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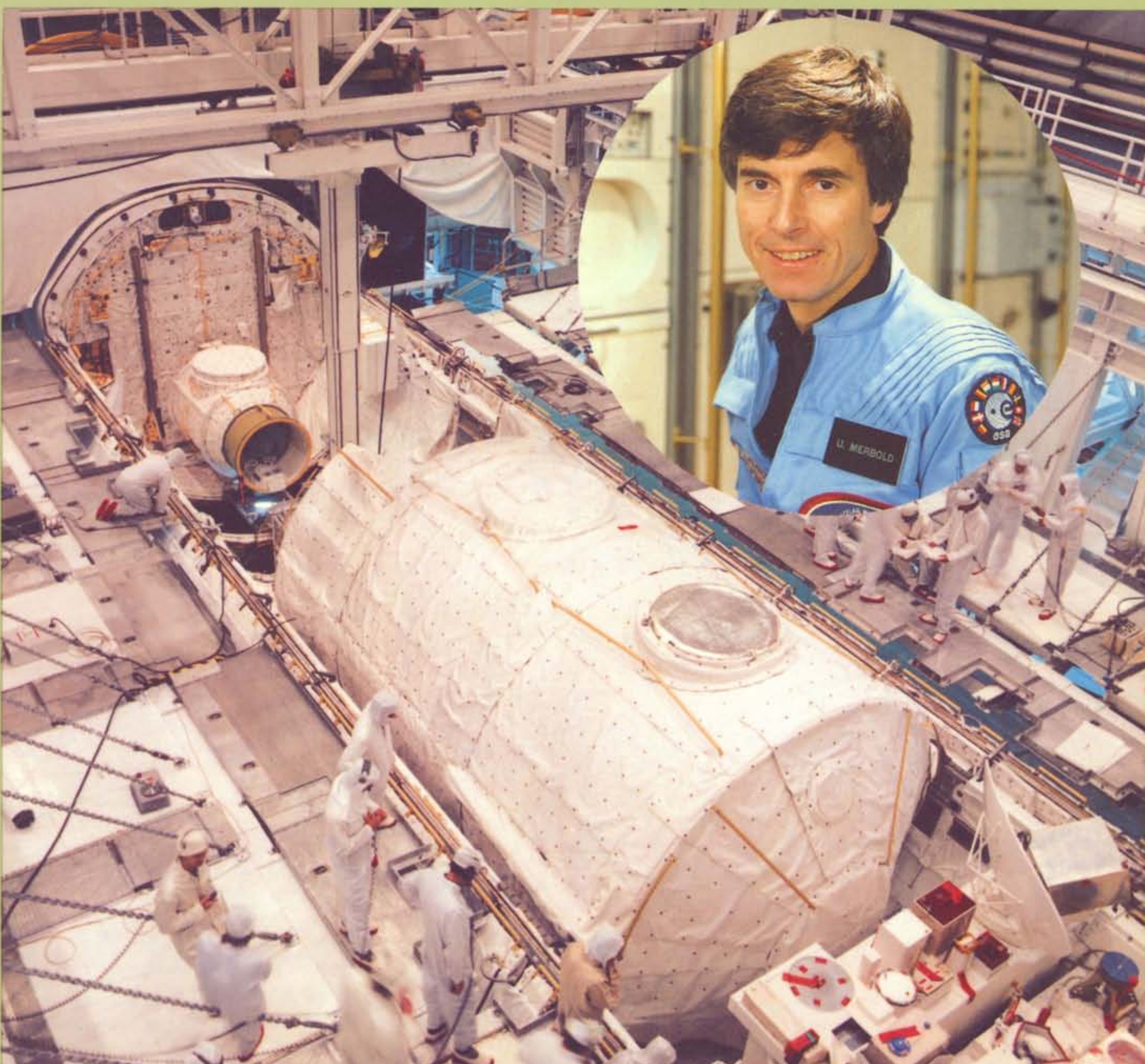

european space agency

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 Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Spain, Sweden, Switzerland and the United Kingdom. Austria and Norway are Associate Members of the Agency. Canada has Observer status.

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 Director of Scientific Programmes; the Director of Applications Programmes; the Director of Space Transportation Systems, the Technical Director, 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: Prof. H. Curien (France).

Director General: Mr. E. Quistgaard.

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, la Belgique, le Danemark, l'Espagne, la France, l'Irlande, l'Italie, les Pays-Bas, le Royaume-Uni, la Suède et la Suisse. L'Autriche et la Norvège sont membres associés de l'Agence. Le Canada bénéficie d'un statut d'observateur.

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 satellites 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, du Directeur des Programmes scientifiques, du Directeur des Programmes d'Applications, du Directeur des Systèmes de Transport spatial, du Directeur technique, du Directeur des Opérations et du Directeur de l'Administration.

Le SIEGE de l'ESA est à Paris.

Les principaux Etablissements de l'ESA sont:

LE CENTRE EUROPEEN DE RECHERCHE ET DE TECHNOLOGIE SPATIALES (ESTEC), Noordwijk, Pays-Bas.

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

ESRIN, Frascati, Italie.

Président du Conseil: Prof. H. Curien (France).

Directeur général: M. E. Quistgaard.

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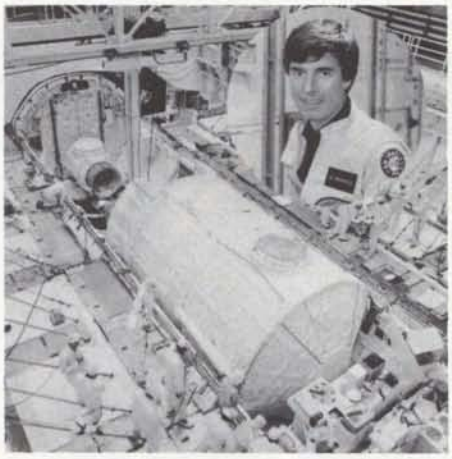

Front cover: Installation of Spacelab-1 in the Space Shuttle's cargo bay at Kennedy Space Center (see page 6). Inset: Ulf Merbold, European Spacelab-1 Payload Specialist.

Back cover: Ariane launch of Intelsat-V (F7) from ESA's Kourou launch base on 18 October (see page 65).

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competitivity - performance
ariane/sylda
Aerospatiale designed and built Sylda, Ariane's dual launch system. This light-weight, high-performing graphite epoxy structure makes it possible to place two satellites into geostationary orbit simultaneously. It makes Ariane extremely competitive in the medium-size satellite field: Marecs, Sirio, ECS, Telecom 1, Arabsat, Westas, G-Star, SPCC, etc.
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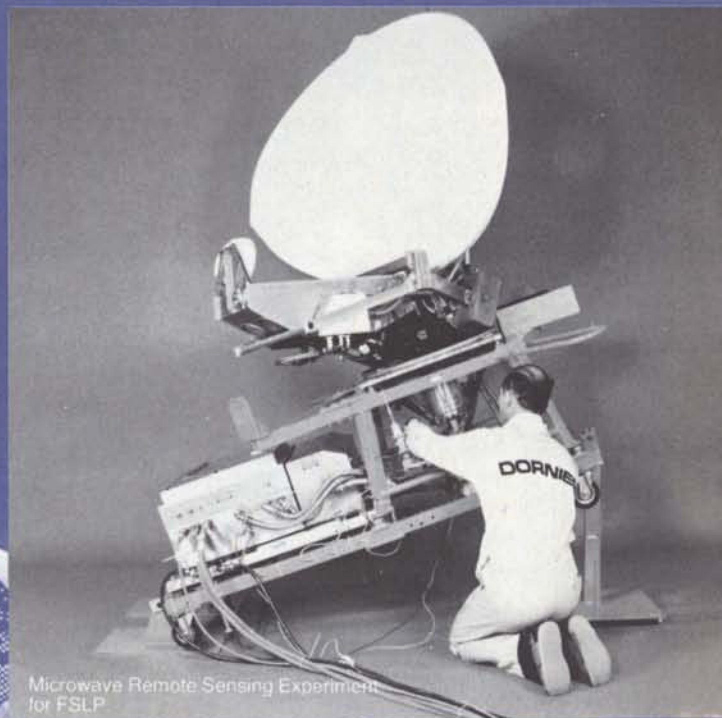
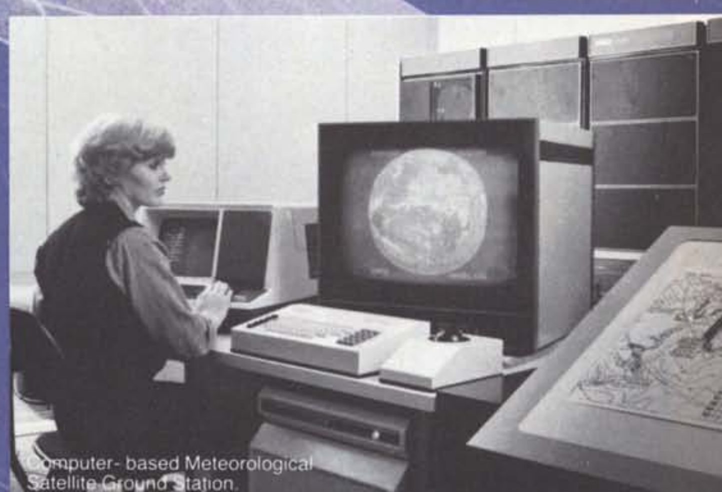


Microwave Remote Sensing Experiment for FSLP

Study on 2nd Generation SAR-Experiment with 2 Frequencies.



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SAAB SPACE

Spacelab's Development

M. Bignier, Director of Space Transportation Systems, ESA, Paris

The first dedicated flight of the European-built Spacelab as a major element of the Space Shuttle system, scheduled to take place in the coming weeks, is a major event in the history of manned spaceflight and a milestone in the largest international cooperative space programme yet to be undertaken.

Spacelab, Europe's contribution to the US Space Transportation System, has been developed and funded in Europe at a cost of approximately 1 billion US$. It signifies Europe's entry into the manned space field. It is part of the joint ESA/NASA Spacelab Programme in which ESA funded, developed and delivered the first Flight Unit to NASA. NASA is responsible for operating Spacelab as part of its Space Transportation System and has purchased a second Spacelab.

Spacelab converts the Space Transportation System into a versatile scientific laboratory for the peaceful exploration and exploitation of space. Two unpressurised Spacelab pallets have already flown with scientific payloads on the second and third orbital test flights of the Space Shuttle, and have provided very successful scientific results.

Spacelab is a fine example of the essential need for, and fruitful results of, international cooperation, not only between the ten participating Western European nations that have funded, designed and built Spacelab as a joint European programme within ESA, but also in terms of the coordination of the ESA and NASA parts of the Programme.

This article is intended to highlight the international cooperation in space related to the Spacelab Programme by retracing some of the history, by identifying the roles Europe and the United States have played, and by reviewing the coordinatory structure that has been employed.

Historical background and Agreements

ESA (then ESRO) was invited in the autumn of 1969 by the NASA Administrator, Dr. Thomas O. Paine, to participate in the Post-Apollo Programme. In 1970 the European Space Conference authorised studies of orbital transportation systems. In the meantime, it had become clear that Spacelab was the most suitable part of the Post-Apollo Programme for European development. Throughout 1972, ESA performed independent feasibility studies using three competing European consortia. At the Ministerial Meeting of the European Space Conference in Brussels on 20 December 1972, the European Ministers responsible for space entrusted ESRO with the task of implementing the Spacelab Programme.

In February 1973, the three initial consortia recombined into two, as MBB (Messerschmitt-Bölkow-Blohm) and ERNO-VFW-Fokker (both of which acted as prime contractors) and began independent Phase-B definition studies to provide the ESA Member States with a firm costing on which to make their final decision. That decision was taken in August 1973. The NASA Marshall Space Flight Center meanwhile continued its in-house study until the Europeans made their final commitment to continue in the Spacelab Programme.

On 24 September 1973 an Inter-Governmental Agreement (IGA) between the nine Member States then participating in the Programme (Belgium, Denmark, France, Germany, Italy, The Netherlands, Spain, Switzerland and the United

Figure 1 — Signature of the Spacelab Memorandum of Understanding (MOU) in Washington DC on 24 September 1973 by Dr. A. Hocker, ESRO Director General, and Dr. J.C. Fletcher, NASA Administrator (right)

Figure 2 — Early hard mock-up of Spacelab module at ERNO (Bremen) in 1977

Kingdom. Austria, an Associate ESA Member State, also subsequently joined the Programme) and the USA came into force. The IGA recognised that this was the first step in a trans-Atlantic cooperation in manned spaceflight. On the same day, a Memorandum of Understanding (MOU) was signed between Dr. A. Hocker, ESA's Director General, and Dr. J. Fletcher, NASA Administrator, describing the conditions of this cooperation. Under the terms of the MOU, Europe was made entirely responsible for the funding, design and development of Spacelab, and for the delivery free of charge to NASA of the Engineering Model and the first Flight Unit plus associated Ground Support Equipment (GSE). NASA was to provide the Transportation System (Space Shuttle) and be responsible for the operation of Spacelab as part of that System. NASA also committed itself to purchase from Europe any additional Spacelabs it may require for the Programme. The agreement also stipulated that the first flight of the first unit (SL-1) was to be a joint flight with scientific investigations provided by both NASA and ESA.

Ten ESA Member States have pooled their technical, financial and intellectual resources in the interests of the Spacelab Programme. Germany has been the largest single contributor, furnishing more than 50% of the budget.

The development of Spacelab

The Memorandum of Understanding assigned to ESA the design and development of Spacelab, and the role of Spacelab operator to NASA, with each Agency funding its own activities.

The initial requirements on the Spacelab system and the resources to be provided by the Shuttle Orbiter to Spacelab have been derived from the users' requirements solicited through the forum of the Joint ESA/NASA User Requirements Group (JURG).

Coordination of programmes has been under the control of the ESA/NASA Joint Spacelab Working Group (JSLWG), which has monitored the ESA and NASA sides of the programmes, settled major interface questions between the Spacelab and Shuttle Programmes, coordinated changes in requirements or programme content, and settled cost issues. As a coordinating body the JSLWG has no joint management responsibility, each party managing its own budget.

The ten ESA States constitute the Participants to the Programme, and are represented in the Spacelab Programme Board. This Board, as an Advisory Group

Figures 3 & 4 – First Spacelab Payload (FSLP) elements undergoing integration at ERNO (Bremen) in the course of 1981

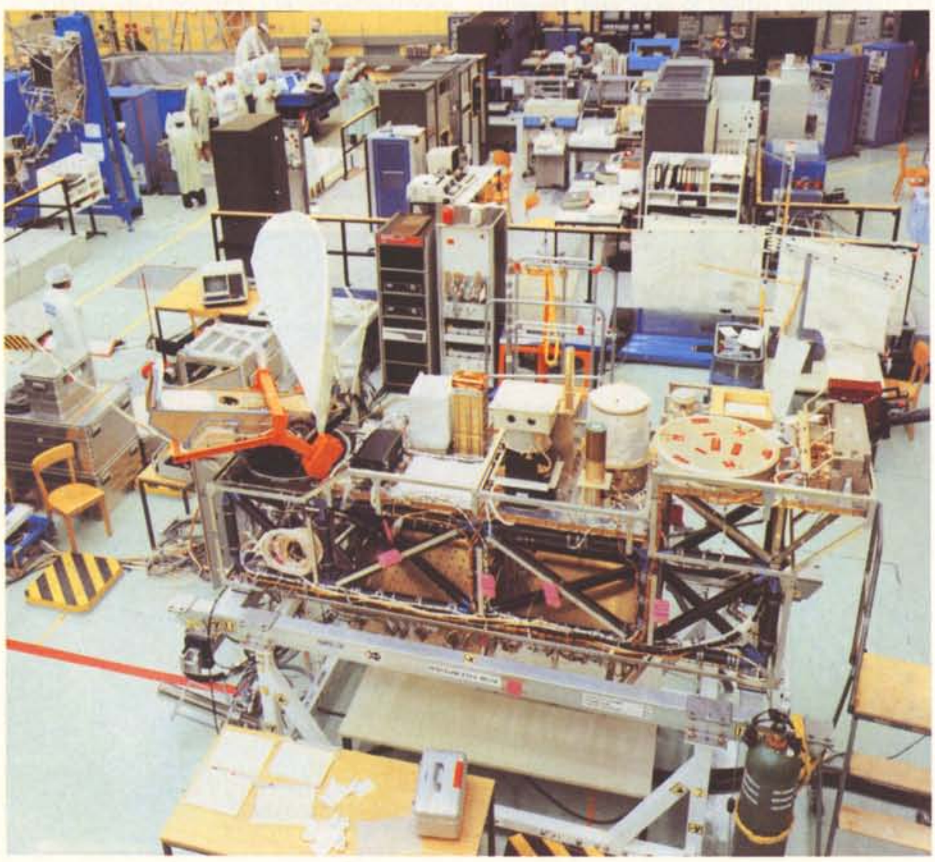
to the ESA Council, has monitored the Spacelab Development Programme and provided general direction.

The ESA Project Team consisted at its peak of about 100 engineers and has been based at ESTEC in Noordwijk.

ERNO Raumfahrttechnik GmbH, based in Bremen, Germany, is ESA's Prime Contractor and, together with some 40 industrial companies spread throughout ESA's Member States, has been responsible for the development and manufacture of Spacelab over the past decade. At the height of the development phase, an industrial work force of about 2000 was employed on the Programme. Their efforts have come to fruition with Spacelab's first flight.

The distribution of work to the different nations has been aligned as closely as possible throughout the Programme with their relative financial contributions, following the ESA principle of equitable geographical return.

The Prime Contractor divided Spacelab development into functional subsystems under the responsibility of a number of co-contractors. Each co-contractor has in turn been supported by several subcontractors, leading to a total of ten co-contractors and 36 subcontractors in 11 countries. The Prime Contractor has had overall management and integration responsibility, ensuring that all were aware of the latest technical information, design requirements and agreements, and monitoring progress, advising and directing to meet critical reviews, test and integration dates. ERNO has also supervised the financial arrangements involving 11 currencies and final Spacelab assembly and integration takes place in Bremen. Some companies in the USA have also been involved as co- or subcontractors to ERNO for particular Spacelab items.



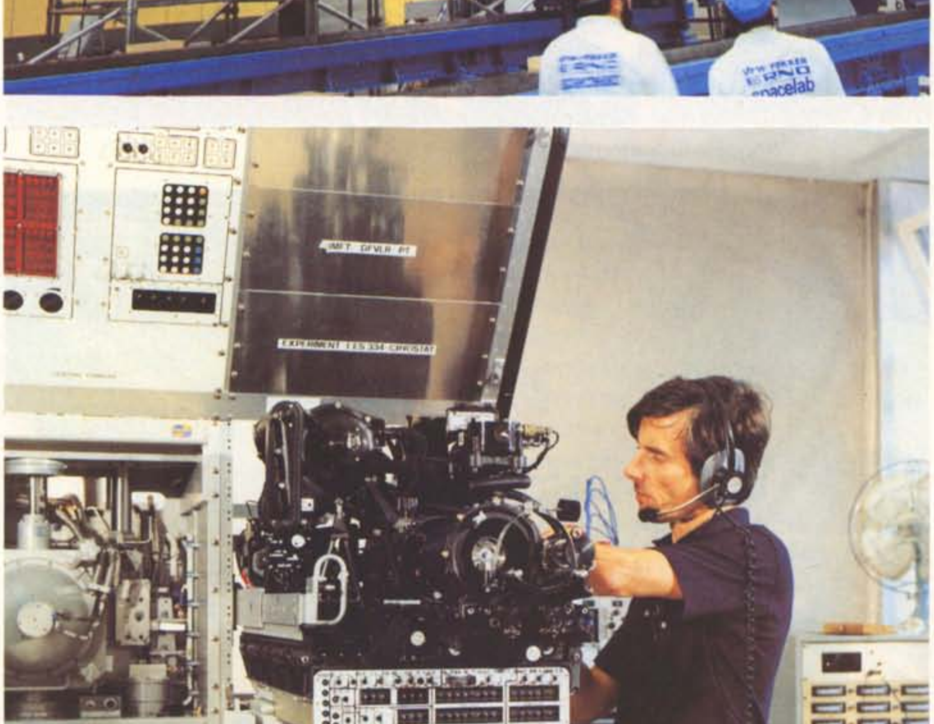
It goes without saying that the coordination of so many industries in so many countries has been a major undertaking. Nevertheless, this effort has been very successful; difficulties have been minor and a high-quality product has been delivered.

At senior management level, progress was monitored at major milestone reviews:

– The Preliminary Requirements Review (PRR) in 1974 established a conceptual baseline for subsequent reviews and gave preliminary

Figure 5 – Preparation at ERNO for transport to the USA, in December 1981, of the core segment of the Spacelab module

Figure 6 – Spacelab-1 Payload Specialist Ulf Merbold training at ESA's SPICE facility at Porz-Wahn (Germany) in October 1982



approval to higher level system specifications and plans.

- The System Requirements Review (SRR) in 1975 updated the system requirements and served as a start for the final subsystem definition and design phase.
- The Preliminary Design Review (PDR) in 1976 was a technical review of the basic design approach, leading to authorisation for Engineering Model design and manufacture.
- The Critical Design Review (CDR) in 1978 formally established the production baseline for the first flight unit.
- The Final Acceptance Review (FAR) in 1981, at which ESA formally accepted the Spacelab Module flight unit from ERNO and NASA accepted it from ESA.
- The Final Acceptance Review (FAR) in 1982, at which ESA formally accepted the flight units of the Spacelab igloo and pallets from ERNO and NASA accepted them from ESA.

NASA provided strong and very valuable technical support to these reviews, in part to familiarise itself with Spacelab in view of its ultimate responsibility for its operation.

To provide NASA with adequate time to

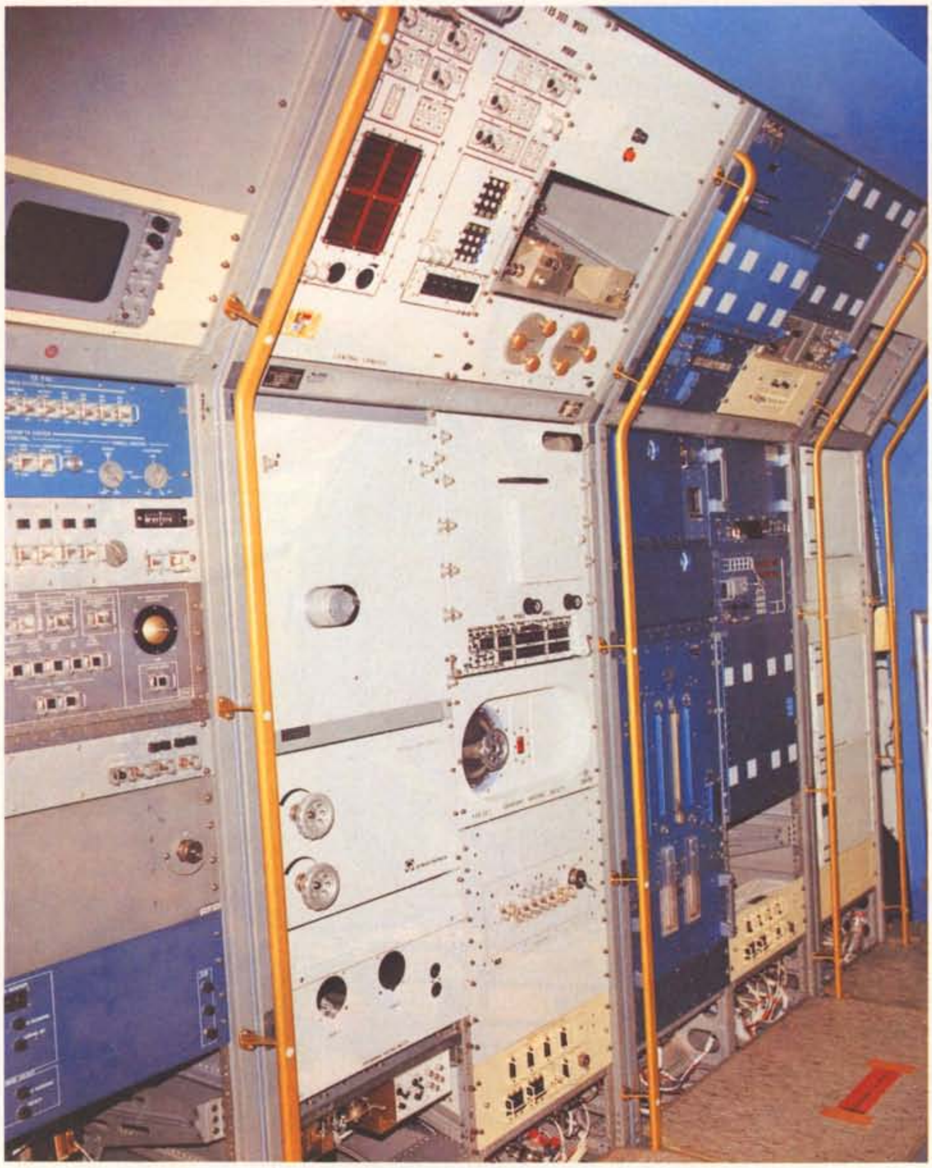


Figure 7 – Spacelab-1's Materials-Science Double Rack (MSDR) photographed at Kennedy Space Center (KSC) in mid-1982

Figure 8 – Spacelab-1 being moved from test stand to Cargo Integration and Test Equipment (CITE) at KSC in May 1983 (below left)

Figure 9 – Installation of Spacelab-1 in Shuttle Payload Canister at KSC in August 1983 (below right)

integrate experiments into Spacelab and to integrate Spacelab into the Orbiter, it was required that the first Spacelab Flight Unit be delivered to NASA at least one year before launch.

Flight Unit Configuration I, which corresponds almost to the configuration of the first Spacelab flight – namely a long module and one pallet (SL-1) – was formally accepted by NASA in February 1982 at an unveiling ceremony at Kennedy Space Center attended by George Bush, Vice-President of the United States (see ESA Bulletin No. 30, page 73).

Flight Unit Configuration II, an igloo and

Figure 10 — Flight crew for the First Spacelab Mission. From left to right: Owen K. Garriott (Mission Specialist), Byron K. Lichtenburg (Payload Specialist), Brewster H. Shaw Jr. (Pilot), John W. Young (Commander), Ulf Merbold (Payload Specialist), and Robert A.R. Parker (Mission Specialist)

Figure 11 — Installation of Spacelab-1 in the Shuttle Orbiter in the Orbiter Processing Facility (OPF) at KSC, in August 1983

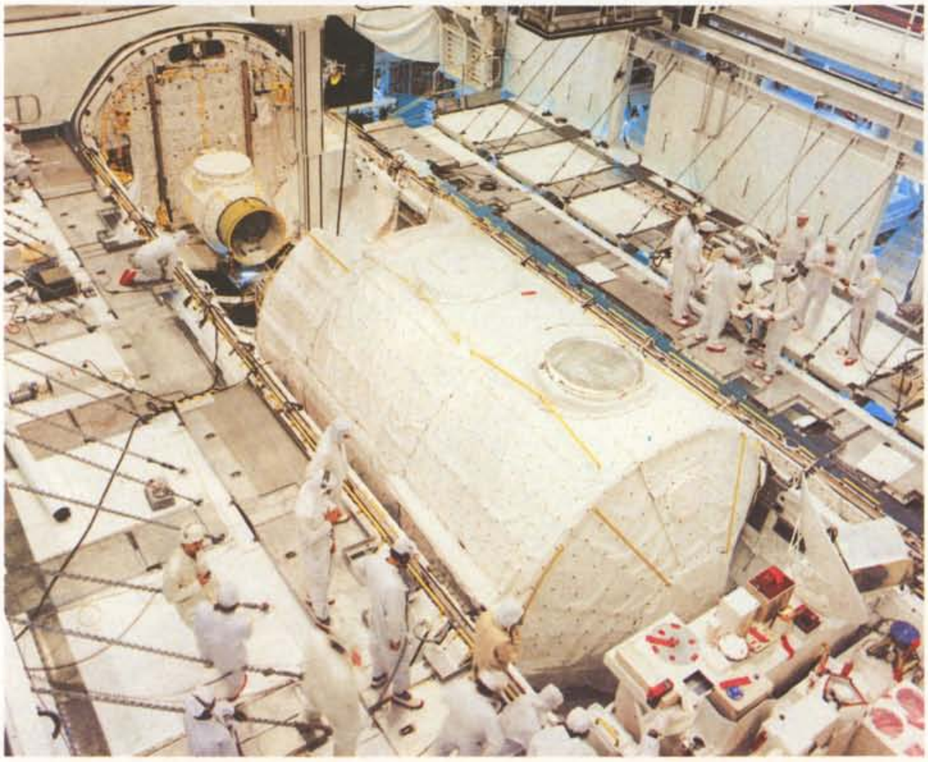
pallets, corresponding almost to the configuration of the 'pallet-only' second Spacelab flight (SL-2), was delivered to Kennedy Space Center during summer 1982.

With the first flight of Spacelab itself the major space experimentation phase begins. This first flight will thoroughly test the facility and the payload that is being operated has been specially chosen to demonstrate Spacelab's capabilities in a wide variety of disciplines (see ESA Bulletin No. 31, page 34, for example). The experiences gained and the results of the experiments conducted on this inaugural flight will be reported in the coming issues of the ESA Bulletin.

The flight of Spacelab-2 is currently scheduled for March 1985.

Future outlook

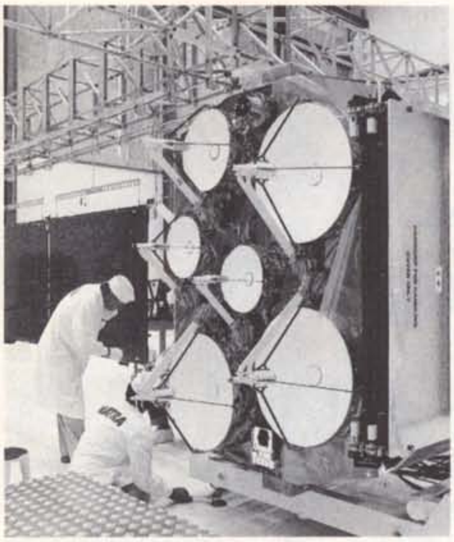
In the domain of unpressurised platforms, ESA has taken the initiative with the development of Eureca, the European Retrievable Carrier. The Spacelab module, once proven in space, can provide the basis for more sophisticated, long-term manned space stations. Last January, the Agency started a Space Transportation Systems Long-Term Preparatory Programme (STS-LTPP), to explore the various options open to Europe for future space transportation systems (i.e. beyond Spacelab Follow-On Development and Eureca).



These options are now being examined under a study programme with three main themes:

- Preserving Europe's access to manned systems opened up by Spacelab by taking part in American space-station activities and giving thought to the evolution of European orbital infrastructures.
- The provision of a European capability to conduct orbital operations (including a return to Earth) by means of an orbital infrastructure developed independently or in cooperation with NASA within the framework of American space-station activities.
- The maintenance in Europe of an independent launch capability to meet the foreseeable requirements of European and other users which will be competitive with the transportation systems existing or planned elsewhere.

Preliminary studies on each of these themes have already been undertaken by the main European firms, and in principle the STS-LTPP Programme will be completed by late 1985.



ECS – First Months in Orbit

G.G. Fuller, ECS Project Division, ESA Directorate of Application Programmes, ESTEC, Noordwijk, The Netherlands

Having successfully completed its commissioning and acceptance tests since its launch on 16 June, the first European Communications Satellite ECS-1 is now ready to begin its commercial mission.

Launch and early orbit operations

ECS-1 was launched by Ariane (L6) on 16 June 1983, together with the radio-amateur satellite Amsat. A brief description of the launch and the early-orbit operations was given in the August 1983 issue of the Bulletin. The launcher provided an accurate transfer orbit and the satellite's apogee motor injected ECS-1 into a nearly perfect drift orbit, the satellite arriving on station at 10°E longitude 21 days after launch, as planned. The operations during these 21 days followed the predetermined plan in copybook manner and were effectively a re-run of the many pre-launch training simulations.

The satellite-commissioning phase

Once ECS-1 had been positioned at its required orbital location, the satellite commissioning phase was begun. This phase consisted of exercising the various satellite functions, subsystems and redundancies to ensure that nothing had been damaged during launch and to make final optimising adjustments before undertaking the comprehensive acceptance-test phase.

