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Spaceflight

The International Magazine of Space and Astronautics

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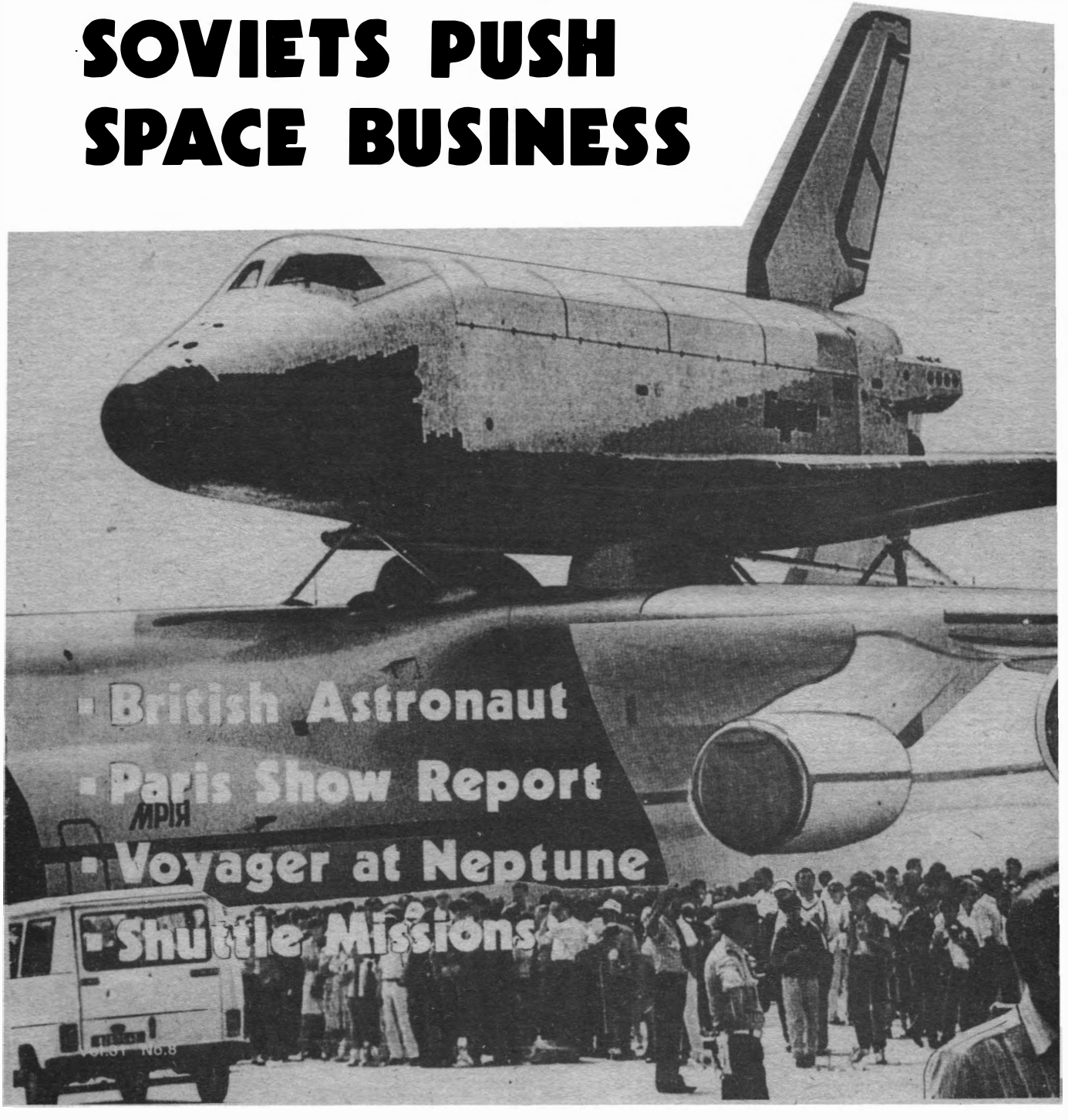

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Spaceflight
The International Magazine of Space and Astronautics

Vol. 31 No.8 **August 1989**

Cover Photo: Buran atop the Antonov Mriya dominates the sky line at this year's Paris Air Show. *Steven Young*

Successful Launch of Olympus 1

The highly advanced Olympus 1 communications satellite, built by a consortium of aerospace companies led by British Aerospace, has been successfully launched by an Ariane 3 from the Guiana Space Centre, Kourou, French Guiana. The launch took place at 1.14 am BST on July 12 (9.14 pm local time on July 11).

Olympus 1, built under contract to the European Space Agency, is the world's largest and most powerful civil three-axis stabilised communications satellite. Designed as a technology demonstrator, Olympus 1 employs a range of innovative satellite and payload technologies.

Olympus 1, weighing 2,612 kg (5,758 lb) at launch, uses a bi-propellant fuel system to power the satellite's on-board liquid apogee engine (LAE) and 16 reaction control thrusters.

The LAE which provides low thrust will enable the solar arrays to be deployed before firing so providing the satellite with electricity from the transfer phase to geostationary orbit. Throughout transfer the satellite is three-axis stabilised (rather than the conventional spin-stabilised), enabling efficient use of fuel and precise on station positioning.

Olympus 1 will arrive at its final geostationary orbital position at 19° West between seven and 21 days after launch. Once on station the satellite will undergo extensive in-orbit tests with the compietion of the commissioning phase some 90 days after launch.

Olympus 1 benefits from a sophisticated Attitude and Orbital Control System providing highly accurate pointing for its four communications payloads. These payloads will demonstrate new types of communications systems aimed at stimulating the introduction of new satellite based services and techniques.

Olympus 1's flexible solar arrays provide the spacecraft with up to 3.6 kW of electric power. The Olympus power subsystems and design can accommodate larger arrays measuring up to 56 m (184 ft) from tip to tip. Future Olympus satellites could therefore provide up to 7.7 kW to meet predicted trends for increased power which will be necessary for future high powered services such as high definition direct broadcast television.

Arianespace Joins OSC and Hercules In The Pegasus Project

Orbital Sciences Corporation (OSC) and Hercules Aerospace Company of the United States and Arianespace of Europe have announced a preliminary agreement concerning marketing and sales of the Pegasus air-launched space booster.

Pegasus is pioneering an innovative approach for launch of small satellite payloads (see p. 269). Pegasus launch services have been purchased by the United States Government and commercial customers for low-orbit and geosynchronous-orbit applications. With first launch scheduled for August 1989, Pegasus will complement present ground-launched vehicles for scientific, defence and commercial missions.

The Memorandum of Understanding signed by OSC, Hercules and Arianespace outlines terms of cooperation under which Arianespace will exclusively market and sell Pegasus launch services in Europe. During the initial period of two years, the parties will evaluate possible activities including performance upgrades to Pegasus and establishment of a European base of operations.

NEWS IN BRIEF

Voyager Discovers New Moon

Voyager 2 has discovered a new moon orbiting Neptune. The moon has been designated 1989-N-1. Two moons were previously known to be orbiting Neptune - Triton and Nereid. Voyager will make its closest approach to Neptune on August 25.

New Parliamentary Space Committee

A new Parliamentary committee is to be established to act as a forum of discussion for parliamentarians and industrialists in order to promote a better understanding of Space activity in the United Kingdom and the economic, technological and scientific benefits which it brings. The committee, to be known as the "Parliamentary Space Committee" is to be formed to include Members of Parliament who belong to the All Party Space Committee, and member companies of the United Kingdom Industrial Space Committee (UKISC) and British Association of Remote Sensing companies (BARSC). The group intends to operate in a similar way to other Parliamentary Committees which have been influential for a number of years in the technology sectors of British business.

European Astronauts

On June 28, 1989 during its meeting at ESTEC (European Space Research and Technology Centre) in Noordwijk, the Netherlands, the ESA Council unanimously approved the policy on European astronauts. The policy for European astronauts is the basis for the operation of the Columbus and Hermes Programmes, which are the key to further European manned space flight. A single European astronauts corps for the ESA mission will be set up under the authority of the Director General. The policy defines the selection procedures for the European astronauts. The pre-selection will be done by Member States. The final selection will be ESA's responsibility. The aim is to have at least one national from each Member State to become a member of the corps.

Satellite Damaged by Crane

The INSAT-ID Indian communications satellite has been badly damaged after it was hit by a crane's hook while it sat atop a Delta II launch vehicle at Cape Canaveral Air Force Station. The satellite has been removed for inspection and the launch has been postponed indefinitely.

Ariane Contract For UK Firm

The UK firm EASAMS Ltd has announced the receipt of a £1.1m order for the further supply of flight software for the vehicle. EASAMS, provides the on-board guidance and control software for Ariane. These Flight Programmes guide the launcher throughout its flight.

SDI Payload For Delta

McDonnell Douglas has won a contract to launch the Low-power Atmospheric Compensation Experiment (LACE) and the Relay Mirror Experiment (RME) on a Delta II rocket for the Strategic Defense Initiative (SDI).

The LACE experiment involves a satellite which will study the distortion effects of the Earth's atmosphere on laser beams and to what extent these distortions can be removed.

RME features a cylindrical satellite that is to orbit the Earth for about six months with a mirror pointed toward the ground. The goal of the experiment is to demonstrate that a space mirror can be used to accurately capture and point an unlinked ground based laser beam.

This marks the 9th Commercial rocket contract for McDonnell Douglas and is scheduled for launch in late 1989.

Sweden Joins Space Station Project

Sweden has become a participant in the ESA Columbus development programme and will be subscribing 1% of the programme's budget.

The request to join the Columbus programme was presented by the Swedish Delegation during ESA's Council meeting held on June 28-29, 1989 at ESTEC (the European Space Research and Technology Centre) in Noordwijk, the Netherlands. The Columbus programme is the Agency's contribution to the Freedom Space Station. With this decision, Sweden becomes the tenth ESA Member State to join the Columbus development programme.

(Above) NASA Administrator Truly, on the far left, welcomes home the crew of STS-30. See p 260 for a full report on this mission *NASA*

Truly Confirmed as Administrator

The nominations of Richard Truly for NASA Administrator and J.R. Thompson as deputy have been approved by the US Senate.

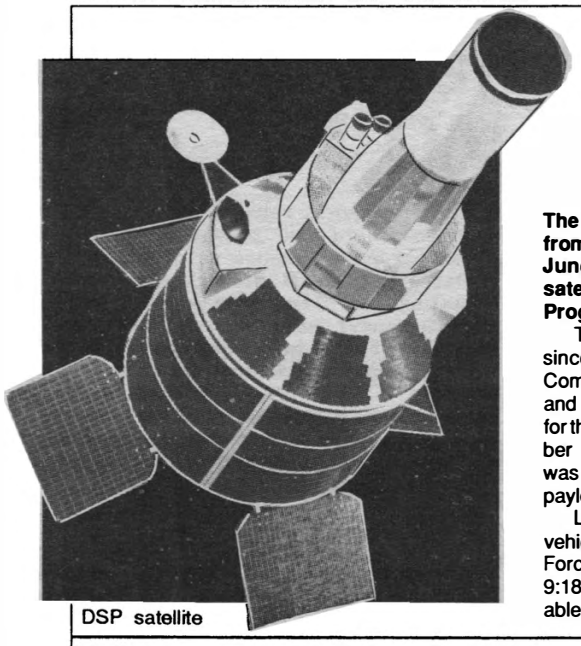
The confirmation followed passage of bills in both the Senate and the US House of Representatives that waived the requirement for the administrator to come from civilian life. The bills require that Truly retire from the US Navy within 60 days of his confirmation and allowed him to retain his rank, status and pension as a retired Navy officer. Truly officially became NASA Administrator at a short swearing-in ceremony held at NASA Headquarters in early July.

NASP to be Scaled Down

The National Space Council is expected to recommend to President Bush that the goals for the National Aerospace Plane (NASP) should be made less ambitious.

The project has already had its budget cut for 1990. US Defense Secretary Richard Cheney wanted to end Air Force participation in NASP, giving NASA full responsibility for the project. But it is believed the National Space Council will recommend the Air Force continue funding NASP because of the craft's possible military applications.

(Right) An 80-foot mock-up of the NASP appeared at this year's Paris Air Show, dominating the US Pavilion See p.265 for reports on the Air Show



DSP satellite

First Titan 4 Launches Early Warning Satellite

The first Martin Marietta Titan 4 blasted off from Cape Canaveral Air Force Station on June 14 carrying a military early warning satellite known as DSP (Defense Support Program).

The Titan 4 has suffered a series of delays since it was assembled on the launch pad at Complex 41 in May 1988. Hardware, software and shakedown problems dogged preparations for the first launch, originally scheduled for October 1988. One of the more serious problems was doubts over the structural integrity of the payload fairing.

Last minute checks on June 14 gave the vehicle a clean bill of health. A joint industry - Air Force team gave the go for launch and at 9:18am EDT America's most powerful expendable launch vehicle roared into the sky above Cape Canaveral. The Titan's payload, a DoD early warning satellite named DSP, was successfully placed into orbit.

The DSP satellite's infrared sensors are designed to detect the rocket exhaust of a nuclear missile from its vantage point in geostationary orbit. The satellite will also be used to record valuable information on Soviet missile tests and space launches. DSP's sensitive detectors are thought to be capable of tracking aircraft flying on afterburn.

The Titan 4 is able to lift 4,536 kg to Geostationary Orbit and 17,690 kg to Low Earth Orbit from Cape Canaveral. The booster can also make launches from Vandenberg Air Force Base to place satellites into polar orbit. The Air Force expects to launch six Titan 4s per year by 1993 and nine per year from 1995.

Soviet-Austrian Space Flight Details

In 1988 Austria agreed with the Soviet Union to participate in a joint space mission to the Mir orbital complex. The flight is a commercial venture, with Austria reportedly paying about ten million dollars for the flight.

An Austrian official revealed that the agreement covered payment for elements in the flight such as training and launch services.

A TV and newspaper campaign was mounted to invite applications.

The first round of medico-psychological examinations began on about 50 persons on February 20, 1989. The cosmonaut should possess the medical, psychological and physiological classification of a full

By Johannes M. Fritzer and Neville Kidger

fighter jet pilot However, pilots are to be excluded from the selection. The second leg of the selection began in June and involved the assistance of Soviet experts.

As a result the group is to be reduced to between 10 and 15 candidates.

A Soviet-Austrian team will pass a resolution to allow six of these to enter the third and final stage which will begin in Moscow in September. At this stage the two finalists will be decided.

Training should begin in December 1989 and will last for one-and-a-half years.

Experiments

On March 10, 1989 the Austrian Minister for Science and Technology chose 15 experiments for the flight. A total of 34 experiment proposals were received. Total mass of the experiments is 150 kg and the time allocated to them in space is 42 hours.

Of the experiments, 11 are of a medical nature, three are technological in nature and the final one is a remote sensing experiment.

On April 6, 1989 a meeting was held between the Soviet and Austrian sides at Graz, the administrative centre of Styria. This is one of many meetings before the flight, which should take place in 1991.

Experiments for the 1991 Soviet-Austrian Space Flight

MEDICAL EXPERIMENTS

MONIMIR (Motormonitoring in Space)
Analysis of postural reflexes in zero gravity and the development of a computer based neurological measurement system.

COGIMIR (Cognitive Functions on Mir)
Analysis of cognitive functions during spaceflight conditions.

LUNGMON (Lung Monitoring)
Testing of a electrical heart and lung monitoring system.

DOSIMIR (Dosimeter on Mir)
Dosimetric monitoring of the austrian cosmonaut and testing of a TLD space dosimeter.

PULSTRANS (Pulse Transmission)
Analysis of pulse transmission and heart frequency during changes of body position and during strain.

MIKROVIB (Microvibrations)
Analysis of spontaneous and stimulate microvibrations of the body surface in zero gravity.

BODYFLUIDS (Bodyfluids)
Measurement of the velocity of sound in vein blood of the cosmonaut to determine the dynamics of transient fluid motions after volume effective stimulations.

OPTOVERT (Optokinetic Vertical Vectionperception)
Vertical vectionperception via optokinetic stimulation in zero gravity and comparison with ground conditions.

MIRGEN (Genetic Material on Mir)
Analysis of space flight effects on genetic material via blood sample analysis before and after the space mission.

AUDIMIR (Binaural Audio Experiment on Mir)
Analysis of binaural technology for the cosmonaut communication system and its impetus on the sense of balance in zero gravity.

MOTOMIR (Human Motorics on Mir)
Neurophysiological analysis of human motorics during defined movements in zero gravity on the space station Mir.

TECHNOLOGICAL EXPERIMENTS

BRILLOMIR (Brillouin-Strewing on Mir)
Measurement of critical fluctuations during decomposition of binary liquid mixtures in zero gravity via Rayleigh-Mandelstam-Brillouin-Strewing.

LOGION (Low Gravity Ion Emitter)
Testing and determination of working characteristics of a liquid metal ion source in zero gravity to be used for potential control of spacecraft.

MIGMAS (Microgravity Mass Spectrometer)
Testing of a mass spectrometer for microgravity microanalysis which might be used later on COLUMBUS or on a cometary mission.

REMOTE SENSING EXPERIMENT

FEM (Fernerkundung auf Mir)
Use of MKF-6 multispectral camera for remote sensing experiments.

Search for UK Astronaut Underway

Speakers at the London press conference to launch the Juno project (left to right) Dr Gregg Briarty of Nottingham University, Mike Parker, deputy managing director of Saatchi & Saatchi, Peter Graham, Juno Mission Director, Sergey Konychev, deputy chairman of the Moscow Narodny Bank and John Wodger director of MSL International

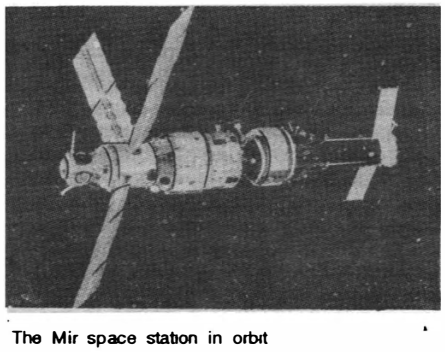
The first Briton in space will be launched from the Baikonur Cosmodrome in 1991 under an agreement signed in Moscow on June 29. The search to find the British astronaut is underway through a nationwide advertising campaign. The eight day mission will be the first to be financed entirely by the private sector.

The Anglo-Soviet space flight was announced at simultaneous press conferences held in London and Moscow linked live via satellite. The historic agreement was signed by Glavkosmos and VVO Licensintorg, which acts as Glavkosmos' foreign trade agents, and Antequera Limited, a specially formed British company. Lord Young, UK Trade and Industry Secretary was present at the signing, and wished the 'historic project' every success.

The mission, named Juno (after the Roman goddess of marriage), will take place between March and July 1991. The British astronaut will be launched onboard a Soyuz TM spacecraft and dock with the Mir space station. Two British astronauts - a prime candidate and a backup - will train for 18 months at Star City in the Soviet Union. During the mission the back-up astronaut will conduct duplicate experiments on the ground to compare results with the experiments carried out in orbit.

The search for the British astronaut is being led by Air Vice-Marshall Peter Howard in cooperation with recruitment consultants MSL International. The successful candidate will be a fit and healthy man or woman aged between 21 and 40. A science degree and the proven ability to learn a foreign language are also necessary - the two finalists will have to learn to speak Russian fluently.

The day following the announcement of the mission advertisements appeared in the national press proclaiming "Astronaut wanted no experience necessary". Prospective candidates were invited to call a special telephone line to obtain an application form. By the time the telephone lines closed on Friday July 14, over 12,000 phone calls had been received.



The Mir space station in orbit

After the closing date for applications on July 24, an initial 'long-short list' of 300 will be drawn up, this will be whittled down to a 'short-short' list from which the two finalists will be selected.

Funding for the mission in entirely from the private sector. The £16 million costs of the Juno mission will be covered by the sale of sponsorship and merchandising packages. The Moscow Narodny Bank is providing start up assistance to Antequera by coordinating the mission's marketing and finance from its London headquarters. A marketing team from the Saatchi and Saatchi group will be responsible for creating a high level of interest in the mission among the general public and the business and science communities. Encouraging sponsors to fund the mission will be a key task.

Professor Heinz Wolff of Brunel University, Middlesex, is to chair a selection board to decide which experiments and equipment from industry, universities or research establishments will be flown on the mission. The mission is limited to between 100-300 kg of scientific experiments, with only 10 kg permitted to return to Earth. The equipment required will push forward miniaturisation technology. All experiments must be simple to operate and robust enough to survive the launch phase. Scientific work during the eight day flight will concentrate on microgravity and medical experiments. Professor Wolff hopes, "the results of the experiments will add significantly to mankind's knowledge."

(See overleaf for an interview with Peter Graham, Juno Mission director.)

"This Mission is for All of Britain"

The day after the signing of the historic agreement to launch the first Briton into space *Spaceflight* spoke to Peter Graham, Mission Director of the Juno project. Mr Graham revealed the background to the project and his hopes for this exciting project.

Mr Graham can you tell me a little about yourself, your background and how you became involved in the Juno project?

I'm British born although clearly by my accent I've been overseas for a number of years, primarily in Canada. I am a lawyer by training. I have graduate finance degrees from universities in France. I was working on large projects in Canada, not necessary directly related to putting people into space, but some of them were connected with the space and defence industries When British businessmen were approached by Glavkosmos to put this space mission together they were looking for someone with experience in large projects to manage it and that's how I became involved.

What are the origins of the joint mission?

The idea was formulated by a group of British business people - some of whom are no longer involved - almost 18 months ago. They approached Glavkosmos which quite frankly has something we need in Britain - they want to sell it and we are interested in buying it. People like Heinz Wolff and Peter Howard have been involved from the start of this programme and are key players. Because it's a private enterprise venture there have been a lot of difficult negotiations with the Soviets that we have had to follow through to conclude a contract and negotiations only concluded a number of weeks ago.

Was UK Government financial support for the project ever a possibility?

The Government was really never approached. The business men involved feel that it has enough British industry support and the benefits to British industry are significant enough that the private nature of this can go forward. Clearly we have discussed the mission with British officials and by Lord Young's presence yesterday there is support for the project. Any government has a lot of expenditures to cover and they've got to make tough decisions on which expenditures get funding and which do not. The project is something that British pnvate industry can manage. What we do need is Government cooperation, but not necessarily Government finances.

Did you need Government permission to go ahead with this project?

The Government did not have to give us formal consent and we were not looking for it. But clearly you do not want to take on an international project of this magnitude without discussing it with Government officials. Because quite frankly they can help, in certain the areas.

Part of the funding of the mission will come from sponsorship - will this involve company logos on space suits etc.?

As we have seen since the launch yesterday, the project is capturing the imagination of the public. This is not going to be unrecognised by business leaders. It is going to be a great opportunity for businesses to promote their products and services. I think when you do a project like this, first and foremost the scientific side must take prionty and be separate from the commercial side. But as a good businessman you've got to cover your expenditures by generating revenues. So yes people will be able to put their products and their company logos on the space suit and the rocket. There is a real opportunity to promote the technology that has been learnt in space. We are not trying to make this a circus, we are trying to make this a strong marketing effort which will give a high profile for those companies interested.

What will happen to the capsule when it is returned to Britain after the mission?

What we would like to travel the country with the capsule. The purpose for this mission is for all of Britain to get exposure. The exposure to children on an educational level is going to be very beneficial. I hope that the capsule will travel around and that the children in Scotland, Wales, England and Northern Ireland will get exposure to this. I think it is very important that everybody gets exposure to it. Whether it returns to one location after a period of touring is something we will have to decide. We will have to find the appropriate place.

You mentioned the educational importance of this flight - will school children be given the chance to fly an experiment with the British astronaut?

