esa bulletin

number 20

november 1979

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, Italy, Netherlands, Spain, Sweden, Switzerland and the United Kingdom. Ireland has signed the ESA Convention and will become a Member State upon its ratification. Austria, Canada and Norway have been granted 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 Planning and Future Programmes; the Director of Administration; the Director of Scientific Programmes; the Director of Applications Programmes; the Director of the Spacelab Programme; the Technical Director and the Director of ESOC.

The ESA HEADQUARTERS are in Paris.

The major establishments of ESA are:

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

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

ESRIN, Frascati, Italy.

Chairman of the Council: Mr. J. Stiernstedt (Sweden).

Director General: Mr. R. Gibson.

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'Italie, les Pays-Bas, le Royaume-Uni, la Suède et la Suisse. L'Irlande a signé la Convention de l'ESA et deviendra Etat membre de l'Agence lorsque la Convention aura été ratifiée. L'Autriche, le Canada et la Norvège bénéficient 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 futurs et des Plans, du Directeur de l'Administration, du Directeur des Programmes scientifiques, du Directeur des Programmes d'Applications, du Directeur du Programme Spacelab, du Directeur technique et du Directeur de l'ESOC.

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: M.J. Stiernstedt (Suède).

Directeur général: M. R. Gibson.

esa bulletin

no. 20 november 1979

contents/sommaire

Front cover: Europe's Ariane launch vehicle on the launch table at Kourou in Guiana.
Back cover: An Ariane engine under qualification test at SEP, in France.

Editorial/Circulation Office
ESA Scientific and Technical Publications Branch
c/o ESTEC, Noordwijk, The Netherlands

Publication Manager
Bruce Battrick

Editors
Bruce Battrick, Duc Guyenne

Assistant Editor & Advertising Manager
Simon Vermeer

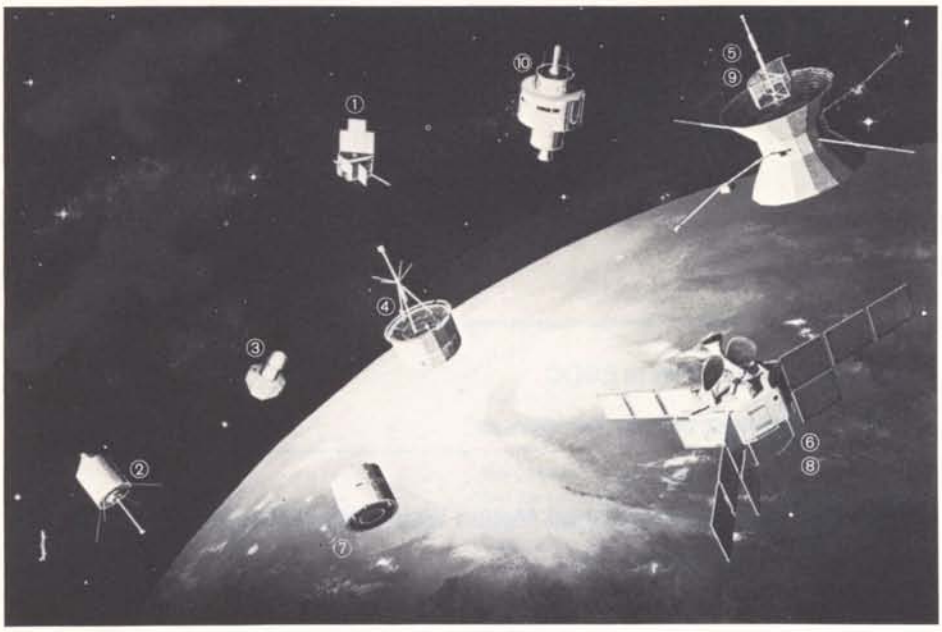
Editorial Assistant
Jacqui Mort

The ESA Bulletin is published by the European Space Agency. Individual articles may be reprinted provided that the credit line reads 'Reprinted from the ESA Bulletin' plus date of issue. Signed articles reprinted must bear the author's name. Advertisements are accepted in good faith; the Agency accepts no responsibility for their content or claims.

Printed in The Netherlands, by ESTEC Reproduction Services 792577
ISSN 0376-4265

european space agency
agence spatiale européenne

8-10, rue Mario-Nikis
75738 Paris 15, France



① Heos 1, ② Azur, ③ Dial, ④ Heos 2, ⑤ Helios 1, ⑥ Symphonie 1, ⑦ Cos B, ⑧ Symphonie 2, ⑨ Helios 2, ⑩ Meteosat.


The active thermal control system (developed by Microtecnica under ESA/Aeritalia contract) being installed on the European Spacelab.
design and production of heat-transfer systems for spacecraft

Spacecraft Operations at ESOC

D.E.B. Wilkins, Operations Department,
European Space Operations Centre (ESOC),
Darmstadt, Germany

The European Space Operations Centre (ESOC) has been conducting spacecraft operations on behalf of ESA for over eleven years. During this period the Agency's operational activities have become progressively more complex and the number of missions being supported has steadily increased. ESOC is presently controlling eight operational satellites, six of them directly from the Darmstadt Operations Control Centre (OCC).

It is hoped that this article will provide Bulletin readers with an understanding of how spacecraft operations are conducted and managed at ESOC. It may also be useful as an introduction for new users of ESOC's operational facilities.

History and background

ESOC was established on 8 September 1967 by consolidation of the existing ESDAC (European Space Data Centre) at Darmstadt (approximately 30 km south of Frankfurt) with the Control Centre Department from ESTEC, Noordwijk, Holland. By 17 May 1968, ESOC was fully operational and successfully supporting the launch of the ESRO-IIB satellite. This satellite was actually the second to be launched by ESRO; the first, ESRO-II, launched on 29 May 1967, failed to achieve orbit due to a launch-vehicle malfunction at Vandenburg Air Force Base, California.

During the ten years that followed, a total of thirteen satellite missions were supported by ESOC, culminating in the launch of Geos-2 on 14 July 1978 from Cape Canaveral, Florida. This launch was significant since it represented the end of an era, Geos-2 being the last ESA satellite to be launched using an American-built vehicle. Future launches of ESA satellites will be made either by the ESA-developed launch vehicle Ariane or, in certain cases, by the Space Shuttle.

As can be seen from Table 1, the early ESRO satellites were all scientific in nature and used the VHF band (136-138 MHz) for data recovery. To provide the necessary telecommand, telemetry and tracking support for these missions, ESRO established a network of tracking stations, controlled from ESOC and linked to Darmstadt by communications links. This network (designated Estrack) has been modified over the years and ESA now maintains a full VHF network to support the launch and early-orbit phases of its space missions (Table 2).

As mission requirements began to dictate the use of more sophisticated data-processing systems, the ESOC facilities were updated accordingly. This led to the construction of a purpose-built Operations Control Centre (OCC) at ESOC, which supported its first mission in January 1972 with the launch of Heos-2.

To support the greatly increased data-handling requirements of the Geos mission and, at the same time, provide a data-processing system capable of supporting multiple missions, ESOC installed its Multi-Satellite Support System (MSSS) in 1975. This system successfully supported the launch of Geos-1 in April 1977 and is presently in continuous daily use in support of Geos-1, Geos-2, OTS, Goes-1 and as back-up support for Meteosat. A series of mission-dedicated facilities were also installed during the years 1974 – 1977 to support the Geos, OTS, Meteosat and IUE missions (Tables 2b and 3). ESOC has now controlled a variety of satellite missions – near-earth orbiting, highly-elliptical and geostationary – in both the scientific and applications fields. As mission complexity has increased over the years, so both the systems and the expertise have been developed to cope with the challenge.

Mission operations and definitions

The scientific or applications objectives to be achieved as a result of satellite in-orbit operations essentially define a mission. Each mission is conducted by operating satellite systems and ground facilities

Table 1 – ESRO/ESA satellite launches and operations conducted by ESOC

Satellite	Launcher	Launch date	End of useful life	Mission	Radio frequency[2]
ESRO-II	Scout	May 1967	Launch failure	Cosmic rays, solar X-rays	V
ESRO-IIB	Scout	May 1968	May 1971	As ESRO-II above	V
ESRO-IA	Scout	October 1968	June 1970	Auroral and polar cap phenomena, ionosphere	V
HEOS-1	Delta	December 1968	October 1975	Solar wind, interplanetary magnetic field, bow shock	V
ESRO-IB	Scout	October 1969	November 1969	As ESRO-IA	V
HEOS-2	Delta	January 1972	August 1974	Polar magnetosphere, neutral point, interplanetary medium	V
TD-1	Delta	March 1972	May 1974	Astronomy (UV, X- and gamma-ray)	V
ESRO-IV	Scout	November 1972	April 1974	Neutral atmosphere, ionosphere, auroral particles	V
ANS[1]	Scout	August 1974	March 1976	Astronomy (UV and X-ray)	V
Cos-B	Delta	August 1975	–	Astronomy (gamma-ray)	V
Geos-1	Delta	April 1977	–	Magnetosphere wave and field measurements	S/V
OTS-1	Delta	September 1977	Launch failure	Radio transmission/propagation experiments	KU(V)
ISEE-2[3]	Delta	October 1977	–	Magnetosphere	S
Meteosat	Delta	November 1977	–	Meteorology	S, L, U(V)
IUE[4]	Delta	January 1978	–	Astronomy (UV)	S/V
OTS-2	Delta	May 1978	–	As OTS-1	KU(V)
Geos-2	Delta	July 1978	–	As Geos-1	S/V
Goes-1	Delta	October 1975	–	Meteorology	S/V

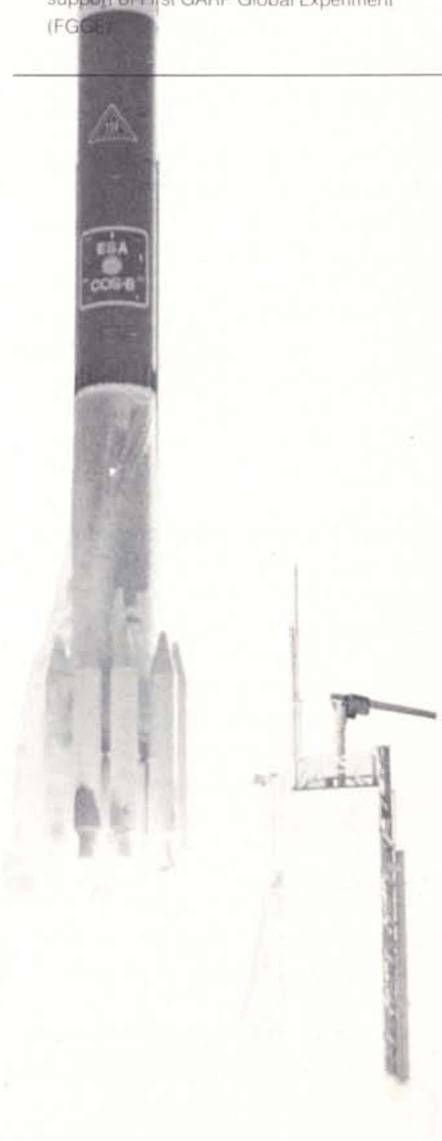
1 ANS was a Dutch national satellite project (NLR) and was supported by the Redu station and OCC. Operations were conducted from the OCC, using ESOC facilities.

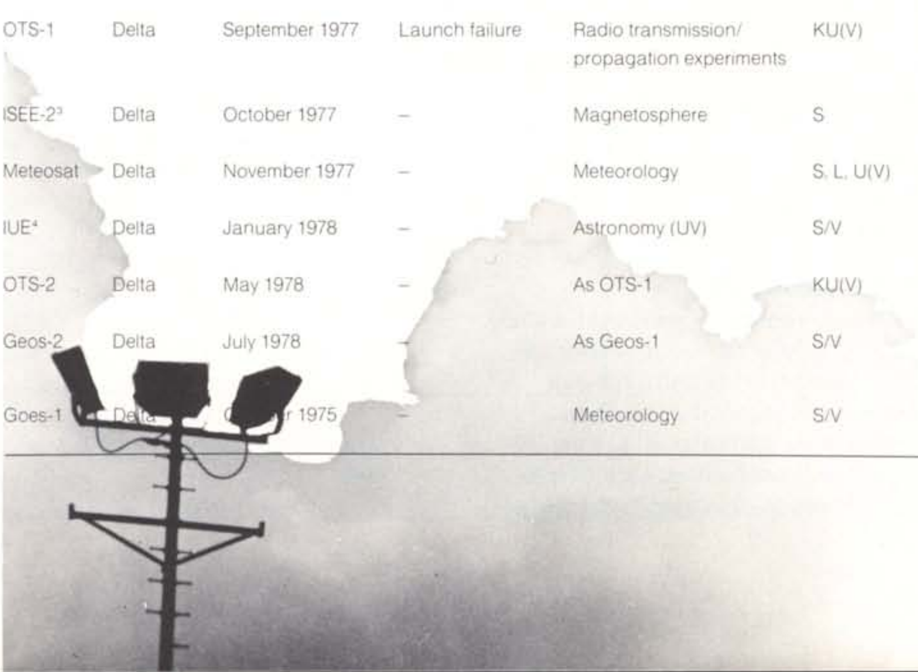
2 Radio frequencies denoted by international codes for radio bands. Downlink is given first. Letter in parenthesis denotes back-up frequency.

3 Launch operations conducted by NASA. Routine operations conducted from GSFC under ESOC control and supervision.

4 Launch operations conducted by NASA. Routine operations conducted from Villafranca for eight hours per day.

5 NOAA spacecraft. Spacecraft operations conducted by ESOC between 1 December 1978 and 30 November 1979. Over Indian Ocean in support of First GARP Global Experiment (FGGE).





according to a certain prescribed pattern. These 'mission operations' are a series of coordinated events, recorded and documented in a Flight Operations Plan, for which the ESOC Spacecraft Operations Manager is responsible. This document, which is prepared by ESOC's Operations Department in collaboration with each Agency Project Manager and team, and which is the mission guideline, undergoes many iterations before it is finalised, and careful coordination is required between ESOC, the project team and the spacecraft manufacturer.

The spacecraft mission itself is divided into three basic phases:
(a) Pre-Launch Phase (F-30 days until t-0)
(b) Launch and Early-Orbit Phase (LEOP)
(c) Routine Phase.

In the case of geostationary missions, the following subdivisions have been established:
(a) Pre-Launch Phase
(b) Launch Phase
(c) Transfer-Orbit Phase
(d) Near-Stationary-Orbit Phase
} Launch and Early-Orbit Phase (LEOP)
(e) Geostationary-Orbit Phase.

Once the LEOP has been completed and the Routine Phase of the mission declared, the Mission Control Team is disbanded and the ESOC Spacecraft Operations Team takes over the routine operations. The latter are controlled by 'Flight Control Procedures' and 'Contingency Recovery Procedures' in the Flight Operations Plan, and are conducted from a control room dedicated to the project. From here, a team of engineers and spacecraft controllers carry out all the operations tasks necessary to ensure the success of every scientific or applications satellite mission.

Throughout the lifetime of the satellite, the team of operations experts maintains coordination with the project and users on all aspects of the mission. Comprehensive reports are issued periodically by ESOC, and an anomaly report is issued immediately any unexpected event occurs.

Table 2 – ESA TT&C facilities (Estrack)

(a) VHF network – reception at 136 – 138 MHz, transmission at 148 – 150 MHz

Station	Location	Longitude	Latitude	Operator
Redu	Belgium	5° 8′	50°	ESA
Malindi	Kenya	40° 11′	−2° 59′	CRA (I)
Kourou	French Guiana	307° 11′	5° 15′	CNES (F)
Carnarvon	Australia	113° 43′	−24° 54′	OTC (Aus)

The network of TT&C stations under the control of ESOC is used to provide support during the launch, transfer orbit and near-synchronous orbit phases (LEOP) of applications and scientific missions.

(b) Dedicated stations – operated by ESOC

Station	Location	Support capabilities
Michelstadt	West Germany	S-band reception for Geos-2[1] high-speed data (112 kbits); S-band TT&C, imaging, Wefax dissemination, and DCP interrogation (UHF) for Meteosat-1
Fucino	Italy	Ku-band (12/14 GHz) TT&C for OTS-2
Villafranca	Spain	S-band reception, ranging and command for IUE; S-band TT&C, VHF back-up telecommand for Goes-1; Ku-band ranging for OTS-2

These stations form the network of mission-dedicated stations for geostationary satellite operations.

1 Geos 2 telecommand and ranging is conducted from Redu via dedicated VHF uplink

Mission preparation

The mission preparation follows the study phase, during which system-level trade-offs have been made and a baseline operational concept defined. That baseline is a technical outline of the ground-segment facilities necessary to fulfil the mission objectives. In the field of operations, the mission-preparation phase begins with the preparation of the Operations Requirements Documents for software and Control Centre facilities, covering mainly:
- online monitoring of spacecraft telemetry
- spacecraft commanding
- attitude and orbit control
- spacecraft performance evaluation
- spacecraft simulators and other test facilities
- interactive equipment in the Control Centre.

The requirements documents are provided to the operational hardware and software design staff at ESOC to assist them in the preparation of Functional Requirements.

The plan and procedures for the integrated tests on the operations system are also drawn up and used for the acceptance and validation of operations support facilities upon completion of systems installation.

A major task of the mission-preparation phase is the production of the spacecraft control documents, mainly:
(a) The Flight Control Procedures, i.e. the instructions to be followed in monitoring and commanding all satellite subsystems under nominal and contingency conditions.
(b) The Flight Operations Plan (FOP), i.e. the detailed sequence of operations to be performed during the various phases of the mission. For every operation, the FOP will specify:
- Control Centre support (online computer, telemetry decommutation equipment, offline computers)
- data, voice and telex communications
- ground stations
- commands
- telemetry monitoring
- timing and reporting

and will refer to the Flight Control Procedures.
(c) The Satellite Data Operation Handbook, i.e. a synthesis of how satellite telemetry words and commands are processed and displayed for the satellite controllers. It provides a ready cross-reference for spacecraft controllers and systems engineers and is a format control handbook for telemetry, telecommand and display formats.
(d) The Flight Dynamics Launch Support Document, which contains detailed plans

Table 3 – Control facilities at ESOC

Control room	Operations presently supported	Future use
(a) Operations Control Centre (OCC)		
Main Control Room (MCR)	Network control, MSSS control, attitude/orbit operations, operations direction (during LEOP)	same
Dedicated Control Rooms:		
DCR1	Central point for all Cos-B operations	Orbit/attitude control room
DCR 2	Central point for all Geos-2 operations Experimenter display and evaluation	Exosat control and observatory
DCR 3	Central point for all OTS-2 operations	–
DCR 4	Central point for all Goes-1 operations	Cos-B operations in 1980 (if required). Marecs DCR
(b) Meteosat Control Centre (MOCC)		
MOCC	Central point for all Meteosat-1 operations	Meteosat-1 and 2 support
DRCC	Data referencing and conditioning centre	Meteosat-1 and 2 support
MIEC	Meteorological Information Extraction Centre (MIEC)	Meteosat-1 and 2 support

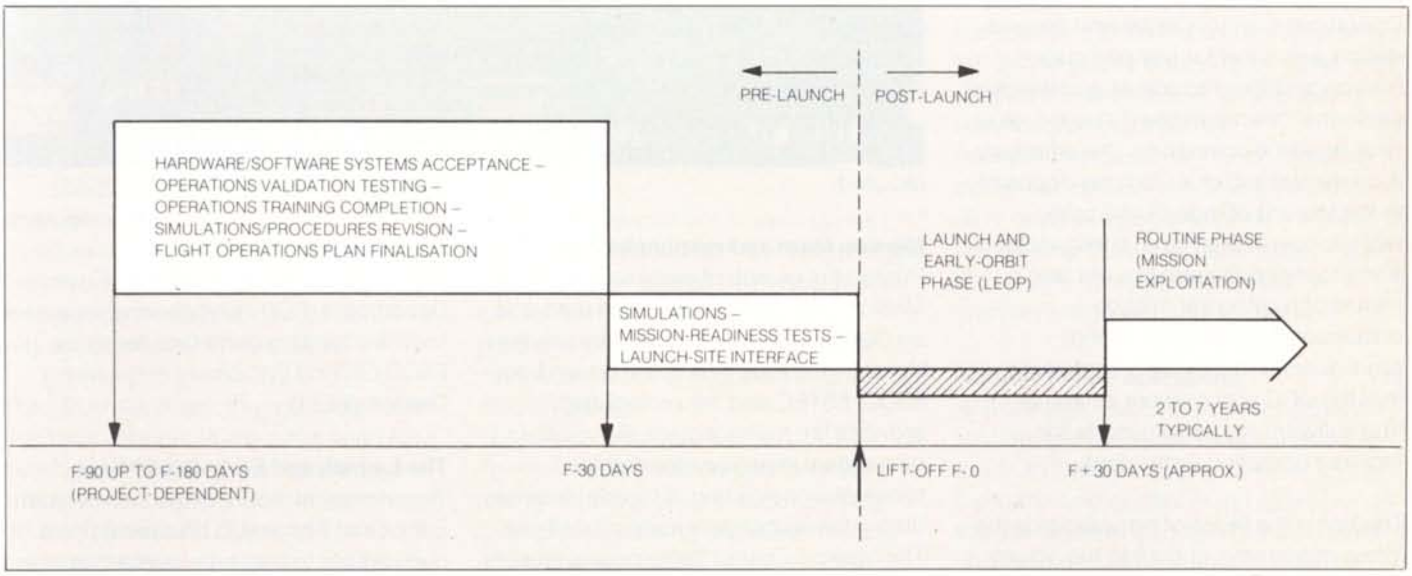


Figure 1 – Pre- and post-launch activities

and procedures for the use of flight-dynamics software during the LEOP. This document contains operational instructions for specific software to be used in support of the FOP.

Pre-launch activities (Fig. 1)

Testing

Approximately six months before launch of a satellite, an ESOC Test Programme Manager, responsible for conducting the Operational Test Programme, together with the Test Team, consisting of ESOC technical staff responsible for preparing, documenting and conducting all test activities, systematically validates and accepts the operations system following the already-prepared plan and procedures. All necessary test facilities (e.g. spacecraft hardware, spacecraft software simulators, magnetic tapes) are employed as data sources, interfaced with the operational system as required. The object of the Test Programme is to ensure that the overall ground system performs such that all the operational requirements of each mission can be supported. Testing therefore starts at individual equipment-unit level and is extended progressively to include entire systems, until finally the entire ground system is tested as a whole (Table 4).

Table 4 – Fundamental test categories

Test	Objective
Engineering Acceptance	To accept newly installed equipment from the manufacturers
Software Acceptance	To validate newly delivered software packages prior to operational handover
Compatibility	To ensure uplink/downlink compatibility between spacecraft and Estrack ground-station equipment
Operation Validation	To validate new or modified ground systems in an operational environment and ability to meet mission objectives
Mission Readiness	To confirm that the overall ground-support system is able to support the mission
Flight Dynamics System Availability	To assure final readiness of the Flight Dynamics Software System and ability to support the LEOP

Simulations

The aim of the simulations is to prepare Operations Control Centre and ground-station personnel for any particular mission and they include all activities and personnel directly involved in real-time or near-real-time operations. The emphasis is on the training of a team (as opposed to the training of individuals) using realistic operational data, configurations and situations. Simulations are also a means of proving the mission documentation and operational procedures and providing confidence that the OCC and network equipment and software are performing to the required operational standard.

The last in the series of simulations is the 'dress rehearsal' just prior to the actual launch. This simulation serves as a final confirmation that all – participants, software and hardware systems and other support – is ready to support the mission.

Training

To ensure that the staff are fully briefed, lectures, videotape courses, discussions and practical training exercises are conducted for both spacecraft-operations and equipment-operations personnel. For missions that utilise completely new facilities, the training programme concentrates on the more nonstandard aspects of the system; for missions that re-use a major part of the existing system the scope of the training can naturally be reduced.

Mission team and responsibilities

Prior to the launch of every satellite, a Mission Control Team is established and an Operations Director appointed by the Director of ESOC. This team, drawn from ESOC, ESTEC and the project itself, provides the management, technical and operational expertise essential for successful completion of mission activities during the launch and early-orbit phase. The Mission Control Team begins its work thirty days before launch (F-30).

The Operations Director, who reports to the Mission Director/Project Manager (Fig. 2), is assisted by three senior specialists. These are the Ground Operations Manager (responsible for ensuring that all ground facilities are fully operational according to requirements), the Spacecraft Operations Manager (who conducts flight operations), and the Flight Dynamics Coordinator (responsible for ensuring that the satellite is placed in the correct orbit).

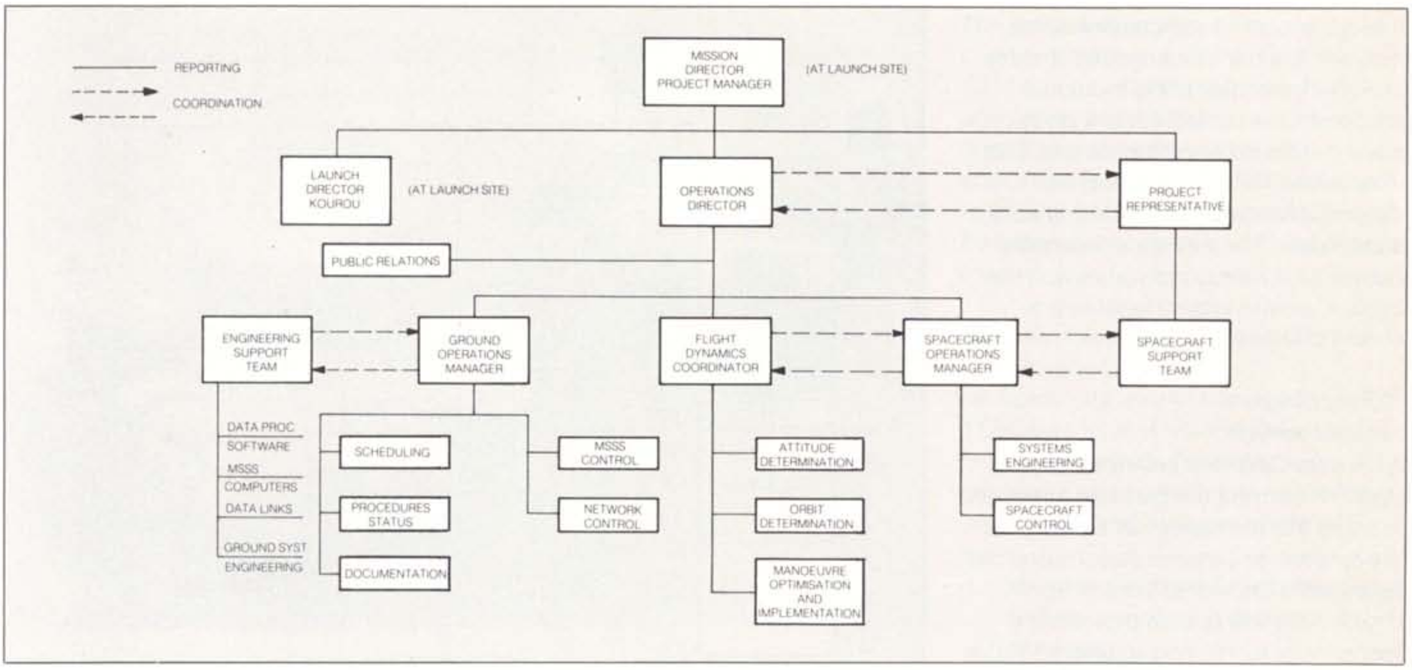
In addition to the above, software and hardware support is provided through the Multi-Satellite Support System (MSSS), data-transmission and on-site computers by ESOC Information Handling Department (IHD) and ESA Computer Department (ECD). Engineering support is provided for all ground facilities by the ESOC Ground Equipment Engineering Division (GEED).

The Launch and Early-Orbit Phase

The primary objective of the Launch and Early-Orbit Phase (LEOP) operations is, quite simply, to place the satellite into the

Figure 2 – Mission Team manning and reporting channels

Figure 3 – Main Control Room at ESOC



requisite orbit and to perform in-flight commissioning and testing prior to putting it into service. The LEOP is therefore, technically and procedurally, a very critical phase of any mission.

The LEOP starts with the final countdown and lasts until the payload has been fully switched on (typically, from a few days to almost a month after lift-off, depending on the type of mission). During this period the spacecraft is operated for the first time in the space environment in which it has been designed to function; in addition, the ground system is used in an operational role for the first time. Hence if any problems are going to occur, they are more likely to occur here than in any other mission phase.

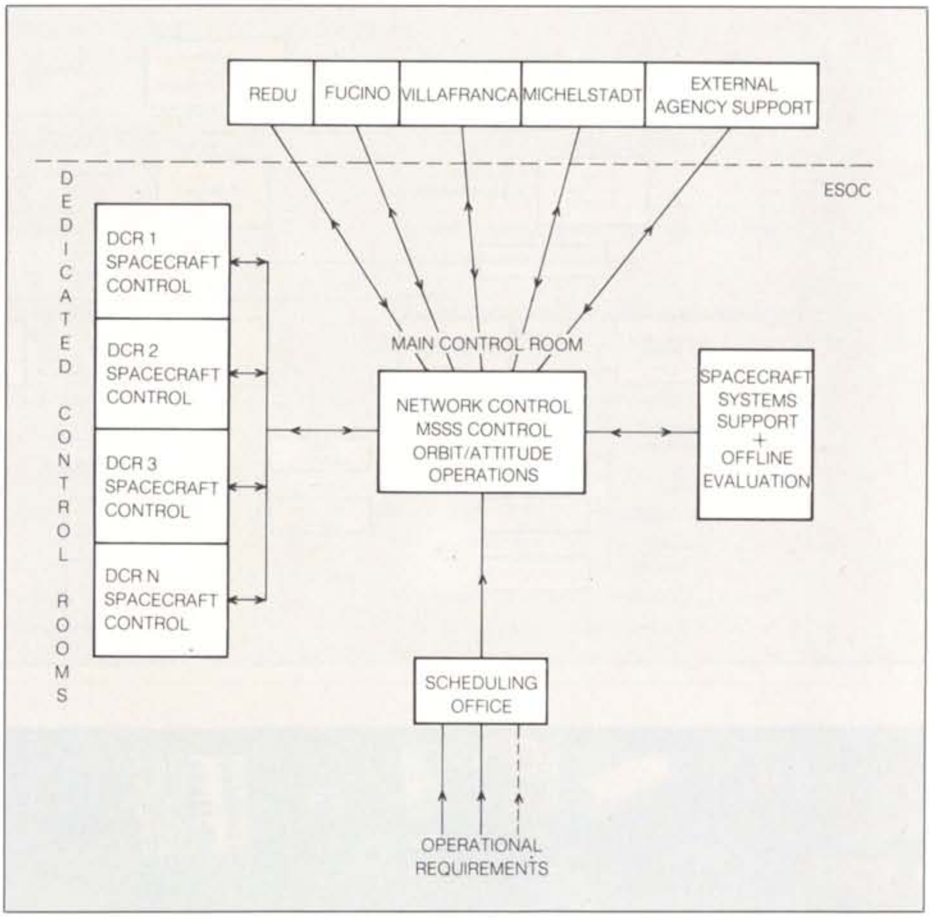
The intense level of operational activity and the number of staff involved at the OCC and supporting telemetry, tracking and command (TT&C) stations could lead to additional problems if operational plans and procedures were not carefully followed. It therefore follows that all of the operations must be conducted in strict accordance with the Flight Operations Plan, and the newly launched spacecraft is accorded first priority in the utilisation of the OCC and Estrack facilities.

In the case of geostationary-satellite early-orbit operations, the major task of the Mission Control Team is to manoeuvre the spacecraft into the correct attitude for firing the Apogee Boost Motor (ABM) that propels the satellite from its elliptical transfer orbit into the final geosynchronous orbit. During the same period (which lasts anywhere from 6 to 38 h, depending on whether the ABM is fired during the first elliptical orbit or later), the spacecraft subsystems must be carefully monitored and controlled.

Routine Phase operations

At this stage, responsibility for conducting routine orbital operations is handed over to ESOC Operations Department, and at the same time control of the spacecraft is transferred from the Main Control Room (Fig. 3) to a control room dedicated to

Figure 4 – Routine spacecraft-operations interfaces



that spacecraft for the duration of the mission. This handover ensures that the operations peculiar to the individual spacecraft are carried out in a single-mission-oriented environment, and it also releases the Main Control Room to support other satellite launch and early-orbit phases. The functional interfaces between the two control rooms and the Estrack ground-station facilities are shown in Figure 4.

