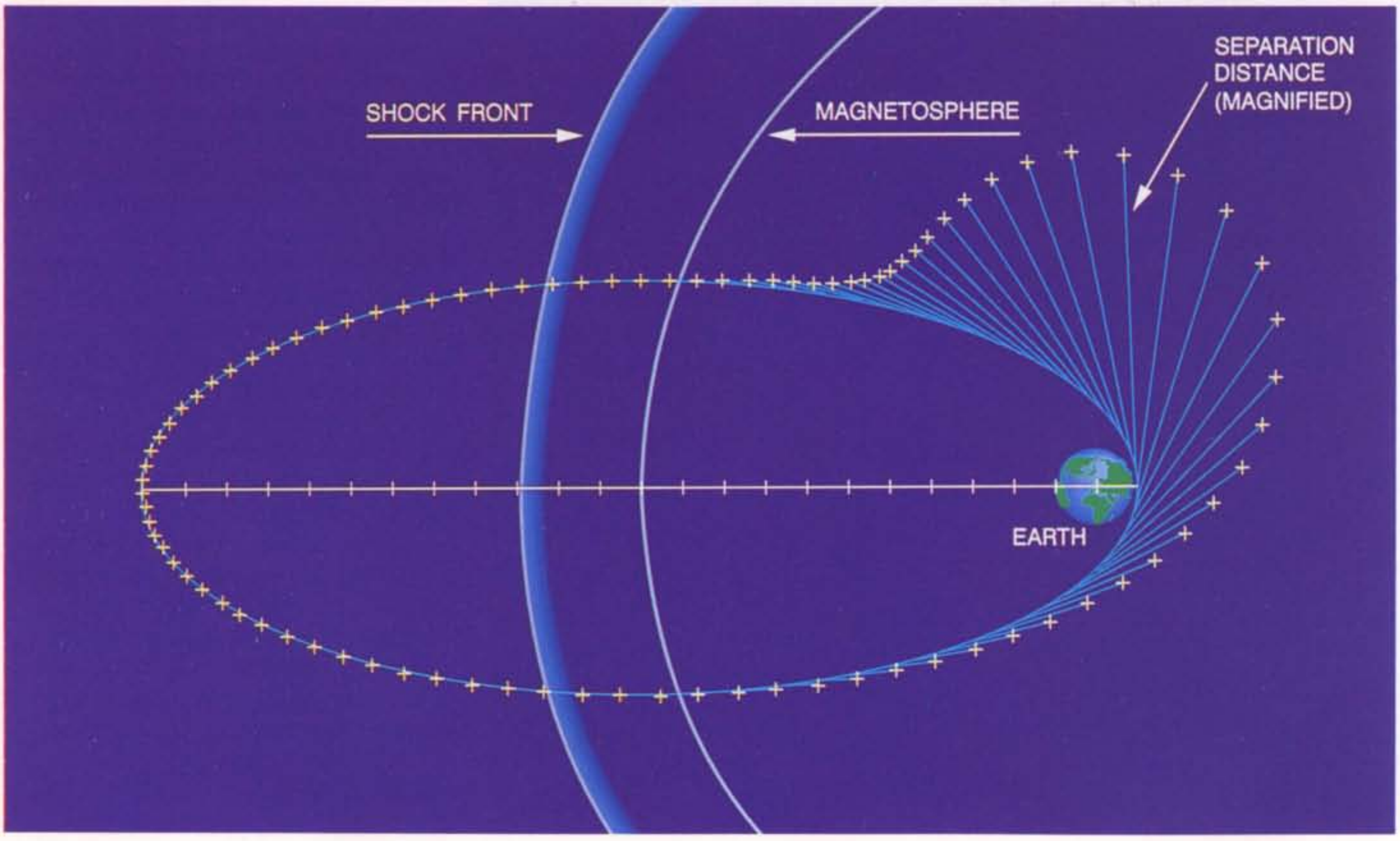
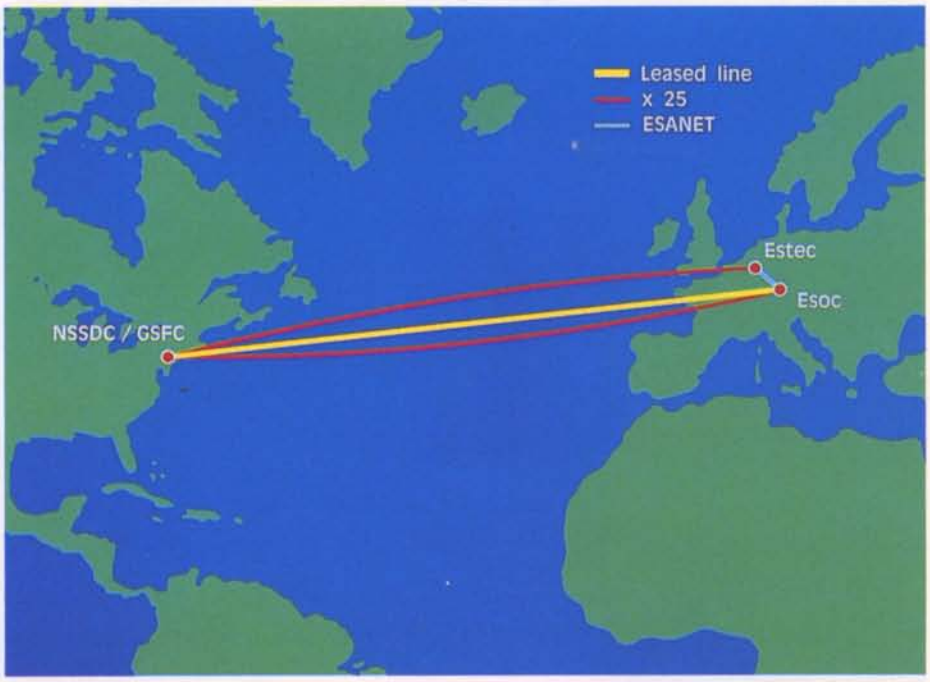


Figure 2 — The trans-Atlantic connection. The thick line across the Atlantic shows the leased line connecting ESOC to GSFC. The thin lines show the backup X.25 possibilities



The Space Physics Analysis Network is basically a collection of VAX (or microVAX) computers networked together using DECnet. The overall management of the US SPAN is the responsibility of the National Space Science Data Center (NSSDC) at Goddard Space Flight Center. One of their primary functions is to allocate node addresses, and to maintain a database of all nodes and users. This database is kept on line at the NSSDC in the SPAN Network Information Center (NIC), and is available in printed form as a directory known as the 'Yellow Pages'.

Basic services on each node include a user list and a node information file, which can be accessed by any node on the network. Additional services available on the network include databases of space-science data. In the US the NSSDC provides many online services, including catalogue browse and ordering of space science data sets.

In Europe, the Space Telescope Data Base has been connected to SPAN, and the database of astronomical objects, SIMBAD can also be accessed. The Exosat computer is connected to the network, the database being transferred to this computer. The IUE computer is connected to SPAN via a local area network, but will soon be connected directly, thus paving the way for the much needed European Space Information System (ESIS) to become a reality.

Interconnection to the JANET network in the UK is possible via a mailer service in ESOC, but this does not as yet provide all the services required of a gateway. Investigations are underway to provide a proper gateway from JANET to SPAN.

A Working Group has been set up to study the implementation of a mail gateway linking SPAN to the European Academic and Research Network (EARN). This will probably be based upon the so-called 'ISO/CCITT X.400' standard for message exchange.

Potential users of SPAN are able to connect to the network in one of three ways. The cheapest solution, and therefore the solution most likely to be adopted by a new node, is to exploit the remote log-in facilities at ESOC and ESTEC, using connections made through the public packet-switched network. At the end of each session, the connection is broken, so that the user pays essentially only for the traffic passed to and from the node.

The next possibility is to make a DECnet connection using the public packet-switched network. This connection can be scheduled for either the length of the session, or for an extended period of time. Here one pays connection charges, traffic charges, and a time-of-connection charge on the public packet-switched network.

Finally, there is the possibility of using a leased line (either in its entirety or multiplexed into a high-bit-rate line). In this case, the connection is in principle available 24 h/day. No traffic charges are incurred and the cost of this connection is solely the cost of the leased line.

Acknowledgements
The authors acknowledge the enthusiasm shown by the many people involved in setting up and running the SPAN network, both in Europe and the USA, without whose help the existence of the network would not have been possible.

A Fresh Look at Launch-Service Contracts

W. Thoma, Contracts Department, Directorate of Administration, ESA, Paris

In ESA Bulletin No. 29 of February 1982, in an article titled 'Launch Service Contracts', I wrote:

'Many other problems have also to be solved, but in the present competitive situation the chances of equitable solutions emerging which do not completely disregard the interests of the customer must be considerably higher than they would have been a decade ago, when there was a virtual monopoly in the launch-service market.'

The situation has indeed changed completely since the ill-fated 'Challenger' crashed into the Atlantic and temporarily put the USA out of the launching business.

An important consequence of the Challenger accident was the subsequent change in American policy regarding non-governmental and commercial launchings. As a result private enterprise was invited to offer launch services as a commercial activity.

Leaving aside private launch initiatives with questionable operational readiness, the new American policy has led to the revival of three primary launchers for commercialisation: the Atlas-Centaur (General Dynamics), the Titan (Martin-Marietta), and the Thor-Delta (McDonnell-Douglas). Further development of these launchers is also planned, mainly to enlarge their capacities.

The marketing teams of these three companies and that of Arianespace are now travelling the World seeking potential customers for the future. A recent American study estimated that, over the next 10 years, about 200 commercial communications satellites will have to be launched. A large and highly competitive market can therefore be envisaged, in which the Soviet Union with its 'Proton' launchers, and China with its 'Long March', will also endeavour to take a share.

A quick analysis shows that until recently lack of availability of launch services was the main problem. It was a seller's market in which the bidder could ask almost any price and impose stringent conditions. This situation will now change rapidly with the transition into a buyer's market.

Customers look not only at availability, but also at the flexibility offered in terms of changes in the launch date, relaunches, overall price and financial conditions and, last but not least, the reliability of the launch system offered.

The technical reliability of the space system, involving both the launcher and the satellite, is becoming more and more crucial for the customers. As everybody knows, the setting up of a satellite-based system requires high investments over a long period before profitability can be achieved. The strategic decision regarding such an investment therefore depends very heavily on the risk involved.

Normally the risk of loss of investment and profit can be insured against, but the recent fluctuations in the space-insurance market have led to extremely high premiums, and in some cases even to the availability of only partial coverage (see article on page 84 of this issue).

The ball is now firmly in the court of space industry as far as increasing the World space market is concerned. By increasing the reliability of its products, it can increase not only the confidence of its potential customers, but also that of the insurers.

This state of affairs should also be reflected by the terms and conditions of the launch-service contracts. In the past, these contracts have been based on the principle of 'best efforts'. This means that the customer has had to carry all of the risks, including slippages in launch date and launch failure, unless he could prove that the launch-service contractor had not applied his 'best efforts'. The latter is very difficult to prove in legal proceedings. It is therefore time to reconsider the notion of 'best efforts'.

For the customer, the most interesting question is probably that of the consequences of a launch-system failure. On a 'best-efforts' basis, he is expected to carry this risk, but for many customers this is no longer acceptable. In today's more competitive environment, we will probably soon see a move towards a guaranteed relaunch, or alternatively repayment of the monies advanced by the customer. This might possibly have an impact on the price of the launch-service contract, but not necessarily as high as that on the insurance premiums. The launch-service contractors could, for instance, earmark one or two launchers in specific production batches for relaunch purposes, and distribute the resulting cost over several launches.

The repayment alternative, applying to all spacecraft for which no replacement is available, would be of interest to many customers in a future buyer's market. The customer could then also consider this alternative if the launch-service contractor were unable to commit himself in the initial launch contract to a relaunch within a certain period. The customer might well not be interested in a late relaunch after the initial failure, preferring to keep his options open and look for an early relaunch opportunity elsewhere.

In addition, the strict application of the 'best-efforts' philosophy to the contractual provisions in the event of a change in launch date needs to be reviewed. In the past, launch-service contractors have neither granted a guaranteed launch date nor accepted to pay postponement fees. The user, on the other hand, has been expected to deliver his payload on time and to pay postponement fees in the event of his having to request a change in launch date. There is therefore a gross imbalance in this system, particularly as recent experience shows that in most cases launch delays have been caused by the launch-service contractors and not by the customers. If the launch industry wants to increase the confidence of potential customers in its products, it will have to accept to pay the same postponement fees for late supply of launch services.

Another solution would be to base postponement fees on the cost-reimbursement rules for both parties. This solution would, however, have the disadvantage of lengthy cost-verification processes and protracted discussions.

The absolute price of a launch is naturally of the utmost importance, but so are the financial conditions linked to it. It is now general practice to contract on a fixed-price basis (either on firm fixed prices or with price escalation for inflation). Deposit and payment plans are putting a heavy burden on the customer, however, particularly when downpayments start in some cases three years before the envisaged launch. Customers will probably ask in future for readjustment of the payment scheme to the new launch date without price escalation, if the delay has been caused by the launch-service contractor. This would bring the situation more in line with normal business practice than it has been in the past.

Of quite a different nature is the 'third-party liability' aspect. This largely legal problem arises if, in the event of a launch-system failure, the launcher explodes on the launch pad or falls back to Earth and causes damage. The chances of a failing launcher crashing on a populated area are very small, but such a risk cannot be totally excluded. Arianespace takes full responsibility for this risk and agrees to cover its customers.

The American launch-service suppliers depend for their launchings on the facilities of the US Government, which is presently not prepared to waive liability of the launch-service contractors and their customers. Users are therefore requested to take out insurance coverage of 500 Million $ (minimum) per launch and to carry the remaining risk above this amount themselves. The remote chance of such a disastrous event occurring doubtless makes some Chairmen of user companies think twice before making such a commitment.

This is not the only problem that arises as a result of the dependency of the American launching firms on US Government facilities. The US Government insists on having priority in the use of their launch facilities to serve US security interests or meet US Government mission requirements. Such a proviso clearly undermines any agreed launch-date guarantee.

It is hoped that the US Government will relent to pressure from industry and international competition and change its current policy concerning 'third-party liability' in the near future.

Conclusion

Given today's developments in the launch-service market, we should soon begin to see improvements in launch-service contracts, particularly as regards those aspects that have been discussed above. Another contributory factor stems from the fact that an increasing number of users are basing their competitive tender actions on a 'delivery in orbit' concept. This is similar to the 'turnkey' concept often adopted for industrial plants, etc.

The entrepreneur has to run a high risk and seeks to cover this in his contractual arrangements with the launch-service contractor. He will be in a particularly strong position as regards obtaining the best conditions from launch-service suppliers if he has several projects in progress.

Programmes under Development and Operations / Programmes en cours de réalisation et d'exploitation

In Orbit / En orbite

	PROJECT	1988 – 1994 (J F M A M J J A S O N D)	COMMENTS
SCIENT. PROG.	IUE		OPS. FUNDED UNTIL END 1988
APPLICATIONS PROGRAMME	MARECS-1		
APPLICATIONS PROGRAMME	MARECS-2		LIFETIME 5 YEARS
APPLICATIONS PROGRAMME	METEOSAT-2		
APPLICATIONS PROGRAMME	ECS-1		LIFETIME 7 YEARS
APPLICATIONS PROGRAMME	ECS-2		LIFETIME 7 YEARS

Under Development / En cours de réalisation

	PROJECT	1988 – 1994 (J F M A M J J A S O N D)	COMMENTS
SCIENTIFIC PROGRAMME	SPACE TELESCOPE		LIFETIME 11 YEARS
SCIENTIFIC PROGRAMME	ULYSSES		MISSION DURATION 4.5 YEARS
SCIENTIFIC PROGRAMME	SOLAR TERRESTRIAL SCIENCE PROG. (STSP)		LAUNCHES: SOHO MARCH 1995, CLUSTER DEC. 1995
SCIENTIFIC PROGRAMME	HIPPARCOS		LIFETIME 2.5 YEARS
SCIENTIFIC PROGRAMME	ISO		LAUNCH 1992/93
TELECOM. PROGRAMME	ECS	ECS-5	LAUNCH DATE UNDER REVIEW
TELECOM. PROGRAMME	OLYMPUS-1		LIFETIME 5 YEARS
TELECOM. PROGRAMME	DATA-RELAY SATELLITE (DRS)		SYSTEM OPERATIONAL 1996
TELECOM. PROGRAMME	PSDE/SAT-2		READY FOR LAUNCH MID-1993
EARTH OBSERVATION & MICROGRAVITY PROGRAMMES	ERS-1		
EARTH OBSERVATION & MICROGRAVITY PROGRAMMES	EARTH OBS. PREPAR. PROG. (EOPP)		
EARTH OBSERVATION & MICROGRAVITY PROGRAMMES	METEOSAT P2/LASSO		LAUNCH DATE UNDER REVIEW
EARTH OBSERVATION & MICROGRAVITY PROGRAMMES	METEOSAT OPS.PROG.	MO-1, MO-2, MO-3	MO-3 LAUNCH DATE UNDER REVIEW
EARTH OBSERVATION & MICROGRAVITY PROGRAMMES	MICROGRAVITY	IML-1, SPACELAB-D2	
SPACE ST. & PLATF. PROG.	EURECA		
SPACE ST. & PLATF. PROG.	COLUMBUS	PHASE 1, PHASE 2	3 YEAR INITIAL DEVELOPMENT PHASE
SPACE TRANSPORTATION PROGRAMME	ARIANE-2/3	V21	LAUNCH DATES UNDER REVIEW
SPACE TRANSPORTATION PROGRAMME	ARIANE-4	V22	OPERATIONAL UNTIL END 1998
SPACE TRANSPORTATION PROGRAMME	ARIANE-5		START MAIN DEVELOPMENT PROG. JANUARY 1988
SPACE TRANSPORTATION PROGRAMME	HERMES	PHASE 1, PHASE 2	3 YEAR INITIAL DEVELOPMENT PHASE
TECH. PROG.	IN-ORBIT TECHNOL. DEMO. PROG. (PH-1)		SEVERAL DIFFERENT CARRIERS USED

= DEFINITION PHASE
~ INTEGRATION
> PREPARATORY PHASE
↑ LAUNCH/READY FOR LAUNCH
▨ MAIN DEVELOPMENT PHASE
• OPERATIONS
▪ STORAGE
- ADDITIONAL LIFE POSSIBLE
◊ HARDWARE DELIVERIES
↓ RETRIEVAL

ISEE

ISEE-1 et ISEE-2 ont tous deux été lancés de Cap Kennedy le 22 octobre 1977 par la même fusée Delta. ISEE-2 représentait la participation de l'Agence à ce programme en collaboration avec la NASA, qui prévoyait également l'envoi d'ISEE-3 loin en amont dans le vent solaire, en plus d'ISEE-1 et d'ISEE-2, voyageant de conserve dans la magnétosphère de la Terre.

Le 26 septembre 1987, ISEE-1 et ISEE-2 ont effectué comme prévu leur rentrée dans l'atmosphère terrestre en raison de la dégénérescence de leur orbite, qui s'est traduite par une altitude insuffisante lors des passages au périgée. Cette date marqua la fin de dix années d'exploitation fructueuse de ces satellites sans aucune détérioration notable des systèmes embarqués, tandis que leurs charges utiles respectives fournissaient encore l'essentiel de leurs paramètres scientifiques à la fin des opérations (voir pages 38 – 44).

Le programme ISEE a été une grande réussite et a permis de mieux comprendre les processus physiques que subit le milieu ionisé qui entoure la Terre sous l'action du Soleil et du vent solaire. En ce sens, il constitue le prolongement logique de la phase exploratoire menée à bien par les engins spatiaux américains et soviétiques antérieurs. De plus, il a renforcé la coopération dans ce domaine entre les milieux scientifiques américains et européens, et s'est traduit par de nombreux ouvrages et exposés d'un haut niveau lors des conférences scientifiques.

Les scientifiques européens en ont retiré un bénéfice supplémentaire lorsqu'on a modifié la trajectoire d'ISEE-3 pour qu'il effectue d'abord des passages profonds dans la queue du champ magnétique terrestre en 1983—84, avant d'être envoyé vers la comète de Giacobini Zinner, qu'il a dépassée en septembre 1985, en profitant de l'attraction de la Lune.

IUE

Cet engin d'exploration internationale dans l'ultraviolet est entré le premier juin 1987 dans sa dixième année d'observations. A sa réunion annuelle, le comité européen chargé des attributions de temps concernant le satellite a alloué du temps pour 138 propositions d'observation sur les 201 soumises. Les observations prévues pour cette période ont commencé normalement, malgré certains retards causés par les observations de la supernova SN 1987A au cours des mois précédents. Le comportement inattendu de cette supernova a entraîné des perturbations plus graves que prévu du calendrier, mais a permis d'effectuer des observations uniques en leur genre (voir pages 31 – 37).

En ce qui concerne le véhicule spatial, une analyse approfondie a donné une explication satisfaisante de la défaillance de la troisième électrode de l'une des batteries de bord. Il est fort probable que l'un des éléments de cette batterie ait perdu sa capacité, sans toutefois entraîner de répercussion notable sur les opérations scientifiques. Pendant les périodes d'ombre, on a pu constater que les batteries assumaient de manière régulière leur part d'alimentation électrique du satellite. Il n'a pas été jugé nécessaire de modifier les procédures relatives aux opérations scientifiques. Au niveau des caméras embarquées, on a trouvé le moyen de limiter le recours à de fortes surexpositions. Le principal souci était de réduire les effets de ces expositions sur les spectres obtenus lors d'opérations ultérieures destinées à d'autres programmes scientifiques. Le satellite poursuit sa mission scientifique sans dégradation notable.

Les travaux relatifs à l'obtention d'un nouveau produit IUE accessible à distance, les données d'archives uniformisées à faible dispersion (ULDA), ont progressé de manière satisfaisante et la première version de cet ensemble de données, ainsi que son logiciel d'accès (USSP) ont été intégrés à Villafranca et leur mise en place dans les instituts nationaux commencera prochainement.

Giotto

Giotto a été mis en hibernation le 2 avril 1986, décrivant depuis lors une orbite autour du Soleil tous les dix mois. On prévoit actuellement de remettre en route et de contrôler le véhicule spatial et tout son appareillage scientifique à la fin de 1989 ou au début de 1990, lorsque Giotto reviendra en direction de la Terre. On déterminera alors si l'état de l'ensemble lui permet de poursuivre sa mission, en vue d'une rencontre avec la comète de courte période Grigg Skjellerup, en juillet 1992.

Au cours des études de planification préliminaires effectuées dans ce but, on a pu constater, au vu des enregistrements, que l'attitude de Giotto sortait des limites préconisées. Un examen a révélé une erreur de calage de 180°. Or, le fait n'a pu être constaté qu'à la lecture d'un récent rapport de l'industrie, retraçant l'historique de la présentation par rapport au Soleil et de la distance au Soleil pendant la période d'hibernation. Si l'engin était resté en état opérationnel normal, on aurait pu détecter et corriger rapidement cette anomalie. Un examen technique initial de la situation a abouti à la conclusion qu'étant donneé les conditions d'attitude et de Présentation par rapport au Soleil qu'a effectivement connues l'engin, la plupart des sous-systèmes auront été soumis à des températures excédant la limite de 50C stipulée pour la qualification. L'apparition de défaillances soudaines et graves semble peu probable, étant donné qu'aucun composant à forte dissipation de chaleur ne se trouvait sous tension. Un jugement précis ne pourra toutefois être prononcé qu'après la remise en marche et la vérification complète de l'engin.

Sur le plan scientifique, l'évaluation et l'analyse des données se poursuivent activement, souvent en collaboration avec des chercheurs travaillant sur les données en provenance des autres sondes spatiales qui se sont approchées de la comète de Halley et avec des observateurs au sol. Le compte rendu du colloque qui s'est tenu à Bruxelles sur la diversité et la similitude des comètes (ESA SP-278) est publié en novembre 1987. Les deux volume de la série 'Astronomie et astrophysique', consacrés à la comète de Halley, sont annoncés pour novembre-décembre 1987.