I think you are probably aware that one of the most captivating experiments in the American programme was submitted by school children and that was to see if a spider could spin a web in space. I think that the input of children is high on our priority level. They will certainly be able to submit an experiment and we are setting up the structure in which they can do that. It's an opportunity that can't be missed. We would like to do a lot of things for children - perhaps form a space cadets type of programme. There are a number of projects we can do for children aimed at an educational level.

How will payload space be sold to experimenters?

It's going to be limited to UK companies. We have a weight restriction - we are allowed up to 300 kg of experiments. It will not go to the highest bidder. In fact if we feel some experiments are important enough we will fund them ourselves. We want to return the scientific results back to Britain and have industry, institutes, schools and the public learn from them.

Can arrangements be made to increase the payload mass if necessary?

Well the Soviets are good businessmen and they recognise there has to be flexibility in any negotiations. We do have flexibility and if something were to come up which was of a special nature we could negotiate with them. But at the present time the limit is 300 kg.

Does the figure of £16 million include your own administration, publicity and recruitment costs?

Yes.

Can you tell me the how much Glavkosmos is charging for the actual flight?

I cannot tell you the actual figure I can say our science budget is estimated at about £3 million. Our overhead is very small so the £16 million is very close to the figure we are being charged.

How confident are you that you can raise the £16 million?

Very confident. The difficulty we have with this project from a business stand point is there is a bit of scepticism as to who is behind the project. There were corporate chairmen from five different corporations in Moscow yesterday and two in the London audience who have expressed interest. The size of this project deems that they call the shots when they want to announce their involvement. Because obviously they want to structure their marketing plans and promotion plans as finely tuned as they can have them. Unfortunately at this stage we can't reveal all the facts and that of course will lead to an understandable amount of scepticism to start with. But I think the press will be pleasantly surprised with some of the announcements that are going to be made over the next few weeks as to the involvement of different people and organisations in the project.

So we are going to see a very active period in the next few weeks?

Because this is the first project of its kind to

be privately financed there is an inner circle of people who are standing, with an outer circle of people who are watching to see if it will go ahead. Until the inner circle goes, the outer circle is not going to do anything. We have put together a management team and spent some seed money and developed some aspects to make this thing go. When people started to see what was happening over the last few weeks, they began to realise how serious this is. I think we are going to have a very active period over the next few weeks, with the selection and naming of the astronauts, but also the announcement of the involvement of British industry and individuals.

Do you expect to make a profit out of this?

Well I would not be a good businessman if I did not say I wanted to get a little bit of a profit. Our goal of raising £16 million basically covers our expenditure. So if we can raise more than that I've done a good job. Yes I would like to see a profit because I would like to see more of these missions go up. There are options within our contract with Glavkosmos for other launch dates. I would like to see a number of British astronauts go up. It will be very exciting.

So this mission is not a one-off. It is not a gimmick as some people would like to portray it as?

No, absolutely not. Its too high profile of an event to be a gimmick. It is really scary how difficult it is to do this, on many fronts - the science side, the negotiations and politics involved with two nations joining together and from a business side it is very difficult. So no, this is not a one off.

You mentioned the option of further flights what sort of frequency are you talking about - once a year, every two years?

As you will appreciate the minimum lead time to train the astronaut is eighteen months - that's the guidelines from the Soviets, they would prefer two years. So we do not see a second flight until probably 1993 or 1994.

Do you think you can sustain public interest and the support of sponsors to maintain such a flight rate?

I think it would be naive of me to yes to that. I think the public is intelligent but grows tired of things very quickly. I believe the viability here really comes from British industry. The Russians have technology that British industry needs. The first flight will demonstrate to British Industry what can be done in space, in particular microgravity experiments. I believe that aspect of it will be sufficient to fund - or to supplement - future mission funding. Clearly with any event that is reoccurring there will always be interest. You have to think of some of the things that will happen here, it will be astronomical. The station goes around the Earth approximately 16 times a day I understand. Some of the film footage out of that will be just gorgeous to see Britain on a nice clear day.

Is it one of your requirements that the station makes over flights of the UK during the mission?

The ' Astronaut Hotline' team answered more than 12,000 calls in two weeks

Yes definitely, we would like overflights of the UK. One day we would like everybody in Glasgow to turn their lights on at night so the astronaut can see them and on the next time round Belfast, and so on.

Can you tell me what areas were covered by the contract signed yesterday?

The contract covers all aspects of the mission. It covers everything from the business side to the scientific side to the selection. It is extremely detailed - we have medical criteria listed that the astronaut must meet, everything from the sugar count in his blood to his eye vision. It covers the rights and obligations under the contract for both parties - what Glavkosmos must do and what we must do and aspects of safety to ensure our astronaut is returned safely to Earth, aspects related to setting up the laboratory in the Soviet Union to monitor the space experiments on Earth as well as in outer space. It is about a 120 page contract, so it took a great deal of drafting and re-drafting and negotiation.

There was a false start back in April when the signing of the contract was postponed. Can you explain what happened?

There was a different group of people involved at that point. There was not a contract at that time, that was the problem. I cannot really comment on why.

Jack Leeming's name was often mentioned as one of the organisers of the British astronaut project. Is he still involved?

Mr Leeming is an extremely important man in the British space industry, he is extremely knowledgable. He has been talking to me almost daily, we had a conversation last night. I think he is vital to the project and I would like to see him involved. As you can appreciate with the magnitude of launching this programme there is a lot of backroom negotiations going on with individuals, institutions and companies. And again you may be surprised what comes out in the next few weeks with the announcement of individuals involved.

In the past Soviet space officials have criticised short flights as unproductive. Is the flight limited to eight days purely due to the cost or is this something the Soviets have imposed?

It really relates to the programme the Soviets have put in place for the use of their Mir station at this point. There will be Soviet missions before and after ours. There will be joint missions after ours - in our contract it clearly states no European country will be going up before us. So it really relates just to the schedule of how Mir is going to be used.

Have the Soviets been very open about their plans for the space programme?

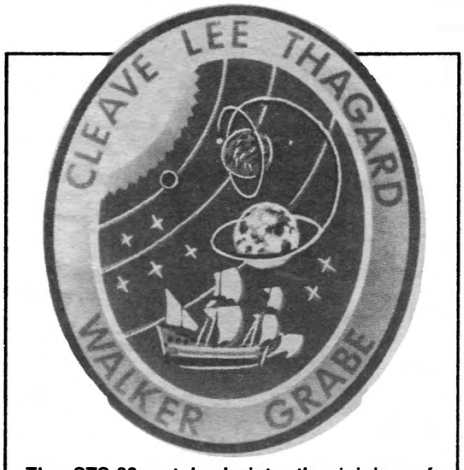
Extremely open, in fact almost surprisingly open. I think you get a little sceptical about the Soviet approach until you sit down and deal with them. They have got some excellent technology, they have a space administration which has a great history to it. They have been very cooperative, very open. There will be footage that will be supplied to the mission that has never been seen in the West before. We view this is a great chance to share the experience with the British people. So we will get lots of live television coverage down to Britain.

Finally, it has been almost 24 hours since you launched the search for Britain's first astronaut - what's the response been so far?

Unfortunately a little bit higher than we expected. As you know the newspaper advertisements are in the papers this morning, so we were not sure we would have much response yesterday. We actually received 600 phone calls. We were thinking we would average 200-300 the per day. So that's 600 on our first day without the advertising and I think we're going to have a great deal more over the next few weeks. It will be a big process screening the candidates, but we've got a good team.

Atlantis Extends the Shuttle's Reach

The STS-30 mission marked the first deployment of an interplanetary probe from the Space Shuttle. The Magellan probe has begun its 15 month journey to the planet Venus where it will accurately map the surface with a powerful radar system. Onboard Atlantis for the four day flight were: Commander David Walker, Pilot Ronald Grabe and Mission Specialists Mark Lee, Norman Thagard and Mary Cleave.



The STS-30 patch depicts the joining of NASA's manned and unmanned space programmes. The Sun and the inner planets of our Solar System are shown with the curve connecting the Earth and Venus symbolising the Shuttle orbit, the spacecraft trajectory toward Venus and its subsequent orbit around our sister planet. A Spanish caravel similar to the ship on the official Magellan programme logo commemorates the 16th Century explorer's journey and his legacy of adventure and discovery. Seven stars on the patch honour the crew of Challenger. The five star cluster in the shape of the constellation Cassiopeia represent the five STS-30 crew members. ***NASA***

Launch Preparations

Processing activities began on Atlantis for the STS-30 mission on December 14, 1988, when it was towed to Orbiter Processing Facility (OPF) bay 2 after its return from Edwards Air Force Base, where its previous mission, STS-27, was completed with a landing on December 6. Post-flight deconfiguration and inspections were conducted in the OPF.

As planned, the three main engines were removed and taken to the main engine shop in the Vehicle Assembly Building (VAB) for the replacement of several components. During post-flight inspections, technicians discovered cracks in one of the high pressure oxidizer turbopump bearing races on the number 3 main engine. The pump was removed and sent to Rocketdyne for analysis. It was determined that the most likely cause for the cracks was the presence of moisture inside the pump which lead to stress corrosion. The production process of the pumps was modified to eliminate the moisture.

Atlantis' three main engines were reinstalled with the defective turbopumps still in place (engine 2027 in the No.1 position, engine 2030 in the No.2 position and engine 2029 in the No.3 position).

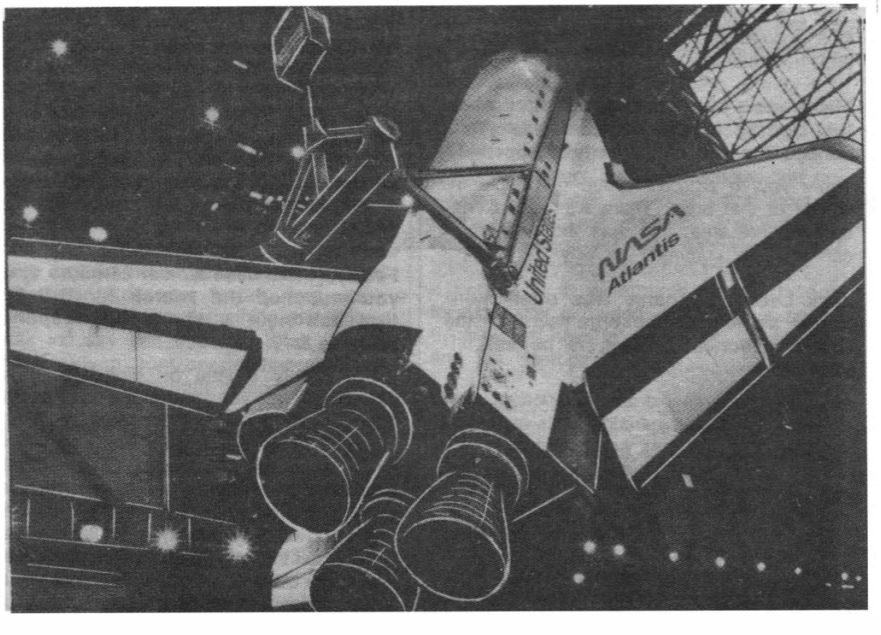
The right-hand Orbital Manoeuvring System pod was removed in early January and transferred to the Hypergolic Maintenance Facility for repairs of a helium regulator that had failed during STS-27. The regulator was re-installed on February 9, 1989.

Stacking of the Solid Rocket Booster (SRB) segments began with the left aft booster on Mobile Launch Platform 1 in the VAB on January 2. Booster stacking operations were completed on February 19 and the External Tank was mated to the boosters on March 2.

The assembled Shuttle vehicle was rolled out of the VAB to launch pad 39B on March 22.

The Terminal Countdown Demonstration Test was carried out on April 6-7

Atlantis is hoisted into the vertical position in the VAB during preparations for STS-30. *NASA*



Magellan Preparations

The Magellan spacecraft arrived at KSC on October 8, 1988. It made the trip from Martin Marietta's Denver plant aboard a specially cushioned, instrumented and environmentally controlled truck-trailer. Upon arrival at the space centre the probe was taken to the Spacecraft Assembly and Encapsulation Facility-2 (SAFE-2)

The forward equipment module and spacecraft body were mated with the liquid propulsion module on December 21 Magellan's radar module was installed on January 6, 1989. The storable propellants that will be used for mid-course corrections and spacecraft control at Venus were loaded aboard on January 18. The probe was then mated with the Star-48 solid propellant motor on February 3. The two solar panels were attached and tested on February 5.

On February 15 the spacecraft was moved to the Vertical Processing Facility where it was mated with its Inertial Upper Stage (IUS) booster two days later.

A test was run to simulate Magellan's deployment from Atlantis' payload bay. STS-30 Mission Specialists, Mark lee and Mary Cleave participated in the deployment exercise.

Having successfully completed its prelaunch checkout, Magellan was placed inside the payload canister and moved to the launch pad on March 17. The probe was transferred to Atlantis' payload bay on March 25 and the connections made between the Magellan and the Shuttle.

First Launch Attempt

Weather at the Cape on April 28 was described by meteorological officers as "perfect weather to go flying". But other factors were to stop the launch that day.

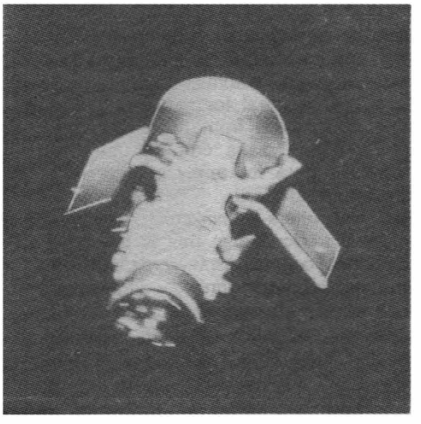
The countdown - one of the smoothest in Shuttle history - reached the T-9 minute point without incident. However during a planned 40 minute hold a problem with a range safety console became apparent. The Range Safety Officer would not give a 'go' for launch until the console recovered. The countdown finally resumed only to be halted at T-31 seconds when a problem was detected with a recirculation pump in Main Engine No.1. The pump's electrical system was shorted out by fragments of metal floating in the liquid hydrogen. The pump is used to recirculate hydrogen through the fuel lines to keep them cool and in condition for ignition. A further problem was discovered after the launch had been aborted. Television cameras picked up a vapour cloud near a hydrogen pipe linking the External Tank to the orbiter. Closer examination after the crew had left Atlantis and the vehicle had been safed revealed a small hole in the pipe's casing, which was allowing hydrogen to escape.

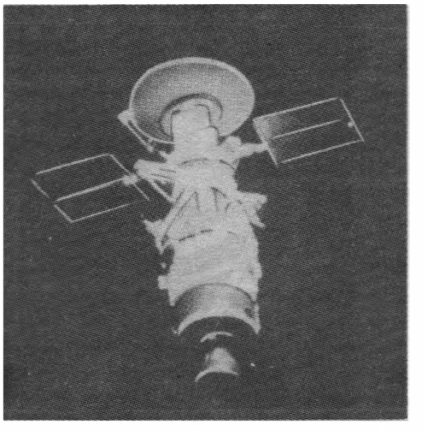
The recirculation pump was replaced with one from OV-105 - now named Endeavour - which is under construction at Rockwell International's Downey plant in California and a new hydrogen pipe installed. The launch was rescheduled for 18:48 BST on May 4.

Launch

On launch day cloud cover over the Shuttle Landing Facility (SLF) adjacent to the launch area was a major concern. If Atlantis had suffered a malfunction which required an abort during the ascent phase of the mission the crew would have performed a Return to Launch Site Abort (RTLS). This difficult manoeuvre requires the Shuttle to reverse its course in order to make a landing back at the Kennedy Space Center. The mission rules required visibility limits at the SLF which the cloud violated. Satellite pictures indicated the Kennedy Space Center was the only location in the area which had cloud cover! The countdown was held at T-9 minutes awaiting a 'go' from the meteorological teams.

Fortunately, as the launch window ticked away the cloud cover became more scattered and it was decided to continue with the countdown until T-5 minutes where it would hold until the weather was within the limits. The countdown was resumed at 19:42 BST and continued without interruption. Atlantis and her crew of five blasted off from Pad 39B at 19:47 BST, with just two minutes remaining in the launch window. During ascent heavy yaw steering was used to place Atlantis into the precise orbit for the deployment of Magellan.





Magellan's solar panels are deployed. The opening of the solar array was photographed through the orbiter flight deck aft windows. *NASA*

The SRBs separated at T+2 min 5 sec and were later returned to Cape Canaveral. (The boosters were disassembled and fully examined. There were no signs of abnormal damage in the joint areas.) After main engine cut-off at T+8 min 31 sec, two Orbital Manoeuvring System (OMS) burns were made. The first to boost the altitude the and second to circularise the orbit.

Day One: May 4, 1989

As soon as post insertion checkouts

THE CREW

COMMANDER
David M. Walker (Captain USN)

Although born in Columbus, Georgia., Walker considers Eustis, Florida, his hometown. Walker is a member of the astronaut class of 1978.

Walker was pilot of STS 51-A, launched November 8, 1984, marking the second flight of the orbiter Discovery. During the mission, the crew deployed two satellites and in the first space salvage mission in history, also retrieved and returned to Earth the Palapa B-2 and Westar VI satellites.

His NASA assignments also have included: Astronaut Office safety officer; deputy chief of Aircraft Operations; STS-1 chase pilot; software verification at the Shuttle Avionics Integration Laboratory (SAIL); and assistant to the director, Flight Crew Operations. He has logged 192 hours in space prior to this flight.

The STS-30 crew: (Left to right) Mission Specialists Norman Thagard, Mary Cleave and Mark Lee. Pilot Ronald Grabe and Commander David Walker. *NASA*

PILOT
Ronald J. Grabe (Colonel USAF)

Grabe was born in New York and is a member of the astronaut class of 1981. Grabe was pilot for STS 51-J, the second Space Shuttle Department of Defense mission, launched October 3, 1985, on the orbiter Atlantis' maiden voyage. He has logged 98 hours in space prior to STS-30.

MISSION SPECIALIST 1
Mark C. Lee (Major USAF)

Lee was making his first space flight. Born in Viroqua, Wisconsin, he is a member of the astronaut class of 1984.

Lee has participated in the planning and simulation of several extravehicular activity missions and has served as the support crewmember for mission STS 51-I, Leasat retrieval and repair. He also has served as a capcom.

MISSION SPECIALIST 2
Norman E. Thagard (M.D.)

Although born in Marianna, Florida, Thagard considers Jacksonville, Florida his hometown. He is a member of the astronaut class of 1978.

Thagard was a mission specialist on STS-7, launched June 8, 1983. It was the second flight for the orbiter Challenger and the first mission with a five-person crew. During the mission, the STS-7 crew operated the Canadian-built remote manipulator system arm to perform the first deployment and retrieval exercise with the Shuttle Pallet Satellite (SPAS-01); conducted the first formation flying of the orbiter with a free-flying satellite (SPAS-01); and carried and operated the first US/German cooperative materials science payload. During the flight, Thagard conducted various medical tests and collected data on physiological changes associated with astronaut adaptation to space.

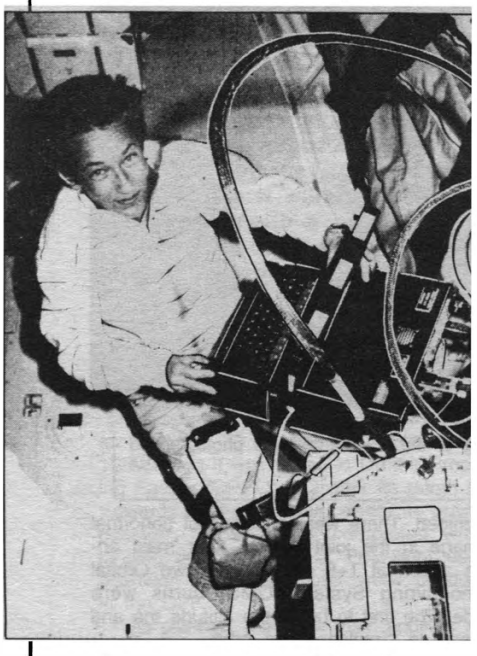
Thagard also served as a mission specialist on STS 51-B, the Spacelab-3 science mission, launched April 29, 1985, aboard Challenger. Duties on orbit included satellite deployment operation with the NUSAT satellite and care for the 24 rodents and two squirrel monkeys contained in the Research Animal Holding Facility.

MISSION SPECIALIST 3
Mary L. Cleave (Ph.D)

Cleave was born in Southampton New York. She is a member of the astronaut class of 1980.

Cleave was a mission specialist on STS 61-B which was launched at night, November 26, 1985. During the mission, the crew deployed communications satellites and conducted two 6-hour spacewalks to demonstrate Space Station construction techniques with the EASE/ACCESS experiments. This was the heaviest payload weight a Space Shuttle had carried to orbit. Cleave also has worked as a capsule communicator (capcom) in the Mission Control Center on five Space Shuttle flights. Cleave has logged 165 hours in space prior to this mission.

Lap-Top Computer Monitors Experiment



Mary Cleave operates the PGSC lap-top computer. *NASA*

The lap-top computer carried on STS-30 is an updated version of the Shuttle Portable Computer (SPoC) used on every Shuttle mission since STS-9. The new computer, called the Payload and General Support Computer (PGSC), brings the latest technology to the Shuttle's crew compartment. While the SPoC represents 1980 technology, the PGSC is 1988 state-of-the-art equipment.

On STS-30, the PGSC was used to gather data from a fluids crystal growth experiment, designated FEA-1 (see box below).

"The PGSC is really going to enhance our ability to do science on the middeck," said STS-30 Mission Specialist, Mary Cleave. "It will give us more of a chance to interact with experiments and prove further the value of having a person available to work with the payload. Right now most experiments are very automated."

The PGSC is ideal for monitoring and gathering information from payloads. The computer's floppy disks can be used to store payload data for analysis upon the Shuttle's return to Earth.

SPoC also offers a miniaturized version of the global tracking map that is the flight control room's central display; readouts of mission elapsed time; time to acquisition and loss of signal; and Greenwich Mean Time. On the portable computers flip-up display, the map shows current position, day and night cycles, Earth observation points and tracking coverage boundaries, both by satellite and ground stations. The portable computer also offers a back-up for calculating deorbit targets to be used only in a dire emergency and a complete loss of communications with the ground. The SPoC has become an essential part of Shuttle equipment - but the computer's 384k memory allows only these functions, plus a few other limited programs.

The PGSC, featuring a 20-megabyte hard disk, can run all the SPoC software with a tremendous amount of room spare for other programs, including word processing and possibly a computerised Flight Data File - a 25 book, 2,500 page file carried aboard the Shuttle that holds the vital information covering all aspects of a mission. In addition, the PGSC has a built-in 3.5 inch floppy disk drive that could revolutionize data gathering from payloads.

The PGSC has an eight megabyte Random Access Memory (RAM), about 16 times that of the SPoC. Despite its expanded capability the PGSC, on average, uses half of the electricity required by the SPoC, and it can run for at least ten minutes on battery power. This facility will allow the crew to move the computer from place to place without turning it off.

The PGSC was first tested in orbit during STS-29 in March by Mission Specialist James Bagian.

Fluids Experiment Apparatus (FEA)

The Fluids Experiment Apparatus (FEA), a multipurpose experiment support system developed by the Space Transportation Systems Division of Rockwell International, is designed to perform materials processing research in space. The result is convenient, low-cost access to space for basic and applied research in a variety of technologies.