Control functions

Network control

A Network Controller ensures that each station is carrying out the tasks assigned to it and that the correct data interfaces are established between stations and the appropriate Dedicated Control Room (Fig. 5). This flow of data provides the telemetry for monitoring spacecraft status and ensures that telecommand paths are readily available between the Dedicated Control Room (DCR) and the ground stations. The Network Controller is assisted by the MSSS Controller, who ensures that the MSSS is configured correctly and that all users are obtaining the facilities they require.

Spacecraft control

Each DCR is manned continuously by a Spacecraft Controller, responsible for a specific spacecraft. Telemetry data reaches the Spacecraft Controller via a ground station, over data lines and through the MSSS, which first processes and then displays requested data on the Controller's console.

In addition to receiving and analysing telemetry data, the Spacecraft Controller is able to set up command sequences on the console and to transmit them back through the MSSS and the data lines to the ground station and thence to the spacecraft. No operator intervention takes place at any point other than the Spacecraft Controller's console. (Some spacecraft missions operate in a more simplified manner, where the commanding task is carried out by the ground station at the request of the Spacecraft Controller, e.g. Goes.)

Orbit/attitude control

To provide ESOC with the latest information on the in-orbit status of the various spacecraft, positional measurements are taken by ground stations and this information is transmitted to Darmstadt over data or telex links. Once the orbital elements have been recalculated, new spacecraft-position predictions relative to the different ground stations are prepared and are transmitted back to the stations involved. This applies to near-earth orbiters, elliptical orbiters and geostationary satellites.

From these continuous orbital calculations, it is possible to detect, for example, the drift rates of geostationary spacecraft with respect to their required on-station positions. All spacecraft operate within a narrow band of longitude tolerance, and sometimes also latitude, which gives rise to a need for east-west and, where appropriate, north-south stationkeeping manoeuvres.

Appropriate orbital corrections are made using on-board gas-jet propulsion systems to ensure that the spacecraft remains on station.

For spin-stabilised satellites, attitude information is also required on a continuous basis. Attitude data contained in the satellite telemetry stream is processed by 'back-end' computers to ensure that this information is always available.

Support functions

Regular offline spacecraft-performance-evaluation programs are also run to provide spacecraft systems engineers with

Figure 5 – Geos Dedicated Control Room at ESOC

Figure 6 – Simplified schematic of data flow between the ESOC Control Centre and its spacecraft

information that enables them to assess the long-term behaviour of on-board systems.

Operational activities are scheduled by a central scheduling office that gathers the inputs from all the users and, using a system of priorities where necessary, allocates facilities according to operational needs. This includes the general-purpose ground stations and computer systems at ESOC, which serve a variety of users.

The ground-support system

In order to carry out effectively all the tasks that have been described, ESOC operates a dedicated ground system (Fig. 6), including the control and computing facilities, the TT&C stations (telemetry, tracking and command) of the Estrack network and the communications links.

Basically, this system is required to fulfil the following functions:

(a) Spacecraft telemetry reception (at the TT&C station) and retransmission to the OCC at Darmstadt. Telemetry data, processed and converted to engineering units in real-time, are used by the OCC for:

- real-time monitoring of satellite status
- real-time monitoring of manoeuvre progress
- filing and archiving of technological, scientific and applications data. Data retrieval from the MSSS of up to 24 hours of filed data is available to each Dedicated Control Room upon keyboard request
- attitude determination.

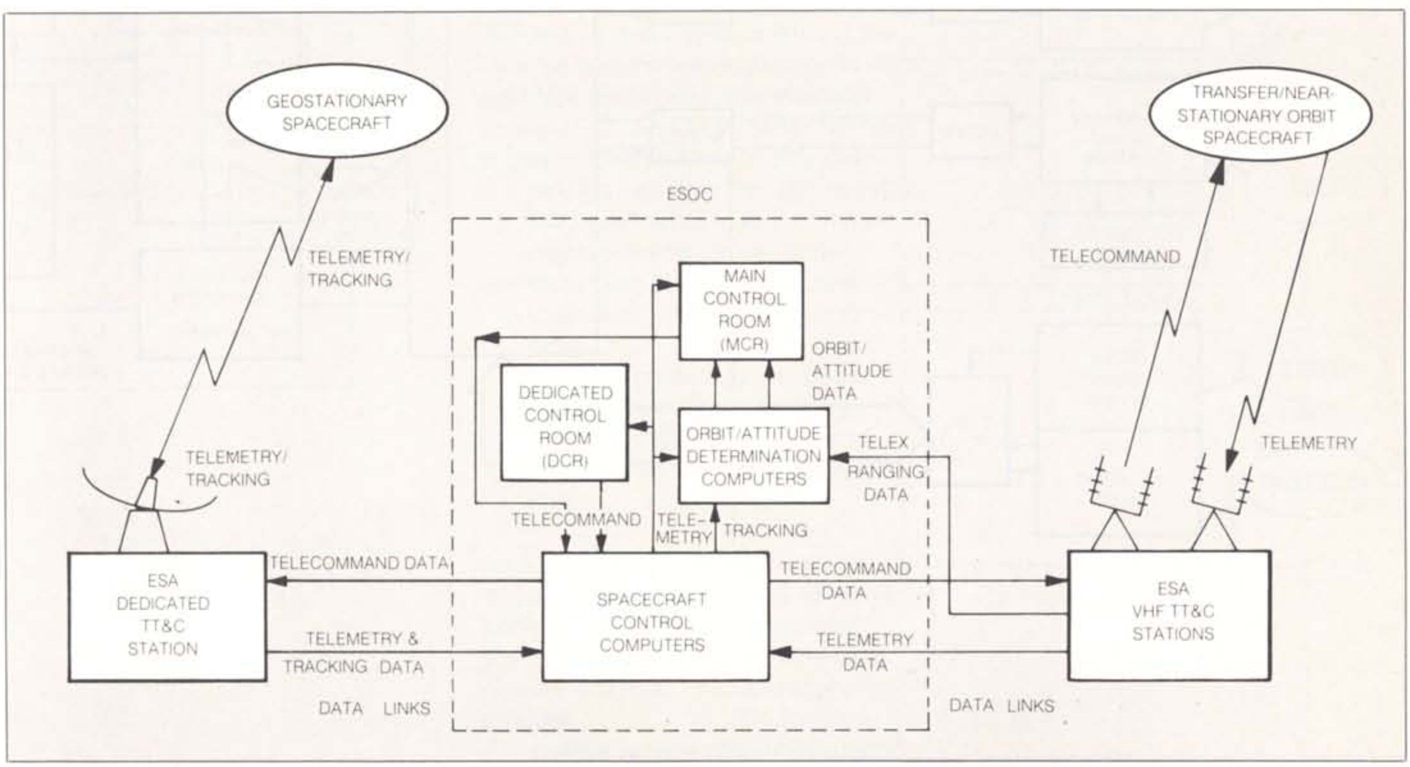
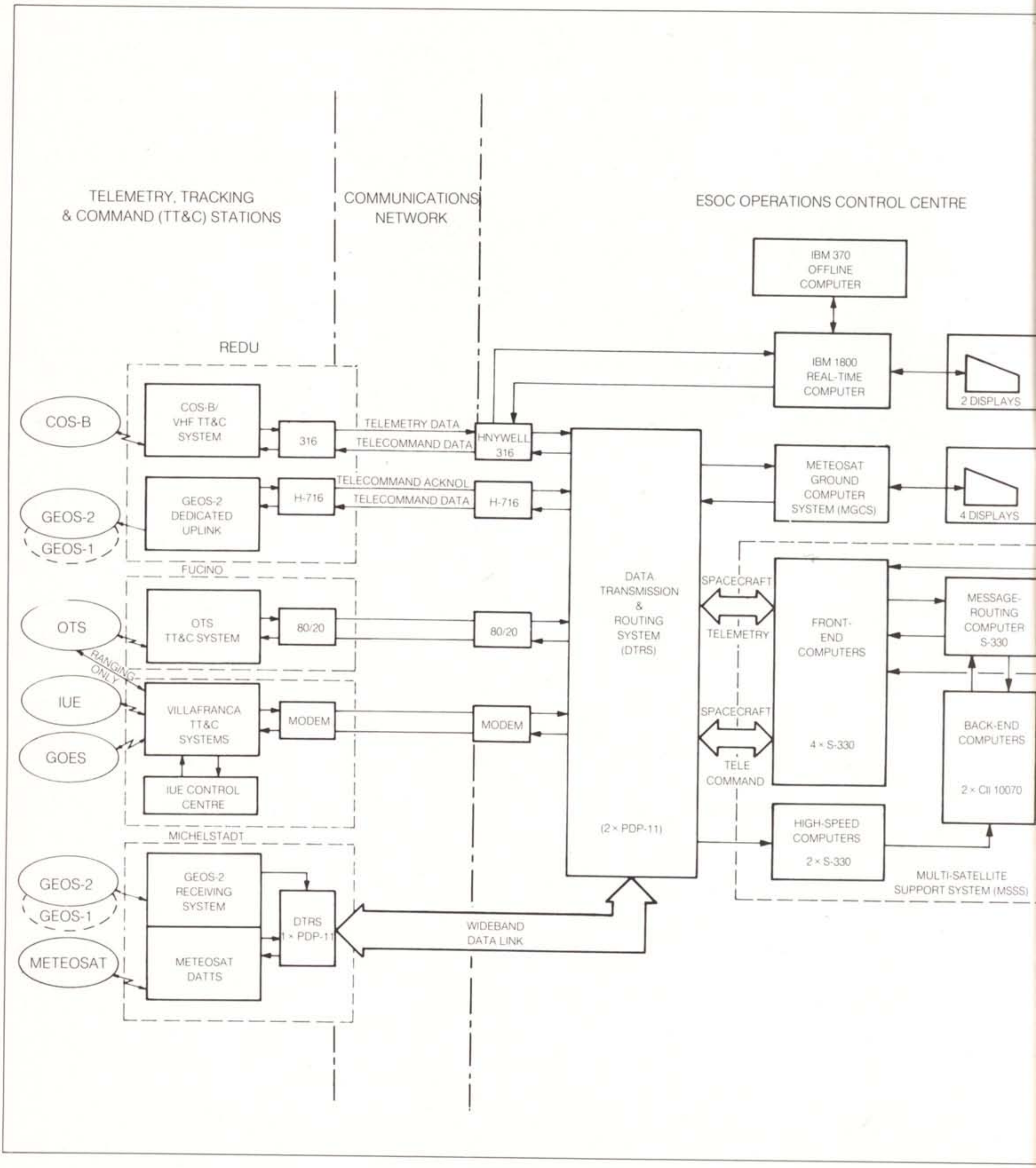
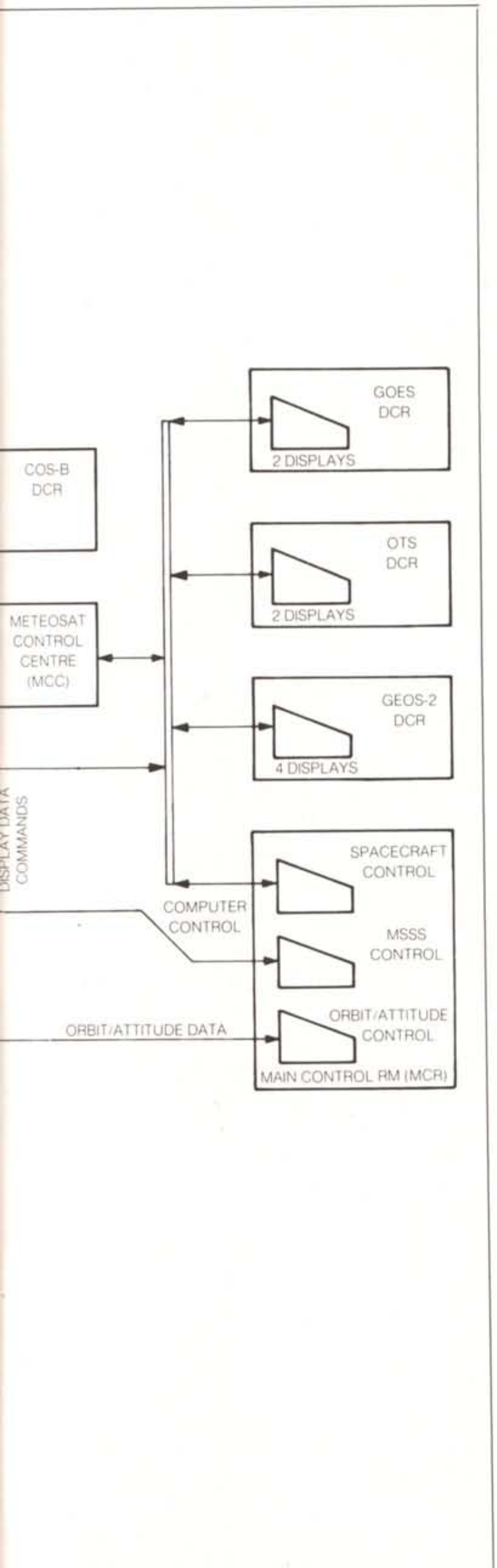


Figure 7 – Functional representation of spacecraft-control data flow





(b) Telecommand transmission and verification through the TT&C stations to each spacecraft under the control of the OCC. Telecommand capability is used by the OCC to:

- control, in real-time, the state of individual subsystems of the spacecraft (real-time command)
- control, on a regular or continuous basis, the status of individual subsystem or payloads (command schedule). This automated function enables a computer program to uplink commands to a spacecraft payload regularly and to provide regular command confirmation to the Spacecraft Controllers
- initiate orbit or attitude manoeuvres and to terminate these manoeuvres on schedule. Such manoeuvres may include drifting the satellite in an easterly or westerly direction, maintaining the satellite at a specific longitude/latitude (stationkeeping), or aligning it in a given direction, for example for the scientific observation of stellar sources (slewing).

(c) Ranging (radio measurement of the distance from the tracking station to each satellite) initiation and data reception between OCC and TT&C stations. This largely automated function provides:
- ranging data from the stations to the OCC orbit-determination computer
- orbital elements derived from processing of the ranging data (precise definition of the satellite orbit)
- coverage predictions for specific satellites over specific tracking stations (enabling Controllers to schedule operational activities at stations during LEOP).

(d) A centralised command, control and display capability at the OCC, which, in addition to facilitating management, scheduling and control of the tracking network and spacecraft operations, provides:
- multiple satellite operations support with one common computer system (MSSS)
- common procedures and similar software for each mission
- standardised format for data displays and command files
- flexibility in switching control of individual spacecraft to alternative control rooms or, should equipment failure limit control from Dedicated Control Rooms, to the Main OCC Control Room.

Figure 7 provides an overview of the flow of spacecraft control data between the OCC Control Rooms and the spacecraft presently under ESOC's control.

Operational Extraction of Cloud-Motion Winds from Meteosat Data

J. Morgan, Meteosat Data Management Department, European Space Operations Centre (ESOC), Darmstadt, Germany

One of the roles of the Meteosat system is the routine calculation of wind vectors by observing the movement of clouds from image to image. This aspect of the system has been in operation on a regular basis since mid-November 1978, immediately before the start of the Global Weather Experiment. By July 1979 it had generated nearly 200 000 cloud wind vectors, which are distributed globally and utilised in real-time as well as contributing significantly to the Experiment's longer term goals.

The basic principle of the methods used at ESOC to derive cloud-motion winds from Meteosat image data is very simple. The starting point is a sequence of satellite images, all covering the same area of the earth. These images must be carefully aligned so that all the coastlines and the earth horizons coincide from image to image. The movement of clouds across the sequence is then apparent from the superimposed images and can be measured. The height of the clouds is determined by reference to their infrared radiances, since these can be converted into temperatures by means of calibration curves and the Planck function. The temperature of that part of the atmosphere in which clouds occur normally decreases with height, so that knowledge of the atmospheric profile permits cloud height to be calculated from cloud-top temperature.

Meteosat image data, which is generated by the satellite at half hourly intervals in up to three spectral channels, is very well suited to the task of calculating cloud wind vectors. The images are relayed in digital form to ESOC, where a powerful computer system computes cloud winds using objective numerical techniques, against working deadlines of a few hours after image time.

Two computer runs for wind extraction are made daily – close to noon and to midnight – and these produce about 1000 cloud winds each day. This task is carried out by the Meteorological Information Extraction Centre (MIEC), which relies on a fully automated system complemented by a manual editing process.

The MIEC scheme is based on the systematic processing of segments of image data. Each segment is an array of 32 × 32 infrared (IR) picture elements (pixels) and covers an area about 200 km square (Fig. 1).

Several distinct stages in the complete process can be identified, and these are described below.

Image referencing

The first step is to register a sequence of three images – an image 'triplet' – so that all are perfectly aligned with each other and so that the location of specific pixels can be given in earth coordinates. This is known as 'image referencing', or 'image navigation', and is achieved fully automatically by software, using a predictive model of the spacecraft's orbital and attitude movements supplemented by earth-edge measurements on the actual images (the horizon transition can readily be detected by software).

The accuracy of the cloud-wind determination is extremely sensitive to the precision of this step, since mis-registration of images an hour apart by as little as one pixel causes an error of more than one metre per second in the resulting wind fields (there are 2500 IR pixels in each of 2500 lines of image data). Careful analyses have shown that satisfactory performance can indeed be achieved, with mean wind errors due to mis-registration of less than 0.5 m/s, which is well within specification.

Figure 1 – The Meteosat coverage area and MIEC segments. The automatic system attempts to compute a wind vector in each of the 3000 segments (small squares) within a 50° great circle arc of the subsatellite point

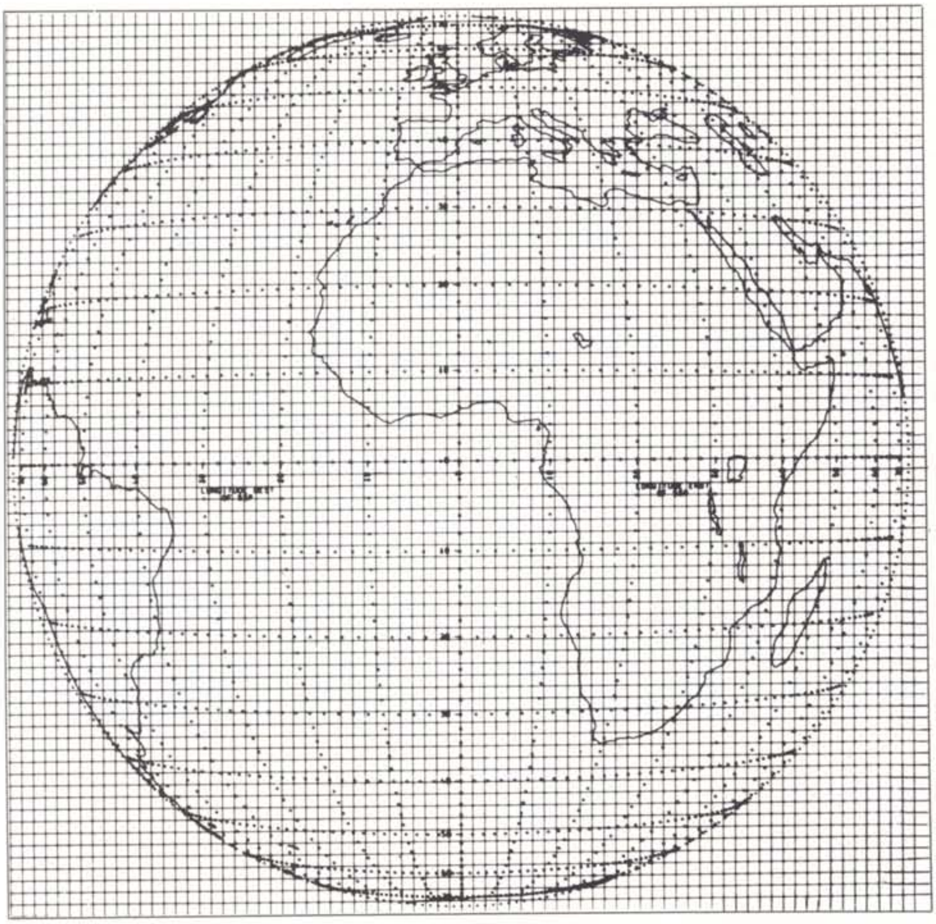
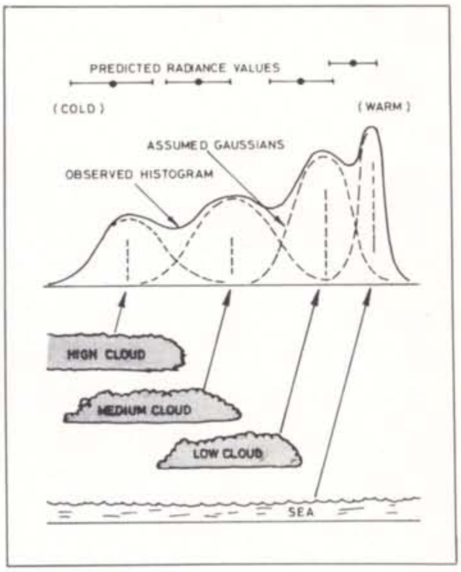


Figure 2 – Idealised schematic of the one-dimensional histogram analysis concept. The segment description gives the predicted radiances at the top of the diagram. The real segment yields an observed histogram which is processed to produce the underlying Gaussians. These are then matched to the predicted values and hence to the physical sources



Segment processing

The basic unit of processing is the segment. This is an array of 32 × 32 IR pixels (64 × 64 visible pixels) cut from the image in such a way that the centre of each segment is always at a fixed geographical location, using image-navigation information. A total of 80 × 80 segments are cut from the full image, which more than covers the full earth's disc; routine processing is restricted to the 64 × 64 segments within a 50° great circle arc of the subsatellite point (Fig. 1).

Before any attempt is made to compute a wind, it is necessary to know if suitable clouds are present in each segment. The segment processing task completes a multispectral analysis of the central image of the triplet, using all available channels, to identify which clouds, if any, are present. The starting point is an *a priori* estimate of the sources of radiation in each segment – clouds at various levels, sea or land. From this information, predictions are made of the radiances from each source. These radiances are corrected for atmospheric effects and hence indicate the expected values at the top of the atmosphere. The actual segment histograms are then analysed for peaks, so that clusters of values (assumed to have Gaussian distributions) can be extracted. Each observed cluster is then matched with the predicted radiances and associated with a physical source of radiation – cloud, land or sea (Fig. 2).

Wind-vector determination

IR segments from three successive images (a 'triplet') are used to determine one wind vector by an automatic correlation process. The central image segment is the target, and the algorithms search for a similar pattern in each of the two adjacent images in turn. Only segments having suitable tracers (determined during segment processing) are utilised as targets. The search area comprises an array of 3 × 3 segments, centred on the target segment of the central image (Fig. 3). A good match of the target in the centre of this search area implies little wind, but in general the match is offset from the centre and the displacement represents the wind vector. The algorithm computes the cross-correlation coefficients for each possible displacement of the target segment within the search window, giving a 65 × 65 matrix of correlation coefficients. This correlation surface is then searched for peaks, which are accepted as indicative of a wind vector only if there are symmetric peaks in the two determinations (central image ± half an hour). This is intended to eliminate most of the spurious wind vectors that can arise from correlation peaks due to repetitive cloud patterns (Fig. 4).

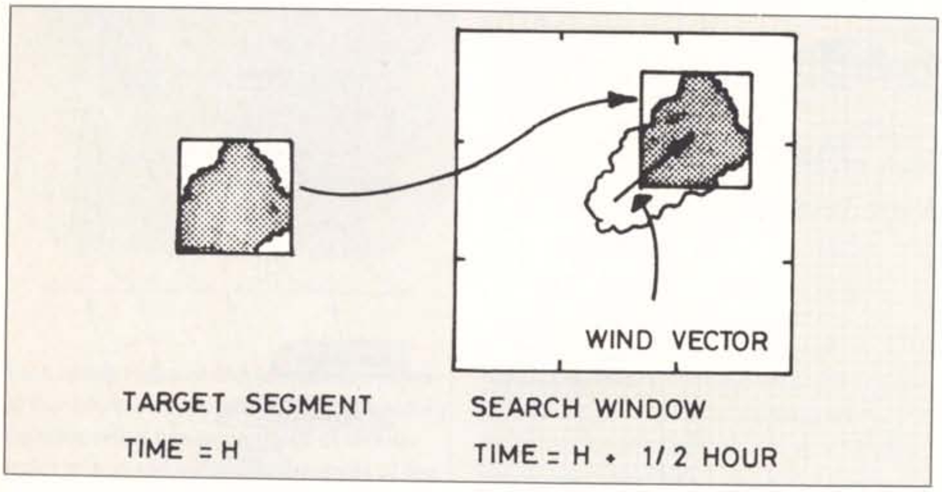
If there is evidence of more than one cloud layer in the segment, the correlation coefficient is computed again, this time only around the previous correlation peak, but with the radiance data modified by grey-scale enhancement to select only one cloud layer at a time.

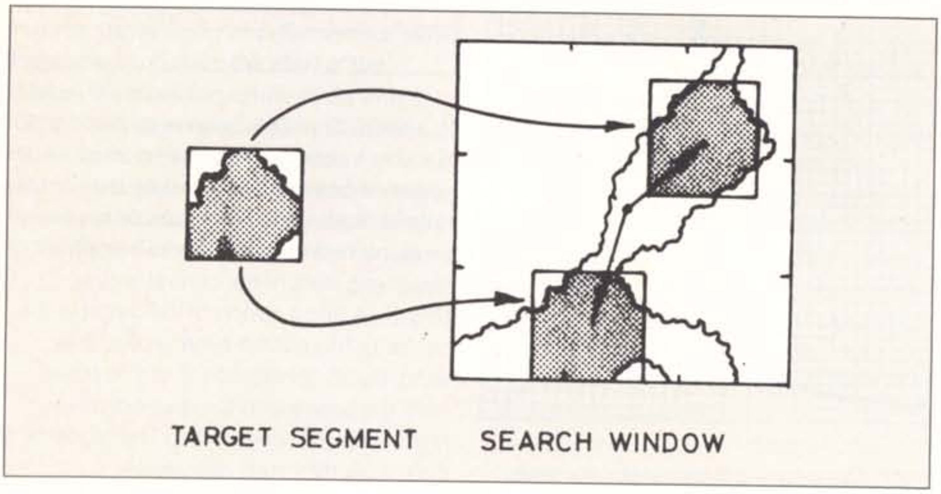
The maximum improvement in correlation

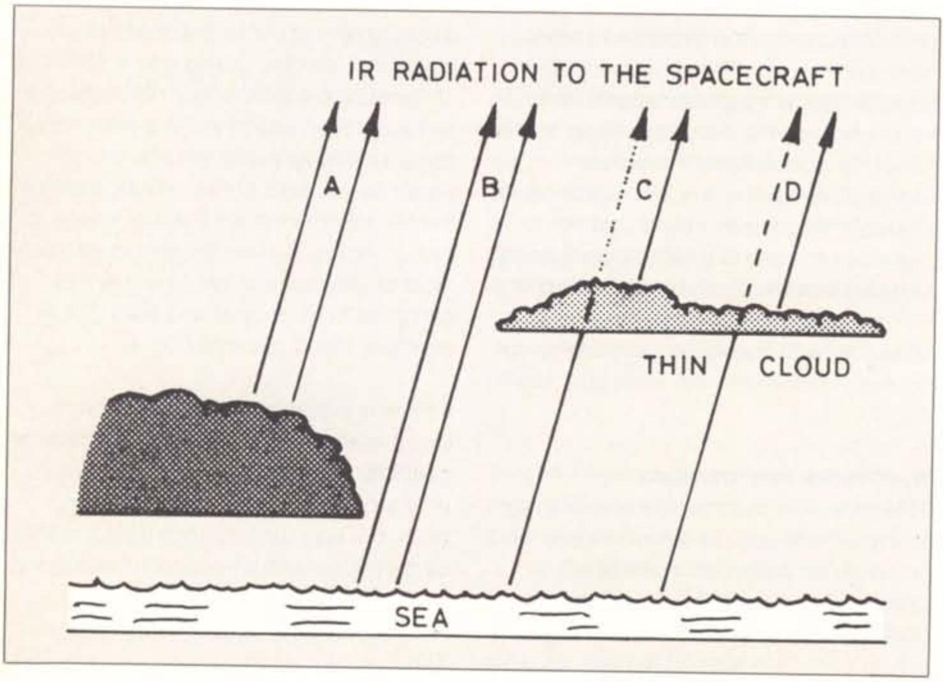
Figure 3 – Correlation matching, in which the target segment at time H is compared with the larger search window at time H + 1/2. The location of best fit (highest correlation value) defines the translation of the target from the centre of the search window, and hence the cloud motion vector

Figure 4 – An example of spurious vectors generated by multiple correlation peaks associated with repetitive cloud patterns

Figure 5 – The transparency problem. Radiation from thick cloud (a) gives a low radiance value corresponding closely to the cloud-top temperature. Pixel (b) has a high radiance value associated with the warmer sea surface. The thin cloud at (c) and (d) is semi-transparent, and hence the radiation reaching the spacecraft is composed partly of high and partly of low radiances. The net radiation in pixel (c) or (d) is therefore overestimated – i.e. it is too warm.







value identifies which cloud layer is associated with the particular displacement peak. The location of the peak is refined by quadratic interpolation over adjacent values. Finally, the wind vector is obtained by computing the total displacement, peak to peak, over the triplet. This gives a one hour vector for the cloud layer involved.

Height attribution

At this point a wind has been determined and has been associated with a cloud layer, classified as low, medium, or high, for which the mean radiance values are known. The IR (11 μm) mean cluster radiance is now adjusted to compensate for the semi-transparency (Fig. 5) of the cloud by use of the corresponding 6 μm radiances in the same segment. The corrected 11 μm radiance is then converted to an equivalent cloud-top temperature by means of the Planck relationship, and hence into a corresponding pressure by use of an atmospheric profile derived from the USA National Weather Service global forecasts (received twice per day at ESOC).

This completes the automatic part of the determination for one wind, and the next segment with a valid tracer is then considered. When all possible segments have been processed the winds are ready for manual checking.

