spaceflight

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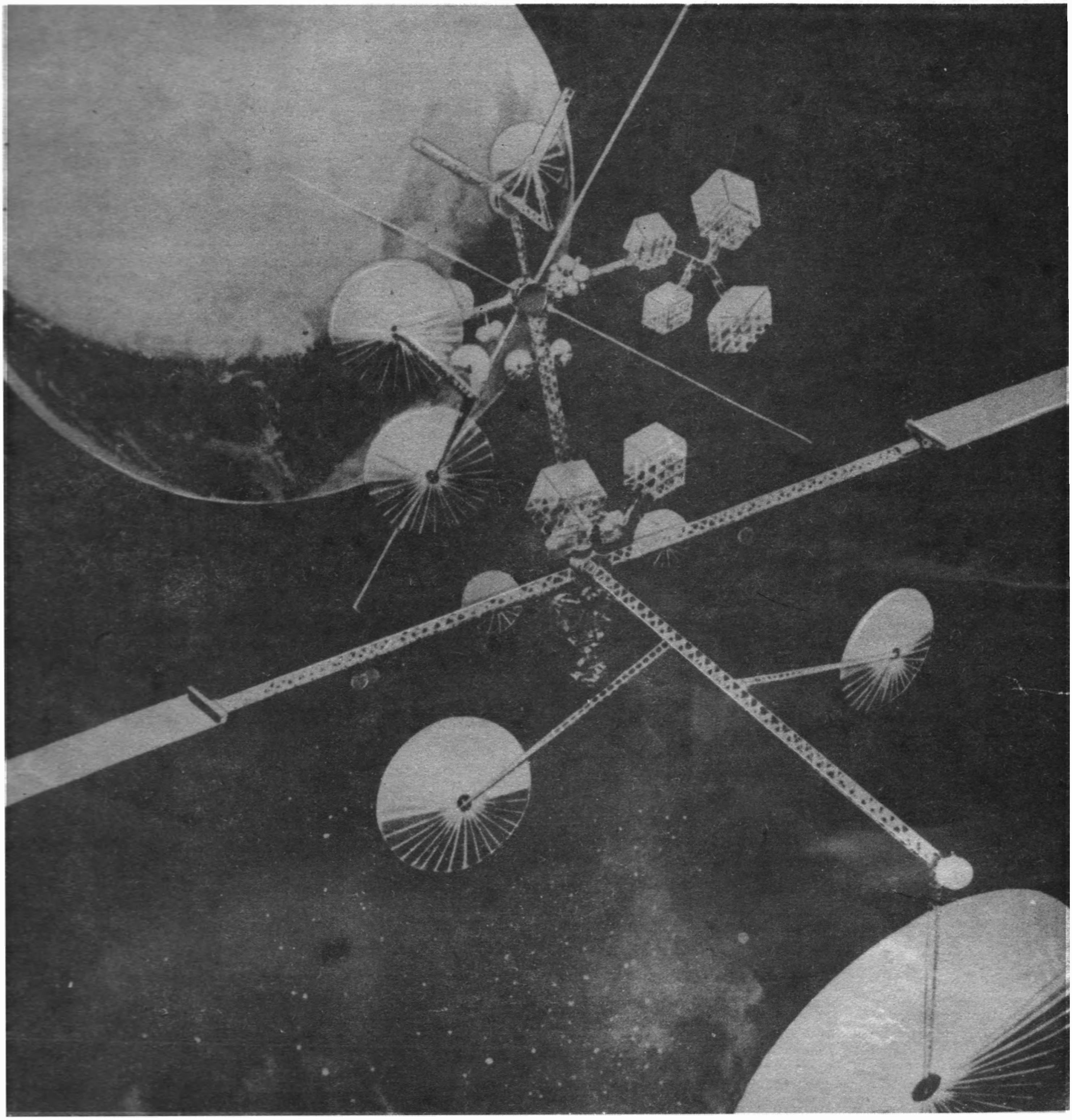
По подписке 1985 г.



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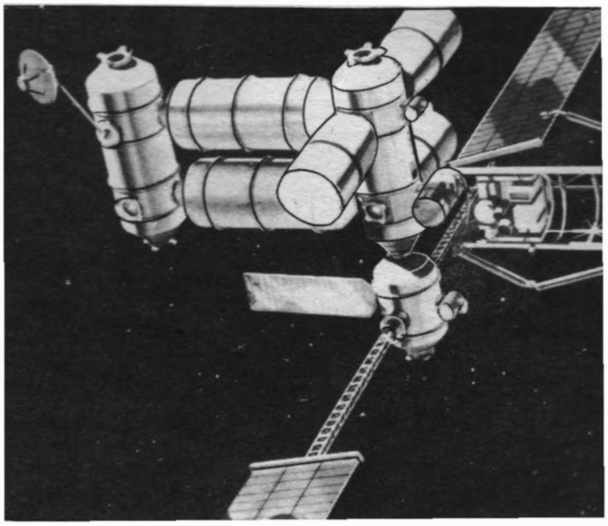
SPACE STATION PLANS

The US Space Station is the next major manned space project of the western world, with initial operations in orbit expected in the early 1990's. Plans for participation are being considered by most European countries, including the UK. Our Society, which has long advocated permanent manned bases in space, will contribute further to the discussions by providing updated reviews at a one-day symposium. The date is 17 April 1985, the venue HQ. A provisional list of papers to be presented by a panel of international speakers will include the following:



1. **'European Space Station Overview,' by F. Longhurst (ESA).**
2. **'Space Station Platform - Overview,' by Dr. R.C. Parkinson (BAe).**
3. **'User Requirements for Space Stations,' by I. Franklin (BAe).**
4. **'Space Station Pressure Compartment,' by Prof. Valleriani (Aeritalia).**
5. **'Application of Propulsion Modules to Space Station Infrastructure,' by D. Gilmour (BAe).**
6. **'Orbital Replacement Units for Space Stations,' (Provisional).**
7. **'Assembly and Maintenance of Space Stations,' (Provisional).**
8. **'European Overview of the Space Station Proposals,' by R. Gibson.**

The Symposium will be held in the Society's Conference Room, 27/29 South Lambeth Road, London SW8 1SZ, England on 17 April, 9.30 a.m. to 5.30 p.m. The registration fee is £15 (non-members £17). Forms are now available from the Executive Secretary at the above address. The places remaining are limited so early application is advised.

1985 SUBSCRIPTION FEES

There is good news for all members: fees for 1985 will remain unchanged from 1984 in spite of rising costs.

Direct Debit Scheme

Our old Bankers Order system has been phased out. Direct Debit slips are now available from the Executive Secretary but, since they will not come into operation until 1986, a separate remittance for 1985 will have to be made.

Amounts payable for the calendar year January-December 1985 are as follows·

RATES

Members	Sterling	US Dollars
Under the age of 18 years	£16.00	$26.00
Between 18 and 20	£18 00	$30.00
21 years of age and over	£21.00	$36.00
Fellows	£23 00	$40.00

Age Allowance

A reduction of £4.00 ($6.00) is allowed to members of every grade over the age of 65 years on 1 January 1985.

JBIS and *Space Education*

The additional subscription payable for *JBIS*, where required as well as *Spaceflight*, is £20.00 ($34.00). For *Space Education*, it is £4.00 ($6.00).

Methods of Payment

Europe

(a) Please pay in sterling with a cheque which shows a UK address, where it can be paid.

(b) Cheques drawn in sterling payable at a bank in Europe must include £2.00 to defray charges and collection costs. Eurocheques have no charges *only* if the account number is written on the back.

(c) Banks which remit directly to the Society must be told to see that the sum is transmitted *free of deductions*

(d) Remittances from Europe are best made by GIRO Our GIRO account number is 53 330 4008

USA and CANADA

(a) US dollar cheques can be drawn on a Bank which gives an address in the United States or in the UK. US dollar cheques drawn elsewhere need to be increased by $8 00 to cover collection charges

(b) US dollar notes are accepted.

(c) US or Canadian money orders can only be accepted if *expressed in Sterling*. Internal money orders from these countries i.e. those expressed payable in dollars will be returned as they cannot be cashed in the UK.

(d) Canadian bank remittances may easily be made in sterling drawn on their UK agents. If payment is made in Canadian dollars the current exchange rate may be used, plus the addition of 8 Canadian dollars to cover exchange and collection charges.

spaceflight

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CONTENTS

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WHERE OH WHERE HAVE THE MEDIA GONE?

The 35th IAF (Lausanne) Congress produced no less than 500 papers ranging over the whole spectrum of astronautics. Its main theme, 'Space for the Benefit of all Nations,' was hardly a mundane topic. Astronauts, cosmonauts and leading space figures jostled in the assemblies. All were discussing major developments in the history of mankind *yet representation by the media was almost totally lacking!*

The Department of Trade and Industry conference last October was concerned with, no less, the nature and extent of UK participation in the American Space Station proposals. There was hardly a more apt subject for discussion, yet representation by the media was *barely a handful.* Our Space '84 event had the interesting theme of 'Space - The Future of Mankind.' Surely, the UK media would have turned up in force for *this,* on their own doorstep. Not so.

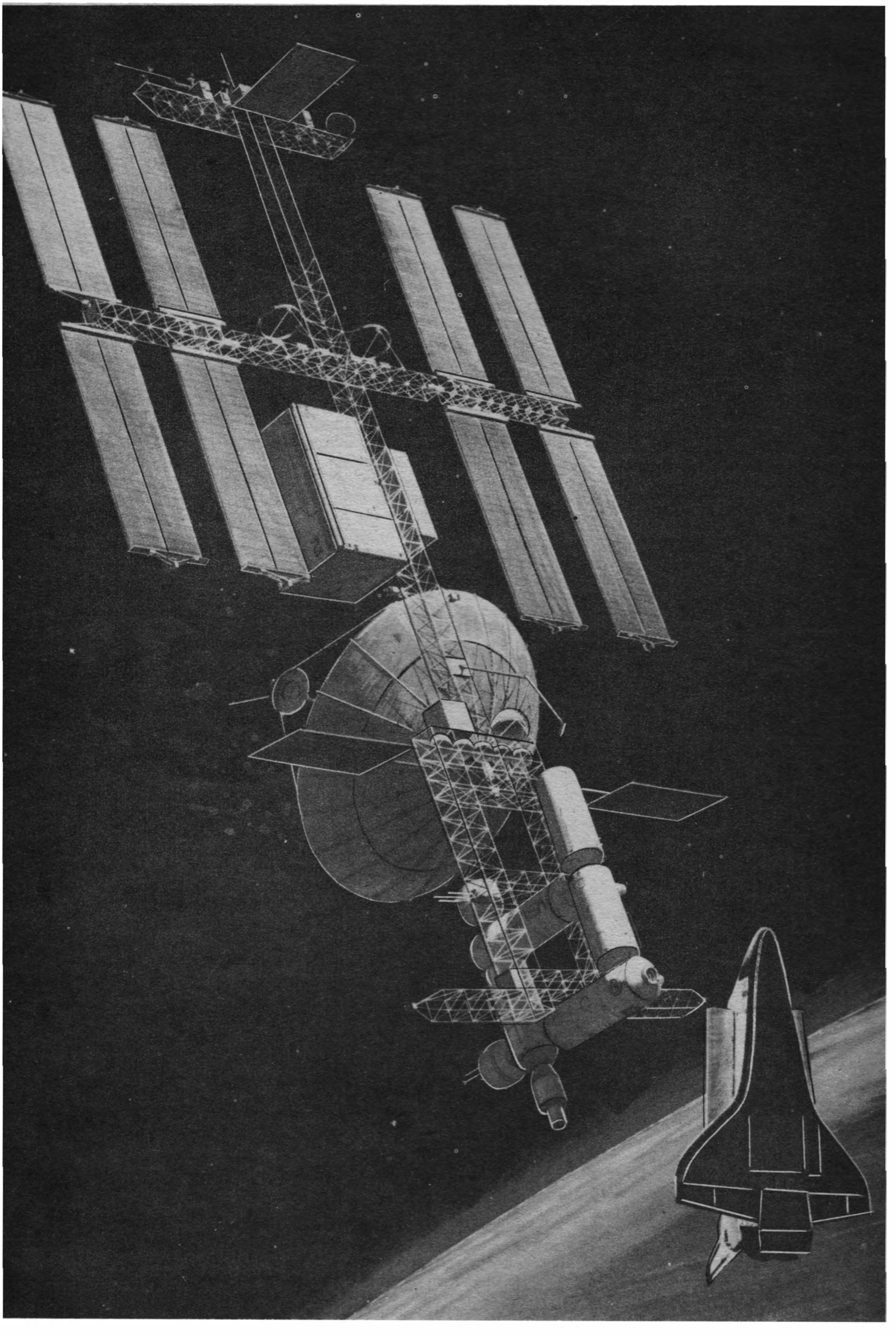
So we have the problem why, apart from a few notable exceptions, is the media coverage so slight? A sight of any newspaper any day will disclose what the media regard as important. Radio and TV coverage is similar. We receive a constant stream of letters pointing out that even spectacular 'Visuals' such as a Shuttle launch are covered in a most superficial manner. Today, among the media, it is the specialised magazines that carry the main torch in presenting to most of us information on these matters of major importance, but they are geared to reach only a few and certainly not the Great British Public.

The media respond that the lack of coverage is owing to the lack of public interest, but the reverse could equally be true - for everyone knows that great intense public interest can be aroused by media coverage. So is it the fault of the newspapers or their reporters, or the Great British Public itself? If the latter, how does one explain the enormous crowds thronging every road to witness the arrival of the Shuttle *Enterprise* (even though only a development model!) at Stansted Airport in 1983? When it comes to the 'presentation' of radio and TV does the public slide away because they instinctively recognise the difference between our plague of 'instant pundits' and the real thing?

Formerly, UK press coverage of space events was extensive and well-informed but few of the press corps who once so faithfully discharged this task are still with us. Wherever the fault lies, it is the result that now worries us, for whole generations are growing up without adequate information or instruction on space - one of the most significant of the major new developments of our time.

COVER

Individual communications satellites might be replaced one day by large antennae 'farms' in geostationary orbit. They could help to prevent congestion of the geostationary arc and the large antennae would facilitate frequency re-use to allow more communications traffic. These platforms would be serviced by remotely-controlled vehicles and would permit payload growth and updating. *NASA*



THE SPACE STATION: THE GREAT DEBATE

By Roy Gibson

This background paper was presented at a meeting organised by the Dept. of Trade and Industry, attended by the Society's President and Executive Secretary. It provides an up-to-date picture of the Space Station situation in the United States, Europe and, more briefly, in Japan and Canada.

NASA Space Station Programme

President Reagan announced on 25 January 1984 that he was instructing NASA to develop a permanent, manned orbiting space station within a decade. He subsequently invited the Heads of Government of the UK, France, FRG, Italy, Japan and Canada to participate in the project and NASA officials have contacted West European states bilaterally and through the European Space Agency (ESA). NASA sees it as the next logical step in the beneficial exploitation of space. They also regard it as a symbol of the linkage between the western democracies and an opportunity to display international cooperation in high technology.

The space station will be assembled in orbit from Shuttle-launched modules and comprise laboratories (both within and outside a shirtsleeve environment), living quarters, a logistics module (for supplies, particularly propellants) and a resource module (to provide power, thermal, propulsion and communications functions). It will orbit at 28.5° inclination to the equator and have 75 kW power. The basic project also includes at least one co-orbiting platform, a polar orbiting platform serviced from the Shuttle, internally and externally attached payloads, arrangements for servicing satellites and orbital manoeuvring vehicles and arrangements for assembly of payloads and large structures.

By the year 2000, NASA envisage a complex costing $20,000 million, but their proposal for the initial programme described above is $8,000 million (1982 prices) not including launch, utilisation or operation costs. The NASA Administrator has suggested that a European contribution should amount to 20-25% of NASA's investment i.e. up to $2,000M over eight years, while Canada and Japan should each contribute 10%. These contributions would be additional to the American $8,000 million and so enhance the programme beyond what the US can immediately afford.

Initial uses of a manned station fall into four classes:

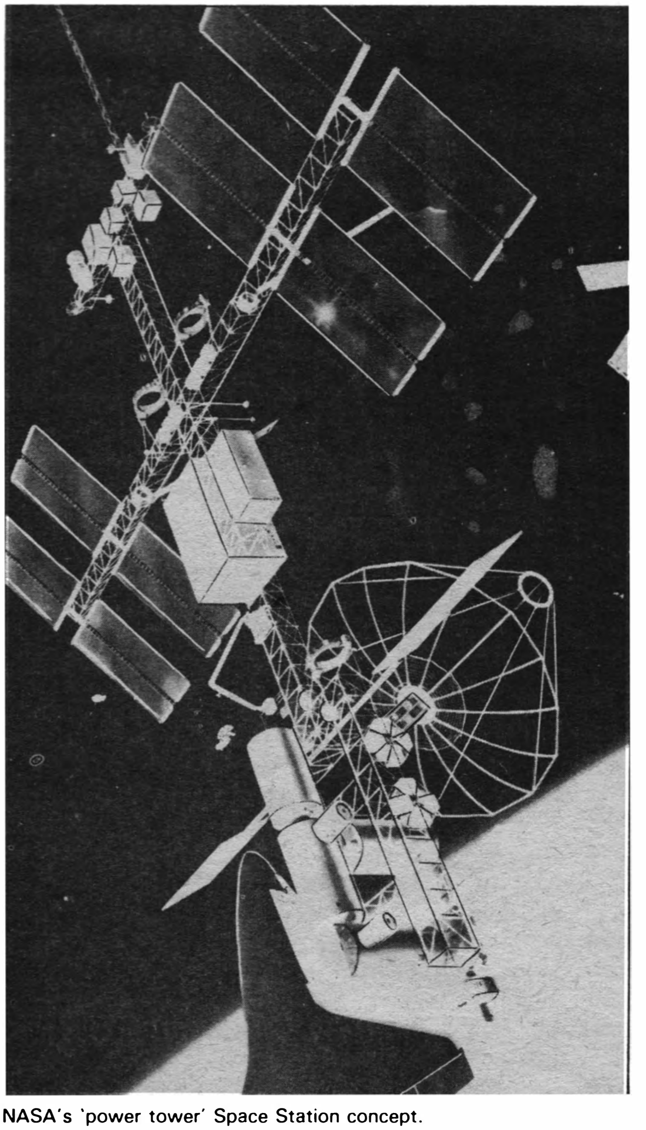
i. those that would exploit the microgravity and vacuum environment for experimental or commercial purposes;

ii. those that would utilise the station or a co-orbiting platform as a permanent satellite;

iii. those that would use the station to test technologies designed for incorporation in other satellites; and

iv. those that would use the station to refurbish and maintain satellites or to undertake check-out and/or final assembly for satellites before they are boosted to their final orbits.

The first encompasses space processing and life sciences. It is impossible to recreate on Earth for any length of time the low gravity environment achieved in orbit. Space could become an important resource for the ultrahigh purification of drugs or production of high value crystals and metal alloys and, whereas the Shuttle and Spacelab can sustain these conditions for several days, a station will do so for months or years.



NASA's 'power tower' Space Station concept.

For remote sensing, the polar-orbiting platform planned as part of the core manned space station could have a far reaching impact.

After several years of in-house NASA study and some external support contracts, the Space Station has been formally approved and an amount of US $155M earmarked from the NASA budget in FY84. A 250 man team, drawn from all NASA establishments, produced on 20 August 1984, a draft Request For Proposal (RFP) for the Space Definition and Preliminary Design. After three weeks for commments both from US industry and from potential international participants, the definitive RFP was issued to industry on 14 September 1984.

For the first time in a NASA programme since Apollo, there will be no industrial prime contractor; this function will be fulfilled by Johnson Space Center. The RFP is thus for four separate work packages, for each of which two contractors will be chosen to work in parallel, each supervised by a NASA centre. The content and approximate value of the contracts is summarised in Table 1.

Contractors are instructed to develop a configuration that would meet estimated needs around the year 2010

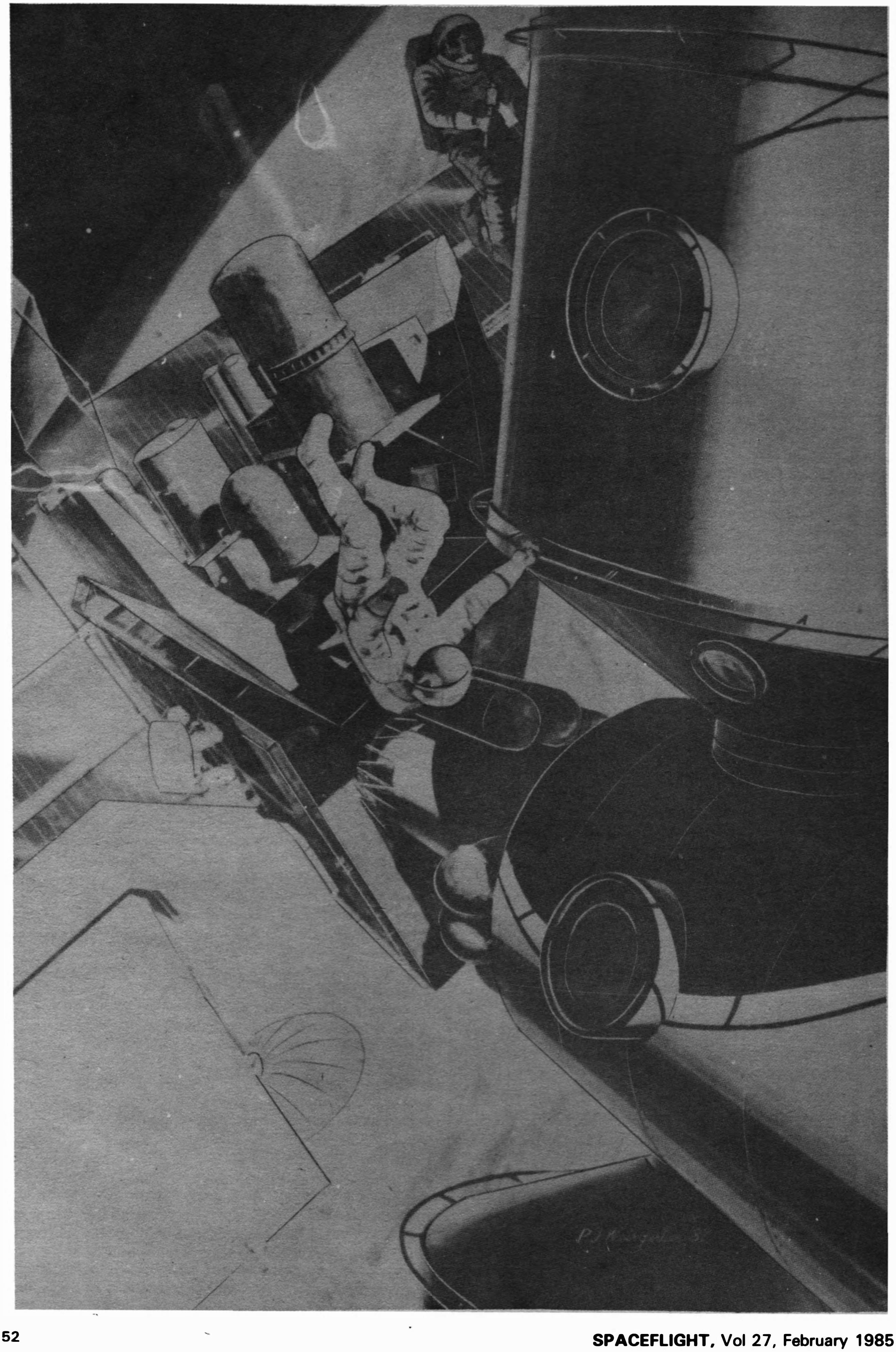
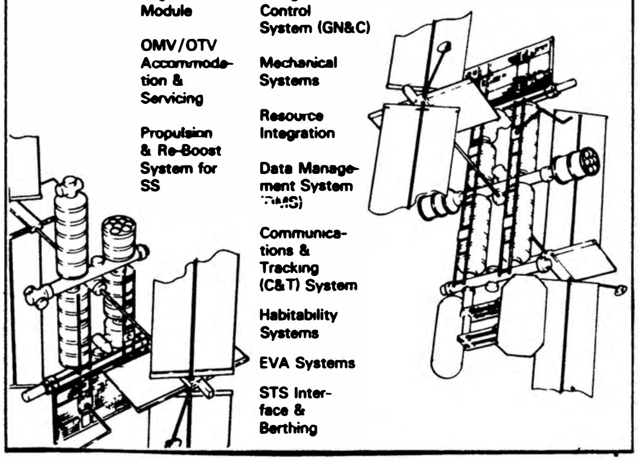


Table 1				
	Work Package 01	02	03	04
Supervising Centre	Marshall Space Flight Center (MSC)	Johnson Space Flight Center (JSC)	Goddard Space Flight Center (GSPC)	Lewis Research Center (LeRc)
Approx Value per Contract	25.85 M $	29.95 M $	10.35 M $	6.25 M $
Principal Contents	Common Module	Assembly Trusses Structures	One Laboratory Module Outfitting	Power Generation Sub-System
	Environmental Control & Life Support System (ECLSS)	Connect/Inter-Connect of Modules	Platforms	Energy Storage Sub-System
			Customer Servicing	Power Management & Conditioning Sub-System
		Airlock	Attached Payload Accommodations	
	One Laboratory Module Outfitting	Heat Rejection & Transport		
	Logistics Module	Guidance Navigation & Control System (GN&C)		
	OMV/OTV Accommodation & Servicing	Mechanical Systems		
		Resource Integration		
	Propulsion & Re-Boost System for SS	Data Management System (DMS)		
		Communications & Tracking (C&T) System		
		Habitability Systems		
		EVA Systems		
		STS Interface & Berthing		



and then scale down to an initial Operating Configuration (IOC) that could be operational in the early 1990's within the approved budget envelope of US $8,000 million. In this way NASA hopes to arrive at a configuration capable of considerable expansion without major design changes.

As a reference configuration for the manned core, NASA has given a gravity gradient stabilised concept which has come to be known as the "Power Tower." This has been driven mainly by pointing requirements and power needs. The main characteristics are summarised in Table 2, together with the postulated growth potential.

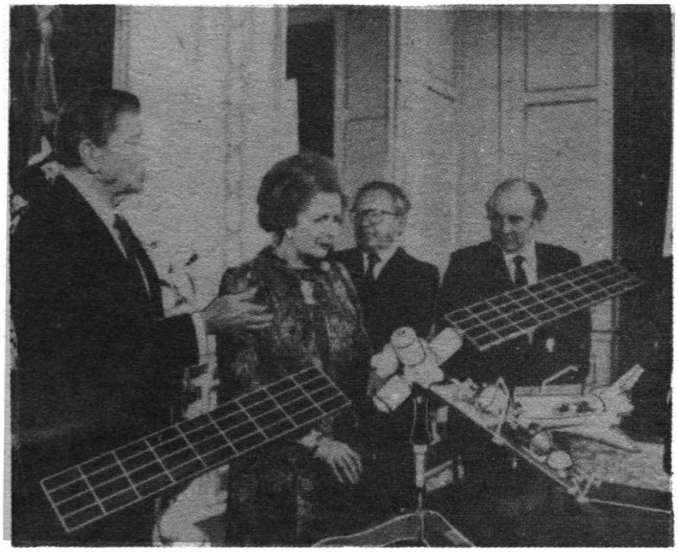
The Space Station will comprise various Space Station Programme Elements (SSEP's) as described below.

Modules

Marshall Space Flight Center, under Works Package 01, is responsible for the definition of a common module

Table 2

	IOC	Growth Potential
Altitude	270 N.Mi	270 N.Mi
Inclination	28.5°	28.5°
Average Power	75 kW	300 kW
Crew	6	18
Number of Pressurised Modules	5	10



President Reagan and Mrs. Thatcher study a Space Station model during the June 1984 economic summit in London.

which - so long as this proves practicable - is to be the basis for all modules developed by NASA. In the initial configuration it is proposed to provide.

- a logistics module
- a living quarters module, and
- two laboratory modules.

Platforms

The original intention was to include possibly only one co-orbiting platform in the initial orbiting configuration but the need for a polar-orbiting platform is being hotly canvassed by potential users and NASA has now had the benefit both of internal studies (particularly by Goddard Space Flight Center and the Jet Propulsion Laboratory) and the recent meetings with scientific and other users. The RFP therefore contains a great deal of flexibility and the call is for a single, multi-purpose platform capable of modular growth and allowing in-orbit interchange of instruments or the processing of module payloads at a standardised interface.

If the money stretches to it, NASA would wish to include, initially, two polar-orbiting platforms (where there is more call for accommodating several instruments on the same platform) and a modular family of co-orbiting platforms. Goddard Space Flight Center appears to favour six to eight small platforms each supplying 5 kW of power.

OTV and OMV

The Orbital Transfer Vehicle (OTV) does not form part of the Space Station, only its accommodation and interfacing. The development of the OTV itself is the responsibility of Marshall Space Flight Center and parallel study contracts have been awarded to Martin Marietta Aerospace and Boeing Aerospace. The Orbital Maneuvering Vehicle (OMV) is, similarly, a separate development, also under the responsibility of Marshall Space Flight Center. The status of these vehicles with regard to international co-operation is unclear but they are not thought to be included in the present invitation.

Congress Approval

It is important to note the conditions imposed by Congress when the Space Station FY84 budget was approved. The commitment of the $155.5M was blocked until 1 April 1985 and its release is subject to NASA

giving satisfaction on two issues:

i. NASA is required to study an option under which the Space Station would initially be man-tended with the permanent manning being phased in at a later date. NASA is under an obligation to spend 10-15% of the definition funds in having this trade-off study made; and

ii. a Space Station Advanced Technology Committee is to be established to identify systems that would advance the technologies of robotics and automation of use, not only in the Space Station but also in ground-based industries. A programme equal to 10% of development costs is to be defined.

NASA has responded promptly to both these requirements. The SSP Phase B contractors are instructed to undertake a meaningful study of the man-tended option and in-house work is also planned in this area. To meet the second point, the California Space Institute (CSI) will lead a university/industry team to guide a comparative effort on systems design and systems technology. The Stanford Research Institute (SRI) will perform technology evaluation and forecasting, and some aerospace companies are to examine the design implications of the Stanford analysis. To pull the work together and to assist NASA in formulating an automation/robotics programme, a high-level advisory and oversight group has been appointed, chaired by Dr. Frosch, the former NASA Administrator.

NASA was due to present to Congress by 15 December 1984 a report on Space Station "Management plans and acquisition strategies."

US Invitation for International Participation

The invitation was first made in President Reagan's last State of the Union message when he invited America's friends and allies to participate, explaining that this participation could range from use of the completed facility to cooperation in the development of the Space Station. In order to underline the political nature of the invitation, Mr. Beggs, Administrator of NASA, was sent to Europe in April 1984 as the US President's personal representative to encourage European countries to respond positively. The subject figured on the agenda of the June 1984 Economic Summit Meeting and the communique provided for a report to the next Summit in 1985.

The draft RFP to industry also addresses this aspects and speaks of an invitation to international friends to become 'builders, users and operators' of the Space Station, warning US contractors that work package allocation could very well be altered as a result of international participation.

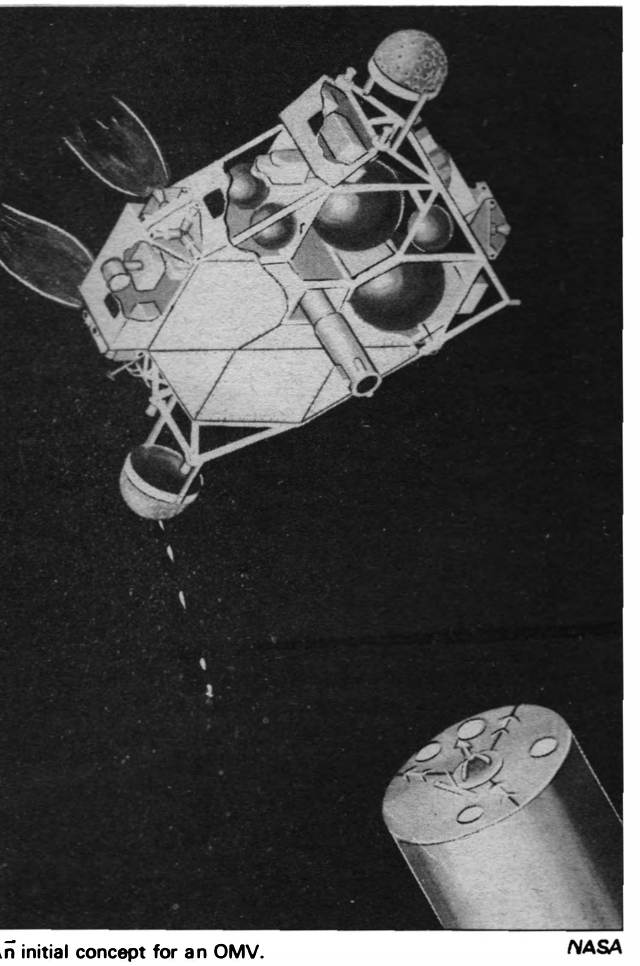
NASA indicated that a reply in principle was being looked for from international participants by the end of 1984 and that they would like all formalities to have been concluded by the end of 1985, i.e. at the time the Space Station configuration is frozen.