Télescope spatial

Activités de la NASA

Le dernier calendrier des tirs de la NASA mentionne le 1er juin 1989 comme date de lancement du Télescope. Il s'agira de la sixième mission depuis la reprise des vols sur la Navette Discovery.

ISEE

ISEE-1 and ISEE-2 were both launched on the same Delta rocket from Cape Kennedy on 22 October 1977. ISEE-2 represented ESA's investment in this collaborative programme with NASA, which besides ISEE-1 and ISEE-2 as tandem spacecraft in the Earth's magnetosphere, also included ISEE-3 far upstream in the solar wind.

On 26 September 1987, ISEE-1 and ISEE-2 re-entered the Earth's atmosphere as foreseen due to orbital degradation resulting in low perigee passes. This marked close to 10 years of successful operations of these spacecraft without any significant degradation of spacecraft systems, and with scientific payloads still providing the prime scientific parameters (see article on pages 38 – 44 of this issue).

The International Sun–Earth Explorer (ISEE) programme has been a very successful one, contributing to the understanding of physical processes in the Earth's plasma environment under the influence of the Sun and the solar wind. As such the programme was a natural continuation of the exploratory phase carried out by earlier US and Soviet spacecraft. The ISEE programme also enhanced the cooperation between American and European science communities in this field and resulted in a large number of high quality publications and presentations at scientific conferences.

The European community gained an extra bonus from this programme when ISEE-3 was re-routed first to make passes deep in the Earth's magnetotail in 1983 – 1984 and was then sent, assisted by the Moon's gravity, to Comet Giacobini Zinner, which was passed in September 1985.

IUE

The International Ultraviolet Explorer (IUE) started its tenth year of observations on 1 June 1987. At its annual meeting the European IUE Allocation Committee allocated time to 138 of the 201 observing proposals submitted. The observations for this period started nominally, although some delays were incurred due to the backlog caused by the supernova SN 1987A observations in the previous months. The unanticipated behaviour of SN 1987A disrupted the schedule more than was expected but this unique opportunity (see article on pages 31 – 37) certainly justifies these delays.

On the spacecraft side, the problem due to the failure of the third electrode in one of the on-board batteries is reasonably well understood after detailed analysis. It is most likely that one cell of this battery has lost capacity. This does not, however, significantly affect the science operations. During the shadow seasons the batteries were found to share the full spacecraft power load in a regular way and it was not necessary to change the science operational procedures. A new policy was established to limit the use of heavy over-exposures on the IUE cameras. This was mainly driven by the desire to limit the effect of such exposures on the spectra taken in subsequent shifts. The IUE spacecraft continues to support the science operations without significant degradation.

Development of a new IUE output product — the remotely accessible Uniform Low Dispersion Archive (ULDA) — has progressed satisfactorily and the first version of this data set, together with its access support software (USSP), has been integrated at Vilspa. Installation of the ULDA/USSP in national host institutes will start shortly.

La salle de contrôle IUE à la station de poursuite de Villafranca

The IUE control room at the Villafranca tracking station (Vilspa)

Giotto

Giotto has been in a hibernation configuration since 2 April 1986, orbiting the Sun with a period of 10 months. It is currently planned to switch on and check out the spacecraft and all experiments at the end of 1989 or early 1990, when the spacecraft will again be approaching the Earth, to find out whether the spacecraft and experiment health will allow a continuation of the Giotto mission for an encounter with the short-period comet Grigg Skjellerup in July 1992.

During the preliminary planning studies in preparation for these activities, examination of the Giotto attitude records indicated that the attitude was outside the preferred range. On investigation it was found that a translation error of 180° had arisen in setting the attitude. This was only revealed following recent submission of an industrial report which reviewed the solar aspect angle and solar distance history during hibernation. If the spacecraft had been under full and normal operational conditions this would have quickly been detected and corrected. An initial engineering

Space Telescope in the clean room at Lockheed

Le Télescope spatial en salle propre chez Lockheed

Générateur solaire

On prévoit de renvoyer les ailes du générateur solaire en Europe au début de 1988 pour retouches. On remplacera les nappes de cellules existantes par de nouvelles, résistant à l'oxygène atomique et faisant gagner 10% en puissance. Un plan de secours est également à l'étude pour assurer la protection des nappes existantes en cas de retard de livraison.

Chambre pour objets faibles

La seconde phase de l'étalonnage de la chambre à la pression atmosphérique a pris fin en octobre 1987. La chambre sera remontée dans le Télescope spatial en janvier 1988.

Ulysse

Le calendrier des vols de la Navette, établi pour la période 1988 – 1990, confirme que le lancement d'Ulysse est prévu pour octobre 1990. Cette date dépend bien entendu de la reprise des vols de la Navette en juin 1988.

L'essentiel des travaux reste consacré à l'élaboration et au maintien de l'interface avec les étages propulsifs IUS et PAM-S, qui serviront à placer Ulysse sur sa trajectoire interplanétaire à destination de Jupiter, après son largage de la Navette. Les inquiétudes que suscitaient initialement les performances et la précision d'injection sont désormais levées, et tout laisse présager la réussite de cette mission scientifique.

Le calendrier des travaux de recertification et de lancement a été revu et affiné, confirmant avant tout la volonté de commencer les travaux sur le matériel dès la fin de 1988 et la campagne de tir en avril 1990. La fenêtre de tir va du 5 au 22 octobre 1990.

Hipparcos

La revue des résultats de la qualification au niveau du système a eu lieu à Toulouse au cours de la troisième semaine de septembre 1987. Elle a été essentiellement consacrée aux essais, au niveau système, des modèles mécanique et optique du véhicule spatial et de sa charge utile, et aux essais du modèle d'identification intégré. Les résultats sont apparus très satisfaisants. Certains travaux confiés à l'industrie en vue de la qualification du satellite devaient s'achever vers la mi-novembre.

Les activités d'intégration et de vérification du modèle d'identification du satellite se sont achevées sans encombre. Le satellite se trouve désormais chez le maître d'oeuvre, où il va être soumis à des essais complémentaires imposés par l'ambiance de lancement d'Ariane-4.

Les activités d'essais et d'étalonnage du prototype-modèle de vol de la charge utile se sont achevées, mettant ainsi un terme aux travaux à accomplir sur le module autonome de la charge utile. Cette dernière est prête à être transportée chez Aeritalia, où elle sera intégrée au véhicule spatial dans la première semaine de novembre.

L'intégration et les essais du prototype-modèle de vol de la charge utile touchent à leur fin. L'électronique de pilotage et la centrale inertielle du sous-système de correction d'attitude et d'orbite ont été livrées à Aeritalia pour être intégrées au véhicule spatial. Il reste à apporter une légère modification à l'alimentation auxiliaire, sans conséquence sur le calendrier. Entretemps, l'intégration se poursuit avec la substitution du modèle d'identification de l'alimentation auxiliaire au prototype-modèle de vol. Les travaux d'intégration doivent s'achever début décembre, après quoi le satellite entièrement intégré sera transporté à Toulouse, chez INTESPACE, en vue des essais de recette mécanique.

assessment of the current situation has concluded that with the set attitude and solar aspect angle conditions, most of the subsystem temperatures will have exceeded qualification limits of 50°C. It is considered unlikely that any catastrophic failure will have resulted, since there are no high dissipative components powered. An accurate assessment can only be made, however, following a spacecraft switch-on and full checkout.

On the science side, the data evaluation and analysis is continuing very actively, in many cases in collaboration with investigators on the other Halley flyby spacecraft and ground-based observers. The Proceedings of the Brussels Symposium on 'The Diversity and Similarity of Comets' (ESA SP-278) was published in November 1987; the two Halley dedicated volumes of 'Astronomy and Astrophysics' are expected in November/December 1987.

Space Telescope

NASA
The most recent NASA launch manifest shows the Space Telescope launch on 1 June 1989, the sixth mission after the resumption of flights on the Orbiter Discovery.

Solar array
Plans are in preparation for the return of the solar-array wings to Europe for reworking in early 1988. The solar array blankets will be replaced with a new set which are resistant to atomic oxygen and will also provide 10% more power. A back-up plan is also underway to protect the existing blankets in case the new flight blankets are late.

Faint Object Camera
The second phase of in-air calibration of the Faint Object Camera (FOC) was completed in October 1987. The FOC will be reinstalled in the Space Telescope in January 1988.

Ulysses

The Shuttle-flight manifest for the period 1988–1990 confirms the launch of Ulysses for October 1990. This date is of course dependent upon Shuttle flights recommencing in June 1988.

The main activity has continued to be the establishment and maintenance of the interface with the Inertial Upper Stage (IUS) and Payload Assist Module (PAM-S) which jointly, after deployment from the Shuttle, place Ulysses upon the interplanetary trajectory towards Jupiter. After some early concerns about performance and injection accuracy, both of these areas now seem to be under control and the indications for a successful scientific mission are good.

The schedule for recertification and launch activities has now been reassessed and established in more detail. This reaffirms the intention to start hardware activity at the end of 1988 and the launch campaign in April 1990. The launch window stretches from 5–22 October 1990.

Hipparcos

The system-level Qualification Results Review, held in Toulouse in the third week of September 1987, concentrated upon system-level testing of structural/optical models of the spacecraft and payload and of the integrated engineering-model satellite. The results were largely found to be satisfactory. A few actions placed upon industry, required for satellite qualification, were scheduled to be completed by mid-November 1987.

The nominal integration and verification activities for the engineering-model satellite have been completed and the satellite has been shipped to the Prime Contractor where it is being prepared for an additional test necessitated by Ariane-4 launch environmental conditions.

Proto-flight model (PFM) payload testing and calibration activities have been completed, concluding the work to be performed on the stand-alone payload module. The payload has been prepared for shipment and will be transported to Aeritalia for integration with the spacecraft during the first week of November.

PFM spacecraft integration and testing is nearing its conclusion. The Attitude and Orbit Control Subsystem (AOCS) control law electronics and inertial reference unit have been delivered to Aeritalia and integrated with the spacecraft. A minor modification is required within the auxiliary power supply (APS), but is expected to be completed shortly. In the interim, spacecraft integration is continuing by substitution of the engineering model APS for that of the PFM model. Integration activities are scheduled for completion in early December, and the fully integrated satellite will then be shipped to INTESPACE, Toulouse, for mechanical-acceptance testing.

ISO

The mid-term review of the satellite system design phase held at the end of May 1987 showed a clear convergence of the definition of the system. A strong effort was made to improve thermal analysis prediction models which now appear satisfactory for the payload module. There is still a potential problem in that the sunshield temperature is too high to use qualified solar cell technology. Materials are being ordered as necessary to safeguard the total programme schedule. The planned satellite system assembly, integration and verification programme (Phase C/D) has been rationalised with the Prime Contractor.

The design system phase was due for completion at the end of October 1987, after which ESA will conduct a formal review of the results. The Request for Quotation (RFQ) for Phase C/D was released in June 1987 and included the request that the tenderer solicit competitive proposals for the optical subsystem, data-handling subsystem, ground support equipment and hi-rel parts procurement. The industrial phase proposal is expected to be submitted to ESA by the end of November 1987, implying the start of Phase C/D in mid-March 1988.

Development of the scientific instrument engineering models is continuing and the definition of interfaces with the satellite is evolving in more detail. The satellite design can accommodate the present mass and volume requirements of the instruments but further work is required

ISO

La revue à mi-étude de la phase de conception du satellite au niveau système qui a eu lieu fin mai fait ressortir une nette convergence de la définition du système. Une attention particulière a été consacrée à l'amélioration des modèles utilisés pour le calcul thermique, qui semblent désormais satisfaire aux exigences du module de charge utile. Il subsiste un problème potentiel, à savoir celui de l'écran solaire, dont la température est trop élevée pour que l'on puisse recourir à une technologie déjà qualifiée de cellules solaires. Les matériaux sont commandés selon les besoins pour ne pas compromettre le calendrier de l'ensemble du programme. Le programme prévu pour l'assemblage, l'intégration et la vérification du satellite au niveau système a été rationalisé avec le maître d'oeuvre.

La phase de conception du système doit être achevée fin octobre, puis l'Agence procèdera à la revue officielle des résultats. L'invitation à soumissionner relative à la phase industrielle (phase C/D) a été diffusée par l'Agence en juin 1987. Le soumissionnaire y était invité à solliciter des offres auprès de la concurrence en ce qui concerne le sous-système optique, le sous-système de traitement de données, l'équipement de soutien au sol et l'acquisition des composants haute fiabilité. La proposition concernant la phase C/D doit être soumise à l'Agence fin novembre 1987, de sorte que cette phase devrait commencer vers la mi-mars 1988.

L'élaboration des modèles d'identification des instruments scientifiques se poursuit et la définition des interfaces avec le satellite est entrée dans une phase plus détaillée. La conception du satellite est conforme aux exigences actuelles en matière de masse et de volume des instruments, mais il reste à résorber les excédents de ressources allouées par rapport à la puissance et au nombre des fils électriques qui traversent la paroi extérieure du cryostat.

ECS

ECS-4, le quatrième exemplaire de vol du système ECS, a été lancé avec succès par Ariane, sur le vol V-19, dans la nuit du 15 au 16 septembre 1987, en compagnie d'Aussat-K3, un satellite de télécommunications construit par Hughes Aircraft pour l'Australie.

Ce vol a permis d'obtenir une remarquable précision des paramètres de l'orbite de transfert. Le moteur d'apogée MAGE-2 d'ECS-4 a été allumé trente-sept heures après le lancement pour placer le satellite sur une orbite de défilement. Le moteur a lui aussi fourni l'accélération requise avec une extrême précision (écart de 0,1%). La conjugaison de ces excellentes performances s'est traduite par une économie importante de combustible lors des manoeuvres initiales du satellite, équivalant à la masse d'hydrazine consommée pendant cinq à six mois pour la venue de poste dans la direction nord-sud.

ECS-4 occupe désormais sa position géostationnaire définitive à 10°E. Les opérations préliminaires de mise en service ayant été couronnées de succès, Eutelsat a pris possession du satellite pour en commencer l'exploitation. Le 30 octobre 1987, ECS-4 a pris le nom d'Eutelsat-I-F4.

Quant à Eutelsat-I-F1 et F2 (dénommés initialement ECS-1 et ECS-2), ils sont exploités de manière permanente par Eutelsat pour la télédistribution, l'Eurovision, les liaisons téléphoniques et les services spécialisés de télécommunications à l'échelle européenne. ECS-3 a en revanche été perdu lors du vol V15 d'Ariane. ECS-5, le dernier satellite de la série, doit être lancé vers le milieu de 1988.

Olympus

Après les essais d'équilibre thermique effectués au Jet Propulsion Laboratory, les laboratoires David Florida d'Ottawa ont achevé le montage en rattrapage de certains matériels en septembre 1987. Les panneaux de communication nord et sud ont été remontés et, l'intégration étant terminée, l'exemplaire de vol du véhicule spatial est prêt à être soumis aux essais électriques. Il a été installé dans la chambre anéchoïque des laboratoires David Florida, où il a subi une série d'essais d'écartométrie simulant les conditions du champ lointain. Une revue des essais a eu lieu en octobre, et la commission de revue en a jugé les résultats satisfaisants, mais il reste certains tests à effectuer.

Les essais électriques du véhicule spatial se sont poursuivis parallèlement aux essais de base du système de communications, faisant intervenir les quatre charges utiles, et au essais du système intégré, effectués à tous les stades importants de la phase d'essais d'environnement du système. La première de ces deux séries d'essais devrait prendre fin début novembre et sera suivi d'une revue des essais. Une revue similaire aura ensuite lieu dans le courant de ce même mois pour examiner les résultats des essais du système intégré. Le véhicule spatial devra ensuite être préparé en vue des essais de compatibilité entre charges utiles, puis des essais de compatibilité électromagnétique, qui seront tous effectués pendant qu'il se trouve en chambre anéchoïque. Le lancement aura lieu à l'occasion du vol Ariane V-30, prévu pour janvier 1989.

Une revue de recette officielle du centre de contrôle des opérations s'est tenue en septembre 1987 à Frascati, en Italie.

Après une acquisition échelonnée, les stations terriennes destinées à l'exploitation d'Olympus après son lancement sont, pour la plupart, en voie d'achèvement. Quant à TDS-7, le dernier type de station, un appel d'offres a été diffusé.

Les préparatifs en vue de l'exploitation du satellite Olympus-1 après son lancement se déroulent comme prévu, et un rapport de situation détaillé a été présenté aux pays membres lors de la réunion qui a eu lieu en octobre 1987 au Jet Propulsion Laboratory.

DRPP

Dans le cadre du Programme préparatoire de système de relais de données (DRPP), phase A1 d'étude a commencé. Deux études parallèles sont en cours chez deux groupes industriels, sous la conduite de Matra et de MBB, Allemagne. Cette première phase d'étude se poursuivra jusqu'en mars 1988, pour aboutir à une définition initiale de l'ensemble du système, y compris les satellites relais, les terminaux à installer en orbite basse et le secteur terrien correspondant.

to resolve resource allocation problems with respect to power and the number of electrical wires through the cryostat outer wall. The instrument development schedules are tight.

ECS

ECS-4, the fourth flight unit of the ECS system, was successfully launched by Ariane flight V19 during the night of 15-16 September 1987. Its co-passenger was Aussat-K3, an Australian telecommunications satellite manufactured by Hughes Aircraft.

The accuracy of the transfer orbit parameters provided by Ariane V19 was exceptionally high. 37 h after launch the ECS-4 MAGE-2 Apogee Boost Motor was ignited and injected the satellite into drift orbit. Once again the motor delivered the required velocity increase with a very high accuracy (0.1% deviation). The combination of these very good performances led to an important saving of on-board fuel for initial satellite manoeuvres, a saving corresponding to the hydrazine mass needed for 5–6 months of north/south station keeping.

The satellite is now stationed at its final geostationary position at 10°E. Having been successfully commissioned, the satellite was transferred to Eutelsat to start its operational life. On 30 October ECS-4 became Eutelsat-1-F4.

Eutelsat-I-F1 and -F2 (formerly ECS-1 and -2 respectively) are permanently used by Eutelsat for cable television, Eurovision, telephony and specialised telecommunications services throughout Europe. ECS-3 was lost onboard Ariane V15. ECS-5, the last of the ECS series, is due to be launched in mid-1988.

Olympus

Retrofitting of some equipment after the thermal balance test at the Jet Propulsion Laboratory (JPL) was completed at the David Florida Laboratories (DFL), Ottawa in early September 1987. The north and south communications panels were then reinstalled and integration of the flight spacecraft completed ready for the start of electrical testing. The spacecraft was installed in the anechoic chamber of the DFL facility and a series of radio-frequency sensing tests performed in which the far-field condition was simulated. A test review board in October concluded that the results were satisfactory with some tests remaining to be performed later in the programme.

Electrical testing of the spacecraft continued in parallel with the communications baseline test (CBT), which tests the four payloads, and the integrated system test (IST), which is performed at significant points throughout the system environmental test phase. The CBT tests are expected to be completed early in November 1987 and a test review board will then be held. A review of the IST results is planned for later in November. The spacecraft will then be prepared for payload inter-compatibility and subsequent electromagnetic compatibility testing, both conducted while the spacecraft is still in the anechoic chamber. Launch is currently scheduled for January 1989 on Ariane V-30.

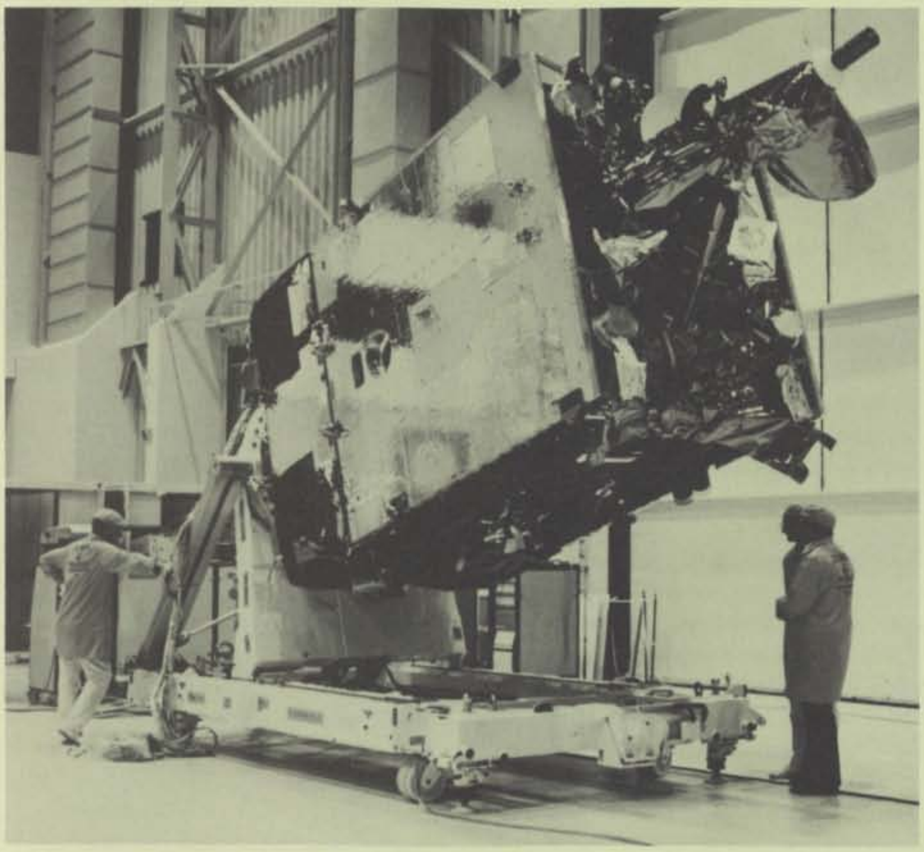
A formal acceptance review of the Operations Control Centre (OCC) at Frascati, Italy was held in September 1987.

The ground stations to be used with Olympus after launch have been procured progressively and most are now nearing completion. The Request for Quotations (RFQ) has now been issued for the last station type, TDS-7.

Preparations for the programme to utilise the Olympus-1 spacecraft in orbit after launch are proceeding according to plan and a detailed situation report was presented to the Member countries at the Joint Communications Board meeting in October 1987.