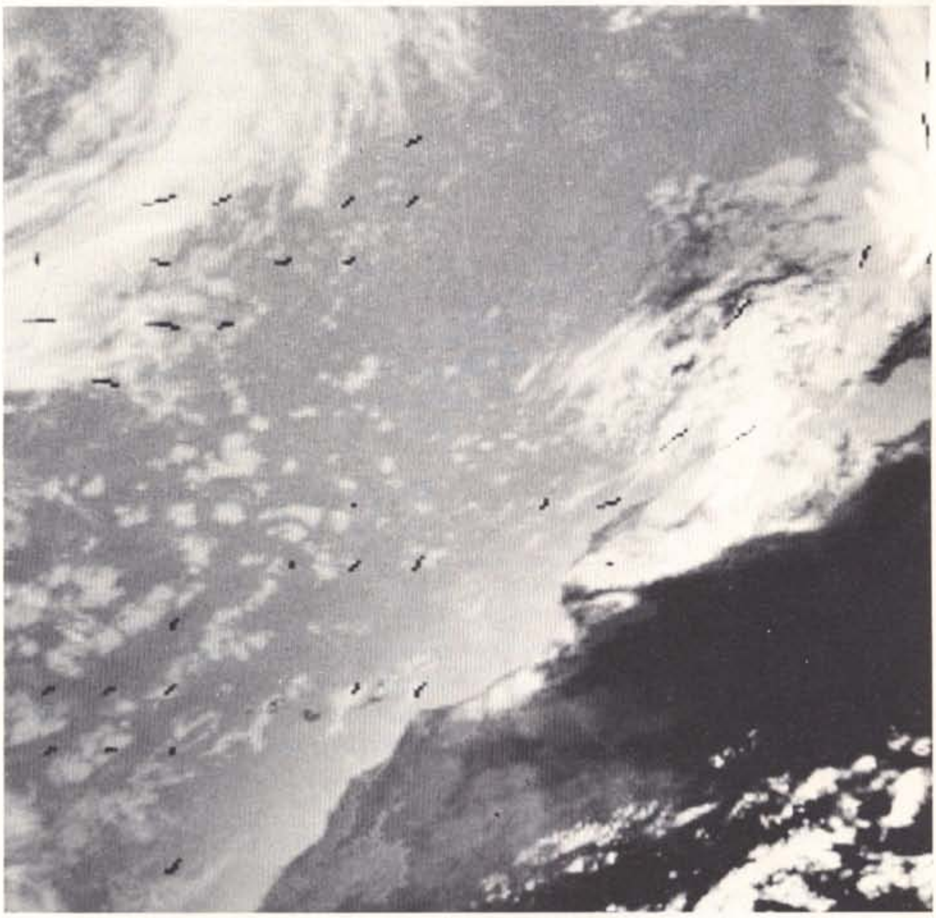
Manual editing

This is an interactive process whereby a trained meteorologist examines all the winds generated by the automatic system and rejects those that appear to be meteorologically unacceptable. The technique relies on a video subsystem (Fig. 6) on which the wind vectors and associated images can be displayed in animated sequence. The wind vectors are colour coded according to height (red for high-level, blue for medium-level, and green for low-level winds) and are displayed on a scale identical to that of the images on which they are superimposed. The operator first displays a full-earth-disc picture of the central

Figure 6 – The MIEC display console. The colour-television display in the centre is used to study both images and results (Fig. 7). The screen on the left displays graphical data in colour, while the right-hand display is for alphanumeric information

Figure 7 – The animated, coloured display used for manual editing of the MIEC winds. The short solid lines on the screen are wind vectors computed automatically from the cloud fields (light tones)

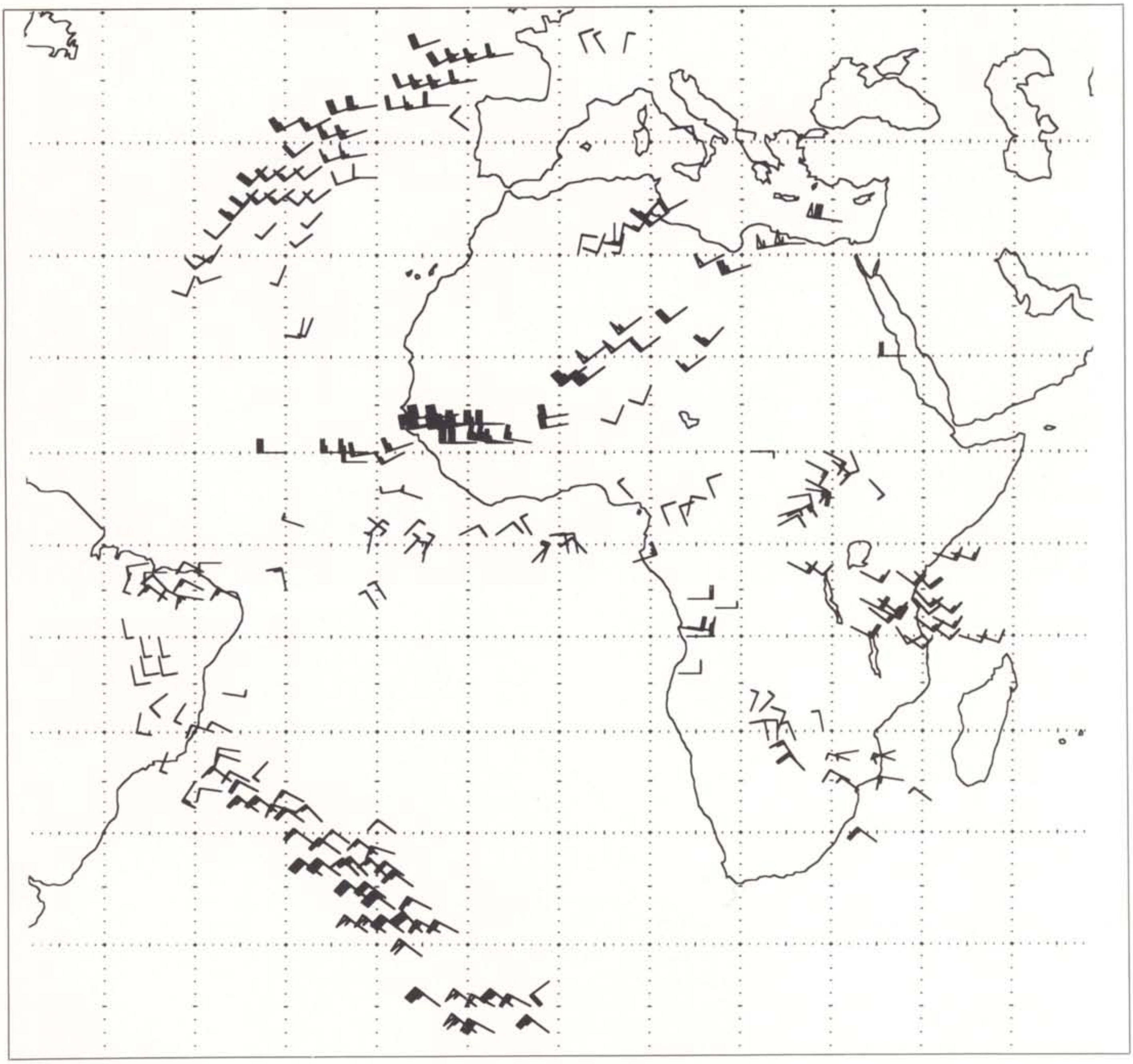
image in low resolution. This gives a feeling for the overall synoptic pattern, since the locations of frontal systems, tropical storms, trade-wind areas, etc. can be clearly identified. One quadrant of the disc is then selected and a triplet sequence set up for this area, at medium resolution. The images can then be viewed in rapid succession, giving an animated effect. The display shows the first image without winds, followed by the second image with the wind calculated from the first two images, followed by the third image with the wind calculated from both image pairs (Fig. 7).



After studying the patterns at this resolution, the operator examines each area in turn at higher resolution (zoom effect) using the same animation sequence and with the winds scaled up to correspond to the zoom factor. All winds that:

- do not appear to correspond to the movement of any cloud
- appear to be attributed to the wrong height
- appear to be associated with orographic clouds (stationary clouds

Figure 8 – Examples of high-level (390 – 100 mb) MIEC winds at 1800 UT on 3 March 1979. The winds define the strong southwesterly flow over the North Atlantic, the subtropical jet over North Africa and the northwesterly jet over the South Atlantic. (The wind arrows point in the direction to which the cloud is moving, the barbs indicate speed. A full length barb is 10 m/s, a triangle 50 m/s). Determination made at 1800 UT due to eclipse around 00 UT



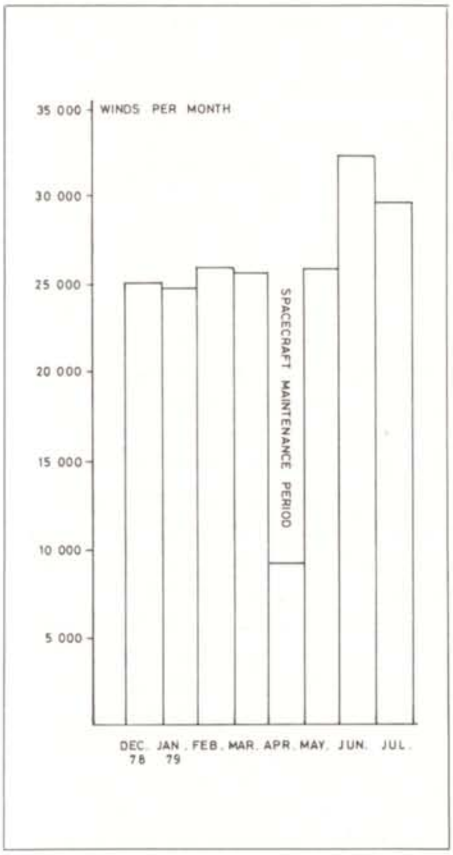
near mountains, for example)
- are associated with the development of, rather than the translation of, clouds, or
- are associated with the movement of cloud systems rather than of individual cloud elements,

are then deleted by the operator. This deletion process is simply a matter of moving a cursor on the screen to the offending wind and using a light pen to delete the vector. The operator has various tools available to check individual winds more closely, by varying the speed of animation, by examining areas at even higher resolution, by modifying the grey levels, etc. These tools are very effective in displaying many of the potentially anomalous cases noted above.

Distribution

After editing, the winds are converted into a digital code, using the standard data formats provided by the World Meteorological Organisation (WMO), and transmitted automatically over WMO's Global Telecommunication System (GTS) via a computer-to-computer link with a system node in Offenbach, Germany.

Figure 9 – Availability of MIEC winds, December 1978 – July 1979. The low availability in April was due mainly to routine spacecraft maintenance scheduled for that month



The total elapsed time between image acquisition and distribution is normally less than three hours in the case of winds computed for the northern hemisphere, and four hours for southern-hemisphere winds.

The wind data are also archived in digital form, and once or twice each month the cumulative results are written on magnetic tape in a special international format and mailed to a data centre in Sweden, where they become part of the information stored and utilised in the Global Weather Experiment, an international cooperative venture running from 1 December 1978 until 30 November 1979.

Quality and availability

The MIEC cloud wind vectors have been subjected to a series of systematic evaluations, internally at ESOC and also in cooperation with six meteorological institutes in Europe. They have also been compared with data from other satellite operations (in Japan and the USA), both directly in the area of overlap with one of the USA spacecraft, and indirectly by means of a standard comparison with conventional data.

The evaluations within Europe took place in April, July and November 1978, as part of a planned development and test sequence. The results of the first two evaluations were used to improve the system and by November it was confirmed that a satisfactory standard had been attained and wind production became a routine operation. Further small changes to the system during 1979 have continued the tuning process, with consequent improvements in quality, which have been confirmed by additional follow-up evaluations. There is therefore no doubt that the system works effectively, and that the results are acceptable.

After quality, the next goal to be achieved was that of high availability. The problems involved in getting this complex system to work as a routine operation have not been trivial, but thanks to the efforts of all those involved at ESOC, the entire system now works smoothly with an availability (second quarter of 1979) of around 99%.

Overall system availability between the start of operations and July 1979 was about 85%. This not only reflects the initial difficulties in setting up the system, but also occasional interruptions due to essential routine spacecraft maintenance.

Nevertheless both quality and availability have now reached acceptable levels, and in all some 199 000 quality-controlled wind vectors have been distributed in the seven full months of operation up to the end of July. They are in daily use by a number of meteorological services, both inside and outside Europe, and there is no doubt about their value or effectiveness, particularly for the data-sparse regions of the tropics and the southern hemisphere. The system represents a useful contribution both to routine meteorological operations and to long-term research into dynamic atmospheric structures and the variability of wind fields over large areas.

As a postscript it is interesting to record that both the USA and Japan also compute cloud wind vectors on a daily basis for images from the Goes and GMS spacecraft, respectively. Their methods are not identical, but the results are similar, so that the Meteosat cloud winds form part of a globally compatible system.

The first day of December 1978 was the historic first date on which satellite cloud winds could be derived on a world-wide basis, using data from five similar spacecraft spaced at roughly equal intervals around the equator. Four of the satellites (two Goes spacecraft, Meteosat and GMS) have real-time wind operations much as described above. The last spacecraft – an American Goes presently being operated by ESA – is only temporarily located over the Indian Ocean for the Global Weather Experiment and its images are used in the USA for delayed production of cloud winds some months after the event.

Application of Meteosat Images for Ecological Studies of Desert Plants

E. Brinckmann, D.J. von Willert & D. Thomas, Lehrstuhl Pflanzenökologie, Universität Bayreuth, Germany
K.-G. Lenhart, European Space Operations Centre (ESOC), Darmstadt, Germany

Adaptation of plants to extreme habitats is one of the most fascinating topics in ecology. Since all reactions of life depend on water, desert plants must develop mechanisms for survival when the water supply is extremely low. The physiological responses of plants to environmental changes have been studied in the southern border region of the Namib desert (Richtersveld). The environmental information collected during the ground survey has been compared with Meteosat images taken at the time, to see if the plant responses to weather changes could be predicted from Meteosat information alone, without recourse to difficult ground monitoring. Similar studies relying on Meteosat-derived information are foreseen for future ecological surveys in Africa.

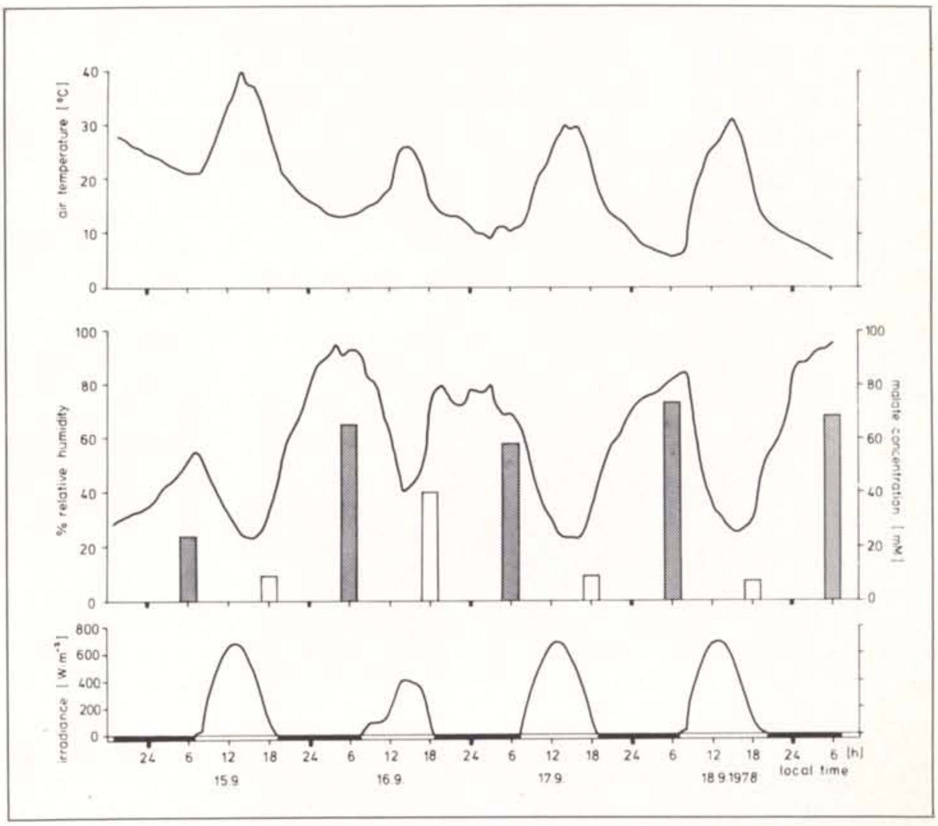
The climate of South Africa's southern Namib desert and the Richtersveld is characterised by very low and erratic precipitation (40–80 mm/y), which falls mainly in the winter. The reason for this low rainfall is the presence of the cold Benguela current which flows past the southwest coast of Africa. On the other hand, the proximity of the coast together with the presence of the Benguela current very often results in cold, highly humid air moving inland at night. The days are mostly hot and dry. The interesting feature of the Richtersveld is that the vegetation density is high compared with other desert regions with similar low and erratic rainfall. To maintain the vital functions in an active state during the dry period the plants still need water; this water is stored in special tissues in the root, stem or leaves of the plants (depending on the site of this tissue, these plants are called root, stem or leaf succulents).

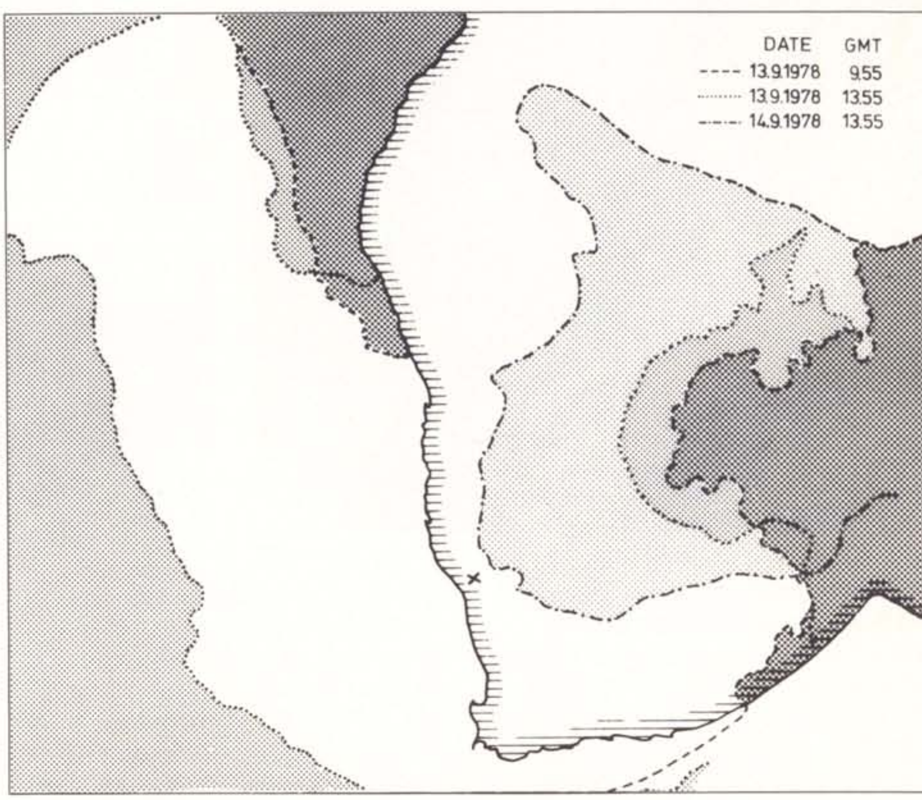
The Richtersveld lies south of the Orange River and is about 20–80 km from the coast. It is a mountainous region (Fig. 1) used by the few inhabitants for grazing goats, which seem to prefer browsing the buds and flowers of the succulents, at least during the dry season. The reason for this may be the very high salt content of the leaves of most of the plants, although the salt concentration of the soil is rather low. This salt accumulation is typical of the Mesembryanthemaceae plant family ('midday-flowers' which open in the afternoon), which are found mainly in the Richtersveld and other parts of South Africa. They constitute about 80% of the ground cover and the question is, how do these plants survive in this region?

Figure 1 – Typical vegetation in the Richtersveld, South Africa

Figure 2 – Air temperature, air humidity, and irradiance at Numees (Richtersveld) and malate concentrations (dark grey at sunrise, light grey at sunset) in the stem tissue of Psilocaulon

Figure 3 – Hot, dry air masses advancing towards the Richtersveld (x). The cloud fronts are redrawn from Meteosat images





Photosynthesis in arid climates

From laboratory experiments with plants grown in the greenhouse, it is known that members of the Mesembryanthemaceae plant family exhibit a physiological behaviour that is the reverse of that of most plants from moderate environments, such as forest trees and crop plants. Nonsucculent plants usually open their small pores or 'stomata', which control water vapour and gas exchange to and from the leaves, during the day and fix the carbon dioxide that comes from the air inside the leaves photosynthetically; i.e. they synthesise sugars and starch with the aid of captured solar energy.

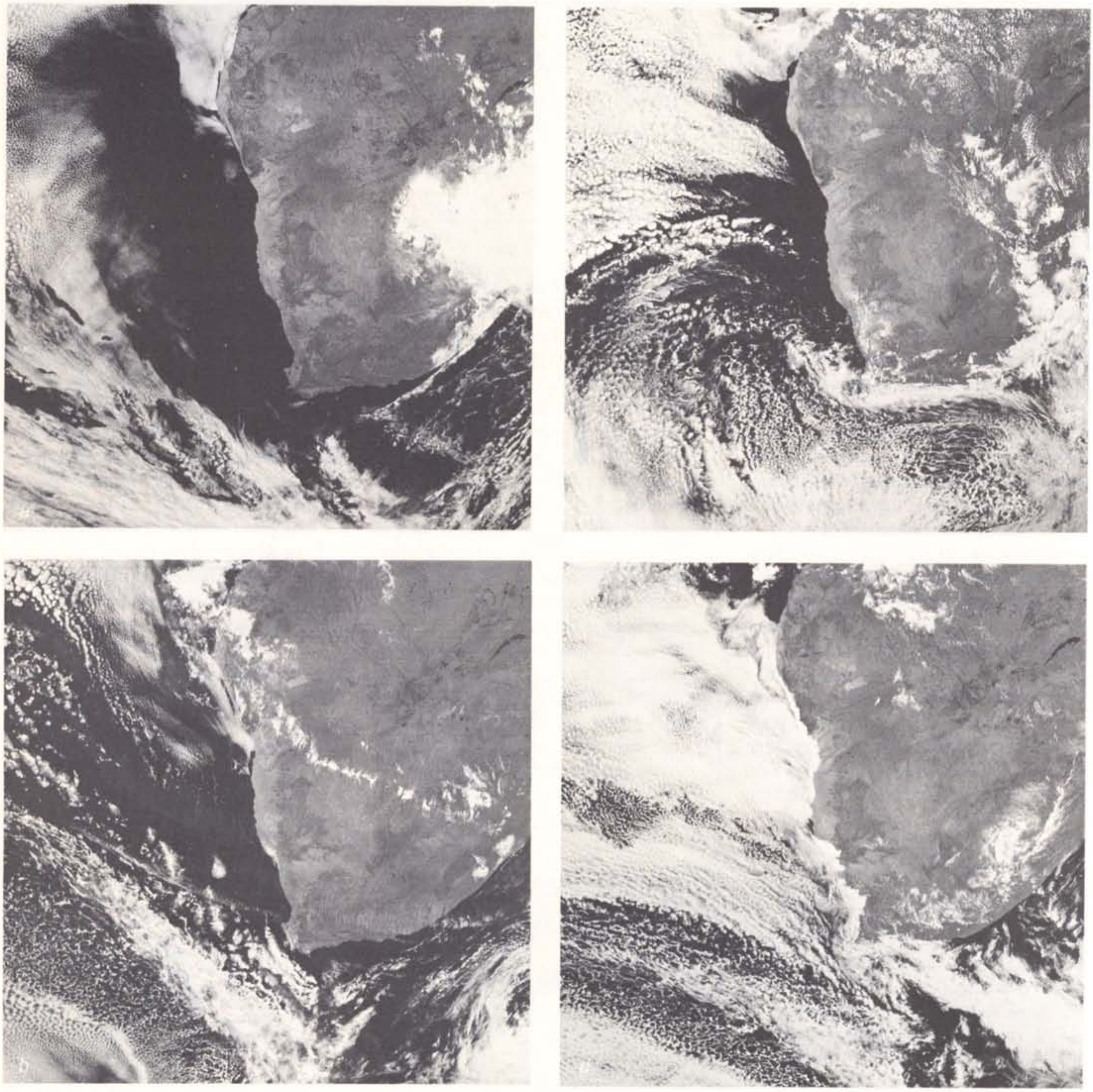
In the arid zones of our globe, the opening of the stomata during the day (especially in the dry season) would result in rapid water loss because of the very low air humidity and the lack of a continual water supply from the soil. Many of the succulent plants (Cactacae, Crassulaceae etc.) avoid this dangerous water loss by opening their stomata only during the night, when the air's water-vapour content is higher. In the hours of darkness they incorporate carbon dioxide into an organic molecule, malic acid, and store this acid until the following day. After sunrise the stomata shut and CO_2 is liberated enzymatically from malic acid. This is then fixed in the normal photosynthetic chain into sugars and starch which are the substrates for growth.

Ground verification

Unfortunately, information on the climate in the Richtersveld over periods of more than a few weeks is rare, and it seemed that Meteosat images could at last provide longer-term climatic data. During the ground survey (13 September – 14 October), therefore, data were collected for comparison with Meteosat image data to get an idea of the extent to which the satellite's images could be used in predicting the physiological responses of the plants.

Figure 2 shows some climate data and

Figure 4 – Typical cloud formations over South Africa on Meteosat images and their subjective classifications for the Richtersveld area:
(a) Clear day (type C), 13 September 1978, 9.55 GMT
(b) Scattered cloud formation (type c), 22 September 1978, 9.55 GMT
(c) Very cloudy sky (type w), 4 October 1978, 13.55 GMT
(d) Completely cloud-covered sky, such that fog and rainfall are possible (type W), 16 September 1978, 9.55 GMT

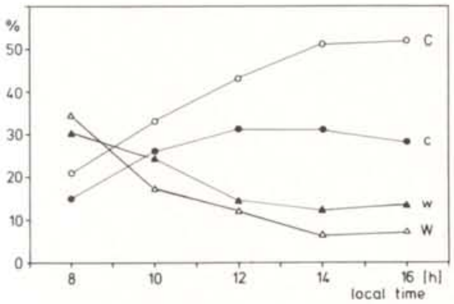


the malate content in the succulent stems of Psilocaulon shrubs. In the evening, prior to sunset, the malate concentration is low except on the 16 September, which will be discussed below.

During the nights with high relative humidity and low temperature, malate formation is high. On the night of 14/15 September, however, there is a lower malate accumulation. This was the last night of a short hot, dry period which came about as a result of an easterly wind. The westbound air movement from the hot Kalahari desert reached the coast on the night of 13/14 September and this can be seen very clearly on the Meteosat images (Figs. 3 and 4a). Figure 3 shows the advance of the cloud front from the east. On 16 September clouds formed over the sea (Fig. 4d), and this correlated

Figure 5 – Frequency of occurrence of four different types of cloud formation (Fig. 4) as a function of time of day (average for 344 days between March 1978 and February 1979)

Figure 6 – Seasonal change in the frequency of the four different types of cloud formation (Fig. 4) in the Richtersveld, evaluated from Meteosat imagery



with the change in wind direction back to the east. Figure 2 shows the marked reaction of the plants to this increase in temperature, with malate formation during the night of 14/15 September only 50% of that during the following cool night.

During the day of 16 September another interesting response of Psilocaulon to weather conditions can be seen. Instead of the nearly complete malate decomposition found on 15 and 17 September, its concentration in the tissue remained high. The Meteosat images (Figs. 4a and 4d) show that for half the day the sky was completely covered by dense cloud (light intensities shown in Fig. 2) and the plants were probably able under these low-light and humid conditions to fix CO_2 from the air and not from the breakdown of stored malate. Additional experiments have shown that the succulents are able to increase the water content in the younger leaves or shoots when temperatures are low and humidities high, for example when there is dew or fog. This mechanism allows plants to survive for several months in the absence of a ground water supply.

Daily and seasonal cloud patterns
To obtain an indication of the incidence of possible 'foggy days', a classification was made of the cloud formations detectable on the satellite imagery in the visible and infrared channels and this was correlated with the ground observations in the Richtersveld. In the classification used

C = clear sky (Fig. 4a);
c = scattered cloud cover (Fig. 4b);
w = large cloud formations in the vicinity or smaller cloud aggregations in the area, i.e. with a probability of fog or rain (Fig. 4c);
W = completely cloud covered sky, indicating a strong possibility of fog or rain (Fig. 4d).

Figure 5 gives the average mean frequency with which these types of cloud formations occur on any given day.

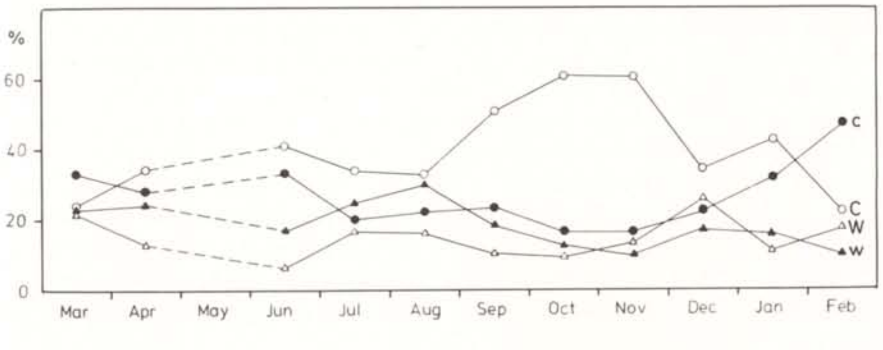
Clear skies together with high temperatures and low humidity can lead to plant water stress. Because cloud cover is more frequent in the morning, plants on east-facing slopes could be expected to be subjected to less total solar radiation, and hence less water stress than those on west-facing slopes. This could be important in determining patterns in species distribution. The high frequency of cloud cover in the mornings and the possibility that the plants may be able to fix external CO_2 photosynthetically under these relatively low stress conditions, as on 16 September (Fig. 2), may at least give a partial clue as to how the Mesembryanthemaceae survive in this region.

Figure 6 shows the monthly frequency of clear, scattered-cloud, cloudy and cloud-covered days between March 1978 and February 1979, determined from Meteosat images. The increase in the number of clear days in the southern spring and decrease in the autumn could explain observed changes in vegetation density and the disappearance of some plant species.

Conclusions
Correlation of ground observations with environmental information derived from Meteosat images could generally be used to explain overall plant behaviour and the mechanisms developed to survive under these arid conditions extremely well. It was not possible, however, for the small area investigated, to predict all days with dew formation in the morning from the satellite images alone. Other information that cannot yet be gained from the images alone is proof of actual rainfall and an accurate estimate of the amount of precipitation, but promising studies are presently under way which will permit better precipitation estimates in the future.

One solution for providing very detailed micro-climatic observations via Meteosat would be to install a Data-Collection Platform (DCP) at any site of interest to relay information via the satellite. By allowing, as an additional benefit, an estimate of the annual radiation climate in the Richtersveld, the Meteosat imagery can also contribute to the design of a solar power supply for the DCP.

The success already achieved in using Meteosat imagery as a source of environmental information has resulted in further plans to apply the same technique in ecological studies in other dry areas of Africa, such as the Sahel zone.



Maritime Mobile Satellites – A Review of Institutions and Activities

K. Barbance, International Affairs Branch
K. Calligan, Directorate of Application Programmes, ESA, Paris

As a result of studies that were started well over a decade ago, a new international organisation INMARSAT, charged with exploitation of maritime mobile satellites on a global basis, recently came into being. Much work has been done concerning the technical, financial and legal aspects of operating maritime satellites, all this in a number of forums and at a time when maritime satellites were already being developed and launched. ESA itself is in the course of constructing three Marecs satellites, and it is against this background that the somewhat complex developments, particularly in the institutional area, are examined.

Initial work

As early as February 1966, studies of the use of satellites for maritime purposes were commenced by the Inter-governmental Maritime Consultative Organisation, IMCO. Thinking was developed in this and other forums, including that of the CCIR, to the point where it became generally agreed that for technical and economic reasons any such satellite system should primarily be used for communication purposes. It was, however, accepted that a number of other services, for example position determination, might be added to this basic service as system use developed.

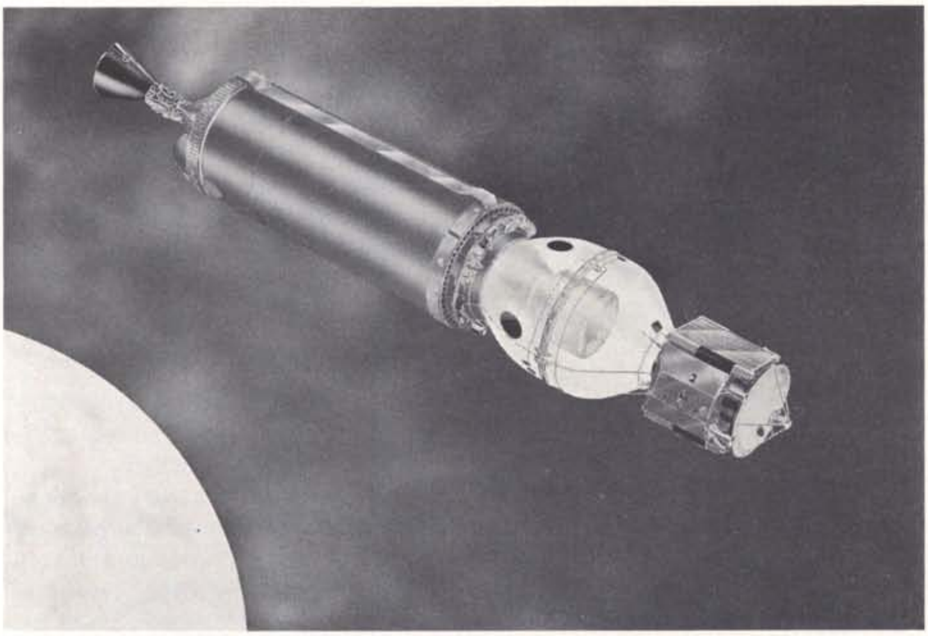
By 1971, discussion had reached a stage such that the Maritime Safety Committee of IMCO felt able to instruct its sub-committee on Radio Communications and subsequently a Panel of Experts to study the subject in detail and with some urgency. During its five sessions in the period July 1972 to September 1974, the Panel of Experts produced a report examining the operational requirements, characteristics and critical elements of such a satellite system, while also treating such economic and institutional questions as were raised by its use[1]. Although now somewhat outdated, this initial work still remains a useful reference document.