The Canadians have indicated to NASA that they are, in principle, interested in participating in the Space Station and that they are presently concluding national studies

NASA Timetable

The key milestones announced by NASA for the SSP are:

Distribution of RFP to industry:	- 14 September 1984
Receipt of industrial proposals:	- November 1984
Selection of contractors and authority to proceed:	- 1 April 1985
Fixing of final configuration:	- October/December 1985
Evaluation of development proposals:	- September 1986-March 1987
Start Phase C/D:	- April 1987



An initial concept for an OMV. *NASA*

to define the nature and extent of this participation. Canada has also informed the European Space Agency (ESA) that Canadian cooperation in the Programme through the Agency is not excluded. A further development of the Remote Manipulator System (RMS) developed for use with the Shuttle is certain to be one, and perhaps the main, Canadian proposal.

The Japanese industry has, from the start, been enthusiastic about participating in the Programme. Four industrial consortia have been formed and internal studies are being carried out, in some cases in association with US firms. The draft proposals are far-ranging and are estimated to cost around US $1,300 million. The Japanese governmental position has not yet been announced but it is known that the Diet will be asked in April 1985 to approve the necessary funding.

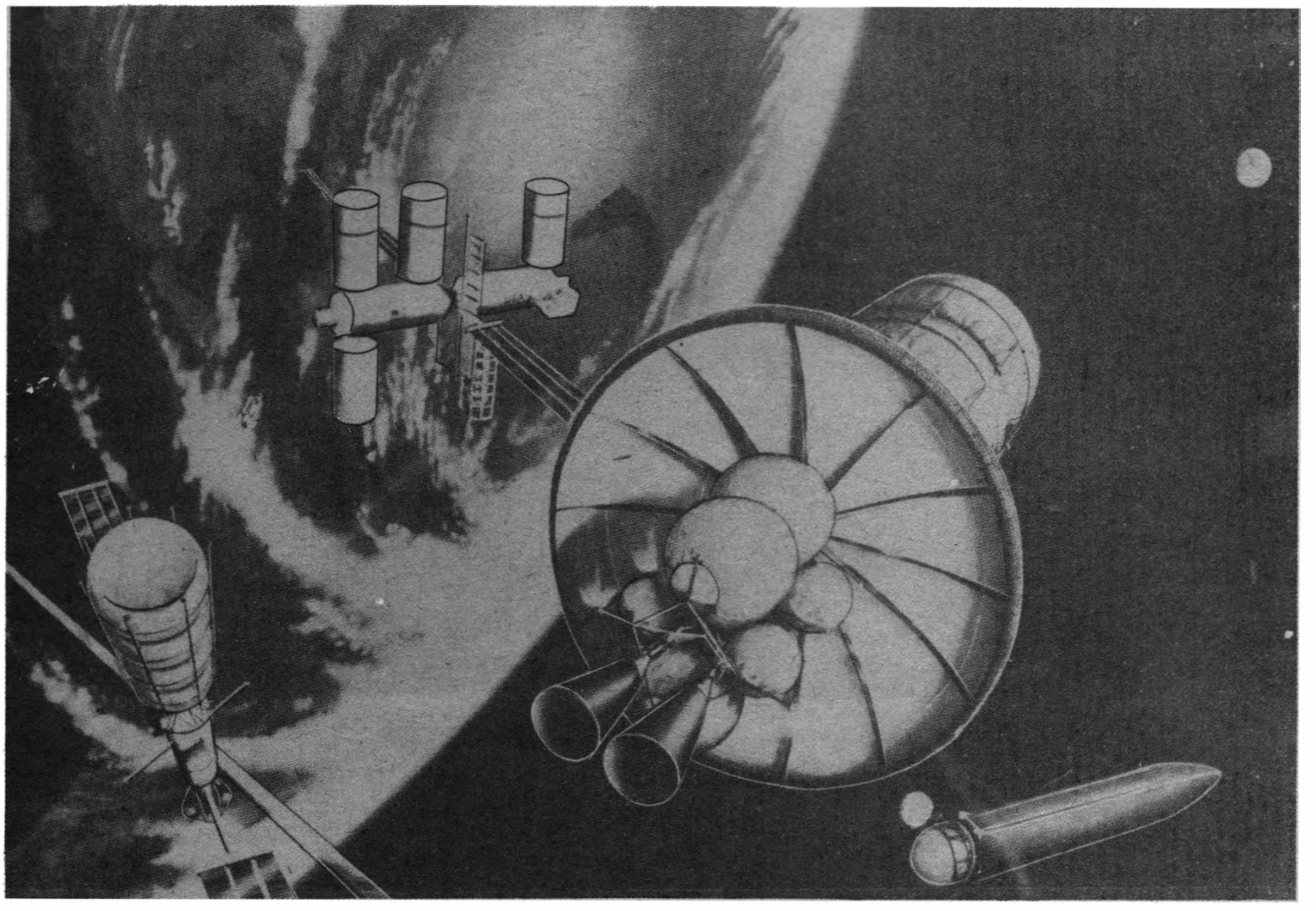
NASA invited potential international participants to attend a workshop in Washington on 20/21 September at which the latest state of the US Programme was described and foreign participants encouraged to discuss the form their contribution might take.

Spacelab Follow-on Programme

Eight ESA Member States agreed to participate in an optional programme, 'Eureca,' at a cost of 155.9MAU. This is a reusable autonomous carrier designed to be launched into space, operated in a free-flying mode for up to six months and retrieved by the Space Shuttle. The first flight is due for mid-1987. The reference orbit is 500 km altitude and an inclination of 28.5°.

European Space Station Programme

In January 1983, nine ESA Member States agreed to contribute to a 13M Accounting Unit 'Space Transporta-



The Space Station could eventually operate as a base for lunar operations. *NASA*

tion Systems (STS) Long-term Preparatory Programme' (LTPP). The object of the programme was to analyse options open to Europe for STS activities beyond Ariane 4 and Spacelab Follow-on Development (FOD) and to prepare decisions on a long-term policy and on the start of new programmes by 1985-86 within the following three areas:

Theme 1 : Future European Launcher.

Theme 2 : European Space In-Orbit Infrastructure (IOI).

Theme 3 : Manned Space Station and continued cooperation with United States.

The United Kingdom contributed to the preparatory plan at the rate of 4%, the average of its share in previous ESA Ariane/Spacelab programmes.

The existence of the plan enabled ESA to reach an agreement with NASA whereby the two agencies keep each other informed on the progress of their studies and permits the participation of US and European industry in all relevant inter-agency conferences.

The ESA Council, meeting in June 1984, agreed on two enabling resolutions approving the execution of two new optional programmes; this means the Agency can examine relevant details and make proposals to the Member States who, before work can start, must formally agree the technical details and funding of these programmes. The new programmes are:

- for the development of the large cryogenic engines (HM60); and for
- a 'space station related programme based on the proposal by the German and Italian delegations...; this programme will be defined with a view to ensure progressively the European autonomy in the field of the manned space station mutually compatible with the future European launching systems.'

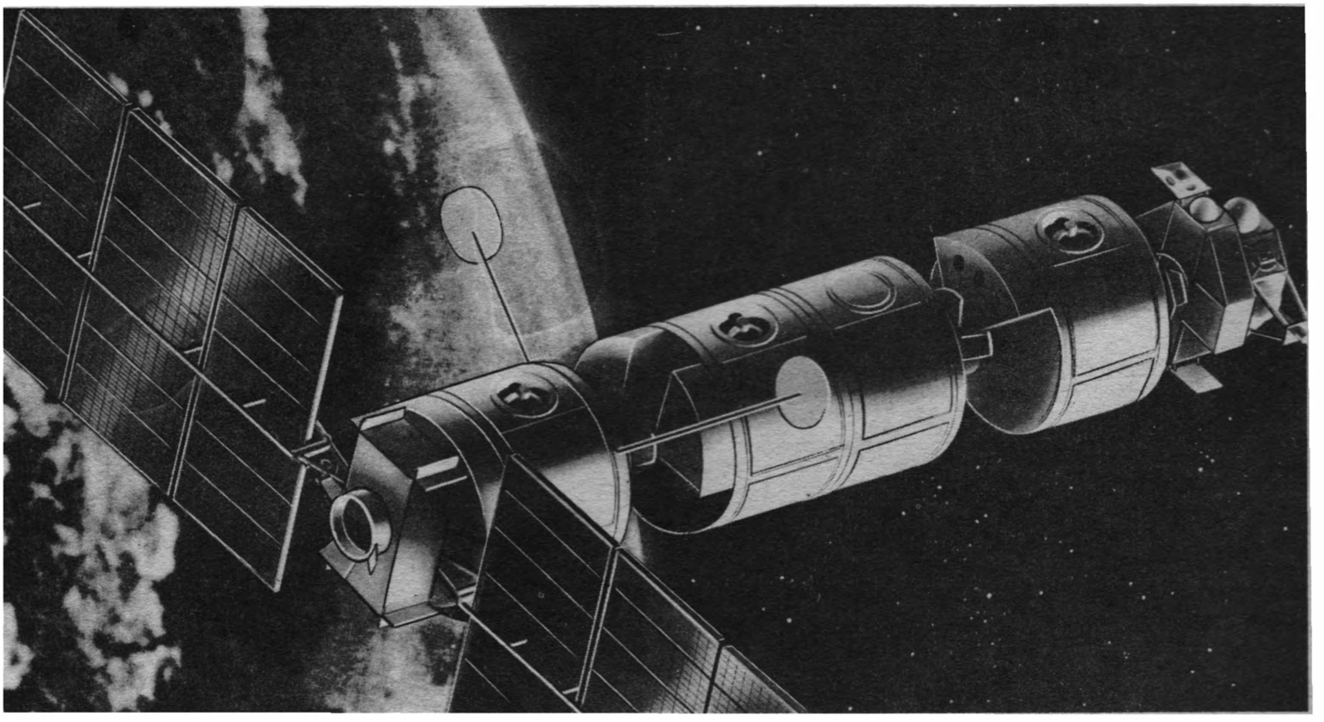
The second Resolution also approved 'in the process of this preparatory programme the consideration of the invitation received from the President of the US...'

The Space Station Resolution envisages a funding of 80 MAU (35 MAU for definition contracts and 45 MAU for a supporting technology programme). For the Space Station Phase B study, ESA hopes to have all the formalities completed in time to allow industry to start work in April 1985 (the same date as for the NASA Phase start).

Meanwhile 1.1 MAU of the Long Term Preparatory Programme will be used to provide two bridging contracts which will be awarded to MBB/ERNO and Aeritalia with instructions to arrange a 'reasonable' geographical distribution of the work. The time before April 1985 is intended to be spent mainly on refining cost analysis, examining maintenance and operations costs and attempting to define the elements in NASA's Space Station Programme available for international participation. The first meeting of the potential participants was arranged for 18 September 1984.

Columbus Programme

The German/Italian proposal referred to in the ESA Space Station Resolution is the so-called Columbus programme. It is funded by the German BMFT (the Ministry of Research and Technology) and the Italian MRST (the Ministry of Scientific and Technological Research) as 'a joint effort for the continuation of European space activities based on the exploitation of Spacelab and Eureca



Columbus envisaged as a free-flyer. *Aeritalia*

technologies and results obtained.' The industrial studies were carried out from April 1983 to July 1984 by MBB/ERNO and Aeritalia, supervised by DFVLR (the German aeronautical and space agency) and the Italian CNR (national research agency and location of the Italian National Space Plan). The studies also took account of considerable in-house DFVLR work which had been done under the name of Orbitas.

As presented to the ESA Council in June 1984, for 'Europeanisation,' the Columbus programme consists of:

i. Pressurised modules (PM), a further development of Spacelab, and intended to be either manned or man-tended;

ii. Payload carriers (PC), a further development of European hardware designed to carry experiments, material production facilities etc; and

iii. Resource Module (RM) providing power, communications, data management and other housekeeping facilities for the PM and PC.

The programme also provides for payloads, ground segment and some demonstration missions in orbit due to commence around 1993. The launching of this initial configuration would depend on the US Shuttle, but Ariane 'could be considered as an option for manned launches.' The programme is intended to be 'compatible' with the NASA Space Station 'as a general policy,' and the pressurised module is seen as being initially attached to and serviced by the Space Station. A prominent feature of the programme is the possibility of the Columbus elements separating from the US Space Station and constituting an independent system serviced by European launches.

The initial programme described above is estimated by the German and Italian delegations as costing 1750 MAU (some additional internal man-power costs would be furnished free by these two Member States in return for a dominant role in the management of the programme). The German delegation has indicated its willingness to fund up to 50% of the programme and Italy appears anxious to provide 25%.

The presentation of the programme to the ESA Council also described an uncosted extension programme which includes further development of the PM to enable it to operate as a man-tended free-flyer and a servicing vehicle providing capability for orbital manoeuvring and crew transfer between the US Space Station or Shuttle and the 'European free-flying system.'

COLUMBUS: SYSTEM CONCEPT AND CONSTITUENTS

Resources Module (RM)
- Provides attitude and orbit control, power supply, heat rejection, TT & C and information management to payload carriers and pressurised module when free-flying.
- Two sizes of RM's envisaged based on mission requirements. Major difference in heat rejection and power supply capability.
- Supports all orbit and attitude requirements of platforms and PM.
- Limited orbit transfer capability.

Platform
- Consists of a modular payload carrier with subcarriers for the payload complements and a resources module.
- Operates at 28° inclination and polar orbits over wide range of altitudes.
- Supports payloads of all identified types with power levels up to 17.5 kW (except those requiring pressurised environment).
- Payload exchange possible on subcarrier or orbit replaceable unit level.

Concept based on Columbus specific requirements and on external requirements stemming from payloads, SS of STS.

Pressurised Module
- Three segment SL-derived module.
- Provides pressurised environment for experiments and crew.
- To operate attached to the Space Station or free flying with resources module (co-orbiting with Space Station).
- Permanently manned for attached operation, man-tended when free flying.

UK SPACE STATION PARTICIPATION: 20 Key Questions

Posed by Dr. David J. Stanley (Logica UK Ltd)

The building of the Space Station and UK involvement have to be firmly justified because of the considerable investment involved. Dr. Stanley considers 20 points of importance.

The Political Dimension

1. What are the justifications for significant new UK investment?
2. How can we harmonise UK/European/US priorities?
3. Who are our most natural partners?
4. What is the role of defence interests, if any?

The Economic Dimension

5. Is the primary benefit to users or developers?
6. Which application areas will eventually generate revenue?
7. Will it make scientific research more cost effective?
8. What is the pay back time?

The Technological Dimension

9. How can we use SS to extend classical space engineering?
10. How does it relate to other UK investments in advanced technology?
11. Will it be a driving force for Information Technology?
12. Is the UK vulnerable to foreign monopoly of expertise/facilities?

The Management Dimension

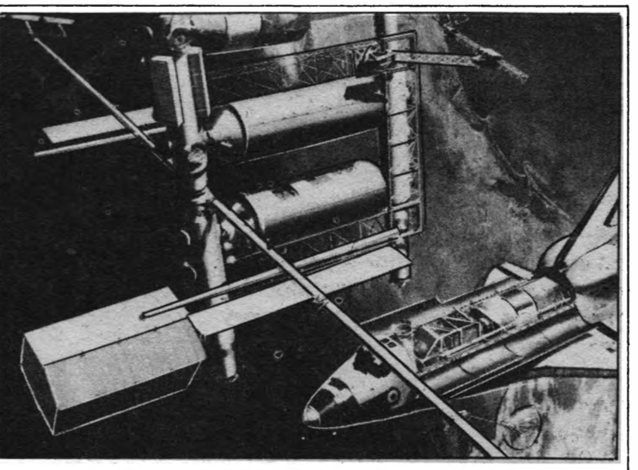
13. Should the UK seek a prime role or concentrate on technology?
14. How do we maintain a direct interface to SS?
15. Can we guarantee total system visibility and access?
16. How do we protect our interests in the exploitation phase?

The Pragmatic Dimension

17. Can the UK get its act together quickly enough?
18. Can Europe get its act together quickly enough?
19. Will the US significantly modify its conditions for participation?
20. How much flexibility should we maintain?

Some Personal Answers

1. To regain our position among the leaders of space exploitation at reasonable cost and risk, with the prospect of providing direct access through UK astronauts.
2. By supporting a truly European response consistent with valid UK interests.
3. A balanced group of ESA member states with an equitable management structure among the industrial contractors.
4. They must be integrated into an overall national strategy for participation with due regard for the constraints imposed by the policies of our partners.
5. The main justification must depend on the advantages offered by SS to users but the technological benefits to the aerospace industry provide an important shorter term payback.



6. It is almost certainly premature to say, except that most organisations who have seriously looked at the options have identified commercial potential.
7. A range of existing platform options will almost certainly mean that a higher proportion of the space science budget can be devoted to payloads.
8. Long; certainly not before the 21st century. We are investing in the future of our children and grandchildren.
9. Concentrate on activities related to manned missions.
10. Harmonisation should be sought especially with the Alvey Programme. I propose the establishment of a technical synergy unit.
11. Emphatically yes. In particular it will place challenging demands on distributed software engineering, artificial intelligence and man-machine interaction.
12. Perhaps in some areas of specialised manufacturing, e.g. ultra-pure semiconducting materials.
13. Subject to the need for gaining sufficient influence, technology will represent a better investment than project management.
14. By ensuring that we retain a role in the core programme or a closely related area.
15. Yes, if we ensure that UK is involved in system level activities and we negotiate hard on the basis of a significant (GNP % minimum) participation in ESA's programme.
16. By having intimate knowledge of the user-oriented system interfaces and by carrying our share of the overall risk to buy indepedence.
17. Yes, if we establish a long-term strategy, act quickly to secure the opportunity without necessarily answering all the questions in detail and are prepared to devote some short-term national funding to catching up with our partners before and during Phase B.
18. Only if we can reverse the trend of history. Survival is probably the common motivation to ensure that a strong early commitment is made to the US.
19. I believe so, despite the current posture. Europe should not shrink from establishing its clear objectives for meaningful participation in the core programme and then negotiating an equitable relationship based on shared risk.
20. The UK must be careful to preserve its options to enable it to respond to the results of detailed study and to changes in the political or economic dimension.

PLATFORMS, MODULES & THE SPACE STATION

By Dr. Bob Parkinson*

The author adds further views on European participation in the US Space Station and considers what contribution British Aerospace may make.

Dr. R.C. Parkinson is currently Study Manager for Space Station studies at British Aerospace.

Introduction

The problem with giving *Spaceflight* readers an insight into the state of play in the question of European participation in the US Space Station programme is that the situation is changing so rapidly. It now looks probable that Europe will opt for a substantial participation in the Space Station programme. A figure of about $2000 million is being proposed, with fairly positive reactions from the ESA member states. Add to this a proposed participation of $1000 million from Japan and a similar, perhaps smaller, amount from Canada as support for the $8000 million US 'core' programme, then it seems probable that the 'US' tag to the Space Station programme may be misleading. Over a third of the total programme could be from non-US sources.

This money is not yet in place. Even the German government, which is proposed to take 50% of the European programme, has not formally agreed to spend such money, and in the first instance what will be committed is funding for the Phase B programme - approximately 80 million ESA Accounting Units. (An "Accounting Unit" is worth a little less than $1 or about 57 pence). Phase B is a two year design study exercise leading to the full development process afterwards (Phase C/D). European commitment to the Phase B programme has to be in place at the opening of 1985.

To prepare for UK participation in the European programme, a 'National Symposium on British Interests in International Space Station Proposals' was held on 4 October 1984, at the request of the Minister of State for Industry and Information Technology, Mr. Geoffrey Pattie. Attendance included senior members of the science research community, the Aerospace Industry and other interested parties. The BIS was represented by the President and Secretary, as well as other members (including the author) in their various official capacities. The concensus from this meeting was that if the UK is to remain active in Space it must pariticipate in the Space Station programme, and that participation should be substantial - 15% is the number most often bandied around. This number surfaced in the early summer and caused a little consternation in some European circles who had got used to the UK being 4% of similar programme (which puts it on a level with Spain). This level of space spending would represent an increase in UK budgets, but there are strong arguments that this is long overdue. German, French and Italian Space budgets have all been increasing at between 10 and 20% per annum (in real terms) for the past three of four years.

European Participation

On the basis that Europe is to invest strongly in the Space Station, what is it to do? Studies to answer this question have been underway for the past two years. The most publicised is the German/Italian Columbus proposal, which was carried out on German and Italian national funding and details of which have only just been made available to the rest of the world. Less well publicised was the ESA-funded 'Space Station Systems Study' (shortened to S-4 by its participants). S-4 involved 11 different companies from eight different countries, and looked at hardware participation in parallel with a 'European Unification Aspects' study (EUA for short) looking for potential users. British Aerospace was part of both studies.

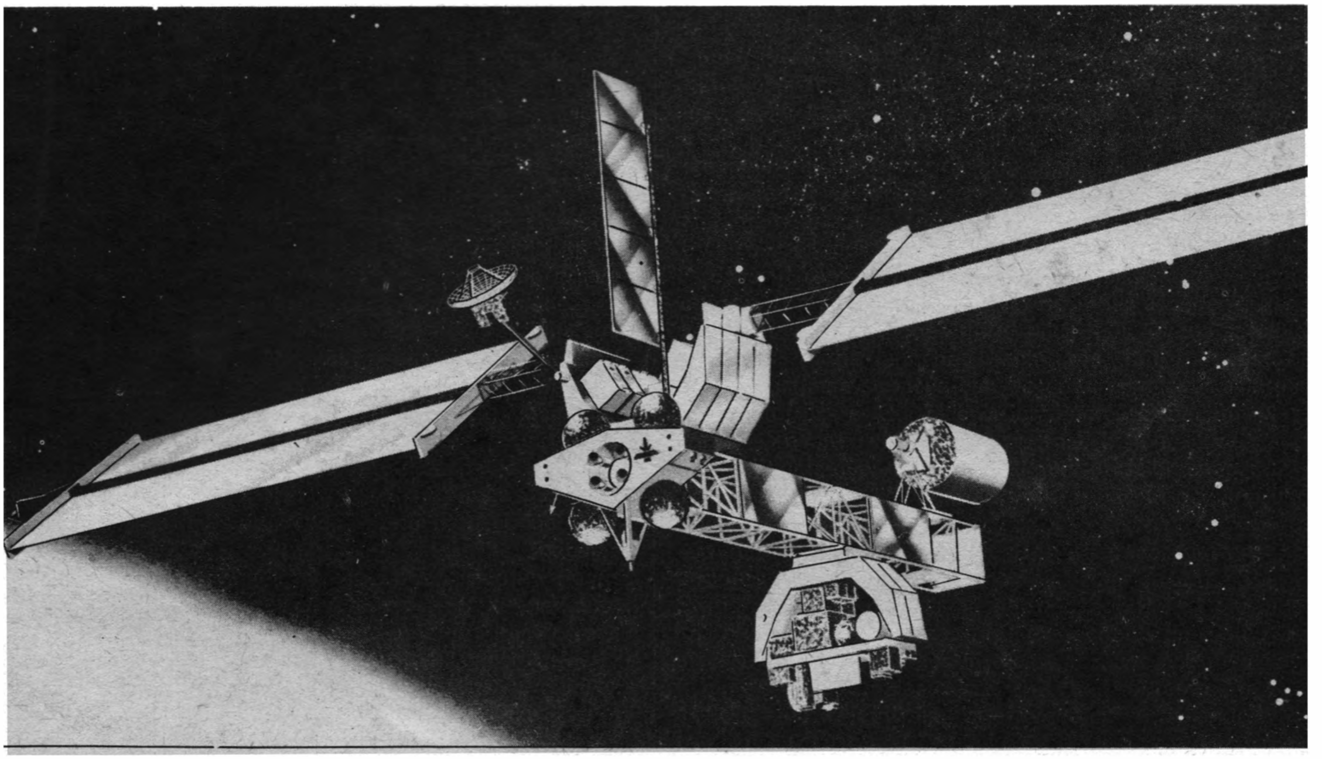
Both Columbus and S-4 came to similar conclusions as to the nature of European involvement. At the topmost level, it is generally agreed that Europe should produce a 'mannable' Experiment Module which can plug into the main Manned Space Station for its services, and an unmanned free-flying Space Platform which can carry payloads away from the immediate vicinity of the Space Station, but which would rely on the same manned infrastructure for servicing and payload exchange. If necessary these two units could, in the early 21st century, form the basis of an independent European Space Station. In addition, in an extended programme, Europe might choose to build a robot servicing and supply vehicle and a data relay satellite.

It may seem strange to include an unmanned, independent Space Platform as a contribution to the Space Station programme. The station itself is the permanently inhabited structure, although the NASA Request for Proposals issued in September 1984 also requests studies of the use of automation to the extent that even this 'core' Station might not need to be permanently manned in the early stages. The Space Station Programme also includes the requirement for a 'co-orbiting' Platform periodically returning to the Manned Station, a polar orbiting Platform, a reusable, cryogenic Orbital Transfer Vehicle for lofting payloads to geosynchronous orbit, and an Orbit Change Vehicle capable of placing and recovering satellites in lower Earth orbits. Not all of these will be paid for out of the initial $8000 million. The Orbit Change Vehicle is being funded earlier that the main Station - but all form part of the Space Station Infrastructure.

British Aerospace consider the Space Platform to be an important element in European participation. Europe will not only have to build components of the Space Station, it will have to support it in operation. It will also have to buy facilities aboard that part of the Space Station it does not build. It is therefore highly desirable that whatever Europe builds, it attracts not only European users but US users also. Then US usage of European elements can be traded *quid pro quo* with European usage of US facilities. A plug-in Experiment Module supports only European users. The correct Space Platform, particularly one in polar orbit, would attract users from all sources.

British Aerospace are arguing that the UK should take a lead in the Space Platform part of the European participa-

* The situation described in this article is as existed in mid-October 1984.



A British Aerospace concept for a Space Platform.

tion programme. Since the Platform accounts for only about a quarter of the total budget, the UK contribution would account for rather more than half of this element. Further, it can be argued that the Platform supports UK interests in space rather better than other elements.

Part of our studies have involved looking at the sources of user funding. Most of the attention given to the use of Space Station facilities has focussed on microgravity processing - manufacturing semiconductor crystals or exotic pharmaceutical products under zero gravity. There is reason to expect microgravity processing to assume a growing importance as we enter the Space Station era, but even with optimistic projections into the 1990's microgravity budgets are likely to remain well below European spending on Space Astronomy and Earth Observation. Earth Observation (resources, meteorology) are not 'commercial' users in the sense that private companies invest in, but they are important public sector services. Because of this there is an immediate demand for a polar orbiting Platform (perhaps even more than one), and derivative 'co-orbiting' Platforms can follow.

The Space Platform being proposed by British Aerospace is a modular, highly adaptable structure. At its heart is a Resource Module which provides the power supply to payloads, an active cooling loop, data collection and communications services as well as overall Platform control. Each of these services is boxed in detachable 'Orbital Replacement Units' (ORUs) which can be replaced on-orbit by astronauts or a robot servicing vehicle at periodic maintenance visits. The services provided by the Resource Module are transmitted to payloads *via* a Payload Beam, which carries berthing points at 6 m intervals at which power, cooling and data connections are available. Payload Carriers could look like Spacelab Pallets with a berthing interface added, carried up as standard units in the Space Shuttle and plugged into appropriate points on the Payload Beam. Alternatively, instruments like astronomical telescopes which have to be directed towards different parts of the sky would be mounted on an Instrument Pointing Module similar to that developed for Spacelab, which in turn would be mounted on the Payload Beam. The platform is completed by a Propulsion Module, capable of boosting the Platform from Space Station/Space Shuttle atltitude to its operating altitude (about 800 km), and later returning to the lower altitude for servicing. By making this a separate Module it can be simply replaced, rather than demanding on-orbit refuelling.

In its initial configuration, the British Aerospace Space Platform is designed to deliver a total of 12 kW payload power to five berthing points, and to cope with the collection of up to 272 Mbps of data from a multiplicity of experiments for relay through a data relay satellite like TDRSS. The Platform would be delivered complete into orbit, including the first Pallet load of payloads, in a single Shuttle launch and assembled *in situ*. Not only is the Space Platform the world's first permanent satellite in the sense that every part can be replaced on-orbit, it is also likely to be the first (excluding the Space Station itself) to be assembled on-station. Rather than developing complex mechanisms for the deployment of antennae, radiators, solar arrays etc., it actually appears cheaper and more effective to deploy astronauts for a six hour EVA to carry out these activities.

Since it represents a permanent facility in orbit, it is cheaper to fly payloads on a Platform than as independent satellites. Not only does the service 'bus' of the satellite not have to be launched each time, but the cost of providing these services can be amortised over a larger number of users. Our calculations indicate that the Platform represents a saving of up to 50% on 'launch and facility' costs over conventional multi-mission spacecraft. To achieve these savings, a Platform has to acquire just two new payloads a year.

Whether or not the British Aerospace Platform is adopted as part of the European participation in the Space Station programme will be decided soon. The grounds will be political and economic, not technical. It would be a big boost to UK Space interests to have a British flag flying on such a major element of the programme in the 1990's, and a good deal of effort is currently underway to ensure that it is so.

US MANNED SPACE STATION: GENERAL IMPLICATIONS

by Peter G. Whicher

A further paper presented at the Dept. of Trade and Industry on 4 October 1984 discussed the philosophy behind a manned Space Station. The author is Deputy Director (E) of the Royal Aircraft Establishment in Farnborough.

Introduction

In space, flights of fancy have often preceded the technology and finance required to support real space projects, with the result that almost every new advance has attracted its full share of scepticism. Space history has shown, however, that money, time, research and good engineering can overcome the most formidable problems. The technical and scientific achievements of the Apollo programme pioneered the active role of man in space exploration and there is no reason to doubt that the manned Space Station proposals are entirely achievable, given adequate resources and commitment.

In spite of advances in automation and robotics, experience in the sea and air environments has shown that human qualities remain valuable for rôles in which initiative, adaptability, perception and originality are important. There is no reason to believe that space will be different and the remarkable achievements of astronauts bear witness to their unique rôle.

The Case for Men in Space

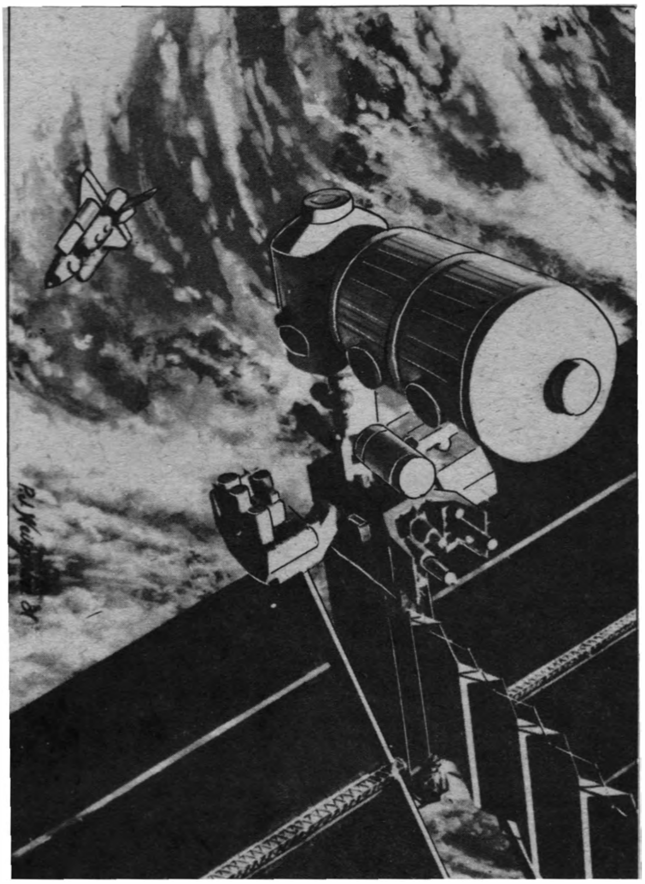
We should not too hastily discount the value of man in space in spite of advances in remote control and robotics. At sea and in the air, both more established environments, both civil and military operations see a continuing role for man. The reason usually given is that it will be a long time before automata can mimic human enterprise, flexibility, inspiration and commonsense. It is difficult to see why space should be different. As in the other environments there are places for unmanned vehicles and robotics, and opportunities for man.

A constructive use of man in space is to assist in system development and optimisation. For example, in remote sensing the perceptive powers of man, if available in a 'man-tended' spacecraft, could be used to help optimise the selection and use of on-board sensors and signal processing, using equipment which may be too complex or vulnerable for totally unattended use.

Industrial and chemical processing, space science and the biological disciplines can all demonstrate new opportunities within the space environment, although the economic returns cannot yet be gauged. The US manned Space Station will, however, probably be the largest and heaviest structure assembled in space and UK participation should, above all, gain us experience in this vital area of development.