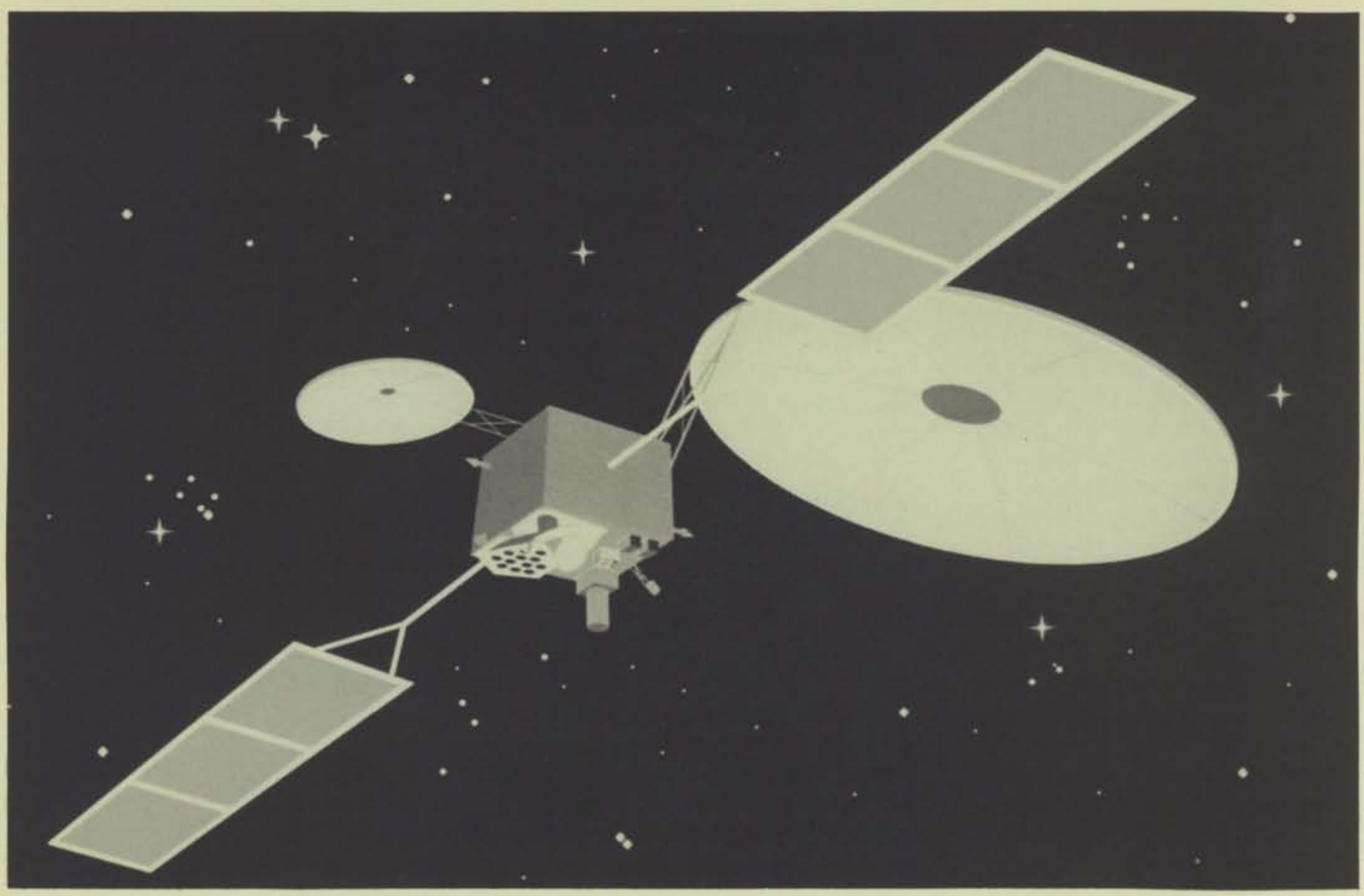
DRPP

Phase-A1 studies of the Data Relay System (DRS) have begun in the context of the Agency's Data-Relay Preparatory Programme (DRPP). Two parallel studies are being conducted by industrial groupings led by Matra, France and MBB, Germany. The first will run until March 1988 and will lead to an initial definition of the complete DRS including



Le satellite Olympus chez DFL à Ottawa

The Olympus spacecraft at DFL, Ottawa



Concept for an advanced communications spacecraft (PSDE programme)

Vue imaginaire d'un satellite de télécommunications d'avant-garde (programme PSDE)

Un contrat a été adjugé à Newtech, Belgique et à SPL, Royaume-Uni pour le développement et la construction de la maquette électrique d'un codeur-décodeur (CODEC) ultra-rapide. Cet élément est essentiel, compte tenu des cadences de transmission très élevées que l'on envisage. Il sera intégré au banc d'essai d'une voie à grand débit pour permettre de vérifier les hypothèses relatives au système.

De nouvelles négociations ont eu lieu avec la NASA et la NASDA pour déterminer quel doit être le degré d'interfonctionnement entre le système de relais de données européen et ses équivalents américain au japonais.

PSDE

Le programme de développement et d'expérimentation de charges utiles et de satellites (PSDE) de l'Agence, d'une durée de dix ans, est destiné à faire progresser la technologie européenne des télécommunications de 1985 à 1995.

Ce programme prévoit la mise au point d'une grande variété de charges utiles de télécommunications, dont certaines doivent être testées en orbite au début des années 1990.

Trois missions sont actuellement prévues, à savoir:
- *l'emport d'une charge utile évoluée de télécommunications avec des mobiles (Aramis) à bord de Sat-1*
- *une mission technologique de télécommunications à bord de Sat-2*
- *l'emport d'une charge utile de télécommunications et de navigation à partir d'une orbite inclinée (Archimedes) à bord de Sat-3.*

Des accords doivent encore être conclus avec divers organismes avant que ces missions puissent être accomplies, mais le prédéveloppement des charges utiles se poursuivra au cours de la première partie du programme PSDE proprement dit.

Les charges utiles à forte teneur technologique qui exigent d'importants travaux de développement ainsi qu'une démonstration en orbite doivent prendre place à bord de PSDE/Sat-2. A cet égard, on envisage actuellement les applications suivantes:
- *communications optiques entre des satellites géostationnaires et des satellites en orbite basse*
- *liaisons de données en bande S vers des terminaux à un seul ou à plusieurs utilisateurs en orbite basse*
- *communications avec des mobiles terrestres*
- *propagation, communications et liaisons entre satellites à de très hautes fréquences*
- *charges utiles de navigation.*

La priorité est donnée au développement des charges utiles, et on prévoit donc d'utiliser pour cette mission des plates-formes existantes. Cela dit, on envisage aussi d'apporter certains perfectionnements, de portée limitée, à la technologie du véhicule spatial, notamment s'ils concourent à résoudre les problèmes critiques d'interface avec des charges utiles délicates.

Les charges utiles à embarquer sur PSDE/Sat-2 seront sélectionnées début 1988. Les travaux de prédéveloppement et les études concernant l'implantation des charges utiles à bord des satellites the data-relay satellites and the associated ground segment.

A contract for the development and breadboarding of a very high speed encoder and decoder (CODEC) has been awarded to Newtech, Belgium with SPL, UK. This item of equipment is essential to permit operation at the very high data rates envisaged. The CODEC will be incorporated into a test bed of a high data rate DRS channel to verify the system assumptions.

Further discussions have been held with NASA and NASDA to examine what degree of interoperability is desirable between the European DRS and the equivalent American and Japanese systems.

PSDE

The Agency's Payload and Spacecraft Development and Experimentation (PSDE) programme, is a ten-year programme designed to advance European communications technology in the period 1985–1995.

A large variety of new communications payloads are to be developed in the course of this programme, some of which are intended to be verified in orbit during the early 1990s.

Three missions have been planned so far, for the following applications:
- an advanced mobile communications payload (ARAMIS), on Sat-1
- a communications technology mission on Sat-2
- a communications and navigation via inclined orbits payload (Archimedes) on Sat-3.

Realisation of these missions is still subject to agreements with various bodies, although the pre-development of payloads will proceed within the first part of the PSDE programme itself.

Those PSDE payloads that have a very strong technological element and that require a significant development effort, combined with a need for in-orbit demonstration, are intended to be flown on PSDE/Sat-2. They include:
- optical communication between geostationary and low-orbiting satellites
- S-band data links to single- and multiple-user terminals in low orbit
- land-mobile communications
- propagation, communications and intersatellite links at extremely high frequencies
- navigational payloads.

The emphasis is on payload development and existing platforms are therefore expected to be used for this mission. Some limited advancements in spacecraft technology are, however, also being considered, particularly where they assist in solving critical interfaces with sensitive payloads.

The payloads to be flown on PSDE/Sat-2 are to be selected early in 1988. The pre-development effort as well as studies associated with the accommodation of the payloads on the satellite platforms will lead to the awarding of a development contract to a single Prime Contractor during the course of 1989.

Delivery of the satellite for launch is presently planned for mid-1993. Preparations are already being made for cooperation with other agencies in establishing in-orbit links between PSDE/Sat-2 and other satellites.

ERS

Development phase work is now at its peak, with the space segment Critical Design Review in full swing at the end of October. This major system review, scheduled for completion in mid-November 1987*, will give the green light for release of the design for flight-model manufacturing. However, pending this approved flight model, in view of the tight schedule, some manufacturing has already commenced.

Flight-model-satellite assembly, integration and testing is scheduled to begin in mid-1989, leading up to the Flight Acceptance Review at the end of 1989 and launch readiness in March 1990. These dates remain critical due mainly to the late availability of hi-rel parts and delays in the engineering-model programme, which is now expected to be completed at the end of 1988.

*See p. 90 for latest information.

Following the ERS-1 Announcement of Opportunity, the Executive's proposal for the preselection of investigators was approved by the Earth Observation Programme Board at its mid-October 1987 meeting. The Board also approved the proposed course of action for final selection.

After some iterations with Industry, an offer for the procurement of a second Flight Unit (ERS-2), identical as far as possible to ERS-1, has been submitted. This forms a reasonable basis for further negotiations with Industry and for discussions with potential participants on the programme proposal and associated declaration.

Earthnet

Landsat

Landsat-5, now in its fourth year of operations, has performed nominally, as have the Fucino, Kiruna and Maspalomas ground stations. New developments such as the Quick-Look Thematic Mapper, the interconnection between stations and Earthnet Central Facility have been completed successfully and are currently being tested.

MOS-1

The Meteosat Operational System (MOS-1) spacecraft is performing nominally. Procurement for the Kiruna and Maspalomas acquisition chains has been completed and acquisition tests with the spacecraft successfully performed. Work for Fucino and Tromsø stations and the processing chains for all stations is in progress.

The response to the Agency's Announcement of Opportunity for the utilisation of MOS-1 data has been encouraging. 64 replies were received covering all themes of the AO. Follow-on missions MOS-1b and J-ERS-1 have been approved by the Japanese authorities for launch in 1990 and 1992 respectively.

The MOS-1 station network includes four Japanese (two in Japan, one in Thailand and one in Antarctica) and three ESA (Fucino, Kiruna and Maspalomas) stations and one station in Australia.

Tiros

Tiros-9 and -10 are performing nominally and data is being acquired at Maspalomas and Tromsø.

déboucheront courant 1989 sur l'attribution d'un contrat de phasse C/D à un contractant principal unique.

La livraison du satellite, prêt pour le lancement, est actuellement prévue pour le milieu de 1993. On a déjà posé les jalons d'une coopération avec d'autres agences, en vue d'établir des liaisons en orbite entre PSDE/Sat-2 et d'autres satellites.

ERS

La phase de développement du projet bat maintenant son plein et un temps fort dans le déroulement des travaux sera atteint fin octobre lors de la revue critique de la conception du secteur spatial. Cette revue majeure du système, qui s'achèvera vers la mi-novembre 1987, donnera le signal de départ de la fabrication du modèle de vol. Toutefois, avant même que la conception de ce dernier ait été approuvée, certains travaux de fbrication ont déjà commencé en raison des impératifs du calendrier.

L'intégration et les essais du modèle de vol du satellite doivent commencer vers le milieu de 1989, la revue d'aptitude au vol étant prévue pour fin 1989 et la répétition générale du lancement pour mars 1990. Ces dates demeurent critiques, en raison surtout de la disponibilité tardive des composants haute fiabilité et du retard du programme d'élaboration du modèle d'identification, dont l'achèvement est prévu pour fin 1988.

A la suite de l'offre de participation à ERS-1, le Conseil directeur du programme d'observation de la Terre a approuvé, à sa réunion de la mi-octobre, la proposition de l'Exécutif relative à la présélection des candidats. Le Conseil a également approuvé les mesures proposées pour la sélection finale.

Des contacts répétés avec l'industrie ont abouti à la formulation d'une offre relative à l'acquisition d'une deuxième unité de vol (ERS-2), identique dans toute la mesure du possible à ERS-1. Cette offre est un bon point de départ en vue des négociations qui auront lieu ultérieurement avec les constructeurs ou de discussions avec des participants potentiels sur la proposition de programme et sur la déclaration qui sera faite dans ce cadre.

Earthnet

Landsat

Landsat-5, qui entre maintenant dans sa quatrième année d'exploitation, donne toute satisfaction, à l'égal des stations terriennes de Fucino, Kiruna et Maspalomas. De nouveaux perfectionnements ont été menés à bien et sont en cours d'essais. On peut citer à ce sujet l'instrument de cartographie thématique à visualisation rapide ainsi que l'interconnexion entre les stations et l'installation centrale Earthnet.

MOS-1

Le système Météosat opérationnel MOS-1 donne pleine satisfaction. Les acquisitions destinées aux chaînes de saisie de Kiruna et de Maspalomas ont pris fin et les essais de saisie effectués avec le véhicule spatial sont concluants. Quant aux stations de Fucino et de Tromsø et aux chaînes de traitement destinées à toutes les stations, les travaux se poursuivent.

Les réponses qu'a reçues l'Agence à son offre de participation à l'exploitation des données de MOS-1 sont encourageantes. L'ensemble de ces réponses, soixante-quatre au total, recouvre toutes les rubriques de l'offre. Les autorités japonaises ont approuvé les missions suivantes MOS-1b et J-ERS-1 (dates de lancement respectives: 1990 et 1992).

Le réseau MOS-1 comprend quatre stations japonaises (deux au Japon, une en Thaïlande et une dans l'Antarctique), trois stations de l'ESA (Fucino, Kiruna et Maspalomas) et une station en Australie.

Tiros

Tiros-9 et -10 fonctionnent conformément aux prévisions et leurs données sont reçues aux stations de Maspalomas et de Tromsø.

ERS-1

Le contrat de phase B relatif au service utilisateur central et aux quatre installations de traitement et d'archivage arrive à son terme et des négociations sont en cours pour les phases suivantes.

Des demandes de prix ont été émises pour l'acquisition auprès de MDA (Canada) des chaînes de traitement à sortie rapide des données, destinées aux stations de Fucino, Gatineau et Maspalomas.

Earthnet facilities at ESRIN in Frascati, Italy

Une installation Earthnet à l'ESRIN, Frascati

ERS-1
The Phase-B contract for the Central User Service (CUS) and for the four Processing and Archiving Facilities (PAFs) are near to completion and contract negotiations for the follow-on phases are in progress.

Tenders have been issued for the procurement of Fast Delivery Processing Chains for Fucino, Gatineau and Maspalomas with MDA (Canada).

EOPP

Solid Earth (Aristoteles)
Progress continues rapidly following the approval of the Phase-A activities by the Earth Observation Programme Board in June 1987. A competitive Invitation to Tender for Phase-A study was issued to Industry in July and an offer received in September is currently being evaluated. Other actions have been initiated for studies of data pre-processing and data analysis. Negotiations are in progress with Industry concerning technological aspects of the gradiometer, the main payload of the satellite. European scientists are now active in organising scientific and organisational schemes for possible implementation in the next phase of the programme.

Second-Generation Meteosat
Industrial activities on the Imaging Radiometer and Lightning Flash Detector are proceeding according to schedule. Study contracts have been awarded for the Sun–Earth Radiation Budget Instrument, the Microwave Sounder, and for a pre-Phase-A system study.

Informal contacts with Eumetsat have been established in order to harmonise future cooperation between the two organisations.

Polar Platform
A sixth coordination meeting has been held in ESTEC with the other Space Station partners, addressing mainly the preparation of the forthcoming NASA and ESA Announcements of Opportunity. A draft version of the European AO was presented at the Earth Observation Advisory Group in September 1987.

The Agriscatt airborne campaign, using a multifrequency microwave scatterometer and two imaging radars, was successfully completed in September and data have been distributed to scientific investigators for assessment. In total five sorties were performed at four sites during the growing season and their results will undoubtedly contribute to the understanding of physical imaging processes in land applications.

Meteosat

Preoperational programme
The launch of Meteosat-P2 on the Ariane-4 test flight was originally scheduled for February 1988.

The P2 spacecraft was therefore unpacked from its storage container and baseline tests were completed in mid-October in order to leave a month's margin for any necessary corrective action before satellite and mechanical, electrical and ground segment equipment departure.

The slippage in the Ariane-4 launch schedule means that Meteosat-P2 will not now be launched before end-April 1988.

Meteosat Operational Programme (MOP)
Flight-hardware manufacture and system testing for the three MOP spacecraft is progressing satisfactorily at Aerospatiale. On MOP-1, system testing was temporarily suspended while the project team prepared the P2 spacecraft for launch. MOP-1 activities will be resumed early in 1988.

Ground segment
Work is continuing on refurbishment and improvement of existing equipment. In preparation for MOP-1 operations, the satellite simulator and Operations Control Centre (OCC) software user requirements document is essentially complete, whilst the preparation of the flight operations plan and the spacecraft data operations handbook is continuing satisfactorily.

Microgravity

Phase-2
NASA has recently announced that the International Microgravity Laboratory (IML-1) mission has been further delayed by one year from April 1990 until April 1991 (the original date was May 1987). The German-D2 mission also suffers an additional delay of some six months and is now foreseen for April 1992.

As a consequence of the Challenger accident NASA has established a more stringent safety policy. This means that Biorack needs to be checked to new safety requirements prior to IML-1 flight acceptance.

The contract with Aeritalia for the development of the fluid science experiment facility, the Bubble, Drop and Particle Unit (BDPU), has been placed.

The Automatic Mirror Furnace (AMF) engineering model has been delivered to the Microgravity User Support Centre (MUSC) at DFVLR, Porz Wahn and the flight model is undergoing thermal vacuum tests at IABG.

The Critical Design Review of the Critical Point Facility started at the end of September 1987.

A Call for Microgravity Experiments for future sounding rocket missions (Texus, Maser) was released at the end of September 1987.

Fifteen ESA experiments, mainly life-science experiments using Anthorack, were embarked on the mid-October NASA KC-135 parabolic flight. The scientific/technical results will be available in early 1988.

Two life-science experiments were carried out on the recent Biokosmos Mission, which lasted from 29 September–12 October 1987. These have been recovered safely and handed over to ESA. The samples are presently under analysis by the investigators and first indications are that the experiments performed well.

Phase-2 extension
Discussions are continuing on the extension of Phase-2, with the following main objectives:
- to bridge the gap in flight opportunities caused by the Challenger accident by use of Shuttle independent flight opportunities
- to maintain the interest and competence of the European microgravity-science communities and to attract the interest of new scientific groups.

EOPP

Programme 'Solide terrestre' (Aristote)
L'approbation des résultats de la phase A par le Conseil directeur du programme d'observation de la Terre en juin 1987 a accéléré la poursuite des travaux. Une invitation à soumissionner, concernant l'étude de phase A, a été diffusée en juillet auprès des industriels. Une offre, reçue en septembre, est en cours d'évaluation. Des dispositions similaires ont été prises en vue d'études relatives au prétraitement et à l'analyse des données. Des négociations ont été engagées avec l'industrie quant aux aspects technologiques du gradient-mètre, lequel forme la principale charge utile du satellite. Dans les milieux scientifiques européens, on s'emploie désormais à élaborer des méthodes scientifiques et des schémas d'organisation susceptibles d'être mis en oeuvre lors de la prochaine phase du programme.

Météosat de seconde génération
Les travaux relatifs aux radiomètres d'imagerie et au détecteur d'éclairs se poursuivent conformément aux prévisions chez les industriels. Des contrats ont été conclus pour l'étude de l'instrument de mesure du bilan de rayonnement Soleil—Terre et du sondeur hyperfréquence et pour une étude de pré-phase A au niveau du système.

Des contacts officieux ont été pris avec Eumetsat afin d'optimiser la coopération future entre les deux organisations.

Plate-forme méridienne
Une sixième réunion de coordination s'est tenue à l'ESTEC avec les autres partenaires du programmes de Station spatiale. Elle a été essentiellement consacrée à l'élaboration des offres de participation que l'ESA et la NASA diffuseront prochainement. Un projet d'offre de participation européenne a été présenté au Groupe consultatif du programme d'observation de la Terre en septembre 1987.

La campagne sur avion Agriscatt, mettant en oeuvre un diffusiomètre multifréquence et deux radars d'imagerie, s'est achevée avec succès en septembre et des résultats ont été communiqués aux chercheurs pour évaluation. Au total, cinq sorties ont été effectuées sur quatre sites au cours de la période de croissance de la végétation, et leurs résultats vont sans nul doute faciliter la compréhension des processus d'imagerie physique dans les applications agraires.

Météosat

Programme Météosat préopérationnel
Le lancement de Météosat P2 dans le cadre du vol de démonstration Ariane-4 était initialement prévu pour février 1988.

Le satellite a été retiré de son conteneur d'entreposage. Les essais de base ont été achevés mi-octobre, ce qui laissait une marge d'un mois pour prendre les mesures correctives éventuellement requises avant le départ du satellite, de l'équipement mécanique et électrique, et du matériel du secteur terrien.

Le glissement du calendrier de lancement d'Ariane-4 repousse maintenant le lancement de Météosat-P2 à fin avril 1988.

Programme Météosat opérationnel
La construction du matériel de vol et les essais d'ensemble se déroulent conformément aux prévisions à l'Aérospatiale, pour les trois exemplaires au programme. Les essais système sur MOP-1 ont été momentanément suspendus, pendant que l'équipe de projet prépare le satellite P2 en vue du lancement. Ils reprendront début 1988.

Quant au secteur terrien, les travaux de réaménagement et d'amélioration du matériel existant se poursuivent. En prévision de l'exploitation de MOP-1, le document sur les besoins des utilisateurs du logiciel du centre directeur des opérations et du générateur de stimuli est pratiquement achevé, tandis que l'élaboration du plan des opérations de vol et du manuel d'utilisation des données du satellite se poursuit comme prévu.

Microgravité

En ce qui concerne le Laboratoire international de microgravité (IML-1), la NASA a récemment annoncé que cette mission serait de nouveau retardée, d'avril 1990 à avril 1991 (la date en avait été initialement fixée à mai 1987). La mission allemande D2 a été retardée d'environ six mois supplémentaires et elle est maintenant prévue pour avril 1992.

A la suite de l'accident de Challenger, la NASA a fixé des règles de sécurité plus strictes. Il convient donc de vérifier si le Biorack répond à ces nouvelles exigences de sécurité, avant de se prononcer sur l'aptitude au vol d'IML-1.

Le contrat de développement de l'installation expérimentale de physique des fluides (unité 'bulles, gouttes et particules'), d'un montant de 7,9 millions d'unités de compte, a été conclu avec Aeritalia.

Le modèle d'identification du four à miroir automatique a été livré au centre d'assistance aux utilisateurs de la microgravité (MUSC) du DFVLR (Porz Wahn) et le modèle de vol est actuellement soumis à des essais en vide-température à l'IABG.

La revue critique de définition de l'installation d'étude des points critiques a commencé fin septembre.

Un appel aux propositions d'expériences de microgravité en vue des futures missions de fusées-sondes (Texus, Maser) a été diffusé fin septembre 1987.

Quinze charges utiles de l'Agence, destinées pour la plupart à des expériences dans le domaine des sciences de la vie et faisant appel à l'Anthorack, ont pris part au vol parabolique KC-135 de la NASA qui a eu lieu mi-octobre. Les résultats techniques et scientifiques seront disponibles au début de 1988.

Deux expériences en sciences de la vie ont été effectuées dans le cadre de la mission Biokosmos qui s'est déroulée du 29 septembre au 12 octobre. Le matériel a été récupéré sans problème et remis à l'Agence. Les chercheurs analysent actuellement les échantillons et il apparaît, au premier abord, que ces expériences ont été concluantes.

Microgravité — Extension de la phase 2
L'extension de la phase 2 est en discussion. Ses principaux objectifs sont les suivants:
- *compenser la raréfaction des vols consécutive à l'accident de Challenger en recourant à des moyens indépendants de la Navette;*

Spacelab and IPS

Spacelab-contract closeout activities are scheduled for completion before the end of 1987, excepting work on the Payload Interface Adaptor (PIA) which will continue into 1988. The hardware failures experienced with the Instrument Pointing System (IPS) fixed-head star trackers have been corrected and all units are back at the Prime Contractor for assembly into the Optical Sensor Package, which is due to be delivered to KSC in December 1987.

Eureca

In its October 1987 manifest, NASA has scheduled Eureca for launch at the end of August 1990 on Shuttle Flight 43. An earlier flight opportunity may, however, arise in the first quarter of 1990. Subsequent retrieval is foreseen after 6–9 months flight duration.

Work has concentrated on the payload-to-Eureca system-interface testing using engineering-model instruments. 10 of the 15 experimental facilities have so far successfully completed these tests.

Satisfactory solutions have been found to resolve the welding problems of the thermal radiators and the by-pass design. The AOCS and thermal-control subsystems are still on the scheduled critical path of the programme.

The System Safety Review preparations have been completed and it will be held in early 1988 with NASA.