As a result of a resolution by the Assembly of IMCO, an International Conference on the establishment of an International Maritime Satellite System was convened in April 1975, and among the documents that this Conference had at its disposal was the report from the Panel of Experts.

At this first session of the conference and at subsequent sessions in February and September of 1976, the institutional framework[2] for a new international organisation, INMARSAT, was developed. The organisation, in common with INTELSAT, would have as one of its governing principles the provision of services on a commercial basis. The provisions of the Convention and Operating Agreement relating to entry into force foresaw that unless 95% of the investment shares listed in the annex to the Operating Agreement were taken up within a period of thirty-six months, both legal instruments would not enter into force. The Marecs programme participants represented approximately 39% of the total investment shares, with other major shareholders being Japan, the USSR and the USA. On 18 May 1979, Teleglobe-Canada signed the Operating Agreement, taking the investment shares above the 95% level and, as a consequence, INMARSAT came into being on 16 July 1979.

The Council of INMARSAT, composed of eighteen representatives of those signatories (or groups of signatories) that have the largest investment shares, met for the first time in Brighton during July 1979. It dealt with a series of organisational matters essential to the creation of the new organisation. Among the decisions taken by the Council was one to create an advisory committee on technical and operational matters. This group will study INMARSAT's operational requirements and submit its findings in October 1979, thereby assisting the Council decision on a space segment.

Figure 1 – Marecs in Ariane launch configuration.



The Assembly of Parties will hold its first session earlier in October 1979, when it will elect four representatives of signatories in order to ensure that the principle of just geographical representation is taken into account. It is to be hoped that the Directorate headed by a Director General can take up their duties before the end of 1979.

The three organs of INMARSAT foreseen by the Convention will then have been constituted and INMARSAT will be able to start to fulfil its demanding role.

Preparatory committee work

The Conference adopted a resolution in 1976 on the establishment of a Preparatory Committee. This Committee held its first meeting at IMCO in January 1977, having as its main objective the performance of a number of preparatory tasks such that, once the organisation were created, its work could start without delay.

The work of the Committee culminated in a report to the INMARSAT Council[3] which was completed in May 1979. A great deal of detail was, however, required to produce such a report and the work was performed by three panels subservient to the Committee and covering, respectively, technical, economic, financial and marketing, and organisational matters. The work of these panels and of the main Committee itself was complicated by the changing situation with respect to available space-segment facilities.

Space-segment developments

Having described the formal institutional picture, it is now necessary to go backwards in time and look at other activities complementary to those steps in preparation for INMARSAT.

The Marisat satellite system, announced in 1973 and put into service over two oceans in mid-1976, has been operated since that time by a consortium of US telecommunications operators headed by COMSAT General. During 1978, a third satellite was brought into operation, providing a global maritime mobile-service capability for the first time. As a result of this move, a small but growing population of users has developed both in conventional shipping and in less conventional areas such as platforms engaged in oil exploration.

Also in 1973, European governments engaged themselves in a development programme to provide an experimental and pre-operational spacecraft. A total of nine states now participate in the programme. The spacecraft was specified to meet the technical requirements developed during the Panel of Experts' discussions. While the original spacecraft concept and its performance capabilities have remained largely unchanged, a number of programme reorientations have been undertaken in order to ensure compatibility with the extant system, while making the satellite more capable of fulfilling what had become an operational role. It has also been possible to alter the planning such that Marecs spacecraft are available for launch around the time that Marisat reaches the end of its design life. With the prospect of having Marecs spacecraft included in an international, global maritime satellite system, the ESA maritime programme participants decided in February 1977 to fund the purchase of a second Marecs satellite. More recently, ESA delegate bodies approved funding ensuring that the construction of a third satellite would be continued, even though the prospective customer was not yet in a position to purchase the satellite.

The Marecs satellite is dedicated completely to the civil maritime service, while Marisat is a hybrid satellite and carries a payload giving US Navy service. Dedicated satellites have the great advantage that they are almost completely unconstrained in providing service to a particular area of the world. Hybrid satellites can suffer from the disadvantage that the needs of one particular service may constrain the provision of another. In some cases, however, it is possible to effect economies by use of shared facilities.

With these considerations in mind, INTELSAT made proposals for the inclusion of maritime mobile-service packages on later models of the Intelsat-V spacecraft, covering two ocean areas. Complementary proposals to cover the third ocean area with dedicated satellites were later effectively withdrawn.

Joint-venture discussions

With the fundamentally different original conceptions of the Marisat and the Marecs systems it was inevitable that there should be a number of technical differences between the two satellites. However, when it became clear that the European telecommunications operators might use the Marecs satellites in a system pre-dating INMARSAT's own system, there was an urgent need to ensure that the Marecs and Marisat systems would be compatible. In particular, it was necessary to ensure that ship terminals could operate with either system.

In a series of discussions between representatives of the CEPT-SMT Group*, the MARISAT partners and ESA, the problems of coordinated operation were discussed. A number of system changes were found to be desirable and some were incorporated in Marecs, notably a small extension in the operating bandwidth.

At the time that these discussions first took place, indeed during much of their progresses, the part that INMARSAT would play in the establishment of a future maritime system was unclear. The stringent conditions attached to the coming into force of the Convention were such that it was only in the several months preceding entry into force that INMARSAT's existence could be said to be certain. Another problem was that by its very constitution, the INMARSAT Preparatory Committee was unable to commit the future INMARSAT Organisation.

While remaining committed to the establishment of INMARSAT, telecommunications operators were seeking a forum in which they could make investment decisions and in which progress towards the establishment of an INMARSAT space segment could be made.

* Conférence Européenne des Administrations des Postes et des Télécommunications – Satellites Maritimes de Télécommunications.

Thus, in this spirit, COMSAT General suggested to the European operators and to the Agency that a cooperative approach to the purchase of a space segment (a Joint Venture) incorporating Marecs should be made. Those involved at that time represented approximately 65% of the potential INMARSAT shareholding. Bearing in mind the very diverse international character of such a new organisation, it was felt, at least among the Europeans, that these discussions should be broadened to include all those of the INMARSAT Preparatory Committee who would have an interest.

Thereafter, during 1978 and the early part of 1979, there followed a series of international conferences attended by a large number of participants in the INMARSAT preparatory work, aimed at the refinement of the space segment options available to it. After an initial involvement and due to domestic problems, the USA were only able to rejoin the discussions from January 1979.

Among the options proposed to the Joint Venture were a hybrid military/civil satellite, ultimately rejected, a hybrid fixed-service/maritime satellite proposed by INTELSAT, and dedicated (Marecs) satellites proposed by the Agency.

By a resolution at the last of the Joint-Venture meetings, held in The Hague in March 1979, a large majority of the participants, representing approximately 80% of the initial INMARSAT investment, signified their interest in a combination of three Intelsat hybrid satellites and three Marecs dedicated satellites.

The progress of these Joint-Venture discussions had been carefully monitored by the INMARSAT Preparatory Committee. A number of scenarios had been considered by it for the provision of a space segment during the course of its work, ranging from a new dedicated system provided by ESA, to a US hybrid military/civil system, to the combined INTELSAT/ESA system mentioned above. The Preparatory Committee had no mandate to select a particular space-segment alternative. It was, however, possible to incorporate the latest proposals available to the Joint Venture (ultimately for use by INMARSAT), noting the various advantages, technical and economic, of these options including the Marecs satellites.

Conclusion

It can be seen from the outline of events give above that there have been a number of parallel lines in the development of systems and institutions for the maritime satellite service, each with its own legal and economic constraints. It is difficult to say at this stage how much the now defunct Joint-Venture forum revealed the need to come to a timely decision, put pressure on all involved and thus assisted in the creation of INMARSAT. Neither is it certain that the INMARSAT Council will necessarily concur with the decisions of the Joint Venture – time will tell.

The Agency, however, looks forward to its dealings with what it hopes will be a vigorous new organisation and not unnaturally hopes that the aspirations of the Marecs programme participants to have European satellites incorporated in a global maritime satellite system will be fulfilled.

1 Study on the Establishment of a Maritime Satellite System – Report of the IMCO Panel of Experts MARSAT/CONF/3, 30 October 1974

2 Convention and Operating Agreement on the International Maritime Satellite Organisation (INMARSAT), September 1976

3 Final Report to the INMARSAT Organisation, INMARSAT Preparatory Committee, Fifth Session. Document PREPCOM/V/6/Add. 1, 29 May 1979

Programmes under Development and Operations*

Programmes en cours de réalisation et d'exploitation

In Orbit / *En orbite*

	Project	1979–1984	Comments
Scientific Programme	COS-B	OPERATION	1 YEAR ADDITION OPERATION LIFE POSSIBLE
Scientific Programme	GEOS 1	OPERATION	LIMITED DATA ACQUISITION FROM "OAKHANGER" STATION
Scientific Programme	ISEE-2	OPERATION	2 YEARS ADDITION OPERATION LIFE POSSIBLE
Scientific Programme	IUE	OPERATION	4 YEARS ADDITION OPERATION LIFE POSSIBLE
Scientific Programme	GEOS 2	OPERATION	2 YEARS ADDITION OPERATION LIFE POSSIBLE
Appl. Prog.	OTS 2	OPERATION	2 YEARS ADDITION OPERATION LIFE POSSIBLE
Appl. Prog.	METEOSAT 1	OPERATION	

Under Development / *En cours de réalisation*

	Project	1979–1984	Comments
Scientific Programme	EXOSAT	MAIN DEVELOPMENT PHASE – LAUNCH – OPERATION	
Scientific Programme	SPACE TELESCOPE	MAIN DEVELOPMENT PHASE – FM TO USA – LAUNCH	LIFETIME 11 YEARS
Scientific Programme	SPACE SLED	DEF. PHASE – MAIN DEVELOPMENT PHASE – FSLP LAUNCH	
Scientific Programme	ISPM	DEF. PHASE – MAIN DEVELOPMENT PHASE – LAUNCH	LIFETIME 4.5 YEARS
Scientific Programme	LIDAR	DEF. PHASE	
Applications Programme – Telecom. Prog.	ECS	MAIN DEVELOPMENT PHASE – LAUNCH F1 – DELIVERY F2 – OPERATION	LIFETIME 7 YEARS
Applications Programme – Telecom. Prog.	MARITIME	MAIN DEVELOPMENT PHASE – LAUNCH A – B READY FOR LAUNCH – C READY FOR LAUNCH – D READY FOR STORAGE – OPERATION	LIFETIME 7 YEARS
Applications Programme – Telecom. Prog.	L-SAT	DEFINITION PHASE – MAIN DEVELOPMENT PHASE – LAUNCH – OPERATION	LIFETIME 7 YEARS
Applications Programme – E.O.P.	METEOSAT 2	INTEGR. – TESTING – LAUNCH – OPERATION	
Applications Programme – E.O.P.	SIRIO 2	MAIN DEVELOPMENT PHASE – LAUNCH – OPERATION	
Applications Programme – E.O.P.	ERS 1	PREPARATORY PHASE – DEFINITION PHASE – MAIN DEVELOPMENT PHASE	LAUNCH END 1985
Spacelab Programme	SPACELAB	MAIN DEVELOPMENT PHASE – FU I AT NASA – FU II AT NASA – FLIGHT 1 – FLIGHT 2	
Spacelab Programme	SPACELAB - FOP	PRODUCTION PHASE – INITIAL DELIVERY – FINAL DELIVERY	
Spacelab Programme	IPS	MAIN DEVELOPMENT PHASE – FU DEL. TO NASA	
Spacelab Programme	IPS - FOP	PRODUCTION PHASE – DELIVERY	
Spacelab Programme	FIRST SPACELAB PAYLOAD	EXPERIMENTS DEVELOPMENT – INTEGRATION – FSLP LAUNCH	
Ariane Programme	ARIANE	DEVEL. PHASE – LO 1 – LO 2 – LO 3 – LO 4	
Ariane Programme	ARIANE PRODUCTION	MANUFACTURE – L5 – L6 – L7 – L8 – L9 – L10 – PROVISIONAL OPERATIONAL LAUNCHES	

* Reporting status as per end August 1979/Bar valid per end September 1979

Bien que le planning ci-dessus soit valide jusqu à fin septembre 1979, la situation des projets décrits dans les pages qui suivent s'arrête à la fin août 1979.

Cos-B

L'expérience de Cos-B a continué de fonctionner correctement depuis le dernier rapport, exception faite d'une petite 'ratée' qui s'est traduite par la perte d'un signal du calorimètre. Cette défaillance, sans incidence sur les données scientifiques, a seulement pour effet de réduire le nombre des modes de fonctionement de l'expérience. En ce qui concerne le satellite, une erreur qui s'est produite au cours de la manoeuvre de réorientation a entraîné, lors d'une récente observation, une incertitude d'orientation de 2°, chiffre trop important pour être acceptable – en fait d'un ordre de grandeur supérieur à la normale. Il reste à bord assez de réserve à la fois pour l'expérience et pour le satellite pour répondre aux besoins de la mission jusqu'à fin 1980.

Des pointages ont été effectués récemment en direction de Carina (pour combler une lacune dans la couverture du plan galactique), de PSR 0740 (avec observations radio simultanées par la CSIRO), du quasar de rayons X QSO 2S2251-178 et de 3C120. Ces derniers objets illustrent la tendance qui se dessine vers des observations extra-galactiques, tendance qui a été encouragée par les mesures de 3C273 effectuées par Cos-B et par les découvertes récentes d'objets extra-galactiques peu ordinaires émetteurs de rayons X.

Les résultats fournis par Cos-B ont été présentés récemment à plusieurs conférences. En particulier, le séminaire organisé à Erice par l'Association européenne de Physique sur le thème 'l'Astronomie des rayons gamma après Cos-B' a inscrit à son programme plusieurs résultats nouveaux obtenus par notre satellite.

Une nouvelle liste de 29 sources de type ponctuel a été présentée après un passage au crible systématique de toutes les données disponibles. Des spectres détaillés des pulsars 0833 (Voiles) et 0531 (Crabe) ont été présentés avec les spectres totaux. Il semble que le pulsar des Voiles soit intégralement pulsé et présente des différences de spectre pour les impulsions primaires et secondaires. Un spectre détaillé de CG195 (gamma 195 de SAS II) confirme qu'il s'agit d'une source énergétique très intense. En dépit d'une bonne localisation (±0,4°), cet objet n'est toujours pas identifié. Une 'source ponctuelle' présente une bonne correspondance avec le complexe nuageux obscur ρ Ophiucci.

Ces résultats ont également été présentés au symposium du COSPAR sur l'astronomie du rayonnement gamma qui s'est tenu à Bangalore ainsi qu'à la 16ème ICRC à Kyoto. A toutes ces réunions les résultats ont été accueillis avec enthousiasme et de nombreux documents interprétatifs commencent à apparaître.

Les prochains pointages de Cos-B couvriront le pulsar des Voiles la nébulosité du Taureau (pointage motivé par les résultats obtenus pour ρ Ophiucci) et d'autres cibles extra-galactiques. Il est évident qu'avec une expérience ayant obtenu ces excellents résultats, une extension de la mission Cos-B jusqu'à fin 1980 pourrait être profitable.

Geos

Geos-1

Une manoeuvre orbitale importante, qui a conduit à porter le périgée de 2000 km à 2700 km a été effectuée le 9 mai. Le but de la manoeuvre était d'éviter des éclipses de très longue durée qui auraient entraîné la congélation de l'hydrazine à bord du satellite. En réduisant la durée des éclipses, et en utilisant toute l'énergie disponible pour le réchauffage du système de commande à réaction, il a été possible de maintenir Geos-1 en vie. A partir de septembre, la durée des éclipses sera inférieure à 30 mn par orbite et on disposera d'énergie électrique pour le fonctionnement des expériences. On envisage pour plus tard, au cours de cette année, deux courtes périodes de remise en activité pour des raisons scientifiques et en vue de l'exécution d'une expérience technologique.

Geos-2

L'alimentation électrique de la charge utile de Geos-2 a été coupée pendant la période du 30 avril au 14 mai afin de traiter les données de Geos-1 reçues par la station d'Oakhanger à la fin de 1978 et au début de 1979. A l'exception de cette période, Geos-2 a fonctionné de façon continue au cours des derniers mois. Pendant le mois de juin et le début du mois de juillet, il a participé à la campagne SBARMO-79 au cours de laquelle un total de 29 charges utiles installées à bord de ballons pour haute altitude ont été lancées du nord de la Scandinavie. Une manoeuvre orbitale destinée à produire une dérive en longitude de 1°/jour vers l'ouest a été effectuée le 10 juillet. Depuis cette date, le satellite a dérivé dans l'équateur géomagnétique pour atteindre la longitude de 6° Est. Une nouvelle manoeuvre a, entre-temps, inversé la dérive et Geos-2 est revenu à sa position initiale, à 37° Est, pour participer à la campagne de fusées dispersant du baryum, qui doit avoir lieu à Kiruna en septembre.

Le fonctionnement est normal et les performances de la charge utile sont nominales et inchangées depuis le dernier rapport, sauf en ce qui concerne le magnétomètre à noyau saturé (S-331). Le détecteur selon l'axe **x** *de cet instrument a cessé de fonctionner correctement le 6 juin. Les performances du détecteur selon l'axe* **z** *se sont également altérées. La méthode de correction manuelle mentionnée dans le rapport du mois de mai ne peut plus être utilisée à partir du 1er juillet. Le détecteur selon l'axe* **z** *est cependant en mesure de déterminer les variations relatives du champ une fois le niveau de correction fixé. Le détecteur selon l'axe* **y** *de l'expérience S-331 ne présente aucune altération de performances.*

En dépit de ces difficultés, il est toujours possible d'obtenir des données sur le champ magnétique, en particulier les données sur l'orientation magnétique fournies par Geos-2. En effet, l'expérience de résonance (S-301) détermine la gyrofréquence, et par conséquent l'intensité totale du champ magnétique toutes les 12 mn. La connaissance du module du champ et de la composante selon l'axe **y** *permet d'effectuer des étalonnages réguliers du signal de sortie du détecteur selon l'axe* **z**, *de sorte que l'on peut reconstituer le vecteur champ magnétique.*

L'expérience S-329 (tracé d'un faisceau d'électrons), qui dépend des données du magnétomètre embarqué, utilise maintenant les signaux du magnétomètre à bobine exploratrice S-300 pour les axes transversaux et reçoit la composante étalonnée selon l'axe **z** *par télécommande du sol, à intervalles réguliers. La grande constante de temps du circuit à l'interface S-300/S-329 entraîne toutefois une réduction de la résolution temporelle de l'expérience sur*

Cos-B

Since the last report, the Cos-B experiment has continued to perform well, with only one minor hiccup in the form of a 'lost' signal from the calorimeter. This malfunction has no impact on the scientific data, but only reduces the number of operating modes of the experiment. On the spacecraft side, an error during a spacecraft reorientation manoeuvre resulted in an unacceptably high attitude uncertainty of 2° for a recent observation – an order of magnitude higher than normal. Consumables for experiment and spacecraft remain sufficient to support the mission throughout 1980.

Recent pointings have included the Carina direction (to fill a gap in galactic-plane coverage), PSR0740 (with contemporary radio observations by CSIRO), the X-ray QSO 2S2251-178 and 3C120. The latter objects reflect the trend towards extragalactic observations stimulated by the Cos-B measurements of 3C273 and recent discoveries of exotic extragalactic X-ray objects.

The Cos-B results have been presented at several conferences recently. In particular, the European Physical Society Workshop at Erice, 'Gamma-Ray Astronomy after Cos-B', featured several new Cos-B findings. A new list of 29 point-like sources was presented following a systematic scan of all the available data. Detailed spectra for the pulsars 0833 (Vela) and 0531 (Crab) were shown with the total spectra. The Vela pulsar appears to be 100% pulsed with differences in spectra for the primary and secondary pulses. A detailed spectrum of CG195 (gamma 195 of SAS II) confirms it to be a very intense hard source. Despite good positional location ($\pm 0.4°$) this object remains unidentified. One 'point source' correlates well with the dark cloud complex ρ Ophiucci.

The results were also presented at the COSPAR symposium on gamma-ray astronomy at Bangalore and at the 16th ICRC in Kyoto. At all meetings the results have been enthusiastically welcomed and many interpretative papers are beginning to emerge.

Future pointings for Cos-B include the Vela pulsar, the Taurus clouds (motivated by the ρ Ophiucci result), and further extragalactic targets. It is clear that good use can be made of an extension of the Cos-B mission throughout 1980 with this successful experiment.

Geos

Geos-1

A major orbital manoeuvre resulting in a perigee raise from 2000 km to 2700 km was carried out on 9 May. The aim of the manoeuvre was to avoid eclipses of very long duration which would have led to freezing of the on-board hydrazine. By shortening the eclipse times and using all available power for heating the reaction control system, it was possible to keep Geos-1 alive. From September onwards, eclipse duration will be less than 30 min per orbit and power for experiment operation will be available. Two short revival periods for scientific reasons and one technological experiment are envisaged for later this year.

Geos-2

The payload of Geos-2 was switched off from 30 April to 14 May to process data from Geos-1 acquired by the Oakhanger station in late 1978 and early 1979. Except for this period, Geos-2 was operated continuously during the reporting period. Throughout June and early July it supported the SBARMO-79 campaign in which a total of 29 high-altitude balloon payloads were launched from Northern Scandinavia. An orbit manoeuvre leading to a 1 deg/day longitudinal drift toward the west was executed on 10 July. The spacecraft has since drifted across the geomagnetic equator to a longitude of 6°E. A further manoeuvre has in the meantime reversed the drift and Geos-2 is on its way back to its initial 37° East position in order to support a barium rocket campaign to be carried out from Kiruna during September.

Payload operation and performance is nominal and unchanged since the last report, except for the fluxgate magnetometer (S-331). The x-axis sensor of this experiment has failed to function correctly since 6 June. The z-sensor performance has also deteriorated. The manual bias adjustment procedure mentioned in the May report cannot be relied upon from 1 July onwards. The z-sensor is, however, still able to determine the relative variations in the field once the bias level is fixed. The y-sensor of experiment S-331 shows no degradation.

In spite of these difficulties it is still possible to obtain magnetic-field data, in particular magnetic attitude data from Geos-2. This is because the resonance experiment (S-301) determines the gyro frequency, and thus the total magnetic-field strength, at 12 min intervals. Knowledge of the field modulus and y-axis component allows regular calibrations of the z-sensor output, and the magnetic-field vector can be reconstituted.

The electron-beam experiment S-329, which depends on on-board magnetometer data, is now using the S-300 search coil magnetometer output for the lateral axes and receives the calibrated z-component by telecommand from the ground at regular intervals. The long time constant in the S-300/S-329 interface circuit, however, causes a reduction in time resolution for the beam experiment of roughly a factor of 10 (e.g. from 6 to 60 s).

Daily operations and data processing at ESOC are running smoothly, after a number of software changes which became necessary as a result of the S-331 difficulties.

Results from Geos-1 and 2 are presented at every major conference on magnetospheric physics and are now being published in the relevant literature. Three workshops at which Geos data will play a major role will take place later this year.

Exciting new results obtained with Geos-1 and 2 so far include the first observation in space of fq-resonances (electrostatic waves with zero group velocity), the discovery of unexpectedly high heavy ion concentrations at certain times (He-ion concentrations up to 60% of the total population have been observed in conjunction with the appearance of He-cyclotron frequency harmonics), and the identification of a stable particle population near the geomagnetic equator with close to 90° pitch angles (pancake distributions). Interesting, but so far unexplained particle distributions and field configurations, have been seen at times when the Geos orbits have been nearly tangential to the magnetopause.

ISEE

The mission continues to run smoothly, but as with all missions there are some difficulties.

le tracé du faisceau, approximativement selon un facteur 10 (à savoir de 6 à 60 s).

L'exploitation quotidienne et le traitement des données à l'ESOC se déroulent sans incident après un certain nombre de changements de logiciel qui ont été rendus nécessaires eu égard aux difficultés rencontrées avec l'expérience S-331.

Les résultats fournis par Geos-1 et 2, qui sont présentés à chaque conférence importante sur la physique de la magnétosphère, sont maintenant publiés dans la littérature consacrée à cette discipline. Trois ateliers pour lesquels les données de Geos joueront un rôle important sont prévus pour une date ultérieure au cours de l'année.

Parmi les résultats nouveaux d'un grand intérêt fournis jusqu'ici par Geos-1 et 2, on peut citer la première observation dans l'espace de résonances fq (ondes électrostatiques d'une vitesse du groupe zéro), la découverte, par instants, de concentrations inattendues d'ions très lourds (des concentrations d'ions He pouvant atteindre 60% de la population totale ont été observées conjointement avec l'apparition d'harmoniques de la fréquence cyclotron de He) et l'identification d'une population stable de particules près de l'équateur géomagnétique avec des angles d'attaque voisins de 90° (distributions en galette). En outre, des distributions de particules et des configurations de champ intéressantes, mais jusqu'ici inexpliquées, ont été observées par instants lorsque l'orbite de l'un des deux satellites était presque tangente à la magnétopause.

ISEE

La mission continue de se dérouler normalement. Toutefois, comme dans toutes les missions, quelques difficultés sont apparues.

ISEE-3 fonctionne maintenant depuis un an. Des difficultés ont été rencontrées dans les mesures tridimentionnelles de l'instrument consacré au plasma énergétique, une défaillance de circuit intégré dans l'un des spectromètres pour particules énergétiques ayant considérablement réduit la résolution et le débit de données et l'autre spectromètre ayant son indicateur de situation bloqué et une résolution légèrement réduite à gain élevé. Sur ISEE-1, lancé avec ISEE-2 en octobre 1977, la défaillance d'un détecteur de l'instrument pour l'étude des rayons cosmiques a réduit les mesures à deux dimensions et la dégradation des performances du multiplicateur de l'instrument d'étude du plasma énergétique a mis celui-ci complètement hors d'action. Aucune défaillance d'instrument n'a été enregistrée sur ISEE-2 depuis le dernier rapport.

Les batteries d'accumulateurs de ISEE-1 et ISEE-2 ont vu leurs performances dégradées de façon presque identique. La batterie d'ISEE-2 a été débranchée pour éviter une explosion. Les deux batteries n'ont été prévues que pour mettre à feu les dispositifs pyrotechniques, de sorte que les incidences sur la mission sont négligeables. Il est apparu que les difficultés rencontrées avec un détecteur d'orientation étaient dues à des oscillations du bras en aiguille; le problème a été résolu par une petite modification du logiciel.

Les chercheurs de l'équipe scientifique ont récemment demandé de faibles écarts entre les véhicules spatiaux, l'alignement des orbites, des mesures perpendiculairement aux axes de rotation et une prolongation de la mission pour couvrir l'intervalle de temps séparant ISEE et OPEN – (OPEN: mission multisatellite proposée par la NASA pour l'étude de l'origine des plasmas dans le voisinage de la Terre).

Les documents sur ISEE publiés à ce jour dépassent largement le nombre de 100 et se situent au premier rang dans les assemblées internationales consacrées à ce domaine scientifique. Plusieurs ateliers très utiles ont été organisés et l'on s'attend à une contribution majeure d'ISEE au symposium IMS qui doit avoir lieu en décembre prochain.

IUE

Engagé désormais dans sa seconde année d'opérations, IUE est en bonne voie avec son programme d'activités complet jusqu'à avril 1980. Son rendement opérationnel continue à croître depuis que des experts de la NASA et du Conseil britannique de la Recherche scientifique (SRC), en collaboration avec du personnel de l'ESA, on consacré, à la Station de Vilspa, un certain temps à optimiser encore davantage le fonctionnement de la chambre. Ceci s'est traduit par un total mensuel record de 252 images en juillet.

Des statistiques récentes montrent comment est constituée l'importante communauté des utilisateurs du temps d'observation réservé à l'ESA au cours des deux premières années.

On a constaté qu'un problème de fonction de transfert d'intensité (il s'agit d'un équipement réalisé par la NASA mais utilisé également par l'ESA) a affecté la chambre de prises de vues ondes courtes. Il s'ensuit que les images ondes courtes traitées à la Vilspa entre juin 1978 et juillet 1979 comporteront des erreurs photométriques. Dans l'ensemble ces

Répartition des chercheurs utilisant IUE au cours des deux premières années d'opération.

Pays	Chercheurs principaux	Chercheurs associés	Total
Italie	22	45	67
Allemagne	14	34	48
Suisse (ESRO compris)	12	6	18
France	10	38	48
Pays-Bas	9	5	14
ESA	1	8	9
Belgique	7	–	7
Suède	4	8	12
Espagne	2	5	7
Autriche	2	1	3
Pologne	1	3	4
Danemark	1	1	2
Argentine	1	–	1
Royaume-Uni	–	10	10
Australie	–	2	2
Iran	–	1	1
Chili	–	1	1
Total	86	168	254

ISEE-3 has now been in operation for one year. There are problems with the three-dimensional measurements of the fast plasma instrument because an integrated-circuit failure on one energetic-particle spectrometer has considerably reduced resolution and data rate and the other spectrometer has a stuck status bit and slightly reduced resolution at high gain. On ISEE-1, launched with ISEE-2 in October 1977, a cosmic-ray instrument sensor failure has reduced the measurements to two-dimensions and multiplier degradation on the fast plasma instrument has put it out of action completely. On ISEE-2 there have been no instrument failures since the last report.

The batteries on ISEE-1 and 2 have degraded in almost identical fashion. The ISEE-2 battery has been disconnected to prevent explosion. Both batteries were mounted only to fire the pyrotechnics and the effect on the mission is insignificant. An attitude-sensor problem was found to be due to wire-boom oscillations and has been cured by a small software change.

The Science Working Team investigators have recently requested small spacecraft separations, orbit alignment, crossed-spin-axes measurements and extension of the mission to cover the time gap between ISEE and OPEN (OPEN, which stands for Origin of Plasmas in the Earth's Neighbourhood, is a proposed NASA multispacecraft mission).

ISEE papers published now number well over 100 and are dominating international assemblies in this scientific field. Several very useful workshops have been organised and a major ISEE contribution is expected at the IMS Symposium to be held in December 1979.

IUE

The second year of IUE operations is now well underway with scheduling complete up to April 1980. Operational efficiency continues to increase, following some time spent at Vilspa by NASA and UK Science Research Council experts working with ESA staff to further optimise camera operations. This led to a record monthly total of 252 images in July.

A set of recently compiled statistics reflects the considerable size of the scientific community using ESA observing time in IUE's first two years:

Breakdown of the scientific community using IUE during the satellite's first two years of operation.