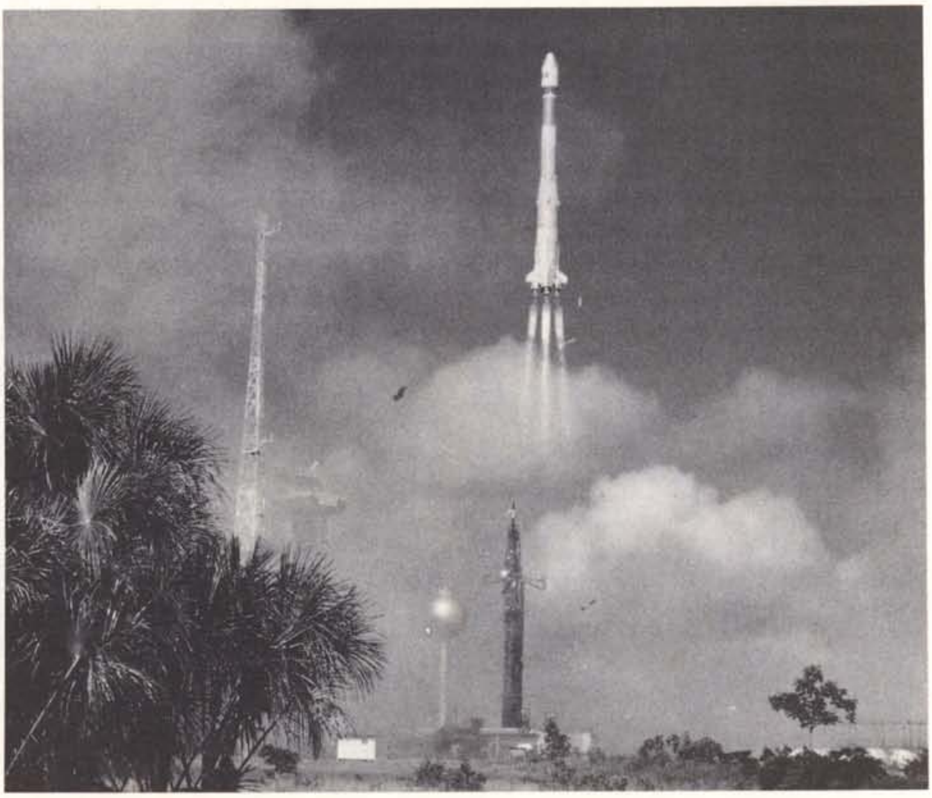
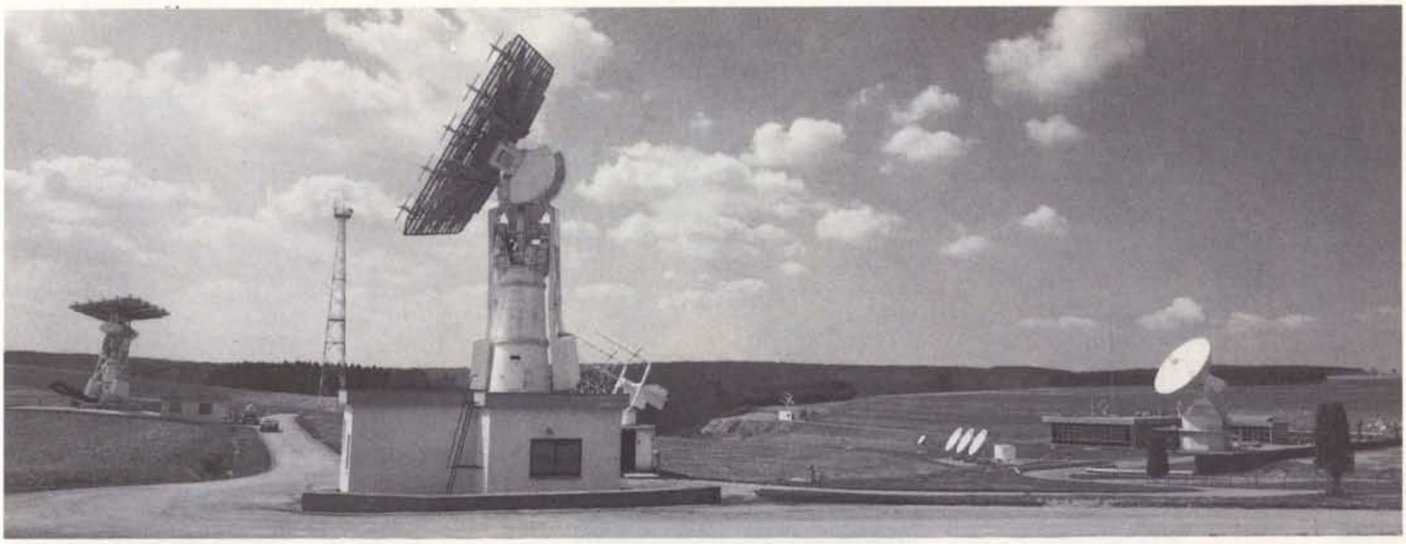
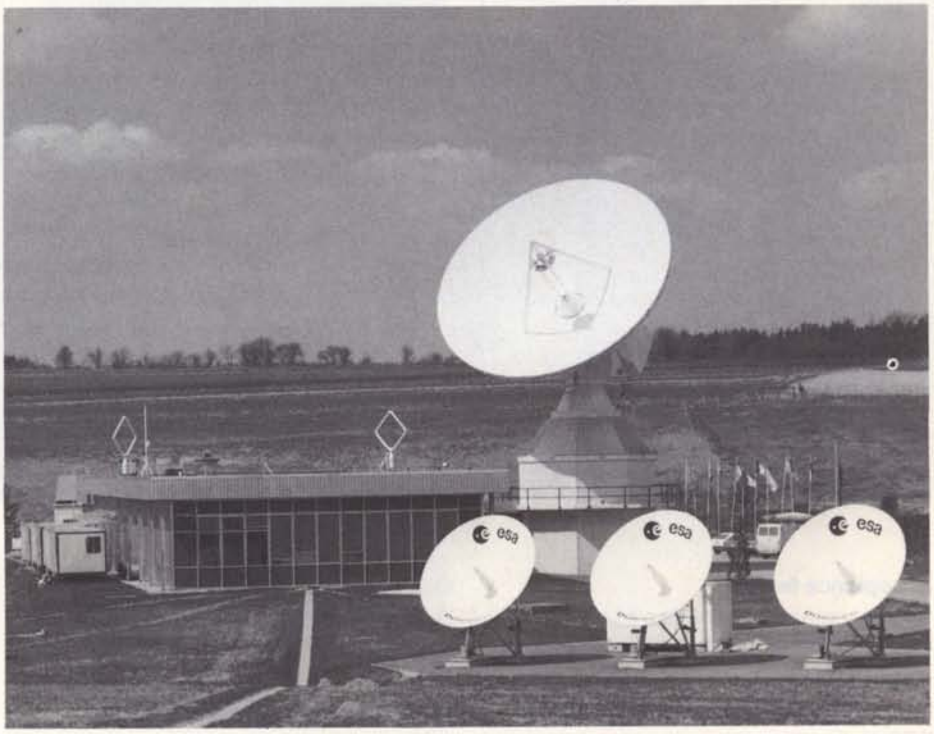


Figure 1 – The Ariane L6 launch of ECS-1 (and Amsat), from Kourou on 16 June

Figure 2 – View of the ESTRACK station at Redu (Belgium) showing the VHF command and telemetry antennas, the SHF telemetry and ranging antennas, and the TMS-1 antenna

Figure 3 – The ECC at Redu showing in the foreground the three 3 m antennas used for SHF telemetry and ranging and in the background the 13.5 m TMS-1 antenna



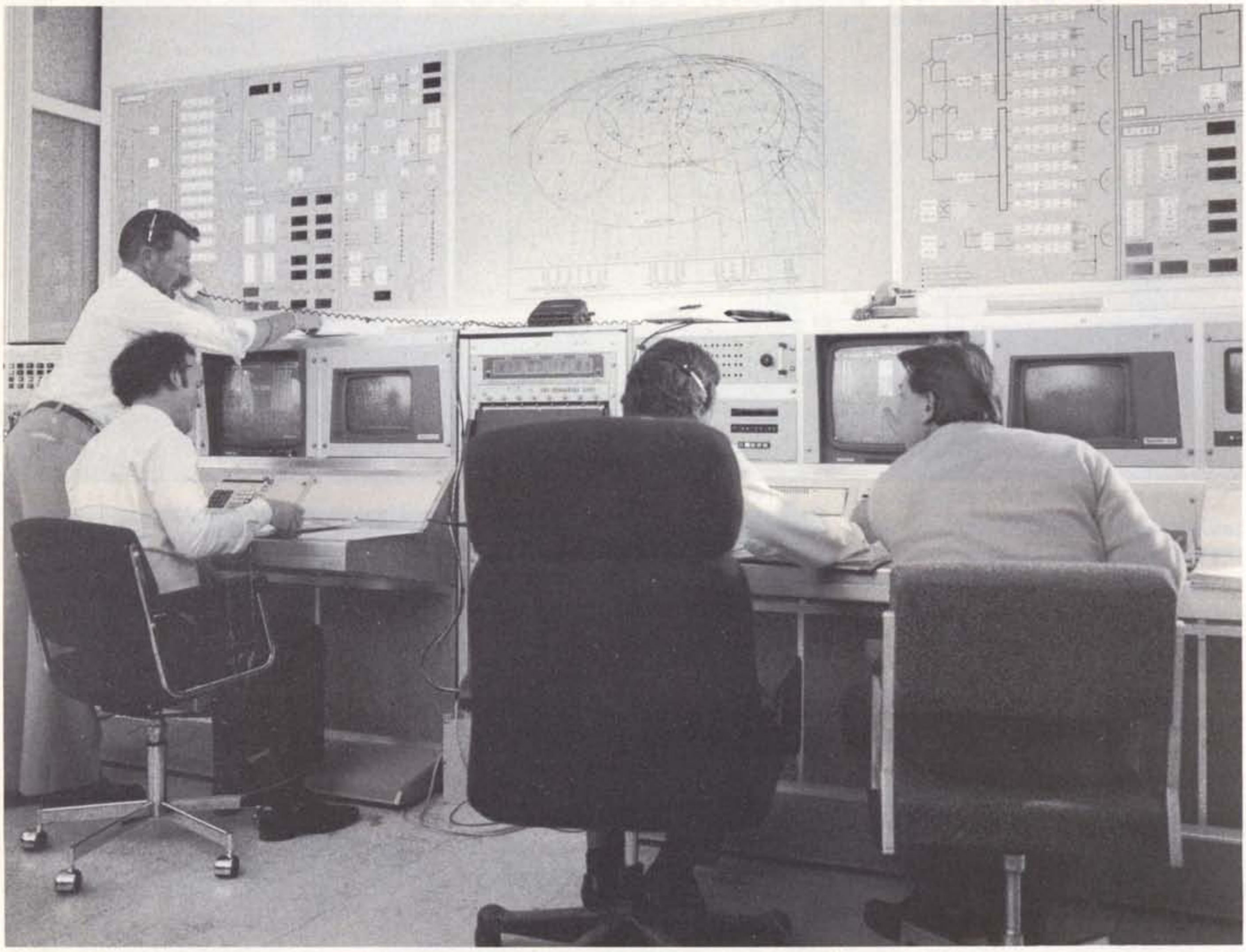


Satellite service commissioning
The testing of the satellite service functions (i.e. power, attitude-control and thermal-control subsystems) did not require the satellite to be on its final station, and so this part of the commissioning was accomplished whilst the satellite was still drifting. It was completed just before the satellite arrived at its final orbital location. All the satellite's subsystems were found to be working exactly according to specification. At this point, satellite control was passed from the European Space Operations Centre (ESOC) in Darmstadt to the new, dedicated ECS Control Centre (ECC), at the ESTRACK facility in Redu, Belgium.

Payload commissioning
The payload was switched on on 10 July from the ECS Control Centre and the next few days of commissioning quickly established that the 12 Ku band repeaters were all working. Precise specification measurements were to be made later.
The payload commissioning (and subsequent acceptance-testing phases) involved the use of several ground stations, to allow the payload's performance to be measured throughout the coverage areas to be illuminated by the ECS-1 antennas (the various beam coverages can be seen on the wall display in the picture of the ECC). These stations and the associated tests are more fully described in the article that follows (page 16). They consist basically of a main control station (TMS-1) at Redu, and three small (1.2 m dish) stations (TMS-3s) that can be quickly transported and set up anywhere in the coverage area.

The use of these various stations quickly confirmed that the payload performances were as predicted prior to launch and that a spacecraft trim manoeuvre of about 0.1° in pitch was needed to achieve optimum orientation. During the payload commissioning it was found that one of the radio-frequency switches which can be used to switch communication channels between antennas could not be operated. It was, however, set in a favourable position prior to launch and consequently this failure has no effect on accomplishment of the mission.

Figure 4 – The ECS Control room at the ECC. In the foreground are the telemetry display and command consoles and in the background the satellite mimic displays and the antenna-beam coverage map



Acceptance testing

The acceptance testing is a tri-partite exercise involving ESA, British Aerospace (the satellite contractor) and Interim Eutelsat (the ultimate owner and user of ECS-1). It is this process that leads to the contractual acceptance of the satellite in orbit by ESA from British Aerospace, and likewise by Interim Eutelsat from ESA.

The test programme started on 22 July and was completed on 5 September. It involved the use not only of the TMS-1 and the three TMS-3 stations, but also of several of the European PTT earth stations that will use ECS in the fully operational phase. They were the PTT stations (north to south) at Nederhorst (NL), Goonhilly (UK), Berçenay (F) and Fucino (I).

The results of the acceptance tests showed a very good correlation between the various participating stations and confirmed by direct measurement all the pre-launch performance predictions. The most noticeable feature was the cross-polarisation characteristic, a parameter that is essential to the operation of the ECS system, which is based on frequency re-use through polarisation discrimination; the measured performance exceeded the predictions by a large margin.

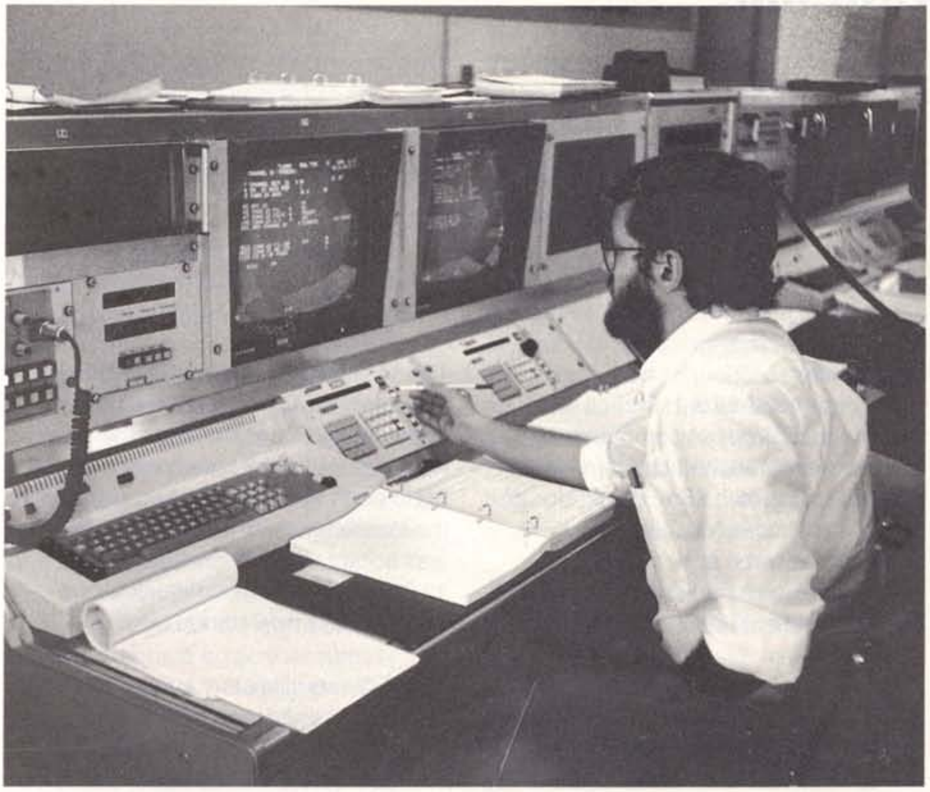
Conclusion

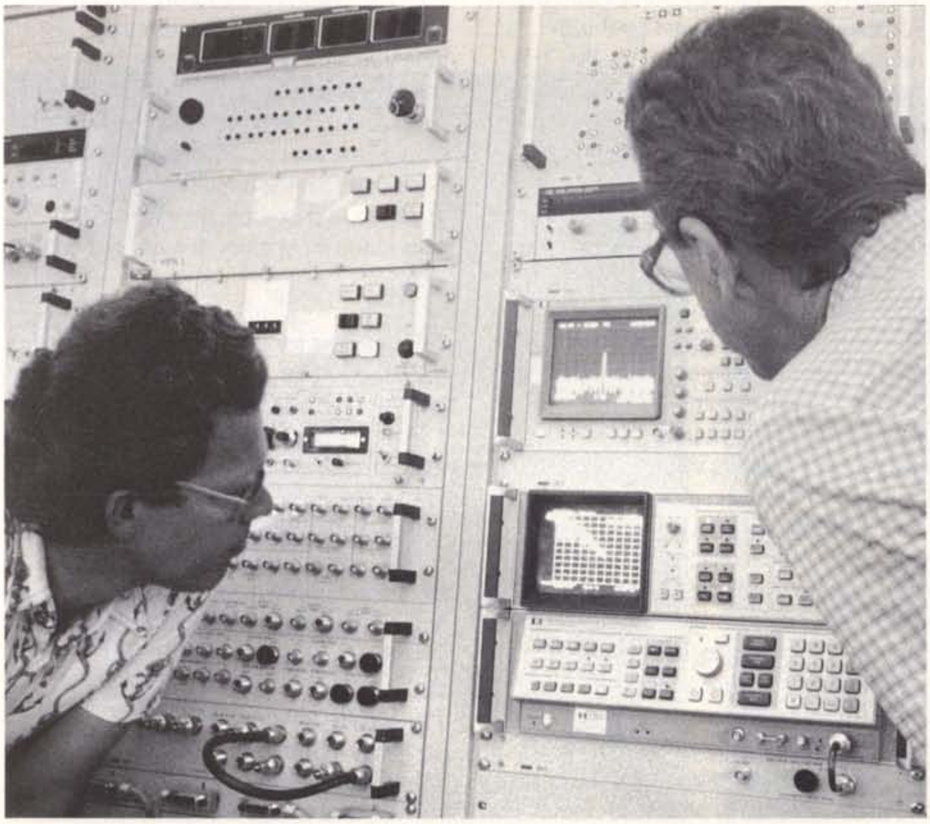
ECS-1 has now passed through its early critical operations and completed all test phases. It has behaved throughout in a most exemplary fashion. The in-orbit acceptance-test programme has been conducted according to plan and has confirmed all pre-flight measurements and predictions.

Routine control operations have been established, with stationkeeping manoeuvres being performed every three weeks to maintain ECS-1 at its allocated orbital position. A ground-based control algorithm ensures that the correct temperature environment is maintained

Figure 5 – Operator in the ECC sending the command that switched on the ECS-1 communications payload on 10 July

Figure 6 – Observation of the first communications test signals received via the TMS-1 station from ECS-1, following the payload switch-on on 10 July



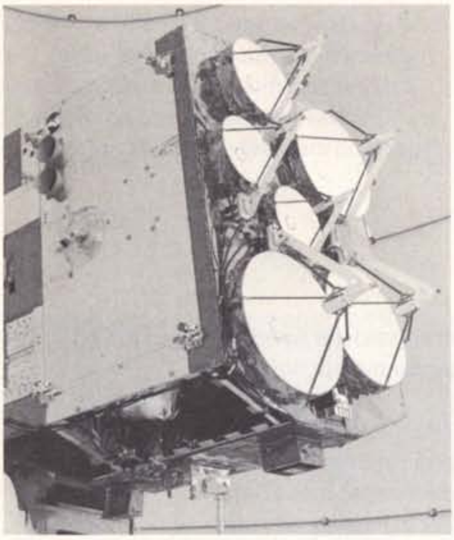


on-board the satellite to keep the payload performing optimally.

The measures taken to protect ECS-1 against interference due to electrostatic discharges (see ESA Bulletin No. 34, page 22) of the type experienced on many other spacecraft, have so far proved completely successful.

The good balance and alignment of ECS-1 have allowed it to be 'solar-sailed' for extended periods whilst still maintaining its required high pointing accuracy. This solar-sailing technique, developed on OTS (see ESA Bulletin No. 31, page 75), allows satellites of the ECS type to maintain full pointing control for long periods of time without using their thrusters, thereby conserving on-board fuel supplies.

ECS-1 now waits in orbit for its partner ECS-2, planned to be launched next year, the two satellites being required to inaugurate the full ECS European Regional Communications System. In the meantime, ECS-1 will be demonstrated to the European and worldwide communication communities at the Telecom '83 exhibition in Geneva. Thereafter it will start distributing television programmes on a commercial basis.



In-Orbit Testing of the ECS-1 Satellite

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After the successful launch and orbit positioning of the ECS-1 satellite, a series of measurements were made from the ground to verify its performance with respect to the specifications. These measurements were conducted using the Agency's earth-station facilities, in collaboration with Interim Eutelsat, and have led to Eutelsat's acceptance of ECS-1 for commercial service.

Introduction

On 16 June 1983, ECS-1, the first of a series of five European communications satellites, was launched by Ariane from French Guiana (see ESA Bulletin No. 35). ECS-1 was successfully placed in geostationary orbit at 10°E and the payload was switched on from the ESA Control Centre at Redu on 10 July.

The ECS satellites are to be used for television, telephony and business services over the whole of the European area, plus North Africa and the eastern Atlantic regions. The satellites themselves are manufactured by a consortium of European companies, led by British Aerospace, under contract to ESA. The payload capacity of the satellites will be handled by Interim Eutelsat and will be sold on a commercial basis to the users.

After the launch of each satellite it is necessary to measure its in-orbit performance, to ensure that the contractual obligations between the manufacturers and ESA have been discharged and also to demonstrate to Interim Eutelsat that the satellite in question is able to support their telecommunications services satisfactorily. These in-orbit measurements therefore have to be carried out accurately and quickly to enable telecommunications operations to begin. In-orbit measurement is also required during the life of each satellite to monitor its long-term performance, so that adequate preparations can be made to launch replacement satellites when necessary, thereby maintaining uninterrupted services over a long period.

The initial in-orbit measurements for the first satellite (ECS-1) have now been successfully completed using the Agency's testing facilities centred on the Redu earth station in Belgium. Based on the excellent results achieved, the satellite was accepted by Interim Eutelsat on 12 October, and telecommunications services have now started.

The ECS satellites carry a relatively complex payload, with twelve transponders and various redundancy configurations. Also the satellite antennas cover a wide geographical area. The in-orbit measurement programme had to be carefully planned to minimise the measurement period, whilst at the same time gaining the maximum of meaningful information. It was therefore essential to employ the best possible earth-station equipment for the measurements and to organise and execute the programme of tests in the most efficient manner.

The facilities for in-orbit measurement

ESA decided back in 1979 to establish in-orbit-test facilities which could be used for the ECS testing activities and would also be extendable for use with future satellites beyond the ECS series. The plan that was established required the construction of a central earth station at Redu, and three small transportable stations which could make measurements at the edge of ECS coverage.

The TMS-1 station

The central station, called Test and Monitoring Station No. 1 (TMS-1), was constructed to Agency specifications under a prime contract with MBB (Germany). This station, which is shown in Figure 1, is equipped with a 13.5 mm diameter, fully steerable antenna and has the ability to access all channels of the ECS-1 satellite.

Great care was taken in the station's design and construction to ensure the stability and accuracy of the equipment. The antenna has been calibrated in transmit and receive gain against several basic standards and also cross-checked by radio-star measurements. The antenna pointing performance is very precise due to the exact and stable construction of the tower, bearing system, backing structure and antenna surface.

All signals received at the station can be directly compared against accurately calibrated and stable locally generated pilot signals. All transmitted carriers are carefully set with respect to known references. These basic features are essential when measuring signals going to and coming from the satellite.

In addition to the antenna and its associated transmitting and receiving equipment, TMS-1 has a suite of specialised measurement equipment (Fig. 2) which is able to generate the various test signals required and measure the resulting outputs from the satellite.

The whole station, and all its subsidiary equipment, is controlled via a computer. The latter is also programmed to generate the complex test sequences needed to measure up to six transponders of the satellite at a time, over 24 h periods, interleaving the individual measurements and correlating and printing the results in graphical or written form.

The TMS-3 stations

Because of the wide coverage of the satellite, antenna measurements were necessary at widely separated geographical locations. Our experience with measurements on the Agency's earlier European Orbital Test Satellite (OTS) had shown that stations at remote fixed locations were expensive to operate and maintain. Also, if we had used fixed stations at the edges of ECS coverage, more facilities would have been required because ECS has three spot beams.

It was therefore decided that the most flexible arrangement would be to use transportable earth stations which could be deployed anywhere in the coverage area and then moved from place to place during the measurement programme. Because the stations are transportable, we were able to cross-calibrate all stations at Redu before the measurement programme began.

One of the TMS-3 stations developed for ECS measurements is shown in Figure 3. The three stations, A, B and C, were developed and manufactured by Dornier System to ESA specifications. They are designed to be transported by air, land or sea to the planned measurement locations.

Each TMS-3 consists of a 1.2 m diameter

Figure 1 – The TMS-1 earth station with TMS-3s standing below

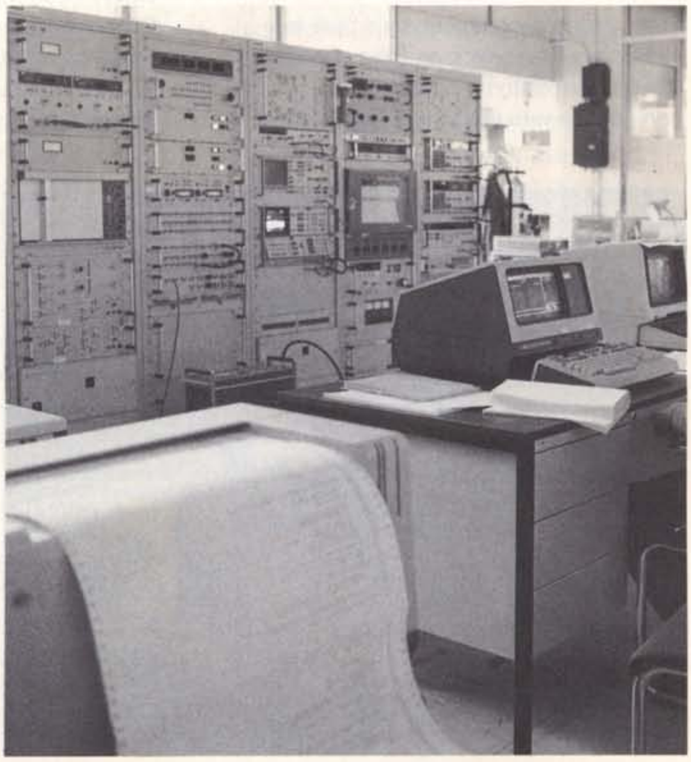


Figure 2 – The TMS-1 measurement equipment

antenna with associated radio-frequency equipment plus receiving and control equipment, which is positioned in the nearest available building. The two groups of equipment are interconnected by flexible cables. For transportation, all equipment items and the cables are contained in a steel box approximately 1.5 m square. The base of the container forms the mount for the antenna after the outer covering has been removed.

As with the TMS-1 station, great care has been taken to ensure the stability and accuracy of both the antenna and the associated electronic equipment. The stations are able to measure the radio-frequency flux radiated by the satellite in any of its frequency bands or polarisations. They can also measure the discrimination between the nominally horizontal and vertical polarisation planes of the various satellite transponders. In another mode, TMS-3s can radiate an accurately known carrier to the satellite, again with any frequency or polarisation, so that the up-path satellite sensitivity can be measured by TMS-1.

Each station is controlled by a built-in microcomputer, which enables complex test sequences to be conducted in conjunction with the other TMS-3s and TMS-1. By using a system of time-divided measurements, we were thus able to test several ECS channels from several locations for a number of parameters (e.g. EIRP, G/T and XPI) over test periods of many hours.

Figure 4 shows the TMS-3s being loaded at the Redu earth station for transportation by road and air to their separate initial destinations of Las Palmas, Madrid and Stockholm. The stations used in Madrid and Las Palmas were flown to Rome and Nicosia, respectively, in a later phase of the test programme.

Execution of the measurement programme

The programme contained two types of testing activities, coverage-dependent and non-coverage-dependent.

The non-coverage-dependent tests were carried out with TMS-1 only, and were as follows:

- Gain adjustment range
- Gain/frequency characteristic
- Group-delay/frequency characteristic
- Spurious modulation
- Spurious outputs and spectrum spreading
- Amplitude to Phase Modulation (AM/PM) conversion and transfer
- Amplitude linearity and intermodulation.

These tests were performed for each of the twelve satellite repeaters, each of which was measured for various switching configurations and setting conditions.

The measurement techniques employed by TMS-1 are in many cases quite novel. They were eminently successful and gave significant advantages in speed and accuracy. After each test-run, results were plotted out automatically in engineering units in such a way that they could be compared directly with the specifications and with measurements made on the ground before the satellite's launch (the methods used will be reported in detail in a future issue of the ESA Journal).

The coverage-dependent tests were carried out using TMS-1 and the TMS-3 stations, each of which was located in a critical part of the satellite coverage zone. The TMS-1 and the TMS-3s worked together as a coupled system for these tests, under the timing control of the TMS-1 computer.

Figure 3 — A TMS-3 unit whilst located at the Makarios Earth Station, Cyprus

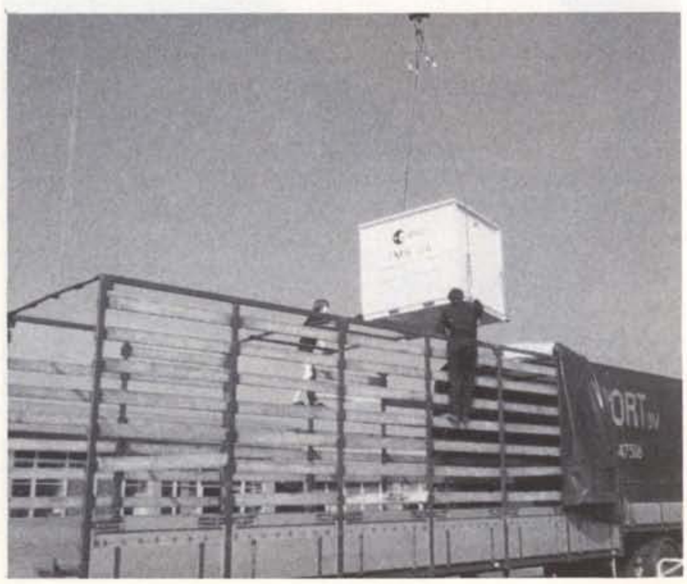


Figure 4 — TMS-3 stations being loaded for transport to their respective sites

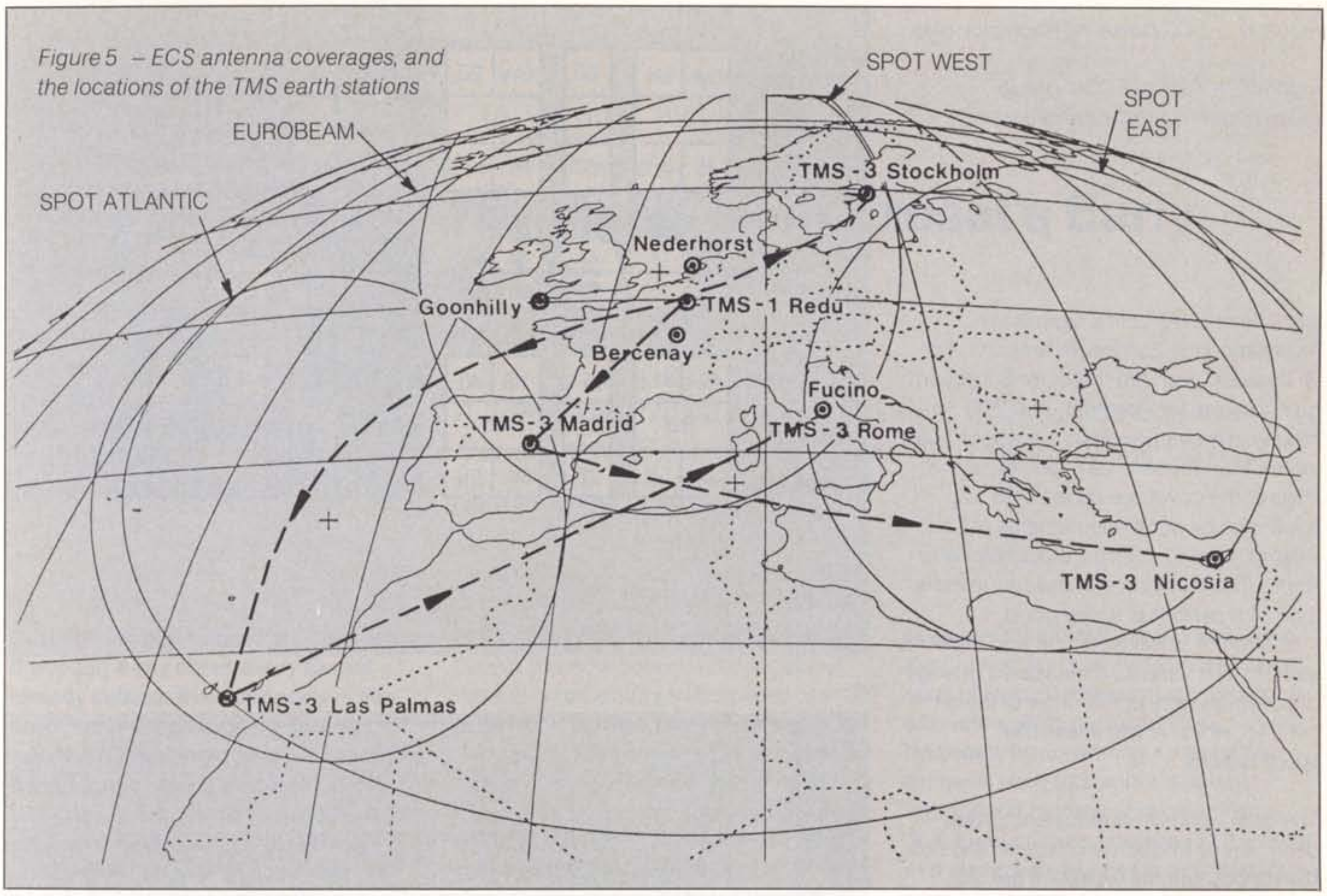


Figure 5 – ECS antenna coverages, and the locations of the TMS earth stations

The coverage-dependent tests were as follows:

- Effective radiated power (EIRP)
- Input power flux density (IPFD)
- Polarisation isolation
- Receiver sensitivity (G/T)
- Beacon EIRP and polarisation.

For the coverage-dependent tests, it was considered essential to get the results from the outlying stations to a central point as quickly as possible. The geographical coverage of the satellite beams could then be analysed quickly to determine whether the specifications were being met at each stage, thus avoiding delays in the test programme.

The locations of each of the TMS-3s and their transportation routes are shown in Figure 5. It can be seen that the sites selected for TMS-3s were at critical points at the edge of the coverage of the satellite beams, whereas the TMS-1 is near the centre of the coverage. The results were collected automatically on magnetic cassettes at the TMS-3 earth stations and passed over normal telephone lines (approximately one 20 min call per TMS-3) to the TMS-1 after each 24 h measurement session. In this way it was possible to agree the results with the customer, Interim Eutelsat, within 24 h of each session finishing.

The overall test programme lasted 50 days. Very little time was wasted because the tests that involved TMS-1 only were carried out during the transportation periods for the TMS-3s.

The test programme also involved the participation of PTT earth stations at Goonhilly (United Kingdom) Nederhorst den Berg (The Netherlands), Fucino (Italy) and Berçenay (France), which made measurements on behalf of Interim Eutelsat. The measurements of these stations could be slotted into the overall test programme without difficulty, largely as a result of the good coordination and cooperation established between Interim Eutelsat and ESA.

The results

In general, the satellite performance was well above specification, with only very minor exceptions. In particular, the cross-polar isolation between channels re-using the same frequency band on orthogonal polarisations was in the range 30–50 dB overall, including earth-station contributions, compared to a specification value of 23 dB. The only shortcoming worthy of mention was the failure of the one of the on-board switches to operate under ground control, which means that channel 5X is permanently connected to Spot Atlantic. This is considered regrettable, but not too serious since no capacity is lost, only a little flexibility.

It is not possible to give the detailed results, which are very extensive, in this article. As already mentioned, a more detailed report will appear in the ESA Journal. However, a few of the most important values are given in simplified form in Figure 6, which shows the satellite's downlink frequency plan, with the beam-centre-measured values of EIRP and G/T superimposed. It can be seen that the satellite has six channels, each of 83 MHz bandwidth, which can be received in nominally horizontal polarisation (X-channels), and six which are nominally vertical (Y-channels).

The channels are allocated to satellite transmit antennas which serve the coverage zones shown in Figure 5. Some channels can be switched between beams, depending on the traffic

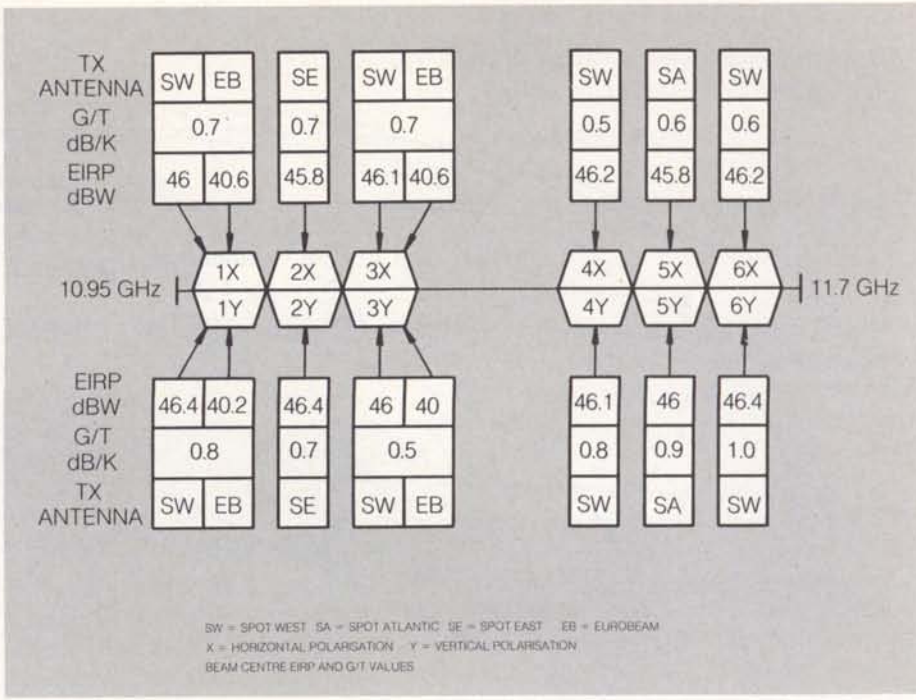


Figure 6 – ECS downlink frequency plan

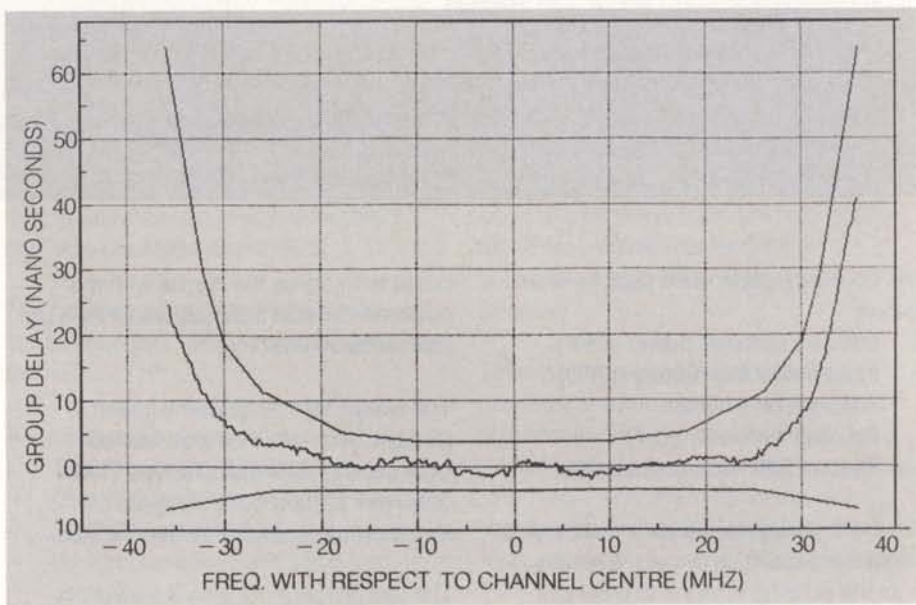


Figure 7 – Typical ECS-1 group-delay/frequency-response diagram

requirements. All uplink signals are received on the Eurobeam antenna. The G/T values given are therefore Eurobeam gain to noise temperature ratio. The beam-centre values given are about 3 dB higher than those to be expected at the edge of the coverage zones. This was confirmed by our measurements at Las Palmas, Madrid, Cyprus, Stockholm and Rome. The variation of these parameters over 24 h periods is a very good indication of satellite attitude and antenna stability. The variations measured at edge of coverage were of the order of 0.6 dB per 24 h, which is well inside the specifications.