Space Station/Columbus

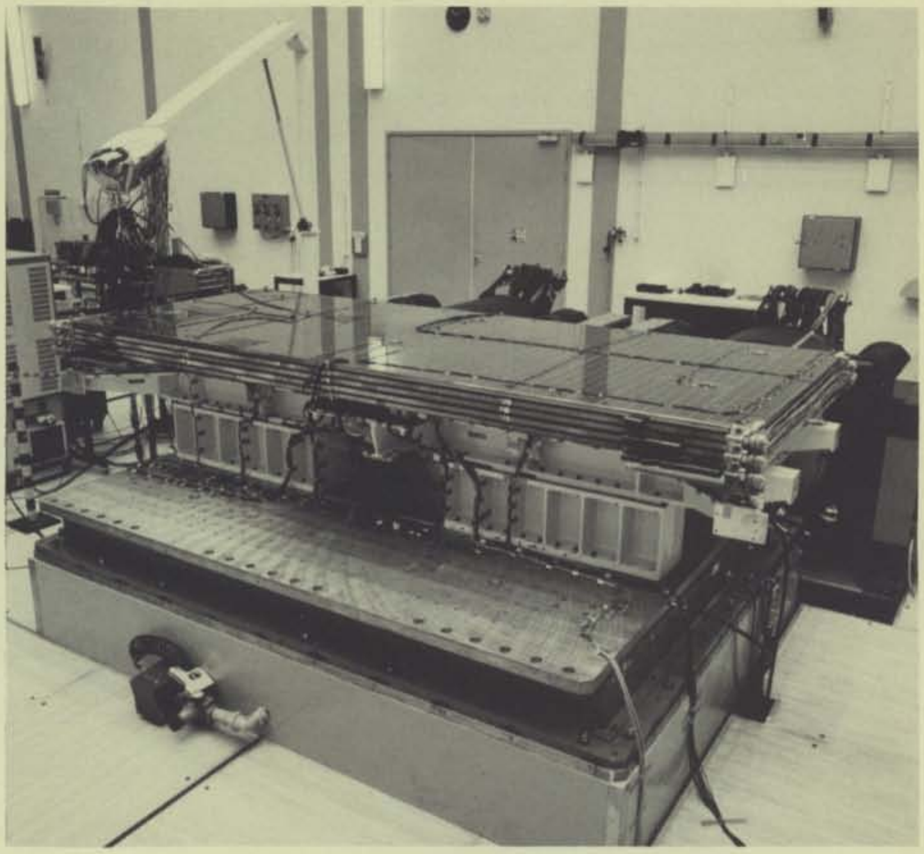
The first Progress Review of the Phase B2 extension period was conducted at MBB/ERNO in September 1987 with the objectives of assessing the space segment definition and reviewing the initial results of step 1 of the Coherence Task Force (CTF) implementation activities. Key results included:

- agreement has been reached on items of equipment to be transferred from the Man-Tended Free Flyer (MTFF) Resource Module to the Pressurised Module to maximise Hermes servicing potential;
- no reduction in MTFF payload volume to accommodate transferred equipment is necessary;
- a single reference servicing configuration for the docked MTFF/Hermes composite was established to accomplish both internal and external MTFF servicing tasks;
- the MTFF Resource Module Orbit Replaceable Unit (ORU) concept was changed to accommodate external servicing by Hermes;
- commonality between the MTFF and the Polar Platform is still feasible at equipment/sub-assembly level.

Based on the status at the Progress Review milestone, a revised planning for the remainder of Phase B2 was established involving a continuation of the phase up to March 1988. This revised planning was accepted by the Columbus Programme Board in mid-September 1987.

CTF implementation activities continued during October with a final meeting at MBB/ERNO at the end of October to close out all remaining step-1 implementation activities. Based on the results of this meeting, a new reference baseline for the MTFF was agreed by ESA, and will now be prepared in detail for presentation at the second Progress Review, scheduled for mid-December. With the accomplishment of this key milestone, all Columbus elements are now being further defined against an updated systems requirements baseline reflecting the CTF recommendations.

The Engineering Change Request (ECR), covering re-alignment of the remaining study milestones and adjustments to selected work packages in the light of the revised requirements baseline, was released in October 1987. The ECR specifically addresses the tasks to be performed during the period January–March 1988. The corresponding industrial proposal will be available in the second half of November 1987.

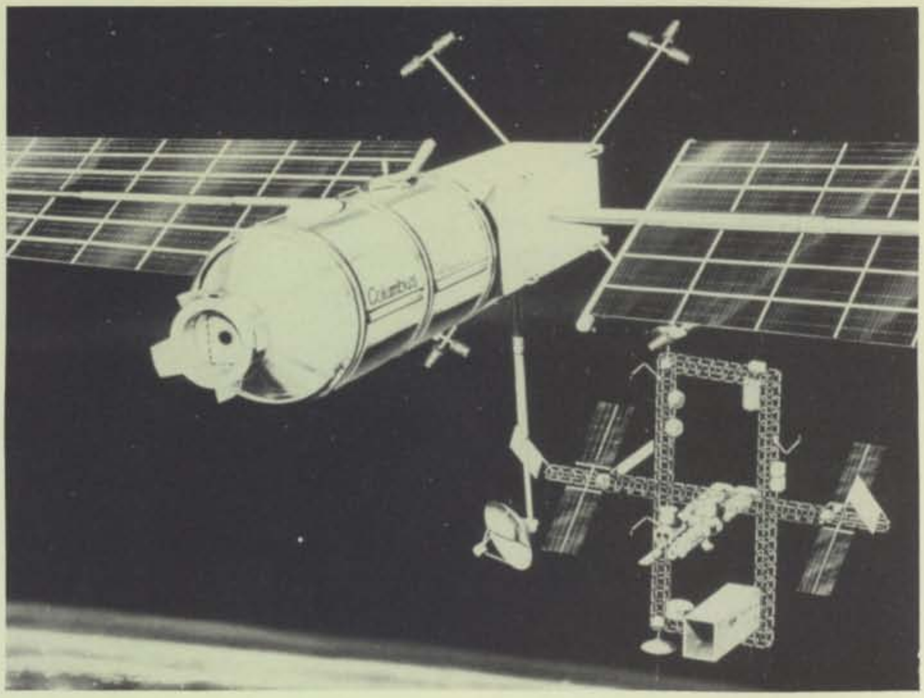


Essais de vibrations des panneaux solaires d'Eureca à l'ESTEC, Noordwijk

Eureca solar panels undergoing vibration testing at ESTEC, Noordwijk

Artist's impression of the Columbus element of the Space Station

Vue imaginaire du module Columbus comme élément de la Station spatiale



— *préserver l'intérêt et les compétences des milieux européens de la microgravité et attirer de nouveaux chercheurs.*

Spacelab et IPS

La liquidation de tous les contrats doit en principe être achevée avant la fin de l'année 1987, sauf en ce qui concerne l'adaptateur d'interface de charge utile, pour lequel les travaux se poursuivront en 1988. Après réparation des défaillances matérielles des suiveurs d'étoiles à tête fixe du système de pointage d'instruments, toutes les unités ont été renvoyées au maître d'oeuvre en vue de leur montage dans le bloc capteur optique, qui doit être livré au Centre spatial Kennedy en décembre 1987.

Eureca

Le dernier calendrier des tirs de la NASA (octobre 1987) mentionne fin août 1990 comme date de lancement d'Eureca, sur le vol 43 de la Navette. Cette date pourrait toutefois être avancée au premier trimestre 1990. Il est prévu de récupérer ensuite la plate-forme du bout de 6 à 9 mois.

Les activités se sont essentiellement concentrées sur les essais de l'interface entre la charge utile et le système Eureca à l'aide des instruments du modèle d'identification. Jusqu'à présent, ces essais se sont révélés concluants pour dix des quinze installations expérimentales.

On a pu résoudre de manière satisfaisante les problèmes de soudage des radiateurs et de conception de la mise en dérivation. Le système de correction d'attitude et d'orbite ainsi que les sous-systèmes de régulation thermique figurent toujours sur le chemin critique du programme.

Les préparatifs de la revue de sécurité du système sont terminés. Cette réunion aura lieu début 1988, avec la NASA.

Station spatiale/Columbus

La première revue de travaux jalonnant la période de prolongation de la phase B2 a eu lieu en septembre 1987 chez MBB/ERNO. Il s'agissait de dresser le bilan technique de la définition du secteur spatial et de passer en revue les résultats initiaux de la première étape des activités de mise en oeuvre faisant suite aux conclusions de l'équipe spéciale chargée d'assurer la cohérence entre Hermès et Columbus.

Voici les plus importants de ces résultats:
- *Un accord a été conclu sur les éléments du matériel à transférer du module de ressources du laboratoire autonome visitable au module pressurisé pour optimiser le potentiel de desserte par Hermès.*
- *Il n'est pas nécessaire de réduire le volume de la charge utile du laboratoire autonome visitable compte tenu de la place occupée par les équipements transférés.*
- *Une configuration unique de desserte de référence a été élaborée pour le laboratoire autonome visitable et Hermès après leur amarrage, en vue de l'exécution des tâches de desserte interne et externe.*
- *La conception ORU du module de ressources du laboratoire a été modifiée pour autoriser la desserte externe par Hermès.*
- *La compatibilité entre le laboratoire autonome visitable et la plate-forme méridienne reste réalisable au niveau de l'équipement et des sous-ensembles.*

Compte tenu de la situation au moment de la revue d'avancement des travaux, le planning a été revu et corrigé pour le reste de la phase B2, qui a été prolongée jusqu'à mars 1988. Ce nouveau planning a été approuvé mi-septembre par le Conseil directeur du programme Columbus.

Les activités de mise en oeuvre évoquées plus haut se sont poursuivies en octobre, avec une ultime implantation chez MBB/ERNO fin octobre, pour liquider toutes les tâches restant à accomplir au titre de l'étape 1. L'Agence a approuvé une nouvelle base de référence pour le laboratoire autonome visitable, compte tenu des résultats de ces ultimes travaux. Les détails en seront mis au point en vue de la présentation et de l'examen qui auront lieu lors de la deuxième revue d'avancement des travaux prévue pour la mi-décembre. Cette grande étape étant franchie, la définition de tous les éléments de

Hermes

In June 1987 a Hermes Development Programme Proposal was submitted to the Hermes Programme Board for approval by the potential participants.

A formal industrial proposal for the extension phase was submitted to ESA by CNES at the end of October 1987 for approval and for presentation to the Industrial Policy Committee.

During the initial phase of the Hermes Preparatory Programme (November 1986 –June 1987) there were three main areas of activity:
- Analysis of the optimum Ariane-5/Hermes composite configuration with particular emphasis on meeting manned safety requirements
- the optimum Hermes configuration for servicing the Man-Tended Free Flyer (MTFF)
- continuation of the technologically critical predevelopment work, begun under CNES leadership before the Europeanisation of the Hermes Programme, with the aim of establishing confidence in the feasibility of the innovative technologies such as hypersonic aerodynamics, high temperature thermal protection, fuel-cell and lightweight-structure materials.

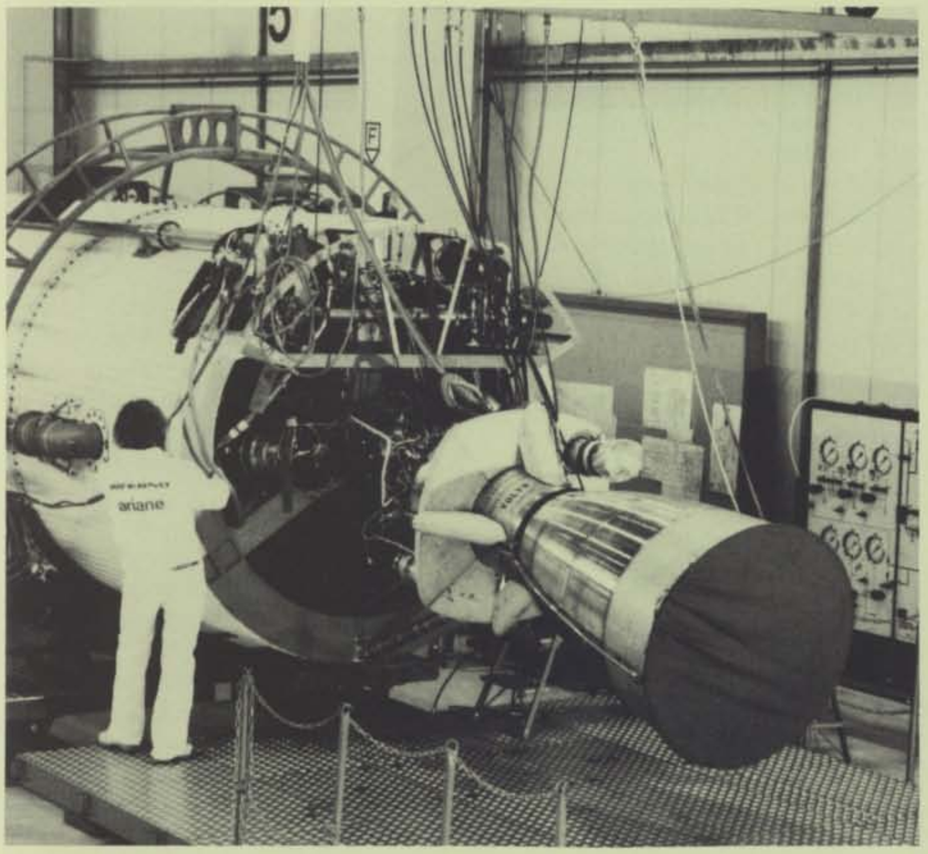
This work led to confirmation of the Ariane-5/Hermes configuration as previously proposed and to important decisions concerning the Hermes spaceplane configuration in late February 1987, namely:
- a closed cargo bay with direct docking capability to the MTFF and International Space Station
- the increase of the total in-orbit mass of the spaceplane to 21 tons
- the introduction of a crew-escape system in the form of an ejectable crew cabin
- a crew of three.

For the remainder of the Preparatory Programme up to beginning of June 1987 work concentrated on updating the Hermes configuration and programme. These changes have been reflected in the Hermes Development Programme Proposal and the updated the ESA Long-Term Plan.

The ESA Programme Proposal was supplemented by a Hermes Programme File prepared and submitted by CNES.

Since the beginning of June 1987 the selected Hermes configuration has been further analysed, and corresponding studies have been initiated, in order to confirm
- the validity of the operational concept with primary emphasis on MTFF servicing
- the feasibility of the ejectable cabin concept
- the feasibility of the spaceplane within the specified budgets, in particular the critical mass budget
- the conformance with manned safety requirements.

This work will continue up to the end of the extension phase, at which time a revised set of specifications and development plans will be available. The study and preliminary design results available at this time confirm the choices of the Hermes configuration and technologies made to date.



Essai d'un moteur auxiliaire ergol liquide d'Ariane-4 chez DFVLR (Allemagne)

Liquid-propellant booster for Ariane-4 under test at DFVLR (Germany)

Ariane

Ariane-4

On 6 November 1987 the Flight Readiness Review Executive Committee authorised the start of the the Ariane-4 demonstration launch (AR 401) campaign for both the launcher (type 44LP12) — with the exception of the third stage, which will be reviewed later — and its payload.

The payload, composed of the three passenger satellites and their adapters, has a total weight of almost 3200 kg.

The European meteorological satellite Meteosat P2 (700 kg), developed by ESA, and the radio amateur satellite Amsat Phase III-C (150 kg), developed under the responsibility of Amsat-Deutschland, will be located under the fairing.

The communications satellite 'Simon Bolivar' (1220 kg) of the Pan American Satellite organisation Panamsat, intended

Columbus se poursuit, conformément aux exigences de base du système, revues et corrigées selon les recommandations de l'équipe spéciale.

La demande de modification technique, portant sur le réajustement des dernières étapes de l'étude et les corrections à apporter à certains lots de tâches en fonction des nouvelles exigences de base, a été diffusée en octobre. Elle touche en particulier les tâches à accomplir entre janvier et mars 1988. Les propositions industrielles correspondantes seront disponibles dans la deuxième quinzaine de novembre 1987.

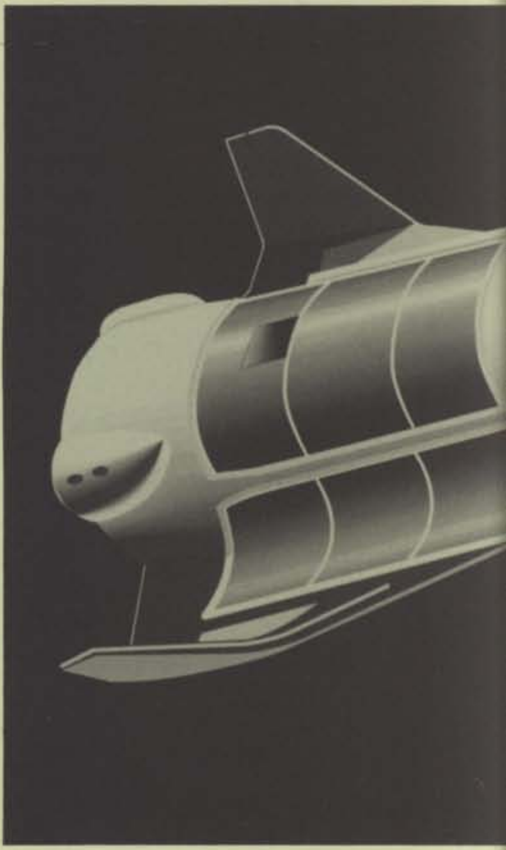
Hermès

En juin 1987, une proposition de programme de développement d'Hermès a été soumise au Conseil directeur du programme, en vue de son approbation par les participants potentiels.

Fin octobre 1987, le CNES a soumis à l'Agence une proposition industrielle officielle relative à la phase d'extension, pour approbation et présentation au Comité de la politique industrielle.

La phase initiale du programme préparatoire Hermès (de novembre 1986 à juin 1987) se subdivisait en trois principaux domaines d'activité:
— analyse de la configuration combinée Ariane-5/Hermès optimale, mettant notamment l'accent sur les exigences de sécurité pour les vols avec équipage
— configuration Hermès optimale pour la desserte du laboratoire autonome visitable
— poursuite des travaux de prédéveloppement critiques sur le plan technologique, commencés sous l'égide du CNES avant l'européanisation du programme, en vue d'affermir la confiance dans la faisabilité des techniques nouvelles, comme l'aérodynamique hypersonique, la protection thermique à haute température, les piles à combustible et les matériaux de construction légers.

Ces travaux ont permis de confirmer la configuration Ariane-5/Hermès initialement proposée et de prendre des décisions importantes fin février 1987 quant à la configuration de l'avion spatial Hermès, à savoir:



The Hermes spaceplane

Maquette de l'avion spatial Hermes

— soute fermée avec possibilité d'amarrage direct au laboratoire autonome visitable et à la Station spatiale internationale
— augmentation à 21 tonnes de la masse totale en orbite de l'avion spatial
— introduction d'un système d'évacuation de l'équipage, sous forme de cabine éjectable
— équipage de trois personnes.

Le reste du programme préparatoire, jusqu'au début juin 1987, a essentiellement été consacré à l'actualisation de la configuration et du programme, dont les modifications ont été incorporées dans le la proposition de programme de développement et dans le plan à long terme revu et corrigé de l'Agence.

La proposition de programme de l'Agence a été complétée d'un fichier du programme Hermès, élaboré et présenté par le CNES.

A partir de juin 1987, on a approfondi l'analyse de la configuration retenue pour l'avion spatial et entamé les études correspondantes, pour confirmer les points suivants:
— validité du principe de conception retenu pour les opérations, tout spécialement en ce qui concerne la desserte du laboratoire autonome visitable
— faisabilité du principe d'habitacle éjectable
— faisabilité de l'avion spatial dans les limites des bilans assignés, notamment celui des masses critiques
— conformité aux exigences de sécurité pour les vols avec équipage.

Ces travaux se poursuivront jusqu'à la fin de la phase d'extension. Les spécifications et plans de développement revus et corrigés seront alors disponibles. Les résultats de l'étude et de la conception préliminaire confirment les décisions prises quant au choix de la configuration d'Hermès et des technologies.

Ariane

Ariane-4

Le Comité directeur de la revue d'aptitude au vol du lancement de démonstration Ariane-4 (AR 401) vient, le 6 novembre 1987, d'autoriser le démarrage de la campagne du lanceur (type 44LP12) — à l'exception du troisième étage, pour lequel la revue est prévue ultérieurement — et de sa charge utile constituée des passagers et de leurs adaptateurs d'une masse totale proche de 3200 kg.

Sous coiffe, les passagers sont le satellite de météorologie européen Météosat P2 (700 kg) réalisé par l'ESA, ainsi que le satellite Amsat phase IIIC (150 kg) de communication pour les radio-amateurs réalisé sous la direction de l'organisation Amsat-Deutschland.

Dans la SPELDA (Structure Porteuse Externe de Lancement Double Ariane), se situe le satellite de communication 'Simon Bolivar' (1220 kg) de l'organisation Pan American Satellite (Panamsat) devant desservir, pour l'essentiel, l'Amérique Centrale et l'Amérique du Sud.

A cette occasion, l'ESA/APEX, avec le

mainly for coverage of Central and South America, will be housed in the Spelda*.

Structures and equipment items specific to this flight but which might have further applications in Ariane programmes are being developed and built by ESA/APEX with the support of CNES, Toulouse. These include, for the upper composite:

- a cylindrical shroud (with 450 kg ballast) plus a type 937 conical attachment fitting for Meteosat P2,
- a conical attachment fitting for Amsat PIIIC,
- a separation system using a 1920 mm diameter pyrotechnic expansion tube,
- a sequencer for the delayed separation of Amsat PIIC;

and, for the lower composite:

- a ballast of about 220 kg, also useful during final on-site integration when handling the combined satelite, satellite adapter and inner cone of the vehicle equipment bay.

*Structure Porteuse Externe de Lancement Double Ariane

TDP

The In-Orbit Technology Demonstration Programme was initiated in January 1987. Five Member States have so far subscribed to the Programme, namely Spain, Switzerland, Belgium, The Netherlands and Italy.

To minimise cost, two common support subsystems — the Payload Control Unit (on-board computer) and the Hitchhiker-G Simulator — for the whole programme have been identified.

The status of the various experiments is currently as follows:
- *Payload Control Unit:* the contract was awarded in 1987, a breadboard will be available by end 1988
- *Hitchhiker-G Simulator:* work has been completed and a breadboard is being tested in ESTEC
- *Gallium Arsenide (GaAs) Solar Array:* the contract for experiment adaptation was awarded in 1987
- *Attitude Sensor Package* (including Earth Sensor, Modular Star Sensor, Yaw Earth Sensor): the contract for experiment adaptation was awarded at the beginning of 1988. Work has been initiated to upgrade the existing sensor to flight status
- *Solid State Micro-accelerometer:* negotiations are in progress due to the complexity of the experiment which involves in-orbit calibration of the device
- *Collapsible Tube Mast and Heat Pipe Radiator:* the Invitation to Tender (ITT) has been sent out to Industry
- *Inflatable Space-Rigidised Antenna:* finalisation of the ITT is pending the complete definition of the carrier interface
- *Dynamic Cooler:* the experiment is being redefined in the light of the availability of new carriers with a fluid loop
- *In-Space Aluminium Coating and Liquid Gauging Technology Experiments:* studies to define experiments are in progress and will be completed during the first quarter of 1988. ITTs will then be issued for the adaptation of these two experiments. Tutorial briefings have been held to explain the safety requirements and carrier constraints for each experiment as well as the common support subsystem.

The use of several different carriers is planned. The following experiments will be flown as Shuttle Get-Away Specials (GAS): the Solid State Micro-accelerometer (G-21), the Liquid Gauging Technology Experiment (G-22) and the In-Space Aluminium Coating Experiment (G-485).

For the experiments using *Hitchhiker-G* carriers – the Attitude Sensor Package, Collapsible Tube Mast and Heat Pipe – all the technical interfaces have been defined with NASA and manifesting is expected in the immediate future. Technical meetings have been held in Moscow on the feasibility of testing the Inflatable Space-Rigidised Antenna on the MIR Space Station.