Even the largest current spacecraft are limited in capability by launch constraints. Key parameters such as electrical power, antenna gain and directivity, sensor size, signal processing capability, particle shielding, manoeuvring and redeployment capabilities have all been limited. Spacecraft lifetime has also been shortened by lack of maintenance, repair and refuelling facilities.

Communications satellites, for example, require larger



A 1982 TRW Space Station concept.

and more complicated antenna farms to accommodate intersatellite links; large antennae for ground links so as to reduce spillover pollution allow better use of the limited frequency spectrum, and bring ground station tests and antenna sizes down to compete with those of normal terrestrial systems. Only then can one of the main benefits of satellite systems - i.e. delivery of the speech, data or images *direct to the end user,* be fully and economically realised.

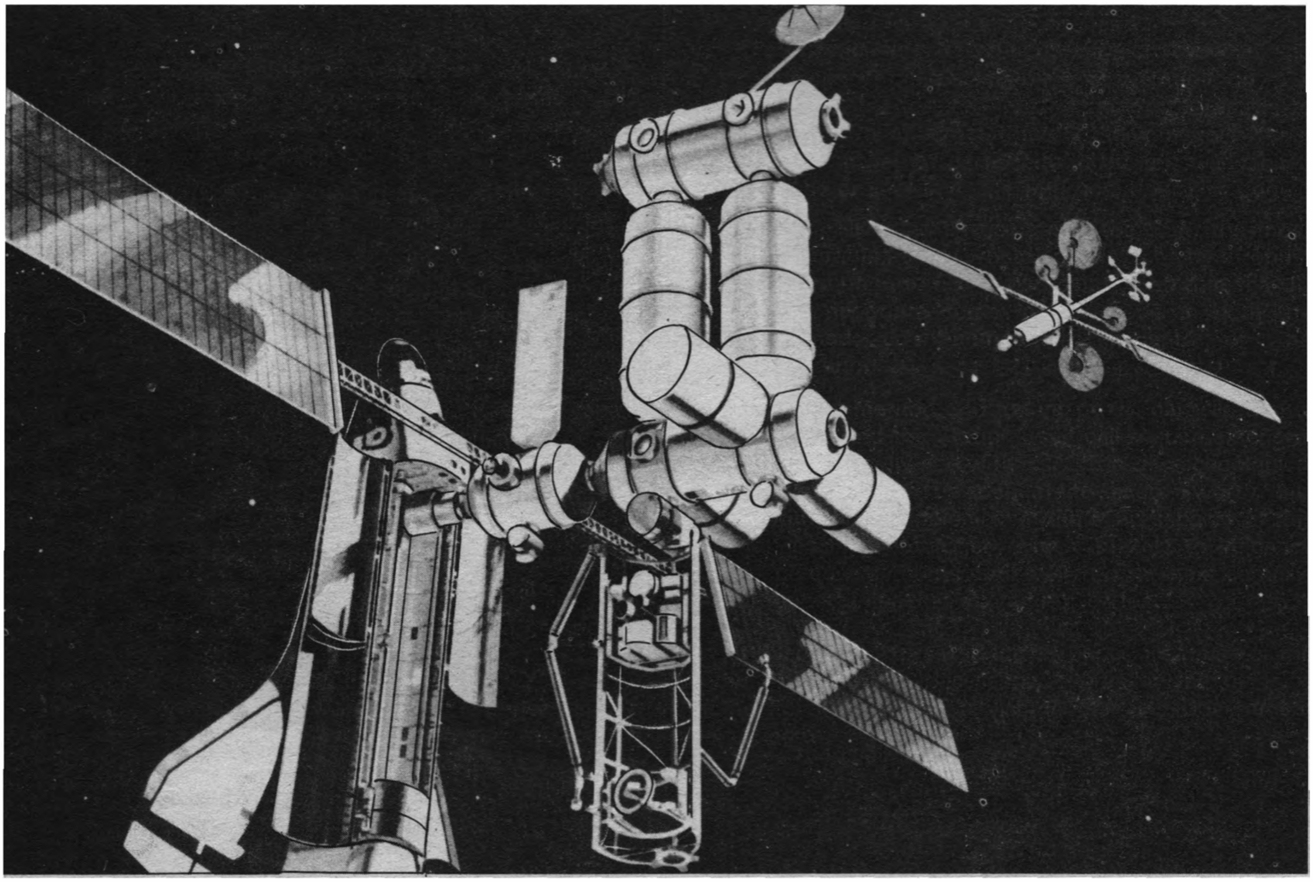
The ever larger and complex satellites that will be needed in the future for this sort of task will, in many cases, have to be assembled and later tended in space. The unmanned Space Station is a significant step in the chain of events which will lead to this capability and in which UK now has a chance to participate.

It is interesting to note the analogy between the development of ships and spacecraft. Each originated with small craft of limited capabilities, severely constrained by the limitations of early technology. In both cases, however, the requirements have constantly multiplied, leading to the development of a wide variety of ever larger craft as techniques have advanced.

Thus, in space, one can foresee ferries, equipment carriers, fuel tankers and specialised research and military vehicles. But the marine development of greatest potential to emulate is the container ship - substantial in size and designed to carry its payload in a large number of standard modules - the ship itself providing a robust propulsion, stabilisation, power generation, navigation and communication infrastructure, and possibly accommodation for regular or occasional operating and maintenance crews. The space station concept is about halfway along the current evolutionary scale for maritime craft.

The Way Ahead

To return, however, to the immediate problem of the



An early 1984 station concept.

space station, three fairly firm assumptions can be made:

1. The US Space Station is likely to go ahead.
2. Germany and Italy will proceed with some form of Space Station probably through ESA.
3. France will wish to advance Ariane and Hermes proposals.

Against this background, UK policy should also take into account that:

1. The demand for larger spacecraft will increase and will need to be matched by increases in UK investment and constructional capabilities in order to retain our competitiveness.
2. The total scope for man in space is still arguable but at least three tasks are becoming accepted:

   a. Assembly and test of large spacecraft and structures which are too big or too complex to trust to a single unmanned launch.

   b. Repairs in space. These will become increasingly cost-effective as spacecraft become more modular and/or as the items to repair become larger and more expensive.

   c. Technological innovation. Ideas stem from necessity, challenging situations, new environments and mental inspiration. The manned space environment offers all these stimuli to participating engineers and scientists.
3. Success in space carries an element of prestige.

Conclusions

Returning to the opening question of the general implications for the UK of the Space Station and associated developments, a few simple conclusions are possible.

1. Shuttle, Ariane and possibly Hermes offer a useful spread of launch capabilities. It is probably too late economically for the UK to go back into building conventional launchers. Trans-atmospheric vehicles and ion engine propulsion are, however, fields worth further examination.
2. Of Columbus and the Space Station, the latter is probably half a generation ahead in concept and substance, It is based upon standard modules and the concept is expandable and adaptable. (It may be possible for the Space Station Programme to absorb Columbus, but hardly the converse). Thus, if UK wishes to participate in the most advanced space programme, the SSP has a decisive edge.
3. If the UK is to participate in the SSP, the most favourable course would appear to be by a robust contribution to ESA's participation so that the UK may negotiate some 'noble' work on both the manned and unmanned elements of the programme.

The precise method and extent of UK participation in the platforms and the Station itself will require extensive discussion nationally and with ESA. The UK technological base, however, should be adequate to secure a worthwhile role in both the technological and human aspects of this very far-reaching enterprise, which is likely to influence civil space developments until well into the next century. It is an opportunity that should not be lost.

Note: The views expressed in this paper are those of the author, and do not necessarily represent the opinions of the Royal Aircraft Establishment or any Government Department.

TO THE MOON?

Now that the Space Station is underway, many feel that a return to the Moon should be the next step. NASA is already making initial studies for bases on the lunar surface and in October 1984 NASA Administrator James Beggs made a significant speech in Washington DC to a symposium on future space activities. An adapted version of his presentation is given below.

NASA's lunar base working group met last April at Los Alamos to debate the pros and cons of establishing a permanently manned base on the Moon's surface. The working group concluded that such a base should be adopted by NASA as a long-term goal for the 21st century.

Even before Apollo, our studies concluded that such a base could serve as a facility for scientific research, economic exploitation of the Moon's resources and colonisation of the Moon.

Today, more than 15 years after we first set our footprints on the Moon, we have learned much about it. Twelve Apollo astronauts walked on the lunar surface; they returned more than 2,000 samples of lunar rocks plus cores of soil from six locations. Soviet unmanned spacecraft have provided samples from three other sites. Spacecraft have photographed the entire Moon from orbit and performed chemical analysis of more than a quarter of its surface.

Our lunar exploration revealed no water, no organic matter and no living organisms. But the Moon rocks contain the secrets of more than 4,500 million years of lunar history. We know now that the Moon not only has plentiful oxygen in its rocks, but also silicon and possibly valuable metals such as iron and titanium.

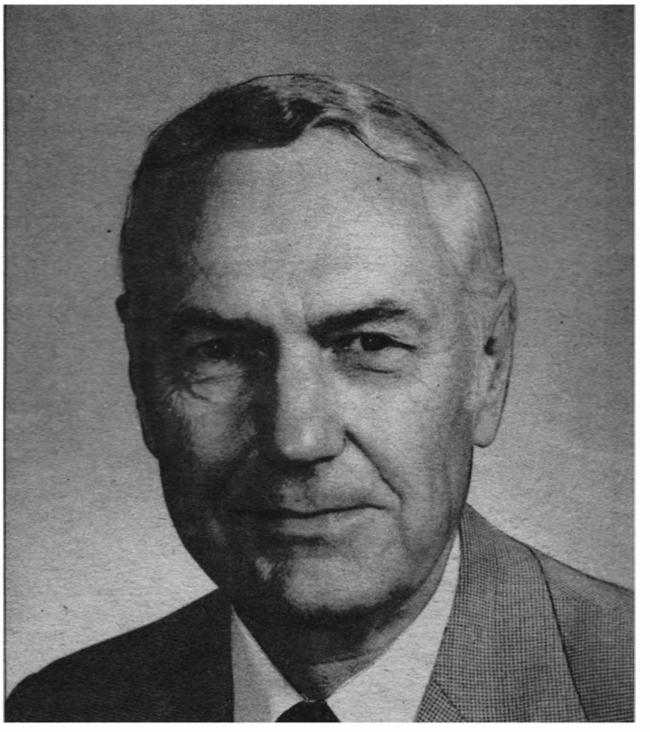
I believe it highly likely that before the first decade of the next century is out, we will, indeed, return to the Moon. We will do so not only to mine its oxygen-rich rocks and other resources but to establish an outpost for further exploration and expansion of human activities in the Solar System, in particular, on Mars and the near-Earth asteroids.

Now that the Shuttle is proving to be the reliable and versatile machine its designers intended, we will use it to help meet our next major challenge. This will be to develop a permanently manned Space Station in low Earth orbit within a decade, as the President directed us to do.

We expect that, by the year 2000, the Space Station will be equipped with a supporting infrastructure that will enable us to operate routinely at both low Earth and geostationary orbits and between them; and, eventually, at distances as far as the Moon and the inner planets. Two key elements of this infrastructure will be reusable and might be compared to a local taxi and an intercontinental airline.

The former is called the Orbital Manoeuvring Vehicle. It will be used to service satellites close to the Space Station and for other tasks. The latter, known as the Orbital Transfer Vehicle, will ferry payloads to and from geosynchronous orbit or launch spacecraft to the Moon and other points in the Solar System.

This enabling technology will permit us to engage in a variety of manned and unmanned activities in space. It will spur exploration and the commercial use of space. It will invigorate Earth applications and stimulate sustained research and development on innovative systems and



NASA Administrator James Beggs. *NASA*

techniques. It could also trigger extensive initiatives to benefit life on Earth, such as satellite power systems and nuclear waste disposal systems in space. It will be the key to future more ambitious missions, such as a manned mission to Mars, the capture of an asteroid, or large automated deep space and planetary probes.

One of those missions could very well be the establishment of a permanently manned lunar base. Many crucial considerations - technical, scientific, political, economic and social - will guide future public policy decisions on a permanently manned lunar base. I'd like to single out just three. First, what should we be doing, if we establish permanent roots there, to make our presence most productive and beneficial for mankind?

Next, we know that any enterprise of the magnitude and scope of a permanently manned lunar base would be an enormous challenge. This implies even greater international cooperation and international sharing of risks and benefits in the future.

In this connection, we expect our friends and allies to accept President Reagan's invitation to join with us in developing the Space Station. Such cooperation could lay the groundwork for even greater international collaboration in space for the future.

A third consideration is technological. If we were to mine the Moon, how would we go about it? Many methods have been proposed but none have been proved.

At present, we know how to extract valuable materials from ore deposits on Earth, but Earth's ore deposits are unusual in that their valuable elements are highly concentrated and relatively easy to extract. Moon rocks and meteorites are different. Their key elements are not concentrated and are hard to extract and we have no Earth-based technology at present that could do the job.

Clearly, such a technology will have to be developed if we are ever to mine the Moon. That's why we should begin soon, on a small scale and in a preliminary way, to study how to extract useful minerals from lunar rock and soil.

In space, as on Earth, there are rich dividends and enormous benefits for those who are able to muster the resources, know-how and vision to follow their dreams.

Space - A New Beginning

Sir, Engineering has always been a significant factor in the crossing of frontiers, the meeting of different peoples and the increase in understanding between nations. This is nowhere more evident than in space engineering.

In the space business the need for a highly professional approach is clear. It is a paramount ingredient for success, to which one has to add enthusiasm, motivation, vision and some boldness in the commercial area. Brunel would surely have been in the front ranks had he lived in the Space Age.

All these factors contribute to making space activity a significant positive contribution to understanding between nations.

The tentacles of the space business spread across a vast number of disciplines and countries. In so doing they bring together diverse interests and nationalities and stimulate the young. This is, I suggest, a significant and healthy factor for the future which those who have been amongst the first in this area of human endeavour have always hoped would happen.

In the course of 20 years in the business, I have met people in many diverse fields, ranging from university scientific communities to the large list of establishments and their various committees. The great space enterprise embraces a wide range of different groups drawn into this exciting business. Besides hardware manufacturers, communications satellites bring in other disciplines, while the entertainment industry adds yet more, to which should be added national and international organisations as well as those in the fields of legal expertise, insurance, banking and entrepreneurs of all sorts.

In due course, social activities tend to follow. One such example, starting from relatively humble beginnings, is the annual 'Ariane Cross.' It consists of several medium distance races for juniors, seniors and veterans of both sexes and is held at the various Ariane project contractors.

It is now a professional affair with well organised races and trophies awarded for each event and with a main prize for the winning team. The UK team have participated for the last five years or so with considerable success, having won the team event on occasion and usually managing to win one or more of the individual events. There is tremendous competition among participants. Last year, for example, there were over 500 runners and about 600 people attending.

The most sceptical reader should agree that an old dream is, indeed, coming true. Nowhere is this more apparent than the latest example in the initiative of President Reagan with the US Manned Space Station. This could develop into a powerful political initiative for a joint endeavour in space and almost certainly lead to the provision of various parts of the Space Station by Europe, Japan and Canada, with contributions to a joint programme and an operational structure involving European, Japanese and Canadian personnel.

PETER CONCHIE
Director, Business Development
British Aerospace Dynamics Group
Space & Communications Division

The Editor is always interested in receiving items of correspondence, notes, comments, or reviews for possible publication. Items submitted must be kept brief, owing to the limitations of space in our magazine. The Editor reserves the right to shorten or otherwise adapt material to fit, for this reason.

Soviet Launch Vehicles

Sir, I read with astonishment (*Spaceflight*, November 1984) about the Soviet so-called Heavy Lift Shuttle. Simple computations show that the payload (if launch mass/thrust are correct) to 180 km orbit will be 30 ± 10 tonne with the lower regime more likely. Possibly the 96+ tonnes quoted refers to the total mass orbited.

The other two new launch vehicles are, at least, consistent, but I wonder if the Medium Vehicle makes sense. It is very similar in performance to the Proton launcher.

Direct discussion with Soviet engineers produced the following information:

1. The Cosmos test model is purely for research/ technology and is not connected with a specific follow-on project.
2. The Heavy Lift Shuttle does not exist (other than in several conceptional plans) of which the design shown is jut one of the configurations studied.
3. No decision has been made to use H_2/O_2 propellants.
4. The Heavy Lift Launch Vehicle is real.

This information, to me, has the ring of truth, but we shall see.

PROF. HARRY RUPPE
Technical University, Munich
W. Germany.

Lunar Rover

Sir, I came across a mention recently to plans to convert the American Surveyor lunar soft-lander into a rover to move around the Moon under control from Earth. Can you shed any further light on this?

RAY SWEETMAN
London

Reply:

There was a firm intention to produce a Surveyor-type lander with wheels several years before the Soviets used their Lunokhod vehicle on the Luna 17 and 21 missions. The photograph shows a full-scale working model. Delays in the Surveyor/Centaur programme (the final landing was made by Surveyor 7 in 1968) pushed the rover so far back that the imminent Apollo landings made it unnecessary. The Surveyor rover is described in the paper 'The Making of a Moon Rover' by Dr. M. Bekker in the next 'Astronautics History' issue of *JBIS*.

US Navy Satellite

Sir, Regarding the letter (*Spaceflight*, 1984, p.392) on the US Navy satellite, I feel that the identification of 83-08B might be in error.

When the USAF announced that an Atlas had been launched on 9 February 1983 from Vandenberg, myself and G.E. Taylor undertook a programme of optical observation of the two objects being tracked (83-08A and B) in order to determine whether or not this was a follow-on Noss after a three year gap, or a completely new version. On 16 February, after earlier nights of unsuccessful sightings, the A and B pieces were seen at magnitude +7 steady, at a range of 1200 km, 60 degrees

in the East. No other pieces were seen while the payload and rocket (Burner derived?) were in view. In comparison with earlier Noss observations, the magnitudes tied in well with previous launches.

If LIPS had been deployed from 83-08A, then surely it would have been tracked almost immediately after launch, instead of on or before February 20th, when the C piece appeared. My own thoughts are that, although the Navy object may have gone up on this launch and be hidden among the debris, a far more likely candidate is 84-12, where NORAD have catalogued up to the L piece at present, slightly more than usual for a recent Noss cluster.

MAX WHITE
Satellite Camera Team,
Royal Greenwich Observatory

Mercury and Gemini Pictures
Sir, During the last Mercury mission (May 1963), a TV camera was used for the first time on an American manned space flight. The pictures of Gordon Cooper were said to be hazy and possibly, because of this, they have never been used in books. Or have they?

During the Gemini 10 mission, Michael Collins did a space walk to the Gemini 8 Agena docking target but the films were of poor quality and they were not widely seen. It would be interesting to see stills from this film.

JOHN COLLIER
California, USA

Reply:
Michael Collins, in his autobiography, points out that he took some very spectacular pictures during his EVA. The only problem was that he then lost the Hasselblad camera, which thus became the first Swedish satellite in orbit!

On Gordon Cooper's flight in 1963 the 5 kg TV camera was used to transmit picture s of the astronaut's head area for medical observers. It was used for less than a total of two hours since only three ground stations were equipped to receive the signals. Some pictures were used by the TV networks.

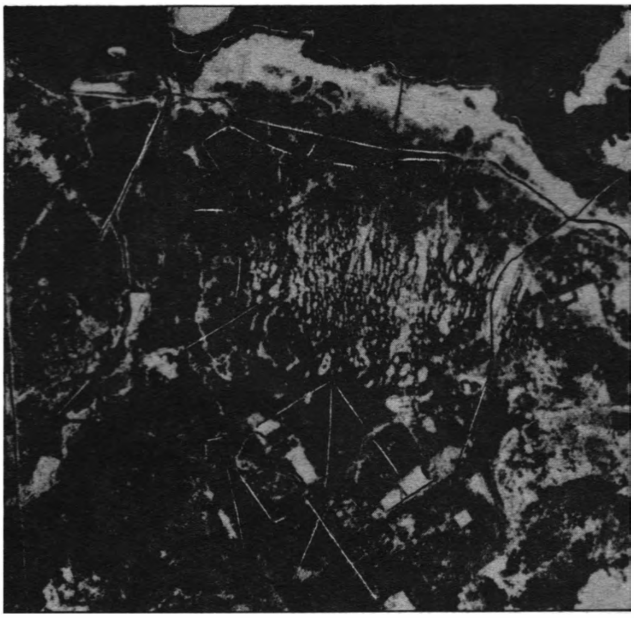
Get it Right!
Sir, I still occasionally hear space lecturers refer to 'Cape Kennedy!' The media often get this wrong but we can hardly complain when those who should know do so too. The name of Cape Canaveral, which was changed to Cape Kennedy after the assassination of President Kennedy in 1963, was reinstated in 1973.

I wish the media would also note that Kourou is in French *Guiana,* not French *Guyana.* No doubt this confusion arose because when the neighbouring colony of British Guiana became independent it took the name of Guyana.

RAY WARD
Sheffield

Confusion sometimes arises because the name 'Kennedy Space Center' is, of course, in use. We have heard people within NASA itself refer to Cape Kennedy! -Ed.

Archaeology from Orbit?
Sir, I am a keen observer of both the archaeological and space scenes and am wondering if archaeologists have



The Shuttle Imaging Radar carried on mission STS-2 in November 1981 probed below the sands of the Sahara to reveal ancient river beds. This is an area in central Florida. Mission 41G in October 1984 carried a more advanced version of the radar capable of resolving finer detail. *NASA*

used images taken from orbit for their work. I know that the radar carried on one of the early Shuttle missions discovered ancient riverbeds under the sands of the Sahara but have satellite images yet been used in the same way as aerial photographs?

MAX WHOLEY
Midhurst, Sussex

Reply:
We know of no specific cases where satellite images have been used for small-scale studies, e.g. tracing the outlines of old buildings, as have aerial pictures. The normal resolution of Earth resources satellites is probably too poor for this type of activity - the military level of capability would be necessary. We would be interested to know if readers have any additional information.

SNIPPETS

It's the Best!
Sir, In my three years as a Society member this is the first time I have written to you. On receiving my renewal form recently, I realised what a bargain it is to be a member - £21 a year for the superb *Spaceflight* magazine, and the opportunity to attend Society meetings.

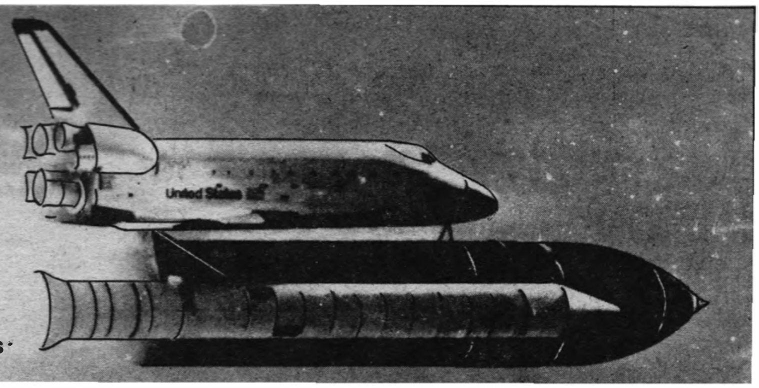
MICHAEL PHILLIPS
Gillingham

Coincidence?
Sir, When the 51C Shuttle mission was postponed until early 1985 that made a total of five Shuttle missions in 1984 - four less than planned. A pattern of one extra flight each successive calendar year seems to be emerging. Two for 1981, three for 1982, four for 1983 and five for 1984. I wonder if the pattern will be continued in 1985, with six flights regardless of the 13 or so planned. If so, at this rate NASA's goal of 24 missions per year will not be realized until AD 2003!

IAN KNOWLES
Leeds

SPACE REPORT

A monthly review of space news and events



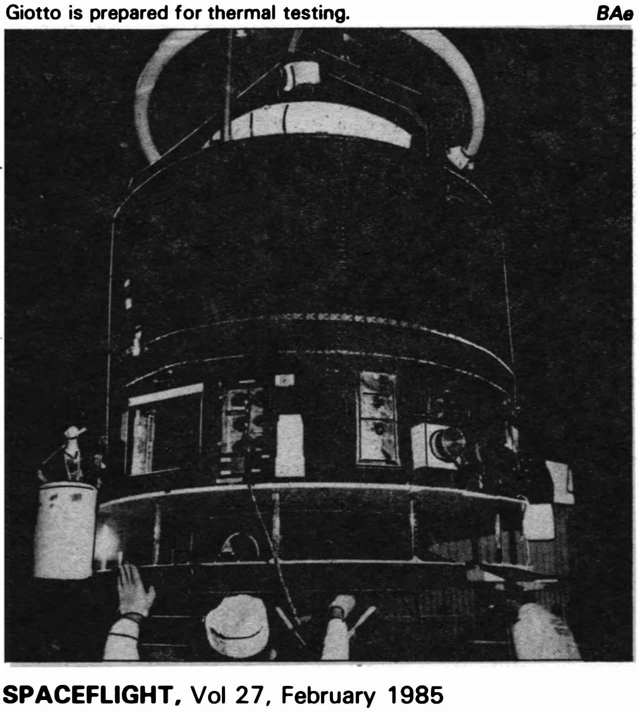
SPACE PROBES

GIOTTO UNDER TEST

The Giotto Halley's comet probe completed its thermal tests at the Centre Spatiale de Toulouse last November in preparation for launch in July. The environmental test programme, consisting of solar simulation, thermal vacuum, acoustic and vibration tests, began last August. Following completion of the thermal work, Giotto entered the final phase with spin balance and demagnetisation tests. Delivery to the European Space Agency's Technology Centre at Noordwijk, is scheduled for early spring and shipment to Kourou in French Guiana will be made during the second half of April.

All of the environmental tests were conducted on the completed flight spacecraft. During solar simulation tests, which lasted for 15 days, the spacecraft was spun at a rate of 10 rpm in a vacuum chamber and positioned at different angles to simulate the thermal rigours of launch, cruise and encounter with the comet. The behaviour of the thermal design was monitored throughout by 300 thermocouples. To prove the mechanical design, the acoustic and vibration tests simulated the conditions of the Ariane launch vehicle. The acoustic work was conducted in a special chamber at noise levels greater than those the human body can tolerate to represent the roar of Ariane's engines.

Giotto is prepared for thermal testing. *BAe*



SPACE SHUTTLE

DELAY OF 51C

Shuttle mission 51C, carrying a classified US Dept. of Defense payload, was delayed from the original 8 December launch target because of problems with the thermal tiles. The decision was made on 5 November to replace up to 2,800 thermal protection tiles on the underside of *Challenger* because of the degradation of the bonding material.

When *Challenger* returned from space on its last mission in October 1984, a black tile from the left wing chine area, just behind and below the crew door area, was missing. About 100 tiles were removed and it was found that the adhesive substance known as 'screed,' used to smooth irregularities in the surface of the Orbiter, had softened. This white, Room Temperature Vulcanizing (RTV) material is used in much the same way that body putty is used on a car. It hardens and can be sanded smooth after it dries.

The screed is used on areas of the body of the Orbiter, such as the underside of the fuselage, body flap, elevons and the sides. It is applied directly over the aluminium skin. All other areas are covered with a primer called red RTV-560 which is used as an adhesive for bonding the strain isolation pads (SIP) to the body and the tile to the SIP.

The NASA crew of Tom Mattingly (commander); Loren Shriver (pilot), Ellison Onizuka and James Buchli (mission specialists) will be joined by USAF specialist Gary Payton as the first of a group of non-NASA astronauts dedicated to Dept. of Defense missions. This will be the first Shuttle mission to use the Inertial Upper Stage since the failure during STS-6 in April 1983. Its payload remains classified.

51C: the Dept. of Defense classified mission originally scheduled for 8 Dec. 1984 was slipped to 22 Jan. *Discovery's* crew is Mattingly, Shriver, Buchli, Onizuka and Payton.

51B: *Discovery* should have flown in January with Spacelab 3 but now moved to April with its crew of seven.

51E: the launch of the second TDRS communications satellite will still go ahead for 18 February, with astronauts Bobko, Williams, Seddon, Hoffman, Griggs and Frenchman Patrick Baudry.

51D: the release of a Leasat communications satellite and the retrieval of the LDEF left in orbit by 41C last April is still scheduled for 18 March with astronauts Brandenstein, Creighton, Lucid, Fabian, Nagel and Jarvis.

Later flights will also be affected; information will be published in *Spaceflight* as it comes to hand. The dates given above were current at the end of November 1984.

SHUTTLE ASSIGNMENTS

NASA has named five astronauts for Shuttle mission 51I, scheduled for August, and changed one previously announced assignment on another flight.

Mission 51I will be commanded by Robert Gibson, who served as pilot on 41B. Charles Bolden will be his pilot. Mission specialists are Drs. Franklin Chang-Diaz, Steven Hawley and George Nelson. 51I will be Chang-Diaz's first trip into space; Hawley was a mission specialist on 41D and Nelson flew on flight 41C to rescue the Solar Max satellite.

The seven-day mission, using Orbiter *Columbia,* will carry two communications satellites, Syncom IV-4 and the American Satellite Company's ASC-1, and a materials processing experiment designated MSL-2.

in a crew change, Roy Bridges has replaced David Griggs as pilot on flight 51F (Spacelab 2) in July 1985. Griggs has also been assigned as a mission specialist on flight 51E in February. The change was made because the proximity of those two flights allowed insufficient time for training.

Flight 51E will carry the second Tracking and Data Relay Satellite (TDRS) and another communications satellite, Telesat I. Flight 51F is the Spacelab 2 mission.

CRIPPEN APPOINTMENT

Astronaut Robert Crippen, who completed four Shuttle missions with 41C last April, has been named as the deputy director of flight crew operations at Johnson Space Center. George Abbey continues as director. Crippen will remain on active flight duty. A US Navy Captain, he was pilot of STS-1 and commanded STS-7, 41C and 41G. He joined NASA in September 1969 after three years of duty with the US Air Force's Manned Orbiting Laboratory programme.

TEACHER IN SPACE

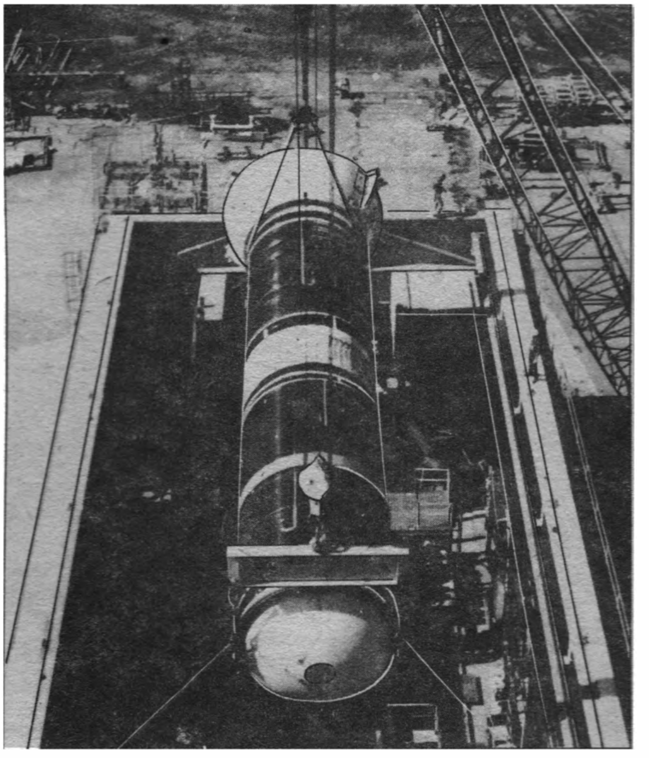
President Reagan's proposal to carry a schoolteacher in an early 1986 Shuttle flight had produced 6,000 enquiries by the end of last October, according to Alan Ludwig who is in charge of the project for NASA. The agency expected to make a formal announcement in November. Applications will be received until 1 February. To be eligible, a candidate must be a US citizen and a full time teacher at elementary or secondary level. He or she must be in 'reasonably good health and be able to walk on and off the Shuttle without help.' Blood pressure must be under 160, vision corrected to 20/40 in one eye and the person must be able to hear a whispered voice at a distance of 1 m. Applications will be screened by the Council of State School Officers Association, after which the chief educational officer of each stage will select nominees. They will attend a workshop, after which a national peer group will recommend 10 semi-finalists by July 1985. This group will undergo tests at Johnson Space Center and the field will be narrowed to five. NASA Administrator James Beggs will choose a primary and backup in September 1985 for eight weeks of training.

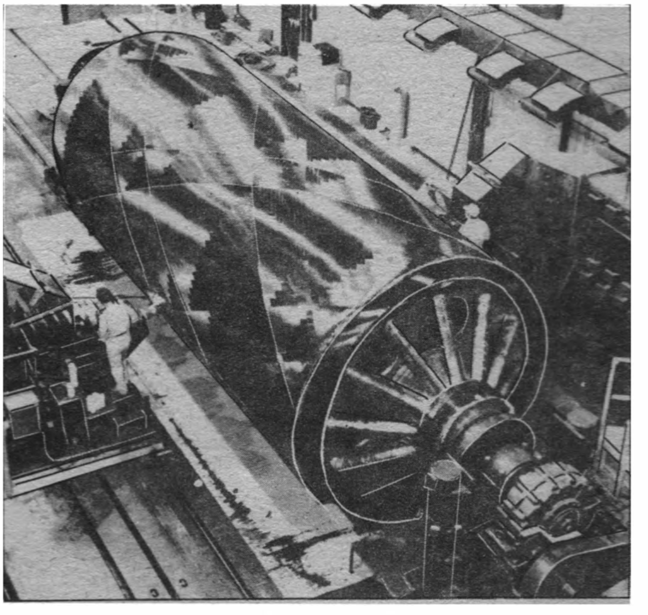
SHUTTLE PARACHUTES

Larger main parachutes were a part of the Shuttle solid rocket booster's deceleration system during mission 51A, launched on 8 November 1984. The main 'chutes are designed to slow the boosters down for a safe descent into the ocean.