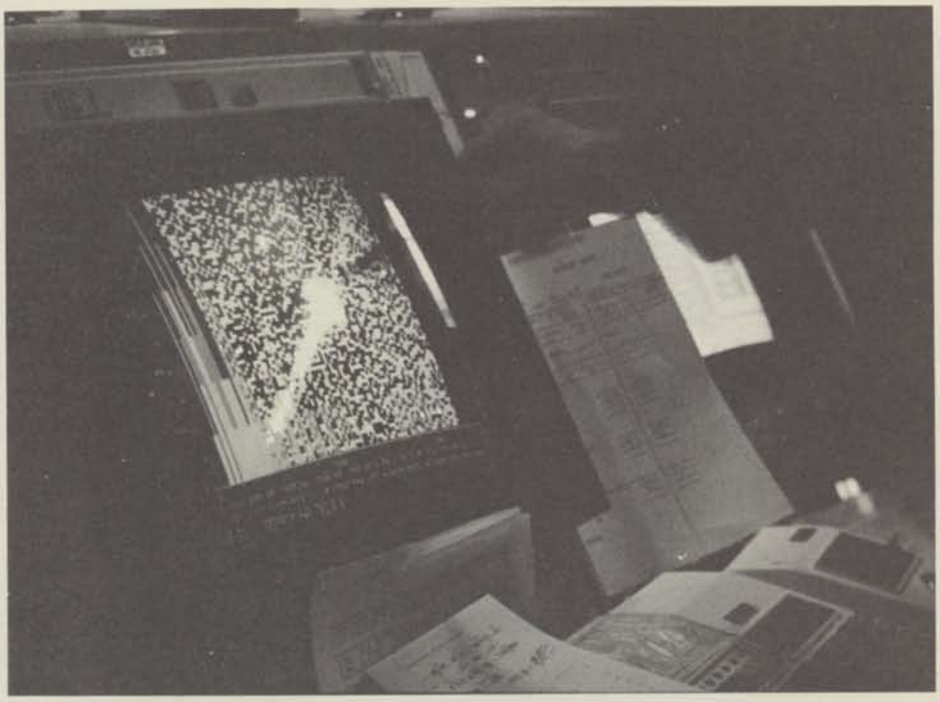
Country	Principal Investigators	Co-Investigators	Total
Italy	22	45	67
Germany	14	34	48
Switzerland [incl. European Southern Observatories (ESO)]	12	6	18
France	10	38	48
Netherlands	9	5	14
ESA	1	8	9
Belgium	7	–	7
Sweden	4	8	12
Spain	2	5	7
Austria	2	1	3
Poland	1	3	4
Denmark	1	1	2
Argentina	1	–	1
United Kingdom	–	10	10
Australia	–	2	2
Iran	–	1	1
Chile	–	1	1
Total	86	168	254

A problem has arisen with the intensity-transfer function (constructed by NASA, but also used by ESA) for the short-wave camera. Consequently the short-wave images processed at Vilspa between June 1978 and July 1979 will have photometric errors. In general these errors are not too serious, but some correction procedure will be necessary and work on this is already in progress.

To date 43 papers based on IUE data have appeared in the main journals, of which 24 have involved ESA time on IUE and 31 Vilspa time (i.e. ESA and UK Science Research Council). Most surprising and almost reversing the 1 to 2 ratio of IUE observing time, is the 22 to 12 ratio of purely European to purely US papers published, which is probably due to the greater speed of the European image processing compared with that at Goddard.

Spectrum of the supernova in the Galaxy NGC 4321, as seen by the IUE satellite and recorded at the Agency's Villafranca ground station (Spain).

Spectre de la supernova observée par IUE dans la Galaxie NGC 4321 et transmise à la station sol de Villafranca.



erreurs ne sont pas trop graves, mais elles nécessiteront néanmoins un certain traitement correctif. On travaille actuellement à ce traitement.

Quarante-trois documents établis à partir des données d'IUE ont été publiés à ce jour dans les principales revues savantes. Parmi ceux-ci vingt-quatre ont impliqué du temps d'observation ESA, trente-et-un du temps Vilspa (c'est-à-dire ESA+ SRC). La proportion, très surprenante, de vingt-deux documents purement européens contre douze documents purement américains, qui représente pratiquement le rapport de 2 à 1 inversé des temps d'exploitation respectifs d'IUE, est probablement due à la vitesse relative de notre traitement images par rapport à celui du Centre Goddard.

OTS

Voici près de dix-huit mois qu'OTS est sur orbite, et l'ensemble du programme d'essais orbitaux (OTP) est réalisé pour l'essentiel avec des résultats très satisfaisants. A l'heure actuelle, le satellite est utilisé la plupart du temps par EUTELSAT, organisation constituée par les administrations européennes des PTT. Des programmes de télévision français sont transmis quotidiennement en Tunisie depuis la mi-juillet. Début juin, OTS a été utilisé avec succès pour des démonstrations au cours du Symposium international de Télévision de Montreux (Suisse) et ensuite au Salon du Bourget. La deuxième série de mesures prévues dans le plan d'intéressement, qui sont effectuées à six mois d'intervalle, ont également été menées à bien. En ce qui concerne le fonctionnement du véhicule spatial, la surveillance de routine se poursuit à la station terrienne de Fucino (Italie) et indique que les performances restent nominales.

Météosat

Secteur spatial

Météosat-1 continue de bien fonctionner et ses performances demeurent conformes aux spécifications. Météosat-2 subit actuellement des essais en vibration pour vérifier le bien-fondé des modifications effectuées en vue de son lancement par Ariane (L03). Du fait des changements apportés au moteur d'apogée européen pour Météosat, il a fallu modifier quelque peu la conception du cône, d'adaptation. L'industrie étudie actuellement la configuration du dispositif d'amortissement des vibrations (VID) pour Météosat.

Exploitation

Le temps moyen entre pannes du calculateur Météosat dépasse maintenant 40 h. Un nouveau lot de logiciel a été mis en place, ce qui accroît de 35% le nombre des formats diffusés. Les températures de la surface de la mer sont maintenant établies quotidiennement mais ne sont pas encore diffusées. Les travaux concernant la néphanalyse sont en cours.

Démonstration/expérimentation

La PDUS (station primaire d'utilisation de données) est installée au CNES à Toulouse depuis février pour une évaluation conjointe des performances du système par l'ESA et par le CNES.

La SDUS (station secondaire d'utilisation de données) entame un troisième circuit en Afrique, en Algérie, au Bénin et au Nigéria.

Le vaisseau britannique de recherche en Antarctique RSS Bransfield est rentré à Southampton le 29 mai. Cette campagne expérimentale montre que la limite de couverture de la plate-forme de collecte de données (DCP) Météosat se situe entre 75° et 82° du point subsatellite. La DCP est maintenant installée sur le navire marchand britannique 'CP Discoverer'.

Projet GOES-I

A la suite des pertes intermittentes du signal IR, la NOAA a procédé à une analyse de l'anomalie, qui n'a toutefois pas permis de dégager des mesures correctives; les opérations se concentrent donc sur les images 'visibles' chaque fois que le signal IR fait défaut. Les données de GOES-I sont traitées par LMD (France) et DFVLR (Allemagne).

Exosat

Satellite

Les travaux de développement sont terminés sur la plupart des sous-systèmes du modèle d'identification et, la structure ayant été livrée au contractant principal, les activités d'intégration ont pu commencer. L'équipement de commande par réaction, le câblage, les sous-systèmes d'énergie et de traitement des données ont été, à quelques exceptions près, entièrement intégrés dans la structure.

Les essais fonctionnels du sous-système RF ont commencé et ce sous-système devrait être livré au contractant principal dans les délais voulus. L'électronique et la centrale gyroscopique, qui font tous deux partie du système de commande d'orientation et de correction d'orbite (AOCS) accusent des retards.

Des livraisons tardives dues à des problèmes techniques et à des grèves survenues ici et là ont conduit à remanier les activités relatives au modèle d'identification; parmi les modifications décidées figure en bonne place l'abandon du principe consistant à utiliser une structure auxiliaire pour les activités de pré-intégration – du moins jusqu'à ce que l'on dispose de la structure réelle. Les unités sont maintenant intégrées directement dans la structure du modèle d'identification.

Le banc propre a satisfait aux essais et, d'après les résultats, il devrait être possible d'assouplir les niveaux de vibration utilisés pour les essais des éléments du tube dissecteur d'images du suiveur stellaire. Le contractant réexamine actuellement la question.

Charge utile

Comme les sous-systèmes du satellite, les éléments 'charge utile' du modèle d'identification sont presque achevés. L'expérience basse énergie a été livrée pour intégration au niveau du satellite tandis que les détecteurs moyenne énergie et l'électronique de commande sont en cours d'intégration et subissent les essais avant livraison. La livraison du compteur à gaz à scintillation a été retardée en raison d'une défaillance d'un tube photomultiplicateur et d'un problème lié à une défaillance de la haute tension apparue au cours des essais d'ambiance.

Lanceur

Le quatrième étage P07 a fait l'objet d'un examen en juillet et un certain nombre d'anomalies ont été constatées, la plus importante pour le satellite étant le risque d'une contamination des photopiles par les jets d'échappement des tuyères d'annulation de la rotation. L'organisme responsable du lanceur étudie actuellement ce problème.

La mise en route des essais dynamiques, qui ont pour objet d'étudier les effet du ballotement des ergols sur l'amortissement et le freinage de la

OTS

OTS has now been in orbit for almost eighteen months and most of the Agency's comprehensive Orbital Test Programme has been performed with very satisfactory results. The satellite is now being used by EUTELSAT (the organisation formed by European PTTs) for the majority of the time. Daily transmissions of French television programmes to Tunisia have been made since mid-July. Early in June, OTS was successfully used in a demonstration during the International Television Symposium at Montreux, Switzerland and subsequently at the Le Bourget Air Show. The second series of incentive-scheme measurements, which are taken at six-monthly intervals, has also been successfully carried out. Routine spacecraft-performance monitoring has continued from the Fucino (Italy) earth station and performance has remained nominal.

Mobile OTS reception antenna on display at the international Telecom 79 exhibition in Geneva.

Antenne mobile de réception d'OTS à l'exposition internationale Telecom 79 à Genève.

Meteosat

Space segment
Meteosat-1 continues to operate well within the performance specifications. Meteosat-2 is now undergoing vibration tests to verify modifications introduced for an Ariane launch (L03). As a result of changes in the European apogee boost motor for Meteosat, certain design modifications had to be made to the conical adaptor. The configuration of the Meteosat VID (Vibration Isolator Device) is presently being studied by industry.

Exploitation
The mean time between failures of the Meteosat computer is now over 40 h. A new software package has been introduced, increasing the number of formats disseminated by 35%. Sea-surface temperatures are now produced on a daily basis, but are not yet being disseminated. Work on cloud analysis is progressing.

Demonstrations/experimental activities
The PDUS (Primary Data User Station) has been installed at CNES/Toulouse since February for a joint ESA/CNES system-performance evaluation.

The SDUS (Secondary Data User Station) is starting a third demonstration tour, through Africa, Algeria, Benin and Nigeria.

The British Antarctic Survey vessel RSS Bransfield returned to Southampton on 29 May, with its Meteosat DCP (Data Collection Platform). The limit of the DCP coverage found by this experimental campaign is between 75° and 82° from the subsatellite point. This DCP is now being installed on the British merchant ship 'CP Discoverer'.

GOES-1 project
A failure analysis performed by NOAA has not provided a correction for the intermittent loss of the IR signal; the operations are therefore concentrated on visible images each time the IR signal is absent. GOES-1 data are being processed by both LMD (France) and DFVLR (Germany).

Exosat

Satellite
Development work on most engineering-model subsystems has been completed and delivery of the structure to the main contractor has enabled integration activities to commence. The reaction-control equipment, harness, power and data-handling subsystems have, with minor exceptions, been completely integrated into the structure.

Functional testing of the RF subsystem has started and it should be delivered to the main contractor on time. The attitude and orbit control electronics (AOCE) and gyro package, both units of the Attitude and Orbit Control System (AOCS), are behind schedule.

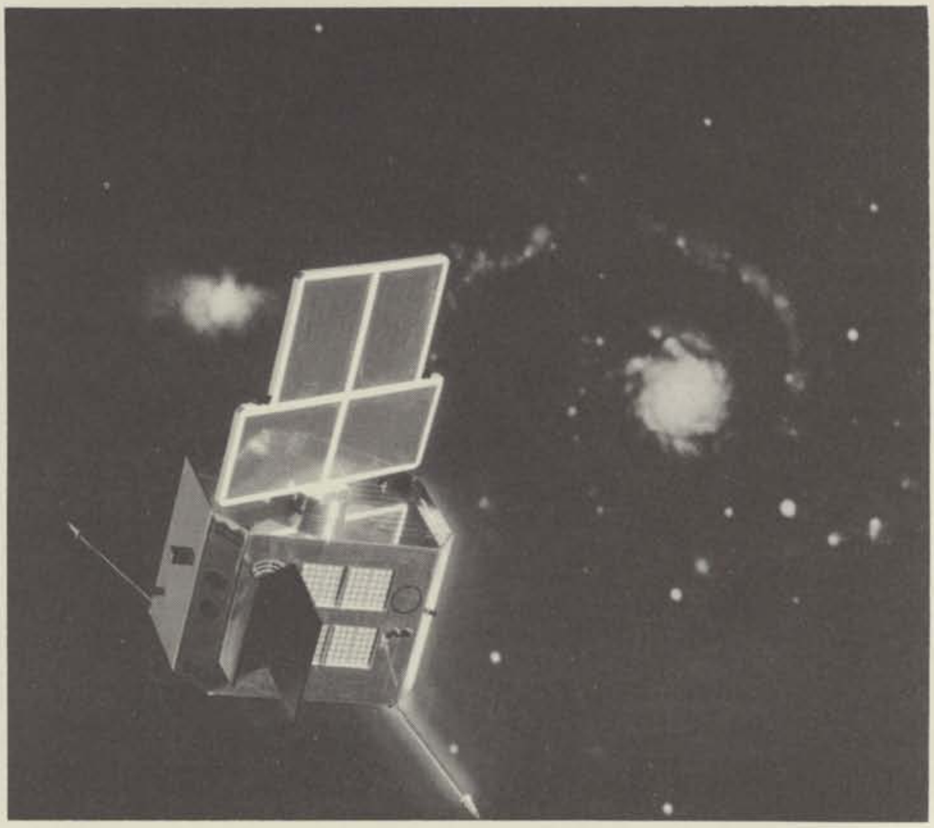
Late deliveries due to technical problems and strikes here and there have led to a rescheduling of engineering-model activities, including the dropping of the idea of using an auxiliary structure for pre-integration work until the engineering-model structure arrived. Units are now being integrated directly into the engineering-model structure.

The clean-bench subassembly has been tested successfully and the results indicate that a relaxation in input vibration levels for unit testing of the star-tracker Image Dissector Tube (IDT) should be possible. This matter is being reviewed by the contractor.

Payload
Like the subsystems, the engineering-model payload units are also nearing completion. The low-energy experiment has been delivered for satellite-level integration, while the medium energy detectors and control electronics unit are presently undergoing integration and test prior to delivery. Delivery of the gas-scintillator experiment has been delayed due to failure of a photomultiplier tube and a high-voltage-breakdown problem

Exosat, satellite d'observation des rayons X (lancement prévu en 1981).

Exosat, the Agency's X-ray observatory satellite, to be launched in 1981.



rotation, a été différée en raison d'un retard dans la livraison du réservoir d'hydrazine d'Exosat.

Un accord est intervenu entre l'Equipe Projet et l'organisme responsable du lanceur sur les équipements et services à fournir dans le cadre général du contrat relatif au lanceur.

Activités de l'ESOC
L'approvisionnement des équipements destinés à la station sol de Villafranca se poursuit. La conception du système sol a fait l'objet d'un second examen qui s'est révélé concluant et un certain nombre d'actions, recommandées par la Commission d'examen, sont en cours de mise en oeuvre.

Télescope spatial

Réseau solaire
Des progrès constants ont été enregistrés pour le réseau solaire. L'examen préliminaire de la conception (PDR) a eu lieu en avril/mai en liaison avec le PDR du Télescope spatial qui s'est tenu aux Etats-Unis en juillet après une longue série d'examens préliminaires de conception au niveau des sous-systèmes. On a opté pour une solution qui protègera le réseau solaire contre les pertes d'énergie occasionnées en permanence par les ombres portées sur le réseau solaire en orbite. La conception tient également compte de l'impératif d'une possibilité de remplacement du réseau en orbite.

Une importante difficulté technique est apparue à la suite du PDR du Télescope spatial lorsqu'il s'est avéré nécessaire, pour des raisons liées à la commande d'orientation, d'imposer un nouvel impératif en ce qui concerne le couple maximal exercé par le réseau solaire sur le Télescope spatial au cours des manoeuvres de pivotement d'orientation. On s'efforce activement de trouver une solution conceptuelle qui limite ce couple à une valeur inférieure à 0,05 Nm.

Module de la chambre pour objets de faible luminosité (FOC)
A la suite de négociations longues et constructives avec le contractant, qui ont eu lieu après que celui-ci ait soumis sa proposition pour la phase C/D, un accord total s'est fait sur la conception de référence technique et sur le coût-objectif correspondant.

La mise au point des interfaces avec le Télescope spatial a considérablement progressé bien qu'il reste encore quelques points critiques non résolus. La fabrication du modèle thermique/de structure est pleinement engagée. Les essais de ce modèle doivent commencer début 1980.

Détecteur de photons (PDA)
Une proposition à prix forfaitaire pour les travaux restant à exécuter dans le cadre du programme du PDA a été reçue du contractant et a fait l'objet de négociations, après quoi le contrat a été envoyé à BAe pour signature.

Du point de vue technique, l'avancement des travaux suit de près les plans, bien que quelques difficultés aient entraîné un certain nombre de glissements dans les dates de livraison. Celles-ci restent néanmoins compatibles avec le programme de la FOC.

Certains éléments du modèle thermique/de structure font actuellement l'objet d'essais.

Relation avec la NASA
La NASA a confirmé le choix des instruments scientifiques américains. L'examen préliminaire de la conception du Télescope spatial s'est bien déroulé et l'avancement du programme est conforme au calendrier.

ISPM

Du côté européen, le projet ISPM continue à progresser conformément au calendrier. Au cours de la période comprise jusqu'à fin juin environ les deux contractants travaillant en compétition pour la phase B1, MBB et Dornier System, ont procédé aux études de conception du système en étroite collaboration avec l'équipe ESA chargée du projet. A la fin de cette période un appel d'offres restreint à ces deux firmes a été diffusé pour les phases suivantes: conception détaillée (phase B2) et développement, fabrication et essais (phase C/D). Les réponses à cet appel d'offres ont été reçues le 27 juillet et soumises à une évaluation technique qui a abouti à une recommandation en faveur d'un contractant unique pour la poursuite du programme.

Sur le plan scientifique, une réunion a eu lieu en mai à l'ESTEC entre les responsables des expériences du véhicule which occurred during environmental testing.

Launcher
A review of the P07 fourth stage was held in July and a number of anomalies were identified, the most significant for the satellite being the possible contamination of solar cells by exhaust plumes from the despin nozzles. The launcher agency is currently investigating the problem.

Commencement of the dynamic tests to investigate the effects of fuel sloshing on damping and despin performance have been delayed because of late delivery of the Exosat hydrazine tank.

Agreement has been reached between project and launcher agency on items and services to be provided within the launcher contractual package.

ESOC activities
Progress continues on the procurement of equipment for the Villafranca ground station. A successful second review of ground-system design status has been held and a number of actions recommended by the Review Board are being implemented.

Space Telescope

Solar array
Progress on the solar array has been steady. The Preliminary Design Review (PDR) was held in April/May in conjunction with the Space Telescope PDR carried out in the United States in July, after a series of subsystem PDRs. A design solution that will protect the solar array against permanent power degradation as a result of shadowing of the solar array in orbit has been agreed upon, as has a design meeting the requirement for the array's in-orbit replacement.

A significant technical difficulty arose from the Telescope PDR, when it was found necessary, for attitude-control reasons, to impose a new requirement on the maximum torque exerted on the Telescope by the solar array during slewing manoeuvres. Considerable effort is now being made to identify a design solution that limits this torque to less than 0.05 Nm.

Camera module
Extensive and constructive negotiations with the contractor following submission of the Phase-C/D proposal have led to full agreement on the technical specification baseline and associated target cost for the Faint-Object Camera (FOC).

Considerable progress has been made on the development of the interfaces with the Telescope itself, although some critical areas still remain open. The manufacture is scheduled to start early in 1980.

Photon detector assembly
A fixed-price proposal for the work remaining in the PDA programme has been received from the contractor and has been negotiated; the contract has since been sent to BAe for signature.

Technical progress is close to plan, though some difficulties have led to some slippages in delivery dates, although these are still compatible with the FOC programme.

Elements of the PDA structural/thermal models are presently under test.

Interfaces with NASA
NASA has reconfirmed the selection of the United States scientific instruments. The Space Telescope Preliminary Design Review has been conducted successfully and the programme is on schedule.

ISPM

Within Europe, the ISPM Project continues to move forward on schedule. In the period up to approximately the end of June the two competing Phase-B1 contractors, MBB and Dornier System, conducted the system design studies in close collaboration with the ESA project team. At the end of this period, a restricted call for tender was made, confined to these two companies, for the subsequent detail design (Phase B2) and development, manufacture and test (Phase C/D) stages of the project. The replies to this were received on 27 July and these have been subjected to technical evaluation, resulting in a recommendation for a single contractor for the continuation of the programme.

On the scientific side, there was a meeting in May at ESTEC of the experimenters on both the ESA and NASA spacecraft, with a total attendance of some 100 people. Considerable progress was made in the understanding and resolution of various interface problems. Individual contacts have also been maintained with the ESA spacecraft experimenters, both European and American, so that formally agreed interface documents now exist for all experiments.

The major concern to the Solar-Polar Mission at this time is the performance of the Space Transportation System (STS), which is the combination of the Shuttle and the Interim Upper Stage (IUS) to be used to inject the two spacecraft into the interplanetary trajectory to Jupiter.

A number of contingency studies are underway in the USA to cover the eventuality that the required performance for ISPM will not be available in time for a 1983 mated launch. Close top-level contact is being maintained between ESA and NASA on this problem.

ECS

The ECS satellite Critical Design Review was held during July in order to establish whether protoflight model manufacture could commence. The majority of the areas covered showed an adequate situation and permission to proceed was granted subject to satisfactory solution of noncompliances in a number of areas. Further design definition and verification work is expected to lead to an established baseline before the end of the year.

The Agreement between EUTELSAT and the Agency for the provision of the ECS space segment was signed on 15 May and is now in force. The ECS 3/4/5 contract is being negotiated and is expected to be signed this year. In addition, a tender action has been initiated for the procurement of a Payload Testing and Monitoring Station to be used for the ECS programme.

Marecs

The next major milestone in the Marecs development programme is the Critical Design Review at the beginning of October. The preliminary steps leading to this overall system reveiw have already commenced with a review of the platform in parallel with the ECS Critical Design Review in July; the payload review will take place during September, when results from development-model testing are available.

spatial de l'ESA et de celui de la NASA, réunion qui a rassemblé une centaine de personnes au total. On a considérablement progressé vers la compréhension et la solution de divers problèmes d'interface. Des contacts personnels ont en outre été maintenus entre les responsables européens et américains des expériences du véhicule spatial de l'ESA de sorte qu'il existe maintenant des documents d'interface formellement approuvés pour toutes les expériences.

La principale préoccupation que pose à ce stade la Mission internationale d'étude des régions polaires du Soleil est liée aux performances du Système de transport spatial (STS), combinaison de la Navette et de l'Etage Relais (Interim Upper Stage: IUS), qui sera utilisé pour injecter les deux véhicules spatiaux sur leur trajectoire interplanétaire vers Jupiter.

Un certain nombre d'études portant sur des solutions de repli sont en cours aux Etats-Unis pour couvrir le cas où les performances requises pour l'ISPM ne pourraient pas être réalisées en temps voulu pour un lancement jumelé en 1983. L'ESA et la NASA restent en étroit contact au niveau le plus élevé à ce sujet.

ECS

La réunion d'examen critique de la conception du satellite ECS s'est tenue courant juillet afin de déterminer si la fabrication du modèle prototype de vol pouvait débuter. La majorité des domaines examinés ont montré que la situation était claire et le feu vert a été donné sous réserve de la correction de non-conformités dans quelques secteurs. De nouveaux travaux de définition et de vérification de la conception devraient mener à l'établissement d'un modèle de référence avant la fin de l'année.

Le 15 mai était signé l'accord entre EUTELSAT et l'Agence pour la fourniture du secteur spatial d'ECS, accord qui est désormais en vigueur. Le contrat couvrant les modèles ECS-3, 4 et 5 est en cours de négociation et devrait être signé cette année. De plus, un appel à la concurrence a été lancé pour l'approvisionnement d'une station d'essai et de vérification de la charge utile qui sera utilisée pour le programme ECS.

Marecs

La prochaine grande étape du programme de développement de Marecs est l'examen critique de la conception, fixé au début d'octobre. Les premières activités menant à cet examen complet du système ont déjà commencé avec la vérification de la plate-forme parallèlement à l'examen critique de la conception d'ECS en juillet; l'examen de la charge utile aura lieu courant septembre, époque à laquelle seront connus les résultats des essais menés sur le modèle de développement.

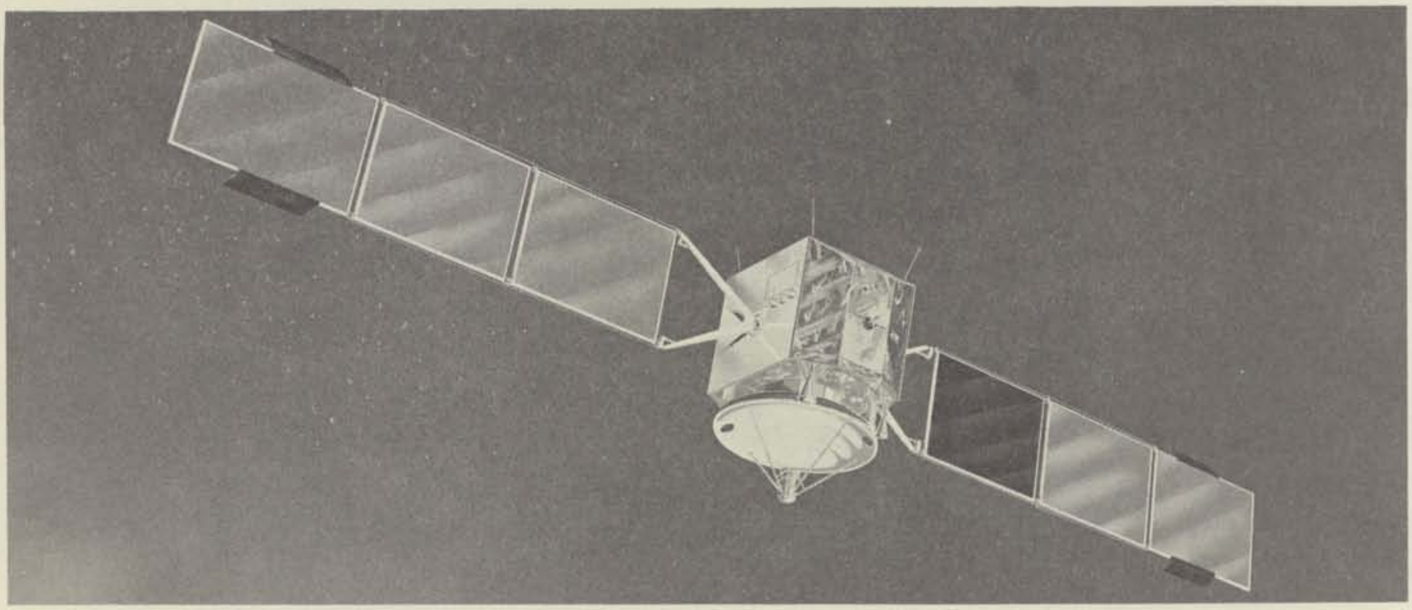
A la réunion du Conseil directeur commun des programmes de satellites de communications qui s'est tenue à Paris le 26 juillet, les Etats membres participant au programme Marecs sont convenus, en attendant la décision finale d'INMARSAT sur la configuration de son secteur spatial à l'échelle du globe, de préfinancer le troisième satellite de communications maritimes de l'Agence (Marecs-C), partie intégrante de l'offre ESA à INMARSAT. Cette décision autorise l'Agence à conclure un contrat avec le contractant principal du satellite (BADG) pour un montant de l'ordre de 25 MUC et à mettre en route un certain nombre de mesures intérimaires pour la fourniture de la station terrienne du Pacifique, nécessaire pour ce programme.

Sirio-2

Les incidences de l'arrêt des travaux LASSO, en avril, sur le planning du programme Sirio-2 ont été évaluées; elles se traduisent, pour le modèle mécanique du satellite par un retard de trois mois et, pour le modèle d'intégration, pas un retard de deux mois mais on ne prévoit pas de retard au niveau de la livraison et du lancement du modèle de vol. On a pu résorber ces retards en réaménageant certaines activités de fabrication, d'intégration et d'essais et en empiétant sur les marges de planning antérieures.

En juillet, la Suède a fait savoir qu'elle était prête à participer au programme pour 1,5% de contribution à condition qu'il soit possible d'assurer à l'industrie suédoise un retour industriel correspondant. Cette condition a été

Vue conceptuelle de Marecs.
Artist's impression of Marecs.



At the Joint Communication Satellites Programme Board held in Paris on 26 July, the Member States participating in the Marecs programme agreed, pending a final decision by INMARSAT on the configuration of its worldwide maritime space segment, to pre-finance the third ESA Maritime Communications Satellite (Marecs-C) which is an integral part of the ESA offer to INMARSAT. This decision authorises the Agency to place a contract with the satellite Prime Contractor (BADG) for approximately 25 MAU and to initiate certain interim measures for provision of the Pacific Ocean ground station required for this programme.

Sirio-2

The impact of the LASSO work stoppage in April on Sirio-2 programme planning has been assessed and amounts to delays of three months for the satellite mechanical model and two months for the integration model, while no delay is expected in the delivery and launch of the flight model. The delays have been absorbed by re-arrangement of certain manufacturing, integration and test activities, and by drawing on previous planning margins.

In July, Sweden announced its willingness to participate in the Sirio Programme with a 1.5% contribution on condition that a corresponding industrial return could be arranged with Swedish industry. This was achieved by organising a work-sharing scheme between SAAB and Laben for the manufacture of the satellite's telemetry encoder.

Preparations for the post-launch exploitation phase are in progress. A proposal has been received from Telespazio for the support programme (spacecraft control, MDD performance monitoring, and LASSO data pre-processing).

Remote Sensing

In the ESA Remote-Sensing (ERS) Programme, the Phase-A studies on LASS and COMSS have been extended. Definition of specifications for the different payload instruments is in progress. A contract has been awarded to Canadian Astronautics Limited to study the capabilities of LASS and/or COMSS to meet the SURSAT mission objectives; results are expected at the end of August. Apart from these studies, five contracts for the Remote-Sensing Preparatory Programme, covering study and pre-development of critical technology elements, have already been awarded, and some others are now in preparation.

Preparation of the two remote-sensing experiments (Microwave Remote-Sensing Experiment (MRSE) and metric camera) to be flown on the first Spacelab is progressing well.

L-Sat

The Large Telecommunications Satellite programme (L-Sat) has been the subject of internal ESA studies during the first half of 1979. These studies culminated in a decision in July by five ESA Member States to undertake the programme-definition phase (Phase-B) and other states may join later in the year. The programme has two main objectives:

- The development of a multipurpose large platform designed to match the user requirements in the field of future telecommunications applications.
- The development and in-flight evaluation of a demonstration service payload that will help users to access the potentialities of new satellite services, stimulate satellite usage, promote new markets and advance European technology.

During the period August to October, the Agency is conducting a competitive evaluation to select the satellite Prime Contractor. In parallel, the Agency has been authorised to check with all possible user authorities on their interest in the programme and their views on payload candidates.

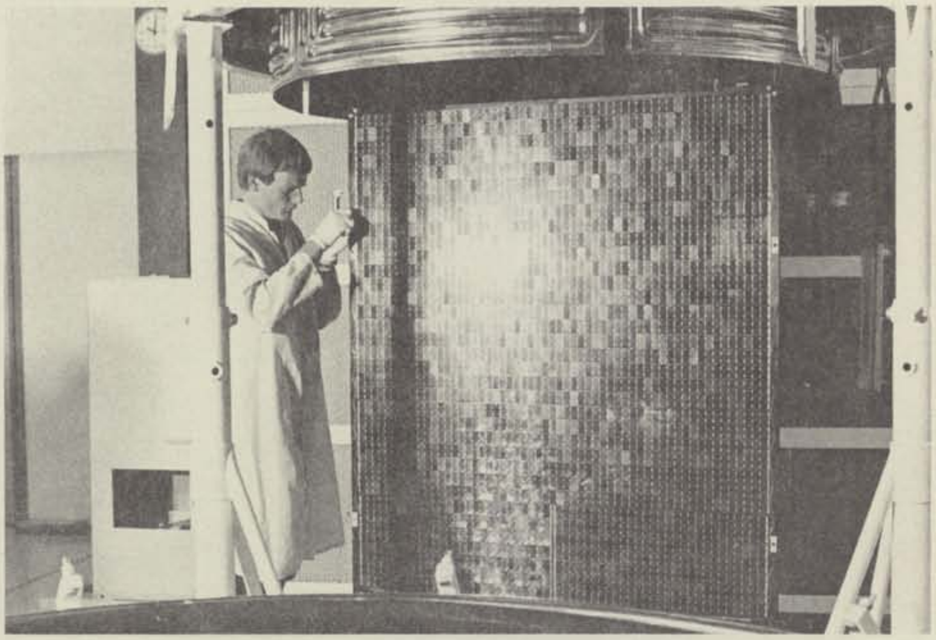
Spacelab

First Spacelab Payload (FSLP)
The instruments, experiments and associated mission-specific equipment that constitute Europe's contribution to the payload for the first Spacelab mission are into the final-design and hardware stages. A recent design review at NASA's Marshall Space Flight Center covered all aspects of the integrated payload (50% European, 50% American).