The selection of a small free-flyer satellite to carry the GaAs Solar Array experiment is in progress. Possible international cooperation with NASA's Office of Aeronautics and Space Technology has taken a new direction with two new experiments proposed by ESA (In-Flight Contamination and Solar Array Module Plasma Interaction), both of which could be carried as passengers with the Collapsible Tube Mast. These experiments are presently under review by NASA and a final selection is expected during the first quarter of 1988.

support du CNES Toulouse, aura développé et réalisé les structures et équipements qui, bien que spécifiques de ce vol, pourraient avoir des applications futures dans les programmes Ariane; ce sont, en particulier, pour le composite haut:
- *une virole cylindrique (lestée de 450 kg), ainsi qu'un adapteur conique type 937 de liaison Météosat P2,*
- *un cône de liaison Amsat PIIIC,*
- *un système de séparation par tube pyrotechnique à expansion de diamètre 1920 mm,*
- *un séquenceur initiant la séparation retardée d'Amsat PIIIC;*

ainsi que, pour le composite bas:
- *un lest de l'ordre de 220 kg utile également à la manipulation, lors des opérations finales d'intégration en campagne, de l'ensemble du satellite, de son adaptateur et du cône interne de la case à équipement du lanceur.*

TDP

Le Programme de démonstration technologique en orbite (TDP) a été approuvée en janvier 1987. Cinq Etats membres s'y sont associés: la Belgique, l'Espagne, l'Italie, les Pays-Bas et la Suisse.

Dans un souci d'économie, deux sous-systèmes de soutien communs pour l'ensemble du programme ont été définis, à savoir, l'élément de commande de charge utile (ordinateur embarqué) et le simulateur Hitchhiker-G.

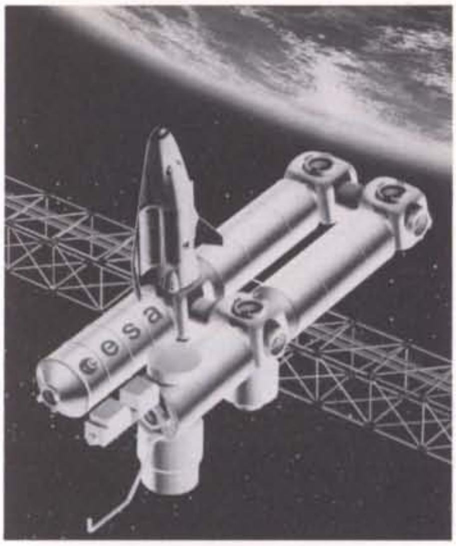
- Elément de commande de charge utile: *le contrat a été adjugé en 1987 et un montage sur table sera disponible fin 1988*
- Simulateur Hitchhiker-G: *le travail est terminé et le montage sur table est actuellement soumis aux essais à l'ESTEC*
- Générateur solaire à arséniure de gallium: *le contrat pour l'adaptation de l'expérience a été adjugé en 1987*
- Ensemble de détection d'attitude *(comprenant le détecteur d'infrarouge terrestre, le viseur d'étoiles modulaire et le détecteur de lacet à référence terrestre): le contrat pour l'adaptation de l'expérience a été adjugé au début de 1988 et le travail de mise à jour au niveau modèle de vol a commencé*
- Microaccéléromètre à l'état solide: *vu la complexité de cette expérience, qui comporte un étalonnage en orbite du microaccéléromètre, les négotiations se poursuivent avec le contractant*
- Mât d'antenne repliable et radiateur à caloducs: *les appels d'offres ont été lancés*
- Antenne gonflable à armature rigide: *l'appel d'offres ne sera lancé qu'après la définition complète de l'interface avec la plate-forme*
- Refroidisseur dynamique: *on procède à une redéfinition de l'expérience dû au fait que des plate-formes à boucle de fluide sont maintenant disponibles*
- Expériences d'aluminiage dans l'espace et de mesure des niveaux de liquide: *les études de définition des expériences seront terminées au cours du premier trimestre 1988. Les appels d'offres seront ensuite lancés pour l'adaptation de ces deux expériences.*

Des présentations techniques ont eu lieu chez les contractants pour expliquer les besoins en matière d'assurance produits et de sécurité, les contraintes spécifiques à chaque expérience à observer au niveau plate-forme, et préciser les sous-systèmes de soutien communs.

On prévoit d'utiliser plusieurs plates-formes différentes. Les expériences suivantes seront embarquées dans les petites charges utiles 'bouche-trou' (Get-Away Specials) à bord de la Navette: le microaccéléromètre à l'état solide (G-21), l'expérience de mesure des niveaux de liquide (G-22) et celle d'aluminiage dans l'espace (G-485).

Quant aux charges utiles faisant appel aux Hitchhikers-G, les interfaces techniques ont été définis avec la NASA pour l'ensemble de détection d'attitude, le mât d'antenne repliable et le radiateur à caloducs. Les dates de lancement devront être fixées dans un proche avenir. De plus, des réunions techniques ont eu lieu à Moscou pour étudier la possibilité de tester l'antenne gonflable à armature rigide à bord de la station soviétique MIR.

Le choix d'un petit satellite autonome pour l'emport de l'expérience des réseaux solaires GaAs en coopération avec l'Office of Aeronautics and Space Technology de la NASA a pris une nouvelle tournure avec la proposition, par l'ESA, de deux nouvelles expériences (contamination en vol et interaction des réseaux solaires avec le plasma) qui pourraient être co-passagers avec le mât d'antenne repliable. La NASA étudie actuellement ces deux expériences; la sélection finale devrait avoir lieu pendant le premier trimestre de 1988.



Principles for Information Systems Design for Space Projects

R.J. Stevens & G. Alvisi, ESA Documentation Service, ESRIN, Frascati, Italy
R.T. Greenwood, Manned and Retrievable Systems Department, ESTEC, Noordwijk, The Netherlands
M. Deschamps, Hermes and Manned Flight Directorate, CNES, Toulouse, France

Information systems should never be viewed as a primarily technical issue. They are merely solutions to meet requirements for a management problem, albeit a very large scale problem. Meeting those needs requires direction of technical areas, and an understanding that information is a prime resource and a central, and not a peripheral, issue in today's space programmes.

Introduction
The net result of a spacecraft's lifetime is information – perhaps in the form of images of a comet or the solar system, knowledge of the effects of space on the human body, how to make better materials, or experience in how to build better satellites. To maximise the return on investment, the results of experiments and the experience of developing and using the spacecraft need to be captured and made available to European industry. Information is the final deliverable product – and a criterion of success –for all ESA investments.

Information handling is also the means that has always made project development possible. As the project activities change in nature and intensity, the flow of information inside the project alters to reflect them. Early in the project's life, that information flow will be about concepts, drawings, minutes, etc. As the project becomes more fixed, it turns into specifications, contracts, official papers, reports, change requests, financial reports, software packages, verification details or test reports. Experimenters will need information about the facilities offered, communicate across Europe details of their equipment as they develop it, and will finally receive the experimental results.

The equivalent of millions of pages of paper, and dozens of different types of information, are involved in the execution of sizeable ESA projects. The information pours between the Agency's departments, to and from contractors, agencies, universities, research institutes, and governments. An efficient management system is essential to process, store, check, retrieve and send that information.

What is an information system?
There is nothing new about information systems, although the terms employed may be different, and our concepts of the importance of information have changed. An information system is simply the combination of electronic and paper-based elements used for organising information. It is the mechanism for controlling project documentation, project-control data, and technical information. Perhaps we are beginning to recognise the importance of information more, because of the increasing use of computers for handling, storing and transferring information.

Information systems have historically been based on paper, and always had to be treated seriously and managed correctly, however much paperwork was disliked. Standards (e.g. the size of paper or envelopes) were provided by international bodies, PTTs, and decades of tradition which helped develop methods and equipment for handling paperwork. Within organisations, standard forms and document types were developed for tasks specific to that organisation. Electronic systems, however, have been developed so quickly that equivalent standards have not yet evolved properly.

Transition to new systems
Over the next decade, ESA projects face the steady transition from paper to

electronic systems for handling information. This move is already well under way, but it should not be forgotten that all information systems in the foreseeable future will involve a mixture of paper and electronic systems. The sheer size of the new ESA programmes would, however, pose severe problems for a purely paper-based system.

Currently computer systems handle and transfer most mail messages, simple documents, and financial details. Computers can even cover more difficult areas such as diagrams, complex three-dimensional models of satellites, project management and requirements control. The difficulty lies in trying to exchange such complex information, because the various systems are usually incompatible!

Electronic systems potentially offer great advantages, particularly in the control of detail, speed and accuracy of transfer, ease of retrieval, and cost of handling. For example, ESA is already able to exchange documents and mail electronically between its various different establishments and with contractors. This exchange is performed using the 'Professional Office System (PROFS)' on IBM systems, and the 'Telemail' and 'Questmail' systems for other users outside the Agency. Without worrying about where the information is produced, potential contractors can browse through Invitations to Tender via the EMITS system.

Such electronic systems will fundamentally alter the way in which projects handle information. However, electronic information systems also demand new skills, discipline, and training.

Background to the information revolution

'Islands' of automation

Computerised equipment was initially installed for single, well-defined tasks, such as financial control, personnel administration and payment of salaries, etc. Computers were used for isolated, well-identified, tasks. Communication between the 'islands of automation' was by paper and thus each different area was free to develop incompatible computer systems. The software which ran on the computers was relatively crude and simple, and largely incomprehensible, except to experts. The users handed in their information to experts as stacks of punched cards, and waited for it to be processed. The output was mounds of poor quality printouts, which were difficult to understand.

The need to build bridges

The handling of information is being transformed by the microelectronics revolution. Consequently, individual users can have more powerful computers than companies could afford a decade ago. Computers are spreading everywhere, and so they are relatively more important to an organisation. There are hundreds of 'islands' and they need to be able to talk to one another, to use relevant information from each other – if only their equipment and software would allow them! It is not sensible for different areas of one organisation to be generating and using the same information many times – staff lists, contractual details, finance, structural models of spacecraft – and not be able to communicate that information electronically to other groups.

If users cannot talk to one another, resources are wasted in: retyping the same information many times (and potentially introducing errors); working on inconsistent sets of information; and carrying paper around Europe which could be sent electronically.

This is perhaps the heart of the matter: the most important objective of an information system must be to enable users to communicate easily with one another.

The raw materials for this new industrial revolution are integrated circuits, and the ever smaller silicon chip. With every decade that passes, a given amount of money will buy a 100–1000 times more powerful computer system. These developments are still continuing in the microelectronics development laboratories, and computers will certainly cost less and be many times more powerful again in the future. The process of change is continuing and perhaps even accelerating, so that waiting for a stable solution is not a practical option.

One expensive computer has been replaced by many small inexpensive machines (Table 1). The software is of much higher quality, far easier to use, cheaper, displayed very well on a screen, and supports rapid feedback of information. Much less skill is needed to drive the programs, and so the number of users and their productivity increases. But there is a cost – the software is much more expensive to develop, and so not practical for a single organisation. It also needs more powerful computer hardware, and a shared machine is no longer enough.

Instead of one machine with little need for user coordination, the more common situation is now a distributed system where the software is the more important element and the hardware cost is largely irrelevant (Fig. 1). The smaller machine can manage all except the heaviest loads, and offers better, more convenient services. The larger machine is then used for the occasional very large task, but more importantly where information needs to be coordinated across the organisation. It is no longer so important as a supplier of computer processing power. Coordination becomes necessary to enable the distributed users to communicate with one another, and a more integrated approach is essential.

Software vs. hardware

The investment cost of a computer system is primarily in the software that runs on it and the training costs for users, not in the hardware.

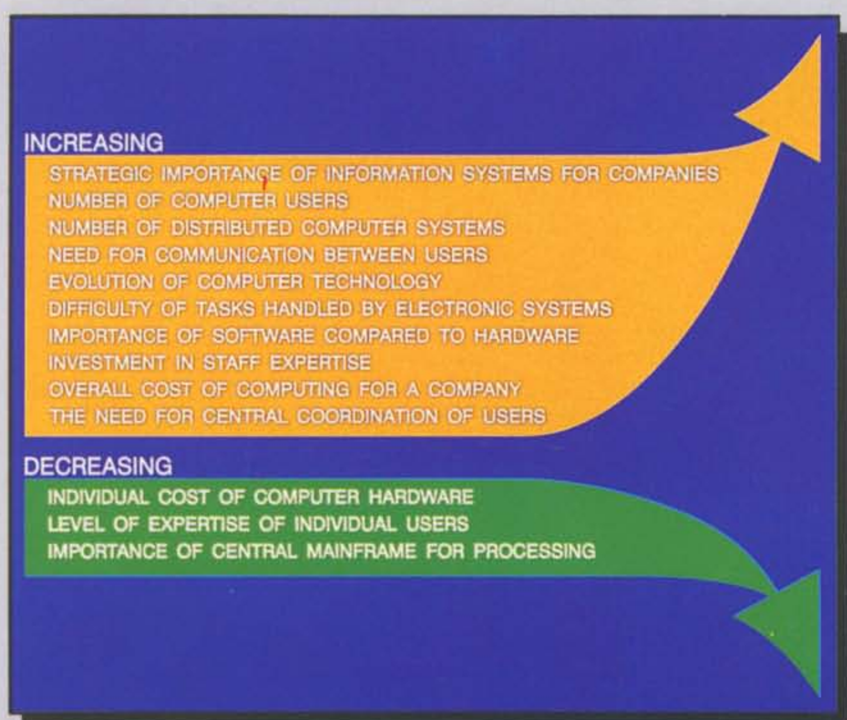
Non-specialists often imagine that the choice of computer hardware is the key factor in designing an information system. Actually, the approach should be:

- find out what needs to be done
- examine the constraints upon the solution
- select commercial software that meets the requirements
- then, and only then, select the computer that runs the software.

Table 1 – The economic basis for the use of many small computers

TYPE OF COMPUTER	COST PER UNIT OF PROCESSING POWER (MIPS)	COST DECREASE PER YEAR FOR PROCESSING POWER (%)	COST OF MEMORY PER MEGABYTE ($)
MAINFRAME COMPUTER e.g. IBM 308X	200,000	25	7,500
MINICOMPUTER e.g. VAX 8800	50,000		
PERSONAL COMPUTER e.g. COMPAQ	2,000	45	100

Figure 1 – Trends that affect information systems design



There is, however, another new factor beyond both the hardware and software: the training of staff to use the new systems. The ability to use a word processor or a spreadsheet, as well as any specialist software, is almost essential for any young engineer. ESA plans to train new entrants to a minimum standard of computer awareness. Who would want to change to a new system after training 1 000 users over several years? When systems are changed, the cost of disruption among users is very high – yet we know that they will be changed by technology. Why should users need retraining when they move to other departments? Somehow a flexible, modular system, which can be changed without user disruption must be produced.

Figure 2 shows how a computer system can be considered as a series of layers between the user and computer hardware. Take a typical example of a user looking at some experimental results. The inside layer of the system is the computer hardware, surrounded by the software which the manufacturer supplies to make the computer hardware (such as the disks or terminal) work. The Data Base Management System (DBMS) that actually organises the experimental results comes next. This is a general-purpose system supplied by a manufacturer, to enable any type of information to be organised. The next layer is the programs that have to be specifically written for the DBMS to be able to process, check and store the experimental results. On the outside come the programs that present those experimental results to the user in an easily understandable form. This outside presentation layer – the man/machine interface – is one of the most important facets of a computer system.

From an organisational point of view, the outside layers are where the real long-term investment is made, either in writing specific programs or in training users. Everything inside can be bought (and

Figure 2 – Relative investments in an information system

supported) commercially, and if it is designed properly should be able to be replaced without disturbing the outer layers.

To summarise, the important trends in information technology are:
- the enormous and continuing increase in the availability of low-cost computer systems
- the use of many distributed computers instead of one shared computer
- the steady increase in the capability of software vis-à-vis hardware
- greater financial importance of software over hardware
- the rapid rise in the number of users, who do their own input rather than hand it to experts
- increasing importance of investment in trained users, which is becoming the most important and inflexible element in computers.

The consequences of these trends are:
- the need to ensure communication and coordination between the users
- the need to keep the man/machine interface as stable as possible.

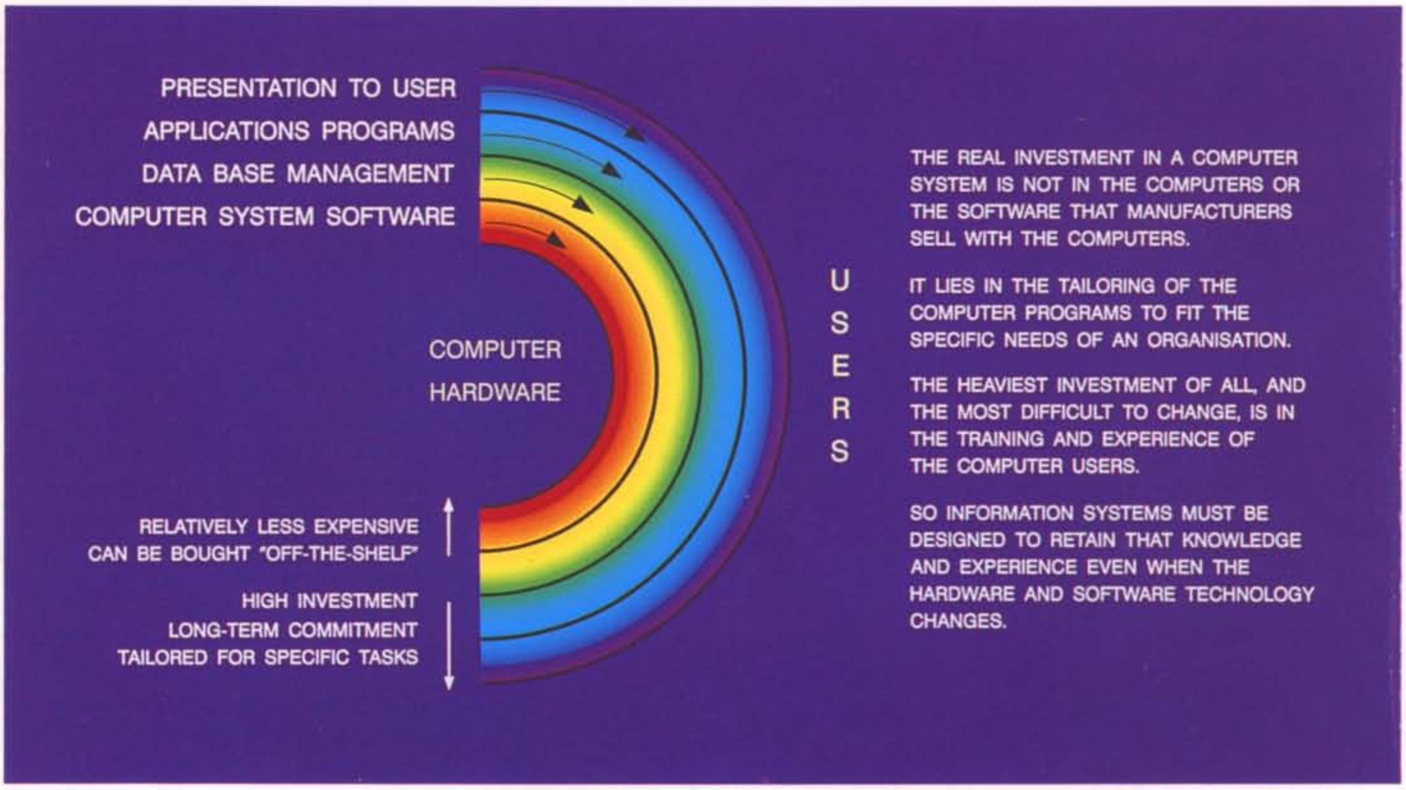
ESA-specific aspects

In the near future, ESA needs a whole range of information systems for projects (e.g. Columbus, Ariane and Hermes), for utilisation departments and user communities. All of these have slightly different needs, but also large areas of overlap.

While some areas in information systems (e.g. in space itself, safety and testing) are specific to the Agency, ESA can in general use commercial products for information systems, and does not need to develop its own software. There are, however, three factors that make ESA information systems different from typical commercial systems. One is the sheer size of the programmes; the second is their longevity; and the third the sharing of responsibilities between ESA, national agencies and prime contractors.

Columbus and Hermes are two very large programmes which will span at least two decades between conception and completion. Information from one phase of the project will be needed, changed or referred to at all other phases. The information systems must also cope with the decentralised nature of these programmes – ESA is itself divided over four major sites; its projects are split among many contractors; and the users cover the whole of Europe.

Even a coherent internal policy solves only a part of ESA's problems. The Agency deals with a whole range of organisations, and so must transmit information to and receive from a completely mixed range of computer systems. Its information system must therefore be able to communicate with all of these various systems without needing to worry about how each partner is organised.



To summarise, the factors peculiar to the design of ESA's information systems are:
- the need to communicate with a vast variety of firms and users
- the decentralised organisations and projects with shared responsibilities
- the long project lifetimes and consequent need for a flexible, evolutionary system.

Elements of the solution

The importance of coherent user requirements

The first step is to understand what needs to be done, and to present that knowledge in a clear and non-technical way. This step – of determining the users' requirements – is obviously critical, but is often overlooked or rushed in the haste to 'get something done'. These requirements are the mechanism by which all parties – the users, the system designer, and the implementers – communicate with each other. They will form the 'contract' for what the information system is meant to do. These user requirements must cover the nature and volume of information to be exchanged, stored or viewed and what happens to that information.

For example, if a computer system must:
- be easy to use
- perform specific tasks to a defined efficiency
- be delivered by a specific date
- be well documented
- cost a specific amount

these needs must be spelled out in non-technical language, along with the contractual clauses that will apply if the delivered system does not meet these requirements. The user requirements' document is not a technical document, and should not use computer jargon. The document should be organised to ensure that requirements are easily verifiable, but the non-specialist customer must understand every part. The ESA software standards rightly try to focus more attention on the critical project phase. Producing a coherent, realistic set of requirements that reflect what is needed is not an easy task.

This discipline is so familiar to engineers that it is surprising to find that it is often neglected for computer applications. This stage cannot be left to computer specialists – this is a job that requires substantial customer effort. Otherwise the customer should not complain when the wrong system is delivered.

There is a wide cultural gap between the users and the technical specialists – and the specialists have often used technicalities to dazzle the non-specialists. Computer specialists can be over-concerned with the technical solutions, without considering whether the user needs them. In turn, project specialists are sometimes unable to express their needs in the necessary structured fashion, and see information systems in terms of their last project, without realising that technology has moved on.

Even so, not all of the users' needs can be met – there are practical restraints imposed upon any system (e.g. cost, the use of existing infrastructure, ESA standards, existing software, etc.). The priorities and options for implementation in the case of financial or time constraints need to be expressed. Many of these constraints – financial resources, strategic policies, etc. – involve managerial rather than technical issues. Producing policies that meet users' needs, are technically viable, and at the same time fulfil the overall aims of the organisation, will require a variety of skills, knowledge and influence, including:
- technical knowledge of how the Agency handles information
- capability in information technology
- understanding of practical constraints, such as finance and schedules.

The need for standardisation

The main functions of an information system are:
- to permit the exchange of information between ESA-internal areas and external systems (Fig. 3)
- to provide utilities for information preparation, processing, archival and retrieval.