The new parachutes are 41 m in diameter, compared to previously-used 35 m 'chutes. According to Keith Henson, booster recovery subsystem manager in the Shuttle Projects Office at NASA's Marshall Space Flight Center, the larger versions reduce the impact velocity from 97 km/hr to 82 km/hr in order to relieve the structural loads by about 25% thus reducing the damage.

Three main parachutes are used on each booster.





The first firing test of a new light-weight Shuttle booster was carried out on 25 October 1984. The casing is a composite material of plastic reinforced with graphite fibres wound into a cylinder. Each booster thus weighs about 13,600 kg less than the older steel versions, allowing the Shuttle to carry 2100 kg more payload. Two firing tests are planned for 1985 and the first flight is intended to be from Vandenberg Air Force Base in October. The steel versions will continue to be used in missions where weight is not critical. *NASA*

Following launch and separation from the Shuttle, the boosters are recovered from the ocean, refurbished and used on a later flight.

According to Henson, the larger 'chutes were tested during mission 41D in August 1984 on the right booster. Beginning with mission 51B, scheduled for early 1985, all future steel case boosters will have the larger 'chutes.

Smaller main 'chutes will continue to be used on some missions, including the 51C mission in January and on missions where lighter-weight filament wound booster motor segments are flown. First use of those segments is planned for October 1985.

SATELLITES

ARIANE 3 LAUNCH SUCCESSFUL

The second launch of the more powerful version of the European launcher, Ariane 3 was successfully completed on 10 November 1984 carrying two communications satellites, Spacenet 2 and Marecs B2. The Marecs satellites allow transmission of high quality voice and data services between ships at sea (about 3000 at present) and shore stations connected to the terrestrial telephone network. This also includes the relaying of ship to shore search and rescue messages. The first of the series was successfully launched by Ariane L04 on 19 December 1981 and has since been providing maritime communications services over the whole of the Atlantic Ocean region. Marecs 1 was lost because of the Ariane L5 launch failure; Marecs B2 is its replacement. Spacenet 2 is a commercial US satellite.

SUCCESSFUL NOAA LAUNCH

The NOAA 9 meteorological satellite was launched from Vandenberg Air Force Base in California on 1 December 1984 into an 870 km polar orbit. The NOAA satellites, apart from imaging weather systems, collect meteorological readings and transmit the information directly to users around the world for local weather analysis and forecasting. Information is used for hurricane tracking and warnings, agriculture, commercial fishing, forestry, maritime and other industries.

Special instrumentation was carried as part of an international, life-saving programme that makes use of satellites to rescue people from crashed aircraft and ships in distress. The project, with primary participation from Canada, France, the Soviet Union and the US started in September 1982 and has saved about 300 lives.

NOAA 9 is the latest in a series of RCA-built Tiros weather satellites dating back almost 25 years to Tiros 1, launched on 1 April 1960. It is the sixth in the current series of 11 satellites developed to give scientists comprehensive meteorological and environmental information. It was built at a cost of $43.5 million, with an additional launch vehicle cost of $11.4 million.

Tiros N (Television and Infrared Observation Satellite) was the first in a series of third generation operational environmental satellites. It was launched on 13 October 1978 and was a research and development prototype for the operational follow-on series, NOAA A to G. Advanced instruments measure parameters of the Earth's atmosphere, its surface and cloud cover, solar protons, alpha particles, the electron flux density, the energy spectrum and the total particular energy disposition at the satellite altitude. As part of its mission, the satellite also receives, processes and retransmits data from free-floating balloons and remote observation stations around the globe.

NOAA 8, launched on 28 March 1983, performed satisfactorily until 12 June 1984 when difficulties arose with its master clock. Complete disruption of the attitude control system occurred on 30 June, leaving the spacecraft tumbling and unable to relay signals to Earth effectively.

CHINA DBS DEPOSIT

NASA has received $200,000 'earnest money' from the Chinese Broadcasting Satellite Corp. for launch reservations in January and September 1988 for two domestic direct broadcast satellites.

On 29 October 1984 NASA Administrator James Beggs met senior members of a CBSC delegation in the US to discuss the procurement of satellits and launch services. The group also observed the launch of Shuttle Misison 51A and visited the Johnson Space Center in Houston.

OTHER NEWS

SPACE STATION STUDY

Lockheed is working under a $1 million contract from NASA to define ways to improve crew performance aboard the Space Station. During the nine-month study, Lockheed will design several crew facilities and will identify operations and training requirements needed to support crew activities.

'Early understanding of how men and women will live and work aboard a Space Station is an essential ingredient in defining how the facility should be developed,' says Bob Marcellini, Director of Space Station Programs at Lockheed.

SPACE STATION BIDS

NASA has received 13 proposals from US industry for definition and preliminary design of the Space Station in response to a Request for Proposal issued on 14 September 1984. The deadline was 15 November.

The request contained four 'work packages' covering definition and preliminary design (Phase B) of Space Station elements. NASA plans to let competing contracts for each of the work packages by 1 April.

This listing below includes the members of each team, with the leaders given first:

Work Package One: Marshall Space Flight Center. Definition and preliminary design of pressurised 'common modules' with appropriate systems for use as laboratories, living areas and logistic transport; environmental control and propulsive systems; plan for equipping a module as a laboratory and additional ones as logistics modules; and plan accommodations for orbital manoeuvring and orbital transfer vehicles.

Boeing-Teledyne Brown Engineering; General Electric; Vought; OAO; Thermacore; Garrett; Hamilton Standard; Life Systems; Lockheed, Umpqua; Perkin-Elmer; Fairchild; Aerojet; Rocketdyne; Rocket Research; Eaton; Sundstrand; Westinghouse; Rockwell Autonetics; TRW; Computer Tech Associates; Hughes; Telephonics; Camus.

General Dynamics-Grumman; Hamilton Standard; Life Systems; Ford Aerospace; TRW; Ball Aerospace; Computer

Sciences; Otha C. Jean & Associates; Aerojet, Honeywell; RCS; Rocketdyne; SPAR Aerospace; Sperry; Telephonics.

Martin Marietta-McDonnell Douglas Technical Services; Hamilton Standard, Honeywell; Hughes; Hercules; Wyle Labs.

Work Package Two: Johnson Space Center. Definition and preliminary design of the structural framework to which the various elements of the Space Station will be attached; interface between the station and the Shuttle; mechanisms such as the Remote Manipulator Systems; attitude control, thermal control, communications and data management systems; plan for equipping a module with sleeping quarters, wardroom and galley; and plan for extravehicular activity (EVA).

Lockheed-TRW; Bendix; Hughes.

McDonnell Douglas - IBM; Honeywell, RCA; Ball Aerospace; Computer Sciences; Design West; Communications and Data Systems Associates; Eagle Engineering; Essex; Fluor; Ford Aerospace and Communications; Hamilton Standard; ILC Space Systems; SPAR Aerospace; LTV Aerospace and Defense.

Rockwell International - Grumman; Harris; Sperry; Intermetrics; SRI International.

Work Package Three: Goddard Space Flight Center. Definition and preliminary design of the automated free-flying platforms and of provisions to service, maintain and repair the platforms and other free-flying spacecraft; provision for instruments and payloads to be attached externally to the Space Station; and plan for equipping a module as a laboratory.

General Electric - TRW; Essex; Integrated Systems Analysts; Perkin-Elmer; SPAR Aerospace; Teledyne Brown Engineering.

RCA-Lockheed; Ball Aerospace; Computer Sciences.

Work Package Four: Lewis Research Center. Definition and preliminary design of the electrical power generation, conditioning and storage systems.

Garrett-Acurex; Advanco; University of Houston; Electro-Space; Mechanical Technology; Thermo Electron; LTV Aerospace and Defence; EBASCO Services; GA Technologies; Lockheed.

Rocketdyne-Sundstrand; Ford Aerospace and Communication; Harris; Lockheed; Spectralab; Acurex; Georgia Tech.

TRW-General Electric; Grumman; General Dynamics; Perkin-Elmer; United Technology; Merchanical Technology; Life Systems.

Other Proposals:
Natural Energy Systems-ODC, Inc. J.C.
J.C. Gadouy

In addition, the request also requires contractors to study how those elements of the Space Station would change were the station originally man-tended rather than permanently manned. Contractors will also be expected to pay particular attention to recommendations of the NASA Advanced Technology Advisory Committee, which is identifying automation and robotic technologies that could be used.

Following completion of the 18-month definition and preliminary design contracts, NASA intends to move, in 1987, into final design and development. Proposers for the definition and preliminary design phase must have the capability to perform and manage the design, development and test phase (Phase C/D) of their appropriate work packages.

MILESTONES

October 1984

31 Japan's first deep space antenna is completed. It will be used to communicate with the Halley's comet probes, MS-T5 and Planet-A.

November 1984

1 The optics for the Hubble Space Telescope, due for launch in 1986, arrive at Lockheed's plant in California for integration with the rest of the telescope.

4 The Nato 3D communications satellite is launched by the 177th Delta rocket from Florida. No further Deltas are scheduled until mid-1986.

5 The military Shuttle mission originally due for launch on 8 Dec. will carry the first of a new batch of astronauts dedicated to such flights. The four-man NASA crew will be joined on 51C by USAF Major Gary Payton; they will launch a classified satellite. *Challenger's* launch time will not be announced in advance. The flight has been delayed to mid-Jan. from 8 Dec. because of problems with the thermal tiles.

5 A stuck bearing on a scanning mirror has been freed aboard the US GOES 1 weather satellite, launched in 1978.

10 Ariane VII, the second 3 version, successfully orbits the Spacenet 2 and Marecs B2 communications satellites.

16 Shuttle *Discovery* lands at KSC to end the 51A mission after 7 d 23 h 45 m; the first to recover satellites. Westar and Palapa will be returned to the Hughes Co. in California for refurbishment and then relaunch. The insurance owners expect to sell them for $30 million each; NASA was paid $10 million for the rescue.

19 NASA has received 13 proposals from US industry for definition and preliminary design work for the Space Station. Contracts are expected by 1 April.

19 NASA's Johnson Space Center has formed an 'Artificial Intelligence and Information Science Office' in support of the Space Station.

19 Model of BAe Olympus communications satellite, due for 1987 operations, successfully completes thermal testing.

20 All of the Systems aboard the Marecs B2 maritime communications satellite have now been switched on and are working satisfactorily.

26 Giotto, the Halley's comet probe, has completed thermal vacuum testing at the French space agency's facility in Toulouse. Giotto is expected to be shipped to the launch site next April.

26 The Ariane 1 rocket carrying the Halley's comet probe, Giotto, next July will see the first attempt at recovery of the first stage. ESA hopes to be able to reuse some components in future versions, including the liquid-propellant boosters of Ariane 4.

26 Astronauts Crippen and Gardner will pilot the first Shuttle flight from the Californian coast next October.

Please note that some of the dates quoted above refer to the announcements of the events and not necessarily to the events themselves.

By Gordon L. Harris

ALTERNATIVE VIEWS

The continuing struggle by the US Congress to influence, if not to dictate, US space policy took a new direction when the Office of Technology Assessment said there should be no commitment to a Manned Space Station until the country defines long-range goals in outer space. Supposedly non-partisan, OTA depends upon congressional support for its existence and funding. The 1984 election, which gave President Reagan an overwhelming vote of confidence, failed to dislodge the Democratic majority controlling the House of Representatives and OTA.

The office released a pp.230 report on 13 November (one week after election), concluding that potential uses outlined for the $8,000 million station pursued by NASA do not justify the cost and effort. 'Because the nation does not have clearly formulated long-range goals and objectives for its civilian space activities,' the report said, 'proceeding to realize the present NASA space station concept is not likely to result in the facility most appropriate for advancing US interests into the second quarter century of the Space Age.'

Thomas Rogers, OTA consultant, emphasised the study's proposal for a broad public debate on national space objectives. No such debate has ever taken place. President John Kennedy caught the public's imagination in 1961 with his call for manned landings on the Moon without the sanction of prolonged discussion or debate.

Rogers said 'it is most important that the general public play a much broader and active role in articulation of programme goals. What alternatives had the public been provided with? Essentially none. We think that's a shame. NASA may be on the best course, but there is a completely different course that has not been explored or debated.' He added that the $150 million NASA is spending over the next 18 months for Space Station design will be a good investment regardless of Congress' decision on future funding.

The OTA report cited 10 'goals' for consideration ranging from a worldwide disaster warning system to a 'modest human presence' on the Moon. OTA spent two years on its study with an advisory panel of engineers and scientists at the request of Congressional committees.

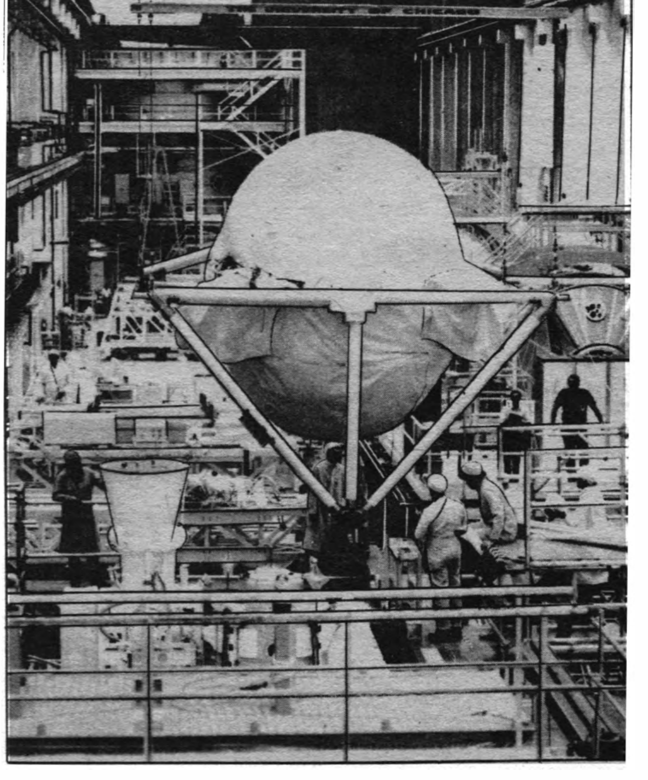
President Reagan directed NASA in January 1984 to develop a station that could be in orbit by the early 1990's. Opponents expect resistance when NASA asks for more money next year.

OTA thinks the National Commission on Space created by Congress last year should take the lead in sponsoring a national debate on space planning. The Commission was an obvious attempt to offset the National Space Council report to the President. A less ambitious orbiting station could be used to store fuel and supplies, launch voyages to the Moon or planets and permit testing new instruments and activities, according to the study.

The report observed that, 'Automated facilities capable of supporting many activities will not be available before 2000 AD even if a large automation program is begun immediately.' As a starting point for debate, OTA suggested reduction of unit cost of space activities, direct public involvement, increased international cooperation, and exploration of the Solar System. The space agency, said OTA, should look at reducing cost by changing procurement methods to encourage investment by foreign governments and private interests.

Some NASA officials were less than pleased by OTA's comparison with the Soviet Salyut, concluding that a US 'Salyut' could be flown for one-third the price tag of NASA's design. 'A USA version that approximates Salyut 7 could be assembled using essentially existing or currently under development technology (Spacelab modules and a service module composed of Eureca or Leasecraft-type power and attitude controls),' the report said. Eureca is the European Retrievable Carrier satellite, while Leasecraft is a commercial orbiter being developed by Fairchild. OTA drew upon a 1982 'minimum cost' Space Station studied by NASA's Marshall Space Flight Center. OTA also cited extended duration Shuttle Orbiters that would sustain a five-man crew for 20-50 days and a free-flying Spacelab with a three-man crew resupplied at 60 to 90-day intervals. MSFC found that a 50-day orbiter could be developed in five to 10 years for $1,500 million. Another $1,000 million would be needed to sustain 12 dedicated 30-day missions. OTA priced its Salyut type at $2,000 million.

The two tonne cosmic ray detector for one of the 12 major astronomical experiments on Spacelab 2 is moved into position. The flight, until recently scheduled for April, might now have to wait until July or later because of the slippages caused by *Challenger's* thermal tile problems.



NASA'S FUTURE PLANS

Some NASA supporters have criticised the agency for failing to define long term goals. The current administrator, James Beggs, silenced critics for a while at least when he predicted that the US would return to the Moon by 2010. His statement came at a symposium conducted by the National Academy of Sciences on lunar bases and space activities in the 21st Century.

Speaking of the lunar goal, Beggs said 'We will do so not only to mine its oxygen rich rock and other resources but to establish an outpost for further exploration and expansion of human activities in the Solar System, in particular on Mars and near-Earth asteroids.' Beggs said that the Space Station of the 1990's will serve as a departure point for lunar exploration.

A little-known report issued by a University of California workshop in mid-1984 urged a 'permanent lunar base to use the Moon as a platform for astronomical, solar and plasma observations and a place to do scientific experiments that cannot be done elsewhere... industrial development is a compelling component of lunar base (to test) our ability to adapt resources of space for our needs in space.

Dr. George Keyworth, science advisor to President Reagan, and Alaska Governor Walter Hickel also addressed the Washington meeting. Keyworth described the Shuttle as 'the beginning of the maturing phase of space technology.' He identified three major questions confronting the nation: 'Are our grand exploration days just beginning, or will we spend our time consolidating our gains, or do a combination of both?' He suggested 'we may have to do both,' cautioning the symposium that we must decide where to go after a Space Station and lunar base exist and what impact they may have on Earth.

A former Interior Secretary, Governor Hickel said that 'as a newcomer to the space programme I was appalled to find out we've dismantled the tools and, more importantly, a collection of minds who built the Saturn moon rocket.'

PAGE RETIRES

George Page, KSC deputy director since June 1982 and launch director for the first three Shuttle missions, has retired from NASA. Page joined the agency in June 1963 as spacecraft test conductor for Gemini; he held the same position during Apollo. Later he served as chief of the spacecraft division for Apollo, Skylab and Apollo Soyuz launch operations, director of expendable vehicle launch operations, director of cargo operations and Shuttle operations director. He received numerous awards for outstanding service.

TAXING ISSUES

Incentives offered to US industry in the form of tax credits, deductions and depreciation do not extend to space - a situation that hinders private enterprise interested in utilising Shuttle missions for profit. Richard Sussman, tax specialist for Fairchild Industries, observed that unless there is a change, it is fair to say that US space-based businesses will never get off the ground. Fairchild and McDonnell Douglas are trying to promote orbiting laboratories and are lining up prospective clients. The Internal Revenue Service insists that firms can claim only deductions and credits for investments whose 'physical location' lies within the US borders. Thus Sussman says Fairchild's proposed $80 million Leasecraft orbiting factory would be subject to heavy taxation: no credit on new equipment (10% is allowed on Earth). Nor do space stations qualify for the five-year depreciation allowed on equipment. The question of how to treat products developed in space has not been resolved. The Commerce Department thinks they would be imports and subject to duties, and when NASA carries a commercial item free of charge in a Shuttle, IRS considers the owner has received taxable income. The next Congress will take up these issues.

NEW SHUTTLE PASSENGER

NASA has invited US Senator Jake Garn (Utah Republican) to become the first public official to fly in a Shuttle. A retired military pilot, Garn expects to board an early mission as a payload specialist and will undergo training for his duties.

LAUNCH ATTENDANCE

Shuttle launches are becoming so routine that fewer people are accepting NASA's invitations to witness the events at the Kennedy Space Center. *Discovery's* liftoff on 8 November 1984, the 14th Shuttle flight, brought about 200 guests, most of them employed by firms that built the cargo. Arnold Richman, chief of visitor services, issued 1,500 passes admitting private vehicles to a vantage point on the causeway linking KSC with Cape Canaveral. The total was less than a third of normal. 'With so many launches people are starting to pick and choose which they want to attend,' Richman said.

SHUTTLE FACILITY

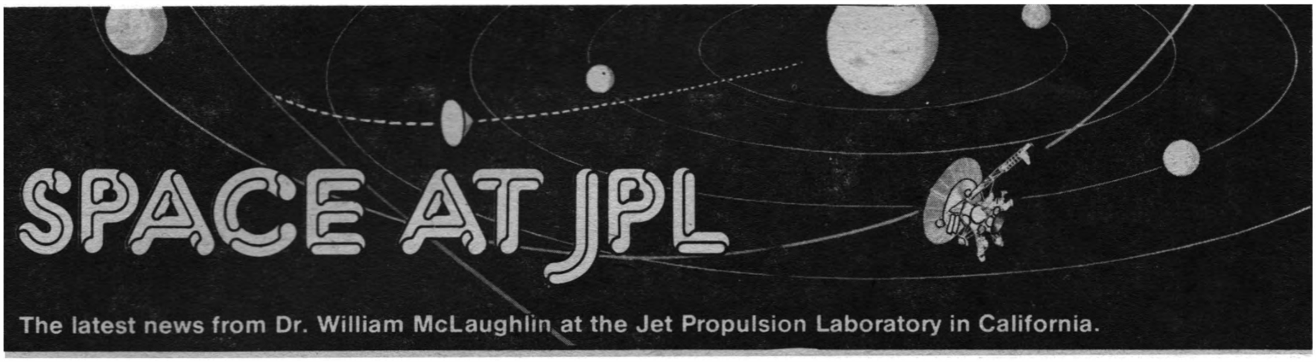
A new facility will be constructed at KSC by the Doster Construction Co., at a cost of $7,500 million. The new structure will include an airlock, high bay and clean room for processing hazardous Shuttle payloads.

LAUNCHER SERVICES

The Kennedy Space Center awarded the Computer Sciences Corp. an extension of a contract valued at $2 million to continue support work at the launch base until 30 September 1985. CSC furnishes instrumentation and computing services for the testing and launching of Delta, Atlas Centaur and Shuttle/Centaur vehicles.

DELTA LAUNCH

One of the few remaining Delta rockets carried the NATO 3D communications satellite off Pad 17A on 4 November. Originally scheduled for 18 October, the event was postponed to permit repair and replacement of four travelling wave tube amplifiers in the satellite.



HYPERVELOCITY IMPACT

One of the central achievements of the programme of Solar System exploration begun by NASA over 20 years ago has been the enormous increase in our knowledge of planetary structure. The most obvious area is the geologic processes revealed by surface imaging of, for example, volcanoes on Io, water-sculpted features on Mars and impact craters on terrestrial type bodies.

Knowledge of structural conditions below the surface, down through the planetary core, has also been augmented by space experiments. Observation of surface conditions and careful measurement of a planetary gravity field provide data for theoreticians to infer the state of the deep interior of a planet.

The pressures in the core are so great, however, that the attempt to model this region runs into the problem that very little is known about how common materials behave under extreme pressures. The advanced-concept review for this month looks at a proposed laboratory experiment to gain additional information on the behaviour of materials under high pressures. It seems fitting that this experiment should itself be conducted in a space laboratory.

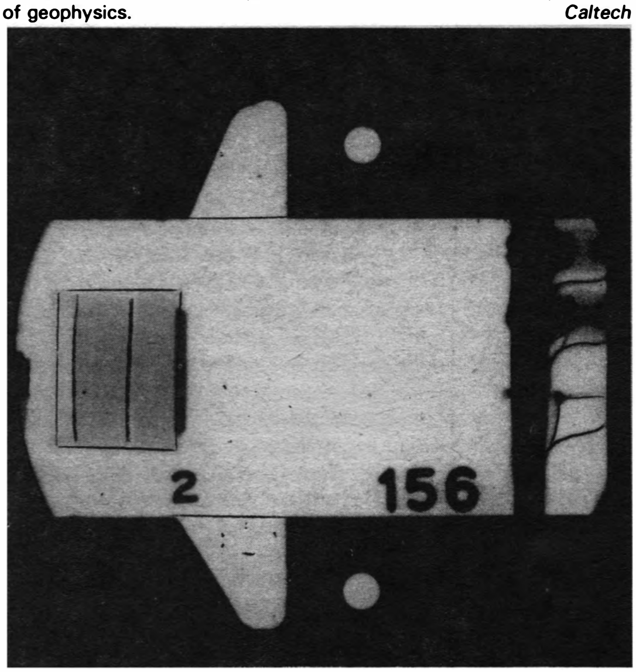
Dr. Thomas Ahrens is a professor of geophysics at Caltech and performs hypervelocity impact experiments in his terrestrial laboratory (the Lindhurst Laboratory of Experimental Geophysics) to study materials under high pressure. The larger of two 'guns' in the laboratory is capable of accelerating a 15 g projectile to 7 km/s (almost low Earth orbital velocity!) over a length of some 10 m. As the projectile hits the target plate at the end of the evacuated gun, a collection of electronic sensors measures the effects associated with the brief period of high pressure: about 10^{-8} sec. The pressure during this instant reaches some 4 megabars (a megabar is approximately equal to one million Earth atmospheres), which is close to the pressure at the centre of the Earth.

In order to extend these laboratory results to longer times and higher pressures, Ahrens has conceived an elegant experiment which would slam together two objects orbiting the Earth in opposite directions and measure the effects on the participating materials. The velocity of impact, approximately 15 km/s, would be twice orbital velocity and the pressure would reach an intense 20 megabars for the 'long' period of 10^{-4} sec. For comparison, pressure at the centre of Jupiter is about 30 megabars and at the centre of Saturn reaches some 20 megabars.

The experiment draws upon near-Earth resources in an efficient fashion: employing the high energy of orbiting objects and the vacuum of space, resources that are obtained only with considerable effort in terrestrial impact experiments.

A second experimental set up for impact studies in space would take advantage of the near vacuum and zero gravity to build a large 'gun.' With this device, higher velocities could be achieved than on Earth due to the increased size of the mechanism, allowing continuous acceleration of the projectile over a longer period. Ahrens speculates that velocities up to 100 km/s might be produced in this fashion, yielding pressures on the order of hundreds to thousands of megabars.

What material phases might be produced under extremes of pressure? A metallic version of diamond could be generated or, less likely but possible, metallic hydrogen. Not only scientific data would result from such experiments; prototypes of space manufacturing operations could be tested, for example, the high pressure phases of titanium dioxide. Thermodynamic considerations indicate that high pressure phases of materials tend to be harder and more temperature resistant than ordinary matter. Thus, a programme screening various materials could be expected to yield additional candidates for industrial use.



In this X-ray photograph a projectile is shown hurtling at 6.22 km/s towards a hypervelocity impact with an instrumented target. Impact will occur in less than 10 micro seconds. The dark flyer plate of the projectile lies directly above the numeral "2" in the photograph and is composed of tantalum. The remainder of the projectile (not as dark) is of plastic; a very light vertical stripe in its centre indicates that it is starting to lose some structural integrity under the stress of flight at near-orbital speed. This photograph was taken in a gas gun at Caltech's Lindhurst Laboratory of Geophysics. The experiment, to study the behaviour of materials under high pressures such as occur in planetary interiors, was under the supervision of Dr. Thomas Ahrens, professor of geophysics. *Caltech*

Ahrens has received NASA funding in the past to develop the design for his orbiting hypervelocity impact experiment (though no work is currently in progress). If the concept should mature into an actual project, one can imagine a mission scenario that might result:

"It is December of 1994 and an impactor vehicle, originally carried into orbit on a Shuttle launched from Vandenberg site in California, speeds south at 7½ km/s at an altitude of 500 km above San Francisco.

"At the same time the larger target vehicle moves in a northerly direction, passing over Los Angeles. It will meet the impactor vehicle in less than one minute.

"In these final seconds before collision laser beams explore the regions between the two vehicles and small trajectory corrections are made to insure that the collision will be head on.

"At the last microsecond before contact the impactor plate ('the hammer') is separated from the target sample by little more than a centimetre of space. As this distance closes to zero the impactor plate begins to crush the 1 m diameter sample against the anvil on which it has been mounted.

"The wave of compression begins its leisurely march across the sample, taking hundreds of microseconds to finish the trek. During this time the flattening sample is subjected to pressures ussually borne only by material inside stars and planets; its molecules are rudely shoved together, penetrating at times their neighbours' electrically repulsive cores. Phase changes wink on and new crystal patterns are formed. The material's electrical conductivity changes. Infrared and visible photons are squeezed out.

"Nearby, on a dynamically isolated observing platform, high-speed cameras record the flow of matter and a spectrometer monitors the flow of photons. The sample is probed by flashing X-rays to measure its density.

"The momentum trap behind the sample is vaporised and expands into free space, arresting the violence of the event and preserving the target vehicle's integrity.

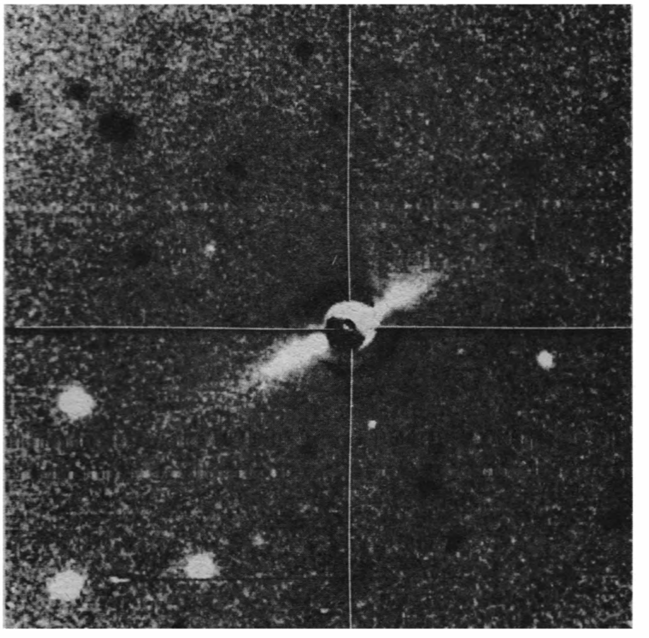
"Information from the monitors is fed back to the ground through NASA's Tracking and Data Relay Satellite (TDRS), enabling analysts to complete the equation of state for the material, applicable to previously inaccessible conditions.

"The target vehicle with its load of samples continues its movement toward the north pole. Ground controllers activate another impactor stored in orbit and begin to manoeuvre it into position for collision with a second sample."

POSSIBLE NEW SOLAR SYSTEM

For the first time, a photograph has been taken that shows a disc of solid material orbiting another star. Dr Bradford Smith (University of Arizona) and Dr. Richard Terrile (Jet Propulsion Laboratory) have photographed a vast swarm of particles orbiting the star Beta Pictoris, 50 light years from Earth. There is some evidence to suggest that planets could have formed. The brightness of the star seen through the disc indicates that the innermost particles of the disc might have been swept away.

Beta Pictoria was distinguished during the 1983 survey of the sky by the Infrared Astronomical Satellite (IRAS) as the star possessing the largest infrared excess (see January 1985's 'Space at JPL') - an indicator of the possible existence of cool, circumstellar material. When, as a result, Smith and Terrile turned the 2.5 m telescope of the Las Campanas Observatory in Chile on Beta Pictoris they were able to detect a flattened disc extending some



This image of particles orbiting the star Beta Pictoris was taken with the 2.5 m telescope at Las Campanas Observatory in Chile The material is in the form of a disc about the star and is seen approximately edge on. The image, in visible light, was taken because of indications of possible material obtained by the Infrared Astronomical Satellite in 1983. *NASA/JPL/Las Campanas*

60 thousand milliom km outwards. The particles probably range in size from tiny grains a few microns in diameter to larger particles several kilometres across. It is not possible to determine if planets are present other than through indirect indications.

Beta Pictoris is a faint, fourth-magnitude star in the constellation Pictor, primarily visible from the southern hemisphere, which makes the Chile location ideal for observing it. Las Campanas Observatory is operated by the Carnegie Institution in Washington.

A charge-coupled device (CCD) and coronagraph were employed along with the reflecting telescope. The CCD makes possible the detection of very faint objects, while the coronagraph helps to block out the otherwise overpowering light from Beta Pictoris. As the name indicates, coronagraphs were originally devised to block out sunlight, allowing astronomers to view the faint corona surrounding the the solar disc without waiting for a natural solar eclipse. The image of the Beta Pictoris system was extensively computer processed at the University of Arizona and JPL. The total observing and processing task was funded by the University and by NASA's Office of Space Science Applications.

NSCAT STARTS UP

The NASA Scatterometer (NSCAT) project has been formed at JPL. The scatterometer is an instrument that will be built for the purpose of flying aboard a satellite to make measurements of wind direction and speed over the surface of the world's oceans. In addition to constructing the instrument, the project is responsible for processing the return data.

The NSCAT Project is NASA's part of a multi-agency programme for which the US Navy has primary responsibility. The Navy Remote Ocean Sensing System (N-ROSS) programme includes participation by the US Air Force and the National Oceanic and Atmospheric Administration (NOAA), in addition to NASA.