The FEA is a modular, microgravity chemistry and physics laboratory used for the first time on STS-30 for materials processing research in crystal growth, general liquid chemistry, fluid physics, and thermodynamics. It has the functional capability to heat, cool, mix, stir, or centrifuge experiment samples that can be gaseous, liquid, or solid. Samples can be processed in a variety of containers or in a semicontainerless floating-zone mode. Multiple samples can be installed, removed, or exchanged during a mission through a 14.1-by 10-inch door in the FEA's cover. Instrumentation can measure the sample's temperature, pressure, viscosity, etc. A video or super-8-millimetre movie camera can be used to record sample behaviour. Experiment data can be recorded by a portable computer with floppy disk drive. This computer is also capable of controlling experiments. (see separate item on the Shuttle lap-top computer).

The FEA is mounted in place of a standard stowage locker in the mid-deck of the Shuttle crew compartment, where it is operated by the flight crew. Modular design permits the FEA to be easily configured for almost any experiment. Configurations can even be changed in orbit, so that experiments of different types can be performed on a given Shuttle mission. Optical subsystems can include custom furnace and oven designs, special sample containers, low-temperature air heaters, specimen centrifuge, special instrumentation, and other equipment specified by the user.

were completed the crew began to prepare for the deployment of Magellan. Deployment of an interplanetary spacecraft requires precision positioning. The orbiter's Inertial Measurement Unit (IMU) and the IMU onboard Magellan were precisely matched. Atlantis' star tracker was used to obtain navigational fixes to ensure the accuracy of the IMUs.

At T+5 hours 40 minutes the crew tilted Magellan and its IUS booster to 29 degrees. With the front of Magellan now outside the payload bay it was possible to test communications between the IUS/Magellan and ground station. After last minute checks of the probe and booster had been completed the crew were given a 'go' for deployment by Mission control. The IUS/Magellan combination was tilted to the deployment angle of 52 degrees and at T+6 hours 14 minutes 29 seconds Mission Specialist Mark Lee triggered powerful springs that sent the probe out of the payload bay.

Commander Walker began a series of RCS firings to distance Atlantis from the probe and then manoeuvred the spacecraft to observe Magellan's solar panel deployment. After the crew witnessed the successful opening of the solar panels Walker fired the OMS engines to increase the separation between the two craft. The final manoeuvre of the deployment sequence was to turn Atlantis' underside towards the probe to protect the orbiter's windows from the exhaust of the IUS booster.

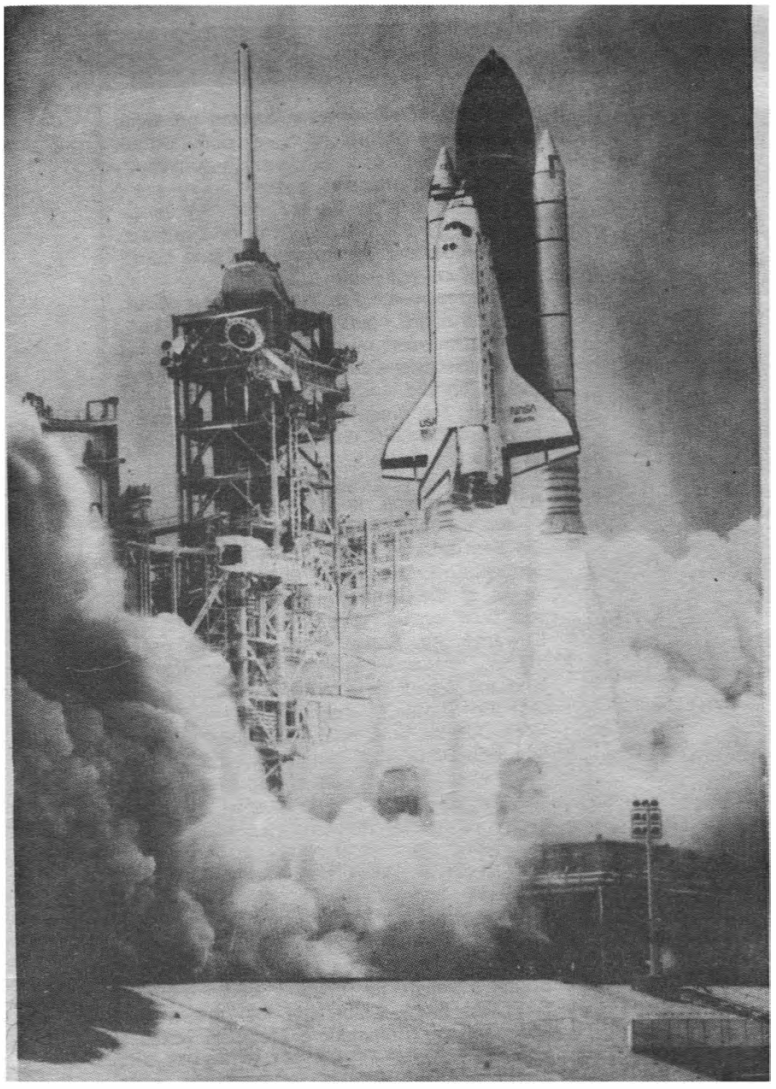
The IUS booster fired an hour later propelling Magellan on its 15 month trip to Venus.

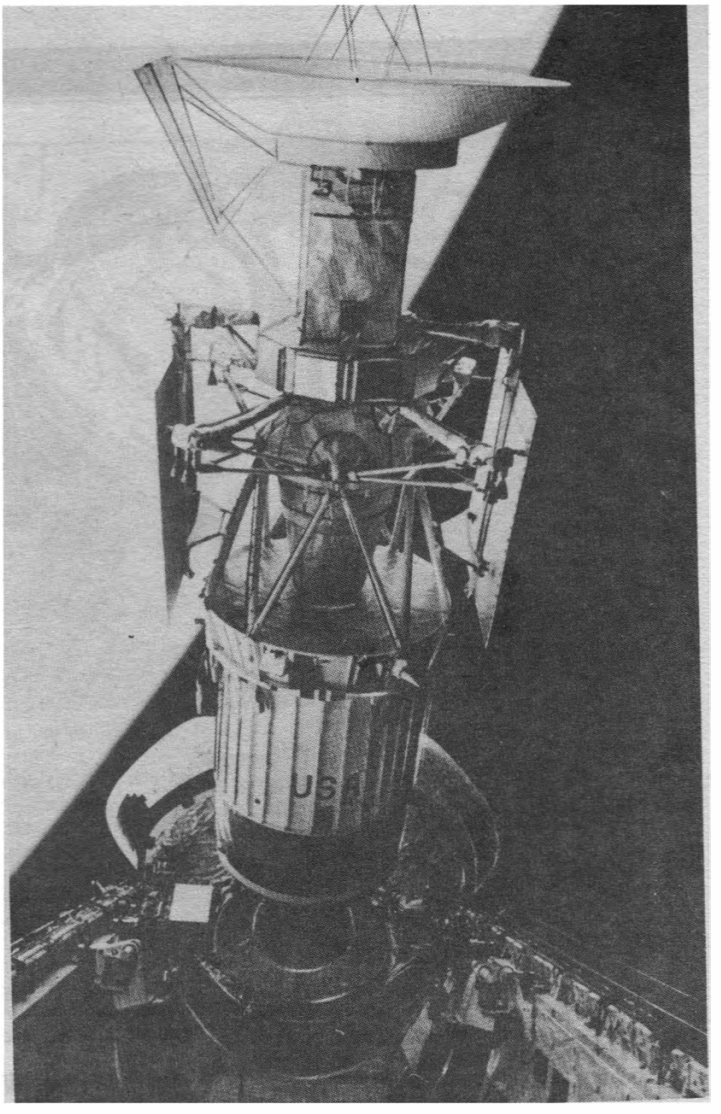
Day two: May 5, 1989

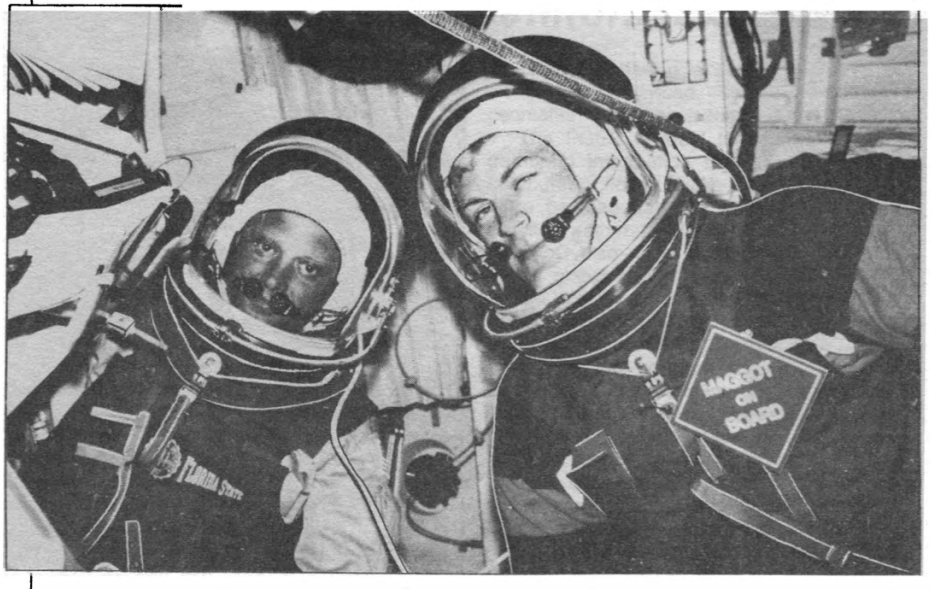
The STS-30 crew spent most of the second day in orbit on scientific experiments Television and 35mm cameras were utilised to study thunderstorm lightning activity over areas of Africa and South America as part of the Mesoscale Lightning Experiment (MLE). The Fluid Experiment Apparatus (FEA-2) was utilised to study the effects of the microgravity environment on materials processing. In addition as part of the AMOS experiment (see **Spaceflight,** May 1989, p.176 for a brief description of AMOS) Atlantis fired its Reaction Control System (RCS) jets while optical instruments on the ground at Maui, Hawaii observed their signatures.

During the day the crew experienced difficulties with the Text and Graphics System (TAGS) which is designed to receive uplinked images and text from the ground. During the four day flight 400 images were to be transmitted via TAGS. However the system experienced several paper jams during operation. The non-invasive central venous pressure measuring system also failed on Day Two. The experiment was

(Top left) Atlantis blasts off from launch pad 39B at the Kennedy Space Center on May 4.
(Top right) The Magellan probe is released from its cradle in the payload bay.
(Bottom) The STS-30 crew pose on the orbiter flight deck. (left to right) Norman Thagard, Ronald Grabe, Mary Cleave, David Walker and Mark Lee. ***NASA***







Mission Specialists Norman Thagard (left) and Mark Lee evaluate the use of Launch Escape Suit Helmets for EVA pre-breathe operations. *NASA*

designed to investigate the shift in body fluids towards the head experienced by astronauts in weightlessness. During the day humidity in the crew cabin increased from the normal 30% to over 50%. The orbiter was realigned so its payload bay radiators were turned towards the cold of space and the humidity gradually decreased.

Day Three: May 6, 1989

The crew was awakened by Mission Control playing collections of the astronauts college songs over the communications system. The crew continued with their scientific experiments including lightning photography, microgravity studies and further AMOS observations.

The crew tested a home-video 8mm camcorder as a cheap and possibly superior alternative to the existing orbiter television system. The camcorder was used to record the FEA experiment results. Commander Walker evaluated the use of the orbiter Heads Up Display (HUD) as a back-up star sighting device for aligning the Inertial Measurement Unit (IMU).

During the day the shutter of a Hasselblad 70mm camera stuck and the crew was unable to repair it. A minor problem developed with the onboard water dispenser, used for the preparation of dehydrated meals. The dispenser would not deliver the required amount of water. By connecting a small piece of hose to the dispenser the crew were able to judge the amount of water injected into their food.

Day Four: May 7, 1989

The crew was awakened by mission control with the theme from the film "Rocky". Later the crew took part in an on-orbit press conference.

The crew continued work on the experiments but were interrupted when one of Atlantis' five General Purpose Computers (GPC) failed. Flight Director Ron Dittemore gave the crew permission to carry out the first on-orbit replacement of a GPC - even though it had recovered - to provide an extra measure of confidence during reentry. A spare GPC is carried in the orbiter middeck and Shuttle crews receive training on their replacement before each mission. Dittemore said the faulty GPC, which controlled the Shuttle's payload buses, never presented a threat to the mission. An initial analysis by the Johnson Space Center's Data Processing Section pointed to a hardware failure in the GPC.

The replacement of the GPC took about four and a half hours, with Cleave and Lee working between middeck lockers to get to the Shuttle avionics bay, the rest of the crew looking on and lending a helping hand when required. The 8mm video camera was used to record the GPC changeout for future reference

Day Five: May 8, 1989

Atlantis' two OMS engines were fired on the 64th orbit to begin the orbiter's reentry sequence. As the orbiter entered the upper layers of the atmosphere, Mission Control was busy evaluating the wind conditions at Edwards Air Force Base. Shuttle programme managers were hoping they could land the orbiter in crosswind conditions to test the Shuttle's tyres and steering systems. Atlantis was due to touch down on lake bed Runway 17 but cross wind conditions there had exceed safety limits Mission Control told Walker to change his landing to concrete Runway 22, where the crosswinds were lighter and almost ideal for the test NASA had in mind.

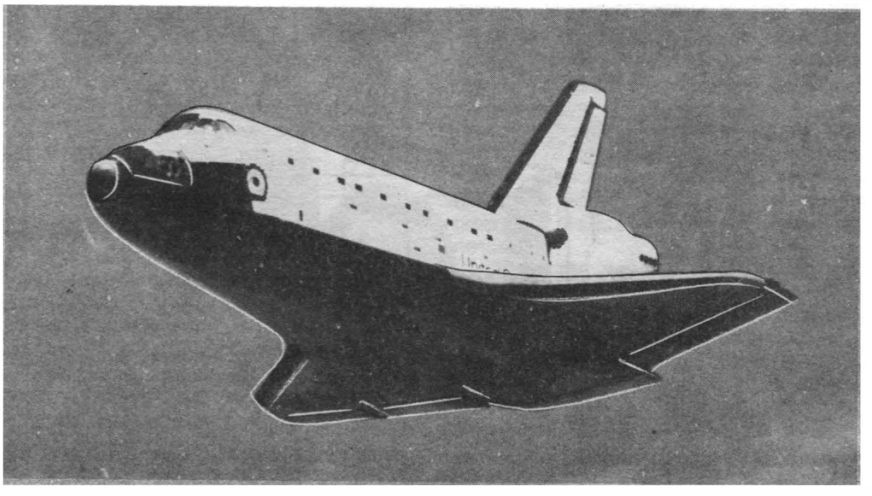
Walker brought Atlantis down to a perfect landing on the concrete runway, the orbiter's wheels coming to a stop at 12:44:33 PDT. "You've extended the Shuttle's reach far beyond Earth orbit," CAPCOM Frank Culbertson told the crew after landing. "Commodore Magellan would approve."

"Roger that," Walker said in return.

"The vehicle looks as clean as any one I've ever seen," said Richard Truly, the then Associate Administrator for Space Flight, now appointed NASA Administrator.

Atlantis has been returned to the Kennedy Space Center and work is underway to prepare her to launch the second interplanetary spacecraft of the year: the Galileo probe to Jupiter

(For further details of Magellan's voyage to Venus see Space at JPL starting on p.282.)



Atlantis glides towards a perfect landing at Edwards Air Force Base on May 8. *NASA*

STS-30 At a Glance

ORBITER: Atlantis (OV-104)
LAUNCHED: May 4, 1989 19:47 BST
LAUNCH SITE: Pad 39B, Kennedy Space Center, USA
LANDED: May 8, 1989 20:43:33 BST
LANDING SITE: Runway 22, Edwards Air Force Base, USA
LIFT-OFF WEIGHT: 4,525,116 pounds
LANDING WEIGHT: 192,313 pounds
APOGEE: 341 km
PERIGEE: 258 km
INCLINATION: 28.85 degrees
DURATION: 4 days 56 minutes 33 seconds
ORBITS: 64.5

COMMANDER: David M. Walker
PILOT: Ronald J. Grabe
MISSION SPECIALIST 1: Mark C. Lee (EV2)
MISSION SPECIALIST 2: Norman E. Thagard (EV1)
MISSION SPECIALIST 3: Mary L. Cleave

PRIMARY PAYLOAD: Magellan/IUS-18
SECONDARY PAYLOADS:
Fluids Experiment Apparatus (FEA)
Mesoscale Lightning Experiment (MLE)

Buran Steals the Show

Keith Wright

The arrival of the Buran space shuttle atop the world's largest aircraft, the Antonov An-225 Mriya (Dream), was the highlight of this year's Paris Air Show. The Mriya and Buran touched down on June 7, emerging from a stormy Paris sky to make a perfect landing on the 2,100 m long runway at Le Bourget Airport.

Buran's journey to Paris began on May 10 when the Antonov arrived at Baikonur to pick up its precious cargo. The Antonov team was not expecting to leave with Buran until May 25 at the earliest. But the operations went so well the number of test flights was reduced from nine to five and the crews found themselves six days ahead of schedule.

On May 19, with a combined weight of 560 tonnes, the Antonov and Buran took off from the Cosmodrome for the Soviet city of Kiev, where the spacecraft was given a thorough check and certified ready to continue. After a brief visit to Moscow the two craft returned to Borispol Airport, Kiev, where final loading of cargo and fuel took place.

Buran and the Antonov made the three and a half hour flight to Paris on June 7. As it entered French air space the Antonov was met by Mirage fighters of the French Air Force and escorted to Le Bourget airport, the air show venue. It made an impressive fly past above the runway before touching down at about 10:40am local time.

Buran seemed unaffected by the rain and turbulence it passed through before landing. US shuttle ferry flights are prohibited in such conditions - the impact of rain drops would damage the orbiter's protective tiles. However Buran's 38,000 quartz fibre tiles are apparently impervious to the rain.

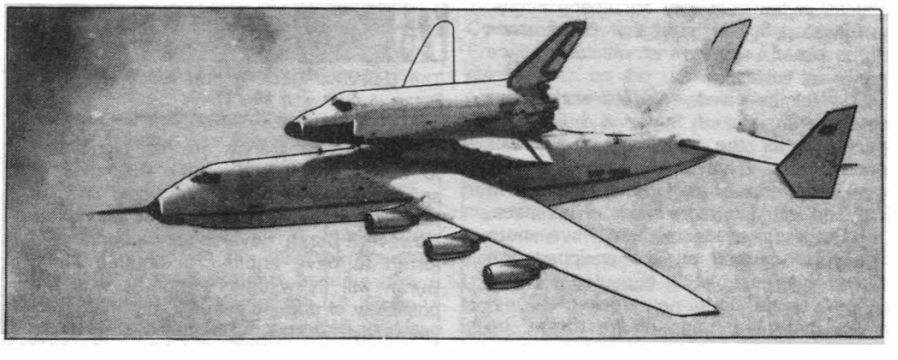
Paris Reports By Steven Young and Theo Pirard

Buran showed few signs of damage following her two orbit flight in November last year. The shuttle's lower surfaces looked pitted in places. The majority of Buran's scorched surfaces had been cleaned. A triangular shaped area along the fuselage and the tops of the payload bay doors seems to have been permanently discoloured. This area has a different type of tile, larger than those on the forward fuselage. Buran does not appear to have any heat insulation blankets, now used extensively by the US shuttle.

The lower surfaces of the RCS pods were blackened following the November mission. It is unclear if this was caused by reentry heating or burns of the RCS thrusters. What ever the cause, it seems the Soviets have decide to replace the original white tiles with black insulation. This work appeared incomplete, with tarnished tiles still in place.

Buran's Paris visit provided the first detailed view of the aft of the Shuttle where the Orbital Manoeuvring System (OMS) engines and triangular umbilical plate are located (see photograph). The entire aft bulkhead is heavily armoured with heat resistant tiles. There is a service hatch on the side of the aft fuselage to giving access to the interior. The Liquid Oxygen and Kerosene tanks for the OMS and RCS thrusters and the Auxiliary Power Units (APUs), which produce pressure for the orbiter's hydraulic systems, are located in this area. There are a number of vents around the aft fuselage possibly exhausts from the APUs and vents

Buran and the An-225 during test flights prior to the Paris visit. *Antonov Design Bureau*



for dumping OMS and RCS fuel

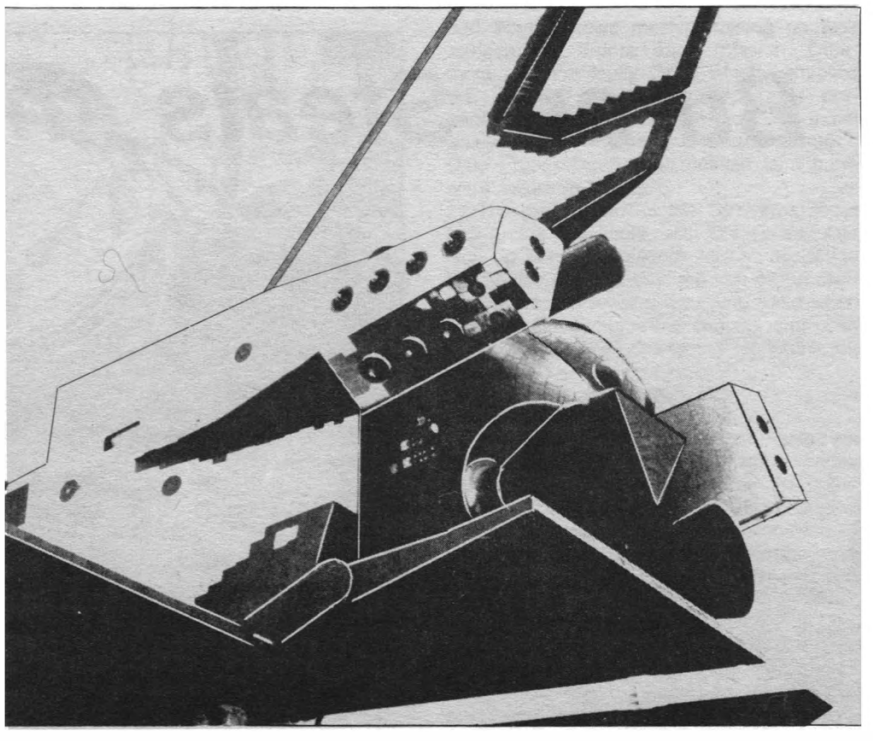
Four vent doors are spaced out along the Soviet orbiter's fuselage and appear to be of exactly the same design used in the US Shuttle. The vents are opened to depressurise the interior of the fuselage during the later stages of ascent and are closed for repressurisation during descent.

The orbiter's OMS and RCS nozzles had been plugged to prevent contamination of their motors The aft RCS primary thrusters are located in exactly the same positions as the US Shuttle's three thrusters on the upper and lower side of the pod and four on the outer side Also located on the lower side of the pod are two vernier thrusters, used for precise manoeuvres and station keeping operations Unlike the US shuttle there are no vernier motors in the forward RCS assembly.

Post-mission examination of Buran was interrupted by the visit to Paris and work will continue upon the shuttle's return. The fact space officials were willing to lose several weeks work while Buran was ferried to Paris indicates it will be some time before its second mission. Cosmonaut Yun Romanenko has revealed Buran's cabin is undergoing a refit in preparation for a manned flight.

Spaceflight was invited aboard the Antonov for a tour of the massive aircraft, writes *Steven Young.*

The guide for the tour was Myria's navigator who had the day before plotted a course from Kiev to Paris. Three large charts in the cavernous cargo bay detailed various payloads the An-225 could carry. The third chart depicted the British Hotol space plane atop the Antonov. A study conducted by the Soviets reportedly shows it would be cheaper to fly Hotol on Myria to an equatorial launch site than it would for Hotol to fly under its own power.