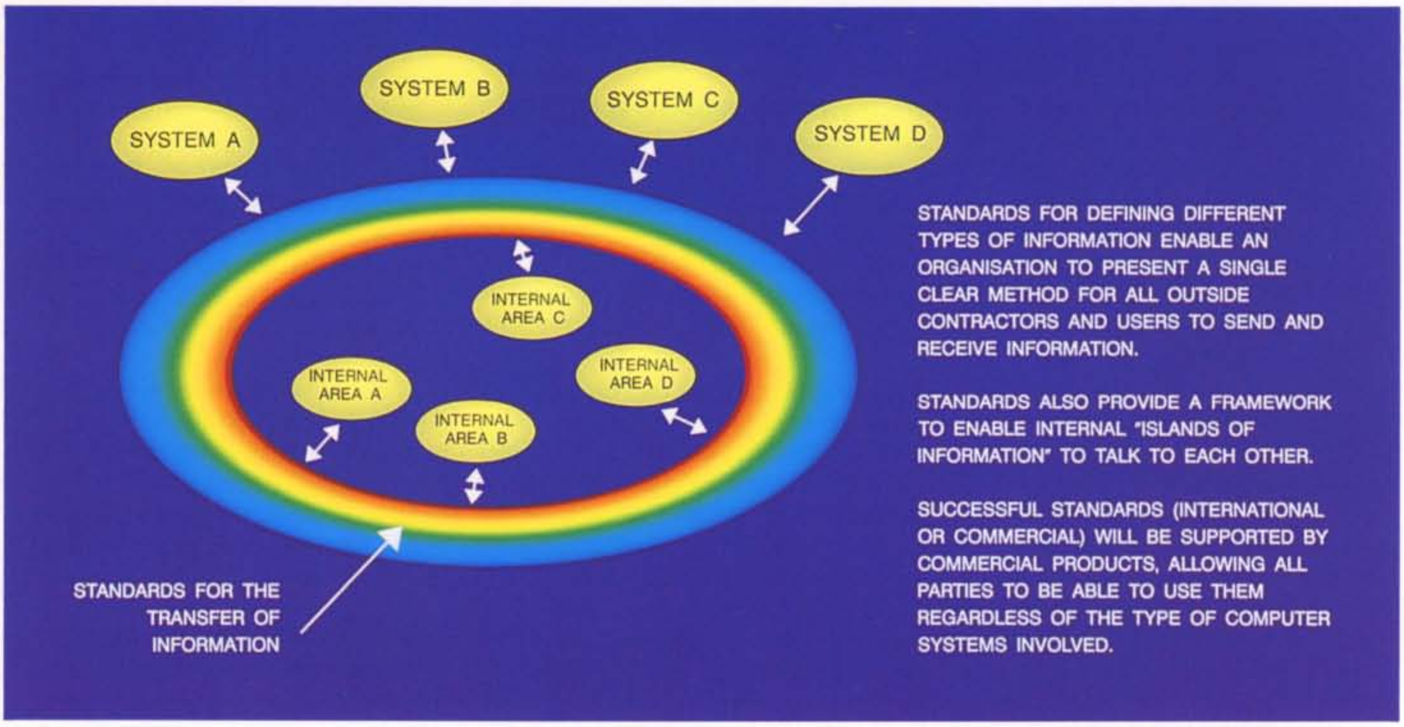
To achieve these objectives, standards for information exchange and information processing must be defined. The former is mandatory and has to be imposed internally, and also agreed with all external partners. The latter should be used inside the Agency as far as possible to save expense through re-use of software, and where maintenance for different systems would be too high. Outside the Agency, such standards should be agreed as rapidly as possible where pre-defined standards do not exist.

Standards for information exchange

To handle the diverse computer systems of external bodies, ESA should produce clear standards to allow information exchange. These standards can be provided via popular software products that are available to all firms, regardless of which computers they use. Even better, international standards should be used, provided they are supported commercially. The conversion between the firm's internal system and the standard then becomes the responsibility of the firm. Figure 3 shows an outline of the interfacing approach that has been used in both the Columbus and Hermes Information Systems definition stages.

This approach has the following advantages:
1. ESA need not become involved with the internal computer systems of any company, and vice-versa. It merely supplies and receives information in international standard or the de-facto standard. Commercial tools are available to all companies to supply information in these standards.
2. Where departments, or areas, are using different standards, the interface approach allows an evolutionary transition to a more integrated solution.

Figure 3 – Communication through the use of standards



3. Even when standards need to be updated, the new versions tend to be compatible with the old, and so avoid vast reorganisational effort.
4. The choice of international standards for exchange of information also loosens the ties to any one manufacturer of equipment. An organisation then at least has the possibility of changing to a better computer company without too much disruption, should such a step become necessary.
5. It is impossible to do better than to offer any external company or organisation one clear, well-defined and well-supported interface across the whole organisation.

The status of standards

If ESA were able to choose successful standards for different types of information, then it would become relatively independent of developments in equipment. Often ESA contractors will also have chosen the same products and no conversion will be needed. Only if international or de-facto standards do not exist should ESA define its own standards for information exchange.

For example, some of the answers for document exchange can be found in international standards such as the emergent ISO standards for documents (Office Document Architecture, ISO ODA/ODIF ISO 8613). This is an interesting concept which allows companies to store and exchange documents sensibly, even when those companies use different machines and software. These standards are the result of a European endeavour, and the ODA approach needs to be adopted by US companies if it is to become really practical. Fortunately, this seems to be happening rather rapidly, and the true depth of commercial commitment to ODA should become clear during 1988.

Standards for information processing

Standardisation of a few basic elements can also ease the problems of developing an information system and reduce costs. These need to be chosen in key areas to minimise long-term investment in training and software and to ease communication between various 'islands'. They should be applied first for tasks that are widespread across the Agency, and where information needs to be spread. Examples include word-processor standards, spreadsheets, data-base management systems, and project-management systems.

For example, information is transmitted around Europe within almost all ESA projects. At each site there will need to be configuration control of information and information types, directories of who is allowed to read or alter the information, etc. The control of information will be handled by a commercial data-base system. If the DBMSs differ between sites, then the applications programs will have to rewritten many times and users will find the systems work differently at the various sites. Standardisation of data-base management systems is therefore an important factor. Naturally, the data-base system should be able to run on a variety of computer hardware, and not be restricted to one company's equipment.

This logic has driven the Agency's Columbus, Ariane and Hermes Programmes to adopt the same data-base system – Oracle. This should ease (but not guarantee) the interchange of information between the Programmes, and allow re-use of data-base programs.

Where clear de-facto commercial standards exist – such as in the software for handling project-management information – tools that conform to the standard should be bought and adopted as internal standards. They can re-used over many projects, even though they will be steadily updated by the manufacturer. This reduces cost and eases training problems, as well as providing a pool of expertise for handling the project. The yearly changes as technology develops are more significant than the different needs of each project. A single uniform information system may not be suitable for all their needs, but all could benefit from standards that facilitate the exchange of information, common design methods, and common use of applications. Significantly, almost all projects will need information from the others and there has to be some standardisation to allow this.

Implementation strategy

The major constraints identified for future information-system developments are the production of a flexible system to cope with the changing technology, and stability of the user interface to avoid large-scale retraining. To meet these objectives, the architecture of information systems must be developed to be independent of the hardware of individual computer companies. The man/machine interface must evolve steadily, smoothing out the changes introduced because of hardware or software developments. The objectives can be realised by a clear separation between the layers shown in Figure 2.

ESA is typically used to handling problems that differ from those of the rest of industry, but fortunately ESA's needs for information systems are similar to those of non-space industry. As a consequence, commercial packages and international standards should be available to meet the Agency's needs, without it needing to develop its own.

Past experience has shown the difference between promises and reality for custom-built software. The delivered product is often late, of poor quality, does not do what is needed, and is very expensive to maintain. By the time it actually works, a commercial package can do the job better and more cheaply. At least commercial products can be seen before they are bought, and the supplier will be able to share the costs of improving the software between many customers.

With the expansion of computer usage, software packages are now available for almost every common task. Organisations need only write software to link commercial products to their infrastructure, or for really unusual applications. Effort spent on writing complex specifications for products would be better applied to searching the marketplace, experimenting with available products, picking those that meet the needs best, and applying that product everywhere. The standardisation has to be enforced. Like all organisations, ESA will need to develop less and less custom software, and settle on commercial products.

Conclusions

The critical factors for the successful implementation of an information system for the space industry are therefore:

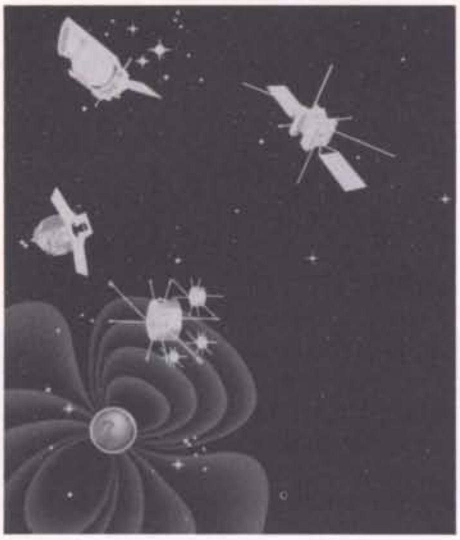
- a thorough analysis of the user needs and the constraints upon solutions
- an emphasis on off-the-shelf products rather than custom development
- the use of an interfacing approach (commercial and international) to exchange information with outside bodies such as contractors and users
- choice of the key long-term software standards for internal work
- training of staff to enable them to use the standards
- the recognition that software policy now drives hardware policy
- design of a system architecture flexible enough to cope with technological changes and changes in users' needs
- the use of existing infrastructure such as knowledge and equipment

Computers are becoming relatively more important to organisations. As the number of users and the size and importance of the tasks increases, they are absorbing more of the overall budget, which can only be transferred from the older technologies they replace.

Examination of past attempts to automate within companies shows that the single most important factor for success is management realisation of the scope and importance of the task. The subject is a core issue for any modern organisation. Information technology is not an area where policies should be decided on a purely technical basis by computer departments or specialist technical groups. Long-term management objectives, support, the imposition of standards and guidelines are essential. Information system management is too important to be left purely to information specialists, but it does need a full understanding of the technical issues.

Acknowledgments

This article is a digest of a paper titled 'Design of a Large Distributed Information System', by R.J. Stevens, R.T. Greenwood (ESTEC), G. Alvisi (ESRIN) and M. Deschamps (CNES), presented at the International Conference of 'Communication and Data Communication', Nivelles, Belgium, 25 – 27 May 1987. This paper will be published in *'Computer Networks and ISDN Systems'* in early 1988.



New Ground Data-Processing System to Support the Agency's Future Satellite Missions

K. Debatin, ESA Computer Department, European Space Operations Centre (ESOC), Darmstadt, Germany

The Multi-Satellite Support System (MSSS) has been used at ESOC for the last ten years as the primary ground data-processing facility for spacecraft operations and mission control. For reasons of technical obsolescence, the MSSS will now be replaced by a new ground data-processing system. This new system, called the 'Distributed Mission Support System' (DMSS), will be decentralised in concept. It will be equipped with more modern data-processing facilities and adequate capacity to meet the more demanding requirements of the Agency's future satellite missions.

The DMSS will be implemented in a phased approach, Hipparcos being the first mission to be supported by the new system. The MSSS will continue its current support role in parallel, until it is finally phased out in the course of 1991.

The Agency's Multi-Satellite Support System (MSSS) has been used for more than ten years as the primary data-processing system in support of the Operations Control Centre (OCC) at ESOC. It was originally conceived with the ambitious objective of providing a real-time data-processing environment for the simultaneous support of a multiplicity of space missions.

In reality, its capacity was dimensioned to cope with the combined workload of either two scientific missions and one telecommunications mission, or one scientific mission and several telecommunications missions, in parallel. In addition, the MSSS had to have a sufficient capacity margin to support the Launch and Early-Orbit Phase (LEOP) operations for a geosynchronous mission. It was configured as a local network of minicomputers provided, for economic reasons, with a comprehensive, common software structure to minimise the need for subsequent mission-specific software investments.

During its lifetime, the MSSS has undergone a number of changes, taking advantage of the continuing developments in computer technology. Major system changes have included renewal of the spacecraft control consoles, with simplification of the computer network and an increase in computing power. Despite these enhancements, computer-capacity limitations have remained the major weakness of the MSSS, these being particularly apparent whenever software development and test activities had to be performed in parallel with ongoing operational support.

The MSSS was put into operation in 1976 and has proved very successful in the meantime, as can be seen from Table 1. Virtually all ESA space missions in the period 1976—1987 have been supported, at least during their initial critical phases, by the MSSS.

The MSSS will continue to support the Marecs-A and Marecs-B2 maritime communications satellites and will also support the LEOP operations for the Meteosat Operational Programme's MOP1 and MOP2 satellites, and the large telecommunications satellite Olympus.

Thereafter, in 1991, the MSSS will be phased out as it becomes technically obsolescent. The new system that will

Table 1 — Missions supported on the MSSS

Missions	Duration of support
Geos-1	April 1977—December 1978
Geos-2	July 1978—December 1983
Exosat	May 1983—April 1986
Giotto	July 1985—April 1986
Meteosat-1	Nov. 1977—Dec. 1977 (LEOP)
Meteosat-2	June 1981—July 1981 (LEOP)
OTS-2	May 1978—
ECS-1	June 1983—July 1983 (LEOP)
ECS-2	Aug. 1984—Sept. 1984 (LEOP)
ECS-3	Sept. 1987—Oct. 1987 (LEOP)
Marecs-A	December 1981—
Marecs-B2	November 1984—

replace it, called the 'Distributed Mission-Support System' (DMSS), will offer more advanced ground control and monitoring facilities in response to the more demanding requirements of Europe's future satellite missions.

The system concept

The task of the DMSS is to provide ground data-processing support for the operation of the conventional missions that the Agency will undertake in the next ten years. This support will include the traditional ground-control functions of:

- acquisition, processing and presentation of spacecraft telemetry data
- generation, transmission and verification of spacecraft commands
- spacecraft attitude and orbit control
- data archiving.

The DMSS will integrate these functions into a coherent system concept, with five basic underlying objectives:

- The system must provide adequate performance to be responsive to the real-time requirements of the orbiting spacecraft.
- The system must ensure high availability.
- The system must have sufficient computing resources and configurational flexibility to allow concurrent support of mission operations and software development activities without imposing operational constraints.
  The system must also be adaptable to the special requirements of individual missions during both the development and the operational phases, without affecting support to other missions.
- Cost effectiveness has to be ensured, particularly with respect to software investments, by providing a general infrastructure to meet all those requirements that are common to the various missions.
- The system must achieve a high degree of automation to facilitate the execution of the ground-control tasks and to reduce the need for human intervention. It has to provide an effective and versatile man/machine interface to the ground-support personnel, taking advantage of modern work-station technology.

The processing load within the DMSS itself is distributed over a network of computers. The time-critical functions are primarily supported on mission-dedicated machines, which are embedded in a general hardware and software infrastructure. The latter provides the basic facilities shared between the missions supported, such as the common software structure for telemetry data processing and flight-dynamics support, the pool of work stations, and the communications links.

Integration of the mission-dedicated computers into the general infrastructure is accomplished via standardised interfaces, so that the DMSS can easily be upgraded to support a new mission by 'plugging in' a mission-dedicated computer.

The basic configuration

The structure of the DMSS is centred around the Mission-Dedicated Front-end Computers (MDFCs) (Fig. 1). The latter support (in real and near real time) the data-processing tasks so essential for controlling the mission and for monitoring and controlling the systems onboard the orbiting spacecraft. The MDFCs, although varying in size, are assumed to be computers of the same type.

At the front end, the MDFCs are interfaced with the telemetry, tracking and command (TTC) station network via an X25 Level-3 based communications network. Depending upon the specific mission requirements, this interface can easily be upgraded to higher level communications protocols (in accordance with the ISO seven-layer standard).

At the back end, the MDFCs are connected to two IBM-compatible mainframes, which support the more demanding tasks in terms of computing resources, such as flight-dynamics manoeuvres, spacecraft attitude reconstitution and orbit determination. The two mainframes also support payload data processing, to the extent that it cannot be performed on the MDFCs. They will also archive (on mass storage) telemetry data received by the MDFCs and provide direct access to this archive for spacecraft performance evaluation purposes.

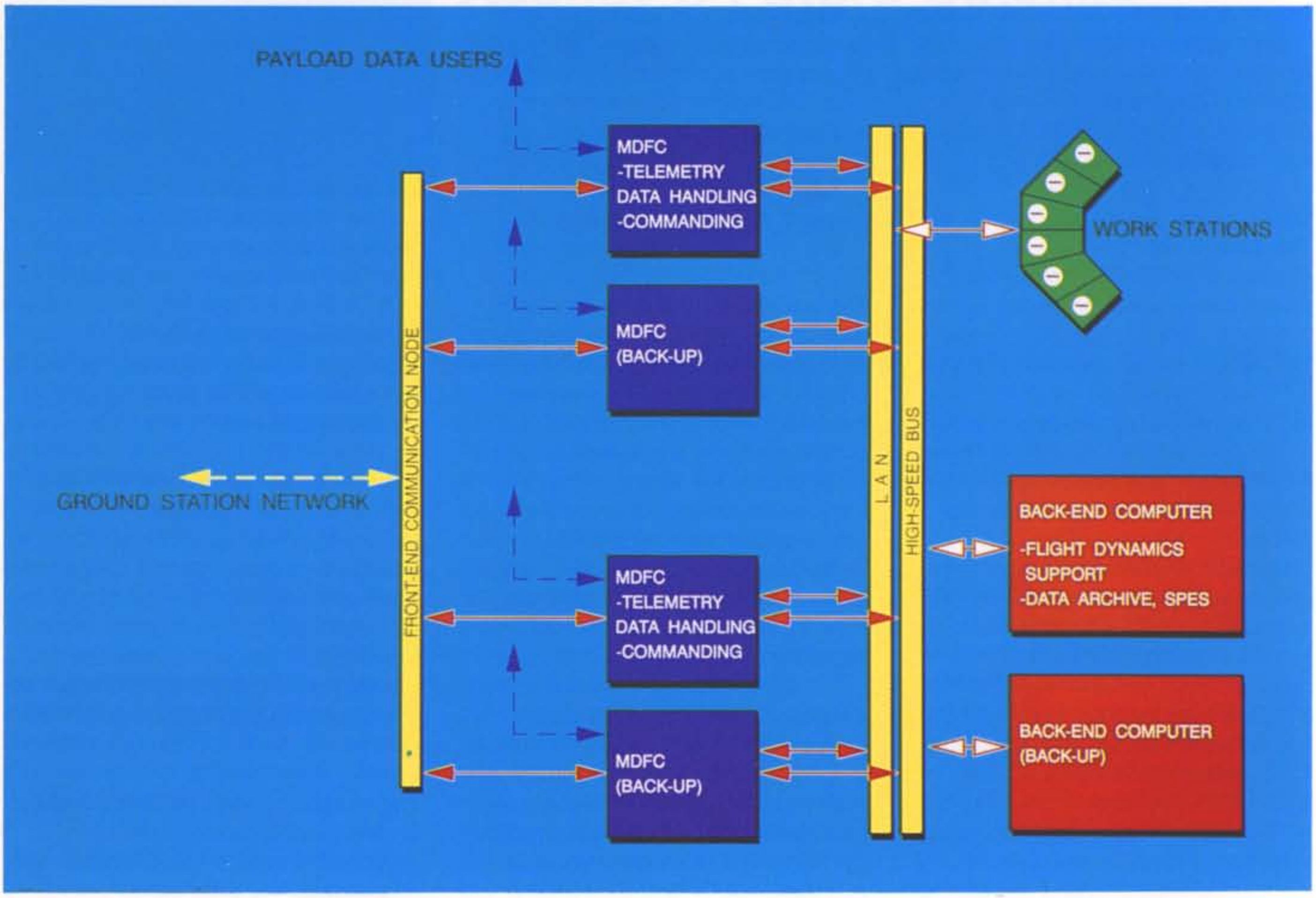
The connection between the MDFCs and the two back-end computers will be realised by a high-speed bus using CSMA* techniques. This bus will support inter-task communication and file transfer with a total throughput capacity of more than 10 Mb/s. The MDFCs will also have a communications link, protected against unauthorised access, with payload user centres.

The interace between the DMSS and the ground-support personnel will be provided via intelligent work stations with sophisticated graphical-display and hardcopy facilities, including multi-windowing and other advanced features. The work stations will be connected to the MDFCs and to the back-end computers via a Local Area Network (LAN), allowing dynamic allocation of work stations between the MDFCs and the various control rooms.

The DMSS configuration will have adequate redundancy to ensure high availability, and error-recovery features will be built in at various levels. All vital components will have a backup facility, particularly the front-end and back-end computers. For economic reasons, however, one backup computer may be shared between two MDFCs, if this is

* Carrier Sense Multiple Access

Figure 1 — Configuration of the Distributed Mission-Support System (DMSS), showing elements of the common infrastructure (yellow and red) and mission-specific elements (blue)



compatible with the operational constraints of the two missions.

Common software structure

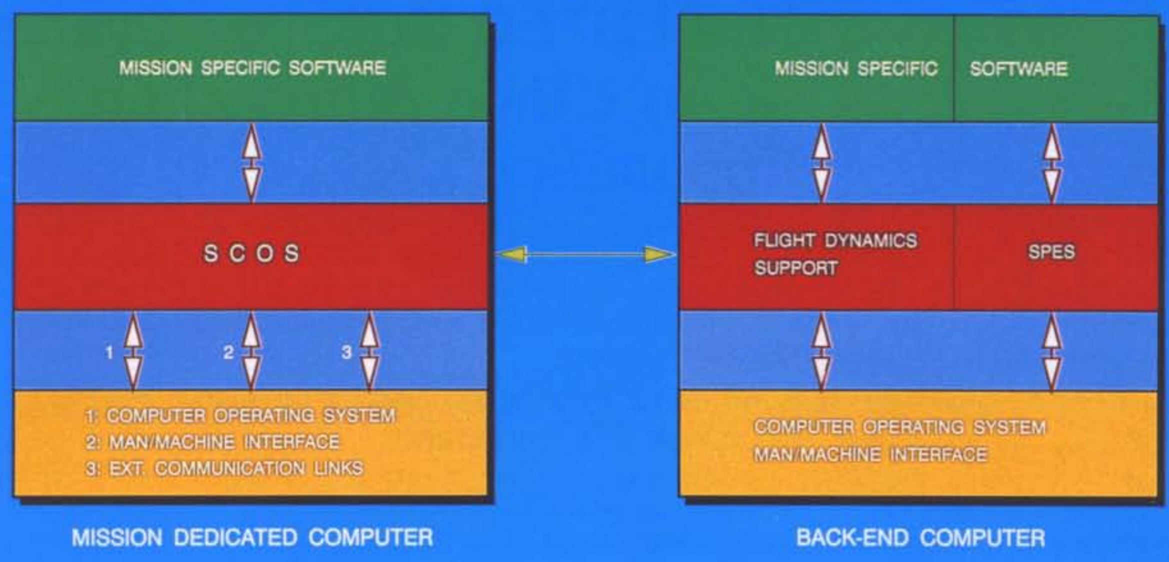
The common software structure of the DMSS consists of those elements of the software that, aside from minor variations, are shared by the various missions. It is mapped on the DMSS configuration as an application layer between the computer-supplied basic software and the mission-specific software modules (Fig. 2). The common software to be used on the MDFCs has been designed as a coherent system called the 'Spacecraft Control and Operations System' (SCOS). The prime functions of SCOS include the acquisition and processing of telemetry data, the presentation of the processed data at the work stations, and the data archiving. The telecommand handling is a somewhat mission-dependent task, which is therefore not part of the SCOS.

The SCOS's telemetry processor assumes that the telemetry data will arrive in a 'packetised' format, according to the standards defined by the Consultative Committee for Space Data Systems Standardisation. This implies that for missions that do not adhere to this standard, a format-conversion routine is required at data-acquisition level.

The SCOS will offer a rich menu of alphanumeric, graphical and mimic display formats, allowing data to be displayed in 'live' mode from real-time telemetry and in retrieval mode from the telemetry history files. It also includes a complex data-management subsystem, with facilities for access to and maintenance of both the various parameter files and the short-term telemetry data archive.
It is intended to expand the SCOS at a later date to incorporate the basic capabilities of an expert system which, in conjunction with the work stations, can be used as a support tool by the spacecraft operators.

The SCOS also provides the interfaces to the work stations, to the mission-specific modules and to the basic computer software. The complex nature of these interfaces reduces the portability of the SCOS and hence imposes a common standard for the MDFCs.