A launch slippage for the Shuttle for the first Spacelab flight to 1982 – the mission is currently planned for 18 April – has recently been announced by NASA.

A meeting of the Investigators Working Group (IWG), representing all FSLP experimenters, took place in Orlando at the end of June to take stock of progress made with the payload and to clarify interexperiment interfaces.

The ESA Council has approved a funding envelope of 21.7 MAU (1978 levels and 1979 exchanges rates) plus a contingency



A solar array for the ECS spacecraft undergoing vacuum testing at ESTEC.

Panneau solaire d'ECS au cours des essais sous vide à l'ESTEC.

remplie grâce à l'organisation d'un plan de partage des travaux entre SAAB et Laben pour la fabrication du codeur de télémesure de Sirio-2.

Les préparatifs pour la phase d'exploitation après le lancement suivent leur cours. En ce qui concerne le programme de soutien (contrôle du véhicule spatial, suivi des performances du MDD et prétraitement des données LASSO), Telespazio a fait parvenir une proposition.

Télédétection

Le programme d'extension des études de phase A sur les systèmes LASS (applications terrestres) et COMSS (surveillance des océans dans les zones côtières) a commencé. La définition des spécifications concernant les différents instruments de charge utile est en cours. Un contrat a été attribué à la société Canadian Astronautics Limited en vue d'étudier la capacité du système LASS et/ou du système COMSS à satisfaire aux objectifs de mission SURSAT; les résultats de ces études devraient être connus fin août. En dehors de ces études, cinq contrats, couvrant l'étude et le prédéveloppement d'éléments technologiques critiques, ont été attribués dans le cadre du programme préparatoire de télédétection, et un certain nombre d'autres contrats sont en préparation.

La préparation des deux expériences de télédétection (expérience hyperfréquences et chambre photogrammétrique) qui doivent être embarquées sur le premier Spacelab, marque des progrès satisfaisants.

L-Sat

Le programme de grand satellite de télécommunications (L-Sat) a fait l'objet d'études internes de l'ESA au cours du premier semestre 1979. Ces études ont abouti en juillet à la décision, prise par cinq Etats membres, d'entreprendre la phase de définition du programme (B), d'autres Etats membres pouvant s'y associer avant la fin de l'année. Ce programme a deux objectifs principaux:

- le développement d'une grande plate-forme polyvalente conçue pour répondre aux besoins des utilisateurs dans le domaine des futures applications des télécommunications;
- le développement et l'évaluation en vol d'une charge utile de démonstration qui facilitera aux utilisateurs l'accès aux possibilités des nouveaux services par satellite, stimulera l'utilisation des satellites, fera progresser la technologie européenne et ouvrira de nouveaux marchés.

Au cours de la période août-octobre 1979, l'Agence procèdera à un appel à la concurrence pour le choix du contractant principal du satellite. Parallèlement, l'Agence a été autorisée à examiner avec les autorités représentant tous les autres utilisateurs potentiels l'intérêt qu'elles portent à ce programme et à connaître leur opinion sur les différentes charges utiles en présence.

Spacelab

Première charge utile du Spacelab (FSLP)

Les instruments, les expériences ainsi que l'équipement particulier de la mission correspondante, qui constituent la contribution de l'Europe à la charge utile du premier vol du Spacelab, sont parvenus au stade final de la conception ou même de la réalisation du matériel. Au cours du récent examen de conception qui a eu lieu au Centre des Vols spatiaux Marshall de la NASA, on a examiné tous les aspects de la charge utile intégrée, c'est-à-dire les contributions, approximativement pour moitié chacun, de l'Europe et des Etats-Unis.

La NASA a annoncé récemment le report à 1982 du premier vol du Spacelab, la date du 18 avril étant actuellement admise dans les plans de la mission.

photo magnum

Une réunion du Groupe de travail des chercheurs (IWG), représentant toutes les expériences de la FSLP, s'est tenue à Orlando à la fin du mois de juin pour prendre note des progrès accomplis en ce qui concerne la charge utile et pour clarifier les interfaces entre expériences.

Le Conseil de l'ESA a approuvé une enveloppe financière de 21,7 MUC (niveau des prix de 1978 et taux de conversion de 1979) plus une marge d'aléas de 2 MUC pour couvrir la nouvelle estimation du coût à achèvement résultat d'une réévaluation complète des coûts du projet effectuée dans le courant de cette année. L'intégration matérielle et les essais seront effectués par l'industrie allemande sous la direction du SPICE. Une proposition à cet effet est en cours d'examen.

Spécialistes 'mission' européens pour les vols de la Navette

La NASA a offert d'admettre des ressortissants de pays étrangers comme spécialistes 'mission' sur les vols de la Navette lorsque la charge utile du vol particulier de la Navette incombe à l'ESA pour la moitié ou plus. L'ESA procéderait à son propre concours de recrutement des spécialistes 'mission' en se fondant sur des critères fournis par la NASA. Avant le vol, les candidats aux fonctions de spécialistes 'mission' de l'ESA suivraient un stage de formation de un ou deux ans très semblable aux stages actuels des candidats astronautes de la NASA.

L'Agence considère que l'offre de la NASA peut être recommandée; elle envisage de l'accepter en principe et étudiera avec la NASA les incidences concernant les coûts.

Production ultérieure du Spacelab (FOP)

Les préparatifs concernant le programme

of 2 MAU to cover the new cost-to-completion estimate arising from a comprehensive re-assessment earlier this year of the project costs. Physical integration and testing will be performed by German industry under the direction of SPICE, and a proposal for this is currently under review.

European mission specialists for Shuttle flights
NASA has offered to accommodate foreign nationals as mission specialists on any Shuttle flights for which ESA sponsors 50% or more of the payload. ESA would be responsible for the competitive recruitment of its own mission specialists, based on criteria provided by NASA. Prior to flight, the ESA mission-specialist candidates would undergo a one- or two-year training period very similar to the current NASA astronaut-candidate programme.

ESA considers the offer attractive, intends to accept it in principle, and will explore the cost implications with NASA.

Spacelab Follow-On Production (FOP)
Preparations for the Spacelab Follow-On Production Programme are continuing in European industry, ESA and NASA. ERNO and Dornier System have submitted revised fixed-price proposals for the production of the second Spacelab flight unit and Instrument Pointing System (IPS). These proposals have been evaluated by ESA, with NASA's assistance. NASA will receive the complete bid for the FOP work by 15 September, including an ESA proposal for the programme's management. Contract award is now scheduled for the end of the year.

A letter of contract signed in July by NASA, ESA and ERNO provides for the acquisition of long-lead items and for approximately 1 MAU of effort to support the delivery of the FOP Spacelab.

Ariane

First stage
The first qualification firing of this stage was carried out on 17 May, under nominal conditions; the second and last qualification test is scheduled for early September.

Third stage
Since the incident with the EP 2 stage during the test in November 1978 there have been:

- six tests on the B 2 propulsion bay ('battleship'), totalling 3000 s of operation;
- three tests with a flight configuration stage (EP 4), totalling 1600 s.

Ariane launch site
The propellant-mock-up operations were completed at the end of May with the simulation of a complete launch count-down to H 0-4 seconds for all the operations relating to filling with propellants and other fluids.

Tests on the overall compatibility of the launch site were completed at the end of June with the validation of the ignition and jettisoning phase and a simulated flight. These tests allowed qualification of all the launch installations and facilities.

Preliminary flight-readiness review
The preliminary flight-readiness review of the L01 launcher, carried out during June, has made it possible to clear the launcher for transport to the launch site in Guiana.

Ariane follow-on development
The ESA Council, on 26 July, approved the implementation of the preparatory programme phase for Ariane follow-on development, which is aimed at increasing the launcher's performance from 1700 kg to 2350 kg in geostationary transfer orbit.

Manufacture of additional launchers
On 26 July, Council also approved the ordering of long-lead-time components for five additional launchers; this increases the number of operational launchers in production or on order from six to eleven.

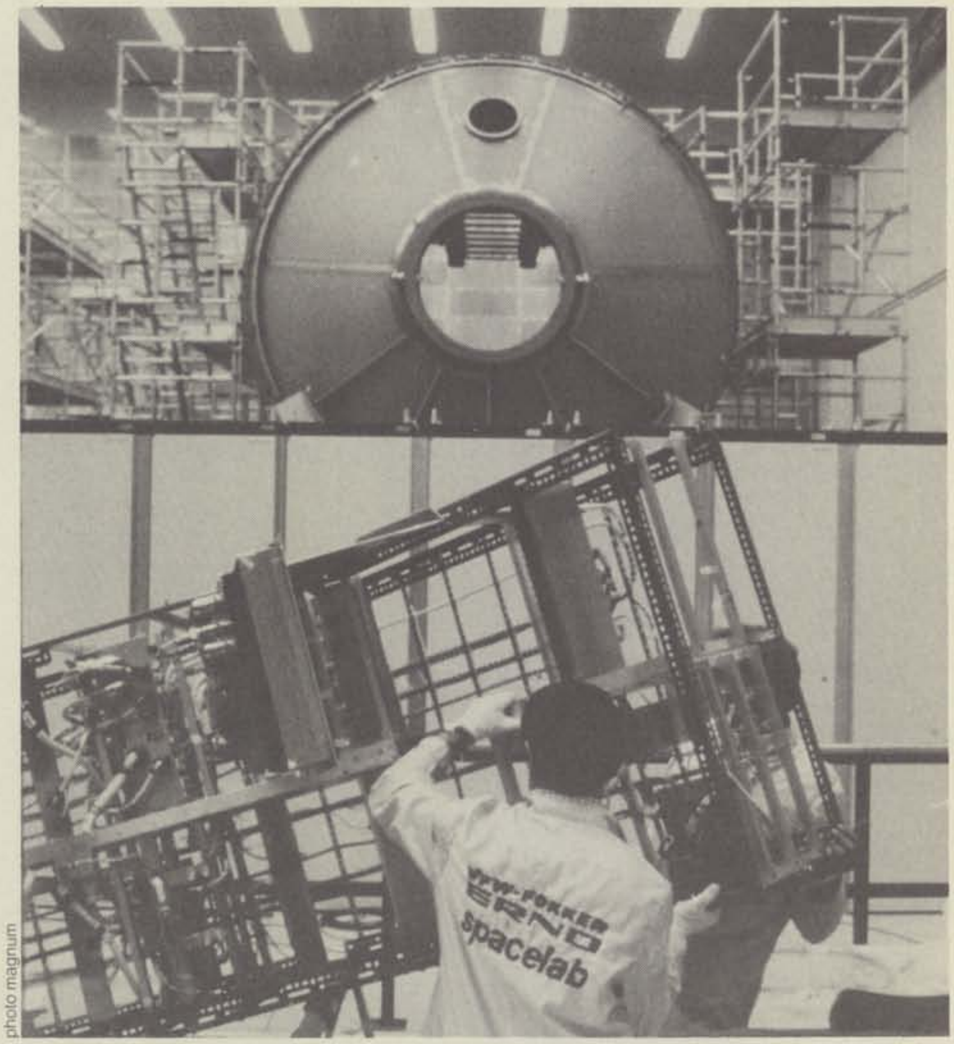
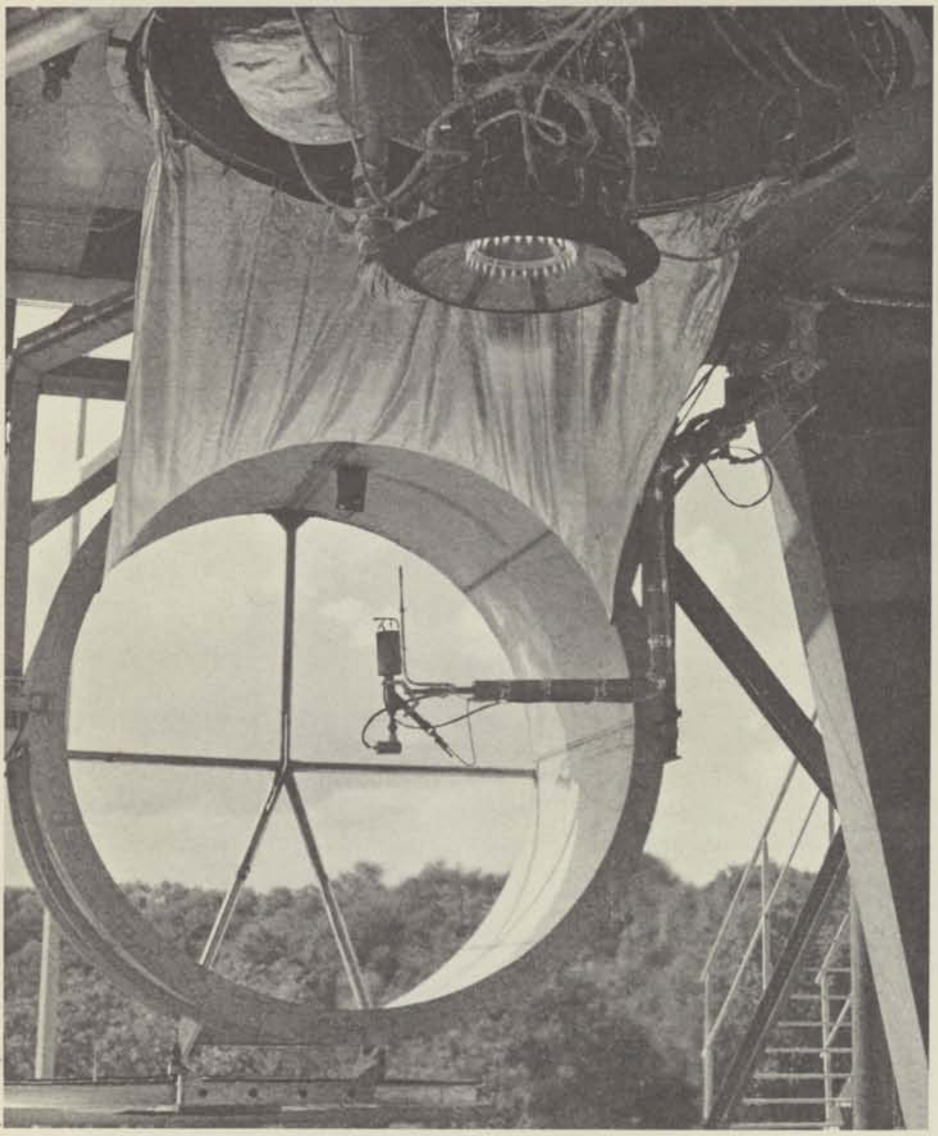


photo magnum

The adjacent photographs (left and right) show Spacelab under integration at ERNO in Bremen.

Le laboratoire spatial en intégration à ERNO, Brême



Essai de l'ensemble propulsif H8 du 3ème étage d'Ariane à la SEP (France).

The H8 propulsion system of Ariane's third stage under test at SEP (France).

de production ultérieure du Spacelab se poursuivent dans l'industrie européenne, à l'ESA et à la NASA. ERNO et Dornier System ont fourni des propositions de prix forfaitaire révisées pour la production du deuxième exemplaire de vol du Spacelab et pour le système de pointage des instruments du Spacelab. Les propositions ont été évaluées par l'ESA avec l'aide de la NASA. En même temps qu'une proposition de l'ESA relative à la gestion du programme de FOP, la NASA recevra vers le 15 septembre l'offre complète pour les travaux de FOP. L'attribution du contrat devrait maintenant avoir lieu vers la fin de l'année.

Un contrat-lettre, signé en juillet par la NASA, l'ESA et ERNO, porte sur des travaux et des commandes à long délai de livraison d'un montant approximatif de 1 MUC en vue de la fourniture du Spacelab de FOP.

Ariane

Premier étage

Le premier tir de qualification de l'étage a été réalisé le 17 mai dernier dans des conditions nominales; le deuxième et dernier essai de qualification est prévu pour début septembre.

Troisième étage

Depuis l'incident sur l'étage EP2 lors de l'essai en novembre 1978, ont été effectués:
- *six essais sur la baie de propulsion B2 ('battleship') totalisant 3000 s de fonctionnement*
- *trois essais avec un étage en configuration de vol (EP4) totalisant 1600 s.*

Ensemble de lancement Ariane

Les opérations maquette ergols se sont terminées fin mai par la simulation d'une chronologie complète jusqu'à H 0-4 secondes pour toutes les opérations relatives aux remplissages en ergols et fluides divers.

Les essais de compatibilité d'ensemble de la base de lancement se sont terminés fin juin avec la validation de la phase d'allumage et de largage et un vol simulé. Ces essais ont permis de qualifier toutes les installations et les moyens de lancement.

Revue préliminaire d'aptitude au vol

La revue préliminaire d'aptitude au vol du lanceur L01, tenue dans le courant du mois de juin, a permis de déclarer le lanceur prêt pour transport à la base de lancement en Guyane.

Développement complémentaire Ariane

Le 26 juillet le Conseil de l'Agence a approuvé l'exécution de la phase préparatoire du programme de développement complémentaire Ariane visant à l'accroissement de la performance du lanceur de 1700 kg à 2350 kg en orbite de transfert géostationnaire.

Mise en fabrication de lanceurs supplémentaires

Le Conseil de l'Agence a également approuvé la commande des approvisionnements à long délai de livraison pour cinq lanceurs supplémentaires; le nombre de lanceurs opérationnels en réalisation ou en commande passe ainsi de six à onze.

Le programme de qualification opérationnelle du Centre Spatial Guyanais

M.-A. Hauzeur, Département Ariane, ESA, Kourou, Guyane

En juin dernier, à l'issue d'importants travaux de remise en état et de mise en configuration Ariane, la qualification opérationnelle du Centre Spatial Guyanais a été prononcée. Cette reconnaissance est une étape majeure dans la réalisation du Programme Ariane puisqu'elle consacre l'aboutissement d'un long effort de revalidation des moyens du champ de tir et de remise au niveau opérationnel des équipes.

Le but de cet article est de situer et de décrire cet effort du CSG pour assurer dans les meilleures conditions de succès le premier lancement de la fusée Ariane*.

* Je remercie M. Niel, chef de la Division Opérations du CSG pour les informations fournies et pour la vérification de cet article.

Historique

Avec la fin du Programme Europa-II du CECLES/ELDO en 1973 et celle du Programme français Diamant en 1975, la décision de mettre le Centre Spatial Guyanais en configuration d'attente était prise conjointement par les Directions du CNES et de l'ESA en vue de leurs installations respectives.

Cette décision se justifiait par l'absence d'activités opérationnelles de lancement sur les années 1976-78 tout en permettant le renouvellement ou l'adaptation des moyens du champ de tir, nécessaire à la réalisation du programme de lanceurs Ariane dont le premier lancement était prévu en 1979.

A l'issue de cette phase de travaux, il était impératif de s'assurer par un programme spécifique de la qualification des moyens et des équipes avant d'accueillir le premier lanceur de développement Ariane.

Objectif et nécessité

La qualification d'un système – et le champ de tir en est un – constitue l'étape ultime de son développement. Pour le CSG, l'objectif est de s'assurer qu'il peut effectuer un lancement dans de bonnes conditions, c'est-à-dire:

a) fournir aux équipes de lancement (Véhicule et Satellite) le soutien opérationnel, logistique et mesure dont elles ont besoin;
b) garantir la qualité des prestations, notamment dans le domaine de l'acquisition et du traitement des données en temps réel, depuis le décollage jusqu'à l'insertion en orbite;
c) assurer la sauvegarde des personnes et des biens.

La nécessité d'un programme spécifique de qualification résultait, d'une part, des modifications importantes intervenues pour Ariane sur les installations et moyens du Centre:

- renouvellement complet du système informatique de localisation
- adoption de la bande E pour la télémesure
- mise en place des stations aval pour ces deux systèmes avec les télécommunications correspondantes
- adaptation de la régie à l'organisation Ariane
- adaptation du pas de tir Europa-II comprenant la tour, le système ergols et fluides, les bancs de contrôle;

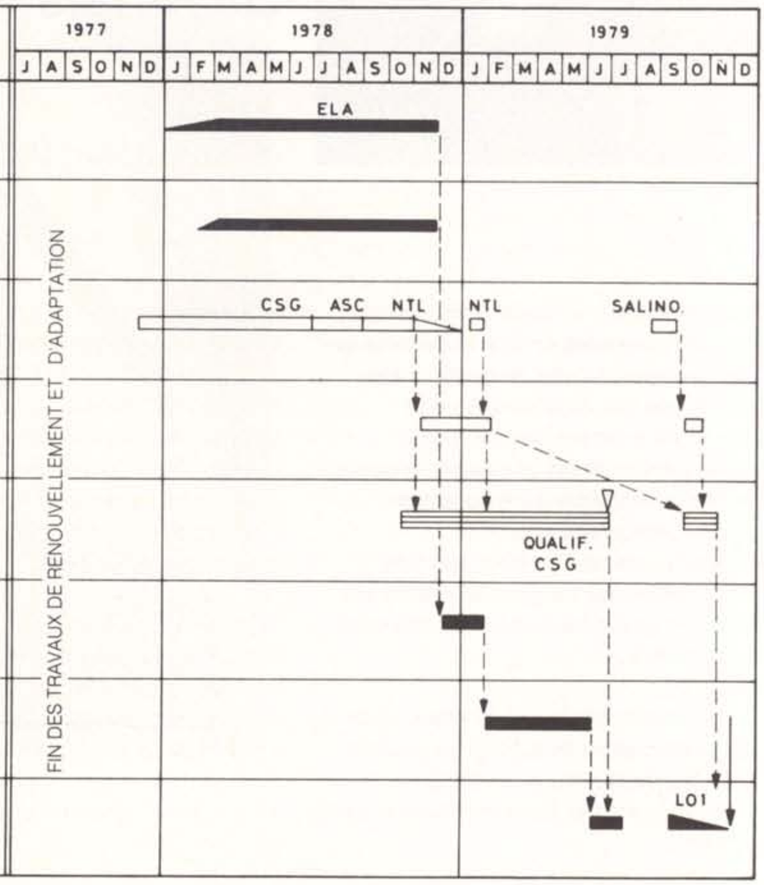
d'autre part, de la nécessité d'un entraînement du personnel, en partie renouvelé, sur ces nouvelles installations dans des conditions recréant celles des opérations réelles.

Cette qualification comporte donc deux aspects essentiels:

a) technique – visant à s'assurer que l'ensemble des moyens requis pour un lancement répond aux spécifications imposées par les missions;
b) opérationnel – visant à s'assurer de la capacité du personnel à mettre en oeuvre ces moyens dans le cadre de chronologies type, suivant des configurations nominales ou dégradées.

Programme de qualification – Déroulement des différentes phases

Phases	Description
1A	ELA ESSAIS FONCTIONNELS – SOL SANS LANCEUR
1B/2A/2B	ELA ESSAIS BANCS DE CONTROLE SIMULATEURS STATIQUES/DYNAMIQ/INSTALL SOL
Qualification technique	CSG + STATIONS-AVAL MOYENS PROPRES (LOCALISATION/TM-TC/ SAUVEGARDE) AVIONS/FUSEES-PONDES/SATELLITE
2C	CSG + STATIONS-AVAL ESSAIS FONCTIONNELS D'ENSEMBLE BANDES TRAJECTOIRES ET SATELLITE
Qualification opérationnelle	CSG + STATIONS-AVAL ENTRAINEMENT DU PERSONNEL AVIONS/FUSEES-PONDES/SATELLITE
3A	ELA ESSAIS ERECTION LANCEUR AVEC MAQUETTE ERGOLS
3B	ELA ESSAIS SYSTEMES MECAN. FLUIDES REMPLISSAGE AVEC MAQUETTE ERGOLS
3C	ELA/BLA ESSAIS SYSTEMES ELECTRIQUE/ENSEMBLE BLA AVEC SIMULATEURS ARIANE



Programme et moyens

L'ensemble du programme de qualification comportait huit phases qui se répartissaient sur environ 18 mois (janvier 1978 – juin 1979) et couvrait la validation et la mise en oeuvre opérationnelle des moyens propres du CSG (localisation, télémesure, sauvegarde, météorologie, régie, logistique, coordination) ainsi que de ceux de l'Agence (Ensemble de Lancement Ariane: ELA).

Les activités se déroulaient en parallèle en plusieurs lieux géographiques: Kourou (CSG), Salinopolis (télémesure) Natal et Ascension (télémesure et trajectographie).

A chaque niveau de validation des installations et d'entraînement du personnel correspondent des moyens de simulation et procédures associées, qui représentent tout ou partie des conditions d'un vol Ariane. Ces moyens sont des simulations câblées, des bandes magnétiques et des moyens mobiles extérieurs. Seuls ces derniers sont susceptibles de simuler l'ensemble des conditions d'un vol Ariane. Ils comprenaient:

a) Avions (1 Xavante: environ 50 h; 1 Piper Cherokee; environ 40 h) equipés en télémesures et en répondeurs radar de type Ariane, plus un récepteur de télécommande;
b) Fusées-sondes (1 Dauphin, 3 Eridans). Ces vecteurs équipés des mêmes moyens que les avions ont permis en particulier de tester les fonctions localisation/sauvegarde en vol/mise en oeuvre logistique/ coordination, au niveau du CSG. Le programme de qualification a, en outre, profité des lancements Exametnet (fusées Super-Arcas de météorologie: deux lancements par mois);
c) Satellite (Geos-III équipé de deux répondeurs radar). C'est le seul moyen mobile pouvant être utilisé pour qualifier la cohésion technique et opérationnelle entre le CSG, Natal et Ascension.

Mise en oeuvre du programme

La philosophie adoptée pour le programme prévu consistait à vérifier la mise en oeuvre de chaque fonction et ensuite de leur ensemble en mode nominal (configurations et procédures), permettant une validation et un entraînement de base, et ensuite à simuler des incidents en cours d'excercice conduisant soit à des procédures de retour au nominal, soit au passage en configurations dégradées, soit encore aux procédures de décisions d'impasses.

Ceci a été appliqué tant dans l'utilisation des moyens fusées-sondes que satellite.

Fusées-sondes
- 1er tir Eridan 015 (23/11/78); 1ère répétition générale au niveau du CSG – mise au point de procédures nominales
- 1er tir Dauphin 06 (8/2/79); entraînement en configuration minimum
- 3ème tir Eridan 017 (13/6/79); introduction d'une vingtaine d'incidents programmés en cours de chronologie, allant de la simulation d'un malaise grave pour le Directeur des Opérations à la coupure d'énergie d'un radar ou d'une alimentation calculateur.
- 4ème tir Eridan 016 (novembre 1979); test final de la configuration nominale du CSG, avant le lancement Ariane L01.

Satellite – La même approche est appliquée ici:
- validation au niveau de chaque site CSG, Natal, Ascension
- essais de mise en liaison
- essais de poursuite Geos-3 ou de désignations sur trajectoire Ariane/bandes, d'abord en configuration nominale, ensuite en modes dégradés (19 modes testés) prévoyant notamment des pertes et recherches du lanceur en l'absence des données de parallaxage.

Au total 107 passages Geos ont été exploités comprenant 14 essais d'ensemble des stations aval dont 11 ont atteint les objectifs assignés.

De plus, les activités concernant les moyens du CSG et celles de l'Ensemble de Lancement Ariane, qui devait assurer outre la validation de ses installations propres, l'interface avec le lanceur proprement dit (phases 3A, B, C), ont été menées indépendamment. Ce n'est qu'au cours de la phase 3C que la qualification de la Base de Lancement (BLA), regroupant ces deux ensembles, a été acquise sur simulateurs Ariane. Le programme s'est achevé par le déroulement de deux séquences synchronisées complètes représentant des lancements fictifs.

Organisation
Au niveau du CSG, le programme de qualification a été traité comme un *projet* et donc dirigé par un chef de projet qui supervisait la réalisation de chaque étape avec les divisions techniques concernées et assurait la coordination générale.

Au niveau du CNES, a été créé dès 1978 un Comité de Revue de Projet Qualification Opérationnelle du CSG, composé de membres de la Direction générale et présidé par l'Inspecteur général.

Ce Comité s'est réuni deux fois:

- en avril 1978, pour faire le point de la situation en ce qui concernait les moyens et le personnel et établir des recommandations pour la suite;
- en juin 1979, pour constater l'état opérationnel du Centre, les difficultés rencontrées et les résultats obtenus pour les essais d'ensemble, et recommander, suite à l'exercice Eridan 017, la prononciation officielle de la qualification opérationnelle du CSG.

Résultats et conclusions
Par sa réalisation et la gamme des moyens mis en oeuvre, le programme de qualification du CSG, a permis, à tous les niveaux des différentes fonctions, d'identifier les lacunes ou les points faibles du système de lancement Ariane et de prendre les actions correctives nécessaires.

Il a permis la mise au point des procédures détaillées pour les différentes configurations prévues et l'entraînement correspondant du personnel.

La compatibilité des interfaces lanceurs/ELA, ELA/CSG, CSG/Stations aval a pu être vérifiée.

Les deux chronologies Eridan 017 ont fait apparaître des problèmes importants sur l'utilisation des moyens.

Les phases 3B et 3C ont été riches d'enseignement et ont engendré une série de modifications et de mises au point du site ELA.

La période qui a précédé la venue d'Ariane L01 (septembre 1979) a permis de régler ces problèmes et nous ne doutons pas que c'est un CSG parfaitement opérationnel qui accueille ce premier lanceur.

The Role of Price-Revision Formulae in ESA Contracts

G. Hoss, ESA Cost Analysis Division, ESTEC, Noordwijk, The Netherlands

Cost escalations, an international phenomenon only too well known to the inflation-conscious among us, are affecting the Agency's contracting processes in a variety of ways. Since the rates of such escalations differ from country to country and month by month it has become progressively more difficult to establish reliable predictions and to take them into account when establishing contracts.

For ESA's cost-reimbursable contracts, the impact of such factors as inflation results in cost increases which, as time goes by, have to be catered for in revised budget appropriations, leading automatically to a higher final price. In cases where a fixed-price contract has been envisaged or appears desirable to avoid cost overruns, the problem is to reach agreement between the parties on a margin that could possibly cover the effects of inflation. This latter practice has been used a great deal in the United States in the past. In Europe, however, the various inflation rates can hardly be anticipated sufficiently for successful negotiation of fixed-price long-term contracts. The only alternatives are then:

(i) for ESA to agree a margin with the contractor for anticipated inflation which is part of the contract price and which – since it is an estimate anticipating future cost increases – may exceptionally lead to an additional profit or loss for the contractor; or
(ii) for ESA to agree with the contractor that the fixed price is valid in relation to a certain reference date only and that for the remainder of the contract inflation will be compensated by application of a formula that forms part of the contract conditions and has thus been agreed upon in advance.

The second of these two possible approaches, although having the inconvenience of involving a heavier administrative procedure during the contract's lifetime, is by far the more objective and it is this approach that has found widest application in Europe in the face of the complex problems of spiralling inflation rates.

Basic principles
When establishing the price-revision formula it is essential that all the elements of work to be performed under a given contract be fully analysed and properly reflected in the formula, a simple example being the division (ratio) between manpower and materials. The next task is to find and agree upon official indices, to be issued regularly, which can be expected to reflect the increases over a certain time period in the cost of the work specified in the contract and as broken down in the formula.

Clearly, the formula should reflect only those increases over which the contractor himself has no control, and increases arising from variations in work load or productivity should on no account be included in the price revision.

In some cases mandatory price-revision formulae and indices are laid down by national departments in accordance with their domestic legal provisions for specific branches of industry or services, and these same formulae are then applied by ESA. Where there are no specific national instructions, ESA makes use of revision indices derived from official sources, or from data that are not specific to a given firm but are valid generally for the economy of the firm's host country. The price revisions take place at contractually agreed times in respect of elapsed periods.