The gain versus frequency and group delay versus frequency characteristics of the various satellite repeaters are also very important. Figure 7 shows a typical measured group-delay/frequency characteristic from the many results taken. The curves of this type are produced by TMS-1 under software control and are compensated automatically to eliminate earth-station contributions from the measured result. This characteristic is well within the specification mask, as were all the others taken.

Conclusions

The testing of the ECS-1 satellite in orbit was highly successful, firstly because ECS-1 was shown to have excellent performance, and secondly because the ground facilities and test programme were proved to be effective. The measurement programme was executed precisely according to the planned schedule and no additional contingency time was needed. As a result of the experience gained it should be possible to shorten the programme a little for later satellites. For example, it may not be necessary to test all combinations of satellite redundancy over 24 h in areas where it is clear that specifications are met by a good margin.

The testing facilities established will be used to test the remaining four ECS satellites following each launch. They will also be used to monitor the satellites' performances over their lifetimes. The Agency is planning to offer the use of the TMS facilities to other spacecraft owners on a service-contract basis when time permits. It is also planned to use the same basic measurement equipment in the future for later generations of ESA communications satellites.

Concerning ECS-1 in particular, we are very pleased that we have been able to provide a satellite of such good performance to Interim Eutelsat, potentially giving an excellent start to their commercial satellite telecommunications operations.

Acknowledgements

The author wishes to acknowledge the hard work and professional competence of all participants in the ESA in-orbit test programme, in particular Messrs. C.F. Moens, C.J. Kooter, G. Oppenhaeuser, F. Absollone, C. Garrido and J. Hoerle.

Highlights from Exosat's Early Orbits

A. Peacock, Exosat Project Scientist, ESA Space Science Department, Directorate of Scientific Programmes, ESTEC, Noordwijk, The Netherlands

Results from the early-orbit phase of the European X-ray observatory Exosat already indicate that astronomers can expect a wealth of exciting data that will help them to untangle some of the highly energetic processes occurring in the Universe. Initial results from such exotic objects as neutron stars, black holes and quasars already indicate that Europe is set to play a leading role in this particularly dynamic area of astronomy for many years to come.

The European X-ray observatory satellite Exosat has now been in orbit for about three months, and has completed over 30 orbits. The first 20 orbits were devoted to calibration and performance verification of both the payload and spacecraft. Since mid-August, the observatory has been conducting routine observations much like any normal ground-based observatory. It is therefore a fitting moment to provide an indication of the exciting results so far achieved from those early, sometimes hectic orbits. It is already clear that the interpretation of these results will occupy many European astronomers for years to come.

Cosmic X-ray astronomy involves the study of some of the most highly energetic objects in the Universe. The physical processes that lead to the bulk of the radiation being emitted at X-ray wavelengths are often thermal in origin, involving a hot gas at temperatures ranging from millions to several hundreds of millions of degrees.

Since the strongest sources of X-ray emission are generally the closest and therefore involve objects in our own Galaxy, it was natural that the initial observations should be dominated by these galactic sources. Such sources range from normal nearby stars like our own Sun, to white dwarfs and even more exotic objects such as neutron stars, black holes, and the remnants of stars that have exploded as supernovae.

The Exosat observation of the supernova remnant Cassiopeia-A, the remnant of a star that exploded about 300 years ago, illustrates rather well the richness of the information that can be extracted from such objects. The original star exploded after exhausting its nuclear fuel, hydrogen, by converting it into heavier elements such as sulphur and iron through the process of nuclear fusion. This same process operating in the heart of a star is just now being simulated by such experimental fusion projects as the Joint European Torus (JET). The observations in the 2–30 kilo electron volts (keV) energy band by the medium-energy experiment(ME) and the gas-scintillation proportional counter (GSPC) have provided data on the remnant's overall temperature and the abundance of heavy elements, particularly iron. The images of the remnant from the low-energy telescope proportional counter cameras have provided some of the finest cosmic X-ray images as a function of X-ray wavelength ever recorded. (See ESA Bulletin No. 35).

This data will provide information on the variation of the gas temperature and mass throughout the remnant. The detailed high-resolution images in a number of broad wavebands from the telescope channel plate cameras (see also ESA Bulletin No. 35) will lead to a better understanding of the dynamics involved in the interaction of the blast wave, resulting from the original stellar explosion, with the surrounding interstellar medium and its local inhomogeneities. The detailed analysis of these pictures and spectra is already underway.

After initial instrument optimisation on a blank field of sky, Exosat was

Figure 1 – The field around the black hole candidate Cygnus X-1 as observed by the low energy telescopes with a channel multiplier camera at the focus

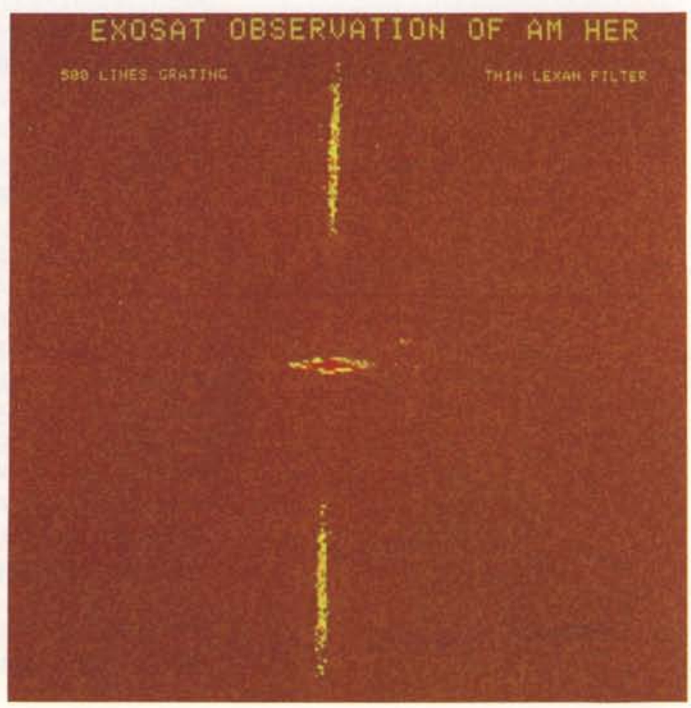
Figure 2 – The X-ray grating image of the spectrum from the cataclysmic binary system Am Hercules

manoeuvred to observe the well-known X-ray source and black-hole candidate Cygnus X-1. This source was used to determine optimum electronic settings for the payload, as well as to establish the angular misalignments between the star tracker and the two low-energy telescopes. The images obtained by the telescopes with the channel-multiplier cameras at the focus produced a number of suprises. In addition to the observation of the bright X-ray source Cygnus X-1, the image revealed a number of serendipitous sources (Fig. 1). Through the use of the X-ray transmission filters, the sources were examined in real time in a number of spectral bands and the emission found to dominate in the ultraviolet (900–2000 Å).

A number of different star fields have in fact now been observed by Exosat, and a large number of sources radiating in the UV (particularly A-type stars) have been observed. Great care is needed in discriminating between UV and X-ray emission and these Exosat observations have raised some questions on the validity of previous stellar X-ray surveys.

As a result of its deep orbit, Exosat is in practically continuous contact with the Observatory Operations Centre at ESOC in Darmstadt. This, coupled with the extensive real-time data-processing facilities, has enabled the Observatory science team to react to unexpected results in nearly real-time, thereby enhancing the quality of the scientific results obtained. An observation of the cataclysmic binary system Am Hercules, which has a binary orbital period of 3 h, illustrates these advantages. Observations by near-Earth X-ray satellites with Earth orbital periods of $\sim$1.5 h are severely hampered in the observation of such variable sources. The Observatory studied the source for more than six binary cycles and it was immediately observed that the source's X-ray intensity was flickering as well as determining the times when the source eclipsed its companion star. The use of the low-energy channel multiplier cameras was optimised in real time by selecting different filters or the diffraction grating depending on the source intensity and binary phase. The X-ray grating image is illustrated in Figure 2. The number of X-ray photons observed with the grating was such that the intensity variations on short time scales could be examined as a function of X-ray wavelength. This data will provide a better geometrical picture of the accreting gas flows in the system.

During the course of a routine observation, the Observatory was notified by Japanese X-ray astronomers of the sudden dramatic appearance of an X-ray star half as bright as the brightest X-ray source in the sky and still increasing in strength – an X-ray transient. The simple instrumentation on board the small Japanese satellite Tenma could not, however, locate the star very accurately. Exosat, with its flexible, real-time contact with the Observatory Centre, could be immediately manoeuvred to point to that region of sky. Within a single 60 min exposure the star was detected in X-rays. Within hours, the telescope data had been analysed and the X-ray source's location pinpointed to within a region of $\sim$15 arcsec. Optical observatories around the world were immediately notified in order to try to identify the optical counterpart. Danish optical



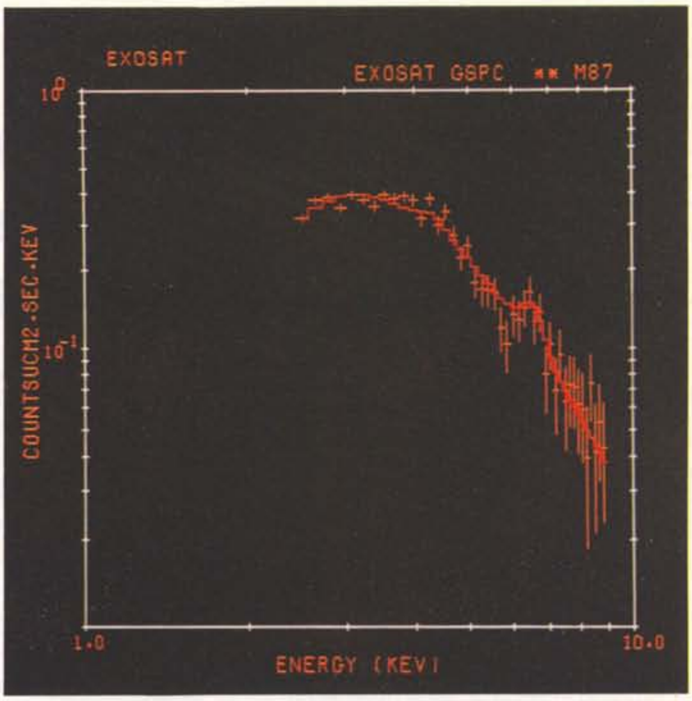


Figure 3 – The X-ray spectrum obtained by the gas scintillation spectrometer of the giant elliptical galaxy in the Virgo cluster M87. A model spectrum (histogram) is also indicated

astronomers have already provided evidence for a star at the X-ray location which is behaving in an unusual manner. A detailed analysis of the X-ray data from the whole payload, which is already underway, should, when coupled with the optical data, provide information as to the nature of this object, in particular whether it is a compact object such as a neutron star in orbit around a normal star.

Whilst Exosat was still in the performance-verification phase, an optical outburst was reported from the old nova system GK-Per. Such optical outbursts occur infrequently and so Exosat's observing schedule was reorganised to include an ~8 h exposure of this white-dwarf binary system. The medium-energy experiment onboard Exosat immediately detected a 351 s periodicity in the X-ray flux. The X-ray modulation was approximately sinusoidal with a pulse fraction of ~50%. The X-ray source was also brighter than expected, indicating a correlation with the current optical outburst. The pulsations result from the rotation of the white dwarf and indicate that it has a significant magnetic field which channels gas accreted from the companion star down onto the white dwarf's magnetic poles. As the white dwarf rotates every 351 s, the X-ray beam from these hot spots crosses the field of view of the Exosat detectors, which detect a pulse of X-ray emission. Two further observations were immediately scheduled to measure the Doppler variation of the pulsation period as the white dwarf moved around its companion star with an orbital period of ~2 d. These observations, when combined with the initial exposure and the optical data, will provide further information on the dynamics of the binary system and the physics involved in the accretion process.

Let us now turn from the exciting observations of galactic sources to the preliminary Exosat results from observations of extragalactic objects, such as normal galaxies, active galactic nuclei, clusters of galaxies and quasars.

The low-energy telescopes have observed our nearby sister galaxy Andromeda (M31). Many individual sources were detected which are considered to be associated with the same types of objects as those producing X-ray emission in our own Galaxy. The detailed analysis of this data, which includes the search for binary periods, will however be complex and require the use of sophisticated image-processing techniques.

Soon after launch it became apparent that the background environment for the medium-energy experiment and the gas-scintillation spectrometer was significantly lower than expected (~ one order of magnitude lower in the case of the spectrometer). This has resulted in a much higher sensitivity and permits the observation of much fainter sources of X-ray emission. Most faint sources are extragalactic in origin, which means that many hundreds of additional sources should now be observable with the spectrometer and their spectra determinable at medium energies (2–20 keV).

The observations of clusters of galaxies such as Virgo, Coma and Perseus have provided high-quality spectra which indicate the presence of highly ionised iron. These spectrometer observations will provide information on the temperatures and mass of the hot intracluster gas thought to be responsible for the X-ray emission as well as the abundance of heavy elements. Such information will provide clues to the creation and evolution of some of the largest formations in the Universe. An example of the type of spectra obtained is shown in Figure 3, which is a 10 h exposure of the giant elliptical galaxy in the Virgo cluster M87. The iron emission around 6–7 keV is clearly visible.

Exosat is now well into its main observation programme and has already observed X-ray emission from such diverse objects as planets (Jupiter), normal stars (Algol), white dwarfs (Feige 31) and a wide variety of extragalactic objects (active galactic nuclei and quasars).

The exciting results already obtained in the early-orbit phase owe much to the enthusiasm and dedication of the Observatory Team, and the observatory's manager Dr. D. Andrews. These results could not have been obtained without both the exceptional efforts of the spacecraft operations manager A. Parkes in ensuring the successful operation of the satellite, and the contribution made by P. Prior, with his detailed knowledge of the attitude control system. The successful accomplishment of the difficult task of mission planning in such a fluid, real-time situation, particularly during the early-orbit 'teething' phase, has been due in large part to the sheer professionalism of M. McKay and V. Wood. Discussions with members of the Exosat hardware groups (ESA Bulletin No. 31) are gratefully acknowledged.

'QUESTLEARN' – A Tool for Conversational Computer-Aided Training

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QUESTLEARN is a new service provided by ESA/IRS from its centre in Frascati, Italy. It is available worldwide via private or public networks, by phone or by telex. It is a generalised set of software, enabling 'instructors' to prepare and store on the ESRIN computer a training course or courses of the 'question and answer' variety, which can then be interrogated in a conversational mode by a 'student'. Although basically intended for customer education in the use of the ESA Information Retrieval Service, the development has been made sufficiently general that many other applications are possible.

* ESA Fellow, 1983

System description

QUESTLEARN is an integral part of QUEST, the main ESA-IRS information-retrieval software system. It uses few commands to store or edit texts and programs in a common data depot, and to execute these programs online. The programs drive a training session. They can be written by the instructor using statements of the BASIC programming language. When the student starts a session, QUEST reads the program from the depot, loads it into main storage and hands control to it.

The program may activate some external interfaces to control the flow of data, as shown in Figure 1. It can send text items from the depot to the user's terminal, after proper reformatting (this is useful for sending large amounts of data to the user). It can also read and evaluate what the student has typed in, and then send back lines of comments and/or instructions.

The program keeps control of the ongoing input/output questions of the training session via the necessary loops and branches, until:
- its successful completion
- an error is found
- the student enters the string 'ABORT' after an input request
- the student presses the 'break' key at the terminal,
- the quantity of statements executed exceeds a predetermined limit (to avoid infinite erroneous program loops).

When one of these conditions is satisfied, control returns to QUEST, which then becomes ready to process a new command.

Access to programs and data is facilitated by the Catalogue Manager (see below). This allows items in the depot to be located via an assigned name rather than a block number.

Catalogue structure

The Catalogue is controlled by a software package which performs all the accesses from/to the catalogue depot. Here the records of item names and related pointers are stored, sorted by name, and higher level indices are maintained to reduce the Catalogue search time.

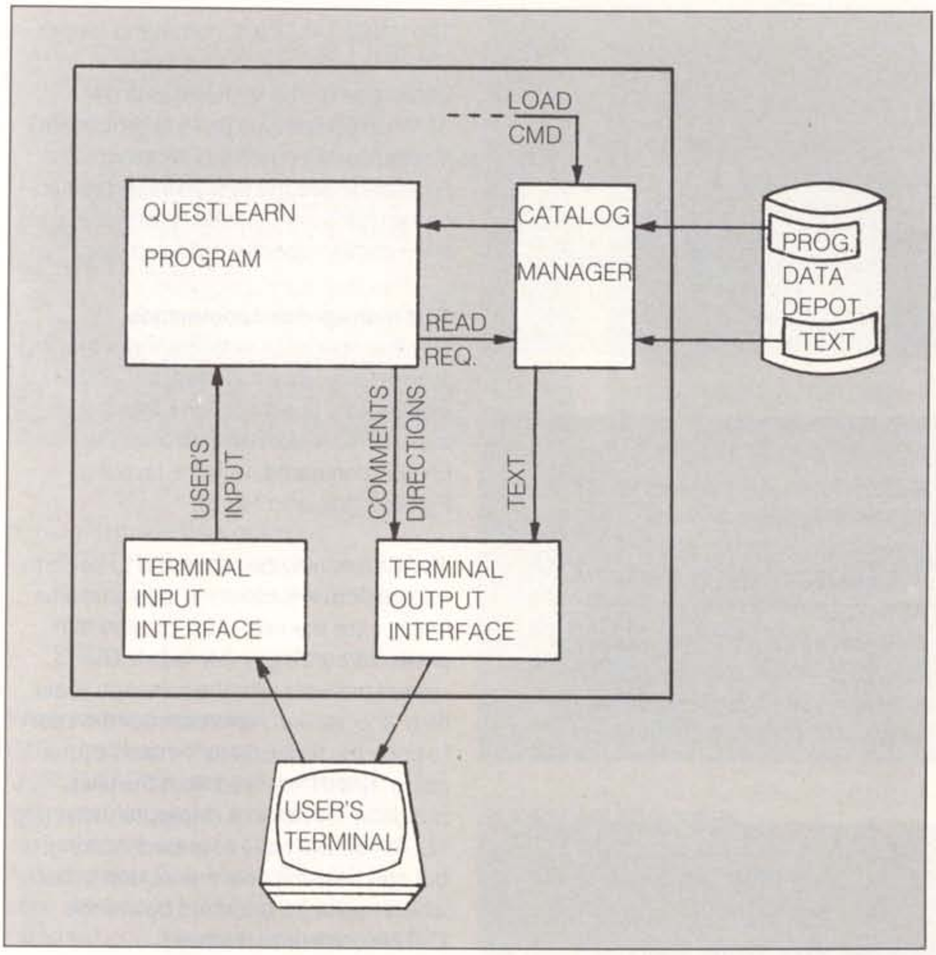
The Catalogue Name layout, shown in Figure 2, is the key to an understanding of the catalogue system. It is made up of three elements: PREFIX, real NAME and SUFFIX.

The PREFIX is five characters long and controls read access (write access is restricted to the item's creator). It may be:
- the user number (default value), so that nobody else can read the data
- a Group identifier (one alphabetic character followed by four alphanumeric ones), to restrict access to users knowing the Group code
- five asterisks to identify public items with no read-access restriction (may be abbreviated with a single asterisk).

The NAME is any unbroken sequence of alphanumeric characters and special separators (e.g. dots), with a maximum

Figure 1 – QUESTLEARN block diagram

Figure 2 – CATALOGUE name layout




```
Command   PREFIX     NAME    SUFFIX

Where :

PREFIX =      User number (default value)
         or   Group code (1 letter + 4 alphanumerics)
         or   ***** (* for shorter reference)
NAME   =      Max 29 alphanumeric characters with separators
SUFFIX =      DATA (default value)
         or   DATABASE
         or   MENU
         or   PROGRAM
         or   QUESTLRN
```

total of 29. It is user-definable and would normally be a mnemonic reminder of the item's contents.

The SUFFIX limits the area of application of the item. It may be one of those listed in Figure 2, and must be provided at the time when the item is created or catalogued. The various functions accessing the items via the Catalogue will access only items having an appropriate suffix related to their application area, to prevent possible misuse of items generated for different purposes.

Catalogue management commands
The following QUEST commands provide direct control of the Catalogue:

CATALOGUE
  Block No.
  Cat. Name

LIST
  Catalogue Name

UNCATALOGUE
  Catalogue Name

The layout of the CATALOGUE command is shown in Figure 3. It needs only two parameters:

- the block number of the item to be catalogued, eventually preceded by the depot identification letter
- the Catalogue Name to be assigned.

The CATALOGUE command (abbr. CAT) when used for QUESTLEARN requires the suffix PROGRAM, to catalogue a program, or QUESTLRN, to catalogue the text items to be displayed on the user's terminal.

The LIST command lists up to 200 entries, starting from the one chosen or the next higher one. The list is limited to the entries matching the prefix and suffix provided. When the suffix is not specified, all entries are shown (for that prefix only, of course). Figure 4 is an example of the LIST command output. The block number represents the data item start position in the depot.

Figure 3 – CATALOGUE command layout

Figure 4 – LIST output example

Figure 5 – ENTER command layout

Figure 6 – Text-entry example

```
CAT?

     CATALOGUE Command Layout (Invalid for DATABASE: ex: CAT 25 TEST.N001):
Parameter      Argument
-------------- ---------------------------------------------------------------
BLOCK NUMBER   xxx or Axxx; no default
CATALOGUE      made of: PREFIX = 5 Group cahr. or "*" or User no. (default);
 NAME           NAME = max 29 contiguous char. with separators (ex. dots);
                SUFFIX (default is DATA) = DATA, DATABASE, MENU, PROGRAM,
                QUESTLRN
```

```
     LIST


                                          Catalogued Data List
     Prefx Name                                 Suffix    Block       User
     ----- -------------------------------- -------- ---------- -----
     00200 DESCRIPTION.MENU                 MENU             33 00200
     00200 EXPLANATION.TEXT.01              QUESTLRN         34 00200
     00200 EXPLANATION.TEXT.02              QUESTLRN         35 00200
     00200 TEST.DATA                        DATA             32 00200
     00200 TEST.PROGRAM                     PROGRAM          31 00200
```

```
ENTER?


                ENTER Command Layout (ex: ENTER TEST.VALUES MENU)
Parameter      Argument
-------------- ----------------------------------------------------------------
FUNCTION       CATALOGUE, CAT, NO CATALOGUE, NOCAT (Default= CATALOGUE, CAT)
CATALOGUE      made of: PREFIX = 5 Group cahr. or "*" or User no. (default);
 NAME           NAME = max 29 contiguous char. with separators (ex. dots);
                SUFFIX (default is DATA) = DATA, DATABASE, MENU, PROGRAM,
                QUESTLRN
```

```
     ? ENTER CAT

     Pls specify name for catalogue entry

     ? BASIC.PROGRAM.EXAMPLE PROGR

     Data Item # 46 started

     10 REM INSTANCE BASIC PROGRAM
     20 INPUT  "TYPE YOUR NAME", NAME$
     30 PRINT "THE USER ",NAME$," IS NOW WORKING AT THIS TERMINAL"
     40 END
     NNNN

     00101 BASIC.PROGRAM.EXAMPLE PROGRAM
     catalogued
```

The UNCATALOGUE command (abbr. UNCAT) requires only the item's Catalogue Name to delete its entry. All these commands provide proper error messages when needed. Moreover, it is possible to see the system interpretation of the user's input if these commands are immediately repeated followed by a '?'.

Text management commands

The first operation in preparing a training session is to enter the program and the explanatory or advice items into the depot. This is accomplished via the ENTER command, with the layout of Figure 5 (see also Fig. 6).

The system may be requested to perform the catalogue function at the same time. In this case the user must provide the preferred catalogue name too. The system answers with the message 'Data Item #xx started', and waits for the user to enter the text, until terminated by the string 'NNNN' (derived from the telex protocol). Users on a display terminal (e.g. TEL42) do not have to issue this string, but can transmit only one screen of data, which has to be prepared before the ENTER command is issued.

The stored programs or texts may be edited via dedicated functions available at present only under the DDS application. Switching back and forth into this application is performed via the commands A DDS and A QUEST.

An editing function may be implemented either at line level (Fig. 7), or at data-item level (Fig. 8). At line level, for example:

- REPLACE substitutes either one line or a character string between two slashes
- ANNEX # inserts a new line after line #
- SHOW shows one or more lines
- DELETE deletes one or more lines
- DO stores all changes performed during the EDIT function
- UNDO terminates the EDIT status without any change in the original data.

Figure 7 – Example of text editing at line level

```
ENTER-EDIT 46

Data Item # 46 ready for EDIT

ENTER-REPLACE 1 10 REM BASIC PROGRAM EXAMPLE
  line 1 replaced
ENTER-DELETE 4
  line 4 deleted
ENTER-REPLACE 2 /YOUR NAME/=/YOUR SURNAME/
  line 2 replaced
ENTER-SHOW 2
   2 20 INPUT "TYPE YOUR SURNAME", NAME$

ENTER-DO

Data Item # 46 Edit performed
```

Figure 8 – Example of text editing at data-item level

```
ENTER-CONTINUE 46

Data Item # 46 Continuation

40 LET REPLY$="YES"
50 INPUT "TYPE YES TO CONTINUE WORKING - ANITHING OTHERWISE",REP$
60 IF REP$<>REPLY$ THEN END
70 ISSUE SIM1
80 INPUT REP$
90 IF REP$<>REPLY$ THEN END
100 ISSUE SIM2
110 LET NUMBER%=1
120 INPUT NUM%
130 IF NUM%<>NUMBER% THEN ISSUE SIM3
140 ISSUE SIM4
150 END
NNNN

DATA Item # 46 finished
```

At data-item level, for example:

- CONTINUE adds data to the data item having the same reference item number
- SHOW displays an existing data item.

Programming language
BASIC has been chosen as QUESTLEARN's user programming language, largely for its simplicity and ease of use, even for nonprogrammers. An interpreter for a Minimal BASIC has been developed following the ISO standard as a minimum, with improved facilities wherever possible.

Character strings and numeric constants as well as variables are allowed in the statements. A variable's value may be assigned explicitly by the programmer or may be the result of an expression within the program.

Numeric or character-string expressions are allowed. Numeric expressions may contain variables and/or constants as operands and addition, subtraction, multiplication, division, and raising to a power as operators. As many pairs of parentheses as allowed by the program line length may be used. The writing and evaluation of numeric expressions follows the normal algebraic rules. String expressions may concatenate string variables and/or string constants.

A BASIC program is executed sequentially, until:

- some other action is dictated by execution of a control statement
- an abnormal condition occurs
- an END statement is found.

The instructions already implemented are as follows.

Assignment statements
LET (this keyword is optional) assigns an immediate value or the result of an expression to any kind of variable type.

Control statement
GOTO forces an unconditional branch to a specified program line.

IF... THEN... ELSE and IF... GOTO allow a change in the program's execution flow according to the result of an expression containing relational operators.

GOSUB allows branching to and return from a subroutine.

Program annotation statement
REM or a single quotation mark (') allow explanatory remarks to be inserted in a program.

Program termination statement
END terminates the program's execution.

Input/output statements
INPUT interrupts program execution and allows the user to interact with the program, supplying values for the variables from the terminal.

PRINT and WRITE allow data to be output at the terminal in tabular or free formats, respectively.

ISSUE allows text to be picked up from the depot, reformatted according to the terminal setting and sent to the user. The statement format is:
ISSUE
   Catalogue Name

It is not necessary to specify the suffix, as it is supplied as a default value by the software, but the text must have been catalogued under the suffix QUESTLRN. If the text cannot be located under the prefix provided, the system will search for it in the public catalogue portion as well. Default for the prefix is the user number.

The text is reformatted according to a simple set of rules:

- blank lines are repeated at the output
- a paragraph is delimited by two lines starting with a blank
- multiple blanks are suppressed in the paragraph
- carry-over is performed without word cutting, if possible
- text indented more than ten characters is centred on the screen
- menu tables are recognised if each line starts with the sequence blank,

```
10 REM BASIC PROGRAM EXAMPLE
20 INPUT "TYPE YOUR SURNAME", NAME$
30 PRINT "THE USER ";NAME$;" IS NOW WORKING AT THIS TERMINAL"
40 LET REPLY$="YES"
50 INPUT "TYPE YES TO CONTINUE WORKING - ANYTHING OTHERWISE",REP$
60 IF REP$<>REPLY$ THEN END
70 ISSUE SIM1
80 INPUT REP$
90 IF REP$<>REPLY$ THEN END
100 ISSUE SIM2
110 LET NUMBER%=1
120 INPUT NUM%
130 IF NUM%<>NUMBER% THEN ISSUE SIM3
135 INPUT "TYPE - YES - TO CONTINUE",REP$
136 IF REP$<>REPLY$ THEN END
140 ISSUE SIM4
150 END



ENTER-ENTER CAT SIM1 QUESTLRN
Data Item # 56 started

              *** QUESTLEARN SIMULATION ***

FOLLOW ME TO LEARN QUESTLEARN PROCEDURE.
UNTIL NOW YOU HAVE INPUT YOUR ESA-PASSWORD AND QUESTLEARN START COMMAND
TYPE - YES - IF YOU LIKE TO CONTINUE THIS SIMULATION
NNNN
00101 SIM1 QUESTLRN catalogued

ENTER-ENTER CAT SIM2 QUESTLRN
Data Item # 57 started

              *** QUESTLEARN SIMULATION ***

FIRST OF ALL YOU CREATE AND CATALOGUE YOUR BASIC PROGRAM DESCRIBING
THE PROCEDURE.  THIS IS REALIZED TYPING - ENTER CAT XXXXX PROGRAM -
COMMAND (XXXXX = PROCEDURE NAME)
DO YOU KNOW THIS COMMAND?
TYPE  - 1 -  IF YES, WHATEVER OTHERWISE.
NNNN
00101 SIM2 QUESTLRN catalogued


ENTER-ENTER CAT SIM3 QUESTLRN

Data Item # 61 started

              *** QUESTLEARN SIMULATION ***

THE FOLLOWING INSTRUCTIONS' SET ENABLES YOU TO CREATE AND CATALOGUE
A NEW APPLICATION
- ENTER
* DATA ITEM #  STARTED
.............
.............                   TYPE YOUR PROGRAM
.............                   TO FINISH THE TEXT TYPE A STRING OF 4N
.............
* DATA ITEM # FINISHED
- CAT # USER.APPL.1  PROGRAM
(USER.APPL.1 WILL BE THE CATALOGUE NAME OF YOUR APPLICATION)
* USER.APPL.1 PROGRAM CATALOGUED
NNNN
00101 SIM3 QUESTLRN catalogued



ENTER-ENTER SIM4 QUESTLRN

Data Item # 63 started


              *** QUESTLEARN SIMULATION ***

ANY TIME YOU LIKE TO RUN YOUR APPLICATION, TYPE THE COMMAND
                RUN  USER.APPL.1

THE EXECUTION OF YOUR BASIC PROGRAM WILL START IMMEDIATELY.
NOW YOU ARE READY TO BEGIN.
GOOD LUCK!!!!!!!
NNNN

00101 SIM4 QUESTLRN catalogued
```

Figure 9 – User's application program

number, blank and at least three lines are available

- menu tables start after a line with at least ten leading blanks
- columns of menu tables are recognised by scanning all of their rows; carry-over within each column is applied as needed.

Online session
An online session is started by entering the command:

RUN Catalogue Name

A suffix need not be specified, as the PROGRAM option is imposed by the software, but the program must have been catalogued under this suffix. As usual the prefix default is the user number.

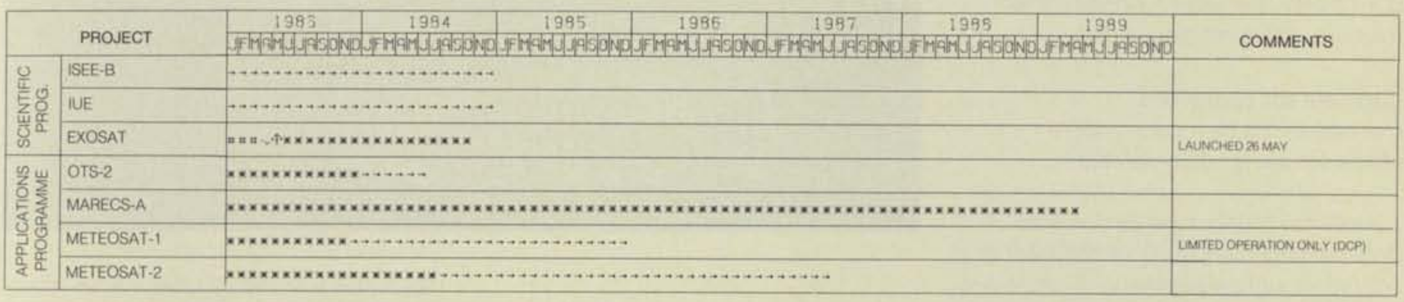
Figure 9 shows the components of a very simple user application.

Conclusions
QUESTLEARN is a very simple, flexible tool both for the filing of training procedures and for their use during online sessions, thanks to the introduction of the catalogue system, the use of a small number of powerful commands, and the choice of BASIC as the programming language.

QUESTLEARN can also be used for applications other than training, such as: documenting office procedures, consulting timetables or price lists and form filling.

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

In Orbit / En orbite



Under Development / En cours de réalisation

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

Météosat

Programme préopérationnel
Segment spatial

Météosat-1 et 2 ont tous deux fonctionné normalement au cours des derniers mois. Météosat-1 continue son soutien à la mission collecte de données tandis que Météosat-2 poursuit les missions prise d'images et diffusion des données.

Le modèle P2 reste en dépôt.

La possibilité de confier la mission Lasso (prévue à l'origine pour Sirio-2) à Météosat - P2 a été présentée lors d'une réunion du STAG en juin et a été favorablement accueillie. En même temps, une étude effectuée par l'industrie a confirmé que l'installation de l'équipement Lasso sur le modèle P2 ne devrait avoir aucune incidence sur les missions météorologiques.

Segment sol/opérations

Des opérations de routine ont été effectuées sur les deux satellites.

Le taux de récupération de données dépasse largement 95%. Le 1er juillet, des opérations ont été menées conjointement avec le Projet international d'étude des nuages et des climats par satellite (ISCCP), permettant de faire un échantillonnage des images Météosat spécialement destinées aux climatologistes et de les mettre en archives une fois toutes les trois heures.

Par ailleurs, les activités d'archivage, de saisie et diffusion de données se sont poursuivies sans rencontrer de problème.

Meteosat image of the Earth taken on 8 July 1983 at 11.55 GMT (visible channel)

Image de la Terre prise par Météosat (canal visible) le 8 juillet 1983 à 11.55 GMT

Exosat

Depuis que la phase du lancement et du début de fonctionnement en orbite (LEOP) s'est terminée le 9 juin, le satellite effectue sa mission scientifique (cf. rapport détaillé de A. Peacock) de façon très satisfaisante dans l'ensemble bien que les opérations se soient révélées plus complexes que prévu. Un comportement au départ anormal dans la transmission et la réception des données a été corrigé par des modifications des procédures opérationnelles et par l'utilisation des redondances à bord. Il a été plus laborieux que prévu de rendre totalement opérationnel le système de commande d'orientation qui est passé à plusieurs reprises sur le mode de sécurité autonome, parfois à des périodes de non-contact avec le sol, ce qui a empêché une analyse complète des causes de ce phénomène. Les procédures opérationnelles ont néanmoins été de nouveau modifiées afin de prévenir la commutation intempestive sur le mode de sécurité et, à l'heure où nous mettons sous presse, leur mise en oeuvre est satisfaisante. Le comportement anormal du compteur proportionnel à détection de position est actuellement soumis à examen. Entre-temps les observations du télescope se font au moyen d'une mosaïque photomultiplicatrice à microcanaux. Les redondances à bord ont été testées et utilisées lorsque les unités principales ont présenté des anomalies. Dans tous les autres secteurs, le satellite fonctionne bien, dans le cadre des limites spécifiées. Le 'groupe directeur de la mission de l'observatoire' déploie un effort particulier pour économiser les ergols embarqués afin de prolonger au maximum la mission scientifique au-delà de la durée de vie (nominale) de deux ans.

Télescope spatial

NASA

La NASA n'a pas encore pris officiellement de décision sur la nouvelle date de lancement du Télescope spatial, mais toutes les activités se poursuivent dans l'hypothèse d'un lancement à la mi-1986.

Réseau solaire

Les essais de recette du premier modèle de vol du mécanisme d'entraînement du réseau solaire et de l'électronique associée se poursuivent de façon satisfaisante. Le programme d'essais de recette des modèles de vol de l'électronique de commande de déploiement a été définitivement arrêté. Certains essais supplémentaires sont en cours sur les cassettes bi-stem de vol avant de passer à la suite de l'intégration du modèle de vol du mécanisme de déploiement secondaire.

Meteosat

Preoperational programme

Space segment

Both Meteosat-1 and -2 have operated nominally during the reporting period with very few anomalies recorded. Meteosat-1 still supports the DCP mission while Meteosat-2 carries out the imaging and dissemination missions.

The P2 model remains in storage.

The possibility of carrying out the Lasso mission (from Sirio-2) with Meteosat-P2 was presented at a STAG meeting in June and was favourably received. In parallel, an industry study has confirmed the feasibility of installing the Lasso equipment on Meteosat-P2 with no impact on the meteorological missions.