The aft fuselage of Buran Note the damage to the underside of the RCS pod, the access hatch and triangular umbilical plate. *Keith Wright*

On the flight deck, sitting in the pilot's seat of the world's largest aircraft, I took the opportunity to question the Navigator.

I asked if the aircraft was difficult to fly with Buran attached. I was told the two craft handled better than expected. Was there any umbilical connections between the An-225 and Buran? No the shuttle was completely inert and required no monitoring during flight. The An-225 had been designed specifically to carry the Soviet shuttle but would have many other uses the Navigator explained.

Shatalov: 'Glavkosmos Must Take Control'

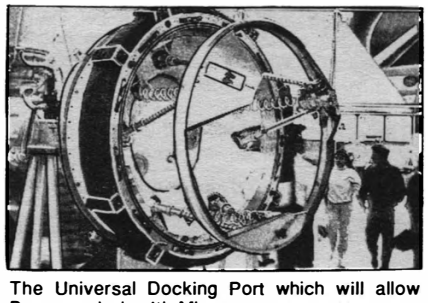
New Soyuz and Progress Spacecraft under Development

Cosmsonaut Training Chief Vladimir Shatalov, accompanied by seven cosmonauts, was a member of the Soviet delegation at the Paris Air show. During a brief interview Shatalov commented on his proposal to establish a Soviet space agency (see *Spaceflight,* July 1989, p.218):

"I criticized Glavkosmos in the hope the organisation would increase its influence in the management of Soviet space activities. Glavkosmos is a young organisation and does not control every element of our space programme. Through glasnost, we wish Glavkosmos will take a serious approach to organise in the best way our space efforts. By criticising it, we hope that Glavkosmos will become a good and efficient space agency in USSR."

Shatalov, revealed: "We are working on improved versions of Soyuz and Progress spacecraft for the utilisation of the Mir space station. The Soyuz spacecraft will have large capacities for manoeuvring in orbit and carrying more payload in space. The Progress spacecraft will have more capacity of payload and be equipped with recoverable/reusable capsules. The launch vehicle, is a new rocket." Questioned about the name of the rocket, he replied: "I have no comment about this name. Zenit, was invented by another team in USSR and I am not frankly responsible for invention of the name!"

About Buran and possible use with the Mir station: "We are not pressed to use this vehicle. Space planes are complementary to Soyuz spacecraft for the utilisation of space station elements. We would like the next flight to be manned and not automated. However, Buran development people preferred to have another automated flight. Buran will fly within 18 months with the possibility of docking with Mir, but that is not yet firmly decided... Six months after this automated mission, cosmonauts will fly aboard Buran."



The Universal Docking Port which will allow Buran to dock with Mir. *James Goddard, Science Museum*

Shatalov went on to say: We are at a crucial point in manned space flight we must explore the acquired know-how and to go ahead with new investigations for the future. There are possibilities of industrial production in space.

Dr. Alexander A. Serebrov, pilot-cosmonaut named for the next Soyuz TM mission in the Mir-Kvant complex, described the next two modules to be launched before the end of this year: "The first module to be launched in September-October will increase the living quarters and experiment opportunities with the Mir station; a special airlock will allow EVA and the use of a space scooter [Manned Manoeuvring Unit]."

"A second module will be launched in December-January and will be equipped with a universal docking port [this port, similar to the androgynous docking system tested during the ASTP mission, was exhibited at the USSR pavilion] and with industrial production facilities; these facilities will consist of optical heating, of fluid physics, electronics and metallurgy production in vacuum, electrophoresis." He said that Buran would be equipped with an androgynous ASTP-type docking system.

Antonov Dream Solves Shuttle Transport Nightmare

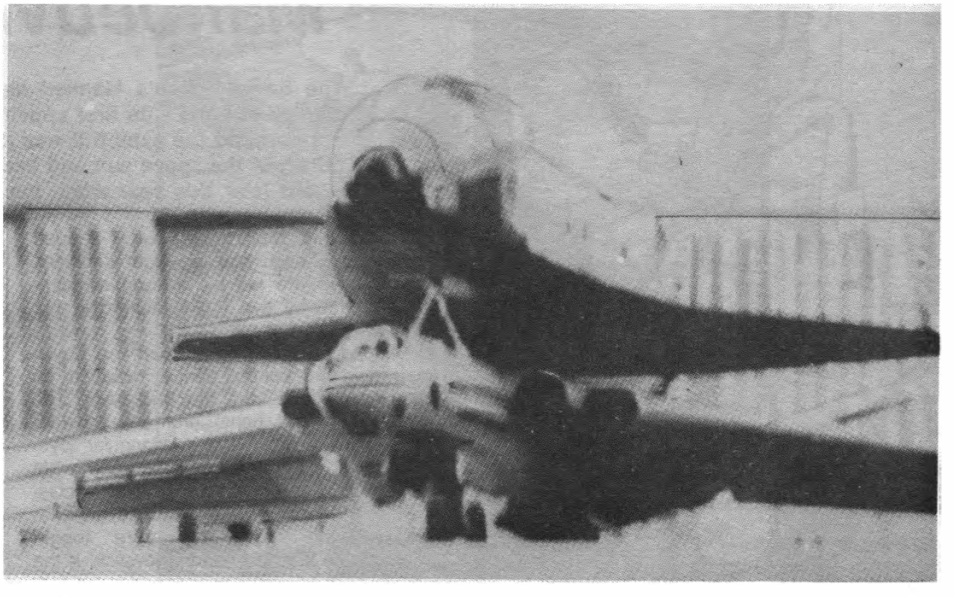
The Antonov An-225 Mriya (Dream) has eased the problem of transporting shuttle orbiter airframes a distance of more than 2,000 km from a factory near Moscow to the Baikonur Cosmodrome in Kazakhstan.

The Soviet orbiters are manufactured by the Molniya Scientific and Industrial Enterprise at its Tushino Machine Building Factory near Moscow. From the factory Buran had to make the 2,000 km trip to Baikonur without its vertical stabilizer and with many of its heat resistant tiles missing. The orbiter could not be transported in its completed form because the 60 tonne craft was too heavy for conventional aircraft. A Myasishchev M-4 bomber was adapted to carry the stripped-down orbiter. The bomber's fuselage was lengthened and reinforced and its vertical stabiliser replaced by two stabilisers mounted on struts either side of the rear fuselage.

Buran was transported from the factory to the airport by road and then by barge. For the entire journey the orbiter was protected from prying eyes by sheets of tarpaulin. At the airfield a large mobile crane placed the orbiter atop the M-4 bomber. A tail cone was was used to protect the carrier aircraft from turbulence. The Soviets said the two craft had excellent aerodynamic qualities.

When Buran arrived at Baikonur it was lifted from the aircraft by a crane similar to the US Shuttle's Mate-Demate device and transported to the Assembly and Testing Plant (ATP), where final work was completed.

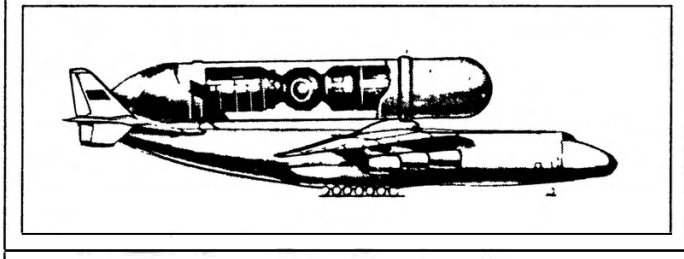
The An-225 will make it possible to transport completed orbiters from the factory to Baikonur. Another important task will be to return the shuttle from a contingency landing site in the event of an emergency landing. The Antonov Mriya will also carry parts for the Energia booster. Both the core stage and strap-on boosters can be carried externally.



An M-4 bomber takes off with the partially assembled Buran.

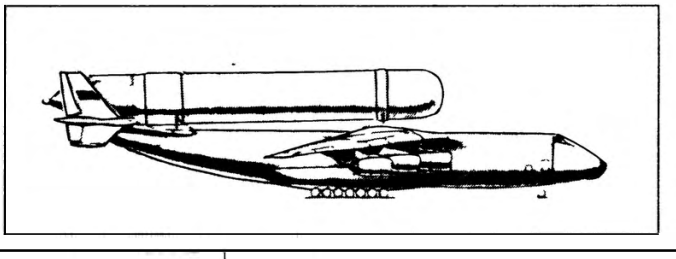
The An-225 carries a future space station module.

Antonov Design Bureau



The Energia core stage can be accommodated atop the An-225

Antonov Design Bureau



CNES to Start Talks on Third Franco-Soviet Mission

The French space agency, CNES, has agreed to negotiate terms with Glavkosmos for a third Soviet-French manned space mission, this time on a commercial basis.

French cosmonaut Jean-Loup Chretien has made two flights aboard Soviet spacecraft, the first to Salyut 7 in June 1982 and the latest being a month long stay onboard the Mir space station last November. The French made no payment for the two missions. The French announced last year they planned to fly a joint mission with the Soviets - on a non-commercial basis - every two years. But the commercial arm of the Soviet space programme, Glavkosmos, insisted they pay for their next flight. After much resistance the French have agreed to the Soviet terms. European independent access to space with Hermes will not be available until the end of the next decade and the Space Shuttle is to carry few 'passenger astronauts'

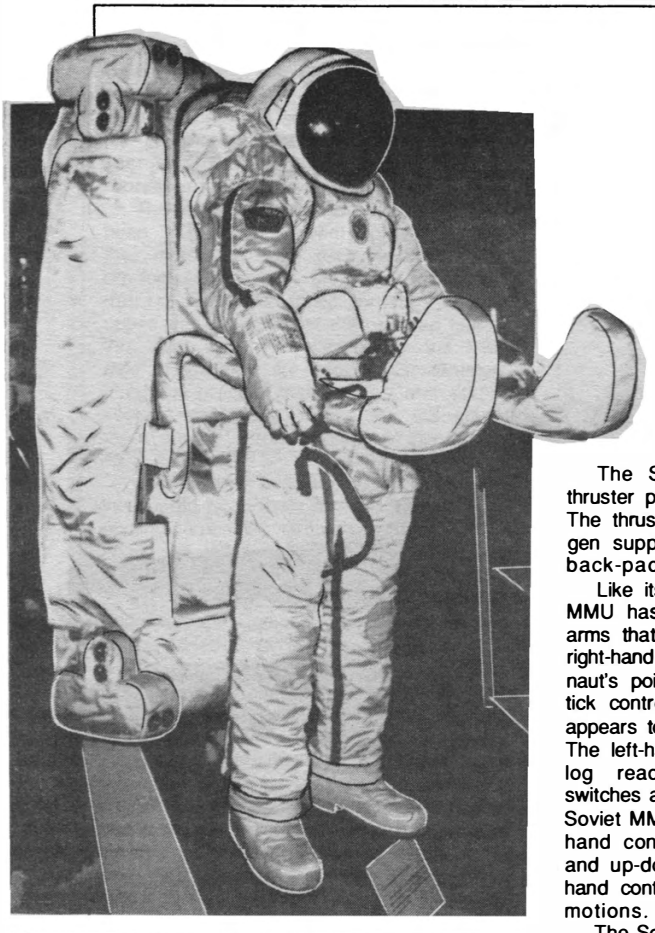
CNES hopes to reduce the fee of $10-12 milion by offering the Soviets use of any French equipment left aboard the station. The Austrians have already come to a similar agreement.

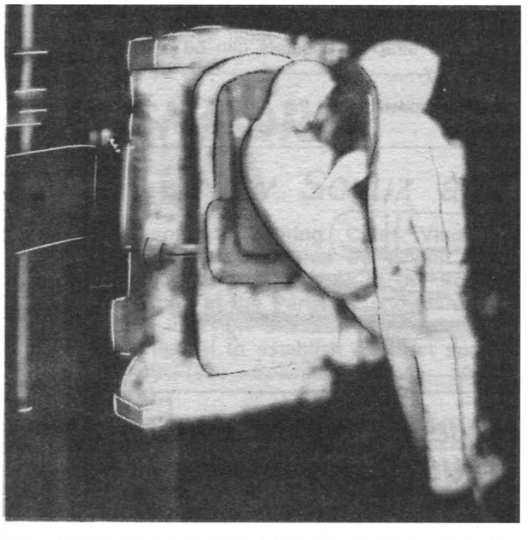
Michel Tognini, back-up to Jean-Loup Chretien, is tipped to be the third French cosmonaut (Patrick Baudry became the second when he flew aboard the US Space Shuttle). Two back-ups are expected to be trained along side Tognini.

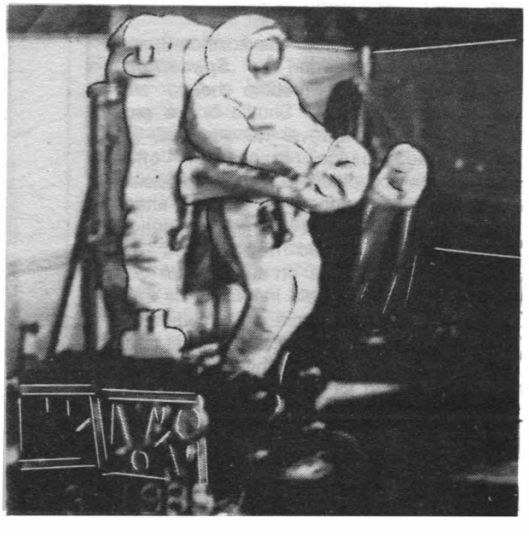
Soviets Offer to Launch US Space Station

The Soviet Union has offered to launch the US Space Station Freedom with its Energia heavy lift booster.

William Wirin of the Glavkosmos-Space Commerce Corporation told ***Spaceflight*** Energia could launch Freedom cheaper and quicker than on the US Shuttle or the proposed Shuttle-C. However he admitted, for political and prestige reasons, the offer would not be accepted. He said the proposal would serve its purpose by drawing attention to the Soviet Union's space capabilities. Wirin said he believed US Government restrictions on the use of Soviet space services would increase. He said US companies could avoid the problems of technology transfer by leasing Soviet satellites. A Gorizont communications satellite can be leased for $1.5 million per anum.







Soviet Union Exhibits Manned Manoeuvring Unit

The Soviet Union's Manned Manoeuvring Unit (MMU) was on display in Paris - its first appearance in the West. With no barriers around the exhibit it was possible to make a close examination of the space suit and back-pack, which is expected to be tested later this year when manned Mir operations resume.

The Soviet MMU has four T-shaped thruster pods each housing eight thrusters. The thrusters are fed by pressurised nitrogen supplied by two tanks located in the back-pack.

Like its American counterpart the Soviet MMU has two control panels mounted on arms that extend from the back-pack. The right-hand control panel (from the cosmonaut's point of view) has a triangular joystick control, six toggle switches and what appears to be a small liquid crystal display. The left-hand control panel carries an analog read-out instrument, more toggle switches and a round headed joystick. If the Soviet MMU follows the US design, the left-hand controller governs fore-aft, right-left and up-down movements, while the right-hand controller handles roll, pitch and yaw motions.

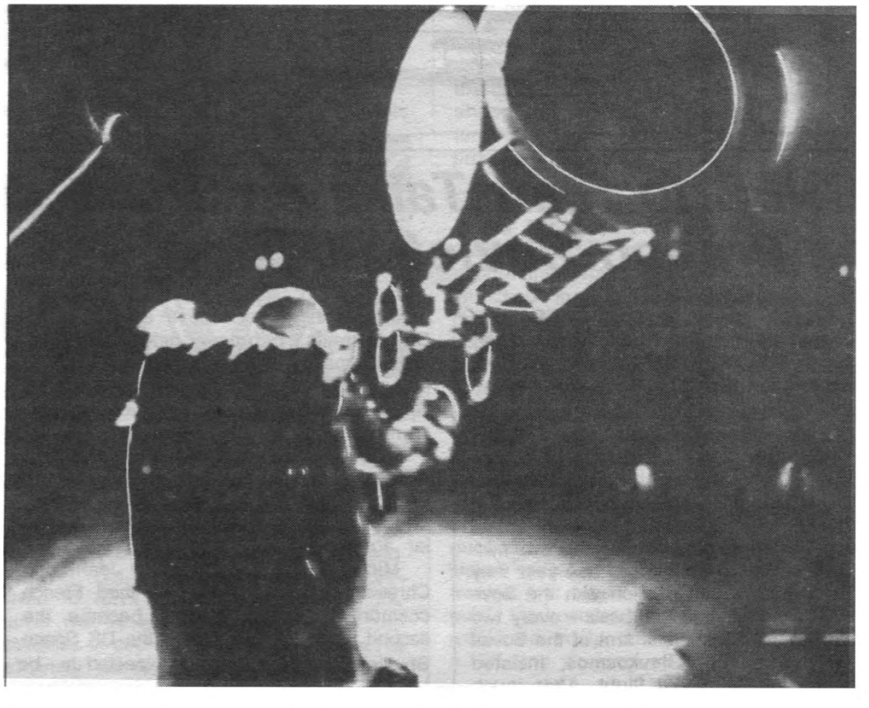
The Soviet MMU is larger and more bulky than the US version, extending from the helmet to below the knees. Unlike the American MMU, which has a metal skin, the Soviet MMU is protected by a layer of thermal blankets. The blankets can be peeled back exposing the MMU interior to allow easy on-orbit maintenance.

A video film in the Soviet Pavilion showed cosmonauts training to use the MMU. The cosmonaut enters the space suit in the normal way, climbing through the back of the suit. Once the seal between the hatch and the suit is made, the MMU control arms are raised into the correct position and the cosmonaut is ready to begin training.

For training purposes the MMU is mounted to what appears to be a hover pad, which lifts the cosmonaut and his MMU fractionally off the ground on a cushion of air. By using the hand controls the cosmonaut can manoeuvre the MMU on the polished floor.

The film sequence showed a cosmonaut approaching a mock-up of the one metre diameter airlock of the new Mir module. A grapple unit on his space suit (not on the suit at Paris) is then used to anchor the cosmonaut to the module. A similar grapple unit was used by the Americans to capture Solar Max during a 1984 Shuttle spacewalk

(Top left) The Soviet MMU as it appeared in Paris (Middle left) A cosmonaut climbs into the space suit with the MMU attached. (Bottom left) Mounted on a hover pad an cosmonaut can train to operate the MMU (Below) A cosmonaut using the MMU simulator approaches a mock-up of the one metre diameter airlock of the new Mir module



Pegasus Set for August 22 Launch

The Pegasus air launched booster is to orbit its first satellite on August 22, Bill Saavedra of the Orbital Sciences Corporation (OSC) told *Spaceflight*. After release from a NASA B-52 aircraft, Pegasus will ignite the first of its three solid rocket motors to place a NASA/Defense Advanced Research Projects Agency (DARPA) payload into Low Earth Orbit.

Preparations for the first launch have proceeded well: The Pegasus stages have undergone test firings on the ground and in July a Pegasus vehicle is to make two captive flights attached to the B-52. Once all these tasks are accomplished the way will be clear for the first launch.

OSC and Hercules Aerospace, the developers of this ingenious launch vehicle, hope Pegasus will promote the growth of light-weight satellites. Ball Aerospace is developing a series of so-called 'lightsats' that can be carried by the Pegasus. The booster is capable of delivering payloads weighing up to 900lb into Low Earth Orbits and carrying payloads of 1,500 lb on suborbital missions.

The Pegasus booster offers relatively cheap access to space, each launch costing about $6-7 million. OSC and Hercules are capable of manufacturing one Pegasus vehicle per month. If the launcher attracts a sufficient number of customers OSC and Hercules will expand their assembly lines to meet the demand. There is very little restriction on the actual launch rate, apart from the availability of the launch vehicles and a suitable carrier aircraft.

According to Mr Saavedra, one of Pegasus' many qualities is the ability to launch almost anywhere in the world. But to allow precise tracking of the vehicle's ascent, the first Pegasus launches will take place within existing launch ranges (in the case of the first flight Vandenberg Air Force Base will be used). Mr Saavedra singled out Kourou, conveniently positioned close to the equator, as one possible launch zone equipped with adequate tracking facilities. To make Pegasus completely independent from ground tracking support, a second aircraft could be fitted with the necessary tracking equipment he added. OSC and Hercules is also looking for a new carrier aircraft as the aging NASA B-52 aircraft will not always be available for their use.

A full scale mock-up of the Pegasus payload fairing with a Ball Aerospace communications satellite
James Goddard, Science Museum

Another feature of Pegasus is its simplicity. The final Pegasus assembly requires just six people and takes place on the back of a specially designed truck. The same truck is then used to transport the vehicle to the aircraft and lift it into position. The Pegasus deployment is controlled by a small console onboard the B-52. An Inertial Measurement Unit (IMU) inside the aircraft is used to update Pegasus' own onboard IMU with the aircraft's exact position. To further increase accuracy, OSC and Hercules plan to install a Global Positioning System receiver onboard the B-52 and eventually inside the booster itself.

If the first launch goes well a second Pegasus could be launched before the end of the year.

Ariane Recoverable Capsule Proposed

The West Germany company MAN Technologie is proposing a retrievable payload capsule for launch in the 1990s by an Ariane 4 or 5. The capsule would carry microgravity experiments into orbit for up to three weeks before returning them to Earth for analysis.

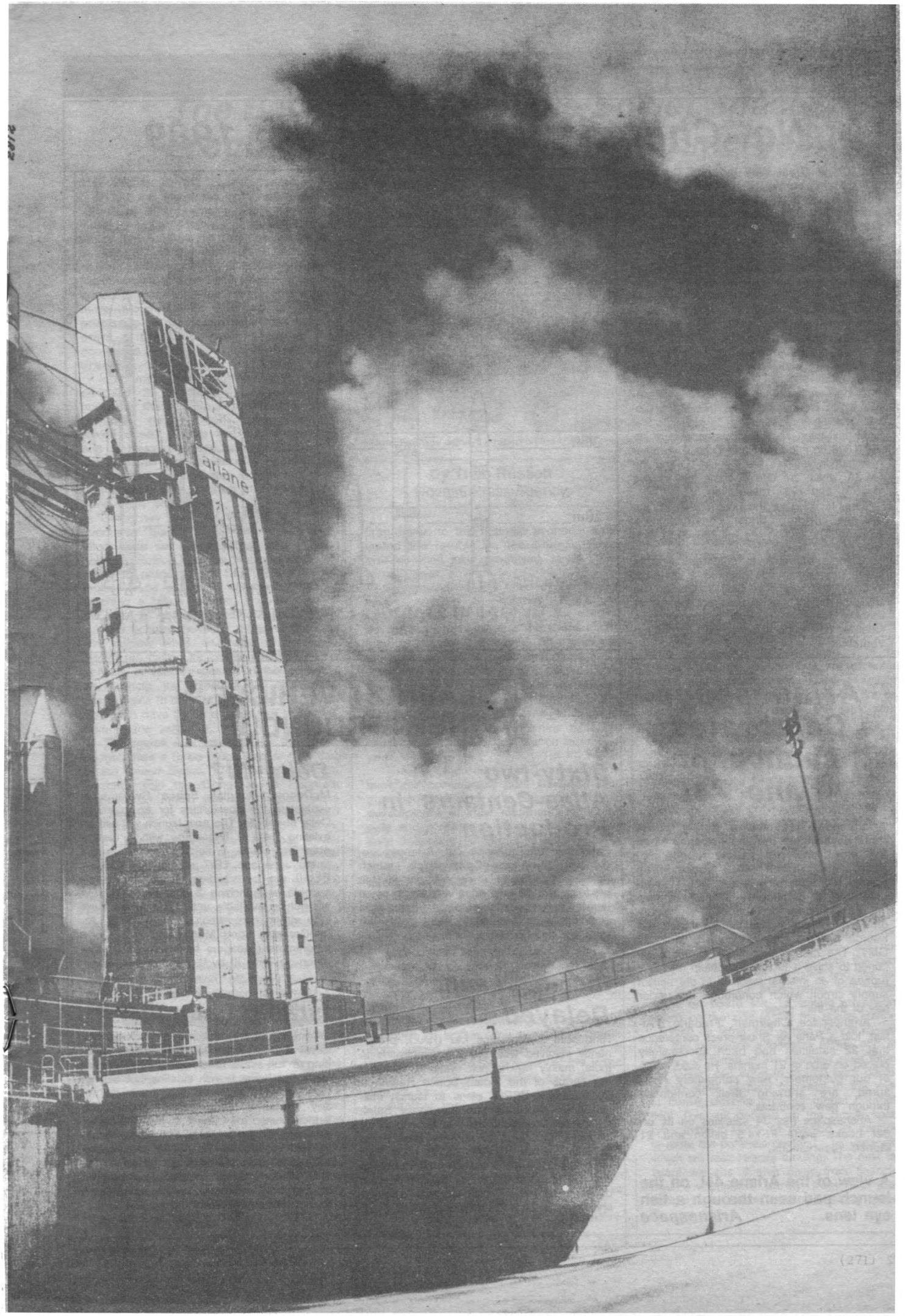
MAN Technologie believes its Ariane Capsule will close a gap in European space capabilities. Europe has had to rely on Soviet and Chinese recoverable capsules or the US Space Shuttle to carry microgravity experiments and return them to Earth.