Establishment of formulae

Formulae and indices prescribed by the State
Among ESA Member States, France in particular has been applying the price-revision formula as a contractual instrument for several decades, establishing formulae and indices for specific branches of industry and services which are also applicable to ESA contracts. One such 'standard formula' used in the aerospace industry for pure services (labour, development work) takes the form:

$$P = P_0 (0.10 + 0.60 \frac{S_1}{S_0} + 0.30 \frac{Psd_1}{Psd_0})$$

in which

P/P_0	= revised/basic price
0.10	= fixed portion
0.60	= variable portion
S_1/S_0	= salary index
0.30	= variable portion
Psd_1/Psd_0	= diverse supplies and services

The indices are established and published on a regular basis by France's Institut National de la Statistique et des Etudes Economiques (INSEE).

Simple formula allowing accurate updating
The formula must cover the evolution in total price and it should therefore contain specific parameters for items such as labour costs, materials, special internal facilities, travel costs, etc. Several indices will usually be needed for the materials alone to cover the different products involved.

A formula constructed in this way could therefore contain at least four indices, possibly even six. Experience shows, however, that formulae with more than three indices are difficult to manage, give rise to errors, and cause delays in adjustment because the various indices are not always updated and published simultaneously.

ESA does not therefore generally include in its formulae specific indices for individual price elements that constitute less than 10% of the total contract price. Consequently, there are many Agency contracts in which the total price is revised only on the basis of a labour-cost index.

Choice of index
In the same way that INSEE is responsible for publishing official indices for France, there are some comparable State institutions publishing figures in the other ESA Member States:

Belgium	Institut National de Statistique, Brussels
Denmark	Danmarks Statistik, Copenhagen
Germany	Statistiches Bundesamt, Wiesbaden
Great Britain	Department of Employment, Department of Industry
Italy	Istituto Centrale di Statistica (ISTAT), Rome
Netherlands	Centraal Bureau voor de Statistiek, The Hague
Spain	Instituto Nacional de Estadistica, Madrid
Switzerland	Bundesamt für Industrie, Gewerbe und Arbeit, Berne

The official statistics that they publish vary from country to country, reflecting the local economic structures and market conditions in their scope (e.g. number of industrial branches considered) and in their detailed subdivision.

In cases where national indices are not suitable for ESA contracts owing to their statistical content, are published only with considerable delay, or do not exist at all, the Agency selects or works out indices from other sources. There are, for example, tariff agreements between employer and employee associations and statistics issued by public bodies.

In Germany reference is often made to a labour-cost index derived from a representative tariff salary and the legal and scheduled social contributions (value of salary); in Switzerland, a labour-cost index is derived from quarterly salary statistics produced by the employers' association of the Swiss mechanical and metalworking industry.

The greatest difficulties arise primarily in the choice of a representative materials index, because several different materials are often included in a single contract and some of them, such as high-reliability parts, are not clearly covered statistically. In such cases, a 'weighted material index' is established that is comparable with the prevailing national price trend.

Timing of price revisions
As the price-revision formula revises the sum agreed for the supply of the service (or the prices corresponding to partial productions) and the performance of the contract relates to a specific period, a basis is needed for the various steps in the revision; this is provided by the 'cost plan' with its various milestones. Payment plans can serve as a basis for the price revision only when the periods covered by the payment dates are compatible with the periods during which the work has been performed.

The practice of revising contract prices on the occasion of every increase in index, rather than in accordance with the general evolution in costs, is not usually applied in ESA contracts.

Continuity of formulae and indices
Continuity does not mean that the same formula can be applied at all times, since its structure depends inter alia on the performance structure that is specific to the contract and which therefore varies. On the other hand, the criteria laid down as a basis for the formula generally apply throughout the contract, particularly the net fixed costs and the portion of additional fixed costs determined following the off-setting of a sub-proportional increase in variable costs.

As there is a reciprocal relation between the index and the fixed-cost part of the formula, the index is also to be retained in all contracts.

Construction of the formula

Cost structure within contracting firm
The structure of labour and material costs in a firm (i.e. the actual or calculated costs included in the hourly rates and overheads) is examined over a long period (if possible a minimum of three years) in order to determine the evolution of the individual types of cost in terms of magnitude and percentage of the total.

For this, the following items are calculated:
- Percentage share of fixed costs in the total costs.
- Percentage change in the variable costs. Here account is taken, as far as possible, of the actual evolution of costs, e.g. the average salary and relevant social charges per employee. If the changes in individual types of cost cannot be identified or would be too expensive to determine, the State price indices are taken, for instance for office supplies and business equipment.
- Percentage share of variable costs in the total.
- Weighted change (usually increase) in the variable costs, derived from the changes in types of cost and their weighting proportion of the total costs.

The next step consists of comparing the increase in variable costs with the index chosen. Experience shows that the evolution in a firm's variable costs is sub-proportional to the evolution of the index.

So that the customer will not derive an unfair benefit from the choice of index, the over-proportional growth of the index with respect to the variable costs must be offset by a fixed part F in the formula:

$$F = 1 - \left[\frac{\text{Index 1} - 100}{\text{Index 2} - 100}\right]$$

Index 1 is the increase bringing the variable costs up to X%; index 2 is the increase bringing the applied index up to X%. For example

Total cost	100%
Fixed cost	4%
Variable costs	96%
Index 1 =	125
Index 2 =	127.5

Therefore,

$$F = 1 - \frac{125-100}{127.5-100}$$

$$= 9.1 \times 96\%$$

$$= 8.7$$

Fixed part	4.0
Total fixed part	12.7%

The calculated 'offsetting fixed part', together with the actual fixed costs, gives the nonrevisable part of the costs included in the hourly rates and overheads.

Any cost-intensive 'special internal facilities' must be examined separately and a special fixed part determined for them.

Contract structure
Firstly, the percentage shares of the individual price elements in the total have to be calculated, gathering together similar elements such as labour costs and external services or materials and external products.

Where in the case of individual price elements a specific index is not to be included in the formula (e.g. because of insufficient data) or cannot be included (because there is none), a calculation is carried out to determine how the costs of these price elements have evolved in relation to the formula index chosen. There are thus parallel features between this exercise and the examination of the cost structure.

For the price elements in question, the corresponding fixed part is likewise determined from the formula given in the above paragraph.

The formula can be constructed on the basis of the principles outlined above. The facing table shows an example for a fixed-price contract with 10% profit on prime cost (profit not limited to a prescribed amount).

Assumptions
The formula should include only the labour-cost index, because the other costs are always less than 10% of the total. The analysis used as a basis for the firm's cost structure showed that the costs included in the hourly rates and overheads vary sub-proportionally to the labour cost index. In order to offset this sub-proportionality, a fixed part of 12.7% is necessary.

The statistics show the following evolution:

Material index	178 – 205:	115%
Computer unit	238 – 250:	105%
Travel cost index	119 – 167:	140%

For the 'special internal facilities', the firm's figures show an increase to 110%. The R & D costs of the firm consist of 80% labour costs and 20% material costs.

The first calculation step involves comparing the formula index (labour-cost index) and cost evolution of the individual price elements:

Material $F = 1 - \frac{115-100}{127.5-100} = 45.5\%$

Computer $F = 1 - \frac{105-100}{127.5-100} = 81.8\%$

Travel costs $F = 1 - \frac{140-100}{127.5-100} = -45.5\%$

Special internal facilities $F = 1 - \frac{110-100}{127.5-100} = 63.6\%$

Price element	Amount	Profit 10%	Price portion amount	%	Compensatory fixed portion due to index %	Fixed portion in total price	Variable portion in total price
Labour cost	600 000						
Mat overhead	8 000						
G & A 12%	84 600						
80% R & D	28 200						
	720 800	72 080	792 880				
Ext services	40 000						
G & A 5%	4 500	–	45 500				
			837 380	83.6	12.7	10.62	
Material	40 000						
20% R & D	7 050						
	47 050	4 705	51 755				
Ext maj products	30 000	–	30 000				
			81 755	8.5	45.5	3.73	
Computer	50 000	5 000	55 000	5.5	81.8	4.50	
Special int facilities	7 000	700	7 700	0.7	63.6	0.45	
Travel & subsistence	20 000	–	20 000	2.0	(45.5)	(0.91)	
Total price			1 001 835	100.0		18.39	81.61

Price revision formula

$$P_1 = P_0 (0.1839 + 0.8161 \frac{\text{Index 1}}{\text{Index 0}})$$

P_1 = Revised price
P_0 = Contractually agreed price
Index 1 = Average value of index for the period to be revised
Index 0 = Value of the same index corresponding to the contractual price level

The second calculation step (see above) includes weighting of the price elements, and calculation of the weighted fixed part of the total price.

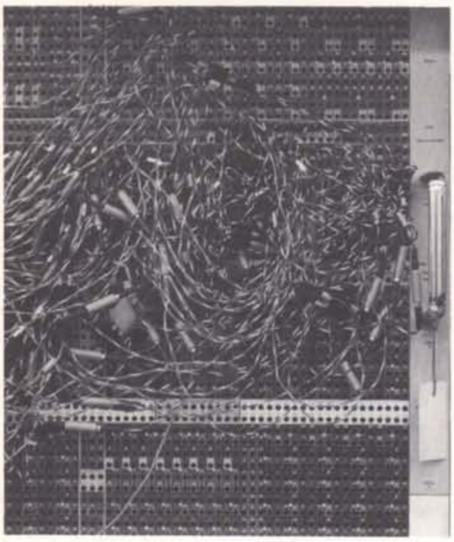
Variants in the construction of a formula
In individual cases it may be appropriate to remove price elements from the general formula and revise them separately:

- Important price elements such as materials and use of test facilities have limited periods of validity. If they remained in the general formula they would falsify the weighting throughout the period covered by it.
- In so far as the costs of certain price elements are incurred at the beginning of the contract period (e.g. on procurement of materials), it is advisable to agree on a firm fixed price for these elements wherever possible.
- Where important work is done by third parties, especially by subcontractors, a specific formula should be established for home-based third parties whenever it is to be assumed that cost structures of contractor and subcontractor differ.
- For foreign-based third parties, a specific formula must be established, since neither their cost structure nor their index can be the same as the contractor's. Where necessary, the formula must include a foreign-currency exchange factor.

Conclusion
Price-revision formulae are an instrument designed to adapt the final financial envelope of a fixed-price contract to the cost and price variations that have taken place during the duration of the contract. ESA recognises only unavoidable 'external' cost and price increases, and those due to 'internal' causes within a contractor's own organisation are ignored. The revision indices used by the Agency are usually derived from official statistics or generally valid public agreements. Sources in the private sector of the national economies are employed only in exceptional cases.

Contractual agreements entered into by the Agency specify:

- the price basis of the agreed price
- the definitions of the applicable index and basic index
- the implementation of the formula, i.e. dates or periods of application covered
- the price elements to be revised at each of the due dates.



La communication interne au sein de l'ESA

R. Soisson, Direction de l'Administration, ESA, Paris

Le développement spectaculaire des moyens de communication a pour conséquence une diversification croissante des technologies, assortie d'une tendance à l'augmentation des besoins et donc des dépenses. Les sombres perspectives ouvertes par ce dernier terme – surtout lorsqu'il représente environ 4 MUC par an – ont présenté pour l'Administration une motivation largement suffisante pour qu'elle s'intéresse à maîtriser au plan interne les incidences de cette évolution. La première étape de sa démarche a consisté à se faire une opinion sur sa propre situation d'utilisateur de moyens de communication. Il en est résulté cet exposé qui a été successivement présenté à Frascati en mars, puis à Paris en mai 1979, devant des publics qui se demandaient a priori sous quels aspects et jusqu'à quel point ce domaine pouvait bien intéresser l'Administration de l'Agence.

L'Administration a l'universelle réputation d'être économe et ce n'est pas nécessairement la plus attirante des obligations qui lui sont faites. Mais il en résulte qu'elle éprouve une instinctive sympathie pour toute technologie et tout procédé qui lui permettent d'être économe de temps, de personnel et d'argent et cette démarche présente deux avantages manifestes: le premier est de considérer d'un oeil critique l'objectif de performance et d'art technique, ce qui conduit généralement à une certaine optimisation du sacro-saint rapport 'coût/efficacité'; le second est qu'elle se trouve ainsi dans l'obligation de s'appliquer à elle-même ce qu'elle est conduite à exiger des autres et qu'elle en devient en conséquence progressivement plus efficace.

En ayant à l'esprit cette forme de pensée un peu particulière, je voudrais exposer ici dans quels domaines, pour quelles raisons et avec quelles espérances l'Administration de l'Agence Spatiale Européenne entend jouer un rôle significatif dans le domaine des moyens de communication.

Dans ce cadre, j'aborderai successivement l'informatique administrative, le traitement des textes, l'archivage des documents, les moyens associés aux services généraux, la téléconférence et enfin les réseaux de communication qui sous-tendent ces applications. Mais avant tout, il n'est peut-être pas inopportun de rappeler brièvement les fonctions essentielles au profit desquelles s'exerce 'l'ingéniérie administrative'.

L'Administration de l'Agence
Les domaines à l'intérieur desquels l'Administration de l'Agence s'épanouit, réconforte ou sévit, selon les circonstances, sont principalement représentés par les entités suivantes:

Les Finances, qui s'évertuent, en premier lieu, à établir et à maintenir un équilibre – perpétuellement instable – entre les aspirations d'une planification technique enthousiaste et la douloureuse réalité de ressources financières limitées et par définition insuffisantes; puis à régler les factures d'un nombre incalculable d'organes dépensiers; enfin, à enregistrer tout cela dans des comptabilités sibyllines qui ont l'ambition de démontrer aux Commissaires aux Comptes que l'emploi du denier public a été rigoureux, orthodoxe et efficace et que les coûts internes ont été réduits au minimum.

Les Contrats, qui s'emploient à faire bénéficier les projets de l'Agence de l'essentiel du savoir-faire de l'Industrie en échange de la plus grande part de nos budgets; à donner un minimum de forme légale aux multiples exigences de nos ingénieurs et de nos partenaires; à susciter l'émulation industrielle dans l'espoir d'obtenir le meilleur produit du meilleur fournisseur au meilleur prix dans le meilleur délai et, en plus de tout cela, à sauvegarder les intérêts patrimoniaux et intellectuels de l'Agence.

La Politique Industrielle, qui s'efforce d'inciter à des structures industrielles efficaces et compétitives, de démontrer à chaque Etat membre que sa contribution aux projets de l'Agence produit pour son

Figure 1 – Le mini-ordinateur Nixdorf du Siège de l'ESA.

industrie propre des effets bénéfiques et multiplicateurs, de maintenir pour chaque participant aux activités de l'Agence un 'juste retour' de travaux industriels en contrepartie de sa participation financière et d'en administrer la preuve à l'aide de savantes formules mathématiques.

Le Personnel qui évalue les ressources humaines – systématiquement au minimum –, établit des structures puis les torture, recrute les personnes, puis les affecte, puis les recycle, puis les déplace, enfin les achemine parfois vers une retraite paisible et à qui il est quand même beaucoup pardonné parce qu'il distribue régulièrement la manne financière.

Et puis je citerai pêle-mêle: le *Contrôle de Projet* qui élabore des méthodes et des procédures sophistiquées, forme des spécialistes, les intègre dans les équipes de projet et tente ainsi de donner à l'Administration le sentiment réconfortant de participer à la gestion technique de ces projets et d'en contrôler les délais, les ressources et les coûts; *l'Organisation, les méthodes et l'informatique administratives*, inévitable conséquence d'une recherche patiente et obstinée de la modernisation administrative et en perpétuelle quête d'une simplification des procédures et d'une visibilité de l'information qui s'inspire de la légende du rocher de Sisyphe; les *Services généraux*, obscurs, besogneux, indispensables et dont on ne décèle la permanente présence que lorsque le courrier n'arrive pas, le téléphone tombe en panne et le chauffeur est en retard; enfin, hors de la mêlée, serein et dogmatique, le *Conseiller Juridique*.

Je pense que maintenant l'Administration de l'Agence est devenue suffisamment familière au lecteur pour qu'il commence à percevoir l'intérêt qu'elle porte aux moyens de communication.

L'informatique administrative

Je commence par l'informatique administrative non parce que c'est un secteur prioritaire, mais parce qu'on peut lui consentir le privilège de l'ancienneté. Depuis les machines mécanographiques jusqu'à l'informatique répartie et aux bases de données distribuées du temps présent, l'informatique administrative s'est donnée pour tâche de collecter, organiser, distribuer et archiver l'information de l'Entreprise. Elle est progressivement devenue le point de convergence des mille petits événements quotidiens qui génèrent les données qui composent l'Histoire. Elle se caractérise en conséquence par des collections monumentales d'informations qui sont généralement traitées avec un instrument mathématique dont le niveau de sophistication moyen dépasse rarement le stade de l'addition. Elle se trouve maintenant au début d'une époque où les valeurs relatives de ses composants s'inversent par rapport aux données du plan informatique d'il y a encore peu d'années. Ainsi le coût de la main d'oeuvre, et donc des logiciels d'application, devient prépondérant, celui des communications préoccupant et celui du matériel, en proportion, mieux acceptable. Je voudrais expliquer comment l'Administration situe sa stratégie face à cette évolution, avec toutefois la prudence que justifie pour elle l'obligation primordiale de continuité.

Il y a dix ans – alors qu'elle était encore enfant – l'informatique administrative s'est développée à l'ombre de sa grande soeur l'informatique scientifique et technique, bénéficiant ainsi d'une infrastructure opérationnelle et gratuite qui lui concédait les quelques disponibilités de temps machine qui lui étaient nécessaires: cette infrastructure s'appelait pour l'essentiel I.B.M.

Il y a cinq ans, pour des raisons scientifiques et techniques, ainsi que quelques sous-jacentes politiques, une configuration européenne à dominante ICL fut substituée à l'infrastructure précédente. L'informatique administrative – devenue entretemps adolescente – se trouva plongée dans des abîmes de perplexité devant les difficultés de l'échange et l'obligation de continuité. L'oeuvre de conversion fut laborieuse, onéreuse et, par dessus tout, elle absorba, pendant une trop longue période, nos ressources humaines spécialisées.

Aujourd'hui, l'informatique administrative est devenue adulte et responsable. Les progrès spectaculaires de la mini-informatique, son aptitude à traiter les transactions administratives et enfin son bilan économique favorable sont trois

Figure 2 – Un poste de traitement de textes au service de traduction.

paramètres qui ont conduit l'Administration de l'Agence à revendiquer une certaine autonomie de moyens, une plus grande indépendance de fonctionnement avec pour conséquence une meilleure stabilité de service.

L'état présent des projets de l'Administration est le suivant:
- le Siège a été doté en 1977 d'un mini-ordinateur Nixdorf;
- la même année et en parallèle, l'ESRIN s'équipait de moyens analogues;
- début 1979, la même opération a été réalisée à l'ESOC;
- d'ici à fin 1979, le même matériel sera implanté à l'ESTEC;
- parallèlement, les gros programmes administratifs, dont l'ampleur excède les capacités de ces mini-ordinateurs, ont été concentrés sur l'ICL de l'ESTEC et seront, au moins à court terme, maintenus sur son successeur dont l'arrivée est attendue, avec quelque appréhension, pour l'année prochaine.

L'étape suivante sera de faire dialoguer ces mini-ordinateurs entre eux et idéalement de promouvoir aussi les échanges entre le mini-Nixdorf de l'ESTEC et son grand frère qui succédera à l'actuel ICL. L'Administration aura alors obtenu trois résultats: une bonne compatibilité de son infrastructure de traitement, une parfaite portabilité des logiciels administratifs et enfin une sensible amélioration de la cohérence et de la circulation de l'information administrative, et donc de la communication.

Le traitement des textes

Je n'espère pas étonner le lecteur en affirmant que le volume des données administratives n'est que la partie émergée de l'iceberg en regard de celui que représentent les textes. C'est dire avec quelles espérances l'Administration voit se développer actuellement un marché dynamique et prometteur dans ce domaine. Elle en imagine les effets bénéfiques en termes de gain de temps et d'effort administratif, de simplification des circuits et des tâches, en un mot en termes d'économie au plan de la communication écrite. On perçoit aisément ce que représentent pour l'Administration de telles perspectives.

L'Administration a entrepris d'avancer dans ce domaine avec un certain pragmatisme et ses projets immédiats couvrent trois expériences qui ont pour objectif commun de simplifier les tâches de dactylographie, de mise à jour, d'édition et de transmission des documents, et présentent chacune des particularités spécifiques.

La première de ces expériences concerne les secrétariats des *services de traduction*. La caractéristique de cette application est de nécessiter une disponibilité mémoire importante, d'autoriser potentiellement le fonctionnement simultané de claviers français, anglais et allemands distincts et enfin de permettre l'interchangeabilité des opératrices.

La seconde expérience intéresse l'élaboration des contrats. Les interventions sur ce type de documents concernent au premier chef le département des Contrats, y inclus les divisions implantées dans les Etablissements mais également le département de la Politique Industrielle et le Conseiller Juridique. Les caractéristiques propres de cette application exigent d'une part une parfaite compatibilité entre les moyens de traitement et d'autre part des dispositifs et des procédures fiables de liaisons inter-Etablissements.

Enfin, la troisième expérience concernera l'ensemble du système interne de '*Reporting*' incluant la gestion de tableaux financiers. Ce type d'application introduira une complexité additionnelle dans la mesure où l'architecture de ces

Figure 3 – Central téléphonique du Siège de l'ESA.

tables nécessitera des écrans et des imprimantes gérés par un logiciel adéquat et présentant des densités de caractères plus importantes qu'il n'est requis pour les textes usuels.

C'est sur les bases qui précèdent qu'un appel d'offres a été récemment lancé avec l'objectif d'identifier quelques constructeurs qui idéalement devraient posséder le double avantage de disposer de matériels performants adaptés aux besoins de l'Agence et d'être en mesure d'offrir un service de qualité comparable au Siège à Paris et au moins aux deux Etablissements situés aux Pays-Bas et en Allemagne.

Bien entendu, si l'expérience est concluante, le champ d'application de ces matériels pourra être progressivement étendu et l'Administration attend avec intérêt l'arrivée des terminaux qui intégreront le traitement des données et des textes ainsi que les dispositifs de transmission et d'édition des documents qui nous conduiront progressivement au courrier électronique et au microfichage automatique des supports.

L'archivage des documents

Ce thème évoque irrésistiblement l'image de sous-sols obscurs où quelques pauvres hères oubliés par le temps s'affairent à découvrir, à travers leurs bésicles, le dossier poussiéreux qui sur le rayonnage sommeille depuis des lustres et qui soudain, par la vertu d'une enquête, est redevenu indispensable et urgent.

Par chance, l'Agence est suffisamment jeune pour que son Administration n'ait pas été confrontée à l'option de cette organisation nostalgique et l'archivage des documents ne lui a pas encore posé de problèmes insolubles. Le déménagement de la Direction Centrale voici environ trois ans a été une bonne occasion pour faire l'inventaire des archives et pour estimer qu'avec un minimum d'effort de reclassement et de destruction, le transfert devait pouvoir s'opérer sans grande difficulté, et il en fut effectivement ainsi.

Mais depuis ce temps, le nombre des documents s'est accru à un rythme quasi exponentiel et c'est pourquoi il a été décidé à la fin de 1978 de procéder au microfichage des archives. Dans un premier temps l'effort a été consacré aux documents officiels qui retracent l'histoire des Organisations spatiales européennes depuis l'origine. Cette tâche devrait s'achever à la fin de cette année, ce qui permettra d'aborder par la suite le domaine des archives financières et des archives relatives aux personnels.

L'Administration espère que, dans un proche avenir, les moyens de traitement des documents seront suffisamment élaborés pour produire automatiquement et à coût marginal les microfiches correspondant aux documents sélectionnés pour ce propos. Ainsi se trouvera définitivement maîtrisée cette fonction ingrate qui traditionnellement lui échoit.

Les moyens associés aux services généraux

On pourrait sans excès de scrupules extrapoler à l'attitude courante d'une entreprise à l'égard de ses services généraux cette boutade d'un auteur célèbre: 'Les femmes ne voient jamais ce que l'on fait pour elles; elles ne voient que ce que l'on ne fait pas.' Aussi, je voudrais dans le cadre de cet article, extraire de la mosaïque des services consciencieusement rendus, deux fonctions vitales dont le développement est promis à un bel avenir: il s'agit de la communication téléphonique et de la transmission de documents.

La communication téléphonique

Schématiquement, l'instrument de communication téléphonique a été généralement perçu comme un assemblage d'installations locales, chaque installation étant constituée d'un autocommutateur, de postes téléphoniques connectés, de liaisons vers l'extérieur spécialisées ou publiques et d'un certain nombre de dispositifs propres à faire fonctionner le tout. Mais les facilités et la souplesse qu'offrent maintenant les autocommutateurs électroniques ainsi que l'attrait que représente fonctionnellement et surtout financièrement la location de liaisons spécialisées tend, d'une part, à agréger les spécifications des installations au profit d'un meilleur équilibre général du service et, d'autre part, à intégrer les besoins du trafic interne à l'Entreprise dans le cadre plus large des réseaux spécialisés de transmission.

Ce concept est important parce que c'est précisément en 1979–1980 qu'il faudra opter soit pour le maintien soit pour le remplacement des autocommutateurs de trois Etablissements: l'ESRIN, l'ESTEC et le Siège; la décision devra satisfaire à la fois l'Agence comme un tout et chaque Etablissement comme partie prenante.

La transmission de documents
On peut grouper sous ce titre le fac-similé, le télex et le courrier.

Il est évident que le raisonnement appliqué aux liaisons téléphoniques intéresse au même titre les communications inter-Etablissements par fac-similé. Il est en outre manifeste que les moyens de traitement des textes joueront également un rôle important dans l'établissement des systèmes futurs de courrier électronique.

Ce qui résulte en définitive de cette brève analyse c'est que l'Administration prend progressivement conscience de la nécessité d'intégrer les moyens dans l'ensemble d'une politique des moyens de communication de l'Agence.

Téléconférence
La téléconférence répond pour l'Administration de l'Agence à la fois à une préoccupation financière et à un certain souci de solidarité technique:

A une préoccupation financière, parce que l'Administration éprouve des 'états d'âme' en considérant le montant du budget affecté aux missions, tout en reconnaissant le bien-fondé et la nécessité des échanges. Elle est parfaitement consciente non seulement de cette obligation de dialogue direct mais également de ce que peut représenter le coût d'un malentendu pouvant résulter d'une insuffisante qualité de la communication interne, surtout dans une Organisation à la fois multilingue et géographiquement répartie comme l'ESA. On comprend ainsi sans peine le prix que l'Administration attache à la téléconférence comme moyen d'amélioration de la communication interne et potentiellement de réduction des budgets de mission inter-Etablissements.

A un souci de solidarité technique, parce qu'il est naturel que l'Administration fasse preuve le solidarité envers les ingénieurs et techniciens de l'Agence en devenant les premiers clients de leurs succès (OTS, satellite géostationnaire sur orbite depuis plus d'un an, et bientôt ECS).

Dans les faits, si les aspirations dans le domaine de la téléconférence sont grandes, les projets concrets sont encore incertains; l'Administration en est au stade de l'évaluation et de l'expectative dans trois directions:
- l'emploi autonome et décentralisé de moyens de téléconférence peu coûteux et rapidement opérationnels sur les réseaux téléphoniques usuels, permettant à des secteurs délimités de l'Agence d'améliorer leur dialogue interne sur des bases empiriques et quasi impromptues;

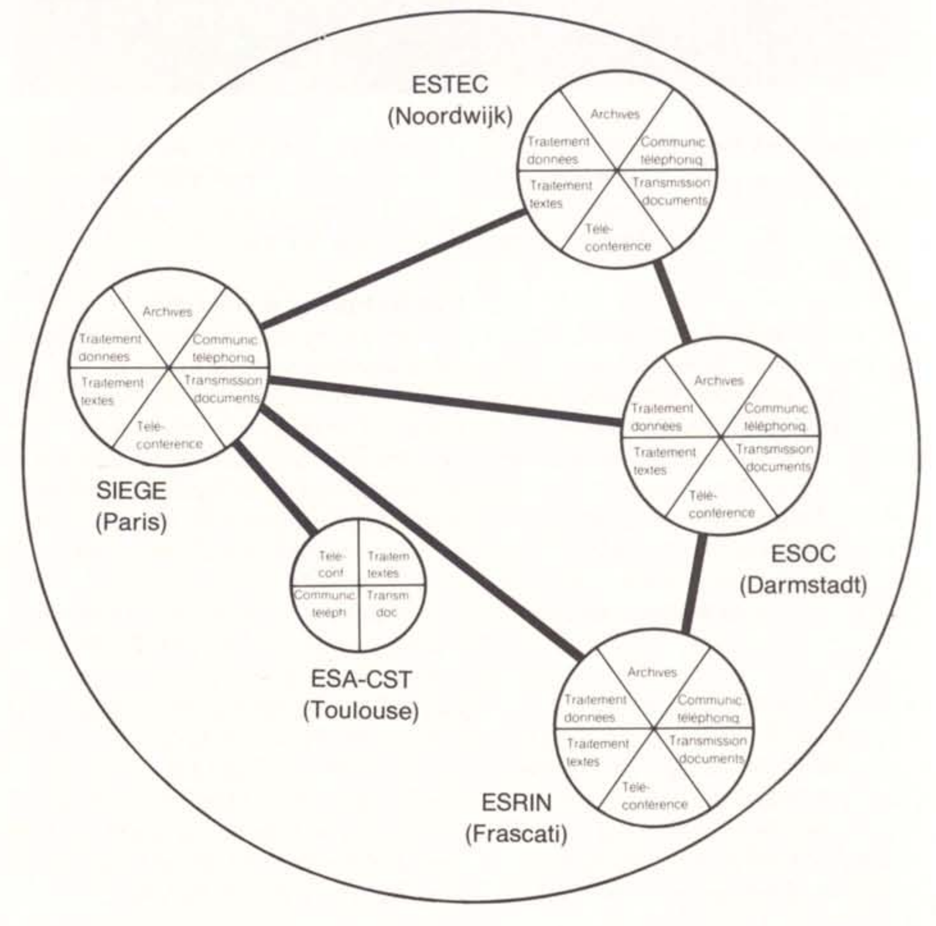


Figure 4 – La communication administrative au sein de l'ESA.

- l'installation de salles pré-équipées, reliées entre elles par des liaisons spécialisées, intégrant des dispositifs d'affichage de documents et de graphes et permettant de tenir des multiconférences organisées à partir de la concentration de groupes de locuteurs dans un même lieu et à un même instant;
- enfin, à partir d'un concept d'intégration plus global encore, la promotion de systèmes de vidéo-conférence non plus comme un ensemble fini de moyens de communication interne, mais comme un sous-ensemble particulier de la télématique expérimentale à laquelle invitent les opportunités qui seront progressivement offertes par l'exploitation des satellites de communications ESA.

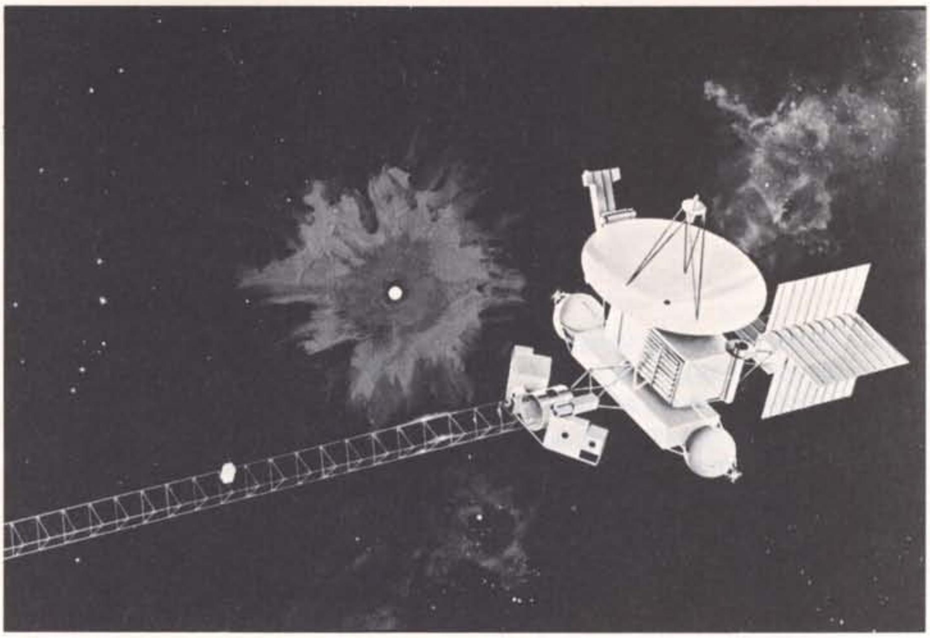
Techniquement et fonctionnellement, aucune de ces directions de recherche ne paraît exclusive, et on peut les concevoir en complémentarité plutôt qu'en concurrence. Il n'en demeure pas moins que le poids relatif que l'on peut accorder à chacune de ces démarches résulte en définitive davantage d'une option de politique générale que de critères purement techniques.