Ground segment/operations

Routine operations have been conducted with both satellites.

The overall meteorological output continued to be well above 95% of scheduled products. On 1 July, in connection with the International Satellite Cloud Climatology Project (ISCCP), operations started whereby Meteosat images, specifically sampled for the climatological community, are archived at three-hourly intervals.

Archiving/retrieval and data-service activities have been running smoothly.

Exosat

Since the completion of the Launch and Early Orbit Phase (LEOP) on 9 June, the spacecraft has supported the scientific mission in a very satisfactory manner, in general, although operations have proved to be more complex than expected (see detailed report by Dr. A. Peacock elsewhere in this issue). An initial anomaly in data transmission and reception has been eliminated by changes to operational procedures and by exercising on-board redundancies. More effort than anticipated has been required to achieve full operational status of the attitude-control system, which has switched to the autonomous safety mode on several occasions, sometimes outside ground contact, thereby preventing a full analysis of the reasons why. Once again, however, operational procedures have been modified to inhibit inadvertent switching into the safety mode and, at the time of writing, successfully implemented. The anomalous behaviour of the position-sensitive proportional counter is under investigation. Meanwhile telescope observations are being undertaken with the channel-multiplier array detectors. On-board redundancies have been tested and exercised when prime units exhibited anomalous behaviour. All other areas are performing well within the specified limits. Particular emphasis is being placed by the Observatory mission-planning group on the economic use of on-board propellants, in order to maximise the scientific mission beyond the nominal two-year lifetime.

Space Telescope

NASA

NASA have not yet taken a formal decision on the new launch date for the Space Telescope, but all activities are proceeding on the assumption of launch by mid-1986.

Solar array

Acceptance testing of the first flight solar-array drive mechanism and associated electronics is proceeding satisfactorily. The acceptance-test programme of the deployment control electronics flight units has been finalised. Some additional testing is being done on the flight bi-stem cassettes before proceeding with further integration of the flight secondary deployment mechanism.

Faint Object Camera

The flight unit of the Photon Detector Assembly was delivered to the Camera Module contractor on 14 June. Integration and electrical/performance testing of the flight Faint Object Camera has since been finalised and acoustic testing is now in progress at IABG. The thermal vacuum test and calibration at ESTEC is scheduled next, with delivery to NASA foreseen by mid-November 1983.

Essais thermiques sous vide de la chambre pour astres faibles du Télescope spatial dans l'Enceinte d'Essais dynamiques de l'ESTEC à Noordwijk

Thermal-vacuum testing of the Space-Telescope Faint-Object Camera in the Dynamic Test Chamber (DTC) at ESTEC, Noordwijk

Chambre pour objets faibles

L'unité de vol de l'ensemble détecteur de photons a été livrée le 14 juin 1983 au contractant du module chambre. Les activités d'intégration et d'essais électriques et fonctionnels qui ont alors été conduites sur le modèle de vol de la chambre à objets faibles sont terminés, tandis que les essais acoustiques de la même chambre se poursuivent chez IABG. Les opérations d'essai et d'étalonnage sous vide thermique suivront à l'ESTEC, la livraison à la NASA étant prévue pour la mi-novembre 1983.

Hipparcos

L'examen préliminaire de la conception (PDR) au niveau système a été mené à bonne fin au cours de la dernière semaine de juillet. Suite de quoi quelques modifications mineures ont été introduites pour présenter un dossier solide sur le plan technique et gestionnel en vue de la proposition officielle de la phase de développement (C/D). Les offres industrielles sont attendues pour le 1er octobre.

Le démarrage de la phase C/D prévu pour début janvier 1984 est maintenu et on a l'intention de terminer autant d'examens PDR que possible avant cette date.

Olympus

La plupart des examens des bases de référence de développement au niveau équipement ont été effectués dans l'industrie pour passer à la fabrication des équipements destinés au modèle d'intégration technique du véhicule spatial. Certains des examens ultérieurs au niveau sous-système ont déjà eu lieu, les autres sont prévus pour le trimestre prochain. L'examen de la base de référence de développement au niveau système que doit effectuer l'Agence est prévu pour la fin de l'année.

Le montage du modèle de structure du véhicule spatial est bien avancé et les préparatifs sont en cours pour procéder plus tard dans l'année aux essais statiques de ce modèle.

Les travaux de fabrication du modèle thermique du véhicule spatial se sont poursuivis et l'on a procédé à un examen conceptuel permettant la conception détaillée et la fabrication des installations d'essais destinées à l'essai de simulation solaire prévu pour le milieu de l'année prochaine.

La demande de prix pour le soutien par le secteur sol des opérations en orbite a été envoyée à Telespazio. L'Agence procède actuellement à une évaluation pour définir les plans d'étude et de développement des composants critiques du secteur sol de communications d'Olympus qui seront nécessaires pour le programme de démonstration et d'essais en orbite.

Les négociations portant sur l'utilisation de la charge utile de radiodiffusion d'Olympus pour des transmissions de programmes en Europe se sont poursuivies entre l'Agence et l'Union européenne de Radiodiffusion.

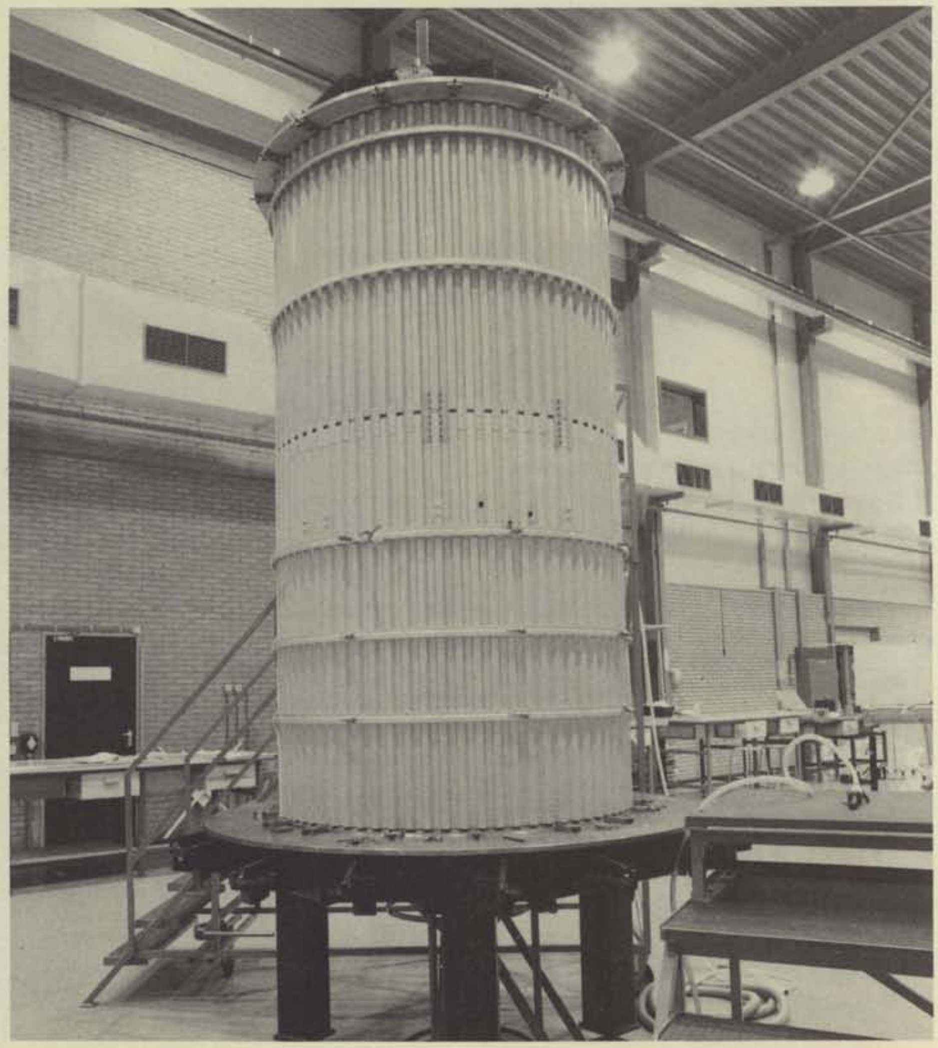
Deux premiers contrats ont été passés pour des études sur les installations de visioconférence qui seront utilisés pour les démonstrations d'Olympus.

L'Agence a signé un contrat avec Arianespace pour la fourniture d'un lanceur pour Olympus-1.

Giotto

Le programme progresse de façon satisfaisante.

Le projet Giotto en est au stade du modèle électrique et toutes les expériences de ce modèle ont été livrées pour intégration à British Aerospace (Bristol). Les activités d'intégration se poursuivent avec l'achèvement et la mise en place des sous-systèmes et le



Propulsion-module cylinder for the Olympus spacecraft, photographed at Fokker (NL)

Le cylindre du module de propulsion destiné au satellite Olympus (photographié chez Fokker, NL)

Hipparcos

The system-level Preliminary Design Review (PDR) was successfully completed during the last week of July. As a result, some relatively minor changes are being implemented to provide a fully satisfactory technical and managerial baseline for the formal Development Phase (C/D) Proposal, which is expected to be received from industry by 1 October.

The planned start for Phase C/D in early January 1984, is being maintained and it is intended to complete as many of the subsystem-level PDRs as possible before that date.

Olympus

The majority of the development baseline reviews at equipment level for Olympus (formerly L-Sat) have now been conducted in industry in order to release the manufacture of equipment for the engineering integration model spacecraft. Some of the subsequent subsystem-level reviews have already been held, while the remainder are planned for the forthcoming quarter. The System Level Development Baseline Review is scheduled for the end of the year.

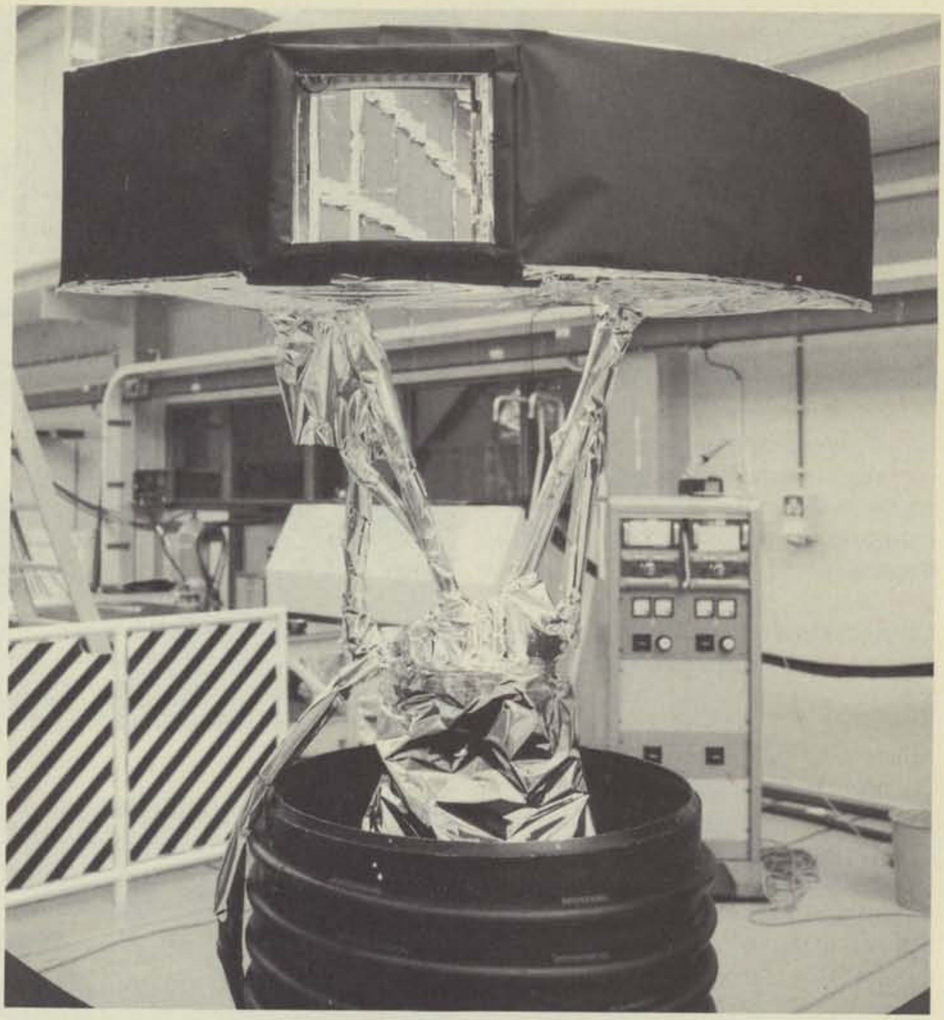
Assembly of the structural-model spacecraft is well in hand, and preparations are being made for the static test on this model later in the year.

Work has continued on thermal-model spacecraft manufacture. A design review has been held to release the detailed design and manufacture of the test rigs for the solar-simulation test scheduled for the middle of next year.

The Request for Quotation for the in-orbit Ground-Segment Operations has been issued to Telespazio.

An assessment is being made by the Agency in order to define the plans for the study and development of the critical components for the Olympus ground communications segment, which will be needed for the in-orbit test and demonstration programme.

Discussions have continued between the Agency and the European Broadcasting Union concerning the use of the Olympus broadcast payload for European programme transmission.



Essais de simulation solaire du rideau thermique du satellite Giotto dans l'enceinte HBF-3 de l'ESTEC

Thermal shutter (top centre) for the Giotto spacecraft under test in the HBF-3 solar-simulation chamber at ESTEC, Noordwijk

Two initial studies concerned with video-conferencing facilities to be employed for Olympus demonstrations have been let.

The Agency has signed a contract with Arianespace for provision of the launch vehicle for Olympus-1.

Giotto

The Giotto programme is in the electrical-model stage and is progressing well. All electrical-model experiments have been delivered for integration at British Aerospace, Bristol. The integration activity is continuing with completion and installation of the spacecraft subsystems, and it is anticipated that the fully integrated spacecraft will be available by mid-September.

During the following few weeks, a combined subsystem to subsystem verification and test, software development/verification programme will be conducted, prior to full system functional and EMC testing in late Autumn.

As the flight-model integration activity is scheduled to start at the end of this year, it is essential that electrical-model schedules are maintained.
Flight-model spacecraft delivery is still predicted for 31 January 1985.

Ariane

In view of the Council decision to launch Giotto on an Ariane-1 vehicle, negotiations with Arianespace will be conducted during the remainder of 1983. Studies have already started, both internally and with Arianespace, to examine the feasibility and potential advantages of a direct-injection launch scenario. If there are indeed significant advantages, the current scenario for launching initially into a geostationary transfer orbit may be dropped in favour of direct injection into the comet transfer orbit. A final decision should be taken before the end of this year.

véhicule spatial pleinement intégré doit en principe être disponible à la mi-septembre.

Au cours des prochaines semaines, un programme combiné de vérification et d'essais sous-système par sous-système, et de mise au point/vérification du logiciel se déroulera avant les essais fonctionnels complets du système et les essais de compatibilité électromécanique qui auront lieu à la fin de l'automne.

Les activités d'intégration du modèle de vol devant commencer à la fin de cette année, il est essentiel que les calendriers prévus pour le modèle électrique soient respectés.

La livraison du modèle de vol du véhicule spatial est toujours fixée au 31 janvier 1985.

Ariane

Les négociations avec Arianespace se dérouleront à la fin de 1983 pour mettre en oeuvre la décision prise par le Conseil de lancer Giotto sur un lanceur Ariane-1. L'Agence et Arianespace ont commencé à étudier la faisabilité et les avantages éventuels d'un lancement avec injection directe. Si cette solution se révèle très avantageuse pour le projet, le scénario actuel de lancement sur une orbite d'attente pourrait être abandonné en faveur d'une injection directe sur l'orbite de transfert en direction de la comète. Une décision devrait être prise avant la fin de l'année.

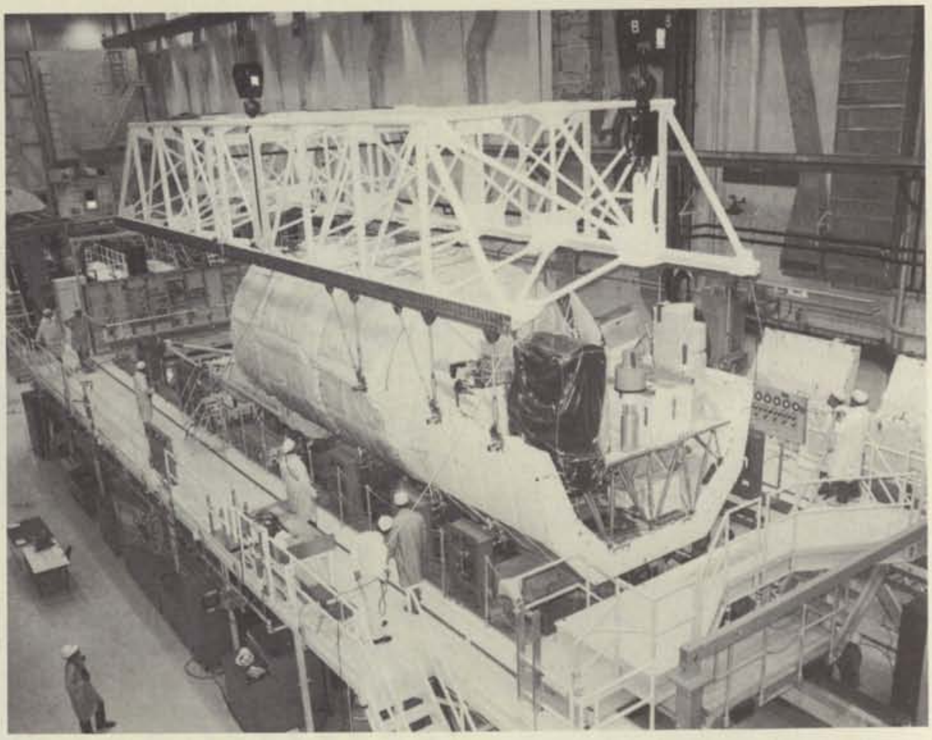
Spacelab

Les préparatifs du lancement de Spacelab 1 (SL-1) se sont poursuivis de façon satisfaisante. Les essais d'intégration, au cours desquels SL-1 a été expérimenté avec la première charge utile Spacelab, se sont avérés positifs puisque seuls des problèmes tout à fait secondaires se sont faits jour. La première partie de l'examen d'aptitude au vol (FRR) auquel a procédé la NASA en présence de responsables de l'ESA n'a mis aucune difficulté en évidence et a conduit à autoriser le transfert du Spacelab le 2 août au hall d'assemblage et de vérification de l'Orbiteur pour l'intégration finale dans celui-ci. Le problème du satellite TDRS a été résolu et la mise sur orbite réussie au mois de juin. Certains problèmes inattendus se sont produits lors des premières tentatives d'établir la liaison avec le TDRS et d'autres concernant le secteur sol se sont également posés mais ils ont maintenant été résolus.

Les difficultés rencontrées avec le TDRS et l'imposant volume de travail nécessité par la préparation du vol 8 de la Navette ont provoqué un glissement de la date du lancement qui est fixée à fin novembre. Les principales opérations à accomplir d'ici là sont des essais finaux, la fermeture des portes de la soute de l'Orbiteur, le transfert de l'Orbiteur au bâtiment de montage en position verticale, et le transfert de l'Orbiteur à la rampe de lancement.

Production ultérieure

Le travail dans l'industrie avance comme prévu. De fréquentes livraisons de pièces détachées et de matériels dépendants de la mission, commandés au titre du contrat de production ultérieure du Spacelab, sont faites à la NASA. Les préparatifs du lancement du Spacelab nécessitent parfois des livraisons anticipées imprévues de matériels relevant du programme de production ultérieure. Grâce à la bonne coopération du consortium industriel, ces exigences sont normalement satisfaites. Le montage du module Spacelab chez le contractant principal, ERNO, a été interrompu momentanément, suivant les directives de l'ESA, en attendant la décision de la NASA concernant le remplacement ou le traitement spécial des matériaux d'insonorisation utilisés à l'intérieur du Spacelab.



Spacelab-1 being transferred from the test stand to the Shuttle Cargo Integration and Test Equipment (CITE) stand at Kennedy Space Center (KSC)

Transfert de Spacelab-1 du stand d'essais au hall d'intégration et d'essais de la Navette au Centre spatial Kennedy

Le calendrier de production ultérieure de l'IPS est perturbé par des retards qui se sont produits dans la réalisation de travaux de développement et de qualification. Cependant, la date de livraison des principaux éléments complets prévus au contrat IPS est toujours fixée à décembre 1984.

Des appels d'offre concernant la livraison de pièces de rechanges supplémentaires pour le Spacelab et l'IPS ont été envoyés aux contractants principaux. L'ESA pense que cela prolongera le calendrier de livraison du contrat FOP passé avec la NASA jusqu'à fin 1985.

IPS

Les défaillances qui se sont récemment produites au cours des essais du système

Spacelab

Preparations for the Spacelab-1 (SL-1) launch have proceeded satisfactorily. Integration tests, in which SL-1 was tested with the First Spacelab Payload, were successful in that only very minor problems were discovered. The first part of the Flight Readiness Review held by NASA with ESA in attendance exposed no difficulties and paved the way for the decision to move Spacelab on 2 August to the Orbiter Processing Facility (OPF) for final integration with the Orbiter. The problem with the TDRS satellite was solved and the orbit was reached successfully in June. Some unexpected problems were experienced during the initial attempts to set up the communications link with the TDRSS and problems were discovered with the ground segment, but they have now been resolved.

The problems with TDRSS and the volume of work involved in preparing for Shuttle flight no. 8 have led to a slip in the launch, which is now scheduled for end November.* The main events before then will be some final testing, closing of the Orbiter Payload doors, transfer of the Orbiter to the Vertical Assembly Building, and the transfer of the Shuttle Orbiter to the launch pad.

Follow-on Production

The industrial work is proceeding as planned. Frequent deliveries of spares and mission-dependent hardware ordered under the Spacelab FOP Contract are made to NASA. Spacelab launch-preparation activities demand occasional unplanned, advance deliveries of FOP hardware. Due to the responsiveness of the Industrial Consortium, such demands are normally met. Spacelab Module assembly at the Prime Contractor, ERNO, has been stopped temporarily at ESA's request pending decisions to be taken by NASA regarding replacement or special treatment of noise-suppression materials used inside Spacelab.

The IPS FOP schedule is affected by delays in completing development and qualification activities. However, the delivery date for the main IPS contract items remains December 1984.

Requests for proposals for the delivery of additional spares for Spacelab and IPS have been issued to the Prime Contractors. ESA anticipates that this will extend the delivery schedule under the FOP contract with NASA to the end of 1985.

IPS

The recent failures during payload clamp testing are presently being overcome by local re-design. NASA has agreed to a corresponding shift in the associated qualification status and acceptance review for the early delivery of the payload clamp assembly to mid-November 1983. A joint ESA/NASA/Dornier Software Working Group meeting early in August has resulted in an agreement to have all SL-2 required modifications performed prior to delivery.

FSLP

The Spacelab-1 launch date was formally re-scheduled from 30 September to the end of October*, following agreement between NASA and ESA at the end of July. The reason for the delay was the lateness in making the TDRS tracking and data relay system ready to support the mission. The events leading up to the launch were re-scheduled accordingly by NASA.

* See page 64 for latest news of launch

Ulf Merbold, spécialiste charge utile (à gauche) et Owen K. Garriott, spécialiste mission (à droite) du complexe Navette/Spacelab en cours d'entraînement au Centre spatial Kennedy

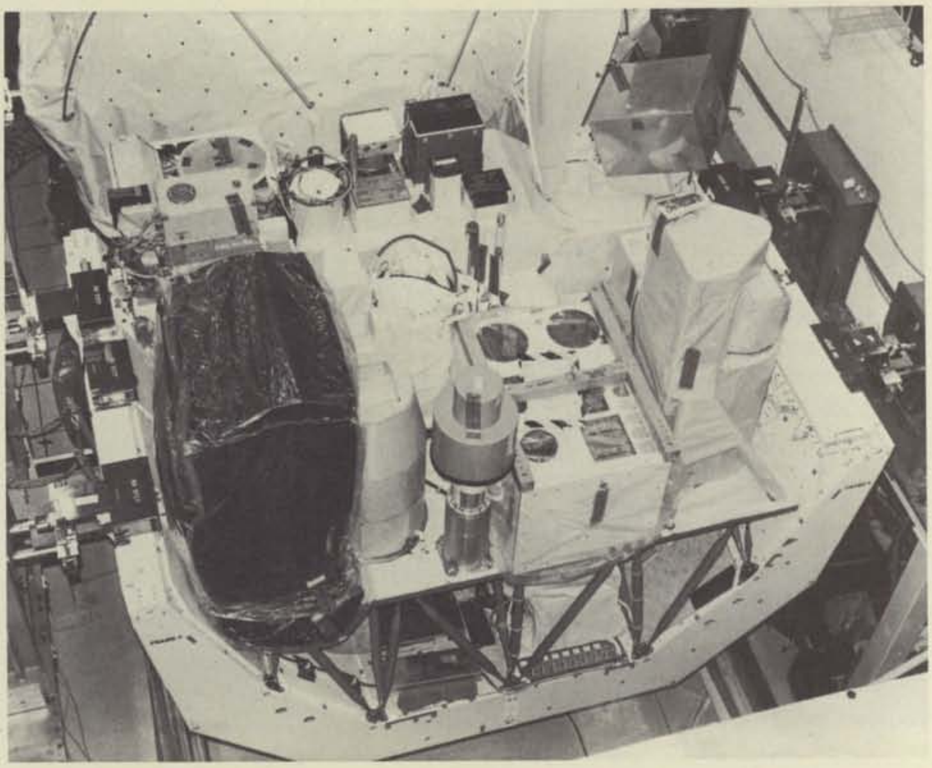
Shuttle/Spacelab-1 Payload Specialist Ulf Merbold (left) and Mission Specialist Owen K. Garriott (right) in training at Kennedy Space Center (KSC) de fixation de la charge utile ont conduit à revoir la conception de certaines pièces et sont en voie d'être corrigées. La NASA a consenti à retarder en conséquence le programme de qualification et l'examen de recette correspondants en vue de la livraison du système de fixation de la charge utile à la mi-novembre 1983. Une réunion ESA/NASA/Dornier du groupe de travail sur le logiciel a eu lieu début août; il y a été convenu d'effectuer toutes les modifications requises pour SL-2 avant la livraison.

FSLP

Le lancement SL-1 (Spacelab-1) a été officiellement reporté du 30 septembre au 28 octobre à la suite de l'accord conclu entre la NASA et la direction de l'ESA à la fin de juillet. Cet ajournement est dû au fait que le système TDRS (Satellites de poursuite et de relais de données), nécessaire au soutien de la mission, a vu sa mise en service retardée. La chronologie des opérations a été actualisée en fonction de cette nouvelle date et la NASA a établi un nouveau calendrier pour les étapes conduisant au lancement.

Au Centre spatial Kennedy de la NASA, les essais des liaisons Investigateurs-Orbiteur-expériences ('Closed-Loop Tests') ont été menés avec succès du 5 au 8 juillet. A la suite de l'examen d'aptitude au vol de la charge utile, le 25 juillet, tous les systèmes ont été déclarés prêts à être transportés à l'installation de préparation de l'Orbiteur (OPF). Les travaux se sont poursuivis à cadence élevée sur les différents éléments d'expériences sans intégration et étaient achevés pour l'essentiel à la fin de juillet, sauf en ce qui concerne les articles à mettre en place peu avant le lancement. Vers la mi-août, le Spacelab, avec sa charge utile intégrée, était transporté à l'OFP et mis en place dans l'Orbiteur 'Columbia'.

Aux Centres spatiaux Marshall et Johnson (MSFC et JSC), de la NASA la préparation des opérations de vol a progressé avec la formation de l'équipage et l'entraînement des investigateurs principaux dans le Centre de contrôle et d'exploitation de la charge utile (POCC). Une simulation de vol a eu lieu en août au JSC. Elle sera suivie par de nouvelles périodes de simulations en septembre et en octobre.



Spacelab-1 pallet carrying an integrated scientific payload, photographed at Kennedy Space Center (KSC). The protective covers will be removed before flight

Le porte-instruments de Spacelab-1 équipé de la charge utile scientifique, photographié au Centre spatial Kennedy (Les bâches de protection seront enlevées avant le vol)

La phase 3 de l'examen de la sécurité en vol était terminée au JSC le 1er juin 1983. Pour l'Agence, il portait principalement sur l'ensemble d'échantillons, de cartouches et autres dispositifs destinés au bâti double 'Sciences des matériaux', le MSDR. Tous ont été acceptés par la NASA.

Les dernières phases de la formation de l'équipage sur la version au sol du MSDR se sont bien achevées en juillet dans les locaux de la DFVLR, à Porz-Wahn, l'accent étant mis sur le module de physique des fluides et le four à miroir.

Afin d'obtenir des données scientifiques de référence sur l'équipage (expériences vestibulaires par exemple), une 'Installation de collecte de données de référence' (BDCF) a été mise en place au Centre de recherches en vol Dryden de la NASA. Cette collecte de données physiologiques sera poursuivie à intervalles réguliers pendant les périodes précédant le vol et suivant l'atterrissage.

L'examen critique de la conception (CDR) du Sled pour D1 s'est tenu chez ERNO les 27 et 28 juillet. A la suite de cet examen, le feu vert a été donné à la fabrication des matériels spécifiques de la mission et les plans encore en suspens ont été approuvés. L'examen de sécurité de vol de phase 1 a eu lieu au JSC pour la mission D1. L'élément Sled de la charge utile a été accepté.

Microgravité

Biorack

Les travaux de l'équipe ESA chargée du projet Biorack ont été axés sur la définition détaillée du plan d'opérations au sol et en vol de la mission D1 et sur la préparation de l'examen de sécurité D1/NASA. Les spécifications du système Biorack ont été mises à jour et une demande de prix pour la fourniture d'équipements spécifiques de la mission et d'équipements de soutien au sol a été envoyée à l'industrie. Les spécifications définitives des enceintes de conditionnement thermique et celles de la boîte à gants ont également fait l'objet de négociations.

Les incompatibilités de calendrier avec le projet D1 ont diminué mais ne sont pas complètement résolues.

Module de physique des fluides amélioré (IFPM)

Le contrat avec le Centre de Recherche FIAT couvrant la remise en état du module de physique des fluides existant et

The Closed Loop Test was successfully performed at Kennedy Space Center (KSC) between 5 and 8 July. The Cargo Readiness Review took place on 25 July, with the outcome that all systems were declared ready for the move to the Orbiter Processing Facility (OPF). Work continued on the various experiment stowage items and was basically completed by the end of July, except for items to be stowed shortly before launch.

In the middle of August, Spacelab and its integrated payload were transported to the OPF and installed in the Orbiter Columbia.

At Marshall Space Flight Center (MSFC) and Johnson Space Center (JSC) preparations for the flight operations have been building up, including crew training and training of Principal Investigators in the Payload Operations and Control Center (POCC). A flight simulation took place at JSC in August and will be followed by further simulation periods in September and October.

The Phase-3 Flight Safety Review was completed at JSC on 1 June. The main items from the ESA side were the array of samples, cartridges and devices for the Material-Sciences Double Rack. All were accepted by NASA.

Final crew training on the ground version of the MSDR has been successfully completed at DFVLR, Porz-Wahn, in July, with emphasis on the Fluid-Physics Module and Mirror Heating Facility.

To obtain reference scientific data on the crew (e.g. vestibular experiments), a so-called 'Baseline Data Collection Facility' (BDCF) has been established at Dryden Flight Research Center. This baseline data collection will be continued at regular intervals during flight and post-landing periods.

The Critical Design Review (CDR) for the Sled payload element for the German Spacelab D1 mission was held at ERNO on 27 and 28 July. The results of the Review included the go-ahead for manufacture of the Mission Peculiar Equipment (MPE) and the approval of the outstanding project plans. The Phase I Flight Safety Review was held at JSC for the D1 mission and the Sled payload element was accepted.

Microgravity

Biorack

The recent work of the ESA Biorack project team has been concentrated on defining, in detail, the ground and flight operations plan for the Spacelab D1 mission, and supporting the D1/NASA Safety Review. The Biorack System Specification has undergone an update and a request for quotation from industry for the supply of mission-peculiar and ground-support equipment has been issued. Activities have also been concentrated on negotiating the final specifications for the thermal-conditioning unit and the glove box.

Schedule incompatibilities with the D1 project have been reduced, though they are not yet completely solved.

Improved Fluid-Physics Module (IFPM)

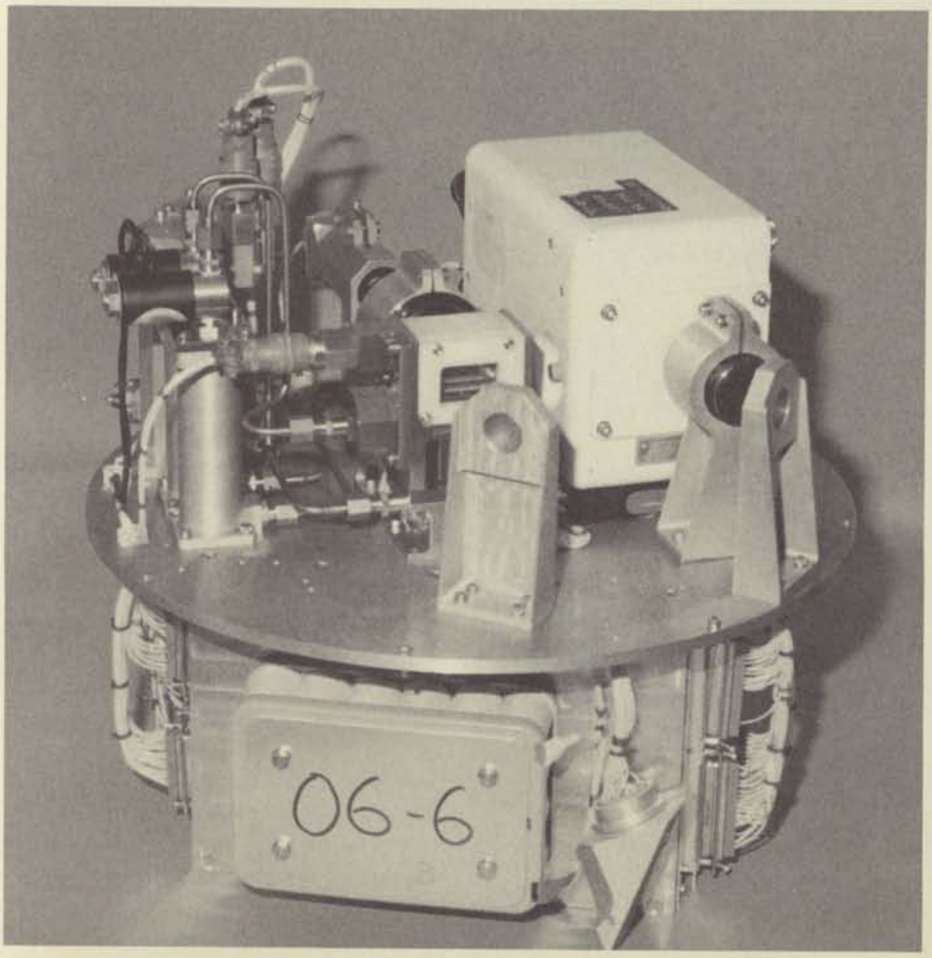
The contract with FIAT Research Center for reflying the existing Fluid Physics Module on the D1 mission has been approved by the Agency's Industrial Policy Committee, and work started at FIAT in July.

The coordination work with the fluid-physics investigators whose experiments were selected for the D1 mission at the last Spacelab Programme Board has been initiated.

The mid-term presentation of the Aeritalia study on an Autonomous Fluid-Physics Module was held in June.