The capsule has the same shape as the US Apollo Command Module but is slightly smaller. The capsule consists of two elements, the payload module (lower part) and the service module (upper part). The payload module is pressurised and can carry experiments weighing 400-900 kg. The spacecraft is powered by batteries and four solar panels mounted to the underside of the payload module. The service module contains the capsule's propulsion systems, parachutes for splashdown and a container where any last minute small payloads can be installed.

The capsule would be manufactured with existing techniques and materials, keeping production costs low. MAN Technologie investigated reusing the capsule but determined it would only be feasible to reuse part of the service module structure and equipment.

After completing a mission of 7-21 days the capsule is deorbited by firing its hydrazine fuelled main engine. During reentry the capsule is protected by an ablative heat shield 40mm thick in places. At the correct altitude the spacecraft's parachutes open and the capsule splashes down in the sea about 400km from the Kourou launch site. After recovery by ship the payload is transported back to Europe where the payloads returned to the investigators.

The Ariane Capsule study was financed by MAN Technologie. The French Space Agency, CNES, has supported the project from its inception and a proposal to implement the project is now with the German Ministry of Research and Technology.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No Chinese Launches in 1989

The China Great Wall Industry Corporation (GWIC) continued its efforts to market the Long March launch vehicle at this year's Paris Air Show. However Mr Luo Ge of the GWIC marketing department told *Spaceflight* China has no plans to launch any satellites this year.

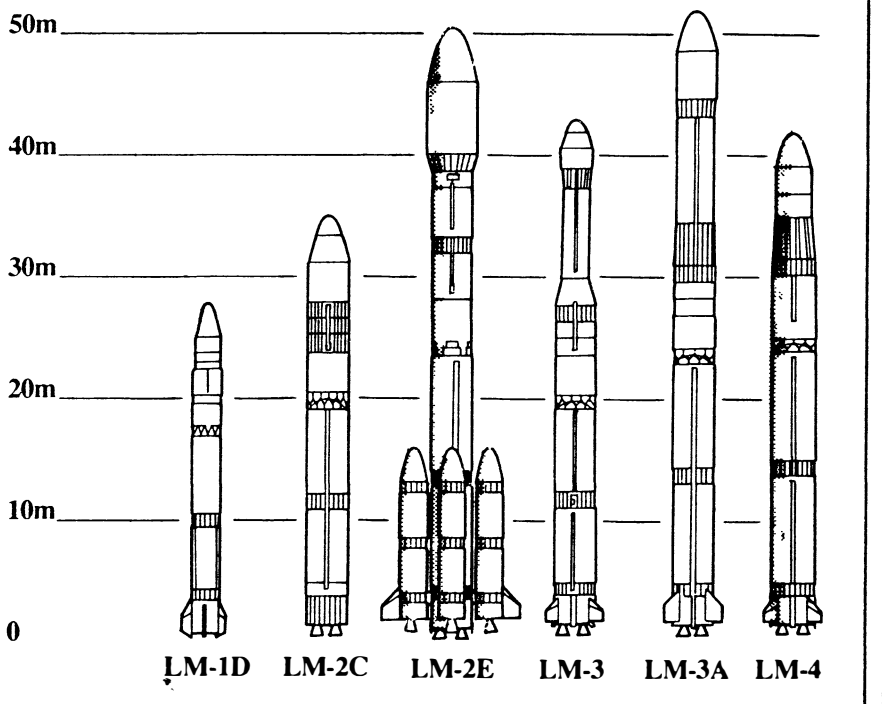
Mr Luo was unwilling to explain why there would be no launches this year, however, he did say launches would resume in 1990. China has launched at least one satellite per year since 1981 and in 1988 achieved four successful launches. Mr Luo went on to say the launch of three Western satellites by Long March would not take place until 1991.

A new variant of the Long March, the LM-2E, which is equipped with four liquid propellant strap-on boosters, is to make its first flight next year. The LM-2E is capable of lifting 8,800 kg into Low Earth Orbit. Two other new launch vehicles are the LM-1D and the LM-3A, which are due to come into service in 1991 and 1992 respectively.

New facilities for the Long March 2E and 3A are currently under construction at Xichang. The launch site will see up to three launches in 1990.

China's attempts to commercialise its space programme has suffered a set back following the recent troubles in China. The US government has suspended the export licenses for three US-built communications satellites due to be launched on Long March vehicles.

The Chinese Long March Family



Arianespace Celebrates Launch of Ariane 44L

Arianespace received a timely boost three days before the show opened when the most powerful Ariane launch vehicle, the Ariane 44L successfully placed the Superbird A and DFS-1 satellites into Geostationary Transfer Orbit.

The launcher - equipped with four strap-on liquid boosters - blasted off from the Kourou Space Centre on June 5 at 22:37 GMT. The launch had been earlier postponed to solve a technical problem due to a rupture of an internal manifold in the helium supply circuit which conditions the upper bay of the third stage.

Arianespace Chairman, Frederic d'Allest, told a Paris Air Show press conference that 22 satellites had been successfully placed on orbit in 21 months. He said: "80% of our customers, now completely reassured, are showing their confidence through new contracts."

Arianespace has 34 satellites on its order books worth FF14.5 billion and 21 launch reservations.

A view of the Ariane 44L on the launch pad seen through a fish eye lens. *Arianespace*

LAUNCH VEHICLE NEWS ROUNDUP

Sixty-two Atlas-Centaurs in Production

Following the example of Arianespace, General Dynamics Commercial Launch Services has made a commitment for the production of 62 new Atlas vehicles to cover launch requirements for eight years. It is planning to achieve up to eight flights per year, for $55-59 million each.

Indian Launches Delayed

Hindustan Aeronautics Ltd (HAL), prominently involved with the space activities in India, mainly with launch systems, revealed the status of the Indian Space Research Organisations (ISRO) plans to launch indigenously spacecraft. The Augmental Satellite Launch Vehicle (ASLV) is scheduled for its third test flight in mid-90. First Polar Satellite Launch Vehicle (PSLV) rocket will fly in mid-91. HAL is initiating the design of the 2nd stage structure for liquid propellant of the next Indian launcher, the Geosynchronous Satellite Launch Vehicle (GSLV).

Delta III?

McDonnell Douglas Space Systems is evaluating the possibilities for an improved Delta III vehicle. The new launch will use an existing Delta II first stage with a restartable 2nd stage. Which engine? It is still open: Japanese LE-7 of Pratt & Whitney RL-10 are possibilities. Delta III will be capable of launching 3 tons into GTO but will not be available until 1993, when it will face strong competition from Ariane 4, Atlas-Centaur, Long March and H-II. Delta programme managers have to make a decision on Delta III by the end of this year.

Israeli Launcher

Israel Aircraft Industries (IAI) were exhibiting a full-scale mock-up of Offek-1, Israel's first home launch satellite, but did not give
any detailed information about the launcher used for Offek-1 or even its name. However, it was revealed that Israeli industry was working on the AMOS communications satellite to be launched by an Ariane 4 in 1993. Israel is apparently working on an improved rocket to launch satellites in geosynchronous orbit.

The Balance Sheet of the Soviet Space Programme: A Clearer Picture Emerges

The debate in the Soviet Union over spending on the space programme is in full flow, with some - such as Boris Yeltsin - calling for cuts of 40 per cent in space expenditure to finance social investments. At the same time, the continuing advance of Glasnost (openness), which is now spilling over into the space programme, has meant that much more information is emerging to give a precise picture of the size and breakdown of the space budget, and of the economic spin-offs from the programme.

Nicolai Ryzhkov delivers a report on the USSR's economic future. President Gorbachev looks on *Novosti*

By Theo Russell
Novosti Press Agency

In his major speech to the new Congress on May 30, President Gorbachev announced that "outlays on space programmes have already been partially scaled down," adding that further cost-cutting measures "should be found". An example of this was the decision to leave the Mir station unmanned from April of this year, until the two new modules to be added on have been completed.

Gorbachev went on to point out, however, that "thanks to the newest space-related ideas we are acquiring unique technologies. Suffice it to say that newest developments produced as part of the Buran project alone can yield substantial returns, reaching a billion roubles, if given over to the national economy and for export."

This echoes the main thrust of the current debate: while advocates of economic reform are calling for better utilisation of the benefits of space research in the economy as a whole, the scientists and technicians are at pains to point out the economic benefits which have been, or soon are to be, felt from space research.

The figures now emerging for the space budget show it to be much smaller than that of the United States. Prime Minister Nicolai Ryzhkov told the Congress of People's Deputies on June 7 that spending on space programmes for the current year amounted to Roubles 6.9 billion, of which 3.9 billion, or 56 per cent, is defence-related. A few days later the Soviet Chief of Staff General Mikhail Moiseyev wrote in *Pravda* that this compared with a US space budget of $29.6 billion, while America's spending on military space programmes was $22.8 billion - six times the equivalent Soviet figure. The comparison for spending on economic and space research was R1.7 billion and $3 billion, and for re-usable space systems R1.3 billion and $3.8 billion. Moiseyev said that the space budget accounted for almost 1.5 per cent of the USSR's total budget.

Detailed figures have also emerged recently allowing comparisons to be made in the cost of the two main thrusts of the Soviet Union's near-Earth space activity - the Mir station and the Energia-Buran system - which reveal that the latter has eaten up a far greater share of resources. Over a period of 13 years the cost of developing the massive Energia booster and the reusable shuttle has totalled R14 billion, according to the Minister of General Machine Building, Vitaly Doghuzhiyev. Doghuzhiyev, writing in the *Government Herald* while the Council of Ministers was debating the scientific and technological benefits of the space programme to the national economy estimated the returns on the Energia-Buran system, when fully operational, at R4-5 billion per year.

By comparison, the head of the Soviet space agency Glavkosmos Alexander Dunayev revealed in May that the cost of developing and operating the Mir station, from its launch in February 1986 until the return to Earth of its latest crew on April 27, amounted to a mere R1,471 million. This figure covers the entire cost of the station, the Kvant astrophysical module, the Gamma observatory, all crew and cargo delivery craft, and the two new modules which are scheduled for launch later this year.

The Soviet economy has indeed already benefitted considerably from its space programme in terms of data collection and the development of new materials, technologies and processes, although the precise level financially is difficult to quantify. According to General Moiseyev, "the use of space equipment in the Soviet economy has already yielded a conventional economic effect of more than 12 billion roubles." He went on to claim that "expenses on space equipment, if maintained at the present level, will be fully reimbursed by 1995."

One specific estimate given by Moiseyev is the use of meteorological satellite data in the Soviet economy, resulting in savings of 500 to 700 million roubles annually.

Detailed assessment of some 64 million hectares of arable land have been made from aboard the Mir space station, as well as observations of the pollution of the Volga River, the Black and Caspian seas and the Sea of Azov.

Another area of particular success is that of space photography, in which the USSR has now entered the world market in earnest. Soviet satellite pictures have already been sold to 200 foreign customers in 12 countries, and have been described in the US journal *Aerospace Technology* as the most accurate available.

Some 600 original scientific and technical inventions arising from the Energia-Buran programme have been made available for use in the economy, including new technologies and materials, machines, scientific equipment, programmes, and automatic control systems. Many of these have already been tested in various branches of industry, according to Vitaly Doghuzhiyev.

But questions remain as to how and when these spin-offs will actually translate into improved industrial performance. Mikhail Gorbachev told the Congress of Peoples Deputies that proposals for giving the new developments over to the economy were represented "in two volumes" to the Defence Council and to "dozens" of enterprises and economic organisations. Only if they were used in the economy and for export, he said, "will our space-exploration expenditures be justified.

It is also intended to use Buran to carry out servicing of satellites already in orbit, which could increase their service life from between 2 and 3 years to between 5 and 7 years or even longer. But with a manned launch of Buran not expected until 1991 at the earliest, it will be some years before the returns on the massive investment in the shuttle scheme will be felt.

As a result of the political pressures for space investment to show returns, combined with the current economic liberalisation and cost-accounting drive in the Soviet Union, various innovative approaches to obtaining a return on space expenditure through selling services abroad are now being adopted. These range from the commercial launching of satellites and the selling of places for experiments and cosmonauts on board Mir, to selling advertising space on the side of the Mir space station.

With its large and varied launch capability, the continued expansion of Mir and the advent of Buran in the relatively near future, the USSR can hope to plough back considerable sums of hard currency in the years to come, despite growing global competition. This will depend on the Soviet space programme's ability to develop its capacity to meet the potential demand - an expansion which will also require funding. The next few years will see a shift away from financing new investments purely from the state budget to a space industry seeking to pay its own way.

Soviet Space Programme

Unknown and unconfirmed details of the Soviet Space Programme are the subject of recent correspondence to ***Spaceflight.***

More to be Revealed by Glasnost

Sir, On April 21, 1989, Cosmonaut Valentin Lebedev visited Texas A & M University in support of his book, *Diary of a Cosmonaut.* I was able to question him about the Zond lunar programme of the 1960's and 70's. During this discussion, I showed the Cosmonaut a drawing of the G-1-e heavy lunar booster, based upon the conical first-staged diagram by Charles Vick, and inquired as to the accuracy of the sketch. Cosmonaut Lebedev replied that the rendition was accurate. Additionally, I asked if the three reported failures of this rocket, reported as July 1969, June 1971 and November 1972 were correct, and received another affirmative answer.

I then inquired as to the Soviet designation for the booster and its name. Mr. Lebedev said that the booster was known as the "N" class, and that its nickname was "Carrier", but that it had no official name. He further commented that "we had a great deal of trouble with that one", in relation to the rocket. I believe the lack of an official name was due to its inability to successfully launch a payload.

When I showed Mr. Lebedev photocopies of Soyuz descent and orbital module-based lunar lander diagrams drawn by D.R. Woods, he immediately began to deny the existence of a Soviet manned lunar landing programme in the 1960's, calling it a "fantasy". He also stated that no cosmonauts had been trained for lunar landing.

Consulting with James Oberg, I learned that there have been no prior admissions of the existence of such a lunar booster by Soviet officials, and that this should be considered the first confirmation of the existence of manned lunar landing-related hardware. It is my hope that Glasnost will reveal more of this program, which still continues to be hidden from Western knowledge.

MARK CAMP
Texas, USA

Soviet Mini-Shuttle Doubts

Sir, "Pravda" articles on the maiden flight of Buran have thrown doubt on Western reports about the existence of a Soviet Hermes class spaceplane to be launched by the SL-16 booster. These reports were largely based on the four SL-8 launched Cosmos scale model orbital flights from Kapustin Yar between 1982 and 1984 and a number of obscure suborbital tests over Soviet territory in the past four years, all of which were generally presumed to have been tests of scaled down versions of the 20 ton spaceplane.

Pravda now links the above projects to the research and development programme for the Buran class Space Shuttle Orbiter and says that they were designed to flight-rate the Shuttle's reusable heatshield. "A lot of attention was paid to tests of the heatshield", chief designers Valentin Glushko and Yuriy Semyonov point out in one article [1].

In another article leading Shuttle designers describe the Cosmos scale models as "the first ever Soviet aerospace flying apparatuses", adding that they allowed engineers to "study the working of the heat-resistant tiles and carbon nosecap in conditions close to those experienced by Buran" [2].

Even more significantly, two leading cosmonaut-designers have emphatically denied the existence of the Soviet spaceplane, Konstantin Feoktistov during a visit to Paris in October 1987 and Oleg Makarov in an interview for the French newspaper "Liberation" on November 15, 1988.

This still leaves the possibility that the Soviet spaceplane programme is a highly classified military project, which cosmonauts are simply not allowed to talk about. However, an earlier suggestion of a launch from the military space centre of Plesetsk (see ***Spaceflight***, May 1988, p.193) is groundless, since Plesetsk does not have the capability of launching the SL-16.

Furthermore, one might ask whether a Hermes class mini-Shuttle could actually play a valuable role in the Soviet space programme and if the Russians could financially afford to simultaneously run three independent manned space projects (Soyuz/Mir, Buran and the mini-Shuttle).

All this does not mean that the Soviet Union never studied alternative Shuttle designs (including the Hermes/Dyna Soar type configuration) before the Buran concept was adopted some ten years ago. One of Buran's designers, Vladimir Struminskiy, was quoted by Radio Moscow as saying that Soviet engineers began working on Shuttle type spacecraft as long ago as the late 1950s. "A spacecraft of that kind was built in the mid-1960s", he said, "although it was much smaller than Buran. It even went through tests, but the project was killed because it was considered too expensive" [3].

Another Radio Moscow programme said that back in the early 1960s Gagarin and other pioneer cosmonauts had done research into designing "an aerospacecraft that greatly resembled American Space Shuttles". "There was no continuation of that research", the report said. "One explanation is the level of space technology at that time would have made it impossible to do such work and would have needed a lot of funds as well" [4]. All this suggests that, as in the United States, the concept of flying people into space aboard winged spacecraft was very seriously studied by the Soviets in the early days of the Space Age, but eventually was dropped in favour of the simpler and less costly idea of launching manned ballistic capsules atop converted military missiles.

BART HENDRICKX
Kapellen, Belgium

References

1. Pravda, November 17, 1988, p.3.
2. Pravda, November 24, 1988, p 3.
3. Radio Moscow World Service, "Update", November 21, 1988.
4. Radio Moscow World Service, "Science and Engineering", November 19, 1988.

More Glasnost Needed

Sir, Now that a Soviet publication has officially acknowledged the occurrence of the "Nedelin catastrophe" of October 24, 1960, the time is ripe to summarise just how far "space glasnost" has gone and how much farther it has to go.

The 15-22 April 1989 issue of 'Ogonyok', No. 16, carried the article "Area-10" by Aleksandr Bolotin which refers to the designation of the barracks area of the base. The article fully and movingly describes the explosion at "Tyura-Tam" (the official Soviet spelling) at about 18:45 hours on the evening of October 24, 1960. The explosion killed Nedelin and a "substantial number" of other specialists, many of them identified (two, Nosov and Ostashev, have streets in Leninsk named after them). The booster was an R-16 ICBM ("SS-7" to NATO) from the Yangel Bureau in Dnepropetrovsk, at a pad about 20 km from the Sputnik launch site. Prior to liftoff, on-pad repairs had to be made to the fully-fuelled vehicle, and the replacement of a command unit caused an unexpected fire signal to be sent to the rocket's second stage, igniting its engine and immediately detonating the first stage. At the pad itself, only coins and pocket change were recovered from the victims. Yangel and a general named Mrykin went into the "smoking hut" for cigarettes, and survived. Much later, in a park in Leninsk, an obelisk was erected with the laconic inscription: "Eternal memory to those fallen in carrying out their military duty on October 24, 1960".

But questions remain: how many died then, how many died in other similar accidents, and when was the booster ultimately successful?

Group Photograph

Sir, I enclose a group photograph which shows the second group of so-called Interkosmonauts who arrived for training at Star Town in March 1978. They are from left-to-right, Georgi Ivanov (Bulgaria), Dumitru Dediu (Romania), Bertalan Farkas (Hungary) Aleksandr Aleksandrov (Bulgaria), Arnaldo Tamayo Mendez (Cuba), Bela Magyari (Hungary), Dumitru Prunariu (Romania), Jose Armando Lopez Falcon (Cuba), Jugderdemidiin Gurragcha and Maydarjaviyn Ganzorig (Both Mongolia).

Two Vietnamese cosmonauts were selected in 1979 to join the group by which time Ivanov had flown the abortive Soyuz 33 mission. The other men in the group to fly were Farkas, Tamayo Mendez, Prunariu and Gurragcha, all of whom flew to Salyut 6 and Aleksandrov who flew in 1988 to the Mir complex.

NICHOLAS E. STEGGALL
West Yorkshire, UK

My earlier reconstructions of this disaster showed many correct details but one major error, which was to identify the vehicle as a Mars probe (official Soviet data of the October 10 and 14 launch failures is still awaited).

Curtis Peebles raised the point that the Kremlin pressure to develop a workable ICBM, as opposed to the militarily useless "SS-6" from the Korolev KB, led to the decisions which killed the best engineers of the "Yangel Bureau". Subsequent launch failures of the SS-7 in 1961 contrasted with a burgeoning American ICBM force, which had been created under the incorrect impression, fostered by Khrushchev, that Soviet ICBM's were rolling off the assembly lines "like sausages" and led to Khrushchev's desperate gamble, the emplacement of missiles (and almost all existing Soviet nuclear missile warheads) in Cuba in 1962. The Nedelin catastrophe may have been a direct cause of the conditions leading to such a gamble.

One may speculate on the motivation for the above Soviet release of the Nedelin story.

First in contemporary importance is the level of military space activities, reflected in "Cosmos" satellite launchings which are still labelled as being for "space exploration". This is the most glaring example of where a policy change is needed so that TASS honestly describes the majority of vehicles as being for "defense purposes". Recent release of data showing that more than half of the space budget is for military purposes goes some way to facing this truth.

The "phantom satellite" designated 1985-53, launched June 21, 1985 remains off the Soviet space record books. Someday responsibility for it must be acknowledged. Photographs of Zenit may soon be published since drawings have just been released. Details of the mysterious test launches of Cosmos-1786, 1820, 1871 and 1873 may take a little longer to be released.

For the past three years, Soviet annual summaries have been listing "date of cessation of work" for all vehicles, which coincides with recovery dates or with breakdown dates. This data is given only for satellites launched that same year; someday retroactive data for satellites launched in previous years which subsequently "cease work" may be supplied.

If recoveries and breakdowns can be announced a year later, they should be announced when they occur. It is not too much to hope that TASS bulletins will eventually provide both liftoff time (not just date) and liftoff location.

Detailed information on Proton-D ("SL-12") vehicle flight history has been provided as part of commercialisation efforts and exact dates and causes of launch failures since 1970 released, except for the odd omission of Cosmos-419, known to be a Mars probe injection failure. Overall statistics for other commercially-offered vehicles (Vostok, Soyuz, Molniya, Tsyklon, Cosmos and Zenit) have been published but detailed lists of failures and causes have not been released. Such records ought to include all vehicles and all the early years. The dramatic booster explosion films (of 'semyorka' and even 'Vostok' rockets) shown on Soviet television in recent years should be identified with dates and intended missions.