A launch date of June 1989 is planned for the N-ROSS satellite at the beginning of its three-year mission; it will be carried aloft from Vandenberg aboard a Titan II launch vehicle of the US Air Force. The satellite, which will carry three other instruments, is planned to be an existing NOAA-D weather satellite bus supplied by NOAA. This vehicle will be modified to be compatible with the telemetry, tracking and command capabilities of the Defense Meteorological Satellite Program's (DMSP) network of ground stations which will track the satellite and forward the data to the processing centres.

The satellite will be placed into a circular orbit 830 km high at an inclination of 98.7°, resulting in a Sun-sychronous orbit.

The scatterometer operates by putting 110 W of power sequentially into six antennae, radiating microwaves on the ocean's surface at a frequency of 14.0 GHz, detecting the returned energy and deducing from it the wind vector just above the surface. The amount of energy returned to the satellite is a mere 10^{-16} W, a reduction of some 18 orders of magnitude over the output power.

The objectives of the NSCAT project are to provide wind vector data for research in oceanography and meteorology and to advance the state of scatterometer instrument development. The resolution of the instrument will result in the determination of the average wind direction and speed over an area only 25 km on a side. The satellite will be employed using fast Fourier transform (FFT) techniques to produce a much lower data rate than if the raw data were transmitted. The instrument will have a mass of about 160 kg and consume a total of 240 W of power.

Scientific announcements of opportunity are scheduled to be issued by NASA this year and will result in the selection of a Science Working Team (SWT) for the project. Processed data will be received by the individuals on the SWT within two weeks after being received at JPL. Other users of data will be in the US Navy, for operational meteorological purposes, and NOAA which will distribute products to the general community of users. Data will also be sent to the Pilot Ocean Data System (PODS), described in the February 1984 edition of 'Space at JPL,' for final archiving and further distribution.

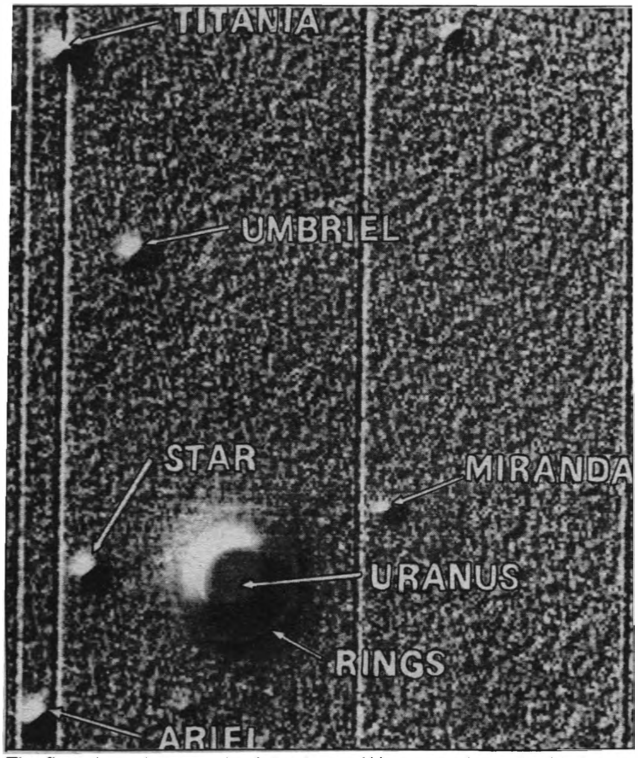
The heritage of NSCAT goes back to the 1978 Seasat proof-of-concept mission which carried a scatterometer as one of its five remote sensing ocean experiments. The Seasat instrument's resolution was only 50 km, and the data were much harder to reduce than those that will be collected by NSCAT because Seasat only carried four scatterometer antennae.

The manager of the NSCAT project is Benn Martin, Dr. Fuk Li is the Project Engineer, and Dr. Michael Freilich is the Project Scientist. NSCAT is managed by JPL for NASA's Office of Space Science and Applications; Bill Townsend is the NASA Programme Manager.

URANIAN RINGS

Dr. Richard Terile of JPL and Dr. Bradford Smith of the University of Arizona have obtained the clearest images to date of the rings of Uranus using the 2.5 m reflector at the Las Capanas Observatory. These two astronomers used the same instrument to record some of the best images of Neptune ever taken, as reported in the November 1984 edition of this column, as well as the Beta Pictoris achievement just discussed.

The pole of Uranus, seeming to have fallen 90° from its 'proper' orientation perpendicular to the ecliptic, currently presents a full, face-on view of the rings and satellites to observers on Earth. But the pole points in a nearly-



The first clear photograph of the rings of Uranus is shown in this image taken with the 2.5 m telescope in Chile. The plane of the rings lies almost entirely in the plane of the image. Most of the light from the planetary disc was blocked off with an occulting device.
NASA/JPL/Las Campanas

constant direction in space as the planet revolves about the Sun every 84 years. So, in a quarter of an orbital period, or about 20 years, the rings will go from being nearly face-on to Earth, as they are now, to nearly edge-on.

Since the five Uranian satellites, as well as the rings, all lie in the equatorial plane of the planet, these objects are laid out for our inspection like grapes on a plate, as the Terrile and Smith image shows. The appearance of the system has also been likened to a bull's-eye which will be pierced by the incoming Voyager 2 spacecraft in January 1986 (but not right in the centre of the target, where the planet lies!). See the illustration in the March 1984 edition of this column for depiction of the relevant geometry of Voyager's approach to Uranus.

The key to the success of the Smith-Terrile image lay in using a very sensitive charge-coupled device (CCD) with the telescope and, at the same time, blocking out the overpowering light from the main body of the planet. The blocking process was not perfectly centred as one can see light from Uranus leaking around the upper left quadrant of the coronagraph device. The vertical lines in the image are due to minor defects in the detector.

The rings of Uranus, discovered in 1977, are among the darkest objects in the Solar System, reflecting only about 2% of the incident sunlight. A paper written a few years ago on the subject in the journal *Science* told it all with its descriptive title: "Uranus: The Rings are Black."

The Uranuan rings also differ from those circling Jupiter and Saturn in that they are nine in number and each is very narrow. The widest one, the so-called epsilon ring, has an average with of about 50 km. One objective of the Voyager exploration will be to try to determine the mechanism that produces such narrow rings. A possibility, as suggested by Voyager images in 1980 and 1981 of the F-ring of Saturn, is that small, shepherding satellites are confining the ring material to narrow zones.

Montreal, Quebec, Canada is shown in this image acquired by the Shuttle Imaging Radar-B (SIR-B) on 7 October 1984, as Shuttle *Challenger* flew over the overcast region. In addition to urban and river features, note the cultivated fields which display long, strip-like patterns typical of French subdivisions of land, as seen in France and some areas of Louisiana settled by the French. *NASA/JPL*

SHUTTLE IMAGING RADAR

The Shuttle Imaging Radar-B (SIR-B) was flown aboard the Shuttle *Challenger* last October and returned useful data despite problems with a Shuttle data link. The SIR-B instrument belongs to the family of synthetic aperture radars. A predecessor, SIR-A, was flown on Shuttle *Columbia* in November 1981 (see 'Space at JPL' in the September-October 1982 issue), and a synthetic aperture radar will be used on the 1988 Venus Radar Mapper mission.

A mechanical problem developed with *Challenger's* antenna, used for transferring high-rate data to the geostationary Tracking and Data Relay Satellite (TDRS) for subsequent relay to the ground. The antenna could not be pointed to TDRS, thus the whole Shuttle had to be positioned so that the immobilised antenna could be properly directed to effect data transfer. During these periods, the radar antenna of SIR-B, used in the imaging process, was not pointed towards its observational targets on the ground and data collection was necesarily interrupted.

Henry Harris of JPL, the Mission Design Manager for SIR-B, and his team had to replan the radar portion of the mission to accommodate these periods of data-collection outage in the Shuttle's timeline. Their basic technique was to employ microcomputers to edit the original mission plan into a form compatible with the new constraints.

Harris' team had learned the value of flexibility and real-time response during the SIR-A experiment and had built a system centred around six microcomputers at the Mission Control Center in NASA's Johnson Space Center. Functionally, the micros were deployed to provide a mission planning station for assessing, for example, the effect of changes in the Shuttle's trajectory; a science planning station at which members of the SIR-B science team could evaluate new strategies; terminals for the display of telemetered data such as signal strength and the temperature of the radar; and a station to hook together all of the other stations into a unified operating system.

The product resulting from the mission planning activity was a command file that was given to the Payload Commander and, after suitable checking, uplinked to *Challenger* for execution. The commands pointed the radar instrument at the desired targets at the correct times for data collection. Orientation of the Shuttle for data transmission to TDRS was accomplished by the astronauts using an onboard computer to calculate the time-varying pointing vector from *Challenger* to TDRS.

Good coordination among the astronauts, ground controllers at Houston, and the mission deisgn team yielded an implementation of approximately 17% of the original mission plan, under difficult conditions. The coordination was facilitated by several mission simulations at Houston, the last one of which the astronauts participated in.

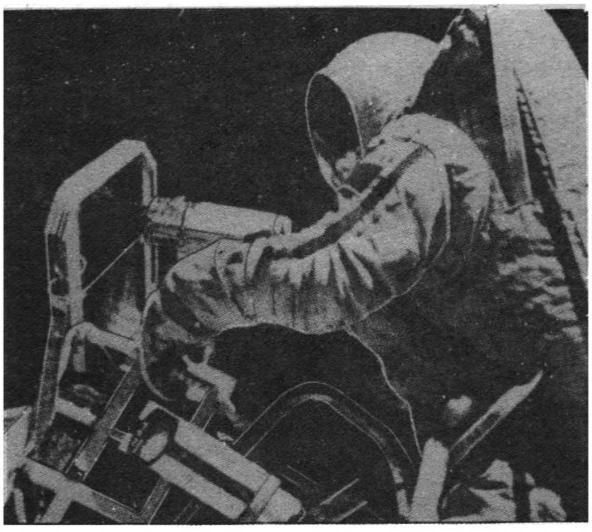
The SIR-B task manager is Edward Cargo and Dr. Charles Elachi is the Principal Investigator. Harris' design team consists of Joan Pojman, Mark Bergam and Su Kim, with software support from Laboratory Microsystems of Los Angeles.

JBIS

The February 1985 issue of *JBIS* is devoted to 'Space chronicle, which includes the following papers:

1. "Spacesuit Development - The American Experience," by K.T. Wilson
2. "US Military Satellites, 1983," by Anthony Kendon
3. "The Flight of Able and Baker," by J.W. Powell
4. "The Soviet Venera Programme," by P.S. Clark.

Copies of the issue are available at a cost of £2 ($4) each, post free from The British Interplanetary Society, 27/29 South Lambeth Road, London SW8 1SZ. The May 1984, August 1983 and April 1983 'Space Chronicle' issues of *JBIS* are still available at a cost of £2 ($4).



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When ordering, please indicate membership grade and allow six weeks for delivery. Provision for ordering these certificates also appears on the 1985 subscription renewal form.

BACK ISSUES

The Society has available some bound and unbound complete *JBIS* volumes for sale. For a list of those available, and their prices please send a stamped addressed envelope to The Executive Secretary, The British Interplanetary Society, 27/29 South Lambeth Road, London, SW8 1SZ.

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A NEW EYE ON THE UNIVERSE

By Dr. J.J. Burger *

The Hubble Space Telescope is one of the most ambitious space science programmes ever undertaken. With its 2.4 m primary mirror and extremely fine pointing accuracy, it will dominate astronomical research for the remainder of the century.

Introduction

NASA began Space Telescope studies in 1971 and in 1975 the European Space Agency began its involvement. Approval for the project by the US Congress was obtained in 1976 and in the same year a 15% participation was approved by the ESA Council. Implementation of the project started in 1977 and launch by the Shuttle into a 500 km orbit is scheduled for 1986. Telescope operations are planned to extend over at least 15 years, to be achieved by in-orbit maintenance and, if necessary, on-ground refurbishment. Communications will be through the TDRSS system from a dedicated Space Telescope Operations Control Center at the Goddard Space Flight Center; a dedicated Space Telescope Science Institute has also been established to guide the observational programme.

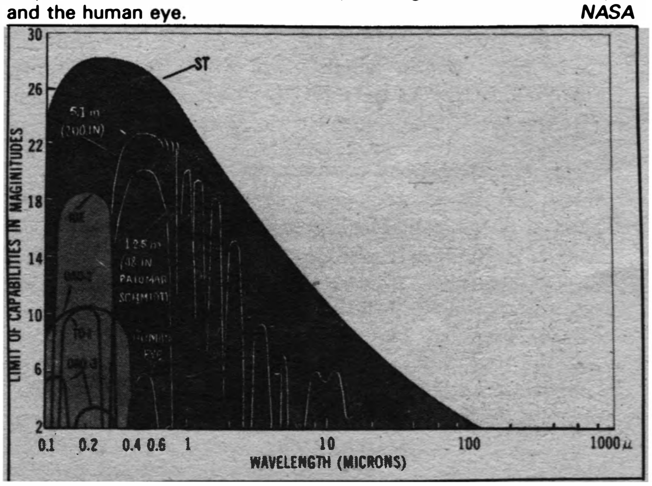
Scientific Objectives

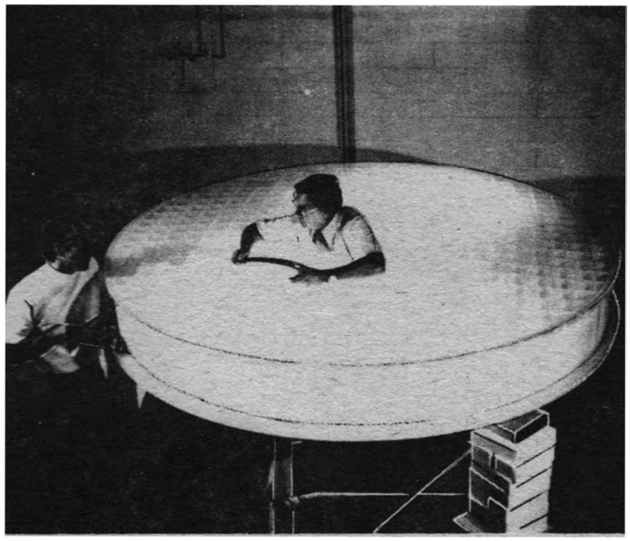
Astronomical observations from the Earth's surface are limited because the atmosphere scatters light, which limits the angular resolution and sets a lower limit on the faintness of observable objects. The Hubble Space Telescope is designed to improve the best ground-based angular resolution by at least a factor of seven and to allow us to see objects 50 times fainter. This implies that we will be able to see objects 10,000 to 15,000 million light years away - close to the edge of the observable Universe. This means we will be able to examine a volume of space 350 times greater than that presently accesible.

A second limitation introduced by the atmosphere is the absorption of light at nearly all but the visible wavelengths. A space observatory thus provides access to ultraviolet and infrared radiation, which carries more astronomical information than the visible. Observations

ESA Project Manager, Space Telescope.

The imaging capability of the telescope (upper curve) in comparison with other space observatories (OAO: Orbiting Astronomical Observatory; IUE: International Ultraviolet Explorer;) ground-based telescopes and the human eye. *NASA*





The primary mirror prior to coating.

with the new telescope will affect almost every area of astronomy: cosmology, quasars, galaxies, stellar evolution, dynamics of planetary atmospheres, the search for planets around nearby stars and many more.

The Spacecraft

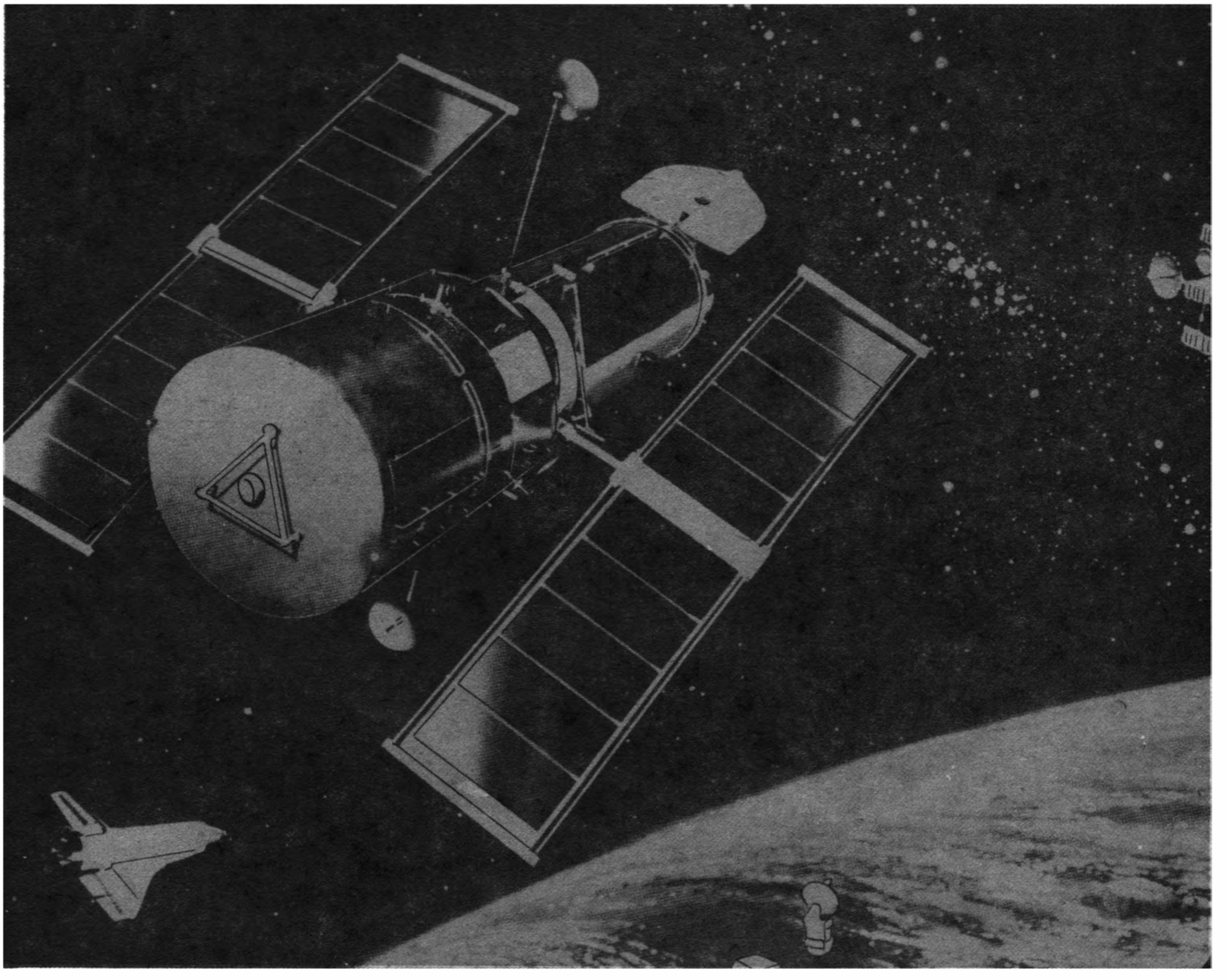
The spacecraft has been designed to fit in the Shuttle's cargo bay for launch. It is 14 m long and 4.5 m in diameter, weighing about 11,000 kg and consisting of three main elements: the Optical Telescope Assembly, the Support Systems Module and the Scientific Instruments with their dedicated Command and Data Handling System. The f/24 Ritchey-Chrétien Cassegrain telescope has a primary mirror of 2.4 m diameter. The optical quality of the mirrors and the mechanical stability of the interconnecting structures have been specified to achieve a diffraction limited performance at 6330 Å. In order to use this optical quality to the full, the attitude control system was specified to have a pointing accuracy of 0.01 arc seconds, with stability over 24 hours better than 7 milliarc seconds. This is equivalent to pointing from Amsterdam at a 1.5 cm diameter circle in Paris.

The image in the focal plane will be used by five scientific instruments and the three fine guidance sensors. Two of these sensors will be used for attitude control; the third can be used for astrometry.

The Optical Telescope Assembly, made by Perkin-Elmer, holds the mirrors rigidly in a precise relationship. The primary is made of ultra-low expansion glass fused to a honeycomb structure to save weight. The optical surface has been polished and coated with an accuracy better than 100 Å over the usable area. This means that if the mirror were scaled up to the size of the USA the largest deviation from the ideal shape would be about 2 cm!

The primary and 30 cm diameter secondary mirror are connected by a carbon fibre truss structure, which meets not only all the typical spacecraft requirements of strength, vibration frequencies and low mass, but also maintains their separation for diffraction limited observations with a pointing stability of 7 milliarc seconds over 16 orbits (half in sunlight, half in eclipse). The secondary mirror can be moved to allow fine focussing in three axes. Actuators at the rear can optimise the shape of the primary mirror in case the allowances made for it being produced in 1 g on Earth were inadequate.

The primary mirror mount is attached to a focal plane structure supporting the five scientific instruments, three



Artist's impression of the Space Telescope in orbit, just launched by the Shuttle and communicating with the ground through the TDRSS system.

fine guidance sensors, three star trackers and six rate gyros. All are designed to allow them to be changed in orbit by astronauts, which requires special latching mechanisms to ensure that the extremely high alignment requirements are met. For structural stability, extensive use is made of carbon fibre and active thermal control systems.

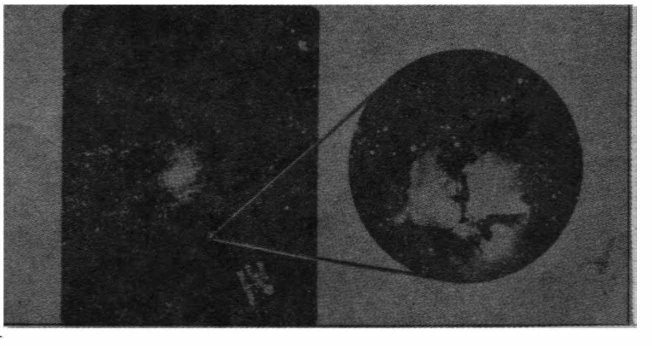
The Support Systems Module is made by Lockheed, who are also responsible for the integrated system design of the complete satellite. The SSM is the main structure of the spacecraft, with interfaces to the Orbiter, light shields, aperture doors (and others to allow astronauts access), communications, data handling, thermal control, power and attitude control systems.

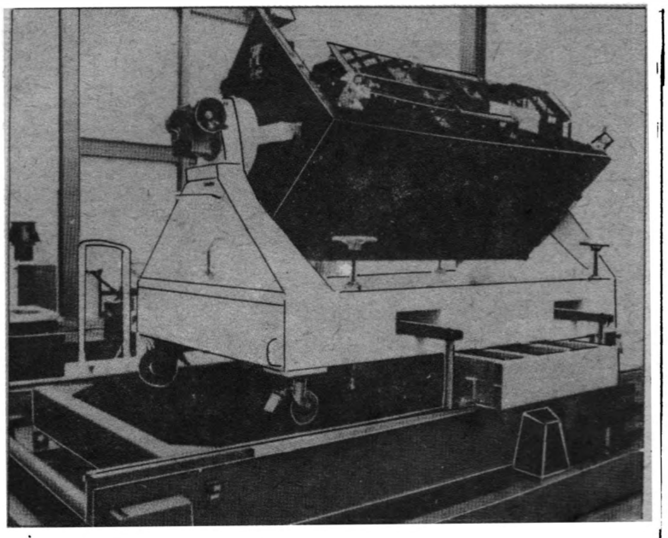
The greatest technical challenge in the SSM is the attitude control system. A computer receives error signals from optical and inertial sensors and computes the required torque moments and commands for four reaction wheels. It also controls magnetic torquers to compensate for the Earth's field. Coarse control is achieved with the aid of star and Sun sensors; fine pointing is done with signals from the fine guidance system looking through the telescope. Rate gyros provide the required inertial signals.

ESA has provided - through British Aerospace - the solar array attached to the SSM with all its mechanisms and associated electronics for deployment and slewing. After two years in orbit it should still provide more than 4,400 W at 34 volts from its 48,760 solar cells (each 2 x 4 cm) spread over two 3 x 12.5 m wings. Designers also had to allow for possible replacement in orbit after five years of operation. At launch (and for landing or maintenance) the array blankets will be rolled up within a diameter of 30 cm. The design also had to avoid unwanted vibration frequencies for the attitude control system to handle.

Another challenging requirement was to hold the interactive torque between the arrays and the spacecraft at all times below 0.1 Nm while slewing. In low Earth orbit the blanket temperatures will fluctuate over each orbit from +100°C to −100°C. Over five years and 30,000 orbits a great deal of stress will be suffered by the solar cell interconnectors.

Artist's impression of the gain in spatial resolution achievable with the Space Telescope in comparison with ground based observations.





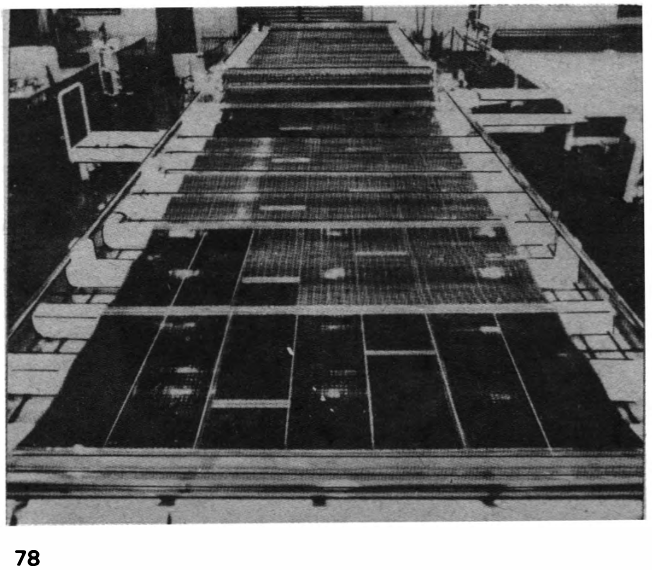
The flight model Faint Object Camera on its integration trolley. The lower part is the optics compartment; the upper contains electronics.

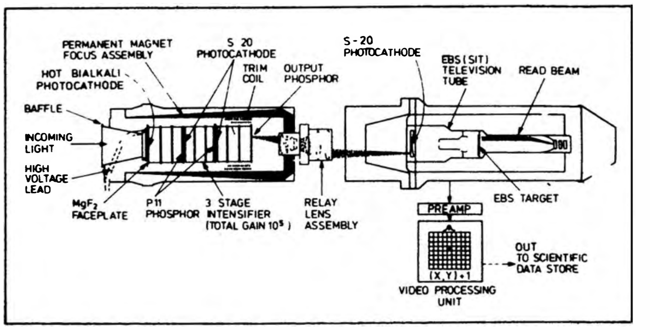
The Scientific Instruments

The Hubble Space Telescope carries five scientific instruments, all interchangable in orbit by new-generation follow-on instruments. The 270 kg Wide Field Camera has its optical axis perpendicular to that of the telescope axis since it is integrated in a radial bay, like the fine guidance sensors, and receives its input light from a 45° pick-off mirror at the centre of the focal plane. It accumulates the image on four CCD detectors (each of 800 x 800 pixels) cooled by heat pipes and an external radiator to −90°C.

The other four instruments have their optical axes roughly parallel to the telescope's axis and are integrated in the four quadrants behind the primary mirror. Their apertures are about three arc minutes off axis, so they have to correct for the off-axis wave front errors. These 'axial' instruments weigh 320 kg and occupy a space of 0.9 x 0.9 x 2.2 m. Included for this first launch are two spectrographs, one optimised for high resolution and one for faint object observations, a high speed photometer and the Faint Object Camera (provided by ESA). All are technically challenging, with the ESA instrument described in more detail below.

The qualification model Solar Array blankets deployed on a water table. Only part of the cells are real, others are dummy.





A schematic drawing of the Faint Object Camera's Photon counting detector.

The Faint Object Camera

The FOC's objective is to exploit the capabilities of the Telescope fully, both in terms of spatial resolution and in reaching the faint object observation limit. To do this, the focal plane image has to be further enlarged and the observations carried out with maximum stability and minimum instrumental noise.

There are two optical relays, one of f/48 and the other of f/96. The optical elements, correcting for the telescope's off-axis distortions, are attached to a carbon fibre optical bench in which a thermal expansion coefficient as low as 10^{-7} has been achieved. To improve the stability further, the optical bench enclosure (the bench itself and the image detectors) has active thermal control - the interface temperatures can vary by more than 50°C but the temperature inside is held to within 1°C.

The image photons are individually counted in the Photon Detector Assembly, consisting of an intensifier tube assembly and lenses coupled to an EBS camera tube. The three stage intensifier, operating at 36,000 V and focussed by a permanent magnet assembly, amplifies the signal from an incoming photon on to the last stage phosphor by a factor of 10^6 and maintains the positional information. The camera tube is operated at 12,000 V and detects the scintillations at the intensifier output. The central x, y coordinates of each light burst is then measured by a video processing unit. Subsequently, the memory cell of a 4 Megabit scientific data store, corresponding to the photon's x, y-position, is incremented by one. The detector's noise level is lower than 10^{-4} counts per pixel per second.

The detector is sensitive from 1200 to 6000 Å and images can be obtained in several formats, ranging from 1024 x 512 pixels to 64 x 64 pixels. Each optical chain also has a large set of selectable filters and polarisers. It is possible to insert an additional small Cassegrain telescope in the f/96 chain to magnify the image further by a factor of three, to f/288. This chain also has a coronograph for observing faint objects near bright sources. The f/48 chain can also be used in a spectrograph mode with spectral resolution of 2000 over the wavelength range 1200 to 5400 Å.

The FOC will be able to observe sources of magnitude +29 or brighter; with neutral density filters a dynamic range of 24 magnitudes is available.

Concluding Remarks

All of the Hubble Space Telescope subsystems have been manufactured and tested, with integration of the complete spacecraft due to start by the end of 1984. The full performance of the complete system cannot be demonstrated on the ground so several months period of in-orbit testing is envisaged. However, exciting images and data are expected even before the telescope reaches full operational status.

FLYING THE SPACE PLASMA LAB

By John Bird

The introduction of the Space Shuttle means that scientists can now fly experiments in space, return them to Earth, make modifications and send them back into orbit. The author discussed just such a project with two of its participants.

Introduction

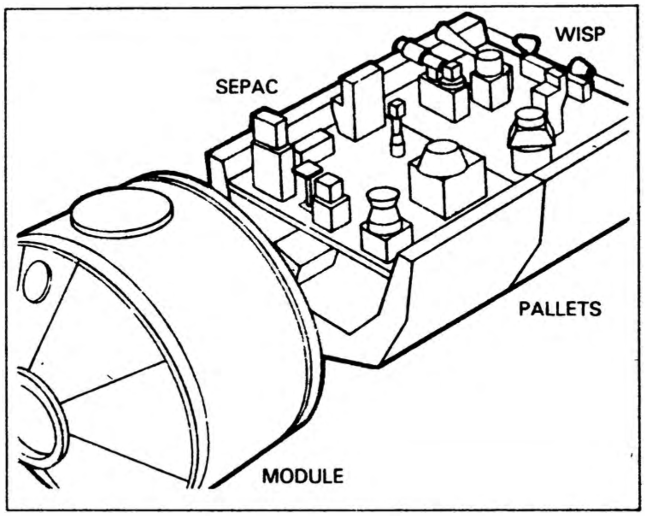
As part of NASA's plan to fly reusable Spacelab payloads, each dedicated to one discipline, the Space Plasma Laboratory will be used every 18 months. It will employ both active and passive techniques to probe the Earth's environment, as explained to me by Mission Scientist David Reasoner. Originally the first flight was tagged as Spacelab 6 but has now been renamed Space Plasma Lab 1.

Many details of the first flight have already been planned. It is a seven day mission scheduled for June 1988 using Shuttle *Discovery* in a 300 km Sun-synchronous orbit, following instrument delivery to Kennedy Space Center in February of that year.

The laboratory is composed of Spacelab pallets and an igloo in *Discovery's* cargo bay. This payload has a mass of 11,000 kg, of which 3,000 kg is experiments, but a pallet-only configuration is also possible. In either case, Payload Specialist astronauts will be part of the crew. Orientation of the Orbiter will be such that the yaw axis is parallel to the magnetic field lines of the Earth, that is the wings will be at 90 degrees to the Earth's surface.