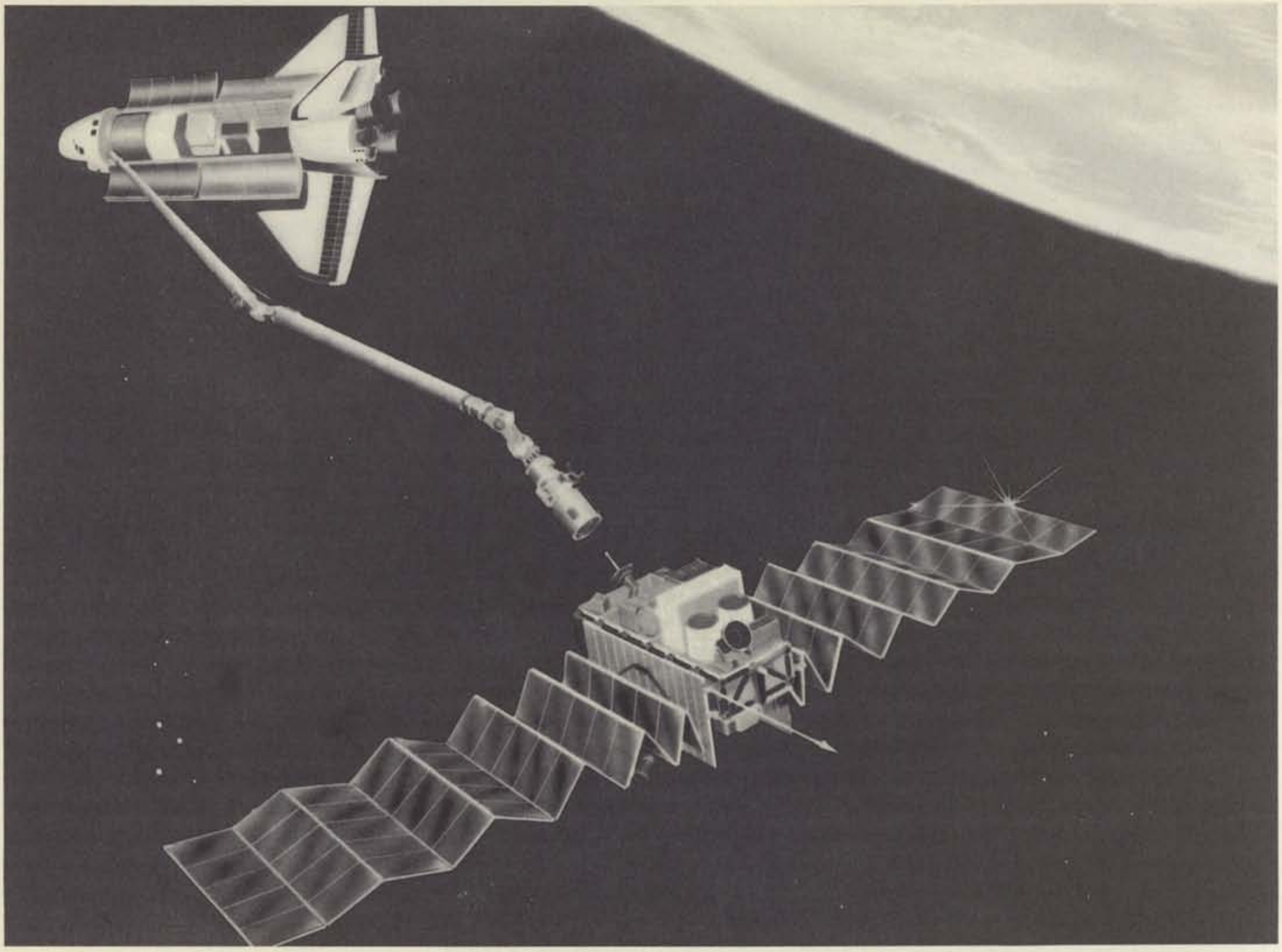
Sounding-Rockets Programme

During its last meeting, the Spacelab Programme Board selected the experiments to be flown on the Texus-9/10 flight in April/May 1984. Detailed technical discussions with the experimenters have taken place over the last three months to arrive at a set of precise technical requirements. Negotiations with the owners of the sounding-rocket experiment facilities (DFVLR and SSC) are under way in order to finalise the ESA part of the Texus-9/10 flight.



Le Module de physique des fluides équipé pour le vol de fusée-sonde Texus-8 (photo ERNO)

Fluid-Physics Module equipped for the Texus-8 flight (photo courtesy of ERNO)



Artist's impression of Eureca's deployment from the Space Shuttle

Vue conceptuelle de la plate-forme récupérable Eureca lors de sa séparation de la Navette spatiale

sa réutilisation pour la mission D1, a été approuvé par le Comité de la politique industrielle et les travaux ont commencé en juillet chez FIAT. Les travaux de coordination avec les chercheurs en physique des fluides sélectionnés pour la mission D1 lors du dernier Conseil directeur du Programme Spacelab ont commencé.

La présentation à mi-course de l'étude d'Aeritalia sur le module autonome de physique des fluides a eu lieu en juin 1983.

Programme de fusées-sondes

Lors de sa dernière réunion, le Conseil directeur du Programme Spacelab a sélectionné les expériences qui seront embarquées sur les vols Texus-9 et 10 prévus pour avril/mai 1984. Des discussions techniques détaillées avec les expérimentateurs se sont déroulées au cours des trois derniers mois de façon à établir des impératifs techniques précis. Les négociations avec les propriétaires des installations expérimentales de fusées-sondes (DFVLR et SSC) sont en cours pour arrêter la participation de l'ESA aux vols Texus-9 et 10.

L'évaluation détaillée des expériences embarquées sur le vol Texus-6 (mai 1982), le premier auquel l'ESA ait participé, est presque terminée et les résultats préliminaires de Texus-7/8 (avril/mai 1983) ont été examinés pour la première fois au cours d'une réunion des expérimentateurs le 8 septembre 1983.

Eureca

En dépit d'une période d'accalmie dans les activités industrielles à l'occasion des vacances, des dispositions ont été prises avec le Contractant Principal (en l'occurence ERNO/MBB) afin que le démarrage de la phase B puisse être effectif le 4 juillet 1983.

Au préalable, la proposition d'étude de phase B avait été approuvée par le Comité de Politique Industrielle (IPC) le 22 juin 1983.

Le type de propergol a été choisi au démarrage de la phase B. Le choix a porté sur un système dit 'monergol' pour des raisons de simplicité, de sécurité et de coût.

Par ailleurs, la concurrence a été ouverte début août auprès de BAe, Fokker et MBB pour la réalisation du réseau solaire qui devra équiper Eureca. La sélection des offres s'effectuera fin septembre.

Les imperfections de la proposition industrielle de phase B qui se situaient dans le secteur de l'ingéniérie de la charge utile et de la gestion d'interface de charge utile ont fait l'objet de discussions avec le Contractant Principal avant le

The detailed experiment evaluation of the Texus-6 flight (May 1982), in which ESA participated for the first time, is coming to an end. Preliminary results from Texus-7/8 (April/May 1983) were discussed for the first time at an experimenter meeting on 8 September.

Eureca

Despite a lull in industrial activity during the holiday period, measures were taken with the Prime Contractor (ERNO/MBB) to enable Phase-B to start on 4 July 1983.

The Phase-B study proposal had been approved beforehand by the Industrial Policy Committee (IPC) on 22 June 1983.

A monopropellant system was chosen for Phase-B start-up for the sake of simplicity, safety and cost.

Competitive tenders were invited in early August from BAe, Fokker and MBB for the solar array for Eureca. The final choice of supplier will be made in late September.

The shortcomings of the Phase-B industrial proposal with regard to payload engineering and payload-interface management were discussed with the Prime Contractor before Phase-B start-up. The next progress meeting, planned for September, should show the effect of the corrections made.

The Phase-B overall plan, extending from start-up in July 1983 to the end of March 1984, complies with Agency requirements. A Preliminary Requirements Review (PRR) at system level is scheduled for the end of November 1983.

In order to plan a satisfactory geographical distribution for the main development phase (Phase-C/D), target figures have been submitted to the contractor.

As regards the definition studies on the six core payload facilities to be carried on the first Eureca flight, the Multi-Furnace Assembly (MFA), the Automatic Gradient Heating Facility (AGHF) and the Botany Facility (BF) are each currently being studied by two competing contractors. The other three multiuser facilities, the Automatic Monoellipsoidal Mirror Furnace Facility (AMMFF), the Solution-Growth Facility (SGF) and the Protein Crystallisation Facility (PCF) are in the course of definition under the Phase-A studies allocated to each of the contractors responsible for development of the previous equipment for these multiuser facilities (built for the FSLP, LDEF, D-1, Texus missions, etc.).

The eight 'Peer Groups' have started examining the 140 experiment and payload proposals received in reply to the Call for Experiments for the first Eureca mission, which was sent out in mid-January. A first experiment and payload selection proposal will be submitted to the Eureca Payload Working Group in late September for discussion, and to the Spacelab Programme Board in December 1983, with selection expected in early 1984.

ESA/NASA discussions regarding the Eureca rendezvous and in-orbit retrieval strategy, and the estimation of the associated costs, will resume in September as soon as NASA has defined, in consultation with ESA, the rendezvous concept and procedure.

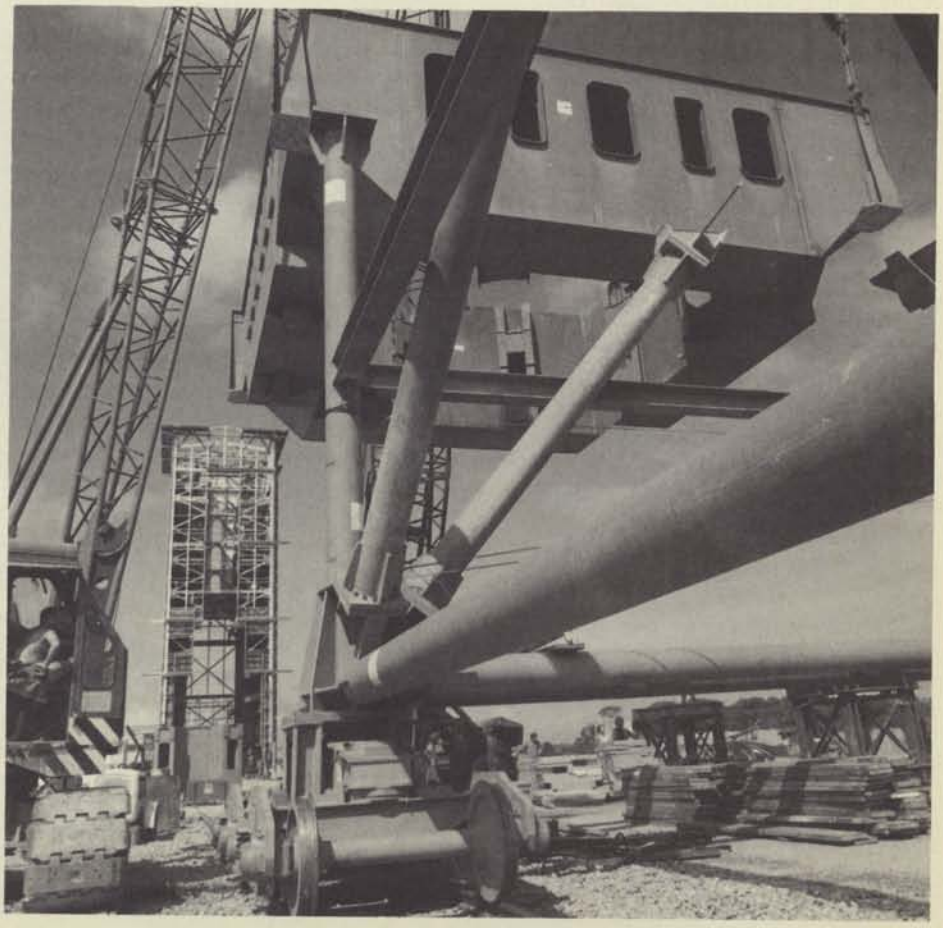
After discussions with the European and NASA specialists, it has been agreed to undertake a Eureca adaptation study in order to fly experiments and instruments on subsequent missions dedicated to Earth observation and astrophysics.

Ariane

ELA-2

The construction programme for the Second Ariane Launch Site (ELA-2) is proceeding on schedule, with a view to having the new launch complex available in October 1984.

Work on the site at Kourou is proceeding as planned. The work force, which has numbered 450, is being reduced, now that the principal civil-engineering tasks have been completed.



Intégration de la table de lancement mobile sur le site ELA-2

Integration of the mobile launch table at ELA-2 *démarrage de la phase B. La prochaine réunion d'avancement du projet, prévue en septembre, devrait faire apparaître l'effet des corrections apportées.*

Le planning général de la phase B, d'une durée allant du commencement de juillet 1983 à la fin de mars 1894, est conforme avec les prescriptions de l'Agence. Un examen préliminaire des impératifs (PRR) au niveau du système est prévu pour la fin novembre 1983.

Afin de planifier une distribution géographique satisfaisante pour la phase C/D, une estimation précise des coûts a été présentée au contractant.

En ce qui concerne les études de définition des six installations du noyau de charge utile à embarquer sur le premier vol d'Eureca, l'ensemble de fours (MFA), le four automatique à gradient (AGHF) et l'installation de botanique (BF) sont actuellement étudiés pour chacun d'eux par deux contractants en concurrence. Les trois autres installations à utilisateurs multiples, le four automatique à miroir monoellipsoïdal (AMMFF), l'installation de cristallogénie en solution (SGF) et l'installation de cristallisation des protéines (PCF) sont en cours de définition dans le cadre des études de la phase A attribuées séparément au contractant ayant effectué le développement des équipements précédents de ces installations, construits pour les missions FSLP, LDEF, D-1, Texus, etc.

Par ailleurs, les huit 'groupes des pairs' ont démarré l'examen des 140 propositions d'expériences et de charges utiles reçues en réponse à l'appel aux expériences pour la première mission Eureca lancé mi-janvier 1983. Une première proposition de sélection d'expériences et de charges utiles sera soumise pour discussion à l'Eureca Payload Working Group fin septembre, puis sera soumis au Conseil directeur du Programme Spacelab en décembre 1983, puis en début 1984 pour sélection.

En ce qui concerne la stratégie de rendez-vous et de récupération en orbite d'Eureca ainsi que l'établissement des coûts y afférant, les discussions ESA/NASA reprendront en septembre dès que NASA aura défini, en accord avec l'Agence, le concept du rendez-vous et la procédure.

Enfin, après discussion avec les spécialistes européens et de NASA, il a été convenu de lancer une étude d'adaptation d'Eureca, afin d'embarquer des expériences et des instruments lors de missions ultérieures dédiées à l'observation de la Terre et au domaine de l'astrophysique.

Ariane

ELA-2

Le programme de réalisation du deuxième Ensemble de Lancement Ariane (ELA-2) à Kourou progresse conformément au calendrier, l'objectif visé étant la disponibilité du nouveau complexe de lancement en octobre 1984. Après avoir connu un volume de main-d'oeuvre de 450 personnes, l'effectif a commencé à décroître, les principaux travaux de génie civil étant terminés.

En Zone de préparation des lanceurs, les travaux d'infrastructure du Centre de lancement, de la Centrale de climatisation sont achevés; le dock d'intégration et le hall d'érection, terminés en gros oeuvre, ont commencé à être bardés et équipés. En Zone de lancement, la tour ombilicale est en équipement de climatisation et de tuyauteries. L'ossature du portique de servitude ($\simeq$3000 t) a été montée jusqu'au niveau du 3ème étage. En Zone de transfert la double voie ferrée a été posée et réglée. La première table de lancement mobile en configuration Ariane-3 a été montée: un premier essai préliminaire de déplacement sur les rails a été effectué dans de bonnes conditions.

Launch-preparation (foreground) and launch zones at the Agency's second Ariane launch site ELA-2 in Kourou, French Guiana

ELA-2 en construction: la Zone de Préparation au lancement (au premier plan) et la Zone de Lancement (arrière plan)

In the launcher-preparation zone, infrastructure work on the Launch Centre and the air-conditioning plant is complete. Foundation work on the integration dock and the erection hall has been completed, and work has started on shielding and fitting out.

In the launch zone, the umbilical tower is being fitted with an air-conditioning system and pipework.

The main structure of the servicing gantry ($\simeq$3000 t) has been erected up to the third stage.

In the transfer zone, the double railway track has been laid and adjusted. The first mobile launch table in Ariane-3 configuration has been assembled and an initial preliminary test involving moving it along the track went smoothly.

Construction of operational hardware is continuing in Europe.

Factory acceptance of the cryogenic arms and testing of the electrical command and control systems have begun. There have been some performance problems with the fluids command and control system, which has been undergoing factory acceptance since July, and these will need to be solved before shipment to Guiana.

The release system is a critical item in the programme: installation of this system, which is currently being set up, is still planned for the summer of 1984.

STS-LTPP

Long-Term Space Transportation Systems Preparatory Programme
In accordance with the studies programme agreed on by the Long-Term Space Transportation Systems Preparatory Programme Committee (LTT-PC), the Executive has started most of the studies planned for 1983.

Regarding the future European launcher studied with Aerospatiale, the final presentation of the first study phase on partially or wholly reusable launchers was made on 8 July to firms and delegations. A second study phase has been started with Aerospatiale, which has appointed ERNO/MBB, Marconi Avionics, Dornier Systems, Aeritalia, Fokker and CASA as co-contractors. This second study phase will pay particular attention to cost estimates. The results will be presented in September 1984.

A study on large solid-propellant boosters for future launchers has been entrusted to the company Difesa e Spazio, while a study on the state of the art in Europe of aero-thermodynamics has been placed with the Von Karman Institute.

Following the satisfactory execution of the first study phase on in-orbit infrastructure carried out in parallel by Matra and Aerospatiale, it was agreed to entrust the second phase of this study to the same groups, one led by ERNO/MBB (with Matra, Aeritalia, BAe and Dornier System), the other by Aerospatiale (with Selenia and Fokker). The purpose of the second phase is to study a demonstration mission for in-orbit rendezvous and docking operations using Eureca as the principal spacecraft. Two systems studies on all of the elements of an in-orbit infrastructure are currently being negotiated with two European industrial groupings.

Regarding the studies on manned systems, the final presentations of the European studies started in 1982 took place at NASA on 21 and 22 June 1983 and gave rise to technical comparisons by ESA's Executive and NASA's Space-Station Task Force. An overall study on the space station is being negotiated with a European industrial grouping. The study conducted by DFVLR on the uses of a manned space station was also presented and discussed with NASA, and a new phase aimed at finding new applications, and deepening contacts with potential users is being negotiated with DFVLR, supported by various European firms (ERNO/MBB, Aeritalia, Matra, Dornier System and BAe).

La réalisation des équipements opérationnels se poursuit en Europe.

La recette usine des bras cryogéniques ainsi que les essais des systèmes de contrôle et de commande électriques ont commencé. Le système de contrôle commande fluides, en recette usine depuis juillet, a rencontré quelques problèmes de performance qui sont à régler avant son transport en Guyane.

Le système de largage constitue le chemin critique du programme: l'installation de ce système, dont la réalisation est en cours, reste prévue pour l'été 1984.

STS-LTPP

Programme Préparatoire des Systèmes de Transport Spatial à Long Terme

Conformément au programme d'études accepté par le Comité du Programme Préparatoire à Long Terme, l'Exécutif a engagé la plupart des études prévues pour 1983.

En ce qui concerne le futur lanceur européen étudié avec Aérospatiale, la présentation finale de la 1ère phase d'étude relative aux lanceurs partiellement ou totalement réutilisables a eu lieu le 8 juillet 1983 devant les industriels et les Délégations. Une deuxième tranche d'étude a été engagée avec Aérospatiale qui s'est adjointe comme co-contractants ERNO/MBB, Marconi Avionics, Dornier System, Aeritalia, Fokker et CASA. Cette 2ème phase d'étude comprendra, en particulier, des évaluations de coût. Les résultats seront présentés en septembre 1984.

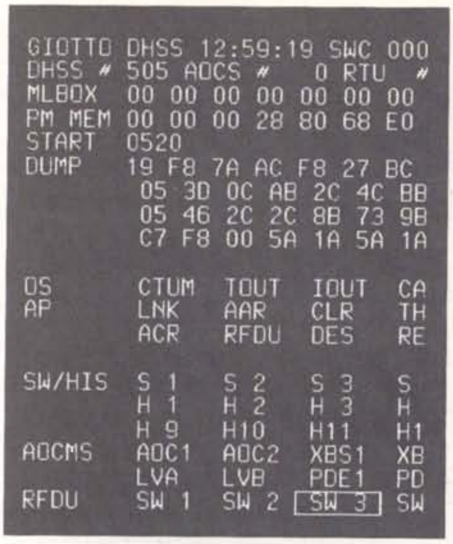
Une étude sur de gros propulseurs d'appoint à poudre pour des lanceurs futurs a été confiée à la Société Difesa e Spazio. Enfin une étude sur l'état de l'art en Europe dans le domaine de l'aérothermodynamique a été confiée à l'Institut Von Karman.

Après l'exécution satisfaisante d'une 1ère phase d'étude sur l'infrastructure orbitale par deux groupes en parallèle (Matra et Aérospatiale), il a été décidé de confier la deuxième phase de cette étude aux mêmes groupes, l'un dirigé par ERNO/MBB avec Matra, Aeritalia, BAe et Dornier System et l'autre par Aérospatiale avec Selenia et Fokker. Cette deuxième phase a pour objectif l'étude d'une mission de démonstration pour des opérations de rendez-vous et d'accostage en orbite, utilisant comme véhicule principal Eureca. Deux études au niveau système de l'ensemble des éléments d'une infrastructure orbitale sont en cours de négociation avec deux groupes industriels européens.

En ce qui concerne les études de systèmes habités, les présentations finales des études européennes engagées en 1982 ont eu lieu à la NASA les 21 et 22 juin 1983 et ont donné lieu à des confrontations techniques entre l'Exécutif de l'ESA et la Space Station Task Force de la NASA. Une étude au niveau global système sur la station spatiale est en cours de négociation avec un groupe industriel européen. Enfin, l'étude sur les utilisations d'une station spatiale habitée conduite par la DFVLR a également fait l'objet d'une présentation et de discussions avec la NASA, et une nouvelle phase ayant pour objectifs de trouver de nouvelles utilisations et d'approfondir les contacts avec les utilisateurs potentiels est en cours de négociation avec la DFVLR, soutenue par différents industriels européens (ERNO/MBB, Aeritalia, Matra, Dornier System et BAe).

Les activités de la NASA se déroulant à un rythme accéléré grâce à la mise en place de l'équipe complète Space Station Task Force, l'ESA a décidé de baser un Agent à son Bureau à Washington pour assurer la liaison technique avec les équipes de la NASA.

Une réunion d'avancement pour l'examen du programme est prévue avec le Comité du Programme Préparatoire des Systèmes de Transport Spatial à Long Terme (LTT-PC) le 7 octobre 1983.



Independent Verification of Giotto On-Board Software

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The 'on-board' software for the Data-Handling Subsystem (DHSS) and the Attitude and Orbit Command and Measurement Subsystem (AOCMS) of the Agency's Giotto spacecraft has been verified independently by ESA Mathematical Support Division using a specially developed software-verification tool incorporating an off-the-shelf emulator package. This tool was operational after three months and complete within six months. The experience gained has proved the validity of such an independent software-verification activity, as well as providing confirmation of the limited manpower required for the tool's development.

Problem definition and constraints
The problem was to build a tool capable of verifying the Giotto spacecraft's on-board software residing in the AOCMS and DHSS subsystems. The major constraints were that:

- the tools should work both independently, and with the DHSS and AOCMS in a coupled mode
- the tools should be operator-friendly, implying considerable software effort dedicated to data presentation and tool manipulation
- a very tight schedule, permitting only six months from conception to delivery in order to provide verification effort before the flight software was finally committed to PROMs (Programmable Read-Only Memories)
- very limited manpower available (one man per subsystem full time)
- spin-off delivery to ESOC in Darmstadt for inclusion in a software simulator used for testing ground-operations software
- interfacing and taking delivery of flight software from two different sources
- adherence to formal in-house software-engineering standards and procedures.

The DHSS and AOCMS subsystems

The AOCMS
This subsystem consists of four parts: the sensors, the thrusters, power distribution and thruster drive electronics, and the control electronics (Fig. 1).

The heart of the system is the control electronics which, similar to the DHSS, contains an 1802 microprocessor, PROM-based software, and comprehensive interface electronics for communication with the other components and the 'outside world'. The software is cyclic and event driven (spin-synchronous). The particular event(s) are serviced, followed by standard housekeeping routines, and finally, depending on status and configuration, one of several manoeuvre modules may be executed to complete the software cycle.

The DHSS
The nucleus of this subsystem is the Central Terminal Unit (CTU), which contains an RCA 1802 microprocessor running software in PROM (Fig. 2).

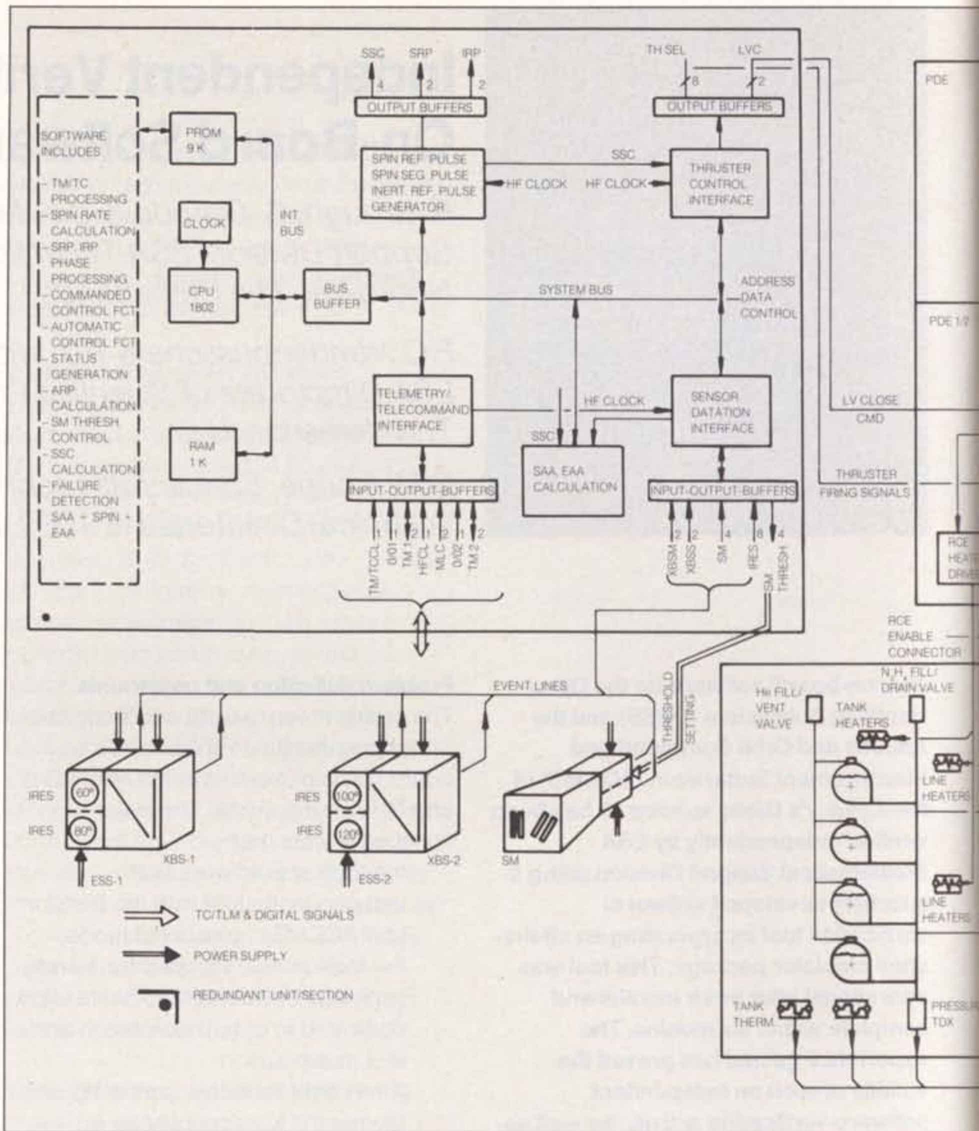
The software can be divided into the basic software and the application programs. The basic software is, in effect, a synchronous operating system triggered by an external clock and synchronised to the telemetry hardware. It provides special input/output (I/O) services, scheduling services and health-check monitoring to detect a malfunction and bring in the redundant unit.

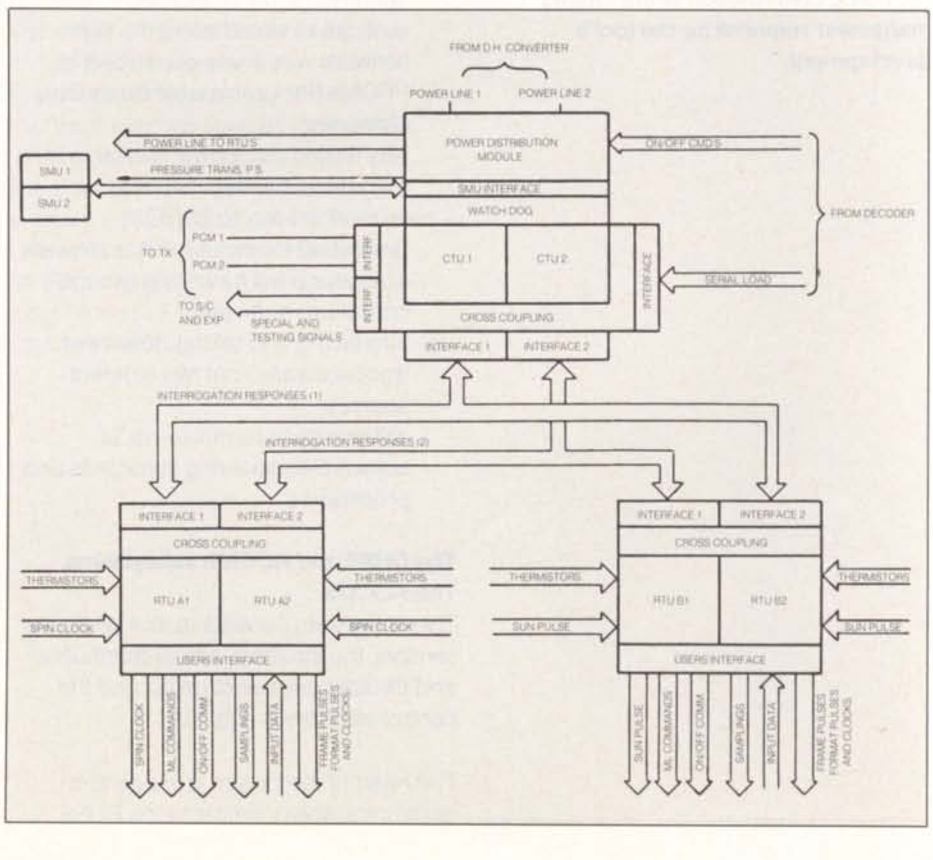
The application programs, of which there are fourteen, are independent modules for real-time process control, each module being dedicated to a particular function, such as thermal control, link recovery, despin recovery, etc.

Selection of a verification tool
Two solutions were initially thought to be feasible and, both are discussed below. For reasons that will become apparent, the 'soft' option was finally chosen.

Figure 1 – Block diagram of the Giotto spacecraft's Attitude and Orbit Command and Measurement Subsystem (AOCMS)

Figure 2 – Block diagram of Giotto's Data-Handling Subsystem (DHSS). (Each unit is duplicated for safety and reliability)





Solution-1: A software-based verification tool using a minicomputer running emulation software

Emulation software for the 1802 microprocessor running on the SEL 32 minicomputer at ESTEC was readily available 'off the shelf'. This emulator package also contained very comprehensive debugging facilities and a full range of input/output simulation. It was written in ANSI FORTRAN IV and delivered in source code. Modification/extension was therefore relatively straightforward.

The emulator package allows for the execution (and debugging) of *unmodified* software.

The only additional software development needed for each subsystem verification tool was:

(i) modelling of special interface hardware
(ii) modelling of the environment (spacecraft dynamics)
(iii) adding control and synchronising software
(iv) adding cosmetic software for additional operator friendliness.

Solution-2: A single-board computer running (slightly modified) flight software linked to a minicomputer modelling the environment

This solution involves extra hardware, and with it the associated link and synchronising software. In addition, the flight software running on the 1802 single-board computer would have to be instrumented to trap and route the input/output to the minicomputer which would, in turn, model the environment and return the appropriate response.

To achieve the above concept, the 1802 must have a monitor program providing loading, dumping, message exchange and synchronisation with the minicomputer. Although not involving a substantial effort, some of these facilities

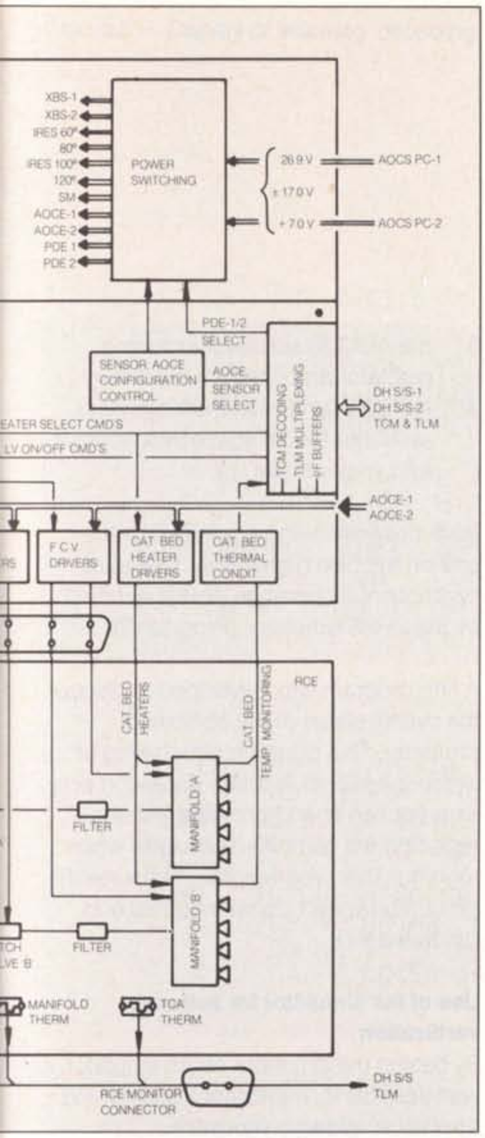
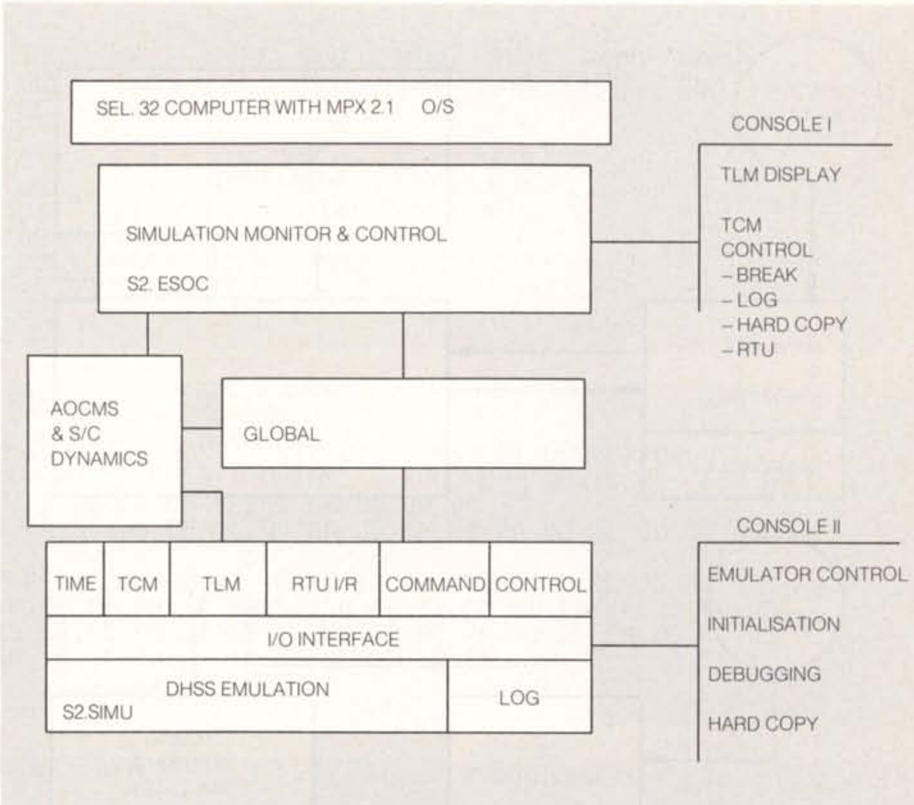


Figure 3 — Block diagram of the DHSS simulator



would have to be developed and integrated into existing monitors.

This solution is inferior to the first in all respects other than 'real time'. As the latter is not strictly necessary for software verification (in any case the emulator also models this aspect) and also because the two subsystems were synchronous/event driven, rather than of the more difficult asynchronous interrupt type, Solution-1 was chosen.

The DHSS simulator design
The structure, main modules, data flow and interface mechanisms are illustrated in Figure 3. The additional software development included:

(i) modelling of special interface hardware, primarily:
  - (user friendly) telecommand link
  - (user friendly) telemetry decoding & presentation
  - simulation of real-time clock hardware
  - simulation of two RTU's for spacecraft input/output
  - AOCMS/DHSS interface via RTU.

(ii) modelling of the spacecraft environment:

  - static constant value RTU tables individually setable by flight software or operator and initialisable from a disk file
  - DHSS/AOCMS environment.