Now that extensive details have come to light on the "missing cosmonauts" and other previously-unknown backup cosmonauts, on the Gagerin landing lie ("In his ship") and on his fatal accident, on the taboo name of "Tyura-Tam" and on the Nedelin catastrophe, further revelations maybe only a matter of time

Who were the "six to eight" cosmonauts killed in training, as admitted by Shatalov to Stafford in 1973? We still only have the name of Bondarenko. The Soviets would be wise to release photographs of the shrine to martyred spacemen located in the administration building at Starry Town, just down the stairs from Shatalov's office and list all the names memorialized there.

Still unavailable are maps of Starry Town, of "Baikonur" (the geographical deception should be dropped and the name "Korolevsk" used instead) and of Plesetsk: access to the museum at the Korolev construction bureau in Kaliningrad is still restricted.

Soyuz-1 remains a major unresolved historical question. Contemporary official accounts still insist the cosmonaut completed all test objectives before dying in a freak end-of-mission glitch. Yet the two-ship linkup was the plan, and problems cropped up almost immediately after launch. Program officials had objected to the premature launch but had not been overruled.

The Soviets' man-to-the-Moon program of the 1960s is also still unveiled. Neither crew training in Zond capsules and the more advanced man-related lunar vehicles tested as Cosmos-379, 382, etc. have been disclosed.

Two separate sources have suggested that the super-booster "SL-15" or "TT-5" etc., was known to the Soviets as the "Enerdin' ("Ener-Dyne"). "It did not burn kerosene", noted one source; "it burned money". Another source repeated the old account of mass fatalities associated with the July 1969 pad failure. A recent memoir confirmed that the Energia/Buran launch pad was built as a modification to an "existing structure", but full details were not given.

The civilian Salyut failures of 1972 (at launch) and 1973 (in orbit, called Cosmos-557), the docking failures of Soyuz-3 (1968) and Soyuz-10 (1971) have still to be acknowledged and explained. Rendezvous failures of Soyuz-8 (1969), Soyuz-15 (1974), and Soyuz-23 (1976) also need to be explained in as much detail as has been the Soyuz-33 failure (1979) and the T-8 failure (1983).

Complete technical drawings and photographs of the Salyut-2, 3 and 5 vehicles (including landing capsules) have never been provided or details of the sudden termination of the Soyuz-21 mission in 1976. Configuration information on Cosmos-929, 1267, 1443 and 1686 is also lacking.

The mystery "twins" of the late 1970s are still to be explained: Cosmos 881/882 (December 15, 1976), a failure in August 1977, Cosmos 997/998 (March 30, 1978), and Cosmos 1100/1101 (May 22, 1979). These were recovered after one orbit and probably related to early space shuttle testing.

A recent Soviet newspaper denunciation of Western misinterpretations of the "spaceplanes" attacked reasonable speculation caused by Soviet silence on that program. Acknowledgement that four orbital tests were part of pre-Buran technology development is not enough. Suborbital tests have not been described nor photographs of pre-launch, liftoff, recovery, and post flight analysis released. Indeed no account has been provided of the fatality during the first Indian Ocean recovery.

Cosmos-1870 spacecraft ("Resurs-R") has not been explained, nor drawings, photographs, and samples of its radar and visual data published.

JAMES E. OBERG
Dickinson, Texas, USA

Neptune Encounter Debris?

Sir, With Voyager 2 soon to rendezvous with Neptune and the prospect of a partial ring system being found, I have re-read A.T. Lawton's article "The many shades of the 10th planet" (***Spaceflight***, March 1979, p.115-123) in which he discusses a possible interaction between the hypothetical 10th planet and Neptune, giving rise to the Pluto-Charon system and the retrograde nature of Triton's orbit. Since Lawton's article predates the suggestion of a Neptunian partial ring system, its discovery in August may add weight to his views and those of Lyttleton and Kuiper and Harrington and van Flandern, which he mentions.

Was the 10th planet so damaged as a result of this interaction that it may not, in fact, be extant as such but rather as an aggregation of orbiting debris, massive enough to cause the unexplained perturbations of Neptune and Uranus but invisible to observation due to its very fragmentation?

Secondly, the Pluto-Charon system may not just be a binary planet or a binary planetoid system but a "dirty system", being an orbiting composite of Pluto, Charon and other debris (although not a ring system) from the aforementioned interaction.

If partial rings and other orbiting material of potential encounter origin are found, either or both suggestions will, of course, not be proven but if no such material is found, then these views may well fall. I will, if necessary, be a cheerful casualty.

Dr. STEPHEN LEWIS
Cardiff, Wales

Brown Dwarf Companion to a White Dwarf Star

Sir, An infrared object has been found at 120 AU from the white dwarf GD 165, located in the constellation Bootes a few degrees south of the red giant star Arcturus. Images taken by Becklin and Zuckermann at several infrared wavelengths have led them to conclude that the companion, GD 165 B, has a surface temperature of 2100 K and a mass of 0.06 to 0.08 solar masses i.e. roughly 70 times the mass of Jupiter.

This is probably too small to be a true star, which shines through internal nuclear reactions, but it is glowing red hot through gravitational shrinkage processes similar to those occurring on Jupiter, but on a larger scale.

Becklin and Zuckermann have surveyed 200 white dwarfs and list a total of 9 (including GD 165) believed to have or have been proved to be accompanied by brown dwarf companions. They state that this survey has shown that brown dwarfs, either as companions to other stars or by themselves, could form the majority of the dark matter believed to exist between stars.

This is the first *positive* indication that smaller bodies than stars do exist elsewhere.

Developments of these techniques might be able to image smaller and cooler objects (5-10 x Jupiter mass) that are orbiting white dwarfs.

A.T. LAWTON
W.Sussex, UK

Ariane Launchers

Sir, I notice in the April edition of ***Spaceflight*** an article concerning the ordering of 50 Ariane 4 launchers. In this article, you specifically mention the roles of British Aerospace and Ferranti.

Could I bring to your attention the role of EASAMS in this programme? As contractors for the Flight Program we are intimately involved in each launch, providing a critical component for flight. Ariane 4 can fly without SPELDA (when only one satellite is being carried) and without the Ferranti platform: it cannot fly without an EASAMS Flight Program.

R.J. SMITH
Project Manager, Software Division
EASAMS, Surrey, UK

New Shuttle Boosters in 1994

NASA has selected a joint Lockheed-Aerojet team to build the next generation of Solid Rocket Boosters (SRBs) for the Space Shuttle. The Advanced Solid Rocket Motor (ASRM) will increase the Shuttle's payload capacity and improve safety. In 1994 the ASRM will replace the present SRBs, manufactured by Morton Thiokol, which were redesigned following the Challenger accident.

The ARMS will increase the Shuttle's payload capacity by 12,000 pounds, allowing NASA to achieve its originally goal of 65,000 pounds per orbit. Based on 14 flights annually, the extra payload capacity is the equivalent of an additional 2.4 flights per year. With this in mind, the development costs should be recovered in four years.

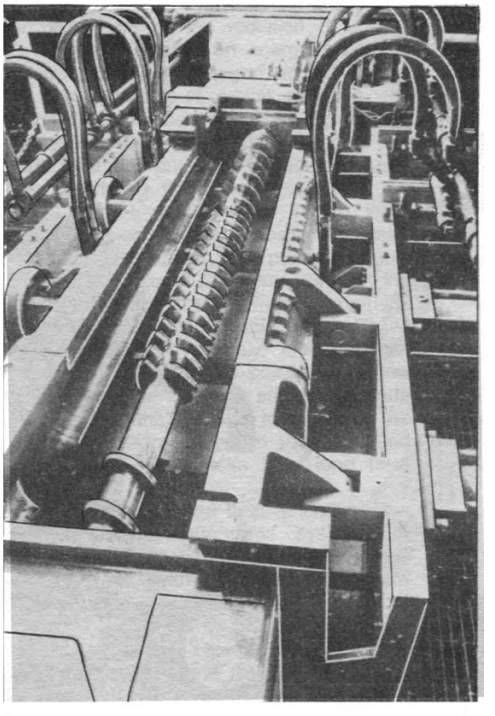
The overall cost of design and development, including the cost of motors for six Shuttle flights, is estimated at just under $1 billion, excluding the costs of facilities which are estimated at $200 to $300 million.

The ASRM manufacturing plant will be built at Yellow Creak, Mississippi on the Tennessee River, construction work is expected to begin this summer. Other facilities will include test installations at NASA's Marshall Space Flight Center and a static test stand at the Stennis Space Center.

In 1993 Aerojet will start manufacture of the ASRMs, leading to a production rate of 32 motors per year. Starting in 1994, ASRM will be barged down inland waterways enroute to the Kennedy Space Center for Shuttle launches.

The ASRM propellant will be manufactured by Aerojet's continuous mix process. This maximizes propellant consistency and allows for continuous assessment of the propellant rather than random sampling.

Each 126 foot long motor will have three segments, one less than the present Thiokol motor. The field joints will be of a better design than the present boosters. The ASRM is able to deliver more thrust because the motor's diameter has been increased from the current 146 inches to 150 inches, adding 200,000 pounds of propellant per motor. The ASRM will adjust thrust, throttling down as the Shuttle passes through maximum aerodynamic stress, eliminating safety problems caused by varying the power levels on the Shuttle's main engines.



This pilot plant shows the type of automated continuous mix machinery that Aerojet will operate at Yellow Creek, Mississippi, to manufacture the ASRM. The casing is open to show the horizontal interrupted screw that will combine oxidizers, pre-mixed fuels and curing agents into the most advanced solid propellant. *Lockheed*

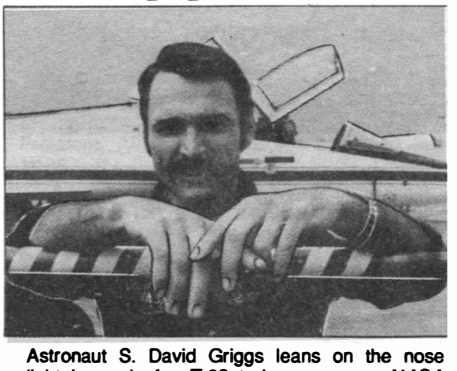
Shuttle Pilot Griggs Dies

We are sad to record the death of astronaut S. David Griggs on June 17. Griggs died when his single-engined 1944 North American Harvard AT-6D trainer crashed. He had flown aboard the Space Shuttle Discovery in 1985 and was due to pilot the STS-33 mission scheduled for later this year.

Griggs was buried at Arlington National Cemetery on June 21, with members of the astronaut corp and other NASA employees in attendance. Astronaut Office Chief Daniel Brandenstein delivered a eulogy as part of the 25 minute service and 51-D crew mates Karol Bobko and Jeff Hoffman served as family escorts. Also present were NASA Administrator Richard Truly and Johnson Space Center Deputy Director Paul Weitz, both former astronauts.

Brandenstein described Griggs as "a very motivated, hard working individual." He went on to say. "He has made numerous contributions to the programme throughout his stay here. He was practically solely responsible for the Head-Up Display, he did extensive work on orbital manoeuvring vehicles and crew rescue and space station development. He was just a hard-charging, get-the-job-done kind of individual. His dedication and talents will be sorely missed in the office."

Griggs was born on September 7, 1939 in Portland, Oregon. He joined NASA in 1970, working as a research pilot at the Lyndon B. Johnson Space Center. In 1974 he was assigned duties as the project pilot for the Shuttle Training Aircraft and participated in the design, development and testing of those aircraft pending their operational deployment in 1976. He was appointed Chief of the Shuttle Training Aircraft Operations Office in January 1976.



Astronaut S. David Griggs leans on the nose lightning rod of a T-38 trainer. *NASA*

In January 1978 Griggs was selected as an astronaut candidate and in August 1979 he successfully completed his training.

From 1979 to 1983 Griggs was involved in many aspects of the Shuttle programme including the development and testing of the Head-Up Display, the development of the Manned Manoeuvring Unit and the definition and verification of on-orbit rendezvous and entry flight phase software and procedures.

In September 1983 Griggs began training as a mission specialist for Shuttle mission STS 51-D, which flew April 12-19, 1985. During the flight Griggs and fellow astronaut Jeff Hoffman conducted the first unscheduled space walk in the history of the US space programme. The space walk lasted for over three hours during which the astronauts attached a 'fly swat' to the end of the remote manipulator arm as part of an operation to revive a disabled satellite.

Griggs was training as the pilot for STS-33, a Shuttle mission for the Department of Defense currently scheduled for launch on November 19. Griggs has been replaced by John Blaha who has been transferred from mission STS-40, due for launch in August 1990. Blaha made his first space flight on STS-29 in March of this year. Blaha is to be replaced on STS-40 by Sydney Gutierrez.

Griggs leaves a wife, Karen, and two daughters, Alison and Carre, to whom we extend our sincere condolences.

Aircraft to Test Shuttle Landing Gear

NASA Convair-900 aircraft will be used next year for extensive tests of Space Shuttle landing gear assemblies, from normal conditions up to and including failures. The tests are to be conducted at NASA's Ames-Dryden Flight Research Facility in California.

Data from the landing tests will give engineers information on what to expect should an orbiter experience a flat tyre or other problems on landing and will provide data to help in developing new crew procedures for various landing conditions.

The test gear assembly will be mounted on the aircraft's fuselage between the main tyres and a hole will be cut in the fuselage to accommodate raising and lowering the gear.

High speed video and film cameras, in addition to other instrumentation, will record the test for thorough analysis.

The official STS-28 crew portrait: (Left to Right) Richard Richards, Mark Brown, Brewster Shaw, Janes Adamson and David Leestma. *NASA*

Columbia Readied For Return to Flight

The Space Shuttle Columbia has waited three and a half years to make its eighth space flight. Columbia last flew in to orbit in January 1986 on mission STS 61-C. It was scheduled to fly again on March 6, 1986, but the Challenger accident left Columbia firmly grounded. Columbia will return to flight in early August when it blasts off on a mission for the US Department of Defense (DoD).

Commander for STS-28 will be Brewster Shaw, a veteran of two Shuttle flights (STS-9 in November 1983 and STS 61-B in November 1985). Richard Richards, pilot, will be making his first space flight. Mission Specialists for STS-28 are: David Leestma (who flew on STS 41-G in October 1984), James Adamson (making his first space flight) and Mark Brown (also making his first space flight).

Launch Preparations

STS-28 has suffered a number of delays During the halt in Shuttle operations NASA took the opportunity to refit Columbia including major work on the orbiter's heat resistant tiles. Unfortunately, work on Columbia fell behind when earlier Shuttle

STS-28
Preview

missions took priority. STS-28 was originally scheduled for launch on July 1. When it became apparent Columbia would not be ready in time NASA rescheduled the launch for July 31 at the earliest. However by mid-July there was no contingency time left in the schedule and the launch will almost certainly to be delayed until early August.

While Discovery and Atlantis were prepared for their missions, Columbia was housed in the Orbiter Maintenance and Refurbishment Facility. The orbiter was transferred to the Orbiter Processing Facility (OPF) on January 23, where work to prepare her for STS-28 could begin in earnest.

Modifications, introduced after the Challenger accident, have been made to Columbia, including the installation of the crew escape pole. When Columbia began its processing flow 2,300 tiles were missing from the orbiter's skin. Work to fit the tiles continued along side other preparations.

In early May the three main engines were installed. Dunng checks of the engines the No.1 engine was found to have a leaking high pressure hydrogen turbopump. Replacement of the pump did not go as planned. Difficulties with ground support equipment delayed the removal of the old pump and the insertion of the replacement. Then technicians had to remove and reinstall the new pump three times because of leaks between the main combustion chamber the turbopump. Yet another leak was discovered in a bearing cap on the pump. In this case technicians were able the correct the problem in less than a day. The operation to replace the pump took two weeks.

The STS-28 crew looked over their space craft in early June to check for any sharp edges or items that could be installed differently. The crew had visited the space center a week earlier to review the launch preparations.

With just minor tile work remaining Columbia was rolled over to the Vehicle Assembly Building (VAB) on July 3. Work to mate the orbiter to the External Tank and

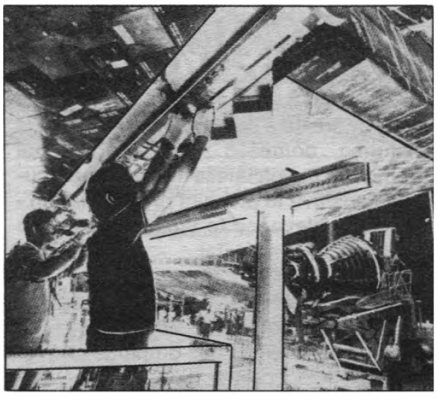
SRBs continued from July 5-6. The Shuttle Interface Test (SIT) began on July 10. The SIT involves testing all the electrical and mechanical connections between the SRBs, External Tank, Orbiter and Mobile Launch Platform. The test had to be halted on July 11 when an electrical problem was detected in the right hand SRB. The test resumed and was expected to continue until just prior to the roll out to the launch pad, scheduled for the early hours of July 14. While the SIT continued last minute tile work on the left wing was completed.

The STS-28 crew were due to arrive at the Kennedy Space Center on July 16 for the Countdown Demonstration Test which will conclude on July 18 with a simulated blast-off at 11:00am EDT.

A Flight Readiness Review is planned for July 25-26 and a firm launch date will be announced then.

The Mission

Columbia is expected to enter a 57 degree inclination, 160 nautical mile circular orbit. During the flight, which will last three to four days, two military satellites will deployed from the orbiter's payload bay. In addition to the satellites a number of secondary payloads will be carried. They include: a contamination monitor, a stellar reference system, one or more Get Away Special canisters, a low altitude heavy ion experiment, a radiation monitoring experiment and longitude and latitude monitoring equipment.



Kennedy Space Center tile technicians continue their work on the Space Shuttle Columbia as one of the three main engines is prepared for installation. *NASA*

After completing its mission Columbia will land at Edwards Air Force Base in Calforinia.

Radiation Monitoring

Aboard Columbia on STS-28 will be a highly advanced device for gauging the amount of radiation astronauts and equipment receive in space.

"Space has different kinds and intensities of natural radiation not found on Earth. As the potential for long term space exploration draws closer, we must determine the biological health effects of radiation and its impact on spacecraft and equipment," said Leslie A. Braby, a staff scientist at Battelle, the developers of the radiation detector.

The device, called an energy deposition spectrometer, will categorize and record the characteristics of orbital radiation and its impact on human cells into 16 different deposition ranges. The data collected will result in a bar graph of minute-by-minute exposure during the Shuttle's orbits of the Earth. Current spectrometers record information into only three deposition ranges.

"The spectrometer will provide important data on a particular orbital zone off the Argentina coast that delivers unusually high doses of radiation," said Braby Called the South Atlantic Anomaly, the zone can provide more radiation exposure in a few minutes than the Shuttle's entire 90 minute orbit of the Earth. "We want to determine the types of radiation present in this zone and the potential health risks from long term exposure."

The device will also help determine how radiation affects electronic systems in spacecraft. "Radiation particles in space can interfere with computers onboard Shuttles or satellites, causing electrical circuits to malfunction," Braby said. "Once we determine the environmental circumstances that produce the malfunctions, preventive measures can be taken and new computers developed that are immune to radiation interferences."

New Shuttle Launch Schedule

Hubble Telescope Postponed until March 1990

NASA has recently released an updated Shuttle launch schedule. The new manifest shows four flights remaining in 1989, nine in 1990, eight in 1991, 12 in 1992 including four flights of the new orbiter Endeavour, 14 in 1993, 13 in 1994 and 10 in 1995 through September 1995.

The planetary schedule is maintained with the deployment of the Galileo probe to Jupiter from Atlantis on October 12 on mission STS-34. The Ulysses probe to the Sun remains scheduled for October 1990.

Launch of the first of the great observatories, the Hubble Space Telescope, has slipped from December to March 1990 in order to protect retrieval of the Long Duration Exposure Facility (LDEF) deployed on mission STS 41-C in April 1984.

Recognising the significance of recovering LDEF, the STS-32 mission is now planned for December 18 aboard Columbia. The free-flying satellite carrying 57 science, technology and applications experiments is in danger of reentering the Earth's atmosphere if not recovered by early 1990. In addition to retrieving LDEF, the Syncom IV-05 satellite will be deployed for the Navy.

In support of Earth sciences, six additional Shuttle Solar Backscatter Ultraviolet (SSBUV) missions have been added to the line-up and the four previously-manifested SSBUV missions have been accelerated. This instrumentation maintains an accurate measurement of global ozone.

Other major science mission changes include the Astro-1 mission in April 1990, the Gamma Ray Observatory flight now in June 1990 and the Spacelab Life Sciences flight in August 1990.

The new manifest includes the first three assembly missions for the Space Station Freedom. All three flights are baselined in 1995.

Also planned are two Flight Telerobotic Servicer (FTS) demonstration test flights. FTS is a system being developed for the space station to assist in assembly, service and inspection of the manned base and its attached payloads.

In the international area, a third European Retrievable Carrier (EURECA-3L) deployment is now slated for launch in May 1995. Eureca is a platform to be placed in orbit for six months, offering conventional services to experimenters.

Two additional Spacehab module flights have been booked, bringing the total number of planned flights to six. Spacehab is a commercially-owned, pressurised module for conducting experiments in a Shuttle middeck environment.

The updated manifest also features six Shuttle "flight opportunities" beginning in 1992. Use of these flight opportunities by payloads which slip from their planned launch will minimise manifest revisions and promote schedule stability in payload programmes.

Engine Fire Should Not Delay Columbia

A Space Shuttle Main Engine (SSME) undergoing a test firing automatically shut down and caught fire near the completion of the long duration test. Shuttle managers believe the incident will not affect STS-28.

A SSME development engine shut down automatically 21 minutes into a planned 22.25 minute firing designed to test several modified engine components. As it shut down, fire broke out around the engine's powerhead. The test was taking place at NASA's Stennis Space Center in Bay, St. Louis, Mississippi.

An early inspection of the engine showed significant damage to the engine's high pressure oxidiser turbopump. The engine has been flown to its manufacturer, Rocketdyne for a detailed examination.

Shuttle managers, at the Kennedy Space Center for a roll out review meeting, decided to proceed as planned with the schedule until a 12-member board of investigation determines the cause of the damage during the extended duration test.

Mission Specialists Assigned

Astronauts Mary Cleave and Norman Thagard, who recently flew on Shuttle mission STS-30, have been named as Mission Specialists for STS-42, a nine day flight aboard Columbia, set for December 1990. The partial crew assignment will allow long-range payload training and integration associated with the International Microgravity Laboratory (IML-1), says NASA.

Anniversary Stamps

It has been a pleasure for me to consider putting together a collection of stamps commemorating the 20th Anniversary of the First Manned Landing on the Moon. I am not so sure that this will culminate in a complete collection because I do not know just how many sets on this theme will be released by the 240-odd stamp issuing authorities on plant Earth.

To simplify my selection, I think I might start with the CAPHCO Omnibus of twelve original sets each comprising stamps and souvenir sheet. But a few words first about CAPHCO.

CAPHCO only became a limited company in 1985 after over 120 years of practical experience with postage stamps. It took over the Crown Agents Stamp Bureau, which commenced operations in 1848 when a contract to print the "Britannia" series for Mauritius was placed with Perkins Bacon, the printers of the Penny Black. By the 1860s the Crown Agents were arranging for the design and printing of many colonial stamps.

Today, CAPHCO is renowned for its prudent policy-advice to nearly 50 stamp - issuing nations. It is very important to carefully create a balance between stamps featuring domestic and international themes as the philatelic market is particularly sensitive to any hint of exploitation - thematic relevance to the issuing nation is desirable, if not vital.

CAPHCO and NASA

CAPHCO contacted the NASA at the conceptual stage of this omnibus and received 100% co-operation from the outset. All the illustrations on the stamps are authentic. Highlights include the inside of NASA's Firing Room, rockets at lift- off, modules in orbit, astronauts and vehicles on the Moon, parachuting spashdowns and recovery operations.