The Experiments

Eleven experiments are planned, falling into three categories: injection of radio waves and particle beams into the atmosphere, experiments deployed by the Remote Manipulator System (including a free flying package), and



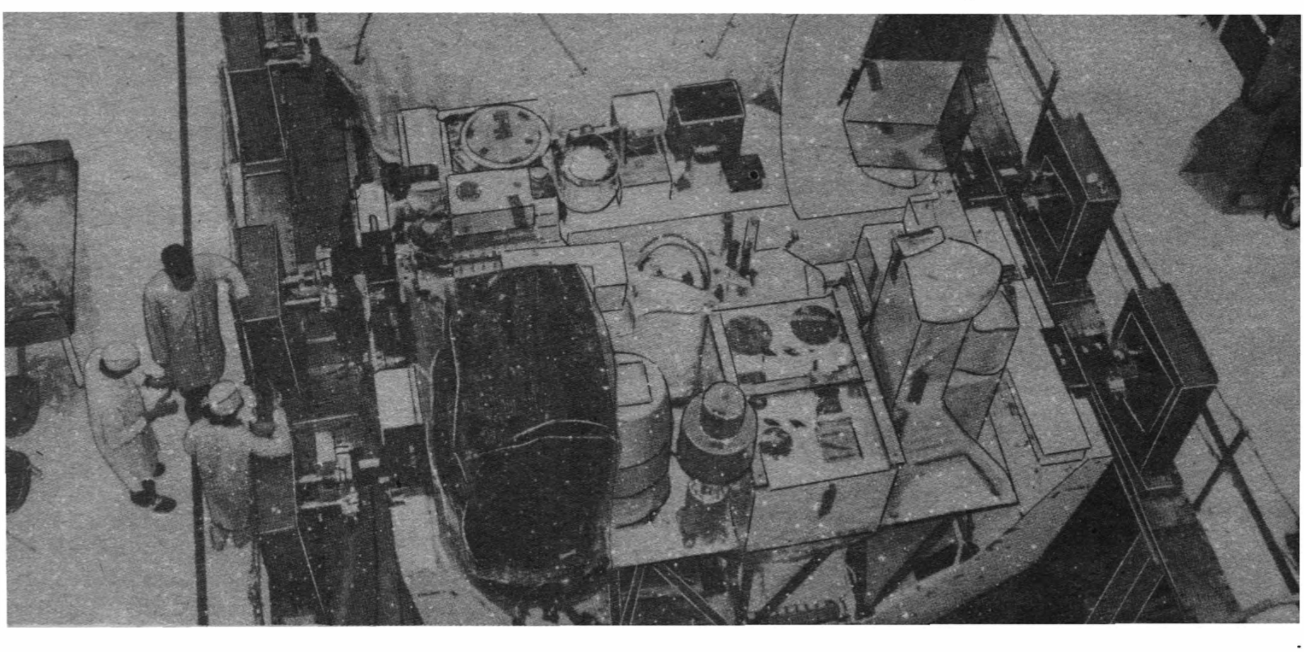
General layout of the Space Plasma Lab. The first flight in 1988 will not carry a pressurised module for the astronauts.

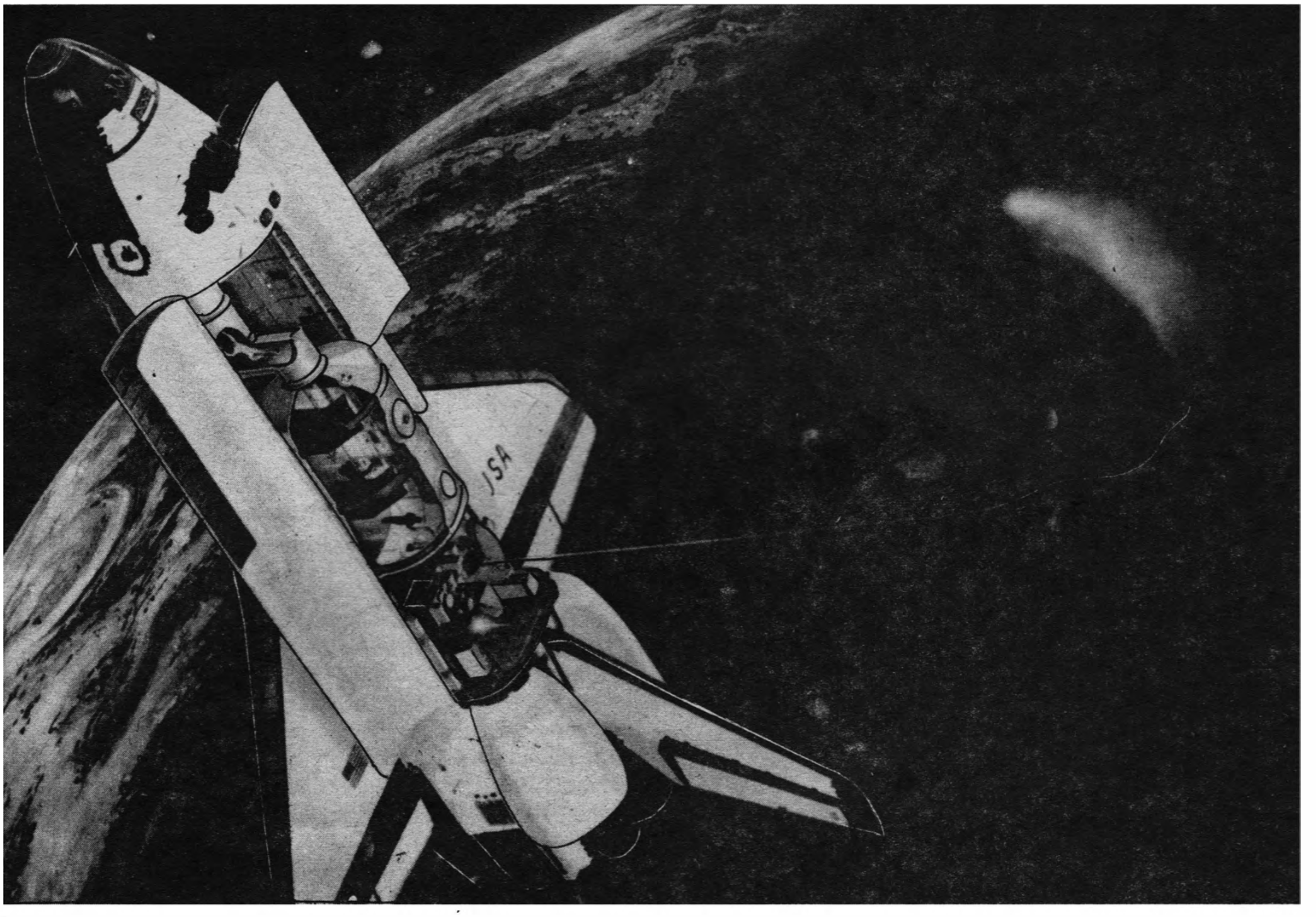
optical sensing experiments. All involve the study of the thin upper atmosphere which is composed of electrically charged particles, or ions — atoms which have lost electrons. This state of matter is called plasma. On an astronomical scale, plasma is very common — it accounts for more than over 99 per cent of the Universe. For example, our Sun is made of plasma.

In order to study the plasma surrounding the Earth, the experiments of Space Plasma Lab 1 will support each other with measurements, analysing the same phenomena by different techniques. One technique is to transmit radio beams into the upper atmospheric plasma and measure the reflected waves; this will be done by Waves in Space Plasma (WISP) transmitting from 300 Hz to 30 MHz. Different frequencies will travel different distances and, by analysing the reflected beam, the electron density at various altitudes may be determined. The antenna used for this experiment will be 300 m long!

Two of the experiments will inject particle beams into space. The Vehicle Charging and Potential (VCAP) is a pulsed electron gun that will emit a beam for the returning current to be measured. The beam will cause the vehicle to become electrically charged and this can be measured

The pallet of Spacelab 1 carried a multitude of experiments. The Space Plasma Lab concepts shown at the top of the page uses two pallets.





The SEPAC experiment aboard Spacelab 1 was designed to shoot electrons, ions and neutral gas into the atmosphere, creating artificial aurorae.
NASA (artist Seijun Fujita)

with respect to the surrounding plasma. The Space Experiments with Particle Accelerators (SEPAC) was first used on Spacelab 1. Some of the SEPAC experiments will study plasma phenomena near the Orbiter, while some are concentrated at greater distances. Close to the Orbiter, vehicle charge neutralisation and beam plasma physics will be studied. Another interesting experiment involves ejecting a neutral gas from the cargo bay and injecting an electron beam into it. The interaction will create a glow for observation by another experiment. To analyse the atmosphere down to 100 km, the SEPAC Electron Beam Accelerator will inject pulses to probe the ionosphere.

Further investigations of the plasma around the Orbiter will be by experiments deployed on the Remote Manipulator System arm. One is the Theoretical and Experimental Study of Beam Plasma Physics (TEBPP). The effects of beams from other experiments with the plasma will be analysed with an energetic particle spectrometer, pulsed plasma probes, a sweeping plasma wave receiver, an electron probe, a neutral particle density detector and a photometer system. To determine the density and composition of ions, the Energetic Ion Mass Spectrometer (EIMS) includes 11 channel electron multipliers, a retarding potential analyser, an electrostatic analyser and a magnetic analyser.

A Recoverable Plasma Diagnostics Package (RPDP) will be set free by the robot arm to take measurements as far as 100 km from the Orbiter before retrieval. The package could also be used as a tethered satellite, or attached to the arm. Instruments will include an ion mass spectrometer, a triaxial magnetometer, electric and magnetic field sensors, and a composition analyser. Non-recoverable subsatellites called Magnetospheric Multiprobes (MMP) will be set free to simultaneously measure plasma waves.

Four of the instruments in the Space Plasma Lab will use optical methods to observe plasma phenomena. The Wide Angle Michelson Doppler Imaging Interferometer (WAMDII) was developed at York University in Toronto by Dr. Gordon Shepherd. He explained that it is an imaging device to map winds and temperatures as functions of height, latitude and time of day. Particular attention will be paid to winds near aurorae and airglow irregularities. The data will complement results from a Fabry-Perot interferometer on the Dynamics Explorer satellite.

The Atmospheric Emissions Photometric Imaging experiment (AEPI) is a low light level TV camera and a Photon Counting Array. These instruments are mounted for steering on a two-axis gimbal made from a modified Apollo Telescope Mount Star Tracker. The camera has wide angle and telephoto lens to observe beams from other experiments and natural light sources such as aurora and airglow. It was first flown on Spacelab 1.

The Energetic Neutral Atom Precipitation experiment (ENAP) will use five spectrometers to observe visible and ultraviolet emissions from a range of altitudes. Another experiment that will examine light emission at various heights is the Atmospheric Lyman Alpha Emissions experiment (ALAE). Lyman alpha is an ultraviolet spectral line emitted by hydrogen that can reveal the temperature of the hydrogen.

Space Plasma Lab is an evolutionary system designed to be modified as required by scientific objectives, but the basic facility will remain the same. This means that time between flights is minimised, but with maximum scientific return, making it a valuable element of research with the Space Shuttle.

MISSIONS TO SALYUT IN 1985

By Phillip Clark and Rex Hall

It is possible to estimate the landing opportunities for manned missions to Salyut orbital stations [1] and to make predictions for crew compositions. An earlier article looked forward to missions for Salyut 7 in 1984 [2]; this version covers 1985.

Landing Opportunities for 1985

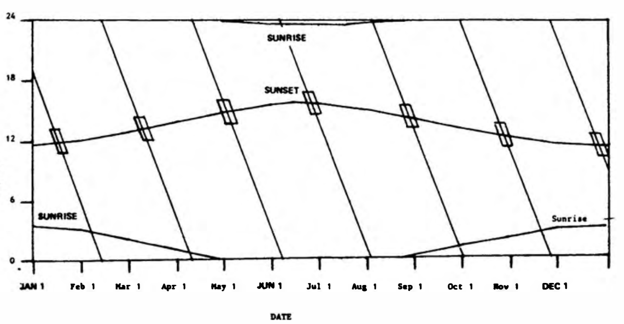
Figure 2 shows the landing opportunities for 1985. The curves show the times of sunrise and sunset over the standard Soyuz landing area, while the sloping straight lines indicate the approximate time of launch or landing for a Soyuz mission to Salyut 7 for any day during the year. A landing 'window' begins when the launch time line crosses the sunset line, the resulting window lasts for about 5 days. During 1985 the nominal landing windows will open on the following dates: 17 January, 10 March, 3 May, 25 June, 1 September, 31 October and 25 December. These are only approximate, and can vary by approximately ±5 days. This is because Salyut's altitude will vary during the year as a result of orbital decay and manoeuvres, resulting in slight changes in the rate at which the orbit precesses about the Earth.

Mission Scenarios for 1985

It is well-established that the missions to Salyut 7 can be divided into two groups [3]: the 'resident' or long-term crews (which can establish new duration records) and 'visiting' or short-term crews which spend 1-2 weeks in orbit. In 1984 the resident crew launched on Soyuz T-10 established a new duration record of 237 days, and it is possible that during 1985 an attempt might be made to extend this to about nine months. More probably, we can expect to see two medium duration 'resident' crews launched, with missions lasting 4-6 months each. In addition, there should be two visiting missions to Salyut during the year. The two possibilities for 1985 are therefore:-

1. A single nine month mission with two visiting crews;
2. One mission of four months duration flowing with a Cosmos Star module docked with Salyut, followed by a further mission lasting for six months with two visiting crews.

Fig. 2. Salyut 7 landing windows in 1985. The details of the graph are noted in the text. Boxes show the probable limits of the landing windows.



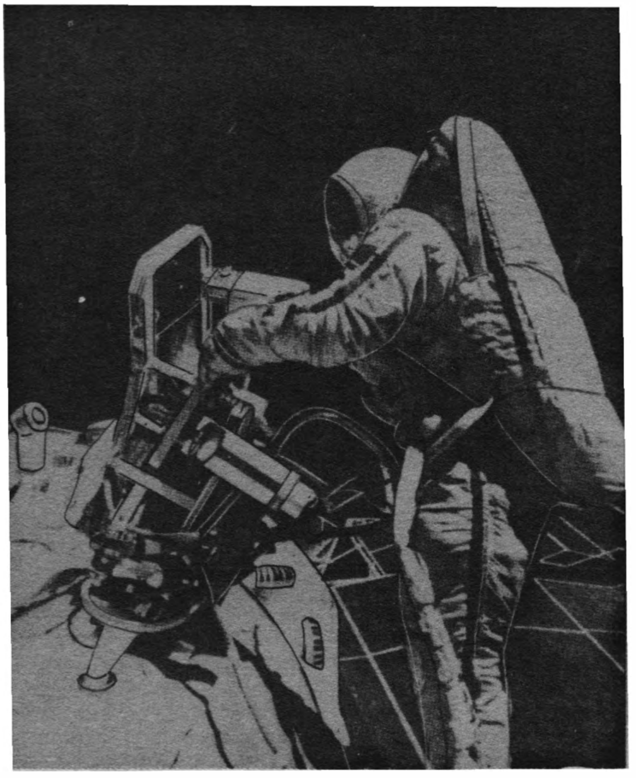


Fig. 1. Svetlana Savitskaya, already a two-time space veteran, could make another flight in 1985. *Novosti*

The flight of Soyuz T-11 in 1984 has shown that the craft can fly for six months in orbit without replacement, and therefore no spacecraft switches would be required for the projected mission in conjunction with a Star module.

Launch Opportunities

The interval between the landing windows is about two months, and therefore missions lasting four or six months will be launched during landing opportunities. If a flight of nine months is planned (or any odd number of months) it will be launched about half-way between landing opportunities. If there is to be a new duration record of nine months, a launch could come in mid-February with a landing in late October or early November. Visiting missions can perhaps be expected in late April and late August.

Alternatively, if medium duration missions are to be

Table 1. List of Active Cosmonauts

Resident
[V.A. Dzhanibekov - Cdr], V.V. Illarianov - Cdr, [Y.V. Malyshev - Cdr], L.I. Popov - Cdr, A.A. Serebrov - FE, [G.M. Strekalov - FE], V.G. Titov - Cdr, [I.P. Volk - FE], ? ? Volkov - Cdr.

Visiting
[A.P. Alexandrov - FE], [O.Y. Atkov - FE], A.N. Beryezovoi - Cdr, V.F. Bykovski - Cdr, A.S. Ivanchenkov - FE, [L.D. Kizim - Cdr], V.V. Kovalenok - Cdr, V.V. Lebedev - FE, V.A. Lyakhov - Cdr, Y.V. Romanenko - Cdr, [V.V. Ryumin - FE], V.P. Savinykh - FE, S.Y. Savitskaya - Cdr?, [V.A. Soloviev - FE], B.V. Volynov - Cdr, "Irena" - FE.

Notes. Names in parentheses are those cosmonauts still active, but who have not been re-cycled to a new assignment. Volkov is a reported new cosmonaut whose initials are not known, while 'Irena' was Savitskaya's female back-up on Soyuz T-7 in 1982, and may have performed the same role for Soyuz T-12 in 1984. Illarianov is a cosmonaut trainee identified at the time of ASTP.

Fig. 3. All three of (from left) Lebedev, Beryzovoi or Savistkaya could fly to Salyut in 1985. *Novosti*

flown, a Soyuz T mission could be launched in January with a Star module docked at the front of Salyut 7, and could return to Earth in early May. A second medium duration mission could follow with a July launch and a late October or late December recovery, and visiting missions launched in mid-August and mid-October. The standard visiting mission (e.g., the Intercosmos visits) lasts for eight days, but the Soyuz T-12 visiting mission in 1984 extended to 12 days.

With the requirement for allowing ground crews and tracking ship crews to stand down, it should not be anticipated that one Salyut resident crew will hand the station over to the next resident crew.

In addition to the manned missions, the Progress unmanned craft will take supplies to Salyut to support the crews. Unless there is a change in the Star module design, the Progress craft will not be able to dock with the Salyut/Star module/Soyuz T complex, and therefore Progress will be flown only when there is a Salyut/Soyuz T complex operating.

Crews for 1985

Table 1 lists all the Soviet cosmonauts who are considered to be still active, but this excludes the many new cosmonauts who will be identified only when they make their first flights. Based upon the existing flight experience, it has been possible to differentiate between those probably training for residency missions and those training for visiting missions. The status of a second Franco-Soviet manned mission is currently uncertain.

In 1984 N.N. Rukavishnikov indicated that an all-woman team is training for a mission to Salyut 7 in 1985, and this will probably be a visiting crew. Since an experienced cosmonaut is always included in a flight crew, one member must be Svetlana Savitskaya, who has already made two flights. In 1980 four woman began training, and it has been reported that a further group began training in 1982.

The following crew pairings for 1985 seem to be possible:-

Resident Missions

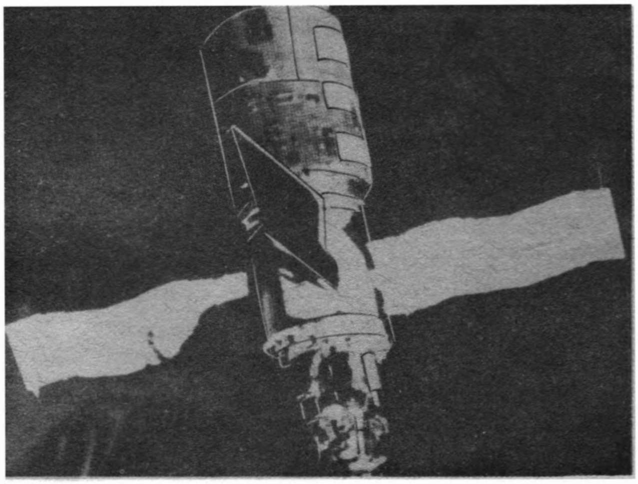
1. Volkov + Serebrov + 1977 'new'
2. Titov + 'new' + 1977 'new'
3. Malyshev + 'new' + 1977 'new'

Visiting Missions

1. Savitskaya + 'Irena' + 1980/82 Woman
2. Romanenko + Savinykh + 'new'
3. Beryezovoi + 'new' + 'new'

The numbers 1977 and 1980/82 indicate the probable cosmonaut groups to which the new cosmonauts belong. The crews are numbered in the order of flight probability for each type of mission. Since each team must have at least one experienced cosmonaut, the back-up team for the Savitskaya crew must include at least one man: this could be Lyakhov with a woman research engineer from 1980/1982 and either a second woman flight engineer or a male flight engineer. It is anticipated that the new mission commanders will be from the 1976 selection.

Fig. 4. Salyut 7. *Novosti*



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SATELLITE SERVICING

By John Bird

A new era has opened in satellite repair and maintenance following the success of April's Shuttle mission to repair the Solar Max satellite in orbit. This ability will be further increased by the Space Station when it becomes operational in ten years' time.

Introduction

Routine maintenance will be done on many satellites at the Space Station by retrieving them with an Orbital Manoeuvering Vehicle or an Orbital Transfer Vehicle (OTV) - the latter for the larger and more distant satellites. The Space Station will be a permanently manned facility in a low orbit with a 28° inclination, supplied by an Orbiter every 90 days with a fresh crew and supplies. In the early 1990's there will be a crew of eight but this will later expand to 16.

There are many advantages in bringing the satellites to the Station to work on them. First of all, more time would be available. On a Shuttle flight there are only a limited number of EVA shifts that can be allocated, whereas a Station could keep the satellite as long as necesary. Secondly, the Shuttle cannot reach satellites in higher orbits, such as those in geosynchronous paths. These *will* be accessible to the Orbital Transfer Vehicle, which will ferry them up and down to the Station.

It is also possible that an inside hangar will be available. Although the Station does not yet have a basic layout, it has been narrowed down to one of three possible configurations. The problem is to define a configuration in which the radiators, solar arrays, docking ports and at least 14 antennae do not interfere with each other.

Satellite Access to the Station

In order to keep some satellites readily accessible they will be held in a 'co-orbiting' configuration, flying in formation with the Station. One of these will be the unmanned Platform, which will be a general purpose support structure with solar arrays, radiators, power distribution systems, communications, etc for a variety of payloads. Other co-orbiters will include observatories such as AXAF and Space Telescope.

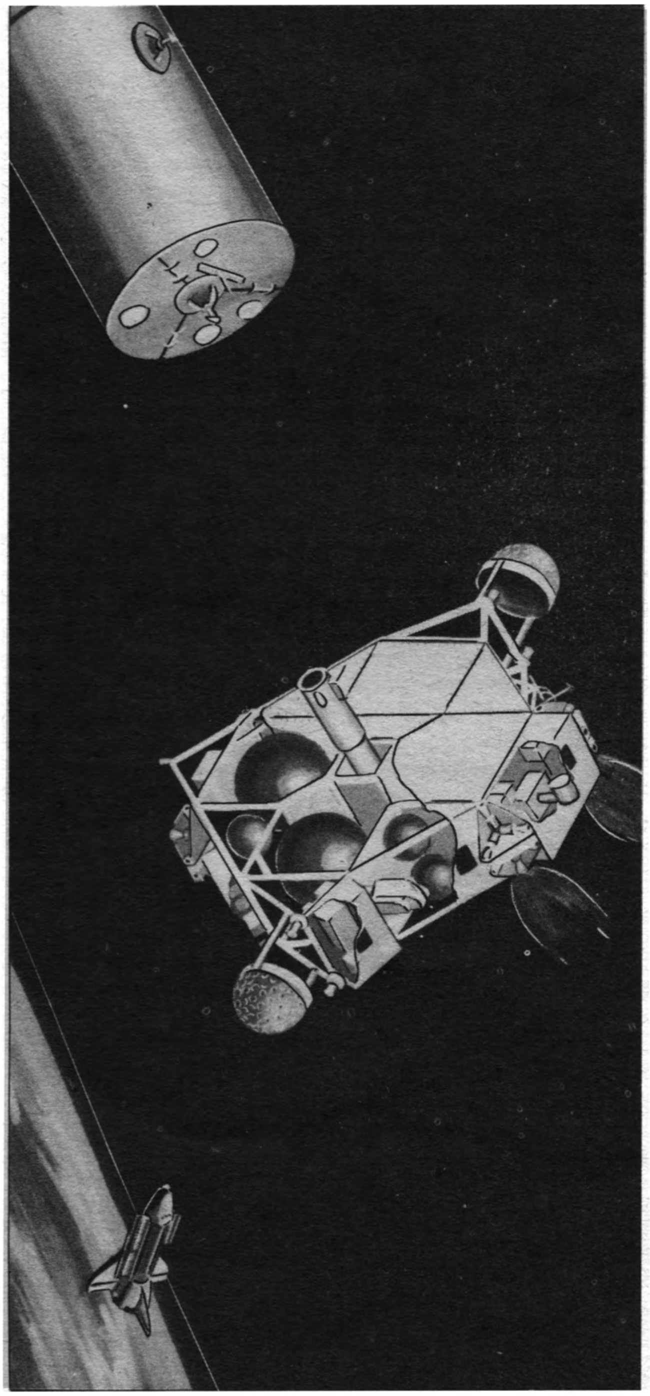
In order to prevent the satellites from drifting into different orbits they must all be at the same altitude as the Space Station. Otherwise, air drag and orbital dynamics would come into play.

There are two modes for flying near the Space Station. One is 'nesting' in which satellites are grouped around a 30 km diameter circle, possibly 500 km from the Station.

The other is 'decaying' in which the satellite is initially about 3 km above the Station and therefore moving slightly slower. By the time it is 1500 km away, its orbit will have started to decay and it will then be moving down to a lower altitude where the orbital velocity is higher. Hence, it would then start to move towards the Station. When it is back underneath the Station, an OMV will dock with it and reboost it to begin the month-long cycle again. A satellite with its own motor would be even simpler to control.

A Typical OMV Retrieval Sequence

The OMV will be an unmanned robotic stage based at the Space Station where, of course, it can be refuelled. Control will be by telepresence, in which an operator uses TV cameras on the OMV to control the stage. Robot arms will be able to replace equipment on the satellites, designed with this in mind. If more extensive work is required, the OMV will bring the satellite back to the Station, put it in a servicing bay and then move back to its berth. Two systems are being considered for the overall design of the bay. One is to attach the satellite directly to the Station, the other is to attach it to a "surrogate cargo bay" which, in turn, is fixed to the Station. The advantage of the latter approach is that the same mechanical fittings used during the satellite's Shuttle launch could be used again. A robot arm similar to the RMS (Shuttle arm) could be included to move astronauts around during repair work, in addition to their Manned Manoeuvering Units.



An artist's concept of an orbital manoeuvring vehicle about to dock with a payload in orbit. OMVs will be used to transfer payloads between orbits that the Shuttle itself cannot reach. Orbital transfer vehicles will handle the larger payloads for higher orbits. *NASA*

By Prof. John Griffith
of Lakehead University,
Ontario, Canada.

THE ORIGIN OF COMETS

Comets are among the oldest heavenly objects known yet attention was focussed almost entirely on orbit determination until around 1950 when two cometary models were put forward. Oort's hypothesis of a cloud of comets surrounding the Solar System (*Bull. Astr. Insts. Neth.,* **11,** 91, 1948) and the dirty iceball theory of Whipple (*Astrophys., J.,* **111,** 375, 1950) provided a new impetus to work in the field. Shin Yabushita of Kyoto University, writing in the *Quarterly Journal of the Royal Astronomical Society* (**24,** 430-442, 1983), examines the dynamical evolution of comets and its implications for cometary origin.

The extremely elongated orbits of comets mean that planetary pertubations have to be combined with stellar perturbations. There are probably a very large number of comets so that, rather than looking at details of an individual cometary orbit, statistical considerations are needed.

Once a comet has been observed and its oscillating orbit determined, it is possible to extend the orbit both forwards and backwards in time. With the average orbital period being a few million years and three or four new comets discovered each year there must be at least 10^7 comets presently associated with the Solar System. Note that these are only those comets whose perihelia lie within the observable region for the Solar System - perhaps within 4 AU from the Sun.

It is pointed out that the Oort cloud was postulated to contain some 10^{11} comets. When examining the effects of planetary perturbations, there are four problems to consider. Loss of comets from the Solar System, evolution from nearly parabolic to short-period orbits, evolution of the distribution of binding energy (the reciprocal of the semi-major axis) among comets and the effects of perturbations by passing stars and by giant molecular clouds are the four major topics.

Planetary perturbations are responsible for the orbits of some comets becoming hyperbolic with consequent loss from the Solar System. More than 90% of comets are expelled in 6 million years.

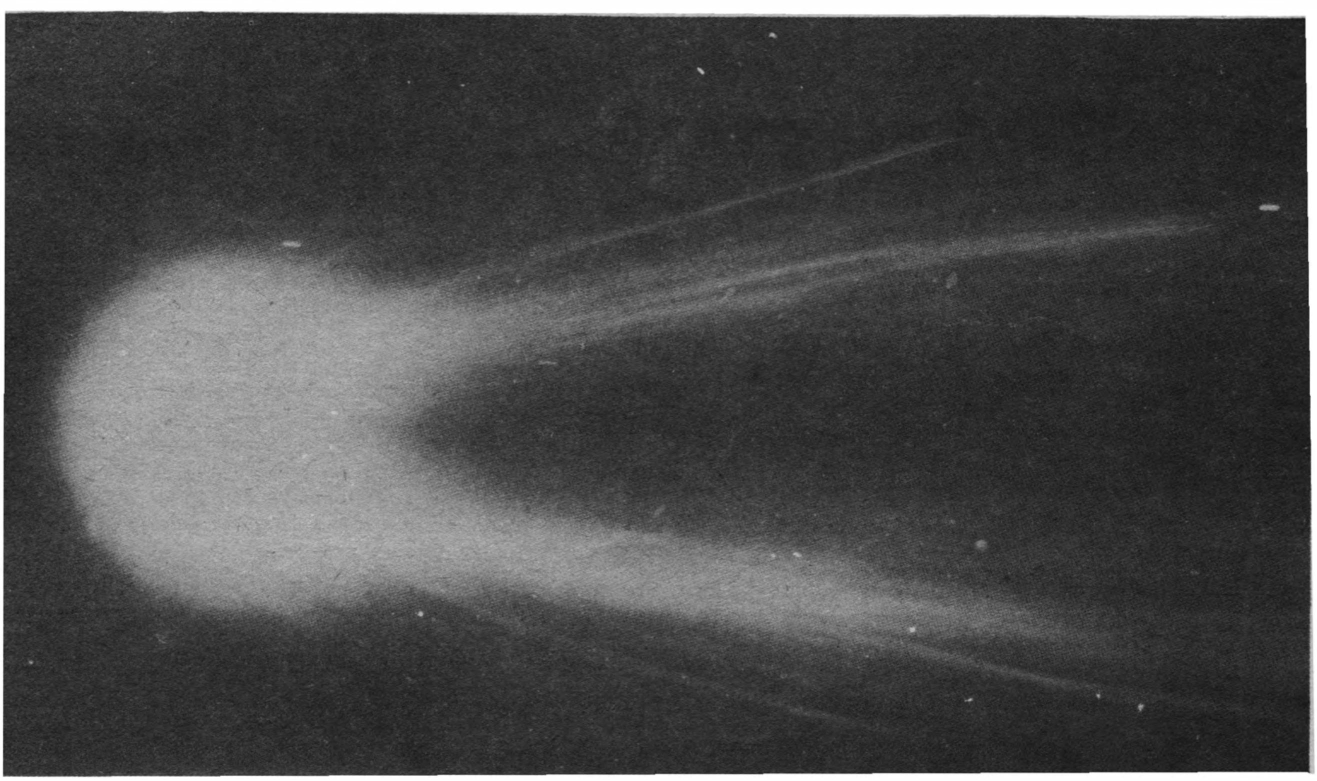
Unfortunately, our observations cover only a few hundred years so we do not know if the population is in a steady state, though the number of new comets seems too large to be consistent with the steady-state hypothesis - three out of four comets are not re-observed after their first perihelion passage.

Consideration of the many comets with semi-major axis greater than 2×10^4 AU and perihelion distance less than 4 AU leads to aphelion distances greater than 4×10^4 AU, at which distance perturbations by passing stars will be important. Oort's cloud of 10^{11} comets may be at 5×10^4 AU (about 1 light year) and would be strongly affected by encounters with giant molecular clouds of masses between 10^4 and 10^5 solar masses.

The distribution of cometary perihelion points in the celestial sphere is concentrated in the northern sky.

Even though there is no satisfactory theory for the

The appearance of Halley's comet in 1910. *Hale Observatories*



formation of comets, it is probable that they originated in the primitive solar nebula. They may have formed in the vicinity of Neptune and have been gradually repelled to the distance of the Oort cloud, but at distances beyond Neptune it seems to take too long for condensation of comets and the formation of cometary nucleii is doubtful.

Some researchers believe that intra-Solar System comets are necessary for the initial evolution of terrestrial life. The primitive Earth either had an oxydizing atmosphere or no atmosphere at all, but for organic compounds to be formed the atmosphere must be reducing. Apparently organic compounds need to be brought from somewhere outside the Earth and estimates of the need for around 100 cometary impacts have been made.

Extra-solar origin of comets by capture has also been discussed but the mechanism is uncertain. The intra- or extra-Solar System origin question may be resolved if the Giotto exploration of Halley's comet reveals differences between the isotope ratio of cometary carbon and that of Solar System material.

EARTH/COMET COLLISIONS

It has been proposed that the cause of the Cretaceous-Tertiary extinction event was due to an impact and consequent injection into the Earth's atmosphere of a large amount of extraterrestrial material. This would have led to a temporary cessation of photosynthesis (similar to the nuclear winter) and collapse of most food chains due to blockage of sunlight, a large temperature variation on a short time scale and a dramatic change in atmospheric chemistry leading to the formation of enormous quantities of toxic acids. Several similar mass extinctions are thought to have taken place and Z. Sekanina and D.K. Yeomans have investigated the frequency of encounters and collisions between the Earth and comets. They find collision rates compatible with those required for the major geolocial extinction events. The investigators both work at the Jet Propulsion Laboratory and report their work in "Close encounters and collisions of comets with the Earth," *Astronomical Journal* **89**, 154-162, 1984.