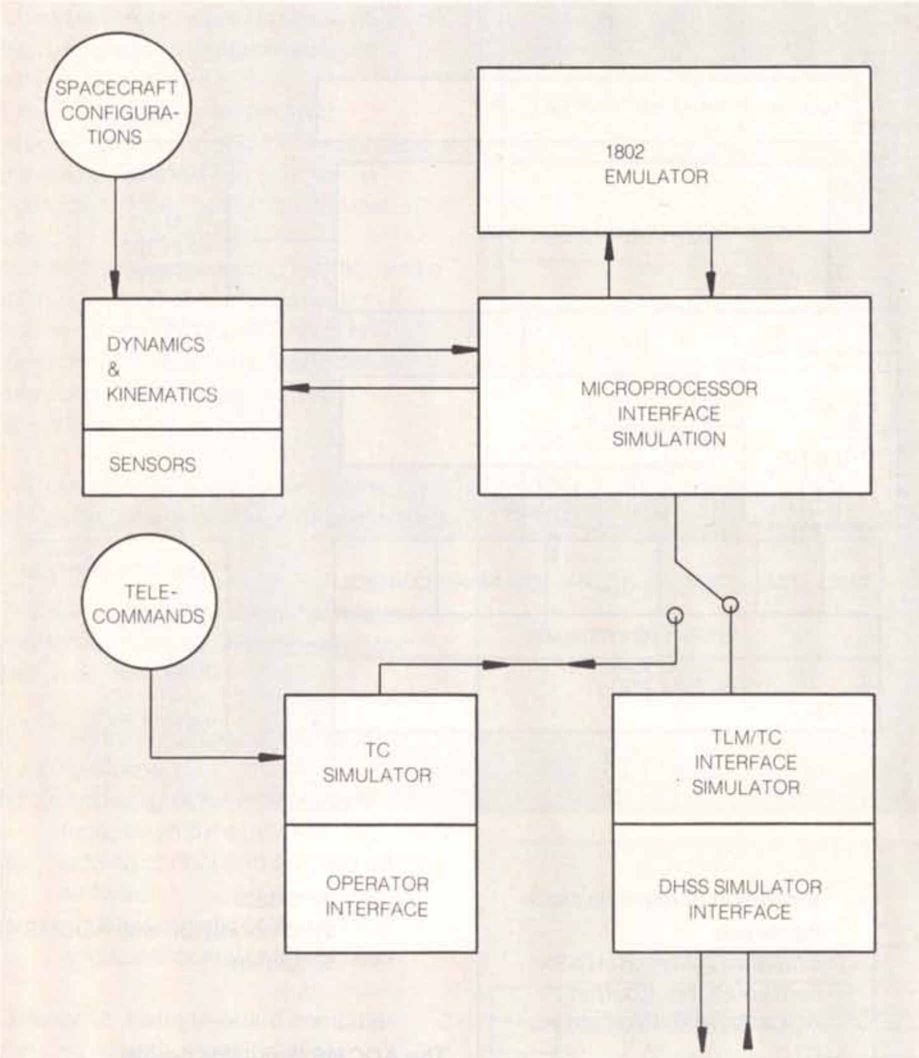
(iii) control and synchronisation mechanisms:

  - acquisition of the telemetry buffer
  - providing asynchronous telecommand services
  - break immediate or at a given time
  - terminate
  - synchronisation with AOCMS simulation.

The AOCMS simulator design
An overview of this software is presented in Figure 4. Included is the switch mechanism showing how the software works either independently or coupled to the DHSS. Additional software development included:

(i) modelling of special interface hardware (complex), consisting primarily of:
  - telemetry/telecommand interface (major DHSS interface)
  - sensor datation interface from Sun and Earth sensors
  - output for thruster control
  - special output pulses
  - telecommand encoding for stand-alone simulation.

Figure 4 — AOCMS simulator software overview



(ii) modelling of the environment (also complex), consisting primarily of:
- dynamic motion of the spacecraft attitude including rotor/platform rate, phase and friction
- thruster torques taking into account control selection logic, timing, misalignment, impingement and fuel-tank pressure
- the Sun and Earth positions and the two sets of Earth sensors and Sun sensors.

(iii) synchronisation and control mechanisms, consisting of:
- control by command interpreter when working 'stand alone', and commanded and controlled by the DHSS for the combined simulator.

Combined DHSS/AOCMS simulator
The combined simulator is comprised of four programs, grouped as follows:

1. simulation monitor and control program, also providing telecommand services and telemetry decoding
2. the DHSS simulator, including emulator, interface modelling and environment modelling
3. the AOCMS simulator including emulator and interface modelling
4. AOCMS dynamics and kinematics simulator for the spacecraft, sensors and environment

each program being controlled by the one on the next higher level. Due to its synchronous operation, time is handled by the DHSS simulator (Program 2).

A fifth program was developed to display the overall status of the combined simulator. This program, scheduling of which is optional, is totally passive. It acts as an observer and provides a status report on the combined simulator when running. This program also measures the simulation speed, comparing real and simulated time.

Use of the simulator for software verification
By basing the simulator on an emulator, it was possible to implement a segmented approach, allowing simulator development and verification activities to run in parallel. This approach was only feasible because the emulator (already validated by use in the field) had very powerful and comprehensive debugging facilities built into it.

The effort involved in software verification should not be underestimated. The verification is only as good and complete as the test procedures which, in turn, call for a detailed knowledge of the flight software and spacecraft operations before complete and effective procedures can be synthesised.

Figures 5, 6 and 7 illustrate the type of output available to the user.

Conclusion
This particular excercise has shown that a successful software-verification tool can be built quickly with very limited manpower. The amount of effort needed for using the tool should not be underestimated, nor should it be forgotten that a software-verification exercise

Figure 5 — Display of telemetry decoding

Figure 6 — Raw-telemetry display

Figure 7 — Display generated by program 5 showing the status of the combined simulation

```
OS       CTUM  TOUT  IOUT  CA    QSET  WDQ   RTUQ  BURQ  ROMQ   RAMQ
AP       LNK   AAR   CLR   THC   LOC   PPU   INA   CYC  [MON]   CLM
         ACR   RFDU  DES   RED

SW/HIS   S 1   S 2   S 3   S 4   S 5   S 6   S 7   S 8
         H 1   H 2   H 3   H 4   H 5   H 6   H 7   H 8
         H 9   H10   H11   H12   H13   H14   H15   H16
AOCMS    AOC1  AOC2  XBS1  XBS2  SM1   SM2
         LVA   LVB   PDE1  PDE2  RCEM  RCER
RFDU     SW 1  SW 2 [SW 3] SW 4 [TX 1] TX 2
```

5

```
GIOTTO DHSS 12:59:19 SWC 000011 (    17) RTC 24 ( 36) OBT 00000220
DHSS # 505 AOCS #    0 RTU   #    1 DHSS : BREAK    WDOG [ON] OBYTE OK  LOG [ON]
MLBOX  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
PM MEM 00 00 00 28 80 68 E0 00 00 00 00 00 00 00 18 00 00 00 20 00 00 00
START  0520
DUMP   19 F8 7A AC F8 27 BC 4C BB 4C AB 1C 1C 1C EC 8B F5 2C 9B 75 2C C3
          05 3D 0C AB 2C 4C BB 9B 5A 1A 8B 5A 1A F8 52 AD 4B 5A 1A 2D 8D CA
          05 46 2C 2C 8B 73 9B 5C C0 02 3B FF FF F8 0F AA F8 25 BA 0B CA 05
          C7 F8 00 5A 1A 5A 1A 5A 1A 5A 1B F8 09 AD F8 25
```

6

```
Time    570.75  5000.00  | Dynamics configuration number : 504
Saa      63.23    15669  |
Eaa      46.27      400  | XBS2   SM2       s/w cycles :      20
Spin    -15.00           |
Nuta       .16           | [XBS] [ARP] XBSF MNAF [ENTQ] MLCV
----------------------------------------------------------------------
--- --- --- --- --- --- --- --- | Pulses=  65498 Phase=    5.4 Width=   59.8
--- --- --- --- --- --- --- --- | Thrusters are enabled.
----------------------------------------------------------------------
SPPE [SAFD] [SACD] SRFD SRCD EAFD [EACD] SRCD SACD CSAP EACD LVCL [PWOK] SDE  SWCE MNA
----------------------------------------------------------------------
PDE1  [PDE2] | Tlc: 800280H     | Tlm: FFFFH/6208H
AOC1  [AOC2] | Int: 000BC0H     |
XBS1  [XBS2] | Res: 000000H     | Swc:       26/001AH   Rtc: 246/F6H
SM1   [SM2]  | Cmd: 800280H     |
[LVA]  LVB   | Command : END    | Status : WAITING                 [DHSS]
```

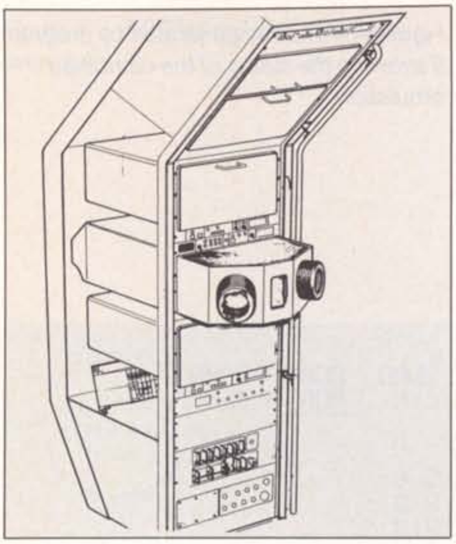
7

should not replace testing of the software using the real hardware.

In the case of this work for Giotto, the verification tool was usable after three months and complete after six, and six manmonths per subsystem were needed for its development. Three manmonths have so far been spent on verification (not yet complete).

The tool has proved extremely useful for Giotto, whose fixed launch date and deep-space mission impose new and very rigid constraints. There has been an additional spin-off benefit in that software developed for the verification tool has been delivered to ESOC for integration into a spacecraft simulator for testing operational procedures and ground operations software.

Acknowledgement
The flight software modules and listings were provided by Laben for the DHSS and by Dornier for the AOCMS.



The Scientific Utilisation of Biorack

D. Mesland, Special Projects Division, ESA Technical Directorate, ESTEC, Noordwijk, The Netherlands

Because life evolved on Earth under the continuous influence of gravity, gravity-dependent mechanisms responsible for living systems' architecture and functions can be expected to be affected by Spacelab's microgravity environment. The Biorack, to be flown as a payload element in Spacelab (D-1 mission), offers the opportunity to conduct fundamental biological research on cells and small multicellular organisms. Fourteen experiments have been selected for the first Biorack flight. The scientific questions to be addressed by these experiments and the variety of biological organisms involved will make use of the full potential of the Biorack system. The latter, being the first multiuser, cell-biology facility for Spacelab, will contribute significantly to the furtherance of biological research in space.

Gravity has a major influence on the form and interactions of all Earth-bound matter, including living systems. As the architecture of biological organisms reflects the result of continuous evolution, gravity's effects can be expected to be apparent at all levels, functional and structural, occurring during particular stages in the evolution of life.

It is generally conjectured that life started on Earth with the interaction of a reducing atmosphere, simple organic molecules and solar energy, which, by chance, produced self-replicating molecule chains (RNA and DNA*) and proteins. The transition from these early replicators to the establishment of a primitive prokaryotic (bacterial) cell constitutes a giant and mysterious step. The process may have been driven by selective reinforcement of those changes in the replicating entities that led to faster and more reliable replication, and to protection of the replicants. These properties were somehow obtained through the development of chemical machinery and structure surrounding the DNA coding for this very development. The resulting cell consists of a highly complex, self-replicating, molecular factory, surrounded by a lipid-protein membrane that constitutes the interface between the cell and its environment. The properties of this membrane, which can behave as a liquid, may well be sensitive to gravity (Fig. 1a).

*RNA = ribonucleic acid
DNA = deoxyribonucleic acid

An important further step was the development of mobile cells. Mobility allowed cells to enlarge their potential food supply at the expense of other immobile cells, and it allowed cell–cell interaction.

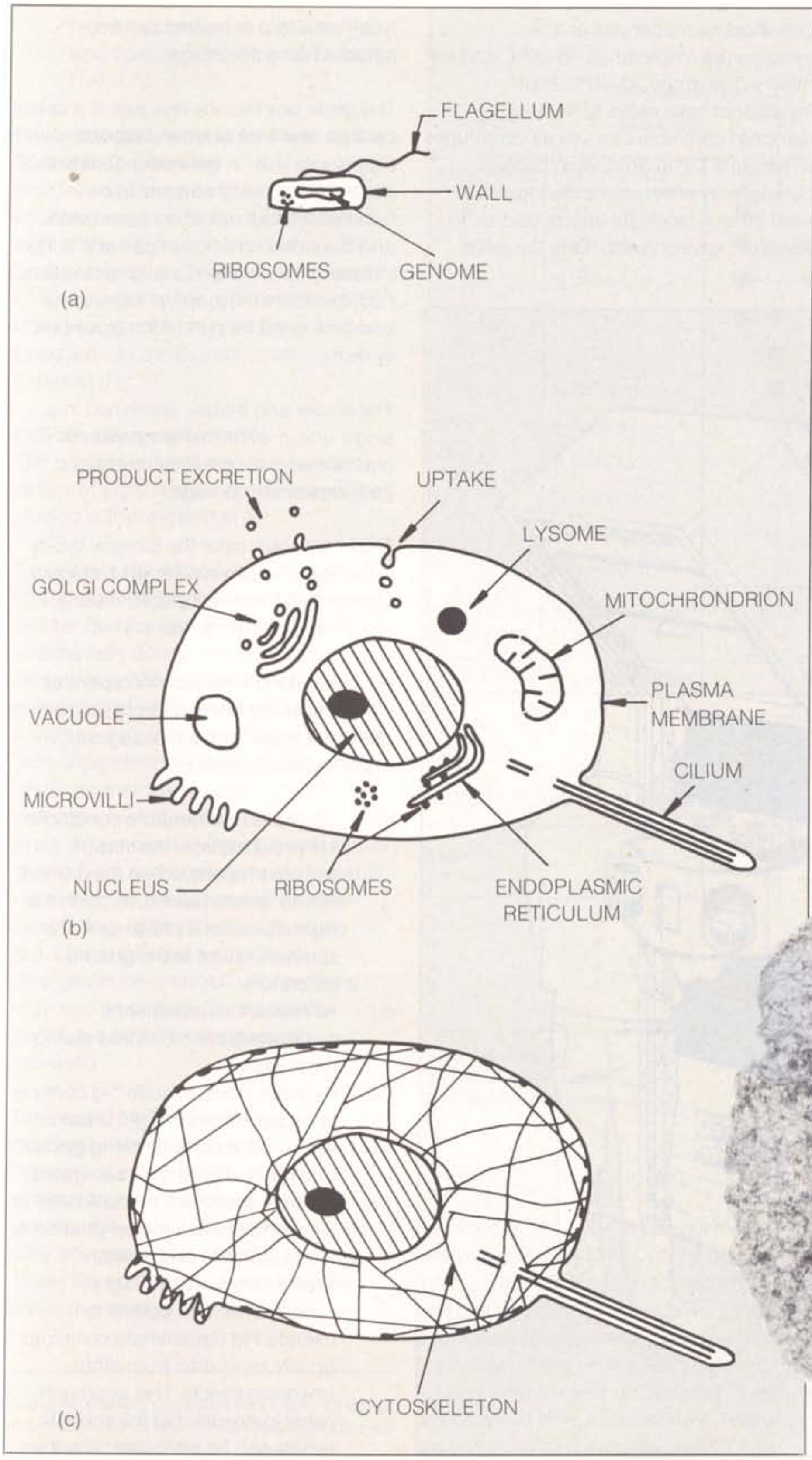
The evolution of several molecular mechanisms providing controlled mobility of whole cells or subcellular complexes may also have been instrumental in the development of the eukaryotic (nucleus-containing) cell, the building block of all multicellular organisms. Induced movements provided the means to engulf neighbouring particles or cells (endocytosis). Eukaryotic cellular organelles (chloroplasts, mitochondria) are believed to originate from bacterial cells endocytosed by the pro-eukaryotic cells and subsequently adapted to function as energy-handling entities within those cells.

In modern eukaryotic cells (Fig. 1b) mobility mechanisms throughout the cell, often referred to as the cytoskeleton (Figs. 1c and 2), control cell shape, membrane movements, distribution of cell organelles, cell division, cell fusion and many other functions. In addition, they influence the distribution and translocation of the cells themselves within a particular environment or within a multicellular organism. Many vital cell properties therefore rely on mechanisms that produce directed movements.

The presence of a net directional force implies coping with the force of gravity. This gravity information may either be processed in real time, as a feedback loop

Figure 1 — Highly schematic representations of a typical prokaryotic (bacterial) cell (a) and an eukaryotic cell (b). In (c) the same eukaryotic cell is represented with its cytoskeleton. Part of this system is shown in the electron micrograph of Figure 2

Figure 2 — Electron micrograph of the inner side of the membrane envelope of a suspended eukaryotic cell (see Fig. 1). Black dots are ribosomes. The network of threads shown represents the cell's cytoskeleton (motility mechanisms) associated with the membrane. Magnification: × 30 000



in the system, or it may be built into the system via previously stored (evolutionary) gravity information.

In summary, imposed microgravity may influence not only steady-state biological mechanisms, but also and especially those biological systems in the process of acquiring new, programmed forms or functions, i.e. differentiating cells and developing organisms. The study of such influences will shed more light on the mechanisms developed by living systems on Earth to: (i) counteract the effects of gravity, and (ii) organise cells and organisms subject to the ever-present gravity vector.

The Biorack system

With the development of the Biorack, to be flown as a Spacelab payload element, a multiuser facility will become available for microgravity research in the fields of cell and developmental biology. The Biorack's configuration and typical mission sequence were described in detail in ESA Bulletin No. 31 (p. 46), but a few essential features will be highlighted here.

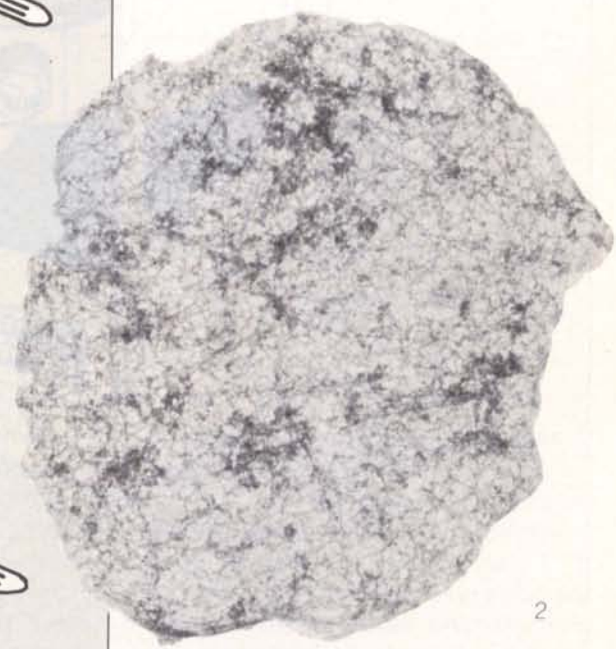

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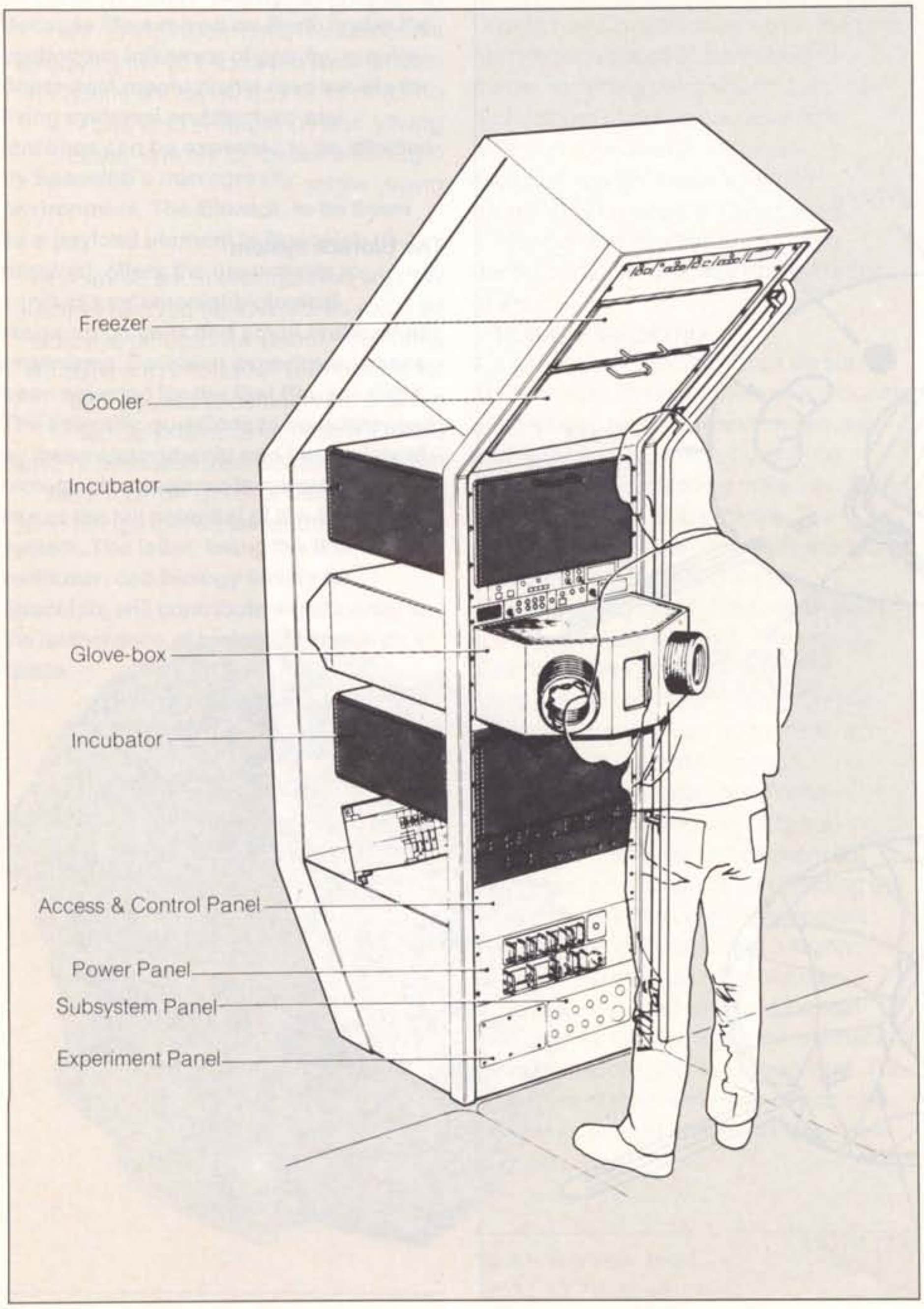
Figure 3 – The Biorack hardware configuration

The main hardware elements of the facility are two incubators, a glove box and a freezer/cooler unit (Fig. 3). The biological specimens and user-developed hardware can be housed in two types of standard container, with volumes of 50 ml (type-I) and 300 ml (type-II), respectively. Approximately eighty such containers can be flown with Biorack.

One incubator operates at a set temperature in the range 18–30°C and the other in the range 30–40°C. Both incubators have racks to hold the standard containers as well as centrifuges to simulate 1-g in orbit, which allows microgravity effects to be distinguished from other spaceflight effects (radiation, vibration, environment). Only the small type-I standard container can be mounted on a centrifuge.



The glove box has the features of a safety cabinet, and maintains a class-100 cleanliness level in the working area. It allows biological specimens to be handled without risk of contamination and the safe exchange of gas and fluids, including toxic materials such as fixatives. Facilities for microscopy, photography and filming will be part of the glove-box system.

The cooler and freezer, combined in a single unit, provide low-temperature environments for pre-experiment and post-experiment storage.

These features make the Biorack facility suitable for research on small biological objects, such as small plants, insects, single cells and bacteria.

A typical Biorack mission incorporates several features needed to obtain the best possible results from the biological experiments conducted:

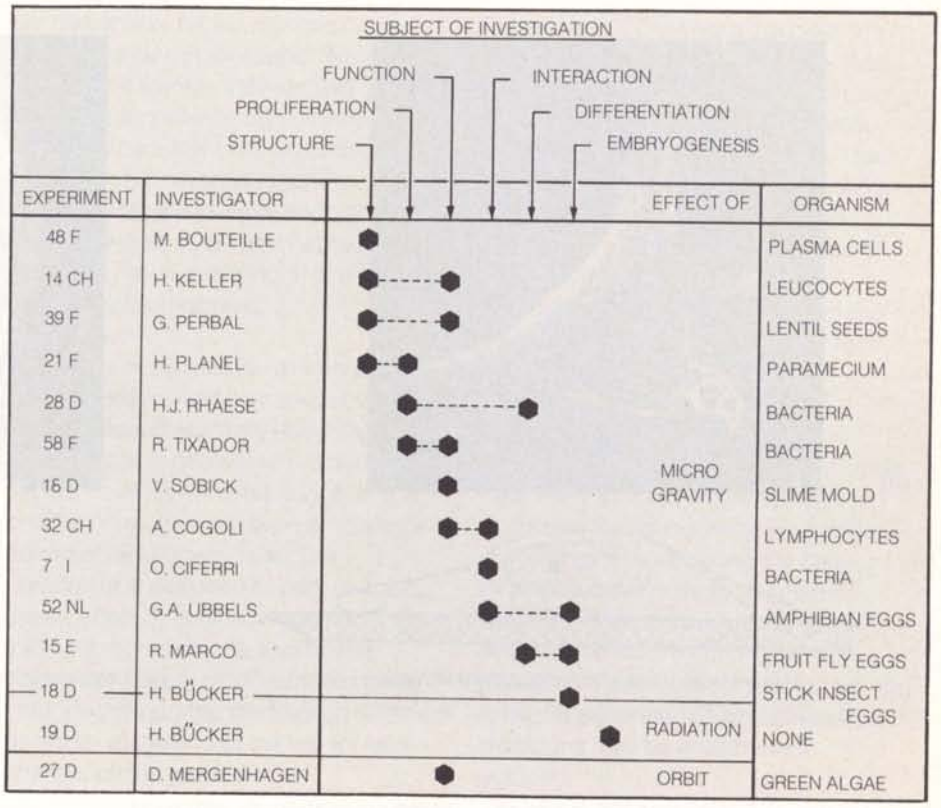
(i) Controlled temperature conditions are provided from the time of sample preparation on the ground shortly before launch, through the flight-operations phase, until the sample's return to the ground laboratory.

(ii) All relevant environmental parameters are monitored during the mission.

(iii) All experiments include 1-g controls to be performed in flight under similar conditions, allowing gravity and other effects to be separated.

(iv) All experiments will be duplicated in a second Biorack model situated at the launch site and in near-synchronism with the flight experiments. This control is intended to discriminate centrifuge gravity simulation from other unknown effects. This approach helps to ensure that the scientific results can be attributed, with the

Figure 4 — Biorack experiments for the Spacelab D-1 mission



highest possible accuracy, to the appropriate flight-dependent factor (Table 1).

Biorack experiments to be flown on the Spacelab D-1 mission

Fourteen experiments from five different countries have been selected by ESA for flight in the Biorack on the German D-1 Spacelab mission. The scientific research areas covered by the experiments and biological specimens have been chosen to exploit fully the Biorack system's potential (Fig. 4)*.

Cell-structure experiments

The ultrastructure of cells fixed under a variety of experimental conditions will be studied in four experiments.

Experiment 48F will monitor possible changes in the distribution of particular cellular components in mammalian plasma cells during exposure to microgravity. Plasma cells are highly differentiated white blood cells that continuously produce antibody proteins (immunoglobulins). Their ultrastructure under normal 1-g conditions has been well documented using advanced analysis techniques. Chemical cell fixation during flight and analysis back on Earth will allow minute changes in the cells' morphology to be detected. By using isotopically labelled amino-acids, changes in the production of proteins may also be detected and possibly correlated with the ultrastructure observed.

Experiment 14CH also employs mammalian white blood cells, in this case leucocytes, which have a rather symmetrical morphology in suspension but change rapidly into highly polarised cells after exposure to certain peptides. These still-suspended, activated cells make movements reminiscent of locomotion. As in the first experiment, cells will be chemically fixed in flight before and after activation. Since direct recording of the induced cell movements would require high-magnification microscopy, a feature not yet available on the Biorack, the appropriate dynamic information has to be obtained from the fixed cells. This will be achieved by distributing microbeads on the cell surface and observing them before and after activation to obtain indirect information on the occurrence of membrane movements. The problem of how a symmetrical, suspended cell achieves a specific polarity is of particular interest in this experiment, which therefore also covers the field of cell function (Figs. 5 and 6).

Table 1 — Experiment controls

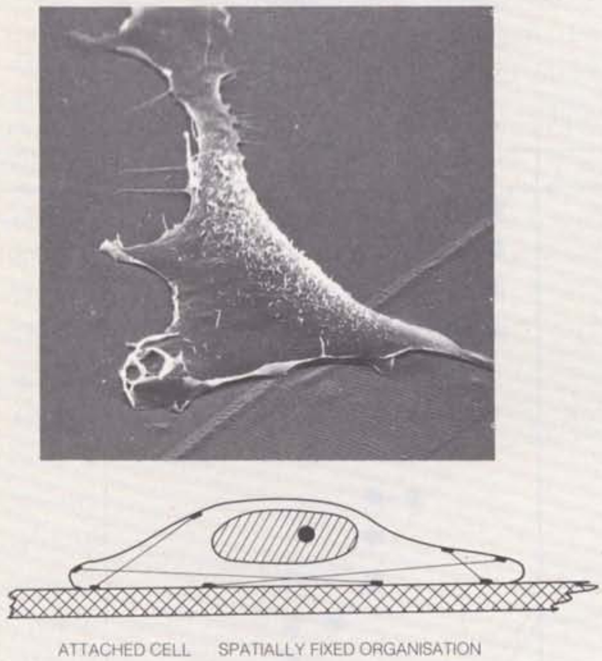
Earth 1 g	Spacelab 1 g	μg	Meaning
0	0	0	No effect
0	0	1	Gravity effect
0	1	0	Effect of centrifuge
0	1	1	Environment, not gravity
0	1	2	Environment *and* gravity

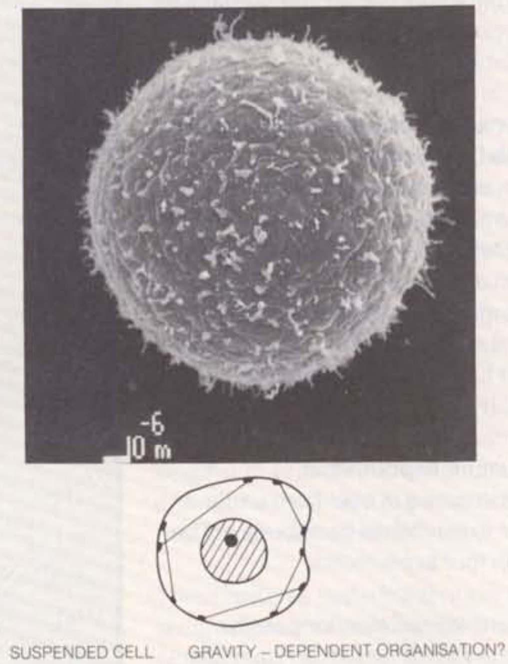
0 – Baseline result
1 – Different from baseline
2 – Different from baseline and 1

* Detailed scientific and experiment-hardware design information can be found in ESA Special Publication SP-206, May 1983.

Figure 5 – Example of a mammalian cell attached to a solid surface (a), magnified × 1350. In (b) it is shown that the attachment can be used by the cell to organise its internal configuration

Figure 6 – Example of a suspended mammalian cell (a), magnified × 3350. Since the cell does not have a physical external point of reference, it is possible that the gravity vector plays a role in its internal organisation (b)

(a)
(b)


(a)
(b)


The objective of Experiment 39F is one of cell function also, using ultrastructural techniques as the method of analysis. Root tips of lentil seedlings contain polarised cells responsible for this organism's gravi-perception, the so-called 'statocytes'.

These cells contain dense particulate structures (statoliths) that are free to move in the direction of gravity. In a polarised statocyte, statoliths contact an elaborate membrane complex at the bottom of the cell, called the 'endoplasmic reticulum'. It is not known at present whether statolith contact with this membrane complex is essential for the cell's gravi-perception, or whether the translocation of the statoliths through the cell provides the appropriate gravity-vector information. Growing root tips under microgravity conditions will cause a random distribution of statoliths in nonpolarised statocytes. By subsequent exposure to 1-g in the Biorack's control centrifuge, it will be investigated whether these roots still sense gravity and how the statocytes react to it. The root morphology will be photographed in flight prior to chemical fixation. As with most experiments, the analysis will be done on Earth after retrieval of the material.

Experiment 21F is concerned with both cell structure and cell proliferation of the unicellular protist Paramecium. It aims at unambiguous confirmation of results obtained earlier on the Russian Salyut-6 spacecraft. Two effects have been observed: (i) a strong increase in cell proliferation due to higher cell division rates, and (ii) an increase in cell volume due to a higher cell water content. As there was no control centrifuge available on board to simulate 1-g conditions, these effects could be attributable to microgravity or radiation, or both. However, in a subsequent balloon flight at a height of 40 km, a similar effect on proliferation was obtained, but not on cell size, suggesting that cell division is affected by radiation but that cell structure is sensitive to gravity conditions. Given the elaborate mobility mechanism that this cell uses to move around and engulf its food, this hypothesis seems very plausible. As in the previous experiments, cells will be induced to proliferate in flight, chemically fixed at different times during the mission, and analysed back on Earth by ultrastructural and physical methods.

Cell-proliferation experiments

Two other experiments in addition to Experiment 21F address the proliferation property; both involve bacteria.

In Experiment 28D, bacterial spores will be grown in flight and optical density measurements used to monitor the proliferation kinetics continuously. On Earth, proliferation always proceeds in a highly characteristic manner, reaching a maximal number of cells at a predictable time. The cells then run out of food and start to differentiate into spores again. This process implies the construction of a wall located asymmetrically in the cell, a feature that is not yet understood. One possibility is that it is mediated by a rearrangement of proteins within the membrane envelope and therefore depends on gravity. Hence, in addition to the automatic density measurements, samples will also be chemically fixed at appropriate times and analysed structurally and biochemically after retrieval.

Experiment 58F will study the effect of different antibiotics on the proliferation of E.coli bacteria. The Russian Salyut-7 spacecraft obtained evidence suggesting diminished sensitivity of these cells to antibiotics under microgravity. Moreover, preliminary results indicated a possible effect of the flight environment on the structure of the bacterial cell wall. As the latter is a barrier between the antibiotic and its target molecules inside the cell, it could be responsible for the change in sensitivity. This experiment will be repeated in the Biorack, concentrating on discriminating between microgravity effects and other factors, and on the structure of the cell wall.

Cell-function experiments
Cellular housekeeping activities and interactions with the environment can be grouped under 'cell function', three examples of which have already been given in the above experiments.

In the slime mold Physarum, a rhythmic streaming of protoplasm is maintained by periodic contraction and relaxation of 'veins' within the organism. The objective of Experiment 16D is to determine to what extent microgravity affects this system's behaviour. Studies with the fast-rotating clinostat have shown that the transition from 1-g to simulated microgravity induces only a temporary increase in the streaming frequency, but a persistent increase in streaming velocity. Reproduction of this phenomenon under real microgravity conditions would provide evidence for a gravi-sensory system in this peculiar organism. This experiment employs the low-magnification Biorack microscope, with which the rhythmic contractions of the organism will be monitored by both photodiode measurements and filming.

Experiment 32CH will study the function of human-blood lymphocytes. These cells are responsible for the recognition of foreign proteins in the blood. Being part of the immune system, they are very important for defence against infection. Previous spaceflights have produced evidence of diminished reactivity of these cells in astronauts' blood. Such an effect may be caused by a variety of factors in the blood produced in flight, or it may be caused by microgravity.

Ground-based experiments with isolated lymphocytes have shown these cells to have increased reactivity under high-g conditions and decreased reactivity on the fast-rotating clinostat, suggesting a positive correlation between lymphocyte activation and gravity level. The experiment is designed to confirm the gravity effect by probing, under microgravity conditions and on the control centrifuge, blood samples taken from the crew during the mission. Cells will be frozen at the end of the test for later analysis on the ground.

Experiment 27D is concerned with the study of circadian rhythms rather than microgravity research. Many biological processes can be shown to manifest themselves in a rhythmic fashion. They may, for example, occur only once in a given constant period, may vary in intensity, or may vary antagonistically.

In most organisms the duration of the period is around 24 h (hence the term circadian).

The unicellular green algae Chlamydomonas (Fig. 7), which propels itself freely through water, appears to move into the light during one half of the day and to avoid it during the other. Changes in the periods of light and darkness do not influence this behaviour, which is therefore by definition truly circadian. The trigger for this rhythm may either be generated by an intra-cellular clock, or it may be environment induced.