Figure 2 — Software structure of the Distributed Mission-Support System (DMSS)



For long-term history evaluation, the processed telemetry data and the derived parameters are transfered by the SCOS to the online archive at the back-end computer, where all spacecraft telemetry data will be collected under the control of the Spacecraft Performance Evaluation System (SPES). The latter will maintain a database of all spacecraft telemetry data processed at the front end, together with derived parameters. It will provide efficient information-extraction tools for the assessment of spacecraft systems performance over the duration of a mission. These tools will include a powerful online query language and extensive graphical presentation and reporting facilities.

An essential element of the common software structure will be the flight-dynamics support system residing on the back-end computers. This system will provide a multiproject support environment capable of supporting several missions simultaneously. It will also hold a number of central libraries for attitude- and orbit-determination software. Every library will be assigned to a specific class of mission support, such as to telecommunications missions, to interplanetary missions, or to LEOP support for geosynchronous missions. Access to these libraries will be organised by means of a versatile interactive system, which will be used during both the preparatory and execution phases of the flight-dynamics manoeuvres. Advanced work stations with sophisticated graphics capabilities will form an integral part of the interactive system.

Implementation schedule

The first ESA missions to be supported on the new DMSS will be the Hipparcos, Eureca and ERS-1 spacecraft. Development of the necessary mission-specific software for all three is proceeding according to schedule.

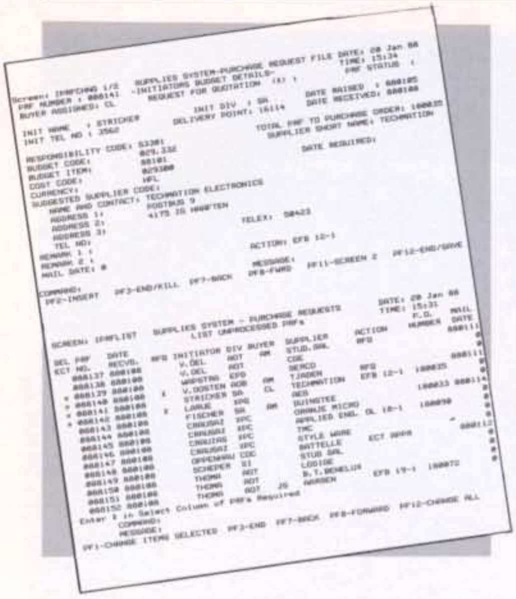
The MDFC for Hipparcos, a VAX 11/785-type computer, has already been installed at the end of 1986, and the Eureca front-end computer, a VAX 8530, was delivered in the first half of 1987. The ERS-1 computer, which is also a VAX 8530, will be installed in the first quarter of 1988. The two back-end computers, a Siemens 7890-E and a Siemens 7860-L, belong to the Agency's mainframe computer configuration.

The implementation of the DMSS common software structure will follow a phased approach. The relevant elements of the common software will be available such that, in accordance with usual ESA practice, ground-segment readiness can be secured for all three missions at least five months before launch.

The first step in the implementation process involves provision of the SCOS and installation of the relevant interfaces with its environment. This installation phase will basically be completed by January 1988.

The second step will be concerned with the implementation of the flight-dynamics support system and of the SPES on the back-end computer. This will be completed by the end of 1988, with the exception of the LEOP flight-dynamics software, which will only be available by the end of 1989. Until that time, LEOP support for geosynchronous missions will continue to be provided by the MSSS.

The third step covers the replacement of the existing work stations by a new generation. Initially, the DMSS will use the MSSS-type work stations and, the new stations will be progressively phased in with the help of software-emulation techniques to avoid affecting on-going projects. This phasing-in process will be completed by the end of 1990, at which time the Agency's new 'Distributed Mission Support System' will be fully operational.



The ESTEC Supplies System — An Office Automation Application

M.R. Watson, Site Services Department, ESTEC, Noordwijk, The Netherlands
E. de Jong, Information Services Division, ESTEC, Noordwijk, The Netherlands

The availability of a computer-based system which integrates the various supplies functions and provides electronic interfaces with customers and other involved services is expected to result in a marked improvement in the performance of the ESTEC supplies service and in a considerable reduction in the administrative overheads. Perhaps equally importantly, statistics relating to supplies will now be readily available. Very important factors such as geographical distribution of expenditure and individual supplier distribution, as well as internal factors such as customer loading, service performance, etc. will be available for management 'at the touch of a button'.

Introduction

The term 'Supplies' can be defined as 'those items or quantities that make up a deficiency, or fulfil a want or demand'. More specifically, this term incorporates the functions of:

- purchasing (negotiating and ordering supply needs)
- stock control (planning, setting and maintaining stock levels)
- stores (for controlled issue of consumables)
- goods inwards (for receipt and distribution of ordered goods).

This article describes the traditional supplies arrangements in ESTEC and discusses the concepts and details of a new, integrated system that is currently under development in ESTEC for handling supplies in the future.

Background

Some 1500 persons are employed at ESTEC, approximately two-thirds of whom are ESA staff members and one-third non-ESA staff. They perform a broad variety of functions and include: dedicated teams working on ESA satellites and other space-related projects; specialised technological research and ancillary groups; and administrative and other supporting staff.

The establishment occupies a site of approximately 50 hectares and accommodates, in addition to extensive office complexes, a wide range of test installations and laboratories. Some of these facilities are unique in Europe and among the largest of their kind in the World. An establishment of this size and complexity clearly has special supplies requirements, and an efficient supplies service is vitally important to the smooth running of the establishment.

ESTEC has a powerful, well-developed and distributed infrastructure of computer/office automation facilities. The establishment operates a general-purpose computer service based on an IBM 3090/VM-CMS hardware/software combination, which includes among its basic services the Professional Office System (PROFS). The PROFS facility can be described briefly as a set of interactive, basic office functions for: time management, electronic mail, document creation/editing and electronic archiving/retrieval (for further details see ESA Bulletin 51, pp. 58–61). Access to the central computer through PROFS is available to anyone at ESTEC who requires it.

It is perhaps surprising that this computer infrastructure has not been exploited as a means of support for the establishment's supplies activities until very recently. This situation, however, is now in the process of radical change through the development and application of modern computer techniques. The new supplies system will considerably improve the effectiveness of the service.

The existing supplies system

The way in which the functions (purchasing, stock control, stores, goods inward) incorporated within the ESTEC supplies service have traditionally been carried out, has the following characteristics:

- largely repetitive, mainly clerical activities, following standard procedures and using standard forms
- enormous quantities of paperwork
- intensive interfaces with customers and other services, in particular with Finance Division for registration of financial commitments, payment of invoices, operating accounts, maintenance of inventory.

One particularly onerous example is that routine procedures require the daily hand-carrying of documents and forms from one part of the establishment to another. Altogether, it is a classically fertile area for reaping the advantages of computerisation.

An idea of the scale of ESTEC supplies activities is given by the following:

Purchase order actions:	≃4500/year
Total value of purchase actions:	≃25 MAU
Stores actions (movements):	≃3600/year
Number of stores items:	≃10 000

In general, each purchase order action requires a corresponding 'commitment of funds' action in Finance Division, so that the number of such actions is also 4500/year. In the case of invoice payment, however, the number of actions is considerably higher, i.e. approximately 7000 invoices per year have to be processed. This is due, mainly, to the inevitable and high incidence of partial deliveries.

A highly simplified diagram of a basic supplies system is shown in Figure 1. A more detailed explanation of the complete purchasing/receipt and distribution/payment sequence is shown in Figure 2.

The new supplies system

The basic concept of the new supplies system is that once a customer's requirements have been specified by the completion of a computer 'form' accessed via PROFS, the resultant information can then be further handled and forwarded via the computer; until now this information has had to be manually rewritten at several stages in the process.

Anyone who has access to the computer can also look at the stores catalogue,

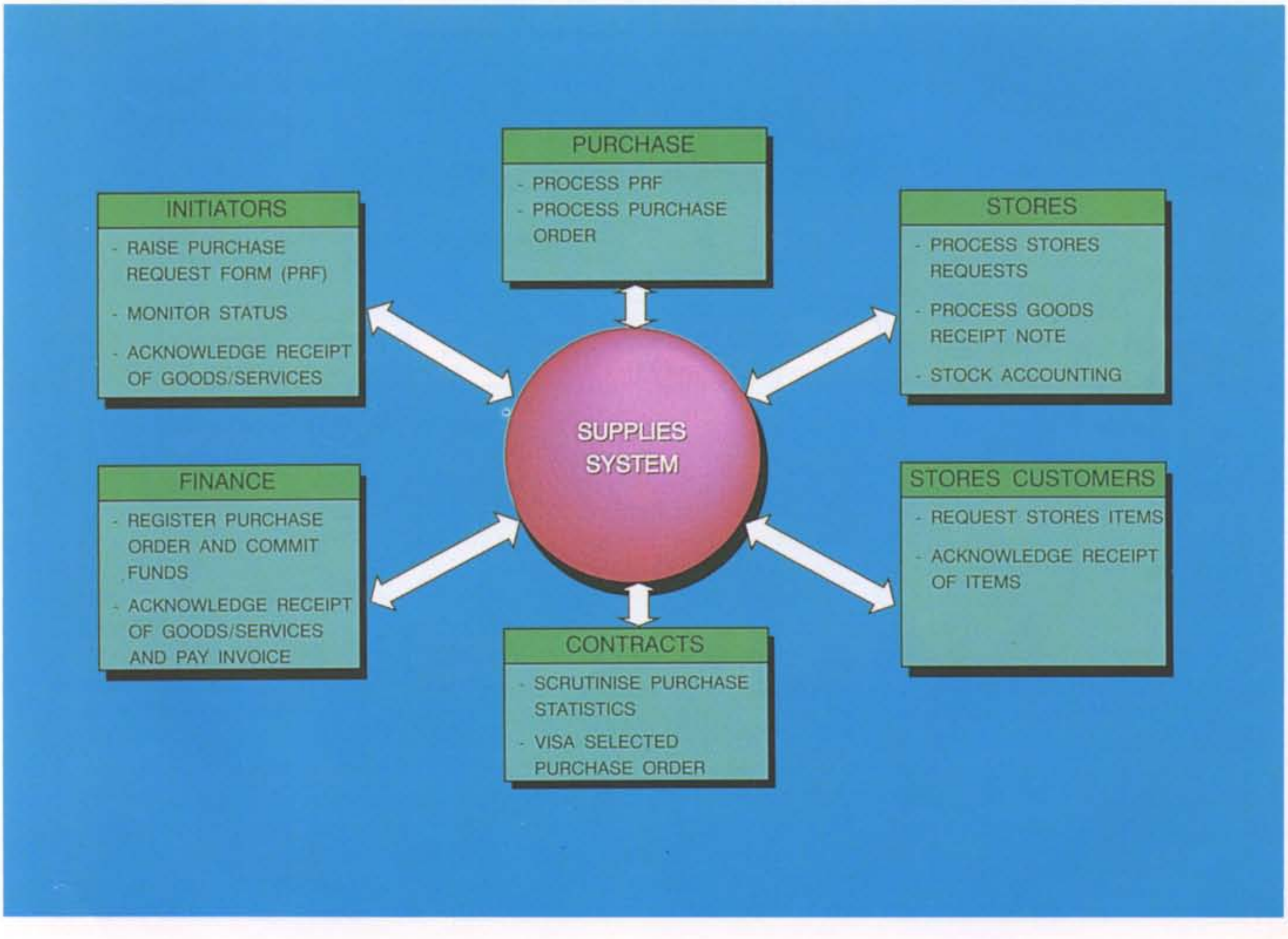
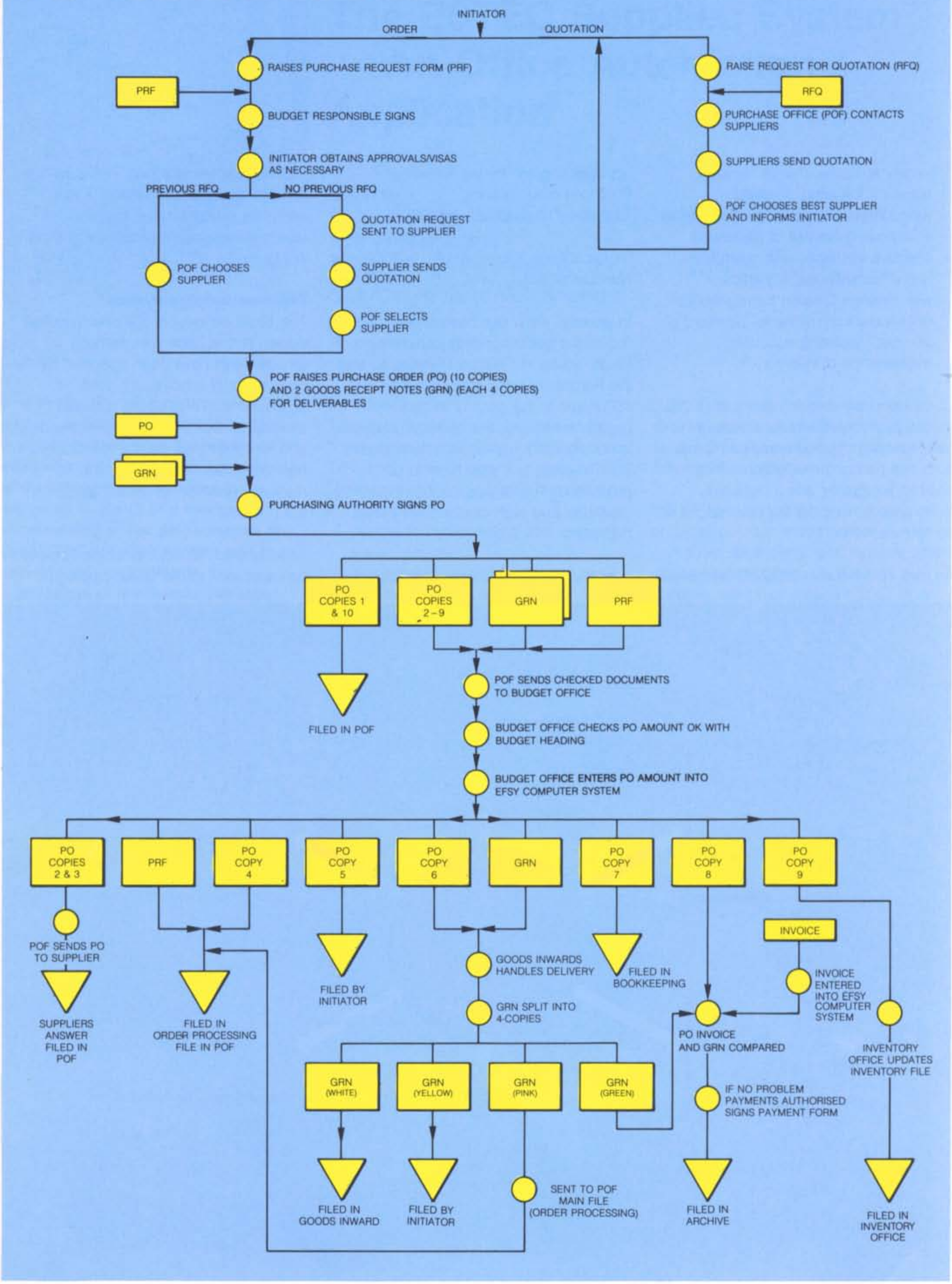


Figure 1 – Simplified diagram of a supplies system

Figure 2 – The current ESTEC supplies system (Level 2)



find out details of current suppliers, or monitor the progress of requests that have been sent to the Purchase Office or the Stores.

The new system will be implemented through:

a) specially developed applications software running on the central computer facility with electronic links to the Finance system, which runs on the same central facility;
b) installation of appropriate hardware (remote terminals and printers) for use by the staff of the supplies service;
c) computerised interface procedures that make use of the existing office automation infrastructure and allow electronic connection between the supplies service and its customers.

The new system is planned to be in operation by mid-1988, with the various functions within the supplies service operating as follows:

Central Stores
Central Stores customers will be able to submit their stores requests through the office automation facilities. A customer can scan the stores catalogue via PROFS using a variety of search criteria. When the customer enters a request onto a stores document screen a description of each item is displayed so that the customer can double-check the order before sending it electronically to Central Stores. It is viewed in Central Stores on a screen which displays not only the customer's order, but the location, quantity available and any issue restrictions for each item. This stores document screen can be printed and the hard copy used as a checklist to collect the items from the Stores. The stores document will also show whether the requested items are to be delivered to the initiator, in which case it will serve as both despatch note and receipt. Once the items ordered have been delivered to and acknowledged by the customer, the returned stores document is used by Central Stores to adjust stock levels.

Stock Controller
At the end of each working day (and on special request), the stock level of all stores items will be checked automatically by means of an algorithm based on anticipated consumption and delivery lead time. These parameters can be tuned to achieve optimum stock levels.

When the stock level of an item drops below its re-order level, it will be flagged together with other items close to the re-order level that are obtained from the same supplier. The flagged items will be displayed on a purchase request document screen, from which the stock controller can decide which items to re-order. The stock controller can, at any time, apply a manual override to alter established re-order quantities.

Purchase Office
Purchase requests will be processed in a similar way to stores requests. Purchase Office customers will be able to access a purchase request document screen via PROFS and send their requests electronically to the Purchase Office. The system automatically time-tags and registers each request and presents it for viewing in the Purchase Office where a purchase order is generated and sent to the supplier. Details of the purchase order are also transferred automatically to Finance Division. The system also provides Finance with a continually updated file on suppliers. Additionally, the initiator will be able to check on the progress of a request via PROFS.

Purchase Office will send out official Requests for Quotation to chosen suppliers and process them in a manner similar to the purchase orders. Where an offical quotation is not required, the initiator may send a PROFS note to the Purchase Office, and the buyer will telex or phone the various companies for the best price or service. Replies from suppliers will be returned to the initiator via PROFS.

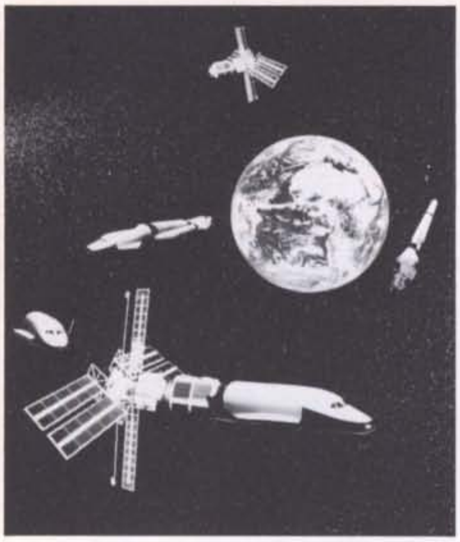
Goods Inward
Whenever goods are received, the purchase order to which they belong will be displayed on the Goods Inward computer terminal either by entering the purchase order number, or other search criteria relating to the supplier (e.g. supplier's name).

Goods Inward will enter the quantity received against each item on the Purchase Order. Internal delivery notes will then be generated automatically so that the goods may be delivered to the initiators. These delivery notes will also be used by the initiator to acknowledge receipt. The details of receipt will be transferred automatically to Finance Division to enable appropriate payment of associated invoices.

Conclusion
The main advantages to the Agency of this new system will be:

— better service to supplies' customers through the immediate flow of information between the customer and the service
– improved overall efficiency through the elimination of duplicated clerical tasks and the elimination of enormous paper filing systems
– readily available statistics relating to the supplies function.

As a result of ESA's earlier established and applied policy of standardisation of all central (mainframe) computing facilities for the different establishments, once the ESTEC-developed supplies system is operational in mid-1988 it can readily be installed at other ESA establishments and adapted to meet their particular requirements. The existing communications network between the various ESA establishments, ESANET, offers further possibilities for integration and rationalisation of supplies arrangements on an Agency-wide basis.



Insurance of Space Risks

L. Plöchinger, Deutscher Luftpool, Munich, Germany

Impressive pictures of rocket launches and magnificent photographs of manned space flights repeatedly raise questions about how far the insurance market is prepared to go in insuring the inherent risks. As a rule, coverage is only offered for commercial spacecraft, such as telecommunications satellites. Insurance protection cannot be obtained for scientific experiments on board manned space vehicles, or for research satellites, since in these cases the risks are incalculable.

It is already more than twenty years since a space risk was first insured — a liability and pre-launch policy taken out in 1965 for 'Early Bird', one of the first commercial satellites. At that time these risks were still covered by the traditional aviation market. It is only since 1968 that a specific market for the insurance of space risks has evolved. In view of the size of the risks and loss experiences to date, the number of primary insurers and re-insurers operating in this market is still very limited.

Possible forms of insurance

Several forms of insurance have evolved over the years for the insurable risks and they can be broken down into three prime categories:

1. Pre-launch risks, covered by 'Pre-launch Insurance'
2. Launch/test (max 180 d) risks, covered by 'Launch Insurance'
3. Post-commissioning (in space) risks, covered by 'In-Orbit (Life) Insurance'.

Pre-launch risks begin with the production of the individual components and their assembly to form a satellite or launching system. As a general rule, these risks are assigned to 'Engineering Insurance'. Transportation to the launching pad by ship, aircraft and/or truck is then covered by 'Marine Insurance'. In certain cases, all of these risks may be covered by the 'Space Insurance' market.

In recent times, however, there has been a growing tendency for the international space-insurance market not to be tapped until the arrival of the satellite at the launch pad. The pre-launch insurance then includes such risks as the final testing prior to the launch, fuelling, and also the satellite's integration into the launching system. Pre-launch insurance terminates either on ignition of the launcher's engines, or on the opening of the clamps.

Launch insurance generally follows on where pre-launch insurance leaves off. It covers the launch risk, including the placing of the satellite into its pre-calculated orbit, and also the subsequent test phase (lasting a maximum of 180 d).

On completion of the test phase and commencement of commercial operations, life coverage — also known as in-orbit insurance — is offered. This covers failures during the operating phase.

In both launch and in-orbit insurance there are deductibles for the policy holder; for example, failure of a certain number of transponders, or a given number of years of life expectancy. War risks, civil commotion, gross negligence and deliberate acts on the part of the policy holder are generally excluded from the coverage.

A further aspect is possible loss or damage caused to third parties by the launch system or satellite. This risk is covered by a Third Party Legal Liability Insurance, which embraces damage caused by the explosion of a launcher on the launch pad or a collision with another satellite, for example.

Figure 1 — Retrieval of the Westar-VI and Palapa-B2 satellites by Space Shuttle 'Discovery'

In addition, special forms of insurance covering risks such as loss of revenue or incentive payments are also possible. Insurance coverage for such risks is of particular interest to operators of radio and television stations and to satellite manufacturers.

Risk assessment
There are two main factors involved in risk assessment:
— Which launch system is to be used?
— What is the intended mission/payload of the satellite?

A distinction has been made in the past between launches with NASA's manned Space Shuttle and unmanned launch vehicles. A satellite launch using the Space Shuttle was initially considered to be relatively favourable in terms of risk up to the point of satellite release, i.e. 300 to 500 km above the Earth's surface. However, the satellite's subsequent injection by means of an additional engine, the Payload Assist Module (PAM), has not been without problems, as the boost-engine failures in the case of the Palapa and Westar satellites in 1984 demonstrated all too clearly. Although the satellites were later salvaged in a spectacular rescue operation, their subsequent sale proved extremely difficult.

In view of NASA's recent decision to greatly restrict the availability of the Space Shuttle for commercial users and possible repair work in space when flights are resumed, in principle in 1988, insurers of space risks will in future be obliged to concern themselves primarily with rocket launchings.

Both the USA and Europe have been experiencing difficulties with their systems. In the USA, concentration on the Space Shuttle has inhibited the development of alternative launch systems. Influenced by the Challenger disaster and NASA's subsequent decisions, increased efforts are now being made to revive this sector in order to catch up again with the Europeans. As the unmanned launch systems have also experienced their share of setbacks in recent times, another two to three years will certainly elapse before reliable systems are again available in sufficient quantities to satisfy the commercial market.