Réseaux de communication
Il est clair que les réseaux de communication intéressent et sous-tendent l'ensemble des applications et des moyens de communication pour lesquels l'intérêt de l'Administration de l'Agence est maintenant évident. Le schéma ci-contre montre comment les applications évoquées plus haut s'intègreront progressivement mais inéluctablement dans un ensemble cohérent de moyens de communication interne au sein de l'Agence.

En guise de conclusion, je voudrais laisser à l'imagination créatrice du lecteur deux thèmes de réflexion:
- le premier est que l'Administration entend jouer un rôle actif, à la fois comme promoteur et utilisateur, dans le domaine des moyens de communication;
- le second est que l'Administration voit s'ouvrir avec un intérêt grandissant ce nouvel univers qui offre à son incurable avidité à économiser des perspectives encore illimitées.

Epilogue
Le 1er juillet 1979, le Directeur général a chargé le Directeur de l'Administration d'établir en collaboration avec le Directeur de l'ESOC pour le 1er janvier 1980 le plan consolidé des moyens de communication interne de l'Agence; ce plan servira, à partir de cette date, à la préparation des budgets, aux décisions d'investissement et au suivi des actions d'équipement.

In brief



Development Contract Awarded for ISPM Spacecraft

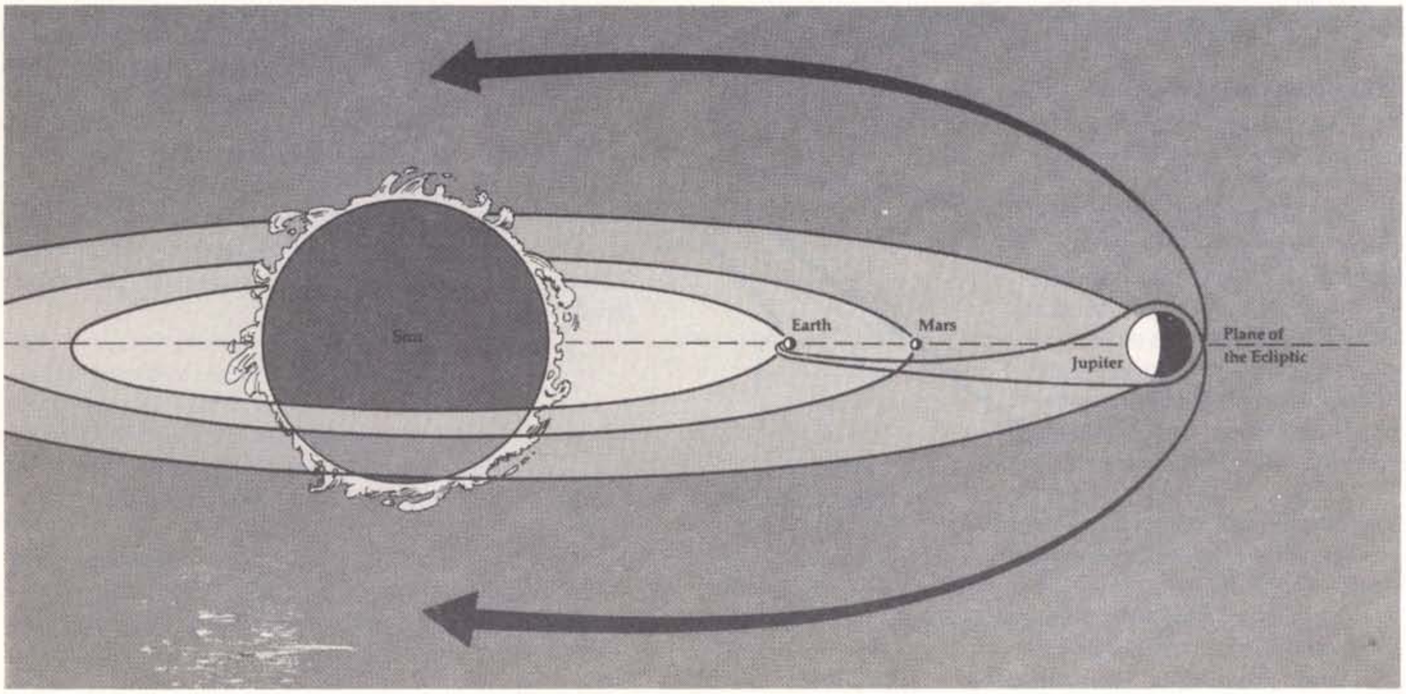
At its meeting in Paris on 26 September, the ESA Industrial Policy Committee approved the choice of Dornier System (Germany), leader of the STAR industrial consortium, as prime contractor for the development of the European spacecraft for the International Solar Polar Mission (ISPM).

* Mid-1979 prices and conversion rates: 1 AU (Accounting Unit) = $US 1.2.

The contract will cover both the satellite's detailed design (Phase B2 amounting to 680 000 AU*), and its development manufacture and testing (Phase C and D, with a ceiling of 46.5 MAU). The major co-contractors are: Thomson-CSF (France) – telecommunications; FIAR/Montedel (Italy) – power and data-processing system; Fokker (Netherlands) – thermal system; Sener (Spain) – mechanical systems; LM Ericsson (Sweden) – antenna; Contraves (Switzerland) – structure; BAe (United Kingdom) – attitude and orbit control system (AOCS); and SEP (France) – propulsion system units.

The two ISPM spacecraft (the second is

Trajectories of the two ISPM spacecraft.



being supplied by NASA) will be launched, mated together, in February 1983, via the US Space Transportation System (Space Shuttle and Inertial Upper Stage). They will be injected almost directly away from the Sun and will intercept the orbit of Jupiter some 16 months after launch. Both spacecraft will travel out of the ecliptic plane (in which the Earth orbits the Sun), with the help of Jupiter's gravitational field, into elliptical heliocentric orbits, approximately at right angles to the ecliptic plane, one initially over the southern and one over the northern hemisphere. Only about four years after launch will they achieve their ultimate objective of passing over the Sun's poles at a distance of approximately 300 000 000 km.

Further Ariane Development Tests Successfully Completed

Ariane's third-stage propulsion system (EP4) was successfully test-fired for the third time on 23 August on the Vernon test stand of Société Européenne de Propulsion (SEP).

The test lasted for the scheduled 555 s and cut-off was achieved by a simulated on-board computer command. A similar

photo sep

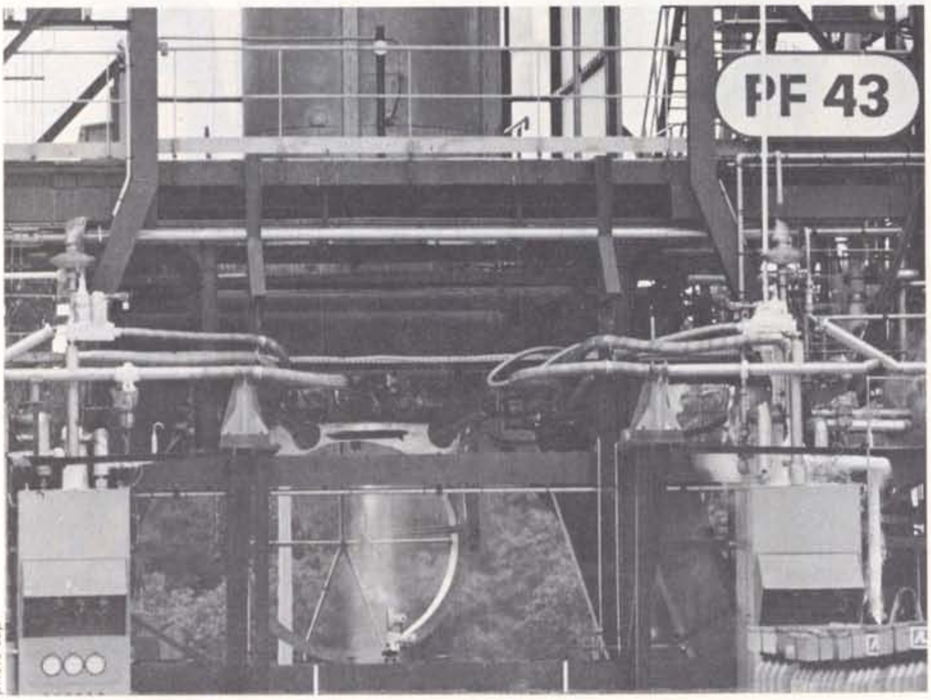


photo sep

test lasting 570 s was also conducted successfully on 3 July.

With the completion of the three tests, the hydrogen and liquid-oxygen (H8) propulsion system (EP4) has now logged a total running time of nearly 1600 s.

The last qualification test of Ariane's first stage took place at SEP on 13 September 1979. The firing lasted for 137 s and an initial evaluation of the results has shown parameters to be nominal. This test, together with the last engine-qualification test carried out on 10 September, concludes the ground qualification of the first stage.

The start of the Ariane launch campaign has been scheduled for 1 October, and the first qualification launch is expected to take place between 8 and 18 December.

ESA at Telecom 79

The accompanying photographs were taken on the Agency's stand in the course of Telecom 79, the 3rd World Telecommunication Exhibition, organised in Geneva from 20 to 26 September, under the auspices of the International Telecommunications Union (ITU). Fifty Heads of State lent their formal support by joining the Committee of Honour of the exhibition, the primary role of which was to 'keep the Members of the Union informed of the latest advances in telecommunication techniques and to publicise the possibilities of applying telecommunications science and technology for the benefit' of all its Members.

The message conveyed on the ESA stand at Telecom 79 was of the practical impact of satellites on astronomy, meteorology, geophysics and, above all, communications, and the emphasis was on confronting visitors with tangible evidence of the benefits that spacecraft can provide.

Under the outspread solar panels of full-size replicas of ESA's current and future telecommunications satellites, OTS-1 and ECS-1, were ranged a bank of television sets, a telefax printer and the consoles of the Agency's Information Retrieval Service (Quest). The TV sets showed programmes relayed from Britain and Germany, the telefax printer delivered photographs transmitted from Fucino in Italy, and the information retrieval consoles performed their usual data-base service, but on this occasion via satellite rather than via land lines. The main aim was to show how communications satellites could be used for a number of purposes simultaneously, connecting various users in different countries and providing broadcast signals of very high quality.

The live OTS-reception demonstration at Telecom 79.

The laser-based telefax system on display on the ESA stand.

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 inside the back cover and using the Order Form on Page 65.

ESA Journal

The following papers were published in Vol 3 No 3:

AN INCOHERENT-TO-COHERENT OPTICAL IMAGE CONVERTER AND ITS APPLICATION IN HYBRID OPTICAL PROCESSORS
A KIESSLING, H KAZMIERCZAK & H-E REINFELDER

SYNTHETIC-APERTURE RADAR SYSTEMS AND SPACELAB EXPERIMENTS FOR ACTIVE MICROWAVE REMOTE SENSING FROM SPACE
G DIETERLE

A 350-400 GHZ SUPERHETERODYNE RECEIVER
G T WRIXON

MEASUREMENT OF THE SMALL-SIGNAL BASE RESISTANCE OF BIPOLAR TRANSISTORS
U PISANI

THE INTERACTIVE IMAGE SYSTEM FOR THE METEOSAT PROJECT
L FUSCO ET AL

GROUND-ANTENNA POINTING DISPERSION FOR EARLY ARIANE TRANSFER ORBITS
M SOOP

Special Publications

ESA SP-143 USE OF DATA FROM METEOROLOGICAL SATELLITES. PROCEEDINGS OF A TECHNICAL CONFERENCE, SPONSORED BY THE EUROPEAN SPACE AGENCY (ESA), THE WORLD METEOROLOGICAL ORGANISATION (WMO), AND SOCIETE METEOROLOGIQUE DE FRANCE (SMF), HELD IN LANNION, FRANCE, 17-21 SEPTEMBER 1979
BATTRICK B (ED)
PRICE CODE C2 (75 FF)

ESA SP-146 SPACECAD '79 - COMPUTER-AIDED DESIGN OF ELECTRONICS FOR SPACE APPLICATIONS. PROCEEDINGS OF AN INTERNATIONAL SYMPOSIUM, SPONSORED BY THE EUROPEAN SPACE AGENCY (ESA), THE INSTITUTE OF ELECTRONICS OF UNIVERSITY OF BOLOGNA AND THE ITALIAN ELECTROTECHNICAL ASSOCIATION, HELD IN BOLOGNA, ITALY, 19-21 SEPTEMBER 1979.
GUYENNE T D (ED)
PRICE CODE C3 (120 FF)

ESA SP-145 SPACECRAFT MATERIALS IN SPACE ENVIRONMENT. PROCEEDINGS OF A SYMPOSIUM, ORGANISED BY THE EUROPEAN SPACE AGENCY AT ESTEC, NOORDWIJK, THE NETHERLANDS 2-5 OCTOBER 1979.
GUYENNE T D (ED)
PRICE CODE C2 (75 FF)

ESA SP-1001 (ISSUE 2) SPACELAB USERS' HANDBOOK - A SHORT INTRODUCTION TO SPACELAB. (MAY 1979)

Procedures, Standards and Specifications

ESA PSS-05 (QRM-10E) ISSUE 1. TEST SPECIFICATION FOR TWO-SIDED PRINTED-CIRCUIT BOARDS (GOLD-PLATED FINISH). (AUGUST 1979).
PRODUCT ASSURANCE DIVISION, ESTEC
PRICE CODE C1

ESA PSS-07 (QRM-01) ISSUE 5. GUIDELINES FOR SPACE MATERIALS SELECTION. (JULY 1979).
PRODUCT ASSURANCE DIVISION, ESTEC
PRICE CODE E1

ESA PSS-48 (TTC.C.10) ISSUE 1. S + S/X BANDS COHERENT TRANSPONDER SPECIFICATION. (MARCH 1979).
SPACE COMMUNICATIONS DIVISION, ESTEC
PRICE CODE C1

ESA PSS-50 (QRM-17E) ISSUE 1. TEST SPECIFICATION FOR TWO-SIDED PRINTED-CIRCUIT BOARDS (FUSED TIN-LEAD FINISH). (AUGUST 1979).
PRODUCT ASSURANCE DIVISION, ESTEC
PRICE CODE C1

Contractor Reports

ESA CR(P)-1159 DESIGN STUDY OF IR EARTH SENSOR FOR ACCURATE EARTH POINTING OF A LOW-ALTITUDE THREE-AXIS STABILISED SATELLITE - FINAL REPORT (APRIL 1978)
OFFICINE GALILEO, ITALY

ESA CR(P)-1160 FACILITIES FOR FLUID LOOP COMPONENTS - FINAL REPORT (SEP 1978)
MICROTECNICA, ITALY

ESA CR(P)-1161 EXPLORATORY DEVELOPMENT OF A VAPOR COMPRESSOR FOR SPACE FLIGHT APPLICATION - FINAL REPORT (DEC 1978)
EIDGENOESSISCHES FLUGZEUGWERK, SWITZERLAND

ESA CR(P)-1163 STUDY OF LASER RANGING INSTRUMENTATION - FINAL REPORT (DEC 1978)
MBB, GERMANY

ESA CR(P)-1164 STUDY OF HIGH-STABILITY STRUCTURAL SYSTEMS: PRE-PHASE A FINAL REPORT (SEP 1978)
CASA, SPAIN

ESA CR(P)-1166 ETUDE GENERALE DE L'INFLUENCE DES LIQUIDES CONTENUS DANS LES SATELLITES (SEP 1978)
ONERA, FRANCE

ESA CR(P)-1167 AN EXPERIMENTAL INVESTIGATION ON LOW-GAIN TT&C S-BAND ANTENNAS - FINAL REPORT (DEC 1978)
INTA, SPAIN

ESA CR(P)-1168 STUDY OF SYSTEMS IMPLICATIONS OF HIGH-SPEED FLYWHEELS AS ENERGY-STORAGE DEVICES ON SATELLITES (OCT 1978)
MATRA, FRANCE

ESA CR(X)-1169 EVALUATION OF THE SCHOTTKY BARRIER DIODE HETERODYNE RECEIVER IN THE FAR INFRARED - FINAL REPORT (NOV 1978)
FARRAN RESEARCH ASSOCIATES, IRELAND

ESA CR(P)-1170 COMPONENT MODELLING OF MICROWAVE TRANSISTORS - FINAL REPORT (SEP 1978)
PLESSEY, UK

ESA CR(P)-1171 PHASE A STUDY OF THE ADAPTATION OF SOUNDING-ROCKET TECHNOLOGY FOR SPACELAB SATELLITES - FINAL REPORT (JUNE 1978)
KAYSER THREDE GMBH, GERMANY

ESA CR(P)-1173 STANDARD PROCESSING ROUTINES - FINAL REPORT. VOL 1 SUMMARY; VOL 2A ALGORITHM DESCRIPTION; VOL 2B ALGORITHM LISTINGS; VOL 3 ALGORITHM TESTING (JUNE 1978)
SAAB-SCANIA, SWEDEN

ESA CR(P)-1174 PHASE A STUDY OF SAR FOR THE EUROPEAN REMOTE SENSING PROGRAMME - FINAL REPORT EXECUTIVE SUMMARY (DEC 1978)
THOMSON-CSF, FRANCE

ESA CR(P)-1175 DESIGN OPTIMISATION OF SOLAR CELL INTERCONNECTORS AND WIRING FOR LOW-ORBIT SPACECRAFT (NOV 1978)
IRD, UK

ESA CR(P)-1176 SPACE DOSIMETRY - FINAL REPORT; VOL 1 PROJECT DESCRIPTION; VOL 2 TECHNICAL APPENDICES (SEP 1978)
FULMER RESEARCH INST, UK

ESA CR(X)-1177 SLALOM - MISSION/SYSTEM DEFINITION - FINAL REPORT (DEC 1978)
MBB, GERMANY

ESA CR(P)-1178 STUDY OF THE TECHNIQUES FOR DESIGN OF HIGH GAIN ANTENNAS WITH CONTOURED BEAMS - FINAL REPORT (DEC 1978)
TICRA APS, DENMARK

ESA CR(P)-1179 ROD-END BEARING EVALUATION (JUNE 1978)
ESTL/UKAEA, UK

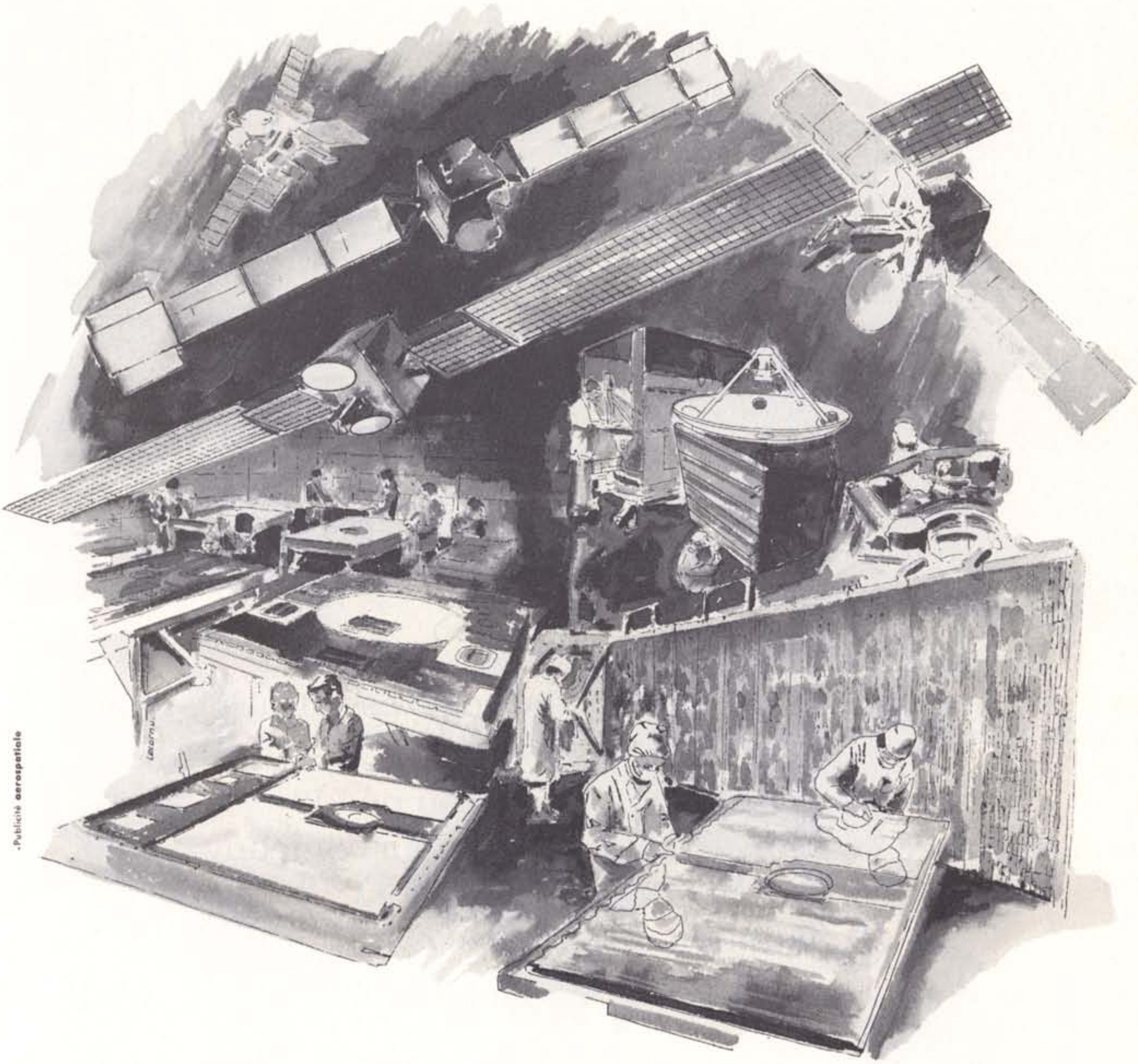
ESA CR(P)-1180 A LOW-COST GROUND STATION FOR RECEPTION AND PREPROCESSING OF REMOTE SENSING SATELLITE DATA (DEC 1978)
NLR, NETHERLANDS

ESA CR(P)-1181 PHASE 2 FINAL REPORT ON SMALL EXPERIMENT MOUNT (SEM) PHASE A STUDY (NOV 1978)
BRITISH AEROSPACE, UK

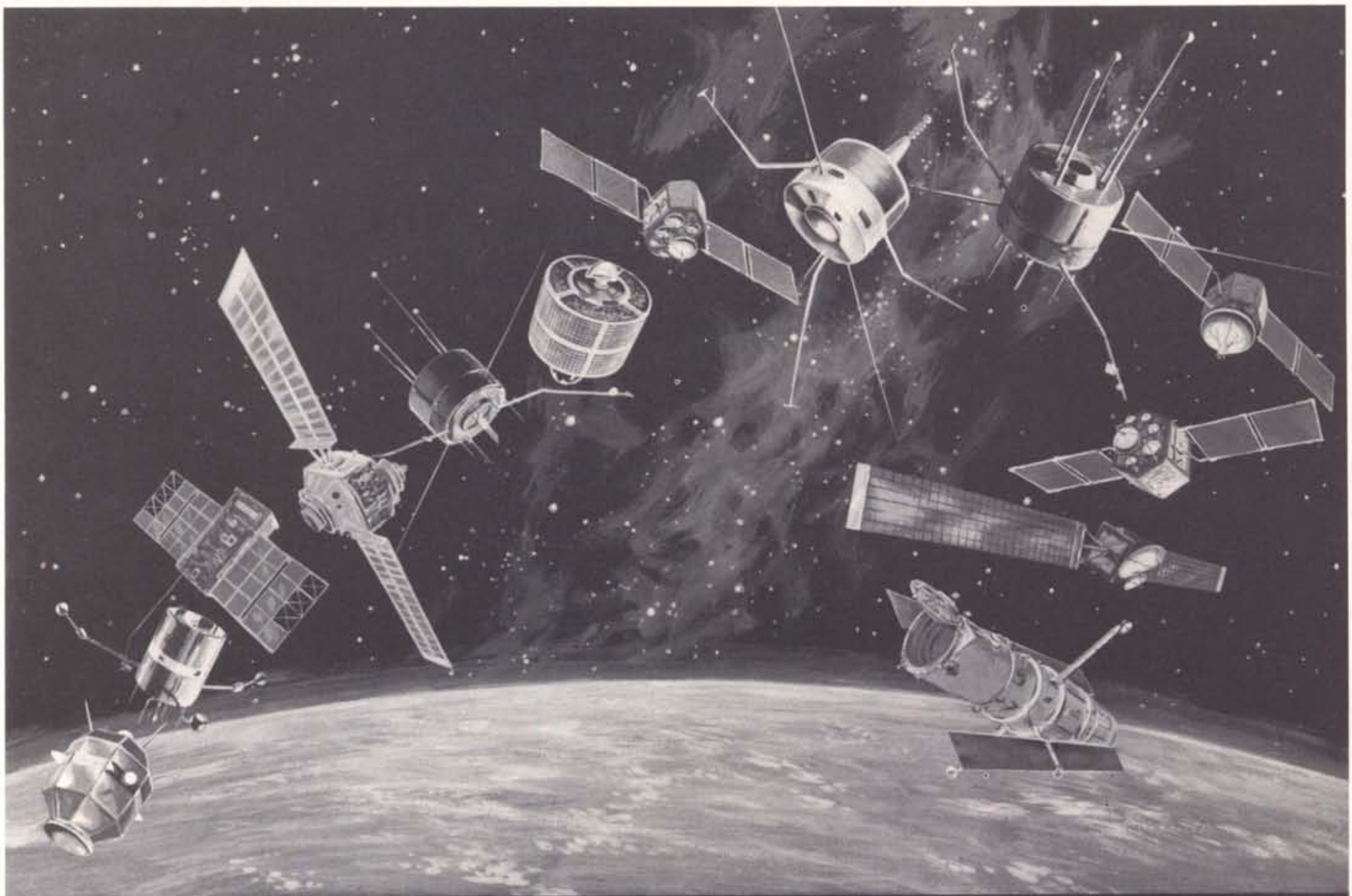
ESA CR(P)-1182 DEFINITION DE L IMPREGNATION ELECTROCHIMIQUE DES ELECTRODES DE NICKEL - RAPPORT FINAL (JAN 1978)
SAFT, FRANCE

Advertisers index

For all advertising information contact:
Simon Vermeer, Advertising Manager,
ESA Bulletin, c/o ESTEC, Noordwijk,
the Netherlands. Tel. 01719-82872. Telex 39098



advertising europa



N.B. FOR HARD-COPY CHARGES, SEE INSIDE BACK COVER

ESA and NASA Scientific/Technical Publications

ORDER FORM

Before using this Order Form

read the important information on the reverse.

To: **DISTRIBUTION OFFICE**
ESA SCIENTIFIC & TECHNICAL
PUBLICATIONS BRANCH
ESTEC, POSTBUS 299, 2200 AG NOORDWIJK
THE NETHERLANDS

From: ______________________

____

____

PLEASE SUPPLY:

Customer's Ref ______________________

Date ______________ Signature ______________________

No. of copies: Printed	Microfiche	Photocopy	ESA or NASA Reference	Title	For ESA use	

IF OUT OF PRINT SUPPLY / DO NOT SUPPLY IN MICROFICHE

MAILING LABEL (Print or type carefully)

ESA Order No.

Customer's Ref ______________________

To Name or Function ______________________

Organisation ______________________

Street Address ______________________

Town, Province, Postal Code ______________________

Country ______________________

ESA/NASA PUBLICATIONS ORDER FORM

INFORMATION

1. Use this form for your order.

2. (a) Except as mentioned below, publications are available in printed form (as long as stocks last), in microfiche and as photocopies.

   (b) If a publication ordered in printed form is out of print, a microfiche copy will be supplied (unless NOTE 1 on the form has been completed to indicate otherwise) and the Order Form will be amended accordingly.

   (c) Publications in the following series are not available in printed form:

   - the ESA CR(P) series;
   - the ESA TT series;
   - all NASA series.

   (d) Publications in the ESA CR(P)* and CR(X) series are not available from ESA. (They are given a very restricted distribution in printed form to the States participating in the relevant programme. The addressees in that distribution can be supplied on request).

EXECUTION OF ORDER

3. After the handling of your order has been completed, the form will be returned to you, marked with the following symbols:–

   A circle – the items encircled have been despatched
   X – out of print or unavailable in printed form
   Z – not available from ESA in any form
   R – publication is restricted and cannot be supplied on this order
   N – publication is in hand, stock not yet received.
   C – unable to identify the publication from the information provided.
   Y – publication requested from NASA, delay of at least 2 months expected.

4. In any subsequent correspondence, please QUOTE THE ESA ORDER NUMBER.

5. Printed copies are despatched from ESTEC, and microfiche and photocopies from ESA Head Office. They will arrive in different packages at different times.

SUPPLIES OF THIS ORDER FORM ARE AVAILABLE FROM ESA SCIENTIFIC AND TECHNICAL PUBLICATIONS BRANCH AT THE ADDRESS SHOWN OVERLEAF

Availability of ESA and NASA Publications

PUBLICATION	Availability Note	DISTRIBUTION OFFICE
REPORTS		
ESA Scientific Reports etc. (ESA SR, SN, SM)	(1) and (2)	
ESA Technical Reports etc. (ESA TR, TN, TM)	(1) and (2)	
ESA Scientific and Technical Reports (ESA STR)	(1) and (2)	
ESA Scientific and Technical Memoranda (ESA STM)	(1) and (2)	
ESA Special Publications (ESA SP)	(1) and (2)	
ESA Contractor Reports (ESA CR)	(1) and (2)	
ESA Contractor Reports (ESA CR(P))	(2)	ESA Scientific & Technical Publications Branch, ESTEC, Postbus 299, 2200 AG Noordwijk, The Netherlands
ESA Contractor Reports (ESA CR(P)* and CR(X))	(3)	
ESA Technical Translations (ESA TT)	(2)	
ESA Electronic Component Databank Catalogues (ESA ECDB)	(1)	
NASA Scientific & Technical Publications	(2)	
PROCEDURES, STANDARDS & SPECIFICATIONS		
ESA PSS	(1) and (2)	
JOURNALS		
ESA Bulletin (quarterly)	(4)	
ESA Journal (quarterly)	(4)	
PUBLIC RELATIONS MATERIAL General literature, brochures, posters, photographs, films, etc.		ESA Public Relations Service 8-10 rue Mario Nikis 75738 PARIS 15 France

(1) – Available in hard (printed) copy against a charge as long as stocks last (see I).
(2) – Available in microfiche or photocopy against a charge (see II).
(3) – Restricted distribution only; further copies NOT available from ESA.
(4) – Available without charge either as a regular issue or as back numbers (as long as stocks last).

I. CHARGES FOR ESA PUBLICATIONS (PRINTED DOCUMENTS)

CATEGORY E

Number of Pages	Code	Price (French francs)
1-100	E1	50
101-200	E2	75
201-350	E3	120
Over 350	E4	150

CATEGORY C

Number of pages	Code	Price (French francs)
1-200	C1	50
201-350	C2	75
351-500	C3	120
Over 500	C4	150

The above charges apply to Member States, Austria, Canada and Norway. A 20% surcharge will be levied on orders from 'other States'.

II. CHARGES FOR ESA & NASA MICROFICHE AND PHOTOCOPIES

Microfiche (up to 98 pages per fiche) FF 8.00
Photocopies (enlargement of one microfiche page) FF 2.10/page 'page

NOTE 1. Minimum orders of FF 55.– per monthly invoice.
NOTE 2. Photocopies are supplied if original document out of print, unless microfiche is specified (see Order Form).

european space agency
agence spatiale européenne

member states	etats membres
belgium	allemagne
denmark	belgique
france	danemark
germany	espagne
italy	france
netherlands	italie
spain	pays bas
sweden	royaume-uni
switzerland	suède
united kingdom	suisse