They used a computer to scan a catalogue of comet-orbits to find all instances when a comet's minimum geocentric distance was less than 2500 Earth radii. The short-period comets are strongly represented and the predicted collision rate gives a collision with an active comet every 33 to 64 million years.

They note that such collisions are considerably less frequent than collisions with asteroids. (Earth-crossing asteroids with absolute magnitude brighter than 18 are estimated to collide with the Earth once every 300,000 years)..

HUBBLE SPACE TELESCOPE

In 1986 NASA plans to launch the Hubble Space Telescope. It will be the first large aperture, long-term optical and ultraviolet observatory in space. In 1982 a special session of Commission 44 of the International Astronomical Union met in Patras, Greece, to hear details of the telescope, its capabilities and planned observations. This session was organised jointly by the European Space Agency and NASA and its deliberations are reported in NASA CP-2244.

In some respects the operation of the telescope will represent the first qualitative improvements in telescope capabilities in the optical domain since the completion in 1948 of the 200 inch Hale Telescope at Palomar Mountain. Its orbit outside the Earth's atmosphere will allow an angular resolution, a sensitivity and a wavelength coverage unachievable from the ground. Since it will be inserted into orbit and maintained or updated by the Shuttle, it is expected to remain operational for over 20 years.

Observations will be at the cutting edge of much of the astronomical research of the next decade. It will consist primarily of a 2.4 m mirror, together with appropriate instrumentation to cover wavelengths from the far ultraviolet to the far infrared.

Its operation is under the guidance of the Space Telescope Science Institute, operated by the Association of universities for Research in Astronomy, Inc. located on the campus of the Johns Hopkins University in Baltimore, Maryland.

Using the telescope, we will be able to see more details in close objects and more distant objects at a wider selection of wavelengths than is possible from the ground. "After a period of hiatus in which astronomers seemed most involved in the digestion of the results flowing from the capital investment of the previous generation, it may well be that the next two decades will be remembered as the heroic construction phase for observational astronomy."

The image surface is divided into eight segments, each supporting a specific scientific instrument or fine guidance sensor. The central region is devoted to the wide field/planetary camera which could be used for cosmological research, increasing our ability to see objects at a distance 10 times that of the 200 inch telescope. Cepheid variables should be detected in the Virgo clusters of galaxies, diameters of HII regions out to the Coma clusters as well as globular clusters and galaxies of very large red-shift. We will be able to probe into early epochs and remote parts of the observable universe and examine details of galaxies presently hidden from us. Optical counterparts of extremely distant quasars and radio galaxies should be observable.

Globular clusters in our Galaxy will be probed and examined in detail, as will the Galactic Centre.

With few planetary missions available in the foreseeable future, the Hubble Telescope will be our primary source of information on the planets. Resolution of details on Jupiter will be comparable with that available from Voyager flyby images. We will be able to obtain better observations of Pluto and its satellite. Planets moving round other stars may be detected from their gravitational effects on the positions of the stars.

Even surface details of asteroids may be observable. Supernovae should be detectable up to a redshift of about 0.3. Comet Halley will be observed. Positions of stars will be available to within a accuracy of 0.002 arcseconds, so double stars will be detectable in some spectroscopic binaries. The accuracy of measurement corresponds to about 10 km at the distance of Saturn.

The report ends with a paper by M.S. Longair of the Royal Observatory, Edinburgh in which he reflects on the impact the use of the telescope will have on astronomy. He lists "what we need to know about astronomy and cosmology" and ends with the hope that the ultimate scientific return will be as great as that emanating from the observatory of Tycho Brahe, whose work formed the basis for the laws of Kepler and the Law of Gravity of Newton.

"If we achieve with Space Telescope anything which even remotely approaches the fundamental importance of that great discovery, Space Telescope will have achieved real greatness."

ASTRONAUTICS AT LAUSANNE

The 35th Congress of the International Astronautical Federation was held in Lausanne, Switzerland on 7-13 October 1984. Len Carter, the Society's Executive Secretary, reports on the proceedings below. Further reports on the Technical Sessions will be included in later issues.

Introduction

The 35th IAF Congress held in Lausanne, in the French speaking part of Switzerland on the borders of Lake Geneva, attracted an audience of about 750. Negotiating the trip between Geneva Airport and Lausanne, and thence to the appropriate hotels at the other end of town, together with daily bus rides to and from the Congress venue itself, all proved surprisingly easy.

Congress activities were centred in the Palais de Beaulieu, a venue big enough to handle an army without overcrowding and with rooms, halls and facilities extending in so many directions that one needed to develop an acute sense of navigation at an early stage.

The Congress was held under the auspices of the Swiss Association for Space Technology, a relative newcomer to the astronautical scene and which thus explains why most of the arrangements, including an interesting exhibition, were in the hands of professional organisers - who presented a slick but impersonal touch.

Participants were able to take their pick of 61 sessions, containing nearly 500 technical papers presented by scientists and engineers from more than 30 countries. Eight technical sessions, held concurrently on most days, attracted an average attendance of 40 and demanded early development of Will-o'-the-wisp characteristics. There were also a number of social events, nearly all of which were on a fee-paying basis.

Opening Session

The first hour of the Opening Ceremony was taken up by the presentation of a host of formal messages, following the usual pattern, all read out in detail though most had already been printed in full in the official programme.

Attending the conference. From left, Jim Harford (AIAA), Dr. Les Shepherd, John McLucas and Len Carter.

The Invited Lecture was by Mr. R. Sunaryo from Indonesia, a representative of a developing country who tackled the theme of "Space to Benefit All Nations." This was taken up later in a Forum discussion, though this was not in the form of a free-for-all but rather a structured programme of four talks.

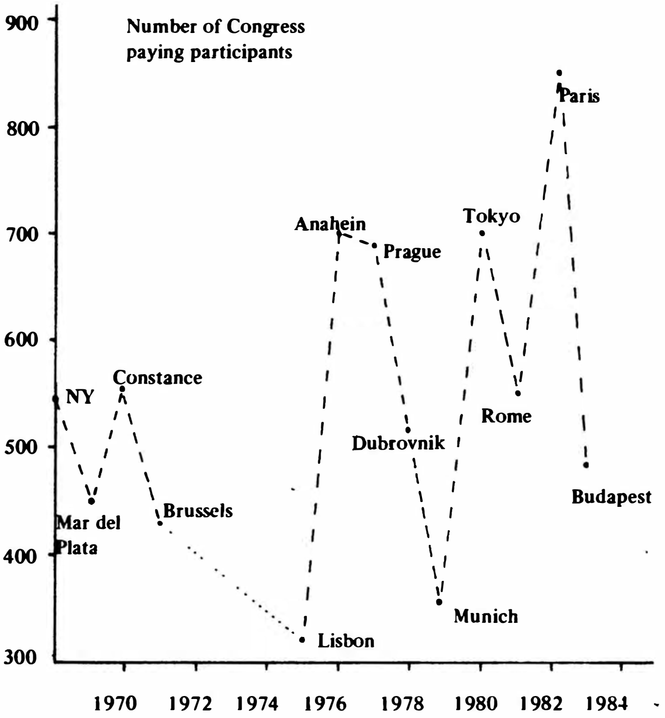
Exhibits

The immediate front entrance of the Palais was occupied by the registration and information areas, bank, postage and souvenir stalls. Behind was a very fine display of exhibits which occupied most of the hall. Brilliantly lit, attractively designed, nicely spaced out and representative of a wide range of space activities, the Shuttle and Ariane were prominent. Displays included both models and charts, as well as plenty of literature. On display were rocket motors from SEP, a 1/20th-scale Ariane 4 from Aerospatiale, a full-scale model of Giotto on the ESA stand, Spacelab was shown by MBB and the Shuttle featured prominently on the NASA stand. Dornier was one of two manufacturers displaying satellite receiving stations, the appropriate antennae being housed outside. Both were receiving pictures of Meteosat 2 and attracted considerable interest. The pictures had first been transmitted from the satellite to ESOC at Darmstadt, where they had been processed i.e. with markers and lines to indicate land masses imposed, the result then being beamed up to Meteosat 2 once more for retransmission to ground receiving stations. On return the pictures were printed out. A set of nine provided full coverage of the Earth though actually they came in three different sets, namely those depicting cloud cover, those picking up infrared and those giving a straightforward optical view. One could thus get a continuous bird's eye view of the weather over the UK throughout the Congress.

Business Sessions

The first session of the IAF General Assembly on Monday, 8 October began with a warning shot from the President indicating that he considered that the dues of the Member-Societies would have to be increased by 15% to meet the growing needs of the Federation. This was despite the fact that the accounts showed a reserve of SFr 80,000 at the present time. He considered this to be preferable to the alternative of increasing the IAF share of the Congress Registration Fee which, at Lausanne, was SFr180 out of a total fee of SFr400. The Swedish host society for the next Congress, at Stockholm, would indicate later that the Registration Fee would be raised to SFr460, but this would not involve any increase in the IAF component. This matter was returned to later in the Agenda at the second session of the Assembly.

The Agenda having been approved, the meeting turned



The number of paying participants at the IAF Congresses from 1968 to 1983 (1972-74 figures not included).

to the subject of Membership. One new application for Institutional, non-voting, membership from a Swiss company was accepted and the membership of an Italian organisation terminated, leaving the total membership, in all catagories, unaltered at 63.

The International Programme Committee for the 36th Congress, at Stockholm in 1985, was approved by the Assembly, with Dr. J.P. Layton (USA) and Dr. Y. Ryesantsev (USSR) as its Co-chairmen. The other members would be Dr. Boeff of Sweden, the Chairmen of all the IAF Committees and the appointed representatives of the IAA and IISL. This Programme Committee structure was a new one that would be followed in future Congresses.

The main activities of the IAF are now concentrated in the hands of ten scientific and technical committees as well as the important Membership and Education

The BIS delegation receives the news of the proposed 15% increase in fees.

Committees and the IAA and IISL committees. The Assembly was required to approve new general and specific Term of Reference for these, which it duly did. One of the principal duties of the committees is the organisation of the symposia and lecture sessions at the annual Congresses and it is on this account that the membership of the Programme Committee is now mainly based upon the committee chairmen.

As regards the plans for the technical sessions at the 1985 Congress, Dr. Layton indicated that his committee proposed to reduce the number of technical sessions from 61 to 54 and also aim for a lower number of papers per session.

Introducing the proposals for the 36th International Astronautical Congress in 1985, the Swedish delegate stated that this would take place in Stockholm from 6th to 13th October. The Registration Fee would be SFr460 for full participation with the IAF share remaining at SFr180, as already indicated. Students would pay SFr50 and the charge for Accompanying Persons would be SFr200. The Swedish representative gave a short illustrated talk about the Congress Venue and interesting aspects of Sweden's capital city.

It was announced that the theme of the Congress would be "Peaceful Space and the Problems of Mankind."

The provisional plans for future Congresses were put before the Assembly for information, it being noted that action on the 1986 Congress was not possible because no firm commitment had been made by any of the member-societies to play host in that year. It should be noted that it is the accepted practice in the IAF to hold its Congress in any given country at the invitation of the Voting Member Society of that country. A tentative offer had come from Indonesia but had not been backed up, so far, by any definite commitment. It was left to the Bureau to try to resolve the problem and to secure a definite offer before the General Assembly in 1985.

The situation beyond 1986 was as follows: the BIS had notified the Bureau that it was now giving firm throught to having the Congress in the UK in 1987 and hoped to be in a position to offer a firm invitation to the IAF at the next meeting of the General Assembly at Stockholm. Other offers were on the table from East Germany, India and Israel, so the possible line-up might be:

1986: Indonesia?
1987: UK
1988: East Germany
1989: India or Israel

Reports on relations with other international organisations continued to figure prominently in the deliberations of the General Assembly, though there had been a conscious attempt to streamline the presentations. The importance of these items is indicated by the growing extent to which the Federation is being drawn into the affairs of official bodies concerned with World collaboration in space. As an example, reference may be made to the IAF report which has been prepared for the UN on the international implications of Large Space Structures. The IAF was involved, increasingly, in jointly organised meetings with COSPAR and other international bodies with which it had formed firm bonds.

The President of the International Academy of Astronautics, Dr. George Mueller, reporting briefly to the Assembly, stated that membership now numbered 558, made up of 11 Honorary Members, 210 Members and 337 Corresponding Members. It was planned to increase the total by 220, all at the full membership level. The Academy was founded in September 1959 but will cele-

brate its Silver Jubillee at Stockholm in 1985. This is appropriate insofar as the inaugural meeting of the Academy was held during the 1960 Congress, also at Stockholm.

Dr. Diederiks-Verschoor, President of the International Institute of Space Law, reported on a joint meeting with the UN Committee on the Peaceful Uses of Outer Space which had been held in March. The topics had included a discussion on Nuclear Power Sources in Space. When the General Assembly returned to financial matters during its second session, the President's proposal to increase IAF-membership subscriptions by 15% had been moderated, following a further meeting of the Finance Committee, to a slightly more acceptable figure of 10%. In announcing this, Dr. Buedeler, Chairman of the Committee, recommended the acceptance of the Budget for 1983/84 and of the Estimates for 1984/85. He noted the concern of the Finance Committee not only over the dues increase but also in the escalation in the Congress Registration Fee. The need for seeking alternative sources of income thus remained a matter of great importance.

The General Assembly, somewhat grudgingly, endorsed both the proposal to increase the Membership-Fee (18 in favour; 2 against; 8 abstentions) and to accept the Registration Fees proposed for Stockholm (19 in favour; 0 against; 9 abstentions).

The final item of business at meetings of the IAF General Assembly at any Congress is the election of Officers for the ensuring year. The Nominations Committee, consisting this year of the representatives of Spain, Yugoslavia, Austria, Japan and Poland, recommended the election of the following:

President:
Dr. Jerry Grey (USA)

Vice Presidents:
Dr. R. Sunaryo (Indonesia) 2nd Term
Dr. Yang Gia Chi (China) 2nd Term
Dr. G.G. Chernyi (USSR)
Dr. Van Reet (Belgium)
Dr. Joachim (German Democratic Republic)

The General Assembly approved the recommendations of the Nominations Committee and the list was adopted *in toto.*

BIS Participation in the Organisations of IAF Affairs

As a founder member, the BIS played a dominant role in the business of the IAF throughout the 1950's. In the subsequent decade the Society's involvement in the Federation was reduced as other bodies joined and sought participating roles. Through most of the 1970's it was at a relatively low level but this trend is now reversing with members of the BIS beginning to undertake an expanding role in the work of the Federation, a situation which, hopefully, will reach a climax in 1987.

The Shuttle display.

Roy Gibson inspects the photographic display

At Lausanne the official representation of the Society in the General Assembly was again delegated to the Executive Secretary, L.J. Carter, and to our International Liason Chairman, Dr. L.R. Shepherd, whose combined experience of IAF affairs extends back to the organisation's birth. Both representatives take a fair share in the work of the Committees; L.J. Carter in the Education Committee and Dr. L.R. Shepherd as current Chairman of the Space Energy Power & Propulsion Committee (and, consequently, a member of the 1985 Programme Committee) as well as the Finance Committee. The BIS Council was also represented at the Congress by its retiring Vice-President, Dr. A.R. Martin. Several other notable members of the Society were present, some of them wearing other hats. One "old timer" deserving mention, was Eric Burgess, now of California. Such is the far-flung nature of our membership that a significant number of those present at the Congress who are qualified to wear the blue tie with its stars and rocket device, spoke with accents decidedly non-British, those with an American flavour being particularly prominent. It should also be mentioned that another Briton,who served as IAF President in 1979 and 1980, Roy Gibson, also continues to play an active role in IAF affairs.

The BIS participation extends to the Academy of Astronautics. Professor G.V. Groves served for some time on the Board of Trustees of the Academy in Section 1 and, currently, Dr. L.R. Shepherd is a member of the Board in Section 2 and is also Chairman of the newly-formed Interstellar Space Exploration Committee. Notable members of the BIS's now famous Interstellar "fellowship," Tony Martin and Alan Bond, attended the inaugural meeting of this Committee and, as Chairman of it, Dr. L.R. Shepherd also serves on the Academy's Scientific Programmes Committee. He is also a lesser member of the IAA Committee on the History of Astronautics, which has a very strong BIS presence - mostly American. Co-

The BIS delegation at work.

Chairman of the History Committee is F.C. Durant III, with Dr. John Becklake (a former Council Member) as a particularly active member of the Committee, as are non-natives Mitch Sharpe (Editor of the *JBIS* 'Astronautics History' issues) and Fred Ordway.

Our President, A.T. Lawton, serves on the CETI Committee. He was not at Lausanne but is now happily recovering from the serious indisposition that prevented him from attending. Nor it would not be forgotten that both the current and Past Presidents of the Academy of Astronautics are Honorary Fellows of the BIS.

The view of the Society's Council is that the IAF is a very important body in the field of international collaboration in space and they regard it as particularly important that it should receive the maximum support from all of its member societies.

Press

Press facilities were somewhat limited. As far as could be seen, the press had to make do with one small room so it is difficult to describe them as being fêted this time round. Press accreditation, when it *was* effected, brought no access to preprints, press handouts or material of any sort. There was no list of participants nor a Congress newspaper.

Education

One of those enjoying new Terms of Reference was the Education Committee, henceforth to be concerned with the effects of space on both the formal and informal education processes, and *vice versa.* Its brief includes specific student activities and supervised youth research experiments besides the use of satellites, spacecraft and ground-based facilities for educational purposes.

The committee's principal activity will, of course, continue to be in assembling the best possible programme for each IAF Congress with two sessions allocated for the Stockholm Congress on:

1. Space Education: uses, motivation and benefits, and
2. Space Systems and Education.

A departure from the norm appeared in the shape of a proposal for a "Young Astronaut Programme." This originated in an announcement by President Reagan designed to utilise space development to stimulate the greater study of science and technology in the US. The concept is designed to reach some 5,000 US elementary schools and be supported by an expanding NASA educational programme.

The value of such a move is self-evident. Not only would it encourage a greater pursuit of science and technology but, eventually, will create a much more technologically proficient workforce which will place the US in a commanding position in the high technology world of the future.

To what extent a similar plan will be adopted by other countries remains to be seen but, undoubtedly, it is a most excellent conception. There is no doubt that a similar project would prove of great interest to the young in the UK, as well as being applicable to other countries which support ESA. There is a greatly-expanded role for our own Society here in fostering such concepts.

The Education sessions included an interesting contribution by Dr. Bettye Burkhalter on experimentation for the Getaway Special canisters. Besides listing many valuable ideas that had surfaced in making use of these relatively small Shuttle-carried canisters, the author addressed herself to the more basic problems of how to reach those teachers and parents who ought to be involved. This, she admitted, is easier said than done and, with the US now in the midst of a major upheaval aimed at academic excellence, this aspect has slipped somewhat.

A suggested programme to put things right had three stages:

1. Educational Leadership.
2. Wide public support.
3. The involvement of classroom teachers - this being the crucial area where things actually happen.

The ingredients required were:

1. Sponsorship, presumably both government and industrial.
2. A programme for the guidance of teachers which produced the material for them to use, though it was not specified whether this was to be set out under traditional classroom subjects or apply to some of the major topics associated with space, *viz:*
   i. Computers/Robotics
   ii. Biological studies.
   iii. Technical (engineering/electronic) etc.

It looked as though point 2(i) had to be resolved first. An Apple for the teacher is long overdue. Students, nowadays, sometimes leave their teachers far behind.

An interesting contribution from the floor came from Buzz Aldrin, the Apollo 11 astronaut. He explained that he had been concerned about the generation gap since 1970, not the one due to parenthood but one that concerned the degree of curiosity in those who will inherit a different world. This stemmed very much from divergent backgrounds while growing up. The older generation had experienced a world of limitations and had been much concerned about what we could and could not do. Now, a new challenge is before us and we must explore how we can tap the resource of the new generations interested in space. If they look they will find immense possibilities but they must have confidence.

Reports on the Technical Sessions will be included in subsequent issues of Spaceflight. *The first are included overleaf.*

LOW EARTH ORBIT AND RETURN

The session provided a summary of recent developments in space transportation. Three papers were given that presented analysis and design definition to date for a new generation of expendable launch vehicles to replace the Japanese H1 and European Ariane 4. The H2 will place two tonnes in geostationary orbit and will have Lox/LH_2 first and second stages along with solid rocket boosters ignited at liftoff. The Ariane 5 will place three-four tonne satellites in geosynchronous orbit; its lower stage consists of two large solid propellant motors. The second stage is Lox/LH_2, while the third can be either storable of cryogenic. These launchers are planned for the 1990's.

The latest engineering definition for the 'Hermes' manned vehicle was described. The vehicle would be launched on Ariane 5 carrying four men and would be capable of landing at either the Guiana launch base or at other European sites. It would be used in conjunction with space stations in the late 1990's. An unmanned reusable re-entry vehicle was described in a separate paper. It could be launched by Ariane 4. Its prime purpose would be to carry materials for space manufacturing back and forth to a space platform; the preferred configuration would carry a payload mass of 650 kg and have the general shape of the Apollo command module.

A survey of the evolution of the Soviets space transportation system was presented. This included the Soyuz and Soyuz-T spacecraft for manned space transport and the Progress spacecraft for unmanned transportation. Both systems are used to support the Salyut station; further developments include the Cosmos 1443 system. To date (October 1984), 35 manned and 23 cargo spacecraft have been launched to support Salyut. The reliability of these systems using flight-proven subsystems was stressed, along with their expected continued use for a number of years.

The three final papers covered the successful testing of the Japanese H1 vehicle Lox/LH_2 propellant system, cost effectiveness of an air-launched rocket system and performance enhancement considerations for the US Space Shuttle using an aerospike concept.

C.A. ORDAHL

CETI-SETI

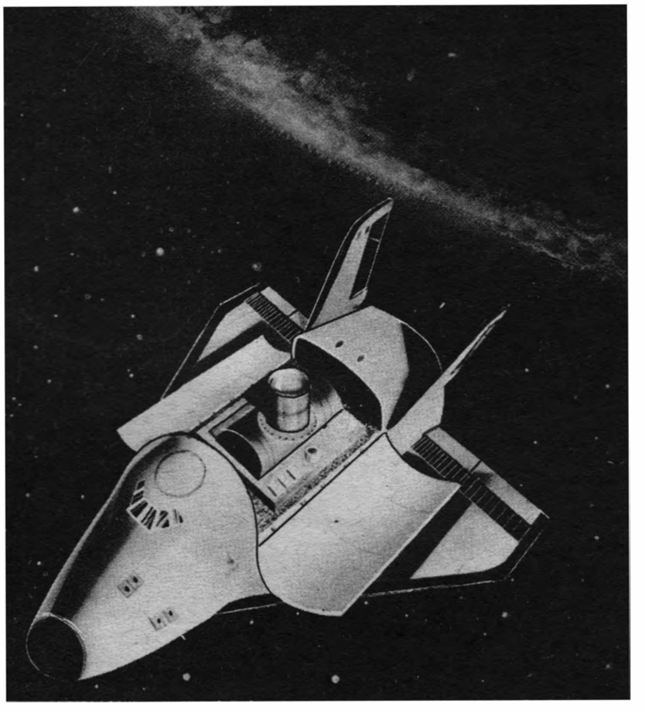
Two CETI-SETI sessions were held at the Congress, with excellent papers presented in both. C. Ponnamperuma discussed chemical evolution and the results of the search for organic molecules in space of abiotic origin. The presence of organic molecules in the atmospheres of stars and in interstellar space might be evidence that chemical evolution is commonplace in the Universe and cosmic in nature.

J. Oro described main requirements (pre-solar, solar and planetary) for the existence and evolution of life. The appropriate conditions were satisfied in the Solar System on Earth and Saturn's satellite Europa and, more ephemerally, on Mars and Venus.

M.D. Papagiannis summarised the most significant results from the first Symposium of the International Astronomical Union on the search for life in the Universe (June 1984, Boston, Mass, USA).

N. Balàza presented the results of his calculations of the habitable zones in our Galaxy and some suggestions concerning new strategies connected with this approach. A.R. Martin and A. Bond reviewed the many aspects of the Fermi Paradox concerning the existence of intelligent life ("If there are so many people out there, where are they?"). This analysis led them to the conclusion that we are alone in the whole Galaxy! B.R. Finney believed that SETI will become part of an overall expansionary process and crucial to the reconnaissance of the Galaxy for possible colonisation sites. Astronaut U. Merbold, A. Souchier and A. Ducrocq presented results of the SETI-modelling experiment on Spacelab 1.

F. Valdes and R.A. Freitas presented a paper on the search for extraterrestrial artifacts (SETA). They also reported on the unsuccessful search for the tritium hyperfine line at 1,516 MHz in 108 astronomical objects. This line is ideal for SETI work because the isotope is rare and the frequency corresponds to the well known 'water hole.'



The French 'Hermes' small shuttle concept is a possibility for the Ariane 5 project. *CNES*

D.K. Cullers presented a paper with B.M. Oliver and J.H. Wolfe on the detection of narrowband pulsed signals by a rotating beacon with a directional antenna. J. Tarter reported on the use of the very large array (VLA) synthesis radio telescopes to perform parasitic SETI when looking for radio stars. M. Subotowicz discussed the threats to CETI-SETI (and to the existence of life up to the level of homo sapiens), analysing the problem first from the standpoint of the cosmological principle.

M. SUBOTOWICZ

SPACE STATIONS AND PLATFORMS

Comprehensive discussion on the state-of-the-art and plans for technologies relevant to the Space Station and Platform were made by US, European and Japanese speakers. Highlights included:

1. Strong indications of a need for larger than previously stated electrical power supplies for the Space Station (over 175 kW).
2. De-emphasis on gallium arsenide solar cell work by the US (insofar as Space Station application is concerned).
3. Elevation of solar dynamic power supply as a serious contendor *vis a vis* photo voltaic for the Space Station.
4. Supercritical water oxidation of waste products under evaluation.
5. Broad consideration being given to utilisation of solar radiation in orbit (plant growth, illumination, recreation, health, as well as electrical power) through collection, filtering and distribution by optical fibre network.
6. Quantitative evaluation of human productivity in space. Assembly and construction under simulated orbital conditions show relatively favourable results of human productivity in EVA tasks - as compared with that expected from pre-Shuttle experience.

JOHN DISHER

SATELLITE DIGEST-180

Robert D. Christy

Continued from the January issue

A monthly listing of satellite and spacecraft launches, compiled from open sources.

The heading to each launch gives the name of the satellite, its international designation and its number in the NORAD catalogue. Launch times are given in Universal Time and are accurate to about five minutes except where marked with an asterisk, where the time is to the nearest minute as announced by the launching agency.

STS-41D 1984-93A, 15234

Launched: 1242*, 30 Aug 1984 from the Kennedy Space Center.
Spacecraft data: Delta-winged vehicle, 37 m long and 24 m across and with mass around 70 tonnes (excluding payload).
Mission: First flight of the orbiter *Discovery* after a delay caused by a fuel leak during a June launch attempt. The crew consisted of Henry Hartsfield, Michael Coats, Steven Hawley, Richard Mullane, Judith Resnik and Charles Walker. Major events were launchings of three communications satellites, testing of a 31 m long, 4 m across solar array, and drug processing. *Discovery* landed at Edwards Air Force Base on Sept 5.
Orbit: 297 x 314 km, 90.43 min, 28.47°.

SBS 4 1984-938, 15235

Launched: 2040*, 30 Aug 1984 from the payload bay of *Discovery.*
Spacecraft data: Standard Huges HS-376 vehicle, cylindrical, with length 2.82 m (6.7 m on extension of the solar array) and diameter 2.16 m. The mass in geosynchronous orbit is 1117 kg, reducing to 571 kg on depletion of fuel.
Mission: Commercial comunications satellite.
Orbit: Geosynchronous above 101° W longitude.

SYNCOM IV-2 1984-93C, 15236

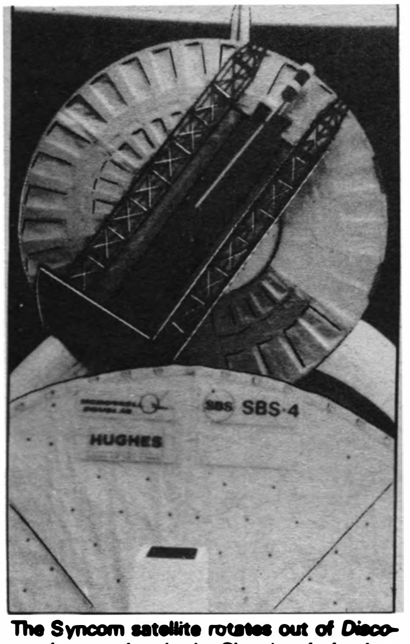
Launched: 1313*, 31 Aug 1984 fro the payload bay of *Discovery.*
Spacecraft data: Cylinder about 3 m long and 4.2 m diameter.
Mission: US Navy communications.
Orbit: Geosynchronous above 105° W longitude.

TELSTAR 3C 1984-93D, 15237

Launched: 1320*, 1 Sep 1984 from the payload bay of *Discovery.*
Spacecraft data: Similar to SBS 4 except dimensions are 2.77 m, 6.83 m and 2.16 m, and the masses 1225 kg and 653 kg, respectively.
Mission: Communications satellite.
Orbit: Geosynchronous above 125° W longitude.

COSMOS 1592 1984-94A, 15257

Launched: 1020, 4 Sep 1984 from Plesetsk by A-2.
Spacecraft data: Possibly based on the Vostok manned spacecraft with spherical re-entry module, instrument unit and a cylindrical, supplementary payload at the forward end. Length 6 m, max diameter 2 m and mass around 6000 kg.
Mission: Military photo-reconnaissance,



The Syncom satellite rotates out of Discovery's cargo bay in the Shuttle mission last August.

recovered after 14 days.
Orbit: 225 x 287 km, 89.67 min, 72.88°.

COSMOS 1593-1595 1984-95A-C, 15259-61

Launched: 1550, 4 Sep 1984 from Tyuratam by D-1-E.
Spacecraft data: Possibly each satellite is a cylinder with domed ends, covered in a drum-shaped solar array with length and diameter both about 2 m, the mass may be around 700 kg.
Mission: Triple launch of satellites in the GLONASS navigation system.
Orbit: 19090 x 19170 km, 675.73 min, 64.79°.

COSMOS 1596 1984-96A, 15267

Launched: 1913, 7 Sep 1984 from Plesetsk by A-2-e.
Spacecraft data: Possibly similar to the Molniya satellites, having a cylindrical body with a conical motor section at one end with power being provided by a 'windmill' of six panels. Length about 4 m, diameter 1.6 m and mass around 2000 kg.
Mission: Missile early warning satellite.
Orbit: Initially 604 x 39248 km, 707.61 min, 62.95° then raised to 718 min period to ensure daily ground track repeats.

NAVSTAR 10 1984-97A, 15271

Launched: 2150, 8 Sep 1984 from Vandenberg AFB by Atlas.
Spacecraft data: Box-shaped body, approx 2 m on each side with two solar panels, mass around 800 kg.
Mission: Navigation satellite.
Orbit: 19956 x 20409 km, 718.01 min, 63.26°.

CHINA 16 1984-98A, 15279

Launched: 0545, 12 Sep 1984 from Shuang Cheng Tse by FB-1.
Spacecraft data: Not available.
Mission: Possibly remote sensing or photo-reconnaissance, a capsule was probably recovered on Sep 17.
Orbit: 174 x 400 km, 90.27 min, 67.94°.

COSMOS 1597 1984-99A, 15287

Launched: 1025, 12 Sep 1984 from Plesetsk by A-2.
Spacecraft data: Similar to Cosmos 1592.
Mission: Photo-reconnaissance, all or part of the payload was an Earth resources package. Recovered after 13 days.
Orbit: 211 x 244 km, 89.12 min, 82.34°.

COSMOS 1598 1984-100A, 15292

Launched: 1554, 13 Sep 1984 from Plesetsk by C-1.
Spacecraft data: Similar to Cosmos 1593.
Mission: Navigation satellite.
Orbit: 970 x 1016 km, 105.02 min, 82.94°.

GALAXY 3 1984-101A, 15308

Launched: 2220, 21 Sep 1984 from Cape Canaveral by Delta.
Spacecraft data: Similar to SBS 4 except masses are 1218 kg and 520 kg.
Mission: Commercial communications satellite.
Orbit: Geosynchronous above 93.5° W longitude.

COSMOS 1599 1984-102A, 15318

Launched: 1430, 5 Sep 1984 freom Plesetsk by A-2.
Spacecraft data: Possibly similar to Cosmos 1592.
Mission: Long life, military photo-reconnaissance.
Orbit: 180 x 327 km, 89.58 min, 67.14°.

COSMOS 1600 1984-103A, 15324

Launched: 0810, 27 Sep 1984 from Tyuratam by A-2.
Spacecraft data: Similar to Cosmos 1592.
Mission: Military photo-reconnaissance, recovered after 14 days.
Orbit: 349 x 416 km, 92.22 min, 68.98°.