The European system, marketed by Arianespace, currently offers launches with Ariane-2 and 3 vehicles, and Ariane-4, a considerably more powerful version, will soon be available. The failure of the Ariane V18 flight in May 1986 resulted in more than a year's delay in the Ariane launch schedule, but the successful V19 and V20 flights in 1987 have served to restore confidence in the European system.

Recently, the People's Republic of China and the USSR have also been trying to attract western satellite operators as customers for their launch systems, known as 'Long March' and 'Proton', respectively. Of significance for the insurance industry here is the fact that China has so far logged only thirteen launches, with two failures, while the USSR has considerably more experience. In both cases the decisive factor as regards risk assessment by the insurer will be how liberal these countries are with information. The People's Republic of China has recently concluded two launch contracts with American companies. For Russian launches, there could be political difficulties if US Government export permits are required.

Japan is currently developing its own launch rockets, some of which have already been flown successfully. However, it is unlikely that these systems will be fully operational before the 1990s.

It is interesting to note that, so far, difficulties with a particular launcher seem to have occurred primarily during the first twenty launches. This is illustrated by the following figures from the USA and Europe:

Delta:	4 total losses in the first 20 launches
Atlas Centaur:	5 total losses in the first 20 launches
Ariane:	4 total losses in the first 20 launches.

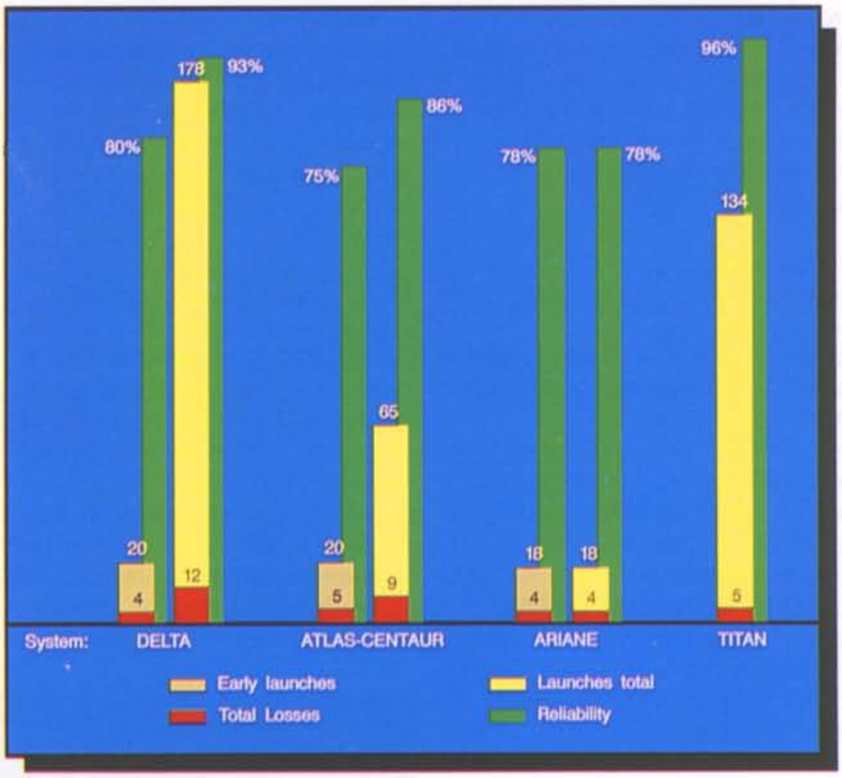
The following reliability rates have been calculated (in December 1986) for the various US systems (see also Fig. 2):

Delta:	93%, for a total of 178 launches
Atlas Centaur:	86%, for a total of 65 launches
Titan:	96%, for a total of 134 launches.

As already mentioned, the space risks to be insured relate at present almost exclusively to communications satellites in geostationary orbit, approx. 36 000 km above the equator. The only difference lies in the payloads. Whereas hitherto such satellites have had a maximum amplifier power of 50 W and have transmitted telephone calls or news, television and radio programmes to ground stations for feeding into local networks, in future more and more direct-broadcasting satellites with substantially more powerful amplifiers will be put into space.

A further factor to be considered in assessing the risks is the differing degrees of experience of the satellite manufacturers. In most cases the satellites are one-off items, and there is little 'series production'. Another aspect to be considered is how many of the systems, subsystems and other components have already been proven successfully on previous satellites.

Figure 2 — Launch statistics per 31 December 1986



Cooperation between satellite manufacturers, launch agencies and insurers is extremely close, with frequent and very candid exchanges of information and ideas taking place. The insurance industry is therefore well informed of all that is going on in the very specialised space market.

Loss experience in space insurance

That the insurance market's readiness to accept risks has, in the past, been put severely to the test is clearly illustrated by the fact that worldwide net premium income since space insurance began is approximately US$ 625 million, whilst claims have already cost the insurers approximately US$ 940 million (per 31 December 1986).

The overwhelming majority of these losses occurred during the launch and positioning phases, and therefore affect launch insurance. The risk after completion of the test phase and transfer of the satellite to its operators is more positively assessed.

Development of premium/problems of capacity

Past experience has led to a massive increase in premiums, particularly for launch insurance. While rates of between 6 and 11% were usual until 1982/83, a premium of up to 25% of the insured sum must currently be assumed. At the moment, it is impossible to predict how things will develop in the future. The only way to get back to premiums that are commercially acceptable and still appropriate to the risk is to improve the reliability of the systems employed.

A further factor in this context is the limited overall capacity of the world space-insurance market, which at present stands at between US$ 80 million and 110 million for launch insurance. While this can be sufficient if only one satellite is being launched, the situation can become critical for the customer with a

Figure 3 — Launch of Ariane vehicle V10 from ESA's Kourou launch site

dual launch of two satellites on one vehicle. Here too, positive experience would attract increased insurance capacity, as has already been observed in the case of in-orbit insurance.

The launch insurance offered by the various launch companies through subsidiaries, which only applies during the launch vehicle's flight, does not really solve the customer's problem; at best, it can help to alleviate the situation in certain cases.

Number of risks to be insured
A further problem for the space-insurance market is the small number of risks for which insurance is sought. So far, the maximum number in a given year was 20 satellites in 1985. In 1986, this number was only 6, owing to the problems with the various launch systems. Even when all of the launch systems are fully operational again, there will be at best a maximum of 25 launches per year. These figures clearly show that there is no compensatory factor in an actuarial sense. This means that in the future, as in the past, each individual risk will have to be subjected to careful scrutiny. Moreover, one cannot rule out the possibility that the insurer could then come to the conclusion that a particular risk is not insurable.

Outlook
The insurance market will have to live with these difficulties for many more years to come. The insurance industry is nevertheless prepared to continue to provide cover, on the understanding that the space industries involved will continue to improve their products, thereby helping to alleviate the present difficulties.

Further challenges are in store in the more distant future. When Space Stations finally allow a broad spectrum of commercial utilisation, and new reusable space systems are available, the insurance market will have to develop new concepts in order to make the requisite insurance coverage available. Then, it will certainly be possible to achieve a better risk spread across a greater number of launches, which will hopefully have an even better reliability record.

Despite the present difficulties, therefore, an optimistic outlook for space travel and space insurance can, on the whole, be justified.

In Brief

Ariane Flight V20 Launches First Direct Broadcasting Satellite for Europe

The German direct-broadcasting satellite TV-Sat 1, built by Eurosatellite in the framework of the joint French/German TV-Sat/TDF-1 programme, was launched successfully on Saturday 21 November at 03 h 19 min. The launch, performed by Arianespace using an Ariane-2 launcher, took place from the ELA-2 facility in Kourou, French Guiana.

The satellite was placed into a geostationary transfer orbit (GTO) with the following provisional parameters:

- Perigee altitude: 199.6 km (nominal value 199.9 km).
- Apogee altitude: 36 136 km (nominal value of 36 094 km, at the injection of the 3rd stage).
- Inclination: 4°, being the nominal value.

Twenty-five minutes after the launch, one of the two solar panels partially deployed as planned, but the other did not. Despite this malfunction, which is presently being investigated, all other operations proceeded as scheduled, with the first of the three apogee-boost-motor ignitions being performed approximately 37 h after launch.

The next Ariane flight is scheduled for the beginning of 1988 from the ELA-1 facility, when an Ariane-3 launcher will launch into GTO the American telecommunications satellite Spacenet-III R/ Geostar-RO1, together with the French satellite Telecom-1C.

After the successful launch of TV-Sat 1, the Arianespace order book amounts to 43 satellites, representing a total revenue of approximately 14 billion French Francs.

Ariane-5 Development Programme Given Go-Ahead

The ESA Council at Ministerial Level, which was held on Monday 9 and Tuesday 10 November (see elsewhere in this issue) approved the Ariane-5 launcher Development Programme. This decision follows up that made in Rome in January 1985 to fund the Ariane-5 Preparatory Programme, which included the development of the HM-60 cryogenic engine and the design of the launch vehicle itself.

There are three main reasons for developing this new European launcher:

- *The trend towards larger automatic payloads:* In 1995, 50% of the satellites that will need to be put into geostationary orbit will weigh between 2.0 and 2.8 t (compared with 25% today), and will have an average diameter of 4.55 m (compared with 3.65 m for Ariane-4).
- *New user requirements:* Launch reliability has to be as high as possible, because payloads are becoming more and more costly and the losses after a launch mishap more and more substantial. Secondly, the launch costs themselves need to be substantially reduced (i.e. the cost per kilo into GTO).
- *In-orbit infrastructure and in-orbit intervention:* To become independent in this sector of space activity, Europe must not only have the capacity to put into orbit elements of manned stations and platforms (Columbus), but also be able to service them with the Hermes spaceplane, to be launched by an Ariane-5 lower composite.

To meet the above requirements, Ariane-5 must have the capacity to put into orbit one or more satellites with a total mass of 6.8 t, including the multiple-launch devices needed. It must also be able to put Columbus station modules or platforms weighing up to 18 t into low orbit (550 km × 550 km, inclination 28.5°). It must also be able to carry Hermes, which will weigh approximately 21 t, into transfer orbit.

Ariane-5 consists of a lower composite, which will be identical for all missions, and an upper composite. The lower composite consists of a main cryogenic stage (H155, with on-ground ignition) propelled by a Vulcain engine, and two large solid-propellant strap-on boosters (P230). The upper composite is mission-dependent: for automatic missions it will be a storable-propellant stage (L5) used for GTO, LEO and SSO missions, an equipment bay, and the upper composite. The latter will be made up of a short or long (Columbus-configuration) fairing for a single-payload launch, and one or two Speltras* for dual or triple launches. For crewed missions the upper composite will consist of the Hermes spaceplane mounted on its adaptor.

* Speltra: Structure Porteuse Externe de Lancements Triples Ariane.

ECS-4 Handed Over to Eutelsat

On 1 November 1987, the European Telecommunications Satellite Organisation, Eutelsat, took formal delivery in orbit of ECS-4, the fourth of five European Communications Satellites built for ESA by British Aerospace Space and Communications Division, leading a European consortium.

Launched by Ariane (V19) from Kourou in French Guiana on 16 September 1987, ECS-4 subsequently successfully completed a series of manoeuvres which placed the spacecraft in its final geostationary orbital position at 10°E (see ESA Bulletin No. 52, pp. 9-11).

Once 'on station' the spacecraft's payload and subsystems were subjected to a series of rigorous acceptance tests, lasting from 9 to 27 October. Following successful completion of these tests, the Compliance Review Board concluded that all major satellite parameters met pre-determined performance requirements.

ECS-4, now re-designated 'Eutelsat I F-4', has therefore been transferred to Eutelsat. Its transponders, operating at 14/11 and 14/12 GHz, will be used mainly for TV distribution. The satellite will complement the Eutelsat I F-1 (ECS-1) and Eutelsat I F-2 (ECS-2) satellites, which provide a range of telecommunications services to Europe, including telephony, business services and TV distribution.

ECS-4 is the eleventh communications satellite in the series of 18 which have been developed from ESA's Orbital Test Satellite, OTS.

Agreement Signed between ESA and Spot Image

On 29 October 1987, Mr Gérard Brachet, Chairman and Managing Director of Spot Image (F) and Mr Philip Goldsmith, Director of ESA's Earth Observation and Microgravity Programmes, signed an Agreement regarding the reception of SPOT satellite images by the Agency's Maspalomas ground station (Canary Islands, Spain).

Under this Agreement images taken by the SPOT satellites over West Africa, from the Ivory Coast and the Niger to Senegal and Mauritania, will be transmitted directly to the Maspalomas station. The data recorded at Maspalomas will be sent in the first instance to Toulouse for pre-processing at the Centre de Rectification des Images Spatiales (CRIS), set up jointly by the French national space agency CNES and the National Geographical Institute. The data will then be marketed by Spot Image. Later on, some processing will also be carried out at the Maspalomas station, with responsibility for marketing remaining with Spot Image.

The Agreement, involving a minimum of 4 million French Francs per year, stems from the cooperation agreement signed in July 1987 between ESA and the Commission of the European Communities on the technical upgrading and exploitation of the Maspalomas station. It will allow SPOT images of West Africa to be used to meet the requirements of the development projects that are going on in this region funded by the European Communities.

The Maspalomas station, operated by Instituto Nacional de Tecnicas Aeronauticas (INTA), is in fact part of ESA's Earthnet system. It has been used for several years to receive data from the American Nimbus-7 and Landsat satellites and will be one of the stations that will receive data from ESA's ERS-1 remote-sensing satellite (due to be launched in 1990).

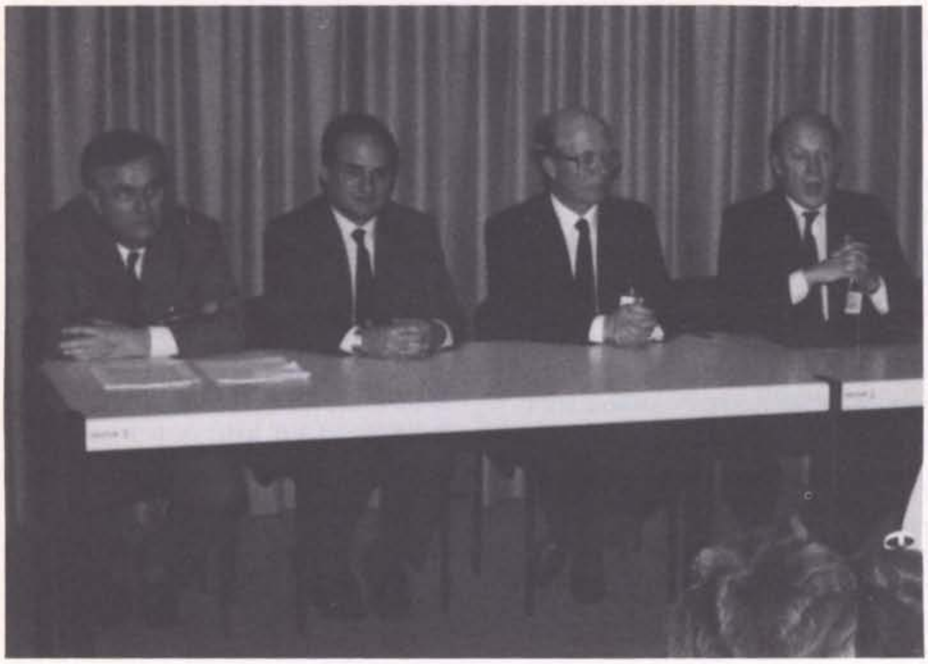
ERS-1 Critical Design Review Successfully Completed

The System Critical Design Review for the Agency's ERS-1 remote-sensing satellite was held successfully at ESTEC in Noordwijk (NL) in the period 22 October – 11 November 1987. This review represented a major milestone in the ERS-1 project, being the point at which industry had to demonstrate that the performance, interface and other project requirements set for the satellite will indeed be met.

ERS-1, which is Europe's first remote-sensing satellite, is equipped with a payload of all-weather Microwave Instrumentation (a synthetic-aperture radar, a wind scatterometer and a radar altimeter), an Along-Track-Scanning Infrared Radiometer and Microwave Sounder, Precise Range and Range-Rate Equipment and a Laser Retro-Reflector. The satellite bus is based on the platform developed for the French SPOT satellite. The satellite weighs approximately 2400 kg and is scheduled for launch into a Sun-synchronous low Earth orbit (800 km) on an Ariane-4 vehicle in April 1990.

ERS-1 will: provide all-weather high-resolution imaging over land, coastal zones and polar ice caps; measure globally ocean wave height and wave lengths; measure wind speeds and direction; determine precise altitudes; measure various ice parameters, sea-surface temperatures and cloud-top temperatures; and detect cloud cover and atmospheric water-vapour content.

The recent System Critical Design Review, which had been preceded by 56 critical design reviews at equipment, subsystem and instrument level, concluded that the required performances can be achieved and that the programme has matured sufficiently to allow progressive release for the flight-model hardware manufacturing.



Meteosat Tenth Anniversary Celebrations

To celebrate Meteosat's tenth anniversary a ceremony was held jointly with EUMETSAT at ESOC, the Agency's operations centre in Darmstadt, Germany, on 3 December 1987. A welcoming address was given by Dr Heinz Riesenhuber, the German Minister for Research and Technology.

Mr Philip Goldsmith, ESA's Director of Earth Observation Programmes, and Mr John Morgan, Director of EUMETSAT, both described Meteosat as an indispensable tool for modern meteorologists and symbol, seen regularly in nearly every household in Europe, of what can be achieved by the united efforts of Europe.

The ceremony was followed by a press conference, the panel comprising (from left to right) Mr K. Heftman, Director of ESOC, Mr J. Morgan, Dr A. Junod, Chairman of the EUMETSAT Council and Mr P. Goldsmith.

Agency's Tele-Invoicing System Goes On-Line

The policy for the introduction of telematic links with Industry for invoicing, particularly for the Agency's major Projects and Programmes, was described in ESA Bulletin No. 49, pp. 24-26. On 10 November 1987, Mr Bernd Moldenhauer (on the right), Head of Finance of Dornier System GmbH, handed over a cheque to Mr Charles Pridgeon, Head of Finance, ESTEC representing his company's contribution to the development costs of the system. Mr E. Slot, Head of Payment Services ESTEC, is also pictured centre.

As a result of the close cooperation between the Agency and Industry during the development phase, Dornier System GmbH is the first contractor to have a 100% electronic link for invoicing with ESTEC. Arrangements for the establishment of similar links with the other Prime Contractors are well advanced. The first half of 1988 will see consolidation of the system, with selected expansion in major areas of activity.

Publications

The documents listed have been issued since the last publications announcement in the Bulletin. Requests for copies should be made in accordance with the Table and using the Order Form inside the back cover of this issue.

ESA Journal

The following papers have been published in ESA Journal Vol. 11, No. 3:

AUTOMATIC TRACKING OF HIGH-LEVEL CLOUDS IN METEOSAT IR IMAGES WITH A RADIANCE WINDOWING TECHNIQUE
SCHMETZ J & NURET M

DATA CIRCULATION IN MICROWAVE POSITIONING SYSTEMS FOR SOLID-EARTH SCIENCE MISSIONS
CORR D G ET AL

REPPRE – REPSIM – REPSTA: PROGRAMS FOR EVALUATING THE AVAILABILITY AND MAINTENANCE OF SPACE SYSTEMS
DEBRUYN J C & JENKS C S

DESIGN AND VERIFICATION OF THE FLECS TEST STRUCTURE
NELLESSEN E

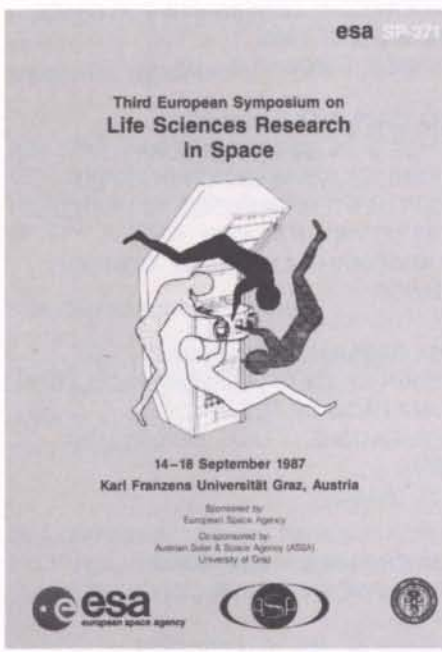
SAMPLING CRITERIA IN MULTICOLLECTION SEARCHING
GILIO A ET AL

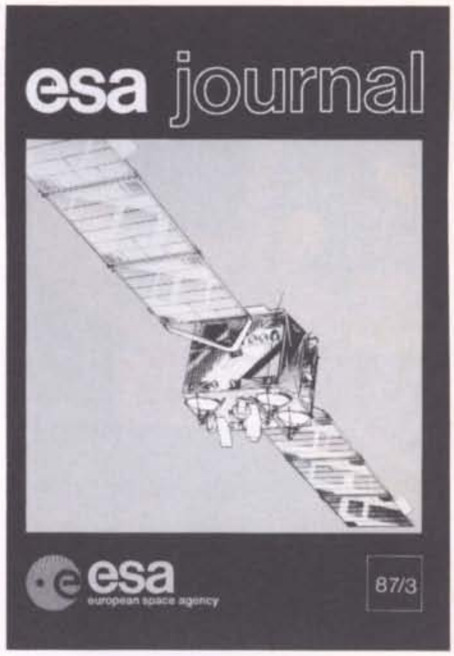
ABSORPTIVE TETHERS – A FIRST TEST IN SPACE
OCKELS W J

REMOTE OPERATION OF COMMUNICATIONS SATELLITES
GARNER J T ET AL

ESA Special Publications

ESA SP-271 // 371 PAGES
LIFE SCIENCES RESEARCH IN SPACE, PROC. THIRD EUROPEAN SYMPOSIUM, GRAZ, AUSTRIA, 14-18 SEPTEMBER 1987 (DECEMBER 1987)
HUNT J J (ED)





ESA SP-272 // 516 PAGES
PROC. FIRST EUROPEAN IN-ORBIT OPERATIONS SYMPOSIUM, TECHNISCHE HOCHSCHULE DARMSTADT, W. GERMANY, 7-9 SEPTEMBER 1987 (NOVEMBER 1987)
ROLFE E J (ED)

ESA SP-279 // 345 PAGES
PROC. THIRD EUROPEAN SPACE MECHANISMS & TRIBOLOGY SYMPOSIUM, MADRID, SPAIN, 30 SEPT – 20 OCT 1987 (DECEMBER 1987)
HUNT J J (ED)

ESA SP-1094 // 59 PAGES
PROC. ESA-NASA WORKSHOP ON A JOINT SOLID EARTH PROGRAMME, MATERA, ITALY, 29-30 APRIL 1987 (OCTOBER 1987)
GUYENNE T D & HUNT J J (EDS)

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THE PREPARATION, ASSEMBLY AND MOUNTING OF RF COAXIAL CABLES (OCTOBER 1987)
MATERIALS & PROCESSES DIVISION, ESTEC

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INSERT DESIGN HANDBOOK (JUNE 1987)
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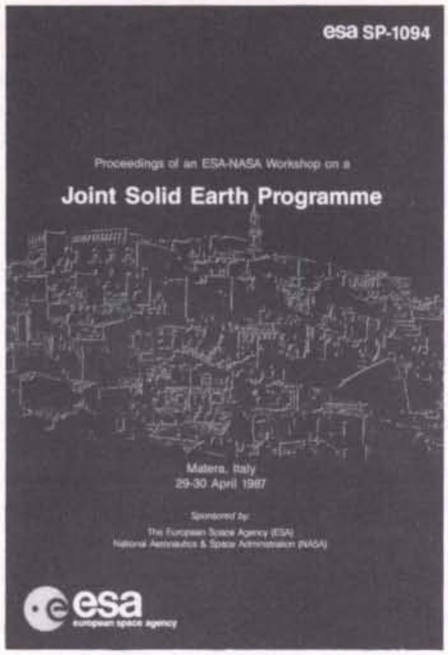

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