Project Mercury was launched in 1961 with suborbital flights by Alan Shephard and Virgil Grissom. It was only 20 days later that President Kennedy went before Congress and called for a national effort to send men to the Moon and back before the end of the decade.

The Apollo 11 Mission

July 16 was the day chosen for the launch of Apollo 11. On the launch pad, the majestic rocket rose 363 ft into the air. More than nine million parts were hidden beneath its sleek exterior. At 9.32 am the five mighty engines of the Saturn V lifted the rocket from the ground atop a pillar of flame in a never-to-be-forgotten spectacle.

Down to Earth

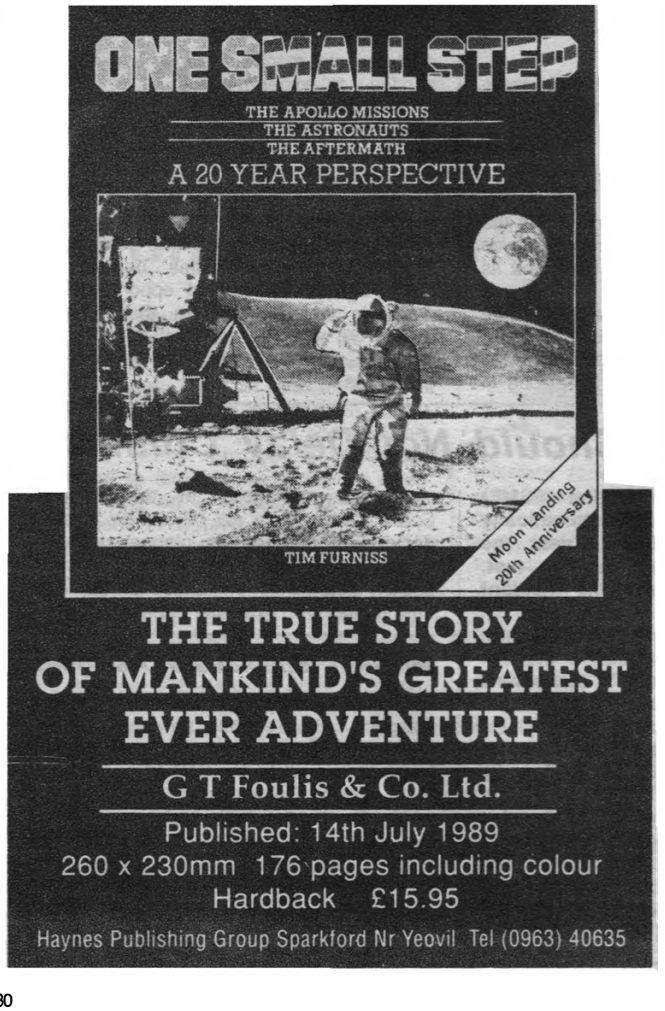
On July 21, after performing a number of experiments. Armstrong and Aldrin departed on the first leg of what was to be a triumphant return to Earth. A small stainless steel plaque on a leg of the module, remaining behind stated:

'Here men from the Planet Earth first set foot upon the Moon. July 1969 AD. We came in peace for all mankind.

The following countries are participating in the CAPHCO omnibus:

Ascension Island * Bahamas * Belize * Kiribati * Liberia * Nevis * St. Kitts * Samoa * Seychelles * Solomon Islands * Venuatu * Zil Elwannyen Sesel

I am particularly fascinated by the Ascension Island 15p value.



JBIS journal of the british interplanetary society

The August 1989 issue of the Journal of the British Interplanetary Society is now available and contains the following papers.

UNIVERSITY OF SHEFFIED
Institute for Space Biomedicine

Space: A Testbed for Basic Biomedical Sciences

Biophysics in Space

Physiological Problems for Man in Space

Exposure to Acceleration During Manned Spaceflight

Water and Salt Disturbances Under Conditions of Microgravity

The Effects of Space Travel on the Nervous System

Calcium Metabolism and the Osteopenia of Space Flight

Food for Thought - Nutritional Problems in Space

Effects of Space Travel on Sexuality and the Human Reproductive System

Non-Ionising Electromagnetic Environments on Manned Spacecraft

Applied Potential Tomography

Copies of JBIS, are priced at £12.00 ($24.00) to non-members, £4.00 ($8.00) to members, post included, can be obtained from the address below. Back issues are also available from the address below.

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. . . in celebration of the 20th Anniversary of Mankind's Greatest Space Achievement

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SPACE AT JPL

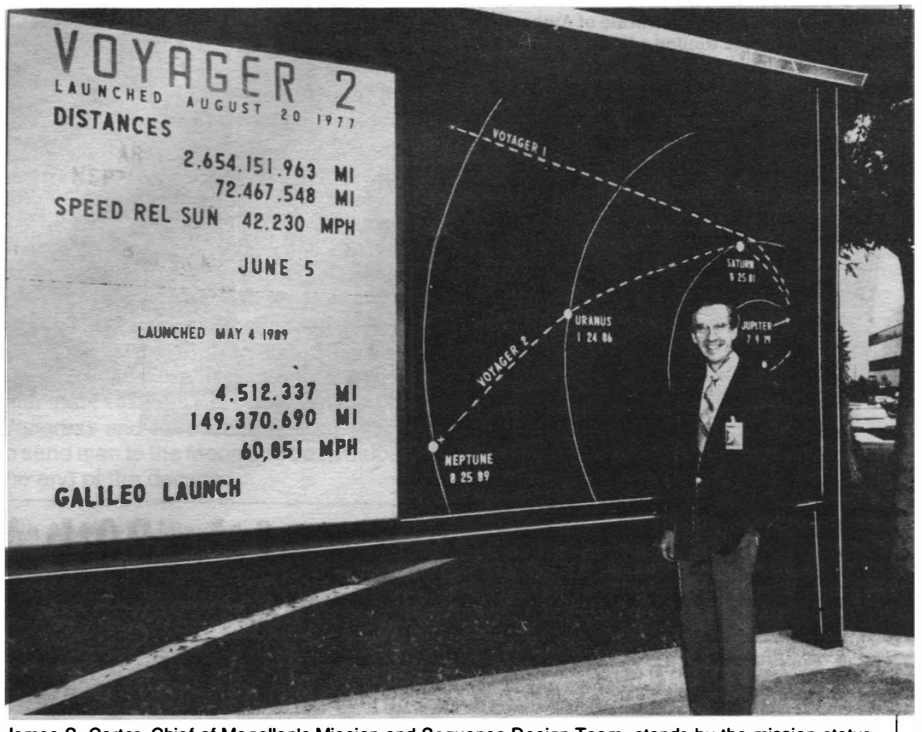
The latest news from Dr. William McLaughlin at the Jet Propulsion Laboratory in California.

Planetary Summer

There is a large display board that stands in the Mall at JPL and posted on it is the current status of missions in flight. For over a decade only Voyager data has been present. But now, Voyager 2's progress toward Neptune is supplemented by information on Magellan's cruise to Venus, and the countdown to the October launch of Galileo, on its Jovian mission is tallied. Three missions, three planets, and the California summer glows even brighter with the promise of planetary adventure.

The opening of Magellan's launch window for Venus was on Friday, April 28 and television monitors throughout JPL carried the countdown. When the launch was scrubbed, due to problems with the Shuttle Atlantis, the waiting began to find out when a second attempt would be made. On Thursday, May 4, the faithful reconvened in front of television monitors at the Laboratory and once more sweated out the countdown. The adequacy of the weather to accompany certain launch-abort scenarios was marginal, but conditions were finally judged suitable and Magellan soared upward at 2:46:59 pm. Eastern Daylight Time.

In the April issue, I presented the results of a (prelaunch) discussion with James S. Carter, Chief of Magellan's Mission and Sequence Design Team (MSDT). The MSDT constructs a detailed layout of each two-week period of activities during the cruise to Venus and feeds this profile to the Spacecraft Team, which then generates the appropriate commands to be sent to Magellan. (Upon arrival at Venus in August 1990, the MSDT will similarly support the radar-mapping mission as the spacecraft orbits the planet every 3.15 hours.) In June, I returned to talk with Carter in order to compare postlaunch reality with prelaunch expectations.



James S. Carter, Chief of Magellan's Mission and Sequence Design Team, stands by the mission status board at JPL. Voyager trajectories, Magellan statistics and the countdown to the launch of Galileo are displayed. *NASA/JPL*

The first piece of information for the MSDT was, of course, the fact that launch and the subsequent injection into interplanetary cruise were successful; the MSDT and other elements of the flight team were in business. Injection was accomplished, after deployment from the Shuttle, by an Inertial Upper-Stage (IUS) rocket. The time of separation (10:27:10 pm, Eastern Daylight time on May 4) of the spacecraft from the solid-stage IUS was the second piece of information required for the MSDT to go to work.

The Galileo spacecraft and support equipment begin their 4 1/2 day ride from JPL to the Kennedy Space Center. *NASA/JPL*

The team's first task was to update a set of real-time commands, collectively called "Cruise O", which were sent to Magellan on Saturday, May 6, in order to bring its onboard computers to states consistent with this period of the mission. Two days later, on Monday, the "Cruise 1" sequence of commands was sent to the spacecraft. Cruise 1, and subsequent loads, each spanning two weeks, are stored onboard the spacecraft as a set of time-tagged commands, each of which is executed when the spacecraft clock agrees with the command's time tag. This is the normal mode of controlling Magellan, Voyager, and Galileo. Real-time commands, exemplified by Cruise O, are executed upon receipt and are used as supplements to cover special situations

Carter said that launch operations and early cruise have proved, so far, to be reasonably smooth. Intensive training before launch paid off for the flight team, and no major hardware anomalies have occurred. Most of us carried in mind the trying experiences after the launch of Voyager 2 in 1977 and were relieved that history declined to repeat itself.

A significant milestone was passed on May 21 (or May 22, at 02:00, in the Universal Time System) with the successful execution of the first trajectory-correction manoeuvre, a small propulsive event which changed the velocity of the spacecraft by 2.9 m/s, utilising 4.2 kg of hydrazine propellant.

At present, the MSDT is occupied full

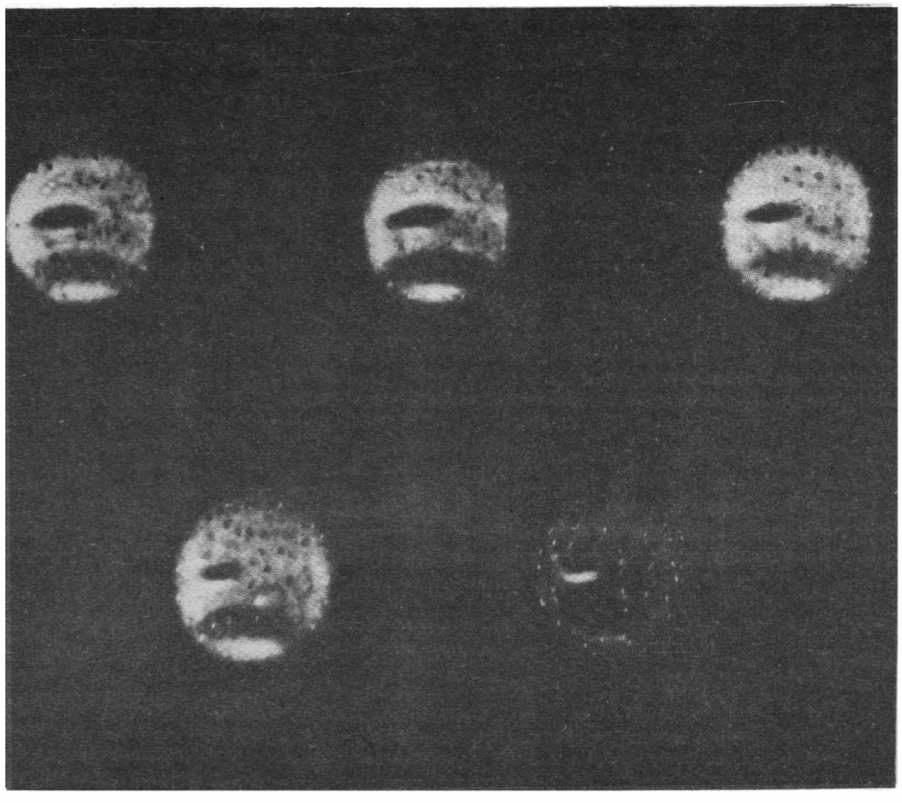
time in keeping up with their duties with regard to the generation of cruise loads for the spacecraft. Carter's intention is to automate selected activities - replacing human effort with the labour of computers - in order to create some time for the MSDT to engage in planning their work after insertion into orbit about Venus in little more than a year from now. "Incremental automation", the process of automating activities bit-by-bit in the light of experience, is a grassroots activity that has paid considerable dividends for Voyager over the years, and it is encouraging to see the emergence of this efficiency measure so early on Magellan. For example, the MSDT needs to examine in more detail their plans for that period of time, a few months after insertion into orbit about Venus, when Magellan will be carried behind the Sun with the sweep of Venus along its solar orbit. The radar survey of the planet will be interrupted for several weeks due to the inability to downlink high-rate data, but care and tending of the spacecraft is necessary so that it emerges in healthy condition from telecommunications exile (even low-rate transmission of commands to the spacecraft will not be possible for several days as a result of solar interference).

While Magellan has just set sail for Venus (what would an historian have made of such a phrase 50 years ago?), Voyager 2 is nearing the end of its 3 1/2 year cruise from Uranus to Neptune. Like Magellan, Voyager 2 consumed command loads during its cruise period: testing newly developed spacecraft capabilities for the Neptune encounter and obtaining scientific data about interplanetary space (plus observations in the ultraviolet of selected astronomical objects). A parallel activity took place during cruise with the crafting of the ten computer command loads for the spacecraft that would carry out the observing program during the encounter period, from June 5 through October 2.

With preliminary versions of these loads "on the shelf", the process of updating them began in late February of this year and will continue until early September. Each update requires between 9 and 16 weeks, and at one time, in late June, the schedule had eight of the ten loads simultaneously being updated: a busy summer!

Among the numerous other activities being handled by the flight team is agreement upon an accurate set of important physical constants. The great distance of Neptune from the Sun makes it very difficult to obtain an accurate set of constants, yet such knowledge is essential for planning and executing the close flyby of Neptune and its large satellite Triton (see the December 1988 edition of this column for a summary of the major events of the near-encounter period).

Quantities such as Neptune's ephemeris, mass, size, shape, orientation, rotation rate, etc. are clearly important to planners and navigators, but the list is considerably longer and also takes into account the ephemerides and physical characteristics of the two known satellites - small Nereid in addition to Triton - plus best estimates for the possible system of ring arcs, and much more. The set of constants is kept up to date as new information is obtained during the approach to Neptune and, after the encounter, will constitute an important component of our new-found understanding of the planetary system.



These five images of Neptune were taken by Voyager 2 on May 24, 1989 at a range of 134 million km from the planet. The images were taken with various filters. The top row of three images employed violet, blue and unfiltered light (left to right) while the two images on the bottom row were green (left) and orange (right) filters. *NASA/JPL*

One of the most crucial updates to the constants will take place in the few days before the August 25 closest approach to the planet (at 04:00 UTC) when the ephemerides of Neptune and Triton are finally determined with high accuracy by the Navigation Team using, primarily, images from the onboard camera system. This information, in concert with an accurate ephemeris for the spacecraft (computed from a combination of optical data and radio tracking data), will be employed to tune at "the last minute" the command load spanning the closest approach period. This action is necessary to insure accurate pointing of the spacecraft's remote-sensing instruments and execution of its intricate radio-science experiments.

Galileo is the third ingredient in the planetary summer - if one stretches with authorial license the seasonal label to include not only the May launch of Magellan but also the scheduled October 12 launch date of Galileo. When the Challenger exploded in January 1986, the spacecraft was within a few months of launch and had to be returned from the Kennedy Space Center (KSC) to JPL for modifications to accommodate its new mission plan; see the May 1987 "Space at JPL" for a summary of the hardware changes. For the 1986 launch, Galileo would have arrived at Jupiter in 1988 after a direct flight from Earth. Now, with the abolition of the powerful Centaur rocket as an upper stage for the Shuttle, a more circuitous route, through the inner solar system, had to be devised in order to take advantage of gravity assists from Venus and Earth. The spacecraft will arrive at Jupiter on December 7, 1995.

The spacecraft arrived at KSC on May 16, 1989 after a 4 1/2 day cross-country trip A "pre-ship" event was held at JPL on Saturday, May 6 with a series of public displays and lectures. Project manager Richard Spehalski and other members of the Galileo team presented aspects of the mission and science objectives, and visitors had the opportunity to sign a register which was subsequently processed and placed onboard the spacecraft to accompany it in flight.

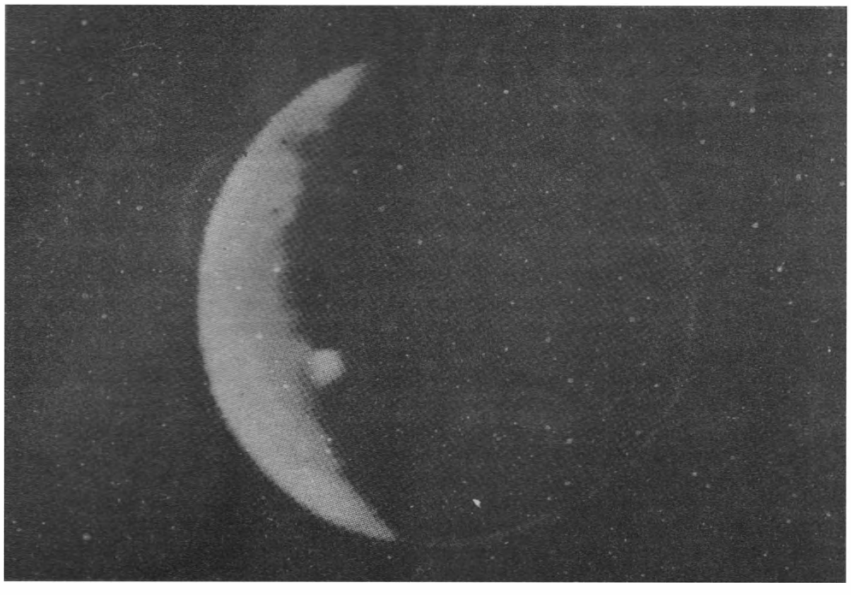
Upon arrival at KSC, the Galileo orbiter began a series of tests prior to mating with the (Jovian) atmospheric Probe. The next step will consist of a move to the Vertical Processing Facility for mating with the IUS booster rocket. In late August, the stack is scheduled for transport to launch pad 39-B and subsequent incorporation into the Shuttle Atlantis.

Do you remember science-fiction writer Ray Bradbury's "Rocket Summer"? It was the initial piece in his 1950 collection *The Martian Chronicles*, and when I was 15, this vignette, set in January 1999, seemed to me to be the apotheosis of optimism and adventure. "Rocket Summer... The Rocket lay on the launching field, blowing out pink clouds of fire and oven heat. The rocket stood in the cold winter morning, making summer with every breath of its mighty exhausts. The rocket made climates, and summer lay for a brief moment upon the land...".

Our planetary summer seems a worthy companion of this vision.

Volcanos on Io

Volcanos on Earth are ferocious geological beasts. Their predatory effects need not be restricted to the immediate vicinity of an eruption; climatic changes induced by material spewed into the stratosphere have caused crop failures, with attendant loss of life, at widely dispersed points. (See the May 1989 edition of this column for a report on some detective work concerning great volcanic explosions throughout history.) However, in the larger setting of solar system events, active vulcanism was unrecognised outside of Earth until the two Voyager spacecraft flew through the Jovian system in 1979 and observed volcanic eruptions in progress on the satellite Io.



Volcanos on the Jovian satellite Io were discovered with this image taken on March 8, 1979 by Voyager 1 at a range of 4.5 million km from the satellite. One plume is seen on the limb of Io, a second eruption is taking place along the terminator *NASA/JPL*

Io is the innermost of the four large satellites of Jupiter that were discovered by Galileo when he turned his telescope to the planet. Along with Europa, the next Galilean satellite in distance from Jupiter, Io is largely a rocky body (although Europa does have a thin coating of ice) and both are about the size of our Moon. The two outer Galilean satellites, Ganymede and Callisto, are larger with diameters more nearly equal to the planet Mercury, but with substantially lower densities than Io and Europa. The difference between these two pairs of satellites seems to be that the inner ones lost much of their less dense, volatile materials early in the history of the Jovian system. Jupiter, then very hot, "cooked" out most of the water and other volatiles from Io and Europa, leaving principally a rocky residuum. A second possible explanation is that the formation environment was sufficiently hot to prevent the initial incorporation of solid volatiles into the two inner satellites, and, in fact, both processes probably played a role.

Today, Jupiter still radiates twice as much energy as it receives from the Sun - energy from the original formation of the planet and the decay of radioactive elements - but the primary effect of the planet upon Io is now gravitational rather than thermal.

An intricate gravitational interaction between Jupiter, Europa, and Io produces tidal heating of Io - rock tides, not water tides - that drives the volcanos observed on the satellite during the flybys of Voyager 1 and 2.

The Voyager spacecraft provided striking images of the mottled orange-yellow topography of Io: painted with sulphur and its compounds by actively spewing volcanos, nine of which were catalogued by Voyager. Sulphur constitutes the motif for this Dante-esque world where even the orbit of the satellite is enveloped in a swirl of sulphurous material.

In late 1995, the Galileo spacecraft is scheduled to go into orbit about Jupiter, extending, among other objectives, our knowledge of Io's vulcanism. However, the progress of Io studies is by no means limited to data obtained from interplanetary spacecraft. Recently, I spoke with Dr. Dennis L. Matson of JPL in order to become acquainted with some of the Earth-based studies in which he is engaged. The substance of this conversation is reported below and illustrates the interplay.

Matson and his colleagues designed an observing programme that was originally focused upon understanding the heat flow from Io. Thus, it was natural to utilise measurements in the infrared portion of the electromagnetic spectrum, and, to this end, he employed NASA's three-meter Infrared Telescope Facility (IRTF) located atop Mauna Kea in Hawaii. The observational program, extending from 1983 to the present, included a period of time when a massive eruptive event took place on the satellite.

The observations suggest that on August 7, 1986 an area approximately 30 km in diameter produced temperatures of about 900°K.

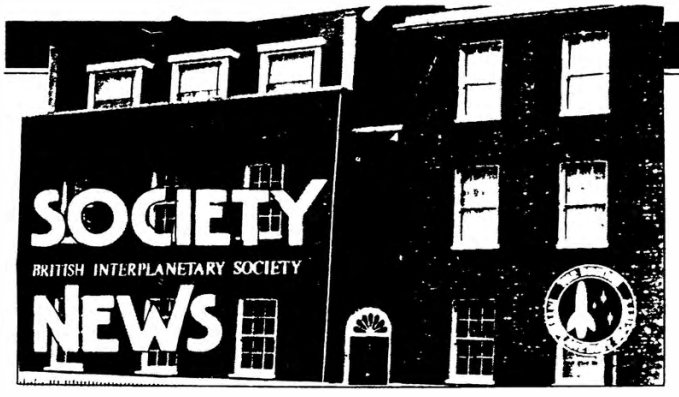
Now this is very interesting: (1) the magnitude of the event, which had a power of approximately 2.6 x 10^{13} W, exceeded any release observed by Voyager, and (2) the 900°K observed temperature was significantly higher than the boiling point of sulphur: estimated to be about 715°K under the conditions at Io.