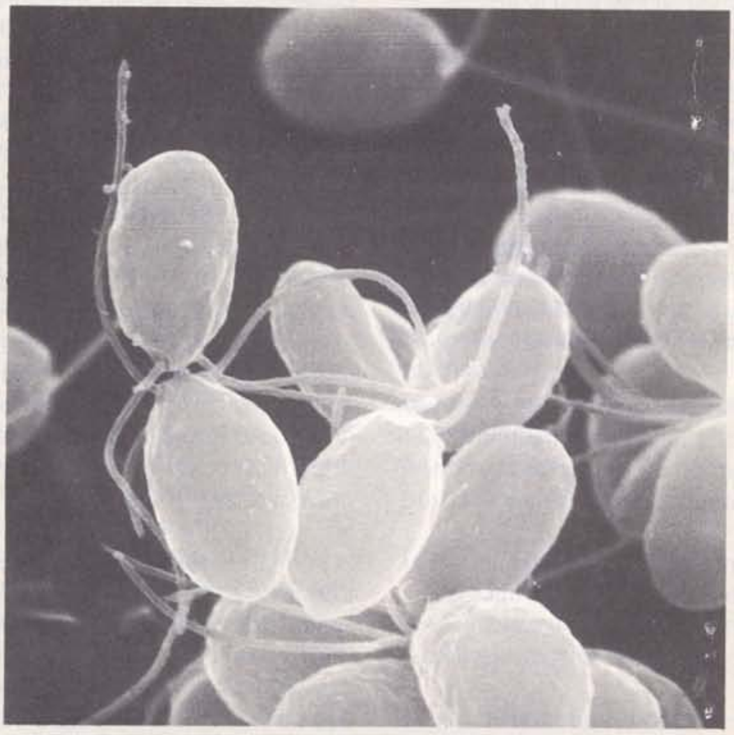


Figure 7 — The unicellular green algae Chlamydomonas

If the Universe provides this 24 h trigger, Spacelab-bound organisms will receive it once per orbit, and their rhythm will be disturbed. Automatic monitoring of the phototactic behaviour of Chlamydomonas during flight will contribute new data with which to attack this problem.

Cell-interaction experiments

Experiment 32CH has also to be mentioned under this heading since lymphocyte activation in all probability includes cell-cell interaction. Two other experiments are concerned with interaction.

Experiment 7I will investigate three different types of bacterial interaction. Some strains of E. coli bacteria have high frequencies of so-called 'conjugations'. These can be considered to be a primitive kind of sexuality in which two cells make contact via a specialised structure and exchange DNAs to produce new combinations. Another type of interaction is the infection of bacteria by viruses (bacteriophages) that bind to the bacterial wall and subsequently inject their DNA into the bacterium. This DNA does not combine, but copies itself at the expense of the host bacterium. The third interaction is an artificial one in which isolated DNA is transferred into the bacterium by chemical means. These interactions constitute fundamental biological phenomena that can be accurately quantified, and their progress under microgravity is of great interest.

Pre-mixed frozen samples will be allowed to interact by warming them up to 37°C. The interaction will be arrested by cooling and the samples analysed after the flight.

Experiment 52NL will be described under embryogenesis, since the cell interaction is just part of the biological system applied to meet the scientific objectives.

Cell-differentiation experiments

As already mentioned, Experiment 28D addresses the question of cell differentiation in bacteria. The same question is addressed in Experiment 15E on a completely different level. It studies the influence of microgravity on the differentiation of cells into eggs (oogenesis) in the fruit fly Drosophila. Eggs have a well-established, polarised internal configuration which is assumed to be essential for normal embryonic development after fertilisation (see Experiment 52NL also). The question is whether the gravity vector plays a role in the establishment of polarisation. Results from previous space flights suggest that the last 48 h of oogenesis may well be influenced by microgravity. This hypothesis will be tested by daily collection, and subsequent freezing, of eggs laid in the solid feeding medium by sample populations of flies, during and after the flight. The occurrence of aberrant embryonic morphologies will be determined by microscopic analysis and plotted against time to trace possible microgravity-induced transitions.

Embryogenesis experiments

Experiment 52NL will study factors in the earliest stages of embryonic development that determine the future dorsal and ventral sides of the body. In the amphibian Xenopus, eggs are polarised into a light animal part and a heavier vegetative part. Each egg is fixed inside a sticky outer membrane, keeping the position of the animal/vegetative axis random with respect to gravity. Upon fertilisation by a spermatozoid (a cell interaction of which the characteristics under weightlessness are not known), the egg is freed from the outer membrane and, due to the internal mass difference, aligns its animal/vegetative axis with the gravity vector.

In normal cases the point of entrance by the spermatozoid will become the future ventral side of the animal. However, if gravity disturbs the initial animal/vegetative distribution inside the egg due to imposed misalignment of its axis, which happens in 30% of cases, this correlation is disturbed. If the initial egg configuration is indeed essential, then fertilisation in space should produce a 100% correlation, since no gravity-induced redistribution could possibly occur. Fertilisation of isolated eggs and chemical fixation at distinct early stages of embryonic development will be effected automatically in this experiment.

The second experiment in this field (15E) has already been described under differentiation.

Experiment 18D differs from the other two in so far as it also includes the study of radiation effects. The biological organisms used are stick-insect eggs fertilised at five well-defined stages of development. Radiation experiments on Earth have shown these stages to differ in radiation sensitivity and in their ability to repair radiation-induced damage. Furthermore, there are indications of synergistic radiation and microgravity effects. In the experiment, sheets containing eggs positioned in a matrix are sandwiched between layers of different radiation-detection material. This stack concept has been applied successfully on previous US spaceflights. Four sets of samples will be obtained: (i) embryos exposed to microgravity and hit by heavy ions; (ii) embryos exposed to microgravity, but not hit by heavy ions; and (iii) and (iv) similar sets to be used as 1-g control samples on the centrifuge. Advanced techniques for analysing the radiation record and morphological studies of the individual embryos will provide further information about the effects of spaceflight on embryonic development.

Experiment 19D does not involve biological material, but is intended to establish a radiation record inside the two Biorack incubators. It consists of type-I containers, each filled with a complete set of radiation-detection sheets capable of detecting a wide range of radiation types.

As in Experiment 18D, advanced techniques will be used to analyse these packages, providing data that will be of

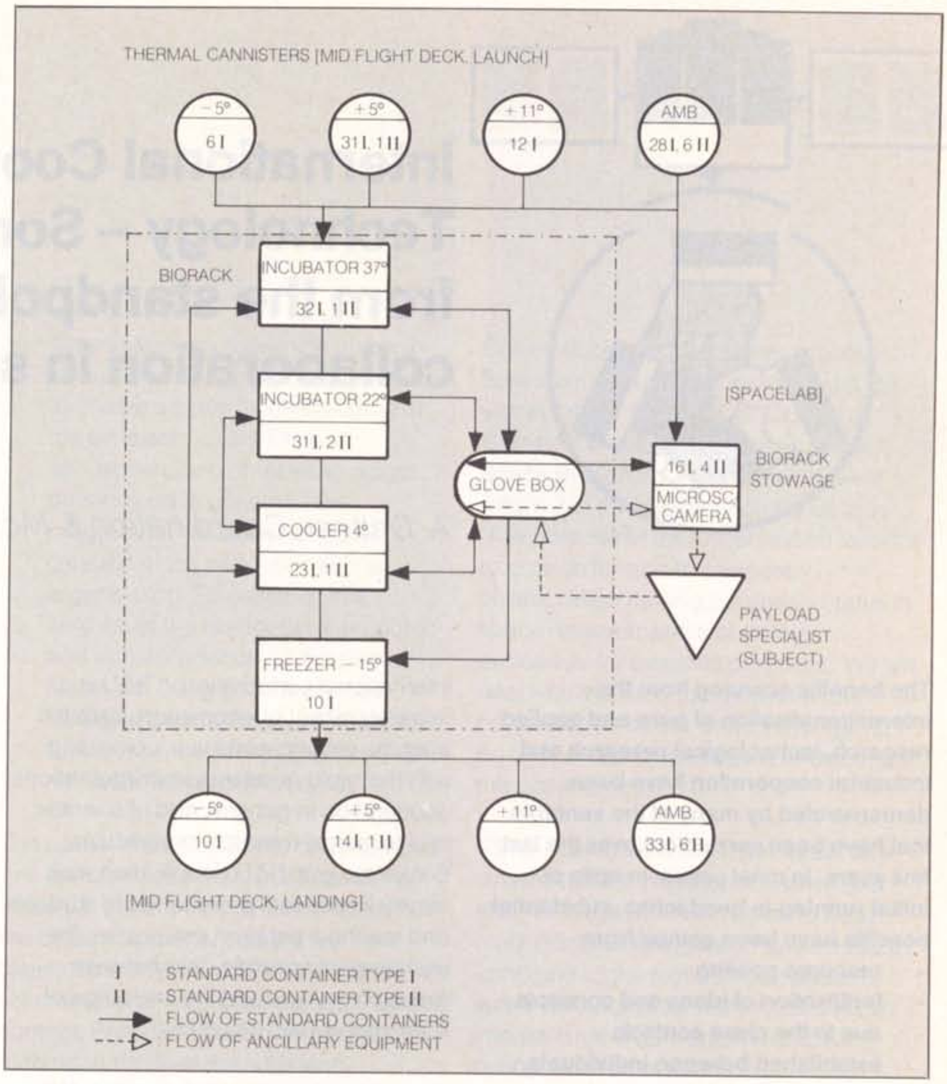


Figure 8 — Flow chart for Biorack's standard containers and ancillary equipment as foreseen for the Spacelab D-1 mission

great interest to most other Biorack experimenters.

Experiment operations

Ten of the experiments require operation by the payload specialist. These operations need to be performed in the glove box, implying transfer from the incubators to this facility. They vary from simple opening and closing of a container to rather complicated microscopic observations and blood-taking exercises. Figure 8 illustrates schematically the logistical flow of containers and other Biorack equipment planned for the D-1 mission.

The scheduling of these operations in compliance with the constraints imposed by the Biorack itself and payload-specialist availability on the one hand, and the experiments on the other, has necessitated the development of computer software as an essential part of the Biorack facility. The need for automation in three experiments has been caused by operational requirements that could not be reconciled with operator availability.

Because biological experimentation very often requires interactive manual operation and human observation, in many cases complete automation is either undesirable or achievable only at costs that generally far exceed the experimenter's budget. The present Biorack, with the availability of trained specialists, is therefore a first and very valuable tool for biological research in space.

Concluding remarks

The experiment package that has been described represents a cross-section through the biology meant to be explored with Biorack, yet it still provides a set of interrelated experiments in many respects, allowing advantageous cross-evaluation of the results that will be obtained.

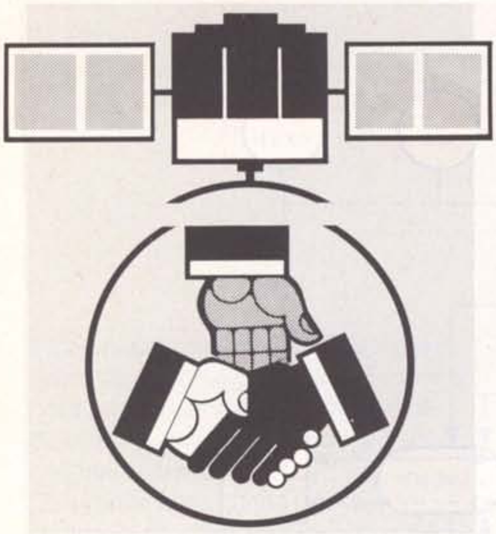
For future missions, the ability to perform high-magnification microscopy, combined with video-recording, would be a most desirable extension to the Biorack's current capabilities, since as argued above, cell movements and dynamic interactions constitute a field of great interest, which should be studied by real-time observations of the living organism.

In this context, it is worth mentioning that many more scientists have proposed valuable experiments which could not be accommodated for various reasons. In addition, due to variability in living organisms, sound biological evidence should be obtained by at least two independent experiments, implying a need to refly some experiments. Opportunities for reflights of the Biorack facility, included in Phase-II of ESA's Microgravity Programme, will therefore be warmly welcomed by these biologists, as well as permitting many new experiments to be conducted.

In its definition of the scientific requirements for such missions, ESA is advised by the Life Sciences Working Group (LSWG) and maintains continuous contacts with the scientific community, in part through the European Low Gravity Research Association (ELGRA). This infrastructure, together with the Biorack itself, provides the necessary technical, organisational and scientific framework for conducting successful biological research in the space environment.

Acknowledgement

The continuous and enthusiastic cooperation of all primary investigators involved is gratefully acknowledged, together with their patience in initiating the author into fields that were hitherto quite unfamiliar.



International Cooperation and High Technology – Some reflections from the standpoint of European collaboration in space*

A. Dattner, Coordination & Monitoring Office, ESA, Paris

The benefits accruing from the internationalisation of pure and applied research, technological research and industrial cooperation have been demonstrated by many of the ventures that have been carried out over the last few years. In most cases, in spite of initial running-in headaches, substantial benefits have been gained from:

- **resource pooling**
- **fertilisation of ideas and concepts due to the close contacts established between individuals, groups, industrial companies, etc.**
- **increased competence through the exchange of ideas and experience, and an increased scale of operations.**

It is likely that today's ventures in international cooperation are setting a pattern for the future, which will see still more important and still larger joint ventures in a variety of fields dominating scientific and technological developments in the coming years.

International cooperation in R&D is a relatively recent phenomenon. It started after the second world war, coinciding with the rapid acceleration in international cooperation in general, and of scientific and technical research in particular. Before the war, R&D cooperation was largely limited to the exchange of students and teachers between universities, the exchange of scientific data between research groups, and the exchange of licences between industries.

It may be argued that the question 'Why Cooperation?' is a trivial one that can be answered by simply pointing to the necessity of pooling resources, human and material, on the grounds that the scale of research undertakings and development activities increased, reaching a level where sharing effort and cost became a necessity. This argument, however, does not reflect the full story and various other elements came into play to justify cooperative efforts. One of the fundamental ones was the search for ideas; cooperation can transport ideas across national and organisational boundaries to receptive areas where they can flourish. As an example of the importance of this, one can point to the very generous distribution of research funds by US funding authorities to universities and research establishments outside the USA during the hectic period of scientific and technical awakening after the Korean war.

Another less trivial factor is the lessons that cooperation can provide with regard to the management of large projects which, by necessity, become international. The number of such projects is steadily increasing.

International collaboration implies solving difficult problems of a legal and financial nature, as well as problems related to intellectual property rights, industrial and technological policy, and above all problems of human relations.

Over the last 20 years the merits of cross-fertilisation between disciplines have been well recognised. In the latter part of this period we have seen the growth of another type of cross-fertilisation, based on international cooperation; the latter has been much talked about, but its effects have rarely been measured.

Cooperation in basic research
In the same period, i.e. following the two world wars, several fields of fundamental research, mainly physics, have developed to a point where experiments were no longer possible without investment in large research installations. As a consequence, several cooperative ventures were born, including:

1. CERN: the European Nuclear Research Organisation in Geneva has provided the scientific community with one of the world's largest accelerators. This venture has taught scientists to combine their university research in home laboratories with the development of experimental hardware for use in the CERN accelerator. As a result of this complex mode of cooperation, and the size and number of the groups participating in every research project

* Based on a presentation to a Government of Japan/OECD Conference on International Cooperation in Science and Technology among OECD Member Countries, Tokyo, 14 – 18 November 1983

working with or at CERN, new methods for multinational collaboration have been developed. Common preparation of experimental hardware (e.g. bubble and spark chambers) and common evaluation of experiment data have formed the basis of this cooperation, and have led to a considerable number of discoveries of new elementary particles.

2. The European Community has promoted collaboration in the field of plasma physics and thermonuclear research, which has led for example to the Joint European Torus (JET) installation at Culham laboratories in Great Britain, one of the largest plasma-physics installations in the world. There is no doubt that it is an installation of that size that will finally lead to the understanding of the problems associated with the confinement of super-hot plasmas for thermonuclear power production.

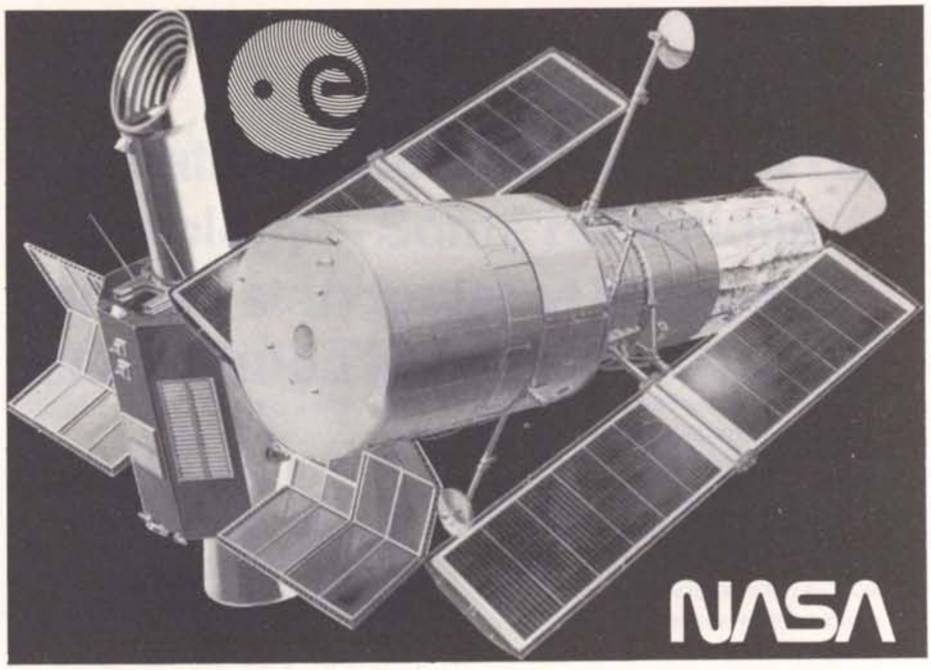
3. Outside physics research, one can cite the European Molecular Biology Organisation (EMBO) and the European Southern Observatory (ESO). Both have brought together specialists in new and promising fields; the first is still one of the few examples of cooperation in the field of life sciences (so far, only limited and rather timid initiatives seem to have been taken in this field, as in the medical sciences); ESO has permitted the European astronomy community to invest jointly in large telescope facilities.

   In the field of meteorology, the World Meteorological Organisation (WMO) and the International Council of Scientific Unions (ICSU) initiated the Global Atmospheric Research Programme (GARP), involving four geostationary meteorological satellites (2 US, 1 European and 1 Japanese). Over a one-year period, they provided synoptic weather observations for the whole globe, in various wavelengths of the spectrum, to enable a better understanding of the behaviour of the Earth's atmosphere and of meteorological phenomena in general. This programme has assisted in the creation of the new international organisation, Eumetsat. In this venture, at the border between pure and applied science, 15 European States are using ESA-developed Meteosat geostationary satellites to supply their meteorological services with weather-prediction data.

The above examples would seem to have one feature in common. In all cases the industrial or commercial element was not the determining one, and the work is clearly centred on fundamental research, with minimal or no immediate applications content. Provided that Governments and funding authorities are sufficiently generous, collaboration on such fundamental research projects is relatively easy, free as it is from elements of industrial and commercial competition.

Cooperation in space research between European nations was initiated with the signature, on 1 December 1960, of a Convention establishing the European Space Research Organisation (ESRO). Article 2 of that Convention states that: 'The purpose of the Organisation shall be to provide for and to promote collaboration among European States in space research and technology exclusively for peaceful purposes.' We will deal with the 'technology' part of the collaboration below, concentrating first on the fundamental research element of this collaboration.

ESRO started on a moderate scale with smaller satellite projects between 1964 and 1971, but soon moved on to larger more complex spacecraft. Here we touch upon one of the most difficult issues of space collaboration, namely: Should an international organisation like ESA concentrate on missions and projects of a



size and complexity greater than those within the reach of any national effort? Or should any scientific venture, whatever its size and complexity, be good enough to be taken up in this type of cooperation, provided its scientific value is not contested? Similar questions arise in fields other than space science.

No definitive answer to this question has yet been found and the controversy will no doubt continue for a long time to come. Clearly, answers will vary depending on their origin; what is small and simple for one Member State may well be large and complex for another. It should, perhaps, be mentioned here that in scientific collaboration within ESRO/ESA, the selection of scientific projects has always been made without compromise, on the grounds of scientific interest and scientific merit rather than the size of the project. To ensure that this would remain the case, a complex procedure for project studies and project selection was set up. The fundamental element of this mechanism was the creation of scientific working groups, composed of outstanding specialists in the different fields of space science, drawn from all cooperating nations. A system was set up with a competitive basis for collecting experiment proposals from the scientific community, for screening them to select the best, and for studying their feasibility and cost.

An important factor in the evolution of European collaboration in space science has been cooperation with the USA. In the early days of ESRO, European scientists had a choice of participating in European (i.e. ESRO) missions or in US (i.e. NASA) missions. At that time American policy was very clearly to attract as much overseas participation as possible in their scientific missions, which were very ambitious compared with what it was then possible to accomplish in Europe, and thus constituted a strong temptation to European scientists. This eventually became another tool for promoting cooperation among European nations in that each European country could, of course, participate with the USA on a bilateral basis. In many cases, however, it became apparent that it was more efficient if they first clubbed together and then participated in NASA missions within the framework of that 'club' (i.e. ESRO).

As a consequence, ESA began to look for challenging collaborative ESA/NASA ventures, several of which have already come to fruition. Here we are talking about collaboration between two distinct partners, and each of the partners has to be satisfied that the cooperative effort brings advantages and that the ultimate scientific return from the project does not suffer. For cooperation to run smoothly, it is important that the interface between the two collaborators be clear, and that each knows exactly what he is supposed to do and what he is supposed to pay. Formal ESA/NASA cooperative ventures are therefore governed by international legal arrangements – the so-called 'Memoranda of Understanding'. We can point to a succession of successful cooperative ventures already in progress, like the International Sun-Earth Explorer (ISEE) and International Ultraviolet Explorer (IUE) missions. Several others are still under development, like the Space Telescope (ST).

Another somewhat different (in scope and objectives) venture in which ESA and NASA have joined forces is the Spacelab project. The first flight, in the coming weeks, will carry experiments in various fields of physics and astronomy, life sciences and material sciences (the latter studying the behaviour of materials, particularly under conditions of extremely low gravitational forces), and is a joint venture with a European/US investigator/astronaut team. In this example of cooperation, again at the border between science and technology, the main motivation is exchange of knowhow and joint concentration of efforts on a large and complex project. There being no exchange of funds in this collaborative venture, European participation gave no right of decision on the US part of the project, and vice versa. In several cases, e.g. IUE and ST, Europe's participation is considerably below 50% and, naturally enough, under those circumstances the predominant role in deciding on technical performance, schedule and cost lies with the USA.

On the whole this type of cooperation has been beneficial to both Europe and the USA and, despite some inherent difficulties, both sides seem open to and eager to continue such cooperation.

Cooperation in technological research
This type of cooperation, in the strict sense of cooperation in *applied research* with a view to developing new technological products, is not the type of venture that occurs very often. Instead, what we usually see is what could best be described as *industrial cooperation* in order to develop large, complex, high-cost products, using a substantial element of existing high technology.

Here, therefore, the accent is on joint product development and marketing, requiring high industrial technological capacity and large capital outlays.

Three highly successful examples of ESA's efforts in this field have been the development of the European Communication Satellites (ECS) and the Maritime Communication Satellites (Marecs), and the development of the Ariane launcher.

The first, ECS, led to the creation of a new International Organisation, Eutelsat, regrouping the PTT Administrations of some 17 European States with the objective of jointly using a satellite communications network covering the European region. The second, Marecs, is now an essential element in Inmarsat's worldwide network, providing an operational maritime telecommunications system. Within the framework of a multinational industrial company, Arianespace is now manufacturing and marketing the Ariane launch vehicles.

Contrary to technological cooperation in the strict sense of the word, there are many examples of 'industrial cooperation with a high technological content'. The most well known are: various advanced-reactor projects, in particular high-temperature reactors, plants for isotope separation, and plants for radioactive waste processing and disposal; space projects within ESA programmes; the European Airbus and various joint developments of military aircraft. All involve:

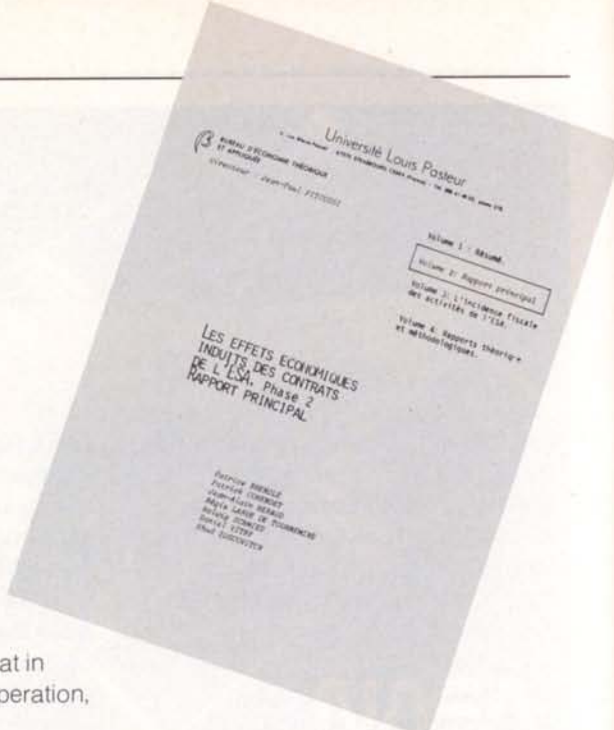
- large investments
- development of complex products
- development of new technologies for incorporation into the projects
- complicated market structures and difficulty in amortising the initial investment; marketing on often-Government-dominated international markets
- need for international management structures to supervise the projects and advanced cost-control methods.

As regards the marketing aspect, the potential customers are frequently Governments or Government-controlled agencies. The marketing effort therefore often has to be supported by international agreements and, when marketing outside countries that have undertaken the development, often needs to be supported at a very high political level. Several difficulties have been experienced in the process: negotiations regarding the distribution of work and sharing out of financial contributions tend to be tedious and difficult when undertaken within the framework of an international agency. The work allocation has to take into account each party's commitment to the venture in question, as well as its national interest. In some cases the two coincide and it is possible to allocate a Member State work in a field in which it has achieved a high level of specialisation. This, however, is not very frequent. What is often noted is particularly strong competition for work which it *is believed* will bring interesting markets and substantial benefits in the future.

Many difficulties are attributable to the differing sizes of the cooperating States and their respective industries. The dilemma runs as follows: in the development stage of a project the sharing out of work can be arranged so as to satisfy all participants; after the development is over, however, and the end product has to be marketed, the number of industrial companies grouped in a Consortium will tend to limit the number of industrial participants to a minimum, thereby hoping to bring down the cost of the programme, particularly the management cost. The result of this may well be the elimination of smaller subcontractor companies from the smaller Member States, which will in turn discourage those Member States from participating in subsequent large development contracts.

This difficulty has been seen many times, particularly in the aerospace field, and no obvious solution to the problem has been found.

Another difficulty occurs when the indust-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rial policy adopted by the international manager of a large programme is not in line with the industrial policy of all individual participating States. Such conflicts can arise when allocating industrial work on grounds which do not take account, for example, of local problems that individual Member States are trying to solve by their own industrial and regional development policies.

Finally, participating Governments prefer, at least in some cases, to select the main companies on the basis of free competition. In other cases, an a priori decision is preferred. When this happens the rules of the game are put into question without necessarily informing all the other partners of the change. Such incidents may well create confusion in the management organisation, within industry, and in the user organisations.

We have been looking at some of the difficulties facing us in the implementation of cooperative projects in the field of high technology. None of them, however, puts into doubt the advantages accruing from such cooperation when it comes to developing high-technology products and marketing them.

In fact the advantages are numerous. Not only do we have once again, as in the examples given above, the pooling of financial, human and other resources, but also industrial cooperation. This should ideally ensure that the best possible use is made of the cooperating firms' specialist knowhow and that the existing specialisation is reinforced and further fostered. On the marketing side, the home market is usually the first on which the product 'breaks through' and where it gets its initial production investment cost covered by sales. Often the product finds itself competing with others available on the world market, and the value of the home market to the product is then even greater. Here the product can get additional support from Government quarters or from the public, and it is often only after a success on the home market that a product can become a worldwide success.

Finally, it should be mentioned that in almost all cases of industrial cooperation, the overall level of industrial and technological development and competence is increased for all those cooperating, leading to induced benefits for all participants in the longer term. However, quantification of these benefits is very difficult. A study of the benefits to be gained from technological cooperation was made for ESA in 1980 by a team of economists from the Louis Pasteur University of Strasbourg, led by Professor Fitoussi. This study estimated the value of the various indirect benefits arising from the technical activity conducted in industry on behalf of the Agency, including:

- technological benefits (new products, improved quality, diversification)
- commercial benefits (new contracts, increased sales, international collaboration)
- benefits from improved organisation and methods (better technical knowhow, economies of effort)
- benefits from improved staff efficiency.

When comparing all indirect benefits together, the Strasbourg team found that they were some three times greater than the funds spent in industry and in the Agency, i.e. the financial benefit was three times greater than the participating States' financial contributions (some 1400 million European accounting units at 1977 prices). Admittedly, such an effect arises more from the high-technology nature of the activity than from its international character, but in the case in point the two are difficult to separate.

Concluding remarks

The aim in documenting the above reflections was not to compile a comprehensive list of lessons learned over the last 20 years' efforts in international cooperation, which would require a much longer treatise. Rather, it represents an attempt to analyse and illustrate by example the motivations for carrying out research through cooperative ventures.

Several examples of cooperative R&D research projects have been cited here and discussed against the background of cooperation in the space field, which has demonstrated its vitality through the very existence of first ESRO and now ESA.

The significance of space cooperation as an example of the problems that can arise in cooperative ventures as well as the benefits accruing from them stems from the fact that:

- space activities are by nature international or even global
- when space activities address scientific problems, they serve a community that already has a tradition of collaboration
- industrial and technological development of space projects (at least in Europe) has been dominated by its international environment and thus by international cooperation.

In brief

New ESA Director of Operations Appointed

At its meeting in Paris on 27 July, the Agency's Council appointed Mr. Kurt Heftman to the post of Director of Operations, responsible for the European Space Operations Centre (ESOC) in Darmstadt, Germany. He succeeds Dr. Reinhold Steiner and will take up his duties in November.

Born in Vienna in 1928, Mr. Heftman has spent most of his professional life at Jet Propulsion Laboratory in Pasadena, where he has worked extensively on spacecraft mission support and operations, as well as on the development of control-centre data systems, sustaining operations at the Goldstone (USA), Canberra (Australia) and Madrid (Spain) tracking complexes.

At ESOC he will be responsible for all of the Agency's satellite operations and the corresponding ground facilities and communications network, including the central Control Centre at ESOC and the telemetry, tracking and control facilities at the ground stations. The ground network currently includes both Agency-owned and national facilities, with stations at Michelstadt (Germany), Redu (Belgium), Villafranca (Spain), Kourou (French Guiana), Carnarvon (Australia), Ibaraki (Japan), Malindi (Kenya) and Fucino (Italy).

Prime Minister Margaret Thatcher Visits ESTEC

The British Prime Minister, Mrs. Margaret Thatcher, visited the European Space Agency's Research and Technology Centre (ESTEC) in Noordwijk on Monday 19 September, in the course of a one-day official visit to The Netherlands. Mrs. Thatcher was accompanied by the Netherlands Vice Premier G.W.M. van Aardenne. Her party also included Mr. P. Mansfield (British Ambassador in The Hague), Jhr. Huydecoper van Nigtevecht (Netherlands Ambassador in London), Mr. F.E.R. Butler (Principal Private Secretary), Mr. A.J. Coles (Private Secretary) and Mr. B. Ingham (Chief Press Secretary).

Mrs. Thatcher was welcomed to ESTEC by ESA's Director General Mr. E. Quistgaard (centre) and its Technical Director Prof. M. Trella (right), who is also Director of ESTEC. Dr. R. Bonnet, ESA's Director of Scientific Programmes, and Mr. E. Mallett, ESA's Director of Applications Programmes were also present.

Mrs. Thatcher was given brief presentations on the Agency's goals and programmes and toured ESTEC's test facilities. Britain's involvement in the European space programme was addressed during her visit. Models of the European Communications Satellite (ECS) developed by European industry under the prime contractorship of British Aerospace and the large communications satellite Olympus being developed by the same British firm, were on display.

Britain has been involved in the European space research effort from the very start, being a founder member of both ESA's forerunner organisations ESRO and ELDO.

Launch contract signed for Marecs-B2

On the basis of a contract signed by representatives of the European Space Agency and Arianespace at the end of July, the Agency's Marecs-B2 satellite will be put into orbit by one of the first Ariane-3 launches in the first half of 1984. Marecs-B2, with a launch mass of 1050 kg, will replace an earlier version of the same spacecraft which was lost following a launch failure on 10 September 1982. The Ariane-3 vehicle is designed to place a single satellite of the 2500 kg class, or two of the 1200 kg class in a dual launch configuration, into geosynchronous transfer orbit.

Marecs-B2 will be stationed at 177.5°E above the Pacific Ocean.

As part of the Inmarsat global maritime communication system, the Marecs satellites provide shipping and offshore industries with access to international public telephone (more than 40 channels) and telex networks, and with facsimile and data-transmission facilities. They also provide a unique facility for handling priority messages for maritime distress and safety services.

Launch contract signed for ECS-3

On 29 September 1983, ESA's Director of Applications Programmes, Mr. E. Mallett, and the Director General of Arianespace, Mr. C. Bigot, signed a contract for the launch of the third European Communications Satellite, ECS-3. This launch, scheduled for August 1985 on an Ariane-3 vehicle, will follow that of ECS-2 in May 1984, for which the launch contract has already been signed.

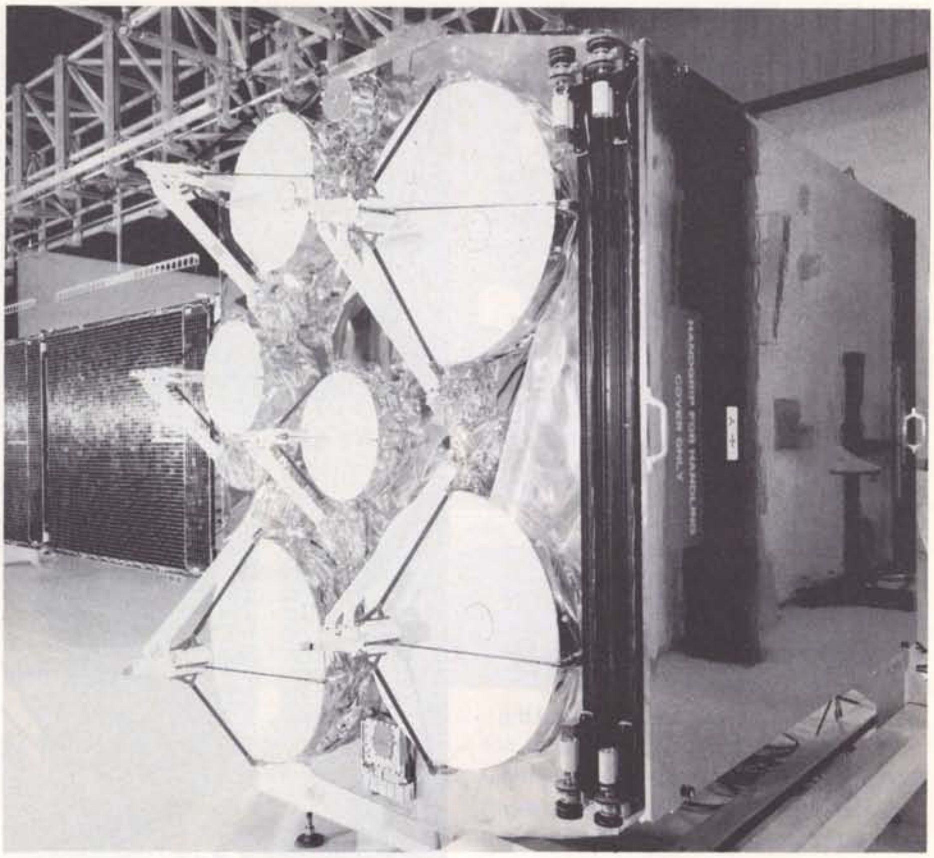
The first ECS satellite was successfully launched by Ariane L6 on 16 June 1983 and is expected to become operational shortly as an integral part of the Eutelsat system (see elsewhere in this Bulletin).

This new contract brings the Arianespace order book up to a total of 5.2 thousand million French francs, for the launch of 25 spacecraft.

In the telecommunications field alone, the European Space Agency has now signed contracts worth 1.6 thousand million French francs for the launch of two Marecs satellites for maritime communications, three ECS satellites, and Olympus, the European large telecommunication and direct TV satellite.

From left to right, Mr. G. van Reeth, Dr. R.C. Collette and Mr. E. Mallett of ESA, with Mr. C. Bigot of Arianespace.

First European Operational Telecommunications Satellite ECS-1 formally accepted by Eutelsat



ECS-1, the first Operational European Telecommunications Satellite, was formally accepted by Eutelsat on 12 October. Christened Eutelsat-1 F1 by its new owners, the satellite forms part of Eutelsat's European Regional Telecommunications System, which will provide facilities for distributing television programmes to national and international cable networks within Europe.

