2/1987

SPACE india

INDIAN SPACE RESEARCH ORGANISATION

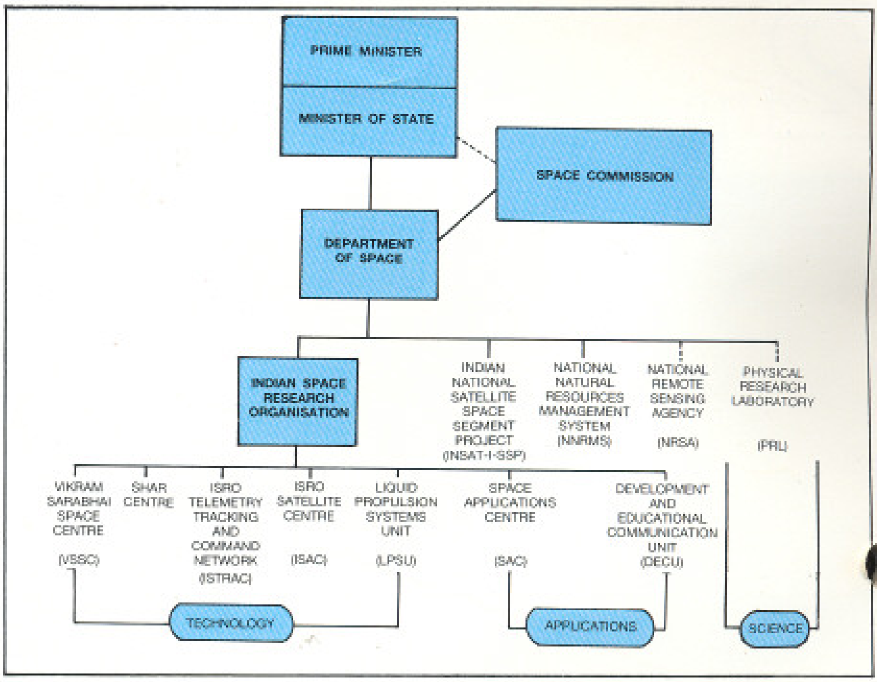
THE INDIAN SPACE PROGRAMME

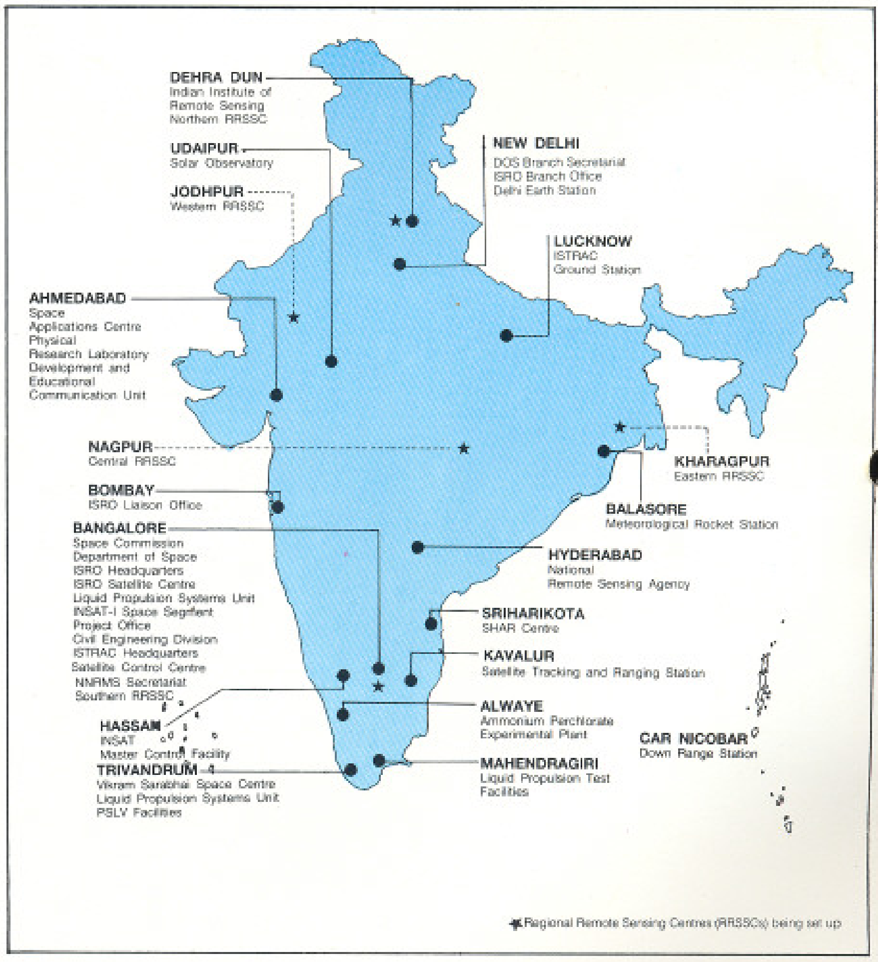
The setting up of the Thumba Equatorial Rocket Launching Station (TERLS) in 1963 marked the beginning of the Indian Space Programme. The Space Commission and the Department of Space (DOS) were established by the Government of India in 1972 to promote unified development and application of space science and technology for identified national objectives.

The Indian Space Programme is directed towards the goal of self-reliant use of Space technology for national development, its main thrusts being: (a) satellite communications for various applications, (b) satellite remote sensing for resources survey and management, environmental monitoring and meteorological services and (c) development and operationalisation of indigenous satellites and launch vehicles for providing these space services.

The Indian Space Research Organisation (ISRO) is the research and development wing of DOS and is responsible for the execution of the national space programme. ISRO also provides support to universities and other academic institutions in the country for research and development projects relevant to the country's space programme.

Both the DOS and ISRO Headquarters are located at Bangalore. The development activities are carried out at the Centres and Units spread over the country□





FRONT COVER
ASLV-D1 lifts off from the launchpad at Sriharikota

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ASLV D-1 Launch

ASLV-D1 flight sequence: The diagram shows the planned trajectory and the course the vehicle actually took.

SRIHARIKOTA, MARCH 24, 1987

The launch countdown for the ASLV-D1 mission proceeds flawlessly at the SHAR range. The giant Mobile Service Structure (MSS) crawls away on the steel rails at T minus 2 hrs exposing the 39-tonne Augmented Satellite Launch Vehicle (ASLV) to the scorching sun. All the pre-launch checks completed, the launch operations sequence switches to computer control. A hold props up at T minus 7 minutes resulting from a spurious reading of a pressure monitor. Hold is lifted within minutes. Shortly after noon, at 12:09 hrs Indian Standard Time, the twin solid propellant motors strapped on to the core vehicle ignite simultaneously. The 25m slender vehicle comes to life with a thunderous noise and lifts vertically.

► **T minus 0 seconds**
Strap-on motors ignition and lift-off.

► **T plus 5 seconds**
Pitch programme execution.

► **T plus 48.5 seconds**
On-board computer command sent for first stage ignition. But ignition does not take place as expected.

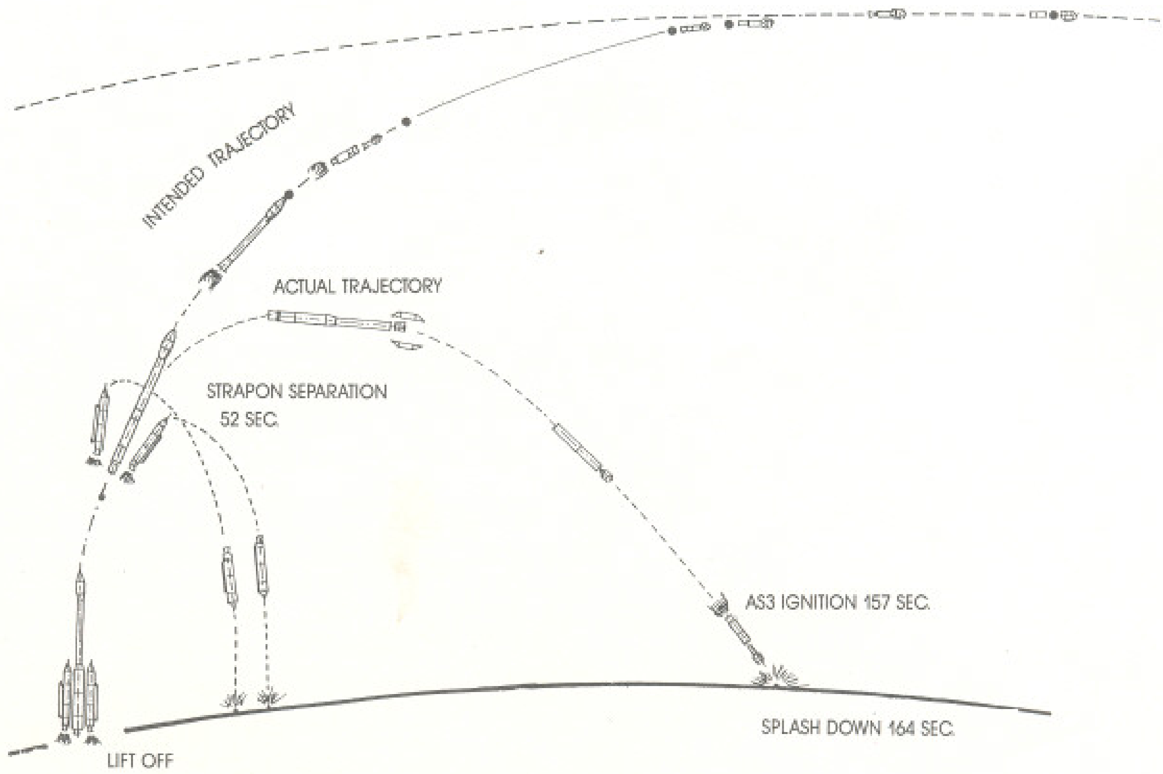
► **T plus 52 seconds**
The strap-on motors separate from the rising vehicle.

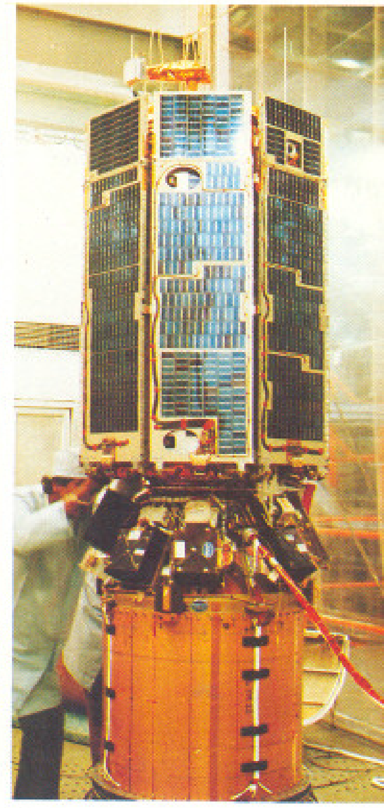
► **T plus 52.5 seconds**
Loss of telemetry data from the first and second stages of the vehicle.

► **T plus 73.9 seconds**
Telemetry indicates heat shield separation event as against planned time of 151.8 sec.

► **T plus 156.8 seconds**
Ignition of third stage motor confirmed by telemetry, as expected.

► **T plus 164 seconds**
Telemetry signals lost and inertial navigation system data show splash down into the sea. Termination of mission □





A fish-eye view of the ASLV with the Mobile Service Structure (MSS) in the background (left)

SROSS-1 satellite being integrated with the launch vehicle inside the Mobile Service Structure (right)

The Performance

Even though the primary objective of placing the SROSS-1 satellite into orbit could not be accomplished, a number of new technology elements relating to the launch vehicle, spacecraft, launch complex and the ground stations have been validated. In a few cases the performance could be assessed for the planned duration of the flight. For a number of other subsystems the assessment is based on their performance during the limited duration in flight.

All the launch complex elements including vertical integration of the launch vehicle, automatic check-out operations and the range safety operations have been fully validated by the exceptionally smooth launch campaign activities carried out.

The crucial strap-on booster technology has been fully evaluated. The pressure-time curves obtained from the telemetry data, show motor performance very close to prediction with matched characteristics for the two strap-ons. The separation of the strap-ons also occurred as per design and smoothly, at the intended time. Another new technology that has been satisfactorily validated is the S-Band TTC system which functioned normally upto the splash-down. Further, the third stage motor, the open loop guidance system, the on-board computer, stage-1 and stage-3 control systems, inertial navigation system, the SROSS-1 electrical bus and the launch vehicle monitoring payloads also performed normally till the mission termination.

The performance of second and fourth stage motors, heat-shield and upper stage separation systems and the celestial gamma ray experiment payload could not be evaluated due to the premature termination of the mission. However the limited data on the closed-loop guidance system performance collected till the termination of the flight shows normal performance.

When the results of further detailed analysis of the entire mission data become available necessary corrective measures will be incorporated into the next ASLV launch. All efforts are being made to accomplish the launch of ASLV-D2 within the next 12 months□

The Prime Minister at SHAR Centre

Mr. Rajiv Gandhi, the Prime Minister of India, accompanied by several dignitaries witnessed the ASLV-D1 launch at Sriharikota. Soon after the launch, the Prime Minister along with Prof. U.R. Rao, Chairman, ISRO and Mr. N.T. Rama Rao, the Chief Minister of Andhra Pradesh, addressed a press conference.

Pointing out that there were bound to be setbacks when one worked at the cutting edge of technology, the Prime Minister said, "I still would like to congratulate our scientists who are doing such good work. The setback will be only in time. The morale is high. ISRO would analyse what went wrong, correct it and move on to Polar Satellite Launch Vehicle and further progress". Exhorting the scientists 'not to lose heart' he added: "It is only when you stumble that you can get up and walk better. I have no doubt ISRO will get up and not only become more dynamic but also stronger" □

The Prime Minister, Mr. Rajiv Gandhi flanked by Shri N.T. Rama Rao, Chief Minister of Andhra Pradesh and Prof. U.R. Rao, Chairman, ISRO, at the press conference held at SHAR Centre immediately after the ASLV-D1 launch

An Interview with Prof. Jordan

"While some terrestrial systems have been available, I am convinced that satellite navigation systems will substitute most of the terrestrial navigation systems in a couple of years."

In January 1987, Prof. Hermann L. Jordan, Chairman of the Board, German Aerospace Research Establishment (DFVLR) was in Bangalore for a review of the co-operative ventures between DFVLR and ISRO. A physicist of repute, Prof. Jordan was appointed as the Director of the Institute of Plasma Physics, KFA-Julich in 1960, a post he held till 1973. For the period between 1964-69, he was concurrently the Director of the European Space Research Institute of ESA at Frascatti. In 1973 he took over as the Chairman of the Board, DFVLR providing leadership to the German aerospace research for a long and fruitful period ending in February 1987 when he retired. Honoured with titles like Knight of the French and Legion d'Honneur, Prof. Jordan is a member of a host of national and international professional bodies like the German Aerospace Society, the American Institute of Aeronautics and Astronautics and the International Academy of Astronautics.

Prof. Jordan is well known for his researches in quantum field theory, plasma physics and solar-terrestrial relations. Prof. Jordan continues, even after retirement, to contribute to international co-operation in science and technology as the co-ordinator for research co-operation for a number of foreign countries.

Dr. S.V. Kibe and Mr. S. Satish of ISRO Headquarters interviewed Prof. Jordan and Prof. U.R. Rao, Chairman, ISRO, on behalf of *SPACE India* soon after the ISRO-DFVLR meeting held at Bangalore during January 19-21, 1987. Excerpts overleaf:

Q: *It is more than 10 years since DFVLR and ISRO signed the special agreement for joint activities in the area of space research. You have been personally associated with this co-operation right from the beginning. Could you please tell us what, in your opinion, are the highlights of this co-operative agreement?*

Prof. Jordan: I think this co-operation has been a model for excellent international co-operation starting with training programmes, moving then gradually to closer co-operation and joint projects of growing importance to science and in complexity.

Q: *We understand that this is the fifth time that the Chairmen-level meeting of DFVLR and ISRO is being held. Could you please tell us what was the outcome of the present meeting?*

Prof. Jordan: In the present meeting, we made a review of the activities of the past, identified a number of problems to be resolved and listed a number of activities which would be of common interest for the years to come. The most important item of our co-operation was seeing the flight of the German stereo camera called MEOSS on an Indian SROSS Satellite. This camera seems to offer unique possibilities for taking stereo photographs from space, which will be of interest both to India and to Germany as well as to a number of other countries.

Prof. Rao: As Prof. Jordan said, the co-operation started about a decade ago starting with training programmes and identifying areas where ISRO needed to build expertise. This soon developed into more concrete projects wherein projects of mutual interest were selected and intensive work was carried out by scientists from DFVLR and from ISRO. The outcome of this was the definition of the MEOSS, the stereo scanner, which is to be put on SROSS-2. We have also reviewed the progress of co-operation in the areas of remote sensing and space sciences. Another feature of this meeting is that, for the first time, we discussed development of future systems and possibilities of co-operation. The development of these systems might fructify 10 or 15 years later but the spadework for these had to be done now.

Q: *We have all known about the successful SPACELAB-D1 mission and the contribution of your country to this programme. Could you please tell us something about your experience in this programme, and how the Challenger accident affects the future missions?*

Prof. Jordan: SPACELAB-D1 mission was a big exercise for us, after the experience we had with the first European-American SPACELAB mission. The D1 mission was the first mission where NASA acted as transport agent for a national mission. It was also the first time that NASA gave the responsibilities for the mission and the responsibility for the management of the payloads, outside of the US to a control centre in Germany. Joint control of the flight and payloads was done by real time communication via satellite between Germany and the United States. This has proved to us, to the Americans and to the world that it is possible to carry out important space missions with divided responsibilities across continents and oceans around the world.

This opens the roads for future co-operation in such ambitious projects as the forthcoming space stations. This organisational and technical aspect of the mission, I think, was a full success. The scientific results of most of the 70 experiments conducted will take years to evaluate, but first results show that the mission has been successful beyond expectation. Interesting experiments were carried out in the fields of microgravity related to biology, to human-medicine and to materials and fluids. The unfortunate Challenger accident will delay future flights for at least two years. But this delay will give us a chance to prepare for future missions with much more detailed exercise than we have been able to do so in the past.

Q: *Could you also tell us something about the project called "Saenger" for the manned missions?*

Prof. Jordan: Recently Europe decided to do a detailed feasibility study of the smaller space plane called Hermes, to be transported by a new member of the Ariane family called the Ariane-V under development. This is a project based on today's technology. The next generation would consist of space planes which are able to start off horizontally from an airfield and which are able to come back to the airfield fully reusable. There are a number of proposals for this and one is the German proposal of a two-stage vehicle. One stage to go up to the top of the atmosphere, the second stage will go into orbit and will be capable of re-entering and landing on an airfield. This is a concept based on the earlier ideas of Prof. Eugen Saenger of Germany (former Director of today's DFVLR Centre at Stuttgart). These projects cannot be built with the present state of art of technology. We are going to invest in the coming years a substantial effort in finding technologies and specifications needed to realise such a project.

Q: *What do you think would be the future of such space flights, where passengers could go on a space flight and, may be, cut short their travel time and reach the other side of the globe in less than half an hour or so. Do you think such flights would be as common as air traffic is today?*

Prof. Jordan: It is difficult to predict. Concepts like Saenger can be realised with reasonable cost and high levels of safety. It would allow in addition the trans-atmospheric transport of people and goods at very high speeds at costs substantially higher than the cost of the air transportation today. Therefore, much will depend on the actual use of the flight possibilities *versus* the economic feasibility.

Q: *Prof. Jordan, you are aware that there is a worldwide shift towards satellite radio navigation for land, air and maritime uses. What is your opinion on this and how is DFVLR gearing up towards using satellite navigation on an operational basis?*

Prof. Jordan: I think the basic steps for worldwide satellite navigation have been taken. Systems are available or will soon be available, with a high degree of precision. We have been spending substantial efforts in the past to find necessary terrestrial systems to be able to use on worldwide scale. While some terrestrial systems have been available, I am convinced that satellite navigation systems will substitute most of the terrestrial navigation systems in a couple of years.

Q: *Could you tell us something about DFVLR's involvement in remote sensing programmes. Do you plan to have a German remote sensing satellite?*

Prof. Jordan: We are not going to have a German remote sensing satellite. We will be using the European satellite, ERS-1. But, again, we are building the ground equipment that is necessary to take advantage of the data from space. Remote sensing has a very wide range of applications.

Q: *Prof. Rao, would you like to say something on our own remote sensing programmes?*

Prof. Rao: India is a large country and the problems which India faces are unique. Probably more or less similar to the problems faced by many of the developing countries. We not only need to monitor the agricultural production but we need to do something for the dry land farming, and look at the soil mechanics and so on. We need to look at the mineral resources, we need to look at water and water resources, particularly the underground water. Other important areas include forestry, ocean resources and monitoring of floods, snow melting and coastal erosion. We need to, obviously, encourage the use of space remote sensing combined with the already existing ground measurement information, so that we get the best out of these for the development of the country.

Q: *How far, in future, does DFVLR look in their plans?*

Prof. Jordan: Our plans are made for the next 20 years because space systems which are being defined now will take 10 years to build and take another 10 years or more to operate. There has to be a consistent framework for the German programme and the European programme as a whole. Nobody can, of course, predict the future but, you can make projections into the future.

Q: *One of the main tasks of DFVLR, as given in your Annual Report, is to develop readily applicable technological and scientific results for future projects of public interest or of major economic interest to the Federal Republic of Germany. Which projects in your view were the most beneficial as far as these two aspects are concerned?*

Prof. Jordan: This is not an easy question to answer because the benefits are different in nature. It is first essential to understand that space is not an end to itself. It is a medium through which we can achieve results in science. There is no discussion about results in telecommunication, which is basically standard operation today. It is in the area of remote sensing where we see larger and larger possibilities emerging. There is a lot of excitement behind the results in microgravity experiments but we do not understand the phenomenon fully. There are 'spin-off' technologies of new materials, new structure, automation and robot systems. Large part of this 'spin-off' cannot be easily identified.

Q: *You have been at the top of DFVLR for the last 13 years. What, in your opinion, have been your most outstanding achievements?*

Prof. Jordan: This is a difficult question. The fact is that we have a large working force in space, aeronautics and modern technologies of different kinds. We have been able to provide a number of new technologies; we have been able to help our aircraft industry substantially. We participated in scientific missions; we have been leading manned space missions together with the Americans. We have built successfully, or are building, test facilities for aeronautics and space as a part of international programmes and we have a well-established co-operation with India which we consider as being of a very high value □

Indo-German Balloon Experiments

A balloon being readied for launch at the National Balloon Facility

A high altitude balloon carrying scientific experiments under the ISRO-DFVLR collaboration was launched successfully from the National Balloon Facility of Tata Institute of Fundamental Research at Hyderabad on March 26, 1987 at 0545 Hrs. The 1,35,000 cubic metre, hydrogen filled balloon lifted a payload of about 400 kg comprising a cryosampler experiment of the Max Planck Institute for Aeronomy (MPAE), Lindau, and a radiation experiment from the Physical Research Laboratory, Ahmedabad. The major objective of the experiments was to measure the height profiles of the atmospheric trace constituents over the low latitudes. These trace gases influence the ozone layer of the atmosphere and the climatic environment.

The balloon reached a ceiling altitude of 35 km. The cryosampler could collect 15 gas samples at pre-determined altitude levels during upward and descent legs. Good data has also been telemetered by the radiation experiment.

A similar collaborative experiment was earlier conducted during March 1985. These experiments were supported by the National Balloon Facility at Hyderabad and the Indian Middle Atmosphere Programme (IMAP) funded by many agencies of the Government of India and managed by ISRO as the nodal agency □

ISRO-DFVLR Co-operation

Co-operation in Space Research between India and the Federal Republic of Germany (FRG) is more than a decade old, beginning with a few joint space science experiments. The governmental umbrella agreement between India and FRG was signed during 1971. Based on further work a special arrangement to define and execute joint activities was signed in 1974 between the Indian Space Research Organisation (ISRO) and the German Aerospace Research Establishment (Deutsche Forschungs und Versuchsanstalt fur Luft und Raumfahrt e.V. - DFVLR). This led to exchange of scientists and a number of joint studies in space sciences, applications and technology; for example, computer systems for mission analysis, Tracking, Telemetry & Command (TTC), and remote sensing experiments.

Prof. U.R. Rao, Chairman, ISRO (left) and Prof. H.L. Jordan Chairman, DFVLR (right) signing the protocol during the recent ISRO-DFVLR meeting at Bangalore.

In 1981 a joint decision was taken to identify a few large specific projects of mutual interest. Accordingly a major sounding rocket experiment called APC-REX (Attitude Payload Control Rocket Experiment) was taken up. Another major milestone in the co-operation is the decision taken to launch the Monocular Electro-Optic Stereo-Scanner (MEOSS) payload developed by DFVLR, on the second Stretched Rohini Satellite (SROSS-2) being developed by ISRO, which will be placed in orbit by an ASLV developmental flight.

ISRO-DFVLR co-operation, which is considered as a good example of international co-operation, has evolved effective management mechanisms including periodic reviews to ensure successful results. The programme is reviewed annually by the Chairmen of the two organisations.

A detailed review took place between ISRO and DFVLR during January 19-21, 1987 at Bangalore. The DFVLR team was led by Prof. H.L. Jordan, Chairman, DFVLR and the ISRO team by Prof. U.R. Rao, Chairman, ISRO. Besides, reviewing the progress of MEOSS mission, rocket experiments etc., a number of joint studies which could lead to co-operative efforts with long term goals in view have been identified in remote sensing, satellite communication, large space structures and systems, etc. Studies on Space-borne LIDAR, Synthetic Aperture Radar and other optical systems are some major examples□

The Mobile Service Structure (MSS) at the ASLV launch complex at Sriharikota: Designed by a private sector industry to ISRO's specifications, the MSS is a tractionable, mobile steel building, 40 metres tall, with foldable access platforms, lifts, cranes, cleanrooms and other fixtures for the integration of the launch vehicle.

PARTNERSHIP IN PROGRESS

Space and Industry

Technological innovation and upgradation are the keys to a nation's economic development today. The benefits derived by the service, business and industrial sectors of modern society from the techniques developed for the space projects are internationally acknowledged. The Indian Space Programme has been no exception to this international pattern. A mutually rewarding partnership between the Indian Space Programme and the industry has been built over the past decade.

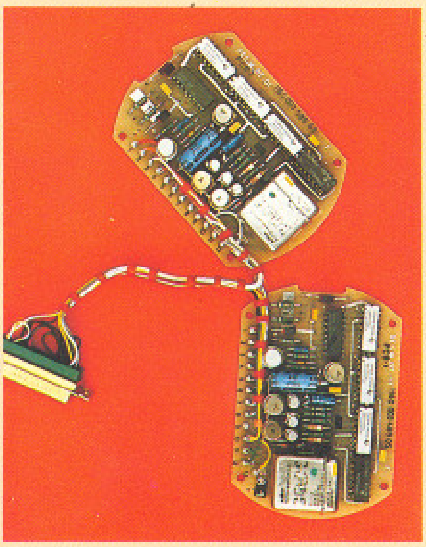
From the beginning, it has been the policy of the space programme to utilise the capabilities and the infrastructure of the Indian Industry for the space projects, as also to promote the application of the know-how for products and processes developed by the space programme towards larger national benefit. Accordingly the programme's partnership with the industrial sector was organised under four closely linked fronts, viz., technology transfer from the space programme to the industry, technological consultancy to the industry, utilisation of industry's own technological expertise by the space programme and the procurement of goods and services from the industrial sector.

The technology transfer scheme of the Indian Space Programme was instituted in 1976. This scheme promotes and supports a large number of Indian industries in three distinct streams: (i) to meet the requirements of the space projects and the R&D programmes through buy-back of products whose technology is transferred to them; (ii) to service the rapidly expanding space applications market in the country in the areas of satellite telecommunications, television and radio broadcasting, meteorological observations and remote sensing for earth resources management; and (iii) to exploit the potential of the indigenous technologies developed by the space programme for various commercial spin-off applications. Today over 100 distinct technologies have been licensed by the Indian Space Research Organisation (ISRO) and the National Remote Sensing Agency (NRSA) in a variety of industrial sectors such as special chemicals and materials, electronics and telecommunication, opto-mechanical and opto-electronic instruments, computer software, special purpose machines and processes, etc.

Similarly the technological consultancy scheme launched in 1982 has evoked excellent

Rural Windmill for pumping water developed by the INSAT Master Control Facility (MCF), and installed at Seegenahalli Village, Mulbagal Taluk in Karnataka: This technology has since been transferred to industry.

Stage separation timer for ISRO's RH-200 rocket manufactured at the Space Electronics Division (SED) of the Bharat Electronics Limited (BEL)

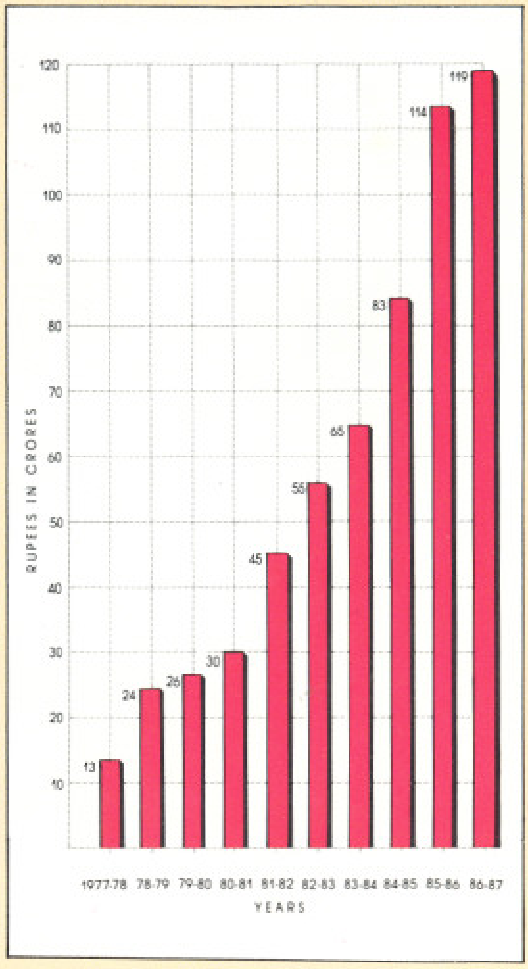


Portable Agrophotometer for the measurement of water content and chlorophyll concentration in plant leaves: The technology for this in situ measurement device developed at the ISRO Satellite Centre (ISAC) has been transferred to an industry for mass production.

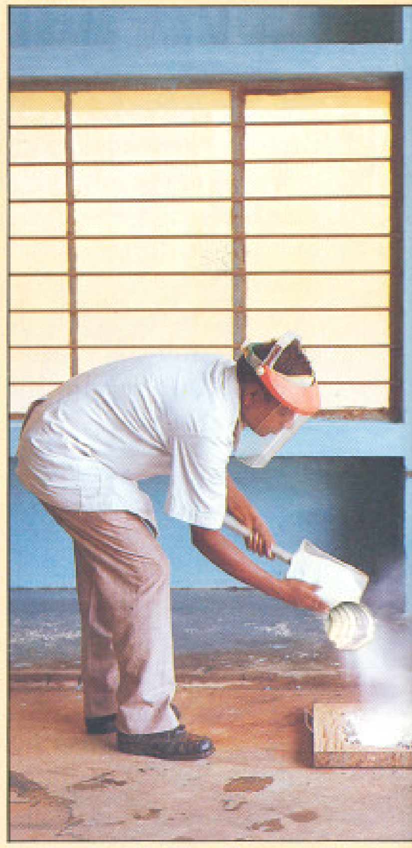
response from the industry and research organisations in the country. More than 50 consultancy assignments have been completed and as many as 25 new projects are in progress.

On their part, the Indian Industry played an important role in the space projects and the infrastructure development. A recent example is the turnkey contract awarded to a consortium of industries led by an Indian prime contractor for the design, development and fabrication of a large space simulation chamber. Similarly the fabrication, execution and commissioning of a large mobile service structure for the assembly of the Polar Satellite Launch Vehicle (PSLV) has commenced at an Indian Industry. Other contributions include supply of systems for satellite control stations, fabrication of rocket motor cases and base shrouds, fabrication of light alloy structures, supply of composite structures, solar cells and printed circuit boards for spacecraft systems, etc.

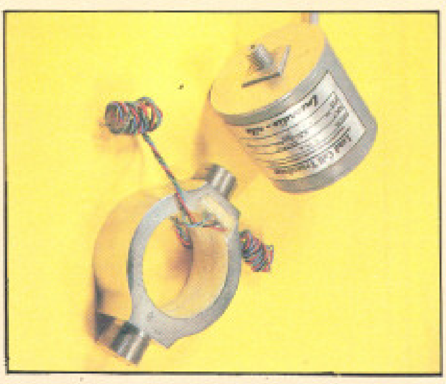
A variety of promotional activities are also carried out to sustain the technology transfer and industry interface programmes. One such is the regular issue of Interest Exploration Notes (IEN) which are disseminated to a wide range of industries and research institutions. The IENs describe the new technologies available for transfer, their specifications and possible applications. Announcements are also made in professional journals regarding availability of such know-how. Licensee-licensor meets at the Centres of Indian Space Research Organisation are organised besides regular seminars conducted in association with the industries.



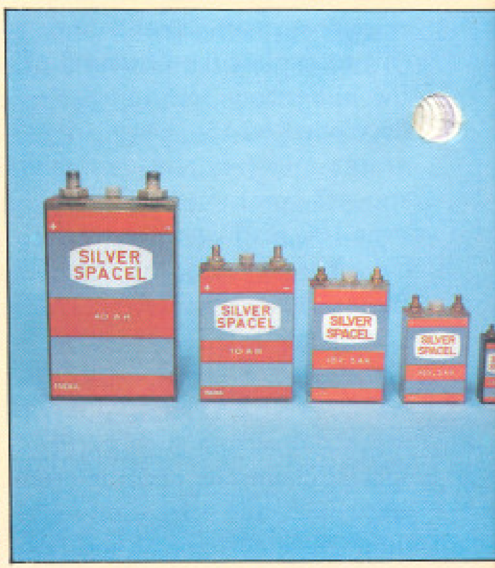
A decade of momentum in space-industry partnership: Annual flow of funds from India's Space Programme to Indian industries (1977-87).



ISRO Dry Powder, a fire extinguishant, developed by the Vikram Sarabhai Space Centre (VSSC): Three private sector industries have been licensed for its manufacture.



Thrust Transducer for space applications developed by the Vikram Sarabhai Space Centre (VSSC): A private sector industry has been licensed for the manufacture of the transducer.



Silver Zinc Cells developed at the Vikram Sarabhai Space Centre (VSSC) for rocket applications, the knowhow for which has been transferred to industry

TECHNOLOGY SPIN-OFFS FROM SPACE PROGRAMME

ADVANCED TECHNOLOGIES

- ★ PROPELLANTS, EXPLOSIVES, PYROTECHNICS
- ★ ORGANIC & POLYMER TECHNOLOGY
- ★ ADVANCED COMPOSITES, SPECIAL MATERIALS
- ★ ELECTRONICS & COMMUNICATIONS
- ★ INERTIAL GUIDANCE SYSTEMS & SENSORS
- ★ ELECTRO-OPTICS, OPTOMECHANICAL
- ★ DESIGN & SETTING UP OF SPECIAL FACILITIES
- ★ HIGH TECH: APPLICATION SOFTWARE
- ★ QUALITY & RELIABILITY ENGINEERING
- ★ SAFETY ENGINEERING
- ★ SYSTEMS ENGINEERING & MANAGEMENT

TRANSFER TO INDUSTRY

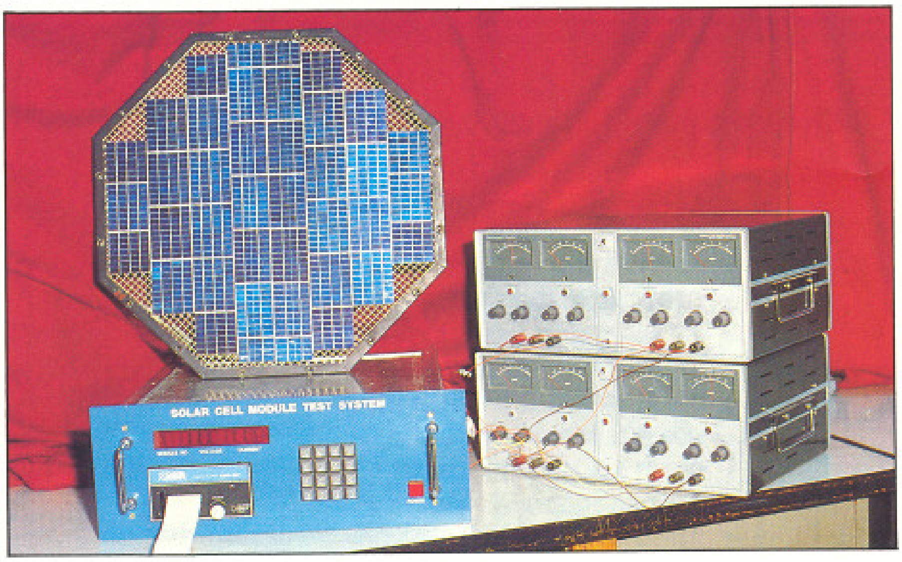
- ★ 102 PRODUCTS/PROCESSES TRANSFERRED (ALREADY 75 UNDER REGULAR PRODUCTION)
- ★ 70 PRODUCTS/PROCESSES BEING TRANSFERRED

TECHNICAL CONSULTANCY

- ★ 75 UNDERTAKEN
  51 COMPLETED

Radio networking receive terminal developed by the Space Applications Centre (SAC) for use with INSAT: The technology for the terminal has been transferred to a public sector industry for manufacture.

Analog Image Analyser for remote sensing applications developed by the National Remote Sensing Agency (NRSA): This technology has been transferred to a private sector industry.



Solar Cells for space applications developed by the Bharat Electronics Limited (BEL) in collaboration with the ISRO Satellite Centre (ISAC), undergoing tests

A two day conference on 'Business opportunities in satellite communications, broadcasting and meteorology for electronics industry' held at the Space Applications Centre, Ahmedabad during August 1986 and a one-day seminar on 'The spectrum of image processing and analysis software from the Indian Space Programme' held at the ISRO Satellite Centre, Bangalore are two such meets held recently.

It is inevitable that, with ISRO's commitment to providing operational space services to the nation, this space-industry interface should grow rapidly in the years to come□

Seventh Indian Engineering Trade Fair

Since 1975, the Confederation of Engineering Industry (CEI) in India has been organising biennially an Indian Engineering Trade Fair (IETF). The 7th IETF was held at New Delhi during February 8-15, 1987. The fair covered all major industry segments - large, medium and small - in the country along with a Technology Transfer Show Window (TTSW) which provided an opportunity to foreign companies to establish linkages in India.

The Indian Space Research Organisation (ISRO) participated in the 7th IETF. On February 11, 1987 a seminar was organised in which specialists from ISRO made presentations on 'Indian Space Programme: Challenges for Engineering Industry'. A display pavilion was also put up by ISRO in the fair, which was adjudged the third best display in the fair from among 500 stalls□

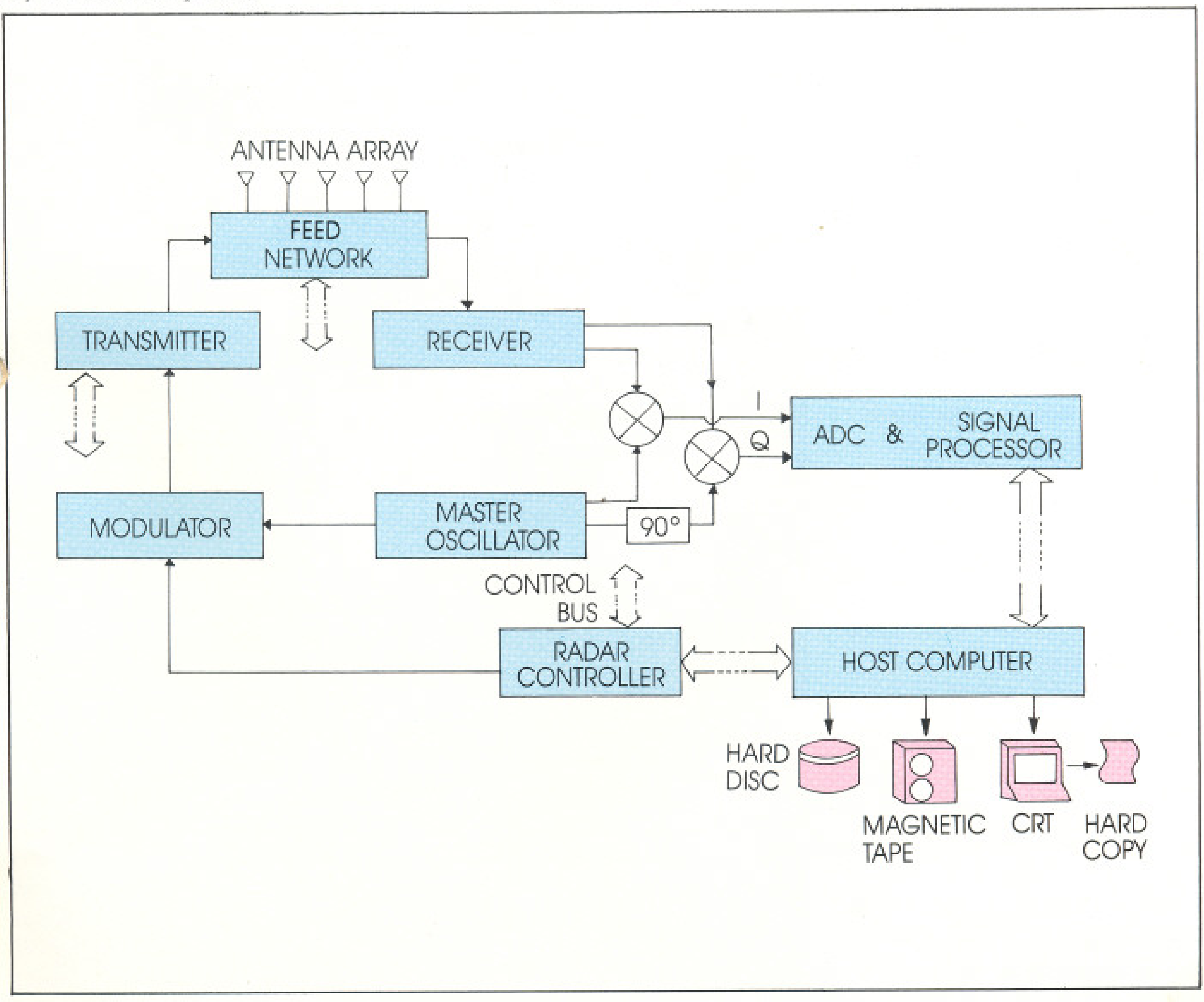
A view of the ISRO Pavilion which won the 'Third Best Display' Commendation Award at the Seventh Indian Engineering Trade Fair at New Delhi

A Radar for SCIENCE

The terrestrial atmosphere, by virtue of its composition and temperature, affects life on earth in a variety of ways. Instruments for the measurement of the atmospheric temperature, humidity, pressure, wind velocity etc., have been developed and used in an effort to understand the dynamical processes of the atmosphere. A radar is one such tool and is considered an excellent ground based instrumentation system for remote sensing of the atmosphere. During the past few years a new generation of sensitive pulse Doppler radars has been developed for the routine observation of wind, turbulence and other dynamic phenomena in the atmospheric layers of Mesosphere, Stratosphere and Troposphere. Such radars are known popularly as MST Radars. These radars use VHF and UHF band of frequencies to study the echoes arising from the refractive index fluctuations in the middle atmosphere and electron density variations in the lower ionosphere. The ability of the MST radar to continuously monitor the atmospheric dynamical processes will enable investigations of prevailing winds, planetary and equatorial waves, gravity waves and turbulence.

Presently not more than five such radars are operational around the world and most of them located at high latitudes. Considering the need for a reliable three dimensional

MST Radar system configuration

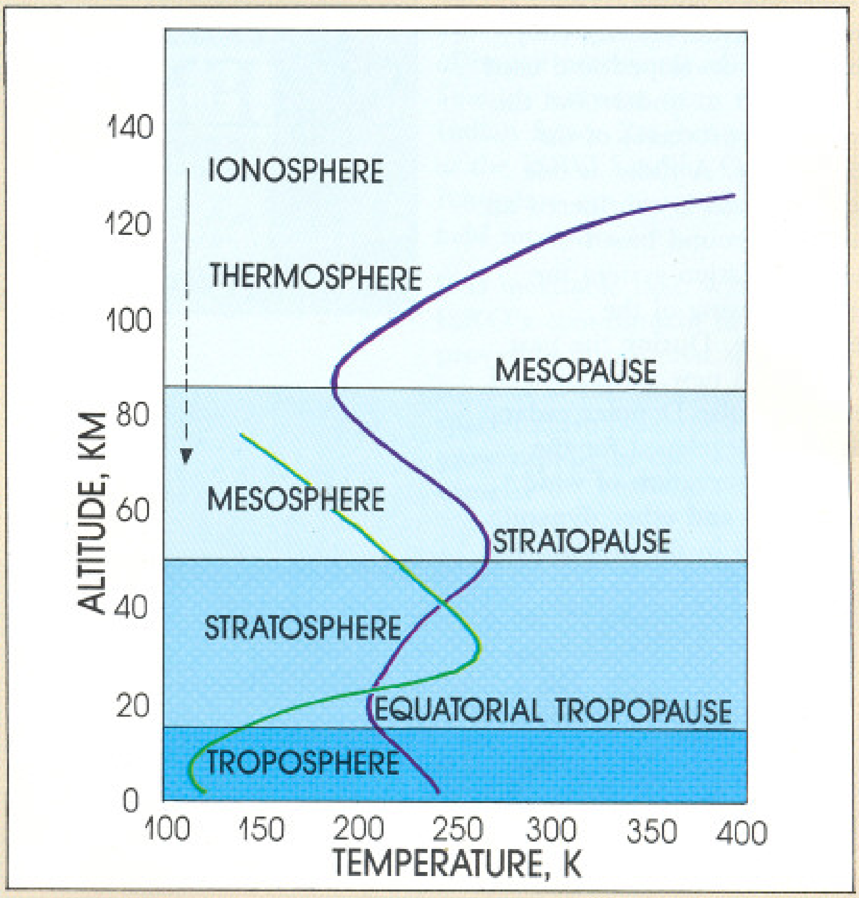


model of the atmosphere over the low latitudes and in the Indian region, a national MST radar project has been initiated in India. Based on the scientific requirements and taking into account the frequency clearance aspects, a site near Tirupathi in Andhra Pradesh has been selected for establishing the Indian MST Radar.

Techniques to measure wind velocities with radars make use of spectrum analysis or correlation methods, either in the time or in the space domain. The Indian MST radar employs what is known as the Doppler Beam Swinging (DBS) technique for measuring wind velocity in the height region of 5-100 km. In this method a minimum of three radio beams are used, one in the zenith direction and others in two perpendicular directions off-zenith. The Doppler shifts in the beam returns are measured to obtain radial wind velocities in each of the directions. From these measurements the three dimensional velocity vector is computed.

The peak power aperture product chosen for Indian MST Radar is 3×10^{10} Wm^2. To achieve such a large power aperture product, a phased array antenna covering an area of nearly 16,000 Sq. metres and employing 1024 crossed Yagi antenna elements is planned. 32 units of modular power amplifiers are distributed across this aperture in such a way that a peak power of 2.5 MW with an average power of 60 KW is generated. Five beams in zenith, ± 20° off-zenith direction in East West & North South planes are generated by electronic scanning. The beam dwell time and sequencing are programmable. The overall radar

Regions of the Atmosphere and their Transitional Zones



The atmosphere that surrounds the Earth consists of layers of gases and mixtures of gases, as well as water vapour and solid and liquid particles. The principal regions of the atmosphere are the troposphere, the stratosphere, the mesosophere, the thermosphere and the like. Each of these regions are characterised by the pattern of vertical distribution of temperatures. Troposphere which is the region of atmosphere that is in contact with the earth's surface, is the realm of the clouds, rain, snow etc. It is characterised in general by a decrease in temperature with increasing altitude. The upper limit of the troposphere, known as the tropopause, is at an altitude of about 17 km at the equator and only six to eight kilometres at the poles. The second region of the atmosphere that has been closely studied is the stratosphere. In its lower section there is a slow, constant increase in temperature with altitude; the temperature rise becomes more rapid with increasing altitude. The upper limit of stratosphere is approximately at 50 km and is known as stratopause. The troposphere and the stratosphere are clearly separated. Above 50 km is the mesosphere or middle region, characterised by a rapid decrease of temperature. Beyond the mesopause is an upper atmospheric region different in character from that of the lower regions □

MST Radar System Features

Operating Frequency:
53 MHz

Peak Power Aperture Product:
3×10^{10} Wm^2

Height range:
5 to 100 km

Spatial Resolution:
Range:
150m (pulse width)
Angle:
3 Deg. (beam width)

Velocity Resolution:
0.1 m/sec

Time Resolution:
30 Sec.

Antenna:
Phased array with 1024 crossed Yagi elements

Transmitter:
Coherent, modular variable pulse width and PRF

Receiver:
Coherent with in-phase and quadrature channels

Signal Processing:
Real time computer controlled

Major Scientific Experiments Planned with Indian MST Radar

- 3 Dimensional structure of gravity waves and turbulence
- Tropospheric wind profile prior to and during the onset of cyclones
- Troposphere – Stratosphere interaction including wave transients and transport of atmospheric constituents
- Detailed characterisation of equatorial waves and atmospheric tides in Mesosphere and Stratosphere.

system including the signal processors is controlled by a 32 bit micro computer supported by a large on-line memory and standard peripherals like CRTs, magnetic tape drives, hard and floppy discs, printer and plotter.

Besides Indian Space Research Organisation, the nodal agency for establishing the national MST Radar facility, many scientific Departments jointly support the programme. These include the Department of Science & Technology, Department of Environment, Forests& Wild Life, Defence Research & Development Organisation, Department of Scientific & Industrial Research and Department of Electronics. The prime contractor for the design and development of the system is the Society for Applied Microwave Electronic Engineering Research (SAMEER) at Bombay. The radar is expected to be operational by the year 1991. Once established the facility will be open to scientists from all the national laboratories, universities and other scientific institutions☐

India Reiterates Commitment to

PEACEFUL USES OF OUTER

The United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) is the nodal UN agency that deals with all the international matters relating to the peaceful uses of space. Technical assistance is provided to this Committee by a Scientific and Technical Sub-committee. The 24th session of this Sub-committee took place in New York during February 17-27, 1987. An Indian delegation led by Prof. U.R. Rao, Secretary, Department of Space and Chairman, ISRO participated in this meeting. Following are excerpts from Prof. Rao's address to the Scientific and Technical Sub-committee of UNCOPUOS:

The occurrence of a number of setbacks to the space missions last year, while seriously disrupting the programme of several countries has also clearly brought home the fragility of the entire system on which more and more nations are becoming vitally dependent. These events call for some serious planning and new mechanisms to be initiated both by individual nations as well as by interested bodies like COPUOS to ensure that recurrences of this type do not significantly affect the global scene as a whole.....

While we too have been affected by international setbacks of last year, we have made substantial progress in our own national effort.....

The most notable achievements were in the field of utilisation of space technology for national development. We have initiated several application projects in major resource sectors such as agriculture, land use, water resources, forestry, geology, marine resources and environment. The utilisation of the INSAT-IB multipurpose spacecraft for various national applications such as telecommunications, TV networking and meteorological forecasting continued to make significant progress.....

We are happy to inform the committee that 0600 GMT VHRR image derived "winds" are regularly put on the Global Telecommunications System (GTS) of the World Meteorological Organisation (WMO). INSAT VHRR data are also being used in the joint INDO-US monsoon research programme.....

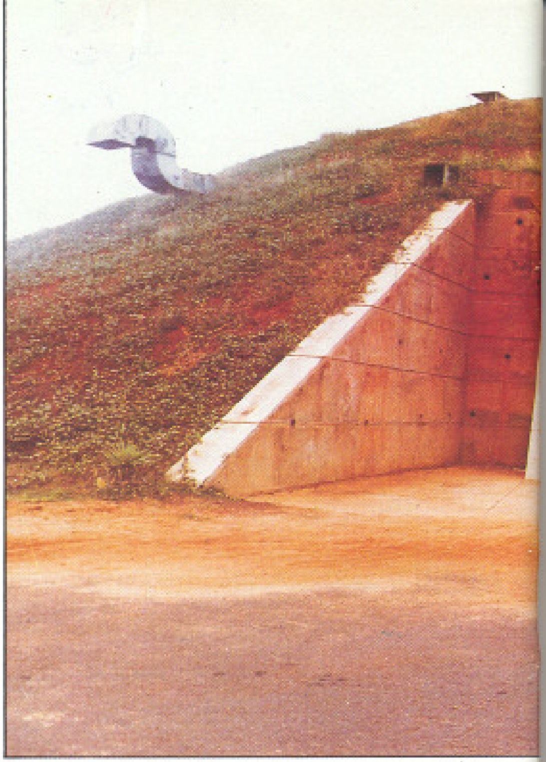
SPACE

Almost five years ago, the UNISPACE 82 Conference on space was successfully conducted in Vienna. A major outcome of the discussions of the conference, which was to be implemented, was to ensure that the benefits of outer space reach all humankind speedily and effectively. While some progress has been achieved through a variety of training programmes conducted by many countries, the progress has been very slow and frustrating. The basic goal of vast benefits of the space technology applications reaching humankind as a whole remains an unrealised dream. Both time and opportunity are slipping by. We need to face the issues squarely in this Committee and come up with the bold new initiatives and mechanisms for achieving our goals.....

We are convinced that it is only through the application of space technology that one can effectively tackle the major problems facing the world in a timely manner. It is also clear to us that unless we initiate new mechanisms we will not succeed in spreading the benefits of this technology to all countries. The most important element in the process of using space for development is to translate all that countries have learnt into practical and immediate benefits. The identification and location of ground water, accurate estimate of changes in forest cover, predicting drought, monitoring the progress of wastelands, estimating acreages of major crops are all practical, relevant and very essential problems being faced by developing countries. One of the tasks of an organisation like COPUOS is to try to match requirements of training of people of a country with the capabilities and operational experience available in a large number of countries. Along with this matching of training needs and available practical experience there should also be a reorientation of the current short term training programmes towards longer term, on the job, project mode training, specifically oriented to tackle the particular problems of a country. It is also our view that adequate number of people should be trained simultaneously from each country in each key area of application. These steps will in our opinion increase considerably the chances of successful application of space for practical benefits.

The key towards achieving this is, of course, international co-operation. An essential pre-requisite for international co-operation is to ensure that outer space is fully used for peaceful applications. My delegation has expressed its concern several times on the dangers of the weaponisation of space. We hope that reason and sanity will prevail and that outer space will indeed be a source of practical benefit and not a place of confrontation and conflict. This is the only guarantee to ensure that the potential of space will be realised by all, especially by the developing countries□

Building for SPACE

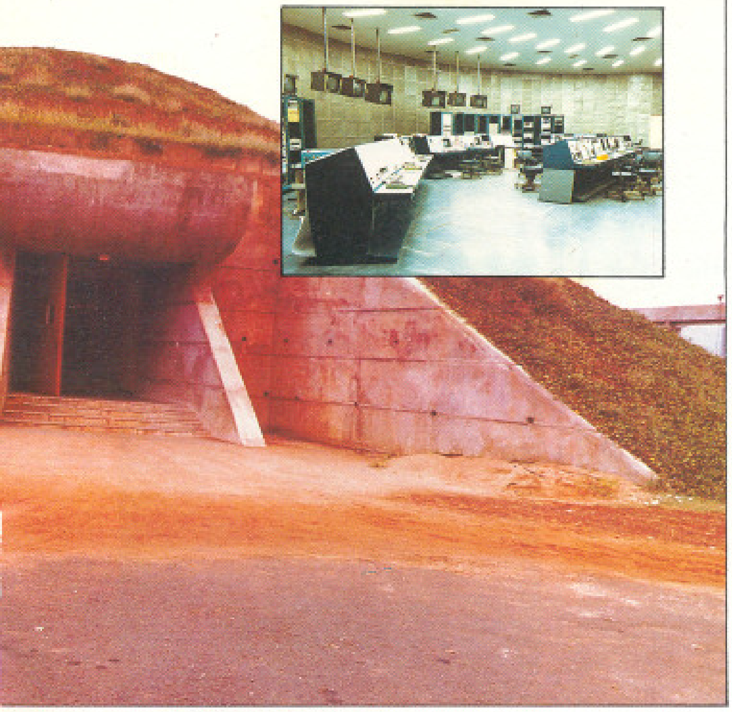


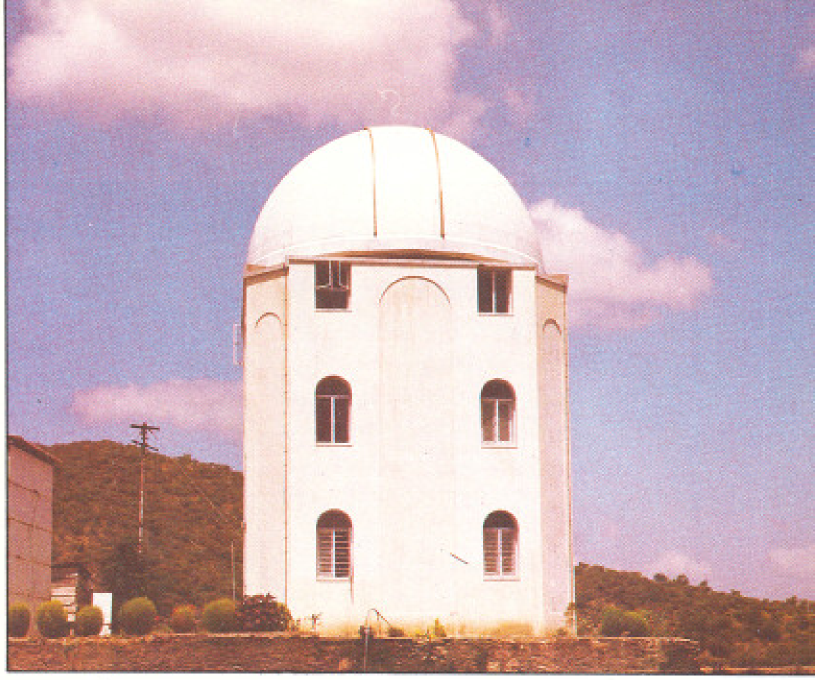
Views of the SLV-3 Block House at SHAR Centre: Exterior and interior (inset). This building, is the nerve-centre for SLV-3 check-out and launch preparation operations. Located partly underground, covering a plinth area of 548 m^2, this dome-shaped RCC shell structure is 24 m in dia, 60 cms thick and designed to withstand a blast pressure of 7.2 T/m^2.

The first thing that impresses any casual visitor to any of the ISRO establishments is the imposing array of Civil Engineering Structures, specially those designed for test facilities, launch pads, service structures, tracking stations and so on. This is rightly so because a high-tech effort like space, calls for specially trained manpower and complex infrastructural facilities which, in turn, need suitably designed civil structures to house them.

Beginning from the makeshift days of 1963 when there were hardly a couple of buildings to house the meagre facilities and miniscule manpower of the infant space programme of the country, the Civil Engineering Division (CED) has come a long way in fulfilling the unique requirements of the mammoth organisation that ISRO is today. The structures built by CED over the years include facilities for safe production of hazardous materials like propellants, super-clean areas for handling delicate micro-electronic circuits, giant-sized launch complexes, anechoic shielded chambers for EMI (Electro Magnetic Interference) testing and a host of others. The most recent example is the acoustic test facility commissioned in Bangalore which meets international standards for testing of launch vehicle and spacecraft systems. In short then the contribution of the CED to the ISRO's progress over the last two decades is truly substantial.

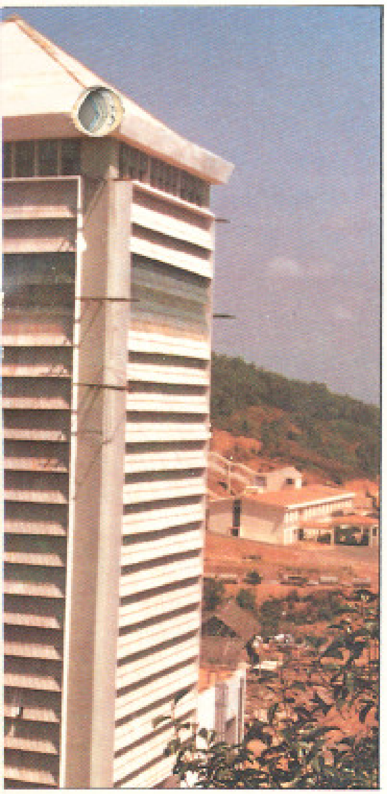
To focus attention on this contribution of the CED a two-day seminar on "Unconventional Structures and Modern Construction Technology" was organised at Bangalore in January this year. Attended by a large number of participants drawn from all over the country, the seminar also covered related themes like modern construction management practices and resources scheduling. An exhibition on modern construction materials was organised at the seminar. A colourful and profusely illustrated brochure titled 'Building for Space' was released on the occasion□





The new Observatory building at Udaipur

Assembly cum Static Firing Test Bay for the PSLV booster motor at SHAR Centre: This facility consists of an assembly bay, test bay and an intermediate storage area. The test area has a 12 m × 25 m RCC floor of M-20 grade concrete, designed for a dynamic horizontal thrust of 600 tonnes. The building is 126 m long, 31 m wide and 40 m high. It covers a plinth area of 1176 m^2.



Assembly and Integration Facility at Valiamala for the dynamic testing of the full-scale models of PSLV: It consists of a stage assembly, pressure test facility, a dynamic test tower and office areas. A special cleanroom is provided for integrating some of the sub-systems. The building has a plinth area of 2621 m^2.

Honours and Awards

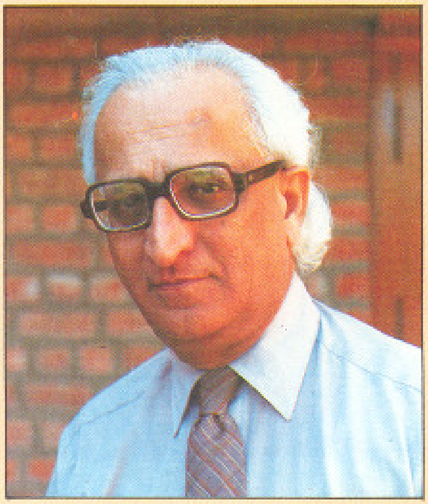
Hari Om Ashram Award for Prof. Chitnis and National Academy of Sciences (India) Award for Dr George Joseph

Prof. Eknath Vasanth Chitnis, Advisor to ISRO's Space Applications Centre (SAC) Ahmedabad, has been honoured with the Hari Om Ashram Award instituted by the University Grants Commission. The award goes to Prof. Chitnis for his significant contributions in the field of 'Interaction between Science and Society'.

Prof. Chitnis began his research career in 1953 at the Physical Research Laboratory (PRL), Ahmedabad where he did pioneering work in the field of cosmic rays. He was at the Massachusetts Institute of Technology (MIT) and Brookhaven National Laboratory, USA for about three years before rejoining the PRL faculty in 1961.

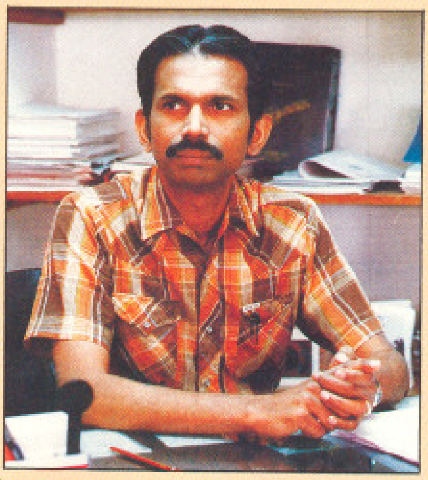
In 1962, when the Indian National Committee for Space Research (INCOSPAR) was constituted, he became its Member-Secretary. He has been very closely involved in the formulation and implementation of the Indian Space Programme, in particular, the establishment of the Thumba Equatorial Rocket Launching Station (TERLS) and the Space Science and Technology Centre (SSTC) (both now part of the Vikram Sarabhai Space Centre at Trivandrum) and the Experimental Satellite Communication Earth Station at Ahmedabad.

As the Programme Manager of India's Satellite Instructional Television Experiment (SITE), conducted during 1975-76, Prof. Chitnis directed the largest communications



experiment ever undertaken anywhere in the world. Later, as Chairman of the Software Systems Group of SAC (1976. to 1981), he devoted his time in acquiring insights into developmental communication through experimental television transmission to the rural areas of Kheda District, Gujarat. He was the Director of the APPLE Applications Programme of ISRO from 1979 to 1983. He was appointed as Director of SAC in 1981, a position which he held until his retirement in 1985.

Professor Chitnis represented India at the Scientific and Technical Sub-committee meetings of the UN Outer Space Committee from 1967 to 1972. He was Chairman of the UN Working Group on Navigational Satellite System. Prof. Chitnis has also worked on the UGC Panel on Mass Communication and facilitated the establishment of Educational Media Research Centres which produce programmes for "the country-wide class room". The Government of India honoured Prof. Chitnis with the Padma Bhushan in 1985□



Dr. George Joseph, Deputy Director (Remote Sensing), Space Applications Centre (SAC) at Ahmedabad, has won the National Academy of Sciences (India) Award for Instrumentation.

Dr. Joseph was with the Tata Institute of Fundamental Research (TIFR), Bombay for over a decade before joining SAC in 1973. He was instrumental in developing a number of electro-optical sensors operating in the visible and infrared region for remote sensing applications. These include multi-spectral scanners, the multi-band television camera systems for the Indian experimental earth observation satellites, Bhaskara I & II, and ground truth radiometers.

Dr. Joseph is currently in charge of the development of the CCD based camera systems for the Indian Remote Sensing Satellite (IRS), scheduled for launch this year. He also directs the programme for the development of the Very High Resolution Radiometer (VHRR), the meteorological instrument for the future indigenous INSAT satellite□

Vikram Sarabhai Awards for Original Books in Hindi

Mr. K.R. Narayanan, Minister of State for Science and Technology, presented the Vikram Sarabhai Awards for original books in Hindi during a meeting of the Hindi Salahakar Samiti held at Bombay on February 6, 1987.

To promote writing books on space sciences and technology in Hindi, the Department of Space has introduced a scheme of awards called **Vikram Sarabhai Awards for Original Books in Hindi.** The books are expected to be written in simple Hindi and in a popular style, covering a particular subject in the field of space sciences and technology.

An evaluation committee set up by the Department considered as many as twelve applications relating to such publications brought out during the calendar year 1984 and declared the following awards:

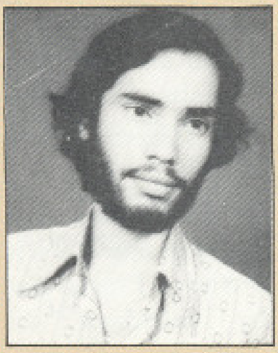
(1) **Bharat Ka Pratham