It had long been conjectured, by Dr. Michael Carr and others, that sulphur is not the only constituent in Io's vulcanism. The scarps and mountains which rise as high as 10 km above the mean surface of Io cannot be supported structurally by sulphur alone. A mixture of sulphur and silicates could do the job. Most investigators believe that both sulphur and silicate vulcanism is taking place on Io; the question at issue concerns the relative proportion of each and their attendant effects on the landforms of Io.

The IRTF was used to measure infrared flux from the satellite at three wavelengths: 4.8, 8.7 and 20 microns (a micron is one millionth of a metre and visible light extends from 0.4 to 0.7 microns). Each measurement summed the flux from the entire visible hemisphere of Io; the disk only subtends an angle of about one arcsecond as seen from Earth, and it is difficult to achieve optical resolution on this scale because of the jitter of the atmosphere.

However, surface resolution is obtainable through two methods: (1) observation of Io at different places in its orbit about Jupiter, thus viewing various hemispherical caps, and (2) using the fact that the three infrared wavelengths provide windows on different physical processes. The 20 micron measurements characterise emission from nonvolcanic cold areas of Io's surface, which constitute approximately 99% of the topography, while the 8.7 micron data supply information about cooler volcanic activity. The 4.8 micron flux encodes hotter volcanic activity and includes an infrared component from reflected sunlight. (Throughout the electromagnetic spectrum, shorter wavelengths correspond to higher energy processes, and, where temperature is relevant, hotter events.)

During the 1986 observing opportunity, observations were made with the IRTF on seven nights. On August 7, the 20 micron flux was normal, but the 8.7 and 4.8 micron fluxes were both increased significantly above normal levels: the former by a factor of two and the latter by a factor of four. From an analysis of the geometry of the observations, it was estimated that the location of the anomalous event was probably near 70° W. longitude. There is no way to estimate latitude, but the motion of Io in its orbit during the evening supplied enough information to constrain longitude. The observed fluxes would be reasonably explained by a volcanic source at the equator with the previously mentioned diameter of 30 km and



Start Made To HQ Extension

Reports on building work at the Society's HQ (see ***Spaceflight***, June 1989, p.205) have already brought to members' attention the many necessary and worthwhile improvements to the structure and facilities of our present building that are in hand.

We can now report that a start has been made with the extension at the rear of the building, plans for which were first announced in ***Spaceflight*** in May 1987. The work undertaken involves the laying of part of the drainage system and has been formally recognised by the Local Authority as constituting a 'start' within the 5 year period since Planning Permission for the extension was granted.

Commenting on the extension project the Executive Secretary said, 'Now that a start has been made, contributions are more than ever needed to the Society's Building Appeal Fund to ensure that the work can continue without delay and I appeal to all who support the Society to take this opportunity to make a contribution to the Building Appeal Fund.

The fund total now stands at £71,000. With construction costs continuing to rise, it is essential that extra money is forthcoming so that we can see our way to clearing the main hurdles of expenditure. Every contribution is one step nearer to the realisation of this project'.

Contributions may be sent with the form on p.288 or enclosed with a covering letter.

Society at Space Development Conference

The Society was well represented at the 8th Annual 1989 International Space Development Conference held in Chicago in May. The four-day programme covered many of the broader aspects of space activity such as education, business, law and medicine and went off very well according to Frederick I. Ordway who represented the Society and gave a short talk on the Society's behalf as part of the dinner held on the Saturday evening. At the luncheon on the Sunday as many BIS members as possible gathered for a group photograph: these included Daniel James Gauthier, Bill Ganoe, Jeffrey Schavland, Andrew Higgins, Jim Potter, Susan Switzer (Fryer), Chuck Carney, Welburne D. Johnson (of *London*, Kentucky), Charles Walker and Frederick I. Ordway. Among other BIS members who attended was Leonard David.

The Society was one of the Co-Sponsors of the Meeting, which was held under the Principal Sponsorship of the National Space Society.

BIS attendees at the Space Development Conference, Chicago, May 26-29, 1989.

'Space' Degree at Leicester

We are pleased to note that Leicester University has agreed to establish a new degree course 'Physics with Space Science and Technology' that will be taking its first

temperature of 900° K. If the volcano were located off of the equator, its diameter would be larger, with the area projected to the line of sight equal to the equatorial estimate.

Matson said eight or nine minutes of time with the telescope were required to obtain each data point. Calibration of observations is important for any series of scientific measurements in order to tie the data to known sources of reference. For the Io observations, the satellite Callisto was used as a local secondary standard by moving the telescope to that body after every two data points at Io (Ganymede can be used if Callisto is not available due to its apparent proximity to Jupiter). For a primary standard, the star Alpha Lyrae (Vega), frequently used for astronomical calibrations, was employed with similar frequency.

The volcanic plumes observed by the Voyager spacecraft in 1979 reached heights up to 300 km above the surface of Io and were the most dramatic manifestation of vulcanism on the satellite. Their colour indicates that they are composed mostly of sulphur or sulphur dioxide. It is difficult to estimate the size of particles in the plumes, so the rate of resurfacing of Io by deposition from volcanic plumes is highly uncertain; estimate range from one ten thousandth of a centimetre per year up to as high as one centimetre per year.

Another approach to estimating the resurfacing rate of the satellite comes from noting the absence of impact craters on its surface - they have been covered up by the ejecta and lava flows of volcanic activity. Knowing the flux of impacting bodies in the solar system, it has been estimated that the resurfacing rate must be at least one tenth of a centimetre per year. However, the general mechanisms of volcanic activity indicate that lava flows provide the predominant mode of resurfacing of Io.

Matson and his colleagues have provided direct evidence which is strongly indicative of the involvement of silicates in Ionian vulcanism and, combined with indirect evidence from topographical structural arguments, sharpens the debate between the sulphur and silicate schools.

The ongoing program of observations consumes 5 or 10 nights per year on the IRTF. Matson hopes to supplement this with more extensive chunks of observing time which will be available on a smaller telescope of 1.2 m, which is scheduled to come on line at JPL's Table Mountain Observatory later this year.

Io is a fascinating geophysical laboratory which will engage the attention of observers and theorists for years to come. Whether its bright surface features are silicates with just a thin coat of sulphur paint, or possess a substantial sulphurous component, is only one of an interesting set of questions. Ground-based observations such as those accomplished by Matson and his colleagues are of value on their own merits and also assist in scientific planning for space missions; Galileo's limited observing time as it flies closely by Io will be more intelligently applied due to *a prior* knowledge. (Radiation constraints close to Jupiter preclude more than one close flyby of Io; that one will take place as the spacecraft is first being inserted into orbit about the planet.)

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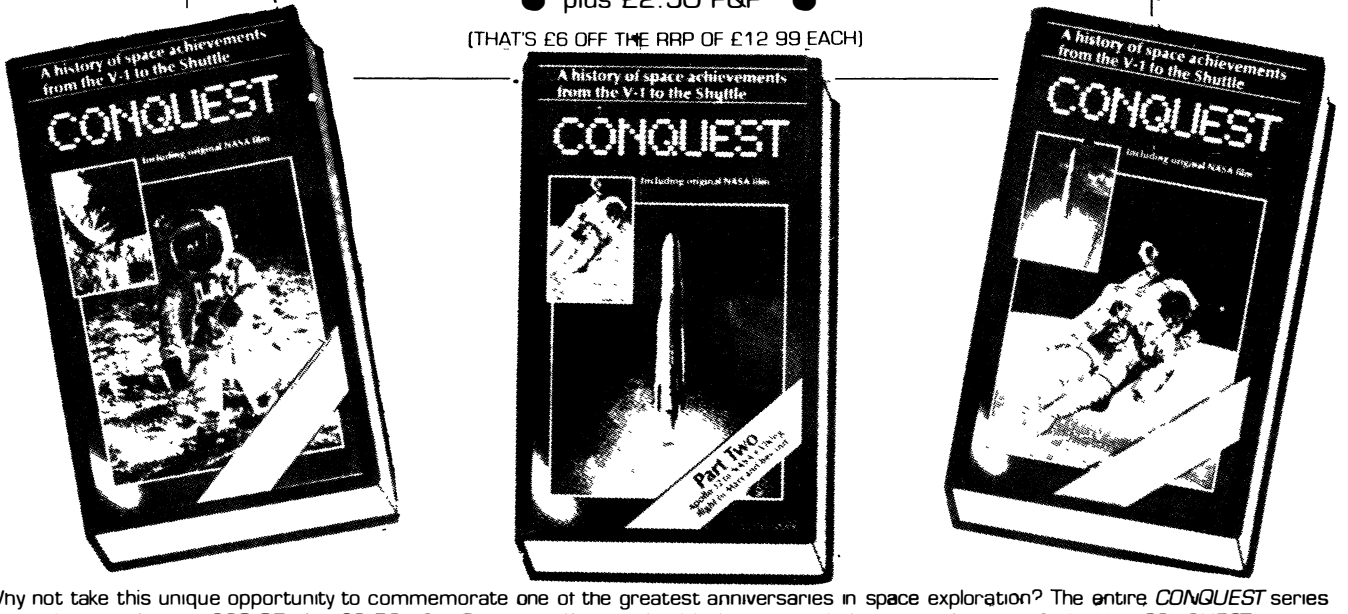

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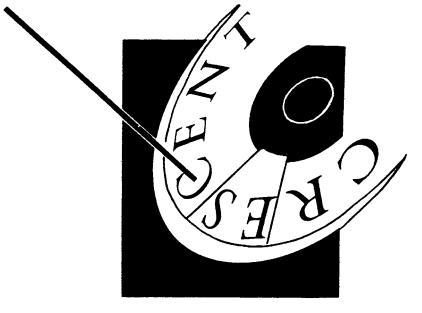

undergraduates in October 1990. News of this should be of interest to younger members and those concerned with the careers of young people.

As the main avenue of entry into the Society's Fellowship grade is *via* graduation with a relevant degree, plus five years relevant scientific, technical or other professional experience, the introduction of a new university course in space science and technology offers additional qualifying opportunities for younger members to progress to the Feilow grade and to undertake responsibilities in the corporate affairs of the Society.

The new course at Leicester University will be held in the Department of Physics where in October 1988 Kenneth Baker inaugurated the new Leceister Space Centre for which an expansion of research facilities is planned. Professor Ken Pounds, Head of Department, writes: 'The new course will be unique of its kind in the UK, although similar courses have been set up in Germany and the USA." Further details may be obtained from Prof. K.A. Pounds, Department of Physics, University of Leicester, University Road, Leicester LE1 7RH.

Members' Visit to Culham

A practical example of the development of nuclear fusion, the process featured so often in past issues of *JBIS* and which may pave the way to interstellar travel, was demonstrated to Society members visiting Culham Laboratory in May to inspect the Joint European Torus (JET) project.

The reaction most likely to yield fusion power first is that between the nuclei of deuterium and tritium, the two heavy isotopes of hydrogen. Virtually unlimited amounts of deuterium can be obtained from water in the oceans whilst tritium can be manufactured (in a fusion reactor) from lithium, a light, plentiful metal.

Special electrical equipment capable of delivering very high power in short pulses is necessary to carry out fusion research. Members had an opportunity of visiting the Control Centre, replete with monitor screens and countdown, to see an experiment in progress.

Deuterium-tritium gas has to be heated to temperatures in excess of 100 million degrees celsius for fusion to occur. Hot plasma which touches the walls is cooled instantly so many different magnetic field patterns have been studied to determine the best confinement system

Nuclear fusion can provide a vast, new source of energy, using fuels both plentiful and widely available throughout the world. It would also be an inherently safe system for radioactivity of the reactor structure, caused by the neutrons, can be minimised be careful materials selection. The storage of radioactive waste could also be limited to less than 100 years for no long-lived fission projects are produced, such as plutonium and other actinides, which require storage and supervision for centuries.

The Tour did not allow examination of the ion thrusters developed by the team headed by Dr. A.R. Martin, a former Council member, though these were featured in one of the displays.

Arthur C. Clarke Appointed Chancellor

We are pleased to report that Arthur C. Clarke, an Honourary Fellow and former President of the Society, has been appointed Chancellor of the International Space University (ISU) for a three-year term.

Arthur C. Clarke helped to found the ISU in April 1987 and has since served on the ISU Board of Advisors, actively sponsoring its initial development which led to its 1988 summer programme attended by over 100 students from more than 20 nations.

The ISO plans to expand into a full-year academic programme and permanent campus locations following 1992, the International Space Year.

Early BIS Days

On seeing a recent ***Spaceflight*** obituary to one of the Society's early pioneers, we hear from Aurthur C. Clarke paying a personal tribute and pointing to the need for preserving a record of the early BIS period. He writes.

> Sir, I was saddened to see the reference in the March issue of ***Spaceflight*** to the death of 'Doc' Slater - though there can be few regrets for anyone who lives an active life to the age of 93!
>
> 'Doc' Slater was one of the most versatile and remarkable men I ever met. He seemed to have mastered at least a dozen talents, including, it was rumoured, the ability to whistle in two separate keys simultaneously!
>
> He was one of the true prioneers of the early BIS days, and I only hope that he left some recorde of that period. There are now very few left to remember it, though I am happy to say that they still include our Founder, Phil Cleator.
>
> ARTHUR C. CLARKE
> Chancellor, University of Moratuwa

The Society takes a particular interest in preserving a record of its early work. The Executive Secretary says, 'It happens all too frequently that valuable early photographs, written items of correspondence or printed matter are discarded from personal collections of memorabilia after a number of years. Should anyone have or envisage disposal of material relating to the Society, to ***Spaceflight*** generally or to the work of members of the Society from several years ago, I would be more than grateful if they would contact me'.'

An article by Phil Cleator recalling early Society history was published in the April 1986 issue of ***JBIS*** and this and other accounts that have appeared, such as the Society's book 'High Road to the Moon' by Bob Parkinson, clearly show the detailed nature of the Society's early work and ideas and how clearly they were confirmed by later events. Any member who was actively involved with the Society or space projects up to the early years of the Space era and who may be able to 'fill in' some of the details of this period from their own recollection and records is asked to contact the Executive Secretary.

Society to be Represented in National Astronomy Week (NAW) 1990

The theme of NAW 1990 is a celebration of British Astronomy with the highlighting and publicity of key astronomical events in 1990. The aim is to raise an awareness of Astronomy among the public at large and follows similar National Astronomy Weeks in 1981 and 1985. The week designated for special events is November 17-24, 1990.

With the increasing contribution that Astronautics is making to astronomical knowledge, the Society is pleased to be participating in the organisational arrangements for NAW 1990. The Chairman of NAW 1990's organising committee is Dr. Nigel Henbest and the Society's representative is Mr. A.T. Lawton, a Vice-President of the Society.

Conference on Space Power

About 150 people attended the International Conference on Space Power in Cleveland, Ohio, USA organised by the Power Committee of the International Astronautical Federation, held on 5-7 June 1989 and co-sponsored by the Society. The following report of the meeting has been provided by Dr. Anthony Martin, who represented the Society:

While the prime sources considered at the Conference were either solar or nuclear, there was a wide-ranging programme of papers on all aspects of converting these sources into useful electrical power. Sessions took place on energy storage, power conditioning and control, power beaming and missions and applications.

On the solar side it was frequently emphasised that the solar power satellite concept was being re-examined as a way of alleviating concerns over global warming and the "greenhouse" effect, in part caused by emissions from ground-based fossil fuel power stations. Several overview papers pointed out that advances in technology, since the last serious studies of the concept in the 1970's, had all served to make such power stations easier to engineer and construct. Problems still exist over the large scale of such systems, and studies of smaller (a few hundred megawatt size) stations should be encouraged.

In the nuclear area it was recognised that, while current efforts are directed towards power sources of less than 100 kilowatts, power levels in excess of one megawatt would be needed to enable missions to be planned on the 2010 timescale. If work was not started on the development of these now, then space programmes could well stall in the earlier years of the next century, while power technology caught up with other system capabilities. It was noted several times that there was little cause for concern over safety issues for properly planned and engineered systems but that environmental impact assessments should be carried out at the earliest possible time in a programme. Full discussion of these issues and efforts to educate concerned persons were needed to ensure acceptance of nuclear systems.

The conference ranged from "blue sky" discussions to details of near-term programmes, with a wide selection of topics in-between. The Organising Committee is to be congratulated on a stimulating and very worthwhile Conference.

A Rare Library Acquisition

The Society has been fortunate in acquiring a copy of a very rare book, *Nova Coelestium terrestrium rerum obervationes et fortasse hactenus non vulgatae*, (literally, "All things new of Heaven and Earth observed carefully and possibly - thus far - not of the ordinary"), written by Francisco Fontana and published in 1646. Fontana (1580-1650) was a lawyer who lived in Naples. He was a contemporary of Galileo (1564-1642) and well aware of his discoveries. In producing his title Fontana was using his words very carefully. He did not want to fall foul of the Church, as Galileo had done. Galileo was too well-known to be executed for heresy - he was house-jailed instead. Fontana was not so well known. Had he written too freely, he would certainly have forfeited his liberty, if not his life.

The book describes observations of the Moon, Venus, Mars and Saturn made by Fontana between 1629 and 1645, illustrated with 27 copper engravings of the Moon (including a full pull-out map) and 25 other wood block engravings.

It is exceptionally badly printed and has considerable off-setting and see-through so it is no work of art. Fontana excuses all this by explaining that the book was prepared in great haste to prevent his illustrations being stolen and used by others as their own work. Two of them actually were stolen and used in this way.

Our copy, unfortunately, lacks the front portrait illustration and the concluding index but is otherwise complete. It is rare to find a copy nowadays, anywhere, in any condition.

Fontana's drawings of Saturn in 1630, 1634 and 1644.

The Headquarters of the Society

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Rex Turner, BIS President 1985/7

I have pleasure in enclosing a contribution* towards the Society's Building Appeal of £ $

I would like to receive a copy of the Society's Brochure *'Guide to Aims and Activities'* ☐

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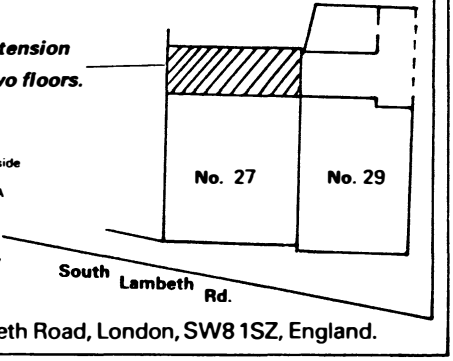

*Payments from UK may be made

(a) By cash, postal order or cheque made payable to BIS

(b) By GIRO Our GIRO account number is 53 330 4008

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(a) From Europe the easiest way is by GIRO transfer

(b) By Eurocheque with the account number written on the reverse side

(c) By US dollar cheque drawn on a Bank with an address in the USA

(d) US dollar notes

(e) Members may instruct their Banks to remit directly to the Society

(f) US or Canadian money orders payable in Sterling

Send to: The Executive Secretary, The British Interplanetary Society, 27/29 South Lambeth Road, London, SW8 1SZ, England.

SOCIETY MEETINGS DIARY

Lectures

4 October 1989 7.00-8.30pm

BEHIND THE SCENES WITH MAGELLAN, VOYAGER AND GALILEO

Interplanetary exploration is showing a strong resurgence in 1989 with three major events leading the way: The Magellan launch to Venus, Voyager 2's flyby of Neptune and the Galileo launch to Jupiter. Bill McLaughlin, who is involved with all three projects at the Jet Propulsion Laboratory, will outline the missions and provide insights into the actual progress and results to date of these three endeavours.

Venue: The Conference Room, British Interplanetary Society, 27/29 South Lambeth Road, London, SW8 1SZ.

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

1 November 1989 7.00-8.30pm

CETI OVERVIEW - AN UPDATE

A. T. Lawton

Recent observations have revealed that at least two nearby stars have "Brown Dwarf" mini-stars as companions. Such studies will undoubtedly lead to the discovery of Brown Dwarfs as individual single stars, so that Proxima Centauri may not be our nearest extra-solar body.
The impact of these new discoveries on the more conventional ideas of CETI will be discussed.

Venue: The Conference Room, British Interplanetary Society, 27/29 South Lambeth Road, London SW8 1SZ.

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

Technical Symposia

13 September 1989 10.00am-4.30pm

SPACE STATIONS AND BEYOND

The 2nd BIS Space Infrastructure Symposium

Following the success of the first infrastructure symposium in November 1988, the British Interplanetary Society is organising a second with the theme of "Space Stations and Beyond".

Papers include:

Mission Capability for A High Performance Orbital Propulsion Module - by E. Kruzins

Strategies for Development of Lunar Base by C.M. Hempsell

Phobos - A Future Space Station - by P.A. Hansson and A. Bond

This series of symposia is the only current forum for discussion of major infrastructure topics such as:

Launch Systems - Lunar Bases - Aerospace Planes - Space Stations - Inter Orbit Transportation - Manned Planetary Exploration

The theme has been chosen because of the studies underway both in America and Europe to plan the next major programmes to be undertaken after the Freedom/Columbus space station is established. Options under study include lunar bases, manned Mars missions and an autonomous European space station.

Venue: The Conference Room, British Interplanetary Society, 27/29 South Lambeth Road, London SW8 1SZ.

Offers of Papers
Authors wishing to present papers should contact the Exectutive Secretary.

Registration
Forms are available from the Executive Secretary. Please enclose a SAE.

27 September 1989 10.00am-4.30pm

BRITISH SOLID PROPELLANT ROCKETRY

The emphasis will be on Bntish post-war solid propellants and the development of associated rocket motor and launch vehicles.

Papers to be presented will have the following themes:

Cordites - by E. Baker
Composite Propellants - by J. Hicks
Sir William Congreve and His Rockets - by P. Turvey
Early Rocket Motors - by V. Green
Gosling - by E.White
Sounding Rocket Motors - by J. Rolfe
IMI Motors - by S. Gordan
Stonechat - by P. Moore

Venue: Conference Room, British Interplanetary Society, 27/29 South Lambeth Road, London, SW8 1SZ.

Offers of Papers
Authors wishing to present papers should contact the Executive Secretary.

Registration
Forms are available from the Executive Secretary. Please enclose a SAE.

LIBRARY OPENING

The Society Library is open to members on the first Wednesday of each month (except August) between 5.30pm and 7pm. Membership cards must be produced.

44th ANNUAL GENERAL MEETING

NOTICE IS HEREBY GIVEN that the 44th ANNUAL GENERAL MEETING of the BRITISH INTERPLANETARY SOCIETY Limited will be held in the Society's Conference Room at 27/29 South Lambeth Road, London, SW8 1SZ on 16 September 1989 at 12 noon precisely.

Attendance is restricted to Fellows of the Society. Admission is by ticket. Those wishing to attend must apply for tickets not later than 10 days before the date of the meeting.

AGENDA

1. To receive the Report of the Council on the Society's Affairs for the year to 31 December 1988.
2. To receive the Society's Balance Sheet and Accounts for the year ended 31 December 1988 and the Auditors Report thereon.
3. To consider the following resolution:

   "That the Society's Council be authorized to raise a loan for the purpose of the proposed extension, if necessary, up to the sum of £30,000".
4. To appoint Auditors and to determine the method of fixing their remuneration. The present Auditors have expressed interest in continuing in Office.
5. To elect four Members of the Council of the Society. In accordance with Article 43, the following Members of the Council will retire at the meeting:

   M.R. Fry
   A.T. Lawton
   I.E. Smith
   C.R. Turner

If the number of nominations exceeds the number of vacancies, election will be by postal ballot in accordance with Article 44. The final date for the receipt of ballot papers will be 31 January 1990.

6. General Discussion.
7. Closing Remarks by President.

By Order of the Council
L.J. CARTER
Executive Secretary

A Fellow who cannot be personally present at the meeting may appoint by proxy some other person, who must be a Fellow of the Society, to attend and vote on his behalf, subject, however, to the proviso that a proxy cannot vote except on a poll.