ECS-1 was launched by Ariane on 16 June and reached its initial operating position at 10°E longitude on 7 July. The communications payload was switched on for the first time on 10 July, when all twelve repeaters were checked and found to work satisfactorily (see ESA Bulletin No. 35, page 12). Since then a series of acceptance tests have been carried out jointly by ESA, Eutelsat and the MESH consortium which developed the spacecraft. In-orbit acceptance tests have been carried out by ESA and PTT earth stations and coordinated from the Agency's ECS Control Centre at Redu (see pages 16-20 of this issue).

The next major landmark in the ECS programme will be the launch, in mid-1984, of the second flight unit, ECS-2. Once operational, ECS-2 will complete the Eutelsat system by adding telephony, data-transmission, and business-telecommunication facilities to the services already available, as well as television distribution for the European Broadcasting Union (EBU).

ESA/NASA/ISAS Solar-Terrestrial Science Meeting

Europe, the United States, and Japan moved a significant step closer to an 'International Solar-Terrestrial Physics Programme' recently as delegates from the space agencies of these countries discussed plans at a meeting of solar and space-physics scientists held at the National Academy of Sciences in Washington DC. NASA hosted the meeting for the 'Trilateral Solar-Terrestrial Science Committee'.

The participants represented the three space research organisations involved: ESA, Japan's Institute of Space and Astronautical Science (ISAS), and NASA. For several months they have been formulating plans for a coordinated, evolving, solar-terrestrial space programme which would involve their respective research organisations in a combined international effort.

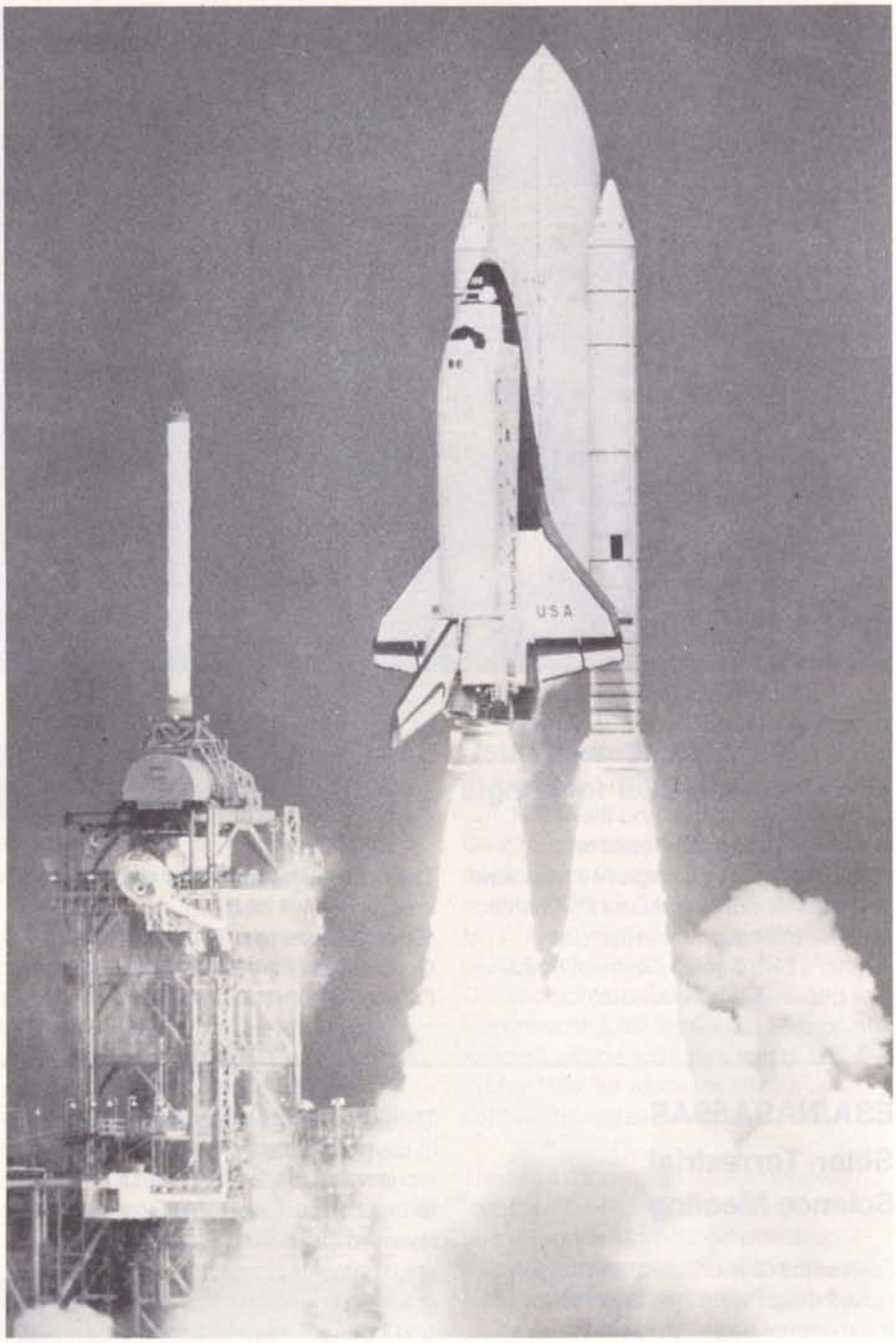
The purpose of the trilateral meeting was to develop a research programme to recommend to ESA, ISAS and NASA for further consideration. The Committee reviewed the existing space solar and space-physics programmes and the project plans of the three space agencies, and identified ways of combining related elements into a cost-effective and scientifically coherent programme strategy. The recommended programme encompasses a detailed look at the Sun, the Earth's space environment and fundamental aspects of the Sun-Earth interaction. In addition, the Committee stressed the importance of developing an international plan for data acquisition and dissemination to the solar-terrestrial science community.

Two projects currently in the planning stage at ESA are potential elements of this international effort: a versatile solar observatory and a cluster of four Earth-orbiting spacecraft to study basic plasma-physics processes. Scientists from ESA's eleven Member States met in Frascati, Italy on 10-11 October 1983 to discuss the scientific merit of these projects.

ISAS (Japan) would also have major involvement in the international programme by providing one of the primary spacecraft for the coordinated effort. The scientific payload would consist of instruments provided by a joint US-Japanese science team.

The US science delegation is recommending that major spacecraft and payload contributions be initiated by NASA. Recommendations to NASA show plans for a scheduled 1986 start for this major study of the Sun-Earth relationships. NASA, as part of the international effort, had indicated a willingness to contribute the use of the Shuttle for launching the satellites involved in the programme.

European and American News Centres for Spacelab's First Flight



Up to the minute news of the progress of the first Spacelab mission will be available from specially established centres on both sides of the Atlantic. Due to continuing uncertainty about the launch date (no earlier than 28 November) no firm schedule data can yet be given, but the centres will be operative throughout the Spacelab-1 flight. Latest information can be obtained from ESA Public Relations Branch at ESA Head Office in Paris (Tel. 33.1.273 72 91/92).

The principal news centre for Europe will be at DFVLR's premises at Cologne-Porz in Germany and that for the USA will be at Johnson Space Center in Houston. In addition, other centres will operate at the launch site (Kennedy Space Center, Florida), at the landing site (Dryden Flight Research Facility, California), and at the Huntsville Operations Support Center at Marshall Space Flight Center in Alabama. As Spacelab-1 is a joint ESA/NASA mission, all news centres will be staffed by personnel from both Agencies. In addition, small information centres will be established at ESA Head Office (Paris), ESTEC (Noordwijk), ESOC (Darmstadt) and ESRIN (Frascati).

The Cologne-Porz information centre will provide up-to-date information on the flight to European news media as well as the general public. The programme will include briefings on Spacelab's development and mission objectives. Eminent European scientists will describe the disciplines and experiments involved and direct audio and video links will be maintained with Johnson Space Center by satellite. Recordings of the NASA video programme (see below) will be flown across the Atlantic each day for presentation at Cologne-Porz. Films on Spacelab's development and flight preparations will also be shown, together with selected clips on the experiments being performed.

A daily programme of events for the Cologne-Porz centre has been drawn up and it is expected that several thousand visitors will attend. Three days have been set aside for special events: an Industry Day, an International Space Day and a Youth and Space Day. The International Space Day is of particular importance since it is intended to stress US-Europe cooperation and the international aspects of space activities. A Panel Session set for the afternoon of the International Space Day will involve top representatives of European space endeavours as well as a leading personality from NASA. It is during this session that Mr. Quistgaard, ESA's Director General, and Mr. H.Riesenhuber, the German Federal Minister for Research and Technology, will talk directly with the European crew member, Ulf Merbold, on board Spacelab.

At Johnson Space Center, Houston, site of the Mission Operations Control Room (MOCR) and the Payload Operations Control Center (POCC), a special news room will be set up providing information on all aspects of the mission. NASA will provide a 24-hour video programme containing live broadcasts from orbit, interviews with principal investigators and background material of interest.

Contact person at the European news centre at Cologne-Porz during the Spacelab-1 mission will be:
Dr. W. Brado, Tel. 49.2203.601 24 74

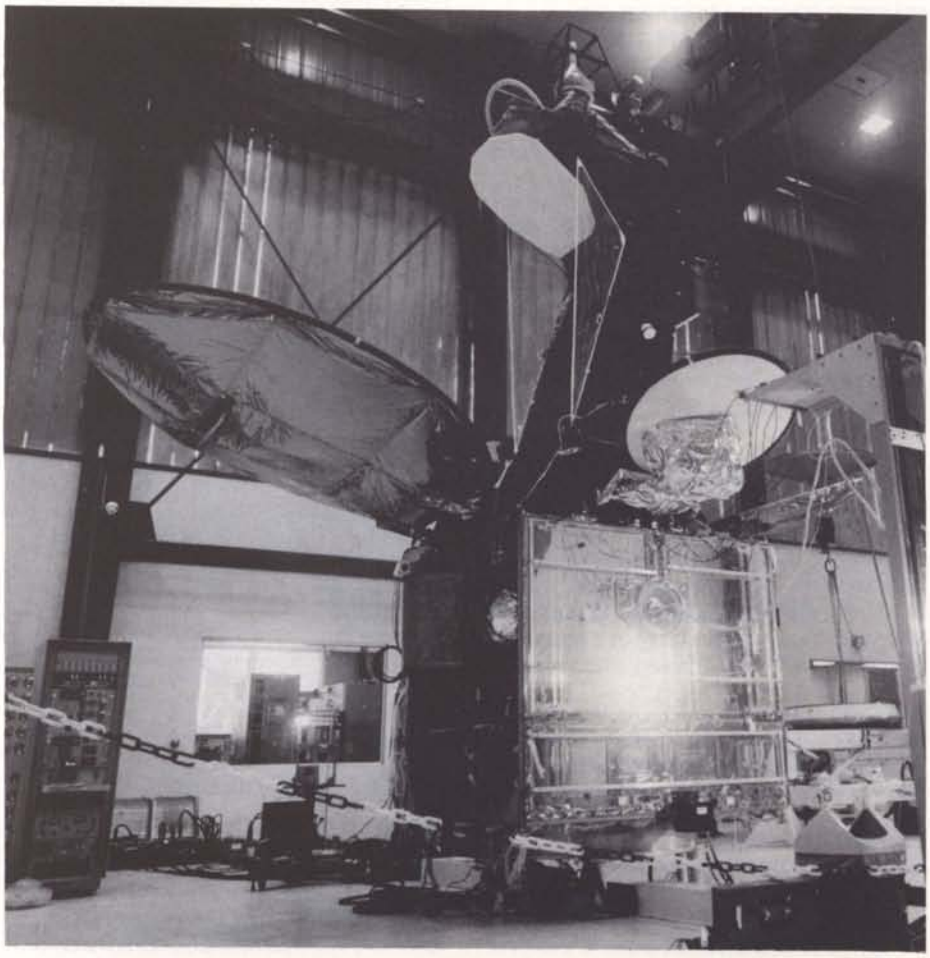
and at Johnson Space Center in Houston:
Mrs. J. Gomérieux,
Tel. 1.713.483 51 11

German Federal Minister for Research and Technology Visits ESOC

ESA Director General Mr. Erik Quistgaard (standing, left) received the German Minister for Research and Technology, Dr. Heinz Riesenhuber (seated, left) when he visited the Agency's Space Operations Centre (ESOC) at Darmstadt near Frankfurt, on Friday 9 September.

Speaking to representatives of the media, Dr. Riesenhuber expressed his appreciation of the excellent work carried out by ESOC, which has successfully monitored and controlled more than a dozen European satellites in orbit via its worldwide network of ground stations. He noted that the Centre's work is seen daily by millions of television viewers through the weather pictures from the European Meteosat meteorological satellite.

The Minister also dwelt at some length on ESA's role in the coming decade. Drawing attention to the fact that a number of major European programmes – the development of the European launcher Ariane, of Spacelab and of the maritime satellites in particular – were drawing to a close, he stressed the need for all ESA Member States to decide, within the coming months, on the direction European space activities should take in the 1990s. Finally, he underlined Germany's determination, as an industrial nation and as a partner in the international community, to continue to support space research.



Ariane Launches Intelsat-V

Intelsat-V F7 was launched successfully, as Ariane's first purely commercial payload, from ESA's Kourou launch base in French Guiana at 21.45 local time on 18 October (45 minutes after midnight on 19 October GMT).

The Ariane launch vehicle injected the International Telecommunications Satellite Organisation's two-ton satellite into an orbit with a perigee of 183 km (against 185.4 km specification) and an apogee of 36 158 km (against 35 987 km specification). Geostationary Transfer Orbit (GTO) was achieved at 2.30 local time.

The launch of Intelsat-V F7, which was originally scheduled for 15 September, had been postponed at the customer's request to allow them to investigate a potential problem in the satellite's maritime communications subsystem.

The launch of Intelsat-V F8, also aboard a European Ariane vehicle, remains on schedule for mid-December.

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 on page 77 and using the Order-Form on page 78.

ESA Journal

The following papers have been published in ESA Journal Vol. 7, No. 3 (September 1983):

RESULTS OF MATERIALS-SCIENCE EXPERIMENTS WITH SOUNDING ROCKETS
WALTER H U

TELECOMMUNICATIONS-SATELLITE ORBIT DETERMINATION VIA TELEVISION-SIGNAL RANGE MEASUREMENTS
DE AGOSTINI A, ET AL

ANALYSIS OF MULTIPLE/CONTOURED BEAM LIMITATIONS FOR TELECOMMUNICATIONS SATELLITE TRANSMISSIONS
SAITTO, A

THE GENERATION AND USE OF BIT-ERROR-RATE SURFACE PLOTS IN TRANSMISSION ANALYSIS
HARRIS, R A & KRISTIANSEN, P

EVALUATION OF BUS IMPEDANCE ON THE SPOT MULTIMISSION PLATFORM
CAPEL, A & BARNABA, A

HIGH-ACCURACY RADIOMETRIC CALIBRATION OF OPTICAL IMAGING INSTRUMENTS IN SPACE
O'MONGAIN, E, ET AL

Special Publications

ESA SP-199//275 PAGES
SOFTWARE ENGINEERING – PROCEEDINGS OF ESA/ESTEC SEMINAR, NOORDWIJK, THE NETHERLANDS, 11-14 OCTOBER 1983 (AUG 1983)
BATTRICK B & ROLFE E (EDS)

Contractor Reports

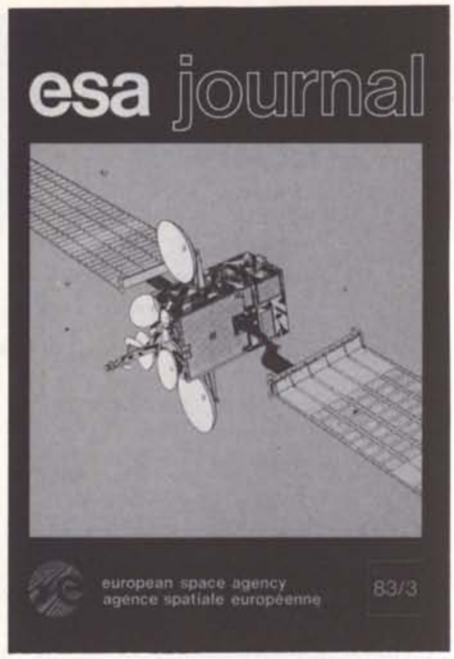
ESA CR(P)-1713//129 PP
SYSTEM STUDY CONCERNING THE DEFINITION OF STANDARD SPACECRAFT POWER INTERFACE CHARACTERISTICS (JUNE 1982)
MBB, GERMANY

ESA CR(P)-1716//138 PP
SEA-SURFACE IMAGING BY SAR – FINAL REPORT (DEC 1982)
MARCONI, UK

ESA CR(P)-1722//43 PP/218 PP
STUDY ON SPACELAB ASSEMBLY, INTEGRATION VERIFICATION (AIV) PROGRAMME GENERALLY APPLICABLE TO OTHER SPACECRAFT PROGRAMMES – VOLUME 1: EXECUTIVE SUMMARY; VOLUME 2: TECHNICAL REPORT (DEC 1982)
MBB/ERNO, GERMANY

ESA CR(P)-1724//47 PP
DEFINITION D'ETALONS ET DE METHODES D'ETALONNAGE POUR L'IMR (MAR 1982)
UNIVERSITE CATHOLIQUE DE LOUVAIN, BELGIUM

ESA CR(P)-1725//466 PP
EFFECTS OF LONG-LIFE REQUIREMENTS ON SPACECRAFT DESIGN AND TECHNOLOGY – FINAL REPORT (NOV 1982)
MATRA, FRANCE

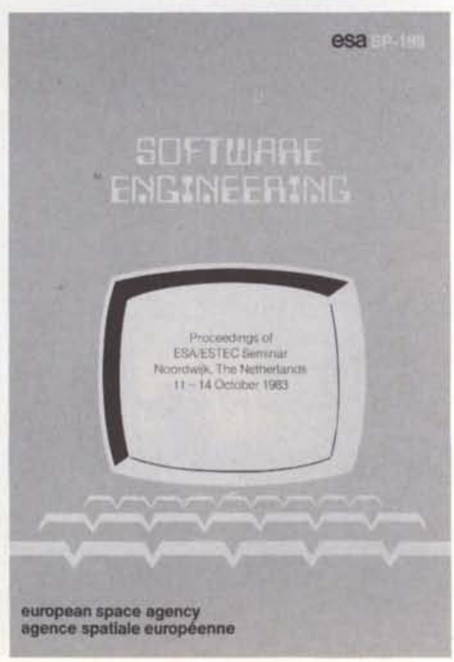


ESA CR(P)-1726//120 PP
OPTIMISATION OF QUALITY-ASSURANCE PROCEDURE, SCREENING AND BURN IN OF COMPLEX MICROCIRCUITS (DEC 1981)
SIEMENS AG, GERMANY

ESA CR(P)-1739//96 PP
A COMPARATIVE STUDY ON PROJECT REVIEW TECHNIQUES – FINAL REPORT (DEC 1982)
ARTHUR D. LITTLE, GERMANY

ESA CR(P)-1743//326 PP
FLUID PHYSICS MODULE – IMPROVED OPTICAL DESIGN FEASIBILITY STUDY – FINAL REPORT (SEPT 1982)
CENTRO RICERCHE FIAT, ITALY

ESA CR(P)-1744//105 PP
ETUDE D'UN CONVERTISSEUR ANALOGIQUE DIGITAL EN OPTIQUE INTEGREE – RAPPORT FINAL (FEB 1983)
THOMSON-CSF, FRANCE



ESA CR(P)-1745//69 PP
ANALYSIS AND TESTING OF THE THERMAL PROPERTIES OF SPACE BATTERY CELLS – FINAL REPORT, PHASE-A (JAN 1983)
ELEKTRONIKCENTRALEN, DENMARK

ESA CR(P)-1746//223 PP
SYSTEM FEASIBILITY STUDY ON RENDEZVOUS AND DOCKING IN TRANSFER ORBIT (FEB 1983)
MATRA, FRANCE

ESA CR(X)-1712//88 PP
FINAL REPORT ON THE DESIGN AND DEVELOPMENT OF DC BRUSHLESS MOTORS FOR SPACE APPLICATION (FEB 1982)
BADG, UK

ESA CR(X)-1714//150 PP
X-80 – SPECTROSCOPY/TIMING-TRANSIENT MISSION IN X-RAY ASTRONOMY – PHASE-A FOLLOW-ON-STUDY FINAL REPORT (NOV 1982)
DORNIER SYSTEM, GERMANY

ESA CR(X)-1715//202 PP
DEVELOPMENT AND EXPLOITATION OF ESA SATELLITE COMMUNICATIONS CONTROLLER – FINAL REPORT (SEP 1982)
LOGICA, UK

ESA CR(X)-1717//258 PP
DEVELOPMENT, MANUFACTURING AND TESTING OF A BRIGHT-STAR SENSOR BREADBOARD MODEL – FINAL REPORT (APR 1982)
OFFICINE GALILEO, ITALY

ESA CR(X)-1718//42 PP
RETRIEVABLE MICROGRAVITY PLATFORM – PREPHASE-A STUDY – VOLUME I: SUMMARY REPORT (JULY 1982)
ERNO, GERMANY

ESA CR(X)-1719//51 PP
DEVELOPMENT OF A CCD SENSOR – PHASE 2 FINAL REPORT (SEP 1977)
GENERAL ELECTRIC, UK

ESA CR(X)-1720//379 PP
RADAR ALTIMETER TWT AMPLIFIER ELECTRICAL MODEL – PHASE 1 – FINAL REPORT (AUG 1982)
AEG-TELEFUNKEN, GERMANY

ESA CR(X)-1721//50 PP
STUDY OF RECEIVERS FOR EUROPEAN SATELLITE BROADCASTING – SUMMARY REPORT (DEC 1982)
ITALTEL SIT, ITALY

ESA CR(X)-1723//55 PP
EARTH-OBSERVATION PAYLOAD ELEMENT FOR SHUTTLE/SPACELAB MISSIONS – FINAL PRESENTATION REPORT (DEC 1979)
MBB, GERMANY

ESA CR(X)-1727//147 PP
STUDY OF ADAPTATION OF POTENTIAL OF THE CCD BRIGHT STAR SENSOR BBM FOR FAINT STAR TRACKING. STUDY OF APPLICABILITY OF PHOTON EVENT CENTROIDING TECHNIQUES TO POINT SOURCE CENTROIDING (JULY 1982)
OFFICINE GALILEO, ITALY

ESA CR(X)-1728//348 PP
STUDY OF 'DOPPLER' FILTERING TECHNIQUES – FINAL REPORT (AUG 1982)
DORNIER SYSTEM, GERMANY

ESA CR(X)-1729//VOL 1: 60 PP; VOL 2: 632 PP
INFRARED SPACE OBSERVATORY – FINAL REPORT OF THE INDUSTRIAL PHASE-A STUDY. VOLUME 1: EXECUTIVE SUMMARY; VOLUME 2: TECHNICAL (JAN 1982)
MBB, GERMANY

ESA CR(X)-1730//314 PP
EMERGENCY COMMUNICATION THROUGH A BROADCAST PAYLOAD (SEP 1982)
MILLER COMMUNICATIONS SYSTEMS LTD., CANADA

ESA CR(X)-1731//87 PP/476 PP/200 PP
DISCO – PHASE-A STUDY – FINAL REPORT – VOLUME 1: EXECUTIVE SUMMARY. VOLUME 2A: TECHNICAL REPORT. VOLUME 2B: APPENDICES (DEC 1982)
BRITISH AEROSPACE, UK

ESA CR(X)-1732//235 PP
ERS PAYLOAD ELECTRONICS MODULE CONCEPT STUDY – FINAL REPORT PHASE 1 (JULY 1982)
CONTRAVES AG, SWITZERLAND

ESA CR(X)-1733//68 PP
CUSTOM LSI TECHNOLOGY, IDENTIFICATION AND VALIDATION – FINAL REPORT (OCT 1982)
BRITISH AEROSPACE, UK

ESA CR(X)-1734//379 PP
DEFINITION OF A CONTROL DATA BASE FOR DCAP IMPROVEMENTS – FINAL REPORT (NOV 1982)
CGR, ITALY

ESA CR(X)-1735//31 PP
POSITION-AND-HOLD MOUNT – PHASE-B – EXECUTIVE SUMMARY REPORT (OCT 1982)
DORNIER SYSTEM, GERMANY

ESA CR(X)-1736//427 PP
FOCAL-PLANE CCD BREADBOARDING (JAN 1983)
TPD-TNO, THE NETHERLANDS

ESA CR(X)-1737//159 PP
BREADBOARDING OF A HYBRID OPTICAL CORRELATION SYSTEM – FINAL REPORT (OCT 1983)
SYSTEMBERATUNG INFORMATIK, GERMANY

ESA CR(X)-1738//VOL 1: 225 PP/VOL 2: 109 PP
STUDY OF RADAR ALTIMETER FOR SCIENCE – FINAL REPORTS A & B (JAN 1983)
THOMSON-CSF, FRANCE

ESA CR(X)-1740//VOL 1: 255 PP/VOL 2: 72 PP/VOL 3: 242 PP
ETUDE DE MARCHE SUR LES BESOINS EN COMMUNICATIONS AERONAUTIQUES – VOLUME 1: COMMUNICATIONS AIR/SOL ET SOL/AIR POUR LES BESOINS ATC DES CONTINENTS AFRICAIN ET SUD-EMERICAIN; VOLUME 2: COMMUNICATIONS AIR/SOL POUR LES BESOINS DES PASSAGERS; VOLUME 3: COMMUNICATIONS AIR/SOL POUR LES BESOINS DES COMPAGNIES (APR 1982)
SOFREAVIA/ITA, FRANCE

ESA CR(X)-1741//411 PP
EVALUATION OF NON-VOLATILE MEMORY CIRCUITS FOR SPACE APPLICATIONS – FINAL REPORT (NOV 1982)
KU LEUVEN, BELGIUM

ESA CR(X)-1742//75 PP
STUDY INTO THE STANDARDISATION OF REMOTE BUS INTERFACES – FINAL REPORT (JULY 1982)
MARCONI SPACE & DEFENCE SYSTEMS, UK

Technical Translations

ESA TT-576//118 PAGES
REPORT ON THE INFLUENCE OF BOUNDARY SURFACE FORCES AT THE BOUNDARIES OF LIQUID PHASES REGARDING PROCESSES OF LIQUID TRANSPORT UNDER ZERO GRAVITY CONDITIONS. LITERATURE SURVEY
LEINER W, SCHINDLER B & SELL P-J, BUNDESMIN. FUER FORSCH. U. TECHNOL., GERMANY

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INVESTIGATION OF INTERACTIONS BETWEEN HELMET-MOUNTED SIGHT/DISPLAY, SENSOR PLATFORM AND HUMAN PILOT
DANNEBERG E, KOHNEN E, STEIN H & STOLZKE U, DFVLR, GERMANY

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ULLRICH R, DFVLR, GERMANY

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BOES U, DFVLR, GERMANY

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HRV AND MRVIR CALIBRATION
DINGUIRARD M & MAISONNEUVE J-M, ONERA, FRANCE

ESA TT-793//48 PAGES
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DINGUIRARD M & MAISONNEUVE J-M, ONERA, FRANCE

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FLIGHT CALIBRATION SYSTEM OF THE HRV CAMERA (FIGURES)
MAISONNEUVE J-M, DINGUIRARD M & DUCHENNE B, ONERA, FRANCE

ESA TT-796//175 PAGES
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MAISONNEUVE J-M, CHAUVE D & PLANTEC M, ONERA, FRANCE

ESA TT-796//178 PAGES
RESULTS OF QUALIFICATION TESTS FOR THE INFLIGHT CALIBRATION LAMP OF THE HRV CAMERA USED IN THE SPOT PROJECT. APPENDIX 5
MAISONNEUVE J-M, CHAUVE D & PLANTEC M, ONERA, FRANCE

ESA TT-797//41 PAGES
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AUBRY Y, ONERA, FRANCE

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AIRBORNE LIDAR FOR OCEANOGRAPHY AND HYDROLOGY (FLOH)
WERNER C & HERRMANN H, DFVLR, GERMANY

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ONERA, FRANCE

ESA TT-803//17 PAGES
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- Small size (TO-8, DIP)
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- Low noise
- Single supply voltage
- 168 hours of burn-in time
- MIL-STD-883/B
- One year warranty

APPLICATIONS
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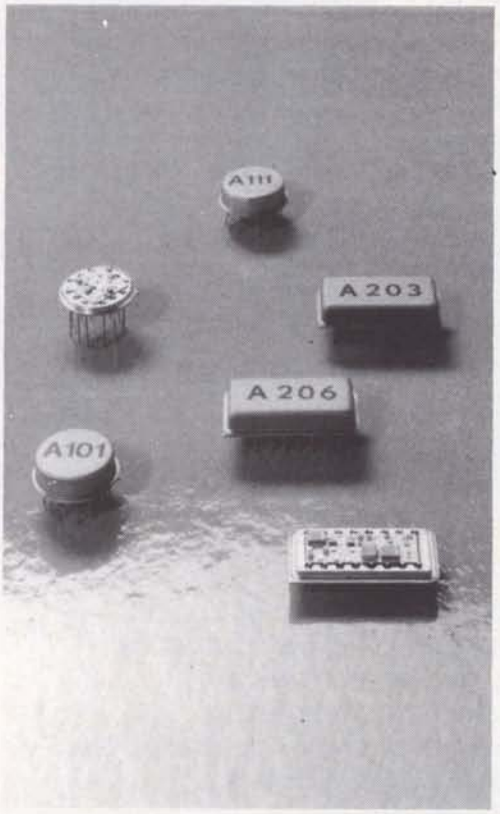
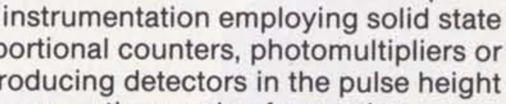
- Portable instrumentation
- Mass spectrometers
- Particle detection
- Imaging
- Research experiments
- Medical and nuclear electronics
- Electro-optical systems

ULTRA LOW NOISE < 280 electrons r.m.s.!
Model A-225 Charge Sensitive Preamplifier and Shaping Amplifier is an FET input preamp designed for high resolution systems employing solid state detectors, proportional counters etc. It represents the state of the art in our industry!

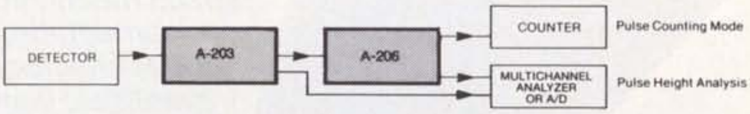


Models A-101 and A-111 are Charge Sensitive Preamplifier-Discriminators developed especially for instrumentation employing photomultiplier tubes, channel electron multipliers (CEM), microchannel plates (MCP), channel electron multiplier arrays (CEMA) and other charge producing detectors in the pulse counting mode.



TYPICAL PARTICLE COUNTING SYSTEM

Models A-203 and A-206 are a Charge Sensitive Preamplifier/Shaping Amplifier and a matching Voltage Amplifier/Low Level Discriminator developed especially for instrumentation employing solid state detectors, proportional counters, photomultipliers or any charge producing detectors in the pulse height analysis or pulse counting mode of operation.



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We would greatly appreciate receiving films, photographs, models, etc., for exhibition purposes. These will be returned after the Symposium. Such materials would have to be received one week before the Symposium begins.

JSASS/AIAA/DGLR SEVENTEENTH INTERNATIONAL ELECTRIC-PROPULSION CONFERENCE

The Seventeenth International Electric Propulsion Conference, cosponsored by the Japan Society for Aeronautical and Space Sciences (JSASS), the American Institute of Aeronautics and Astronautics (AIAA), and the Deutsche Gesellschaft für Luft- und Raumfahrt, e.V. (DGLR), will also be held in Tokyo from 28 May until 31 May 1984, in parallel with the ISTS.

Topics to be covered include: (1) Performance characteristics of electric-propulsion systems; (2) Power sources and electronics for electric-propulsion systems; (3) Space and ground testing of thruster systems, subsystems and components; (4) Concepts and analyses of missions using electric propulsion; (5) Novel electric or advanced propulsion concepts; (6) Development of thrusters and components for electric-propulsion systems; (7) Interaction of electric-propulsion systems with spacecraft and space plasmas; (8) Nonpropulsive application of electric-propulsion technology.

Potential participants are invited to write for further information to the International Conference Chairman:

Professor Kyoichi Kuriki
Institute of Space and Astronautical Science
Komaba, Meguro-ku
Tokyo 153, Japan

Registrants at the Electric-Propulsion Conference will be entitled to attend the ISTS Symposium and vice versa.

NINTH CANADIAN SYMPOSIUM ON REMOTE SENSING
Sponsor: Canadian Remote Sensing Society
Location: Memorial University of Newfoundland
Time: August 13-17, 1984

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CALL FOR PAPERS

The Ninth Canadian Symposium on Remote Sensing will be held in St. John's, Newfoundland, from August 13 to 17, 1984. The theme chosen for the symposium is "Remote Sensing for the Development and Management of Frontier Areas", with emphasis on oceans, the northland and wilderness regions. The conference will consist of plenary, technical and poster sessions.

The Technical Program Committee invites authors to submit a 600-word abstract of papers proposed for presentation at the symposium, no later than February 29, 1984, to the following address:

Dr. Denes Bajzak
Faculty of Engineering and Applied Science
Memorial University of Newfoundland
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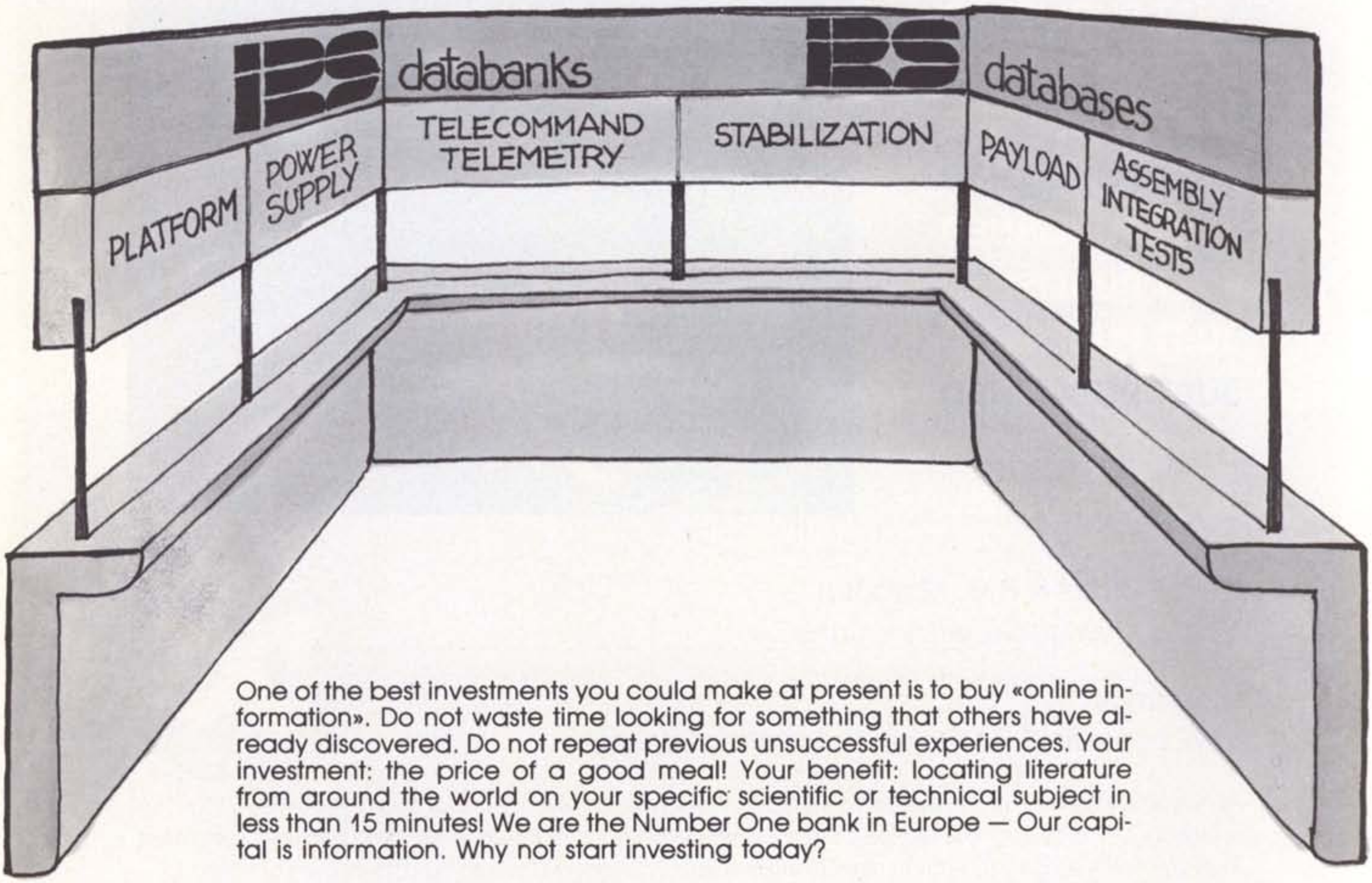

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