FROM THE SECRETARY'S DESK

Eurospace and ESA

I was very pleased to see the developing Eurospace-ESA accord, exemplified by a recent *Spaceflight* Editorial, for our Society has always been very close to both organisations.

The origin of Eurospace really stems from the activities of the late Michael Golovine, BIS President at the end of the 1950's and an incredibly active internationalist. He got in touch with M. Cristofini of SEREB to suggest a joint study designed to open up fruitful international space ventures e.g. communications satellites, reconnaissance satellites and many supporting technical studies.

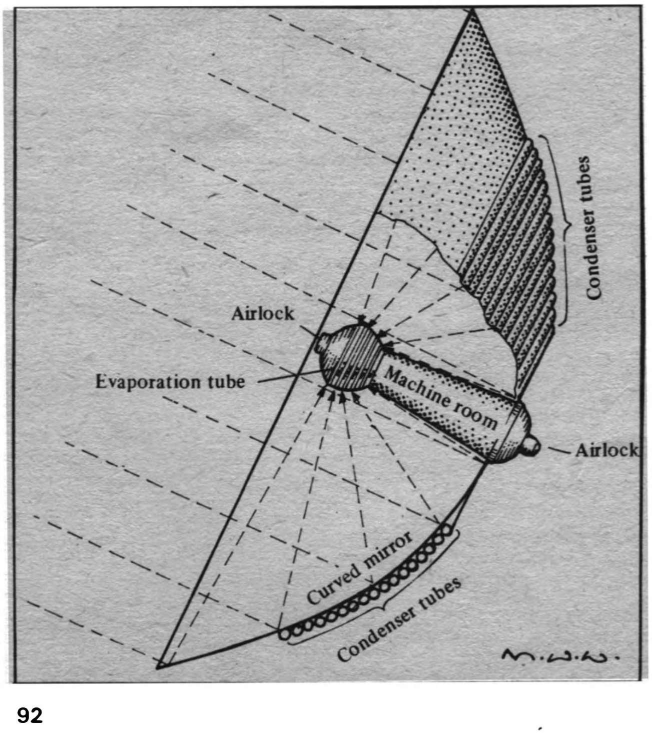
The study attracted little notice at the time but collaboration between Hawker Siddley Aviation (later British Aerospace) and SEREB (later Sud-Aviation) fuelled the interest of other companies. In no time at all the group had grown to 18 Anglo-French companies and, before long, many other companies from all over Europe became involved, thus leading to the creation of EUROSPACE.

Space Station Update

We have, at last, secured a copy of the famous book by Hermann Noordung published in 1929 called *Das Problem Der Befahrung Des Weltraums: Der Raketen-Motor.*

This was a book to which the pre-war BIS Technical Committee frequently referred, though none had actually seen it, for the simple reason that no copies were available. The most they had to go on were *reports* of what the book contained! To a large extent, doubtless, the later BIS space station designs were influenced by the ideas of Noordung (actually this was a pseudonym for an Austrian named Potocnic) even though they were at least one stage removed and without sight of his actual drawings.

Now, after decades, we have secured a copy and are pleased, for the record, to reproduce one of the space station drawings taken from it.



Souvenir Plates

Not many space souvenirs have emanated from the UK so far, so it is all the more delightful to record that Royal Doulton commemorated the Space Shuttle *Discovery* launch on 25 June with the production of bone china plates. In fact, the Shuttle actually carried three of these. All are now on permanent exhibition, one being aboard the ship *RRS Discovery* - now berthed at St. Catherine's Dock, London, as part of the collection of historic ships - so providing an historic link with another mission of 83 years ago when Captain Scott led his expedition to the Antarctic. This *Discovery* had also used fine china made by the same company so it was all the more apt for the Shuttle plates to include the emblem of Captain Scott's expedition - used to decorate the original china - as well as the flight patch of the Shuttle itself.

(A 5-inch reproduction of the plate is now available from many shops at £7.95).

Gourmet's Delight

Generous compliments have often been made about Society events involving meals, Banquets and Dinners. How do we do it?

It began long ago when the Council arranged the first function of this type. I was totally inexperienced and without the slightest notion where to begin. As time pressed, I sought guidance from the Council and received in return 12 totally different concepts - all completely at variance with each other.

In desperation I chose a menu and wines to give me the finest feed-up for years and then waited for roars of complaint. None came, so I have done the same thing ever since.

Sometimes, apparently insurmountable obstacles appear. Once such took place at the IAF Congress in Barcelona where the BIS had to provide a Dinner at the Ritz to selected guests. The menu was unintelligible and the dishes unknown. The impasse was resolved simply

by asking the Manager to produce a meal to my own satisfaction.

It was the same at the IAF Congress in Stockholm, where the local phraseology was even more outlandish. One variation which took place then was that we dispensed with formal speeches. *Everyone* present (there were about 30 of them) spoke as and when the Spirit moved him, rather in the manner of the early Congregational Churches. The requirement was simply "to ding one's glass" make a few suitable remarks and depart gracefully.

I remained to the end, solely from a sense of duty.

Going like Hot Cakes

Members of the Society interested in extending their Library collections should secure a copy of the Society's List of Surplus Books for sale. Those who have availed themselves of this so far (the lists are updated every month or so) appear to be well-satisfied, judging by the number of books sold.

Our latest list features many technical, US Government and other Reports, not normally easily available so the opportunity to obtain them should not be missed.

Would-be purchasers are emerging from as far afield as Australia, New Zealand and America.

At this rate, I doubt if we shall find enough books to satisfy everyone.

Space Coins and Medallions

Recent correspondence in *Spaceflight* about coins and medallions on astronomical and space subjects has made me seek more information on this very interesting topic. To what extent older coins and medallions are still around has yet to be seen but a catalogue of the Library of the American Numismatic Society, for example, proves that they have appeared in a steady stream from Greek and Roman times.

Few members will have the opportunity of digging back in time to secure some of the older items and, if they do, they will be very lucky indeed, but a new and expanding field is opening up, with collectable items of all sorts coming on to the market and providing a hobby which many can enjoy.

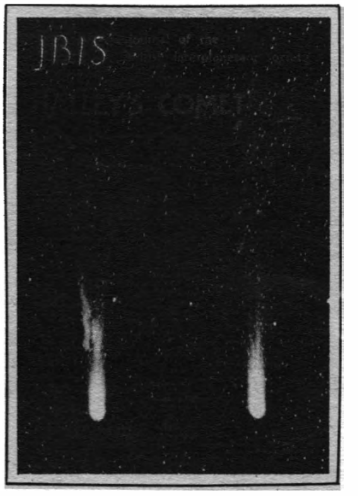
All this has prompted me to put pen to paper and to describe some of the results of my enquiries in an article to appear in *Space Education*.

Halley's Comet

Our normal suave exterior collapsed, momentarily, on reading the September 1984 issue of the "Halley's Comet Watch Newsletter" commenting on the January 1984 "Halley's Comet issue of *JBIS*". At the risk of blushing profusely I quote two extracts:

> "By reading this issue of *JBIS* completely, one could learn just about everything there is to know about Halley's comet. We found the issue even more comprehensive than some of the books currently available..."
>
> "Editor L.J. Carter and The British Interplanetary Society can be proud of the masterpiece they produced in the January 1984 issue of their Journal. If you want to experience "Halleymania" during the next two years as a fully-informed participant, then you should take the time to read this publication from cover to cover."

Members who would like to secure this *JBIS* issue as a souvenir (at £2 or $4, post free) should order without delay now as only a few are left. However, some completely new ground will be trod this year when we publish the papers by Dr. F.R. Stephenson on the early Chinese records of the appearances of Halley's comet from prehistoric times to the Middle Ages. As far as I know, this has never been written up before so a really fascinating account of the comet, as seen through Eastern eyes, will emerge for the first time. Dr. Stephenson has even gone one stage further than merely providing the text: he has prepared a whole series of maps showing the path of the comet in the sky for each return, as it would have appeared to these early observers.



The cover of the January 1984 'Halley's Comet' *JBIS* special issue. A few copies are still available at a cost of £2 ($4) each, post free.

Sign of the Times

The Society recently acquired a "calendar medallion' for the year 1758. The purpose of such medallions was to provide a guide to the days of the month, as well as such other useful information as could be included near the rim e.g. dates of the old Quarter Days. This one is particularly interesting because 1758 was the year when Halley's comet was due to make its first predicted return, an event awaited with mounting excitement for, if comets really did move in elliptical paths, their days as harbingers of fire, death and disease were numbered.

The occasion obviously rubbed on to "D. Silk. Astron." the maker of the medallion - for he has engraved in the margin the words "This year expect the Comete Without Danger."

Halley's comet was actually rediscovered in the Christmas of that year.

Generally Sunny...

Not just a natural disposition but the weather we expect to encounter during our South African trip to see the return of Halley's comet. Other surprises will be in store, too, with the Milky Way as a brilliant white band, almost dazzling, the Coal Sack - and Orion upside down!

Accommodation will be in first class hotels, except during the visits to Kruger National Park and Hazyview, where accommodation will be in rest houses. For the greatest convenience of all, it has now been decided to restrict the numbers participating to not more than 40 i.e. just one coach.

A detailed itinerary for members planning to go and is now available on request.

A portent of things to come took the form of Mr. Glasheen of Tetrovision Productions, collecting information for a two-part film entitled "Halley's Comet to Australia." The first was to show returns of the comet up to 1910 and the second to include not only the

production and launch of Giotto but also a record of the scientific results, and thus provide a complete coverage.

The Premiére will probably be in the new Space Theatre being built in Paris which, with the one just completed in the Hague, now brings the total of Space Theatres to about 15. We haven't anything like this in the UK though a good site exists at Greenwich, near the complex of the old Greenwich Observatory buildings and the National Maritime Museum.

Arc-lights

Deane Davis has thrown new light on the perils of public speaking. His occasion was back in the days following the successful Surveyor flights. Those involved were much in demand as public speakers. Briefings for particularly important VIP's took place in the Convair Presentation Room. On this occasion, Deane was deputed to do his stuff and found himself standing in the spotlights before no less than the President of Convair and a galaxy of Serving Officers.

At that time polyesters were being introduced into mens clothing. These early materials had a habit of unravelling though, with care, offending loose threads could be burned off quickly with a cigarette lighter, the trick lying in the ability to control the flame.

Deane was wearing a new pair of these 50% polyester trousers. During a lull in the proceedings he noticed a thread spilling out from his trousers so he reached down to give it a quick blast with his lighter. At that point a slide came on which read, in large red letters "Launch." For effect, Deane bellowed out the word. Unfortunately, it was accompanied by a sheet of flame belching up from his trousers, with the result that most of his audience found themselves beating out the flames with their caps. Luckily, he was wearing good English woollen stockings at the time.

As the smoke cleared and with the smell of singed fabric still in the air, Deane finished his talk and stood at the door to say "Goodbye" to his audience. They left in silence. The last to go, was a sympathetic Colonel.

He covered Deane's singed hands with his own singed hands and whispered *"Joan, hang in there!"*

[*Joan of Arc was burnt at the stake*—Ed.]

Lectures

With the advent of TV and video the heyday of the public lecture has probably now gone, though exciting events many of them were. One curious lecture I undertook was to a deaf audience. This seemed to present problems but they were overcome by an "interpreter" who translated the talk into sign language. My normal gobbledegook increases with enthusiasm and here the audience became so enthusiastic that the arms of the interpreter flailed like windmills as he put the message across.

To what extent he succeeded I never discovered but, beyond doubt, the audience gleaned sufficient to know what it was all about, as evidence by a cascade of questions afterwards.

In retrospect, this was probably one of my most enthusiastic audiences, yet they probably hadn't heard a word I said. If there is a moral in this, please don't tell me.

Taking up Spacc

The good offices of Andrew Matthewman alerted us to the possibility of obtaining a one-eighth scale model of the Shuttle. This worked out to a craft about 15 ft long, 10 ft wide and weighing 3 cwt, mounted at an angle on an alloy frame built for and owned by the Hepworth Iron Company of Sheffield.

Almost, but not cuite. The ⅛th Shuttle model proved to be just too much for our HQ. *The Yorkshire Post*

The opportunity was not one to be missed, particularly as there was free delivery, too. More good news was that the owners were prepared to donate the model to us. The bad was that we hadn't got the space for it and it was too heavy for us to manoeuvre.

Like fishermen, we can now always describe the really big one that got away.

Music of the Spheres

Cheerfully ignoring all warnings that I was tone deaf (even stone deaf, when it suits me) Doug Girling found a sizeable quantity of pro-space songs and "since the BIS has a reputation for promoting space awareness through its past involvement with science fiction" he belaboured me with a gift - in the form of several tape recordings.

I listened with mixed feelings, in view of some of the titles e.g. "Space heroes and other Fools," "Hymn to Breaking Strain" and "One Way to Go," though "Apollo Lost" brought on a slight touch of nostalgia.

No wiser than before, I consigned the lot to Wally Horwood whose claim to fame rests on the fact that he wrote a book about Adolf Sax, the developer (if that's the right word) of the saxophone. Opening it at random the other day, I read that Sax advocated an enormous Saxophone as a weapon of war, either to deafen the enemy or blow them back the way they came. I can't remember exactly. Wally sent back a glowing testimony.

So there you are. We space folk now have a space lore.

Society Motto

Readers will be relieved to know that I have found at last, a Society motto which satisfactorily sums up its aims, philosophies and acts - all at the same time.

It wasn't far to look: actually it appeared in the 'Secretary's Desk' for November. The motto comes from H.G. Wells' "Things to come" and simply says:

"The Universe, or Nothing."

There is little left unsaid. I feel sure the late Harry Ross, who first sparked off the discussion, would have approved of the choice.

BOOK NOTICES

Conquest
D. Baker, Windward Books (WHS Distributors), St. John's House, East St, Leicester LE1 6NE., 1984, pp.191, £9.95.

The author, well known to *Spaceflight* readers for many years, has produced a well-written, concise account of the Space Age for the general reader. He covers, in six chapters, the origins and basics of astronautics, the first steps in space, the exploration of the Moon and planets, space stations and the Shuttle, concluding with 10 appendices listing the world's rockets, space flights and astronauts.

It is not a book for the space enthusiast alone but an attractive volume to be read by the layman wishing to know more about space.

Entering Space - An Astronaut's Odyssey
J.P. Allen, Orbis Publishing Ltd, 20-22 Bedfordbury, London WC2N 4BT, 1984, 223pp, £15.

J.P. Allen made his first journey into space in November 1982 on the fifth flight of the Shuttle, *Columbia*. Here he provides a first-hand insight into manned space travel by providing a detailed account of the Shuttle flight from the tension of the countdown and launch to the challenges of living and working in space and then the dramatic descent and landing.

The book is particularly noteworthy for its collection of over 200 colour photographs, many not reproduced elsewhere and which dominate the book. To be fair, the book ranges far beyond the Shuttle flight alone, insofar as an extra chapter has been inserted on both manned and unmanned exploration of the Solar System.

Atlas of the Night Sky
S. Dunlop, Newnes Books, 84-88 The Centre, Feltham, Middlesex TW13 4BH, 1984, 80pp, £4.95.

This is a large-format atlas for the amateur astronomer showing the positions of the various constellations in the night sky. It includes a complete series of charts for both the northern and southern hemispheres for the Epoch 2000: most charts, up to now, have been based on the Epoch 1950.

The volume also contains descriptive text for all 88 constellations, arranged in alphabetical order. There are several practical sections on observing the Sun and Moon, including a specially-drawn lunar map.

The section on the planets shows how to plot their positions until the year 2000, and concludes with a chart showing the path of Halley's comet from November 1985 to May 1986.

The Society (with its address) is listed in an appendix, though neither *Spaceflight* nor *Space Education* (nor even *JBIS!*) appear in the list of relevant magazines though all three feature extensive material on planetary and stellar studies.

International Security Dimensions of Space
(Eds) U. Ra'anan and R.L. Pfaltzgraff, Jr., CLIO Distribution Services, 55 St. Thomas' Street, Oxford OX1 1JG, 1984, 324pp, £33.84

The object of this volume is to point out that, despite the current success of the Space Shuttle, the US still faces major weaknesses in its ability to make effective use of outer space - whether for commerce or national security.

The implications of this are so enormous that a number of contributors representing a wide spectrum of American thought have provided papers which revolve around such topics as space as a high frontier for strategic defence, the technological and operational aspects of space systems, and space as a military environment and as an area where policy decisions must be made on matters of security.

It it now commonplace for observations and communications to be conducted *via* space, some operated for civilian use and others for military purposes. Deployment in Earth orbit of weapons of mass destruction is prohibited by treaty, even though this agreement is largely symbolic because it is not clear, at this stage, whether nuclear weapons deployed in Earth orbit possess real military value. Even so, the treaty mentions no other weapons e.g. anti-satellite weapons.

Over the next two decades manned bases in Earth orbit, from which all kinds of space operations will be conducted, will undoubtedly emerge both from the US and USSR. If such programmes could be internationalised at an early stage, the risk of usage for military purposes would probably be greatly reduced.

Contributions in the volume review many aspects of such developments, ranging from near-Earth to slightly more exotic areas.

The comment on past UK space activities seems very apt. It runs: "In the first decade or so after World War II, Britain established an early lead in the development of large boosters but it failed to capitalise on this leadership and, during the 1970's fell behind France and the Federal Republic of Germany in its commitment to space activities. Now, after a period of comparative apathy on the subject, the British Government is showing new vitality concerning space projects in the 1980's and 1990's..."

This book provides abundant further reasons why such a course is highly desirable.

Saturn
Ed. T. Gehrels and M.S. Matthews, University of Arizona Press, 1615 E. Speedway, Tucson, Arizona 85719, U.S.A., 968pp, 1984, $37.50.

A team of 77 authors, most of whom were participants in the Pioneer and Voyager missions to Saturn, present a wealth of data on their analyses regarding Saturn's atmosphere and interior as well as its magnetosphere, rings and satellites.

The Saturn system is undoubtedly the most complex in the solar system. Indeed, one might be forgiven for thinking that the recent probe discoveries have added more to its complexity than was hitherto known. Its unique character was recognised with the discovery of its rings by Galileo in 1610 and, as time went by, it was established to be a giant gaseous planet encircled by three main rings containing centimetre-sized ice-covered particles and a number of satellites. One of these, Titan, was known to be a planetary-sized body with a substantial atmosphere containing methane, which explains why three chapters in the book are devoted to this satellite alone. The flybys in 1979, 1980 and 1981 added an enormous amount of additional information, with the result that, incidentally, the orbits of no less than 17 satellites are currently well known besides several others which have been rather less well-determined.

This book is a compendium of all that is currently known about the planet and its satellites and, although highly technical in parts, is easily the best compendium on the subject currently available.

Annual Review of Astronomy and Astrophysics Vol. 22
Ed. G. Burbidge, *et al*, Annual Reviews, Inc., 4139 El Camino Way, Palo Alto, California 94306, USA, 1984, 635pp, $47.

Once again we welcome this annual compilation of a selection of essays on important developments in astronomy during the past year or so. The present volume contains 20 such contributions though the first contribution is more in the nature

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Most of the above notes are not reviews in the ordinary sense but have been extracted from information provided by the publishers and/or authors, amplified by further brief comment where appropriate.

of an autobiography of Dr. Greenstein. As previously, the wealth of contributions is concerned mainly with developments in stellar astronomy and with our Sun, in this respect, considered more as a nearby star and rating three contributions. Particularly interesting is the contribution on alternatives to the "Big Bang." The latter has reached such acceptance lately that one was hard put to find anyone left willing to put forward some alternative hypotheses. Fortunately, several other choices appear in this contribution.

All contributions are eminently readable but do not pander to the current vogue for plenty of pictures, full colour, low information-content and not much reading matter. What we have here is a collection of contributions which put across the results of substantial research. As such, they are directed to readers who need solid text without any frills.

AAS PUBLICATIONS
All are available from Univelt Limited, P.O. Box 28130, San Diego, CA 92128, California, USA.

Space and Society - Challenges and Choices
Vol. 59, Science and Technology Series, Eds. P. Anaejionu, *et al, 442pp, 1984,* h/c $55, s/c $35.

Proceedings of a conference held 14-16 April 1982 at the University of Texas at Austin. Subjects included are American government and space, political economics and space, foreign space programs, space applications and the future.

Space Safety and Rescue 1982-3
Vol. 58, Science and Technology Series, Ed. G.W. Heath, 1984, 378pp, h/c $50, s/c $40.

Based on symposia of the International Academy of Astronautics held in conjunction with the 33rd and 34th International Astronautical Congresses, Paris, France, Sept. 27 - Oct. 2, 1982, and Budapest, Hungary, Oct. 10-15, 1983. An update of space safety and rescue technology including orbital debris hazards, astronaut and systems safety, psychology and safety of weightlessness, law applications and medical-biological radiation hazards in Earth orbits. Worldwide disaster response, rescue and safety employing space-borne systems includes satellite search and rescue systems, international systems, satellite emergency communication systems, and much more.

Guidance and Control 1984
Vol. 55, Advances in the Astronautical Sciences, Eds. R.D. Culp and P.S. Stafford, 1984, 500pp, h/c $60, s/c $50, Microfiche Suppl. $15.

This volume is based on the Annual Rocky Mountain Guidance and Control Conference held 4-8 February 1984 at Keystone, Colorado. It includes sessions on international space programs, storyboard papers/display, rendezvous, docking and orbit servicing, vehicle guidance, control, and payload effects, and recent experiences. These annual meetings provide a forum for recent and new developments in guidance and control.

Astronomical Objects for Southern Telescopes
E.J. Hartung, Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge, CB2 2RU, 138pp, 1984, £8.95

This is the latest edition of a reference book which has enjoyed enormous popularity as a handbook for amateur observers of the Southern sky. Five introductory chapters discuss, briefly, the various types of objects available for study, followed by tables and descriptions of over 1,000 of the more interesting and attractive objects between the South Pole and 50° N declination.

The book is primarily an aid to observation, hence many references to the equipment actually used by the author over many years.

Mathematical Astronomy in Copernicus' *De Revolutionibus*
N.M. Swerdlow and O. Neugebauer, Springer-Verlag GmbH, Heidelberger Platz 3, Postfach, D-1000 Berlin 33, Germany., 1984, 711pp (In two parts, not available separately), $88.80.

Copernicus was born in 1473 at Torun, then an important island city of the Hanseatic League. Doubtless he learned astronomy at the University of Cracow which he attended until the age of 22 for his earliest dated observation (an occulation of Aldebaran) was made on 9 March 1497. His new theory was conceived about 1510. By the early 1530s knowledge of this was circulating in Europe and was soon to reach the Vatican. The astronomer Clavius (1537-1612) was a supporter of the Ptolemaic system and an opponent of Copernicus. In his *In Sphaerum Ioannis de Sacro Bosco Commentarius* he was apparently the first to accuse Copernicus not only of having presented a physically absurd doctrine but also of having contradicted numerous scriptural passages, though the friendship between Clavius and Galileo began when Galileo was 23, remained unimpaired through Clavius' life.

This important work is a technical exposition of the mathematical astronomy of *De Revolutionibus* and its relation to earlier works in the Ptolemaic tradition known to Copernicus. It is concerned with the object, development and the limitations of *De Revolutionibus* by setting out as completely as possible the demonstrations which it presents. The first part of the current work contains the printed text, the observations and reduction of observations. The second part contains a list of symbols, parameters and all 204 figures.

De Revolutionibus was published in Nurenberg in 1543. Except for the inclusion of a star catalogue at the end of book two, the first two books of *De Revolutionibus* correspond to the order of subjects in Ptolemy's *Almagest* e.g. the first 11 chapters of book one are devoted to a general description of the Universe and of the location and motions of the Earth. Here, Copernicus attempts to defend the motion of the Earth, specifically its daily rotation, against objections. His argument, spread through several chapters, is that the Earth is spherical and rotates uniformly around its axis.

DO YOU REMEMBER?

25 Years Ago...
21 January 1960. Rhesus monkey Miss Sam is launched aboard Little Joe 1B for a Mercury spacecraft launch escape system test. Both capsule and passenger were recovered safely following the 8½ minute flight.

20 Years Ago...
19 January 1965. The unmanned Gemini 2 completes a successful sub-orbital flight to qualify the spacecraft for human occupants.

15 Years Ago...
11 February 1970. Japan becomes the fourth nation after the USSR, USA and France to launch an artificial satellite. The 24 kg satellite, Ohsumi, was an engineering test for the launching of a scientific payload.

10 Years Ago...
8 February 1975. A Soviet party, including cosmonauts Leonov and Kubasov, visit Kennedy Space Center for a three day tour. They inspected the Saturn 1B and Apollo CSM to be used during the Apoll-Soyuz mission later in the year.

5 Years Ago...
14 February 1980. NASA's Solar Maximum Mission satellite is launched into a 566 km orbit to observe solar flares at the peak of the Sun's 11 year cycle. It was the first satellite to use the multi-mission modular spacecraft bus to allow in-orbit refurbishment - as successfully demonstrated during Shuttle mission 41C in April 1984.

K.T. WILSON

EXPLORING THE MAGNETOSPHERE

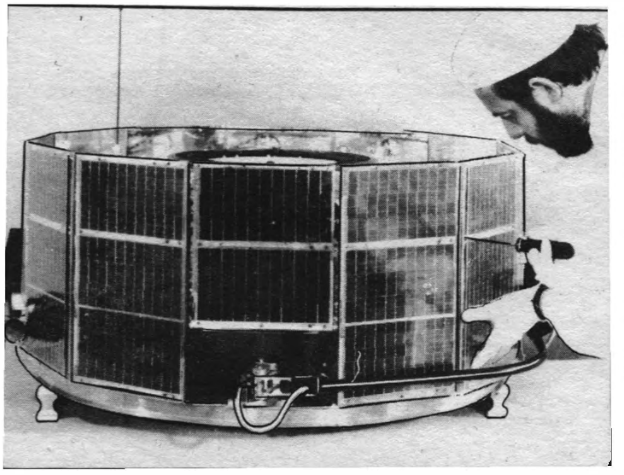
The Society has invited a Rutherford Appleton Laboratory scientist to discuss a current space experiment that is providing a wealth of new data. Dr. Duncan Bryant, the AMPTE United Kingdom Satellite Project Scientist, will describe the background to this exciting project and give an initial survey of the basic results.

AMPTE (Active Magnetosphere Particle Tracer Explorer) is a three-satellite programme launched last August and designed to explore the complex region of charged particles and magnetic fields (the magnetosphere) that envelops the Earth out to distances beyond 100,000 km. This region, as well as being of great scientific interest, protects Earth from the solar wind.

Built jointly by the Rutherford Appleton Laboratory in Oxfordshire and the Mullard Space Science Laboratory of University College London, the UKS satellite is the British contribution.

The German 'Ion Release Module' has ejected canisters of barium and lithium tracer elements for detection by UKS and the US 'Charge Composition Explorer' patrolling much nearer to Earth. Artificial aurorae and a comet have thus been created for study by scientists.

Admission to the talk at Society HQ on **1 May 1985**, 7.00-9.00 p.m. is by ticket only, available from the Executive Secretary, The British Interplanetary Society, 27/29 South Lambeth Road, London SW8 1SZ. Please enclose s.a.e.



The British UKS satellite of the AMPTE project. *RAL*

SURPLUS LIBRARY BOOKS

We have a number of surplus Library Books and Reports on astronomy and space that are being offered at very low prices. To secure a list of those available, simply send a reply-paid envelope with your request to The British Interplanetary Society, 27/29 South Lambeth Rd, London SW8 1SZ. If you spend £20 or more you may deduct a 10% discount.

Please enclose a 20p stamp and specify if you require the Book List, Technical Report List, or both.

BADGES

A range of badges with the Society's motif is available.

Enamel lapel badges (2.5 cm diameter) cost just £1 ($2) each.

A special metal car badge adds that distinguished look to any vehicle for only £3 (£3.50 or $6 abroad).

The Library Committee is endeavouring to build up its collection of first-day covers on

SPACE AND ASTRONOMY

We would welcome hearing from any members with items like this for disposal and willing to give or sell them to the Society.

All manner of items will be considered but the Society has a particular interest at present in securing covers ranging from pre-war launchings to the manned Mercury and Gemini flights.

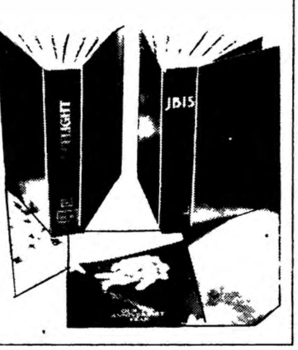
Please contact the Executive Secretary if you think you can help.

BACK ISSUES

The Society has available some bound and unbound complete *JBIS* volumes for sale. For a list of those available, and their prices, please send a stamped addressed envelope to The Executive Secretary, The British Interplanetary Society, 27/29 South Lambeth Road, London, SW8 1SZ.

BINDERS

The ideal way of keeping your magazines in perfect condition. *Spaceflight* binders carry *BLUE* covers, those for *JBIS* are *GREEN*. Gold lettering on the spine identifies the magazine, volume number and year. Cost: £5 ($8 abroad) each. Note: *JBIS* binders fit post-1976 volumes.



spaceflight

Correspondence, manuscripts intended for publication and requests for information on membership may be addressed to the Executive Secretary at the Society's Offices at 27/29 South Lambeth Rd., London SW8 1SZ. Tel: 01–735 3160.

NOTICES OF MEETINGS

Film Show
Theme: **MOMENTS IN HISTORY (PART 2)**

The second of two meetings devoted to historical space films will be held in the Society's Conference Room, 27/29 South Lambeth Rd., London SW8 1SZ on **6 February 1985,** 7.00-8.30 p.m.

The programme will include the following:

(a) A Man's Reach Should Exceed his Grasp

(b) Small Steps, Giant Strides

(c) A Moment in History

(d) Blue Planet

(e) Meteosat

Admission is by ticket only. Members wishing to attend should apply in good time, enclosing a stamped address envelope.

Lecture
Theme: **COMMERCIAL LAUNCH VEHICLES**
By G.M. Webb

The context in which Europe will be competing commercially using its post-Ariane 4 series of launcher will probably be very different from the present situation; the viability of the various options open in the mid-1990's will be discussed.

To be held in the Socity's Conference Room, 27/29 South Lambeth Road, London, SW8 1SZ on **20 February 1985,** 7.00-9.00 p.m.

Admission is by ticket only. Members should apply in good time enclosing a stamped addressed envelope.

Symposium
Theme: **EUROPE-US SPACE ACTIVITIES**

The **1985 Goddard Memorial Symposium,** in conjunction with the **19th European Space Symposium,** will be held at the NASA Goddard Space Flight Center, Maryland, USA on **28-29 March 1985** organised by the American Astronautical Society and co-sponsored by The British Interplanetary Society in association with other Societies.

Offers of papers are invited. Futher information is available from the Executive Secretary and registration forms will be available in due course.

One-day Symposium
Theme: **SPACE STATIONS**

A one-day symposium on the obove theme, considering the technology and applications of Space Stations, will be held in the Society's Conference Room on **17 April 1985.**

Offers of papers are invited. Potential authors are requested to contact the Executive Secretary, at 27/29 South Lambeth Road, London SW8 1SZ.

Lecture
Theme: **PLASMA PHYSICS IN SPACE**
by Dr. D.A. Bryant
Rutherford Appleton Laboratory

Results from the three-satellite AMPTE mission, launched in August 1984 to explore by revolutionary new techniques the interaction of the solar wind with the Earth's magnetosphere and the comet-like behaviour of injected plasma clouds, will be discussed.

To be held in the Society's Conference Room, 27/29 South Lambeth Road, London, SW8 1SZ on **1 May 1985,** 7.00-9.00 p.m.

Admission is by ticket only. Members should apply in good time enclosing a stamped addressed envelope.

Lecture
Theme: **COHERENT LIGHT FROM SUPERNOVAE**
By A.T. Lawton
President of the Society

To be held in the Society's Conference Room, 27/29 South Lambeth Road, London SW8 1SZ on **15 May 1985**, 7.00-9.00 p.m.

Admission is by ticket only. Members should apply in good time enclosing a stamped addressed envelope.

One-day Forum
To be held in the Society's Conference Room, 27/29 South Lambeth Rd, London, SW8 1SZ on **Saturday, 1 June 1985,** 10.00 a.m. to 5.00 p.m.

Topic: **THE SOVIET SPACE PROGRAMME**

Subjects will include :

History of the USSR Lunar Programme

Cosmonaut Update

Soviet EVA Experiments

Offers of papers are invited. Members with a special interest in the Soviet space programme are invited to attend. A registration fee of £5.00 is payable. Forms are available from the Executive Secretary on request, enclosing a stamped addressed envelope.

LIBRARY

The Library will be open to members from 5.30 to 7 p.m. on the following dates:

6 Feb 1985	20 Feb 1985
3 Apr 1985	1 May 1985
15 May 1985	12 Jun 1985

While every effort will be made to adhere to the published programme, the Society cannot be held responsible for any changes made necessary for reasons outside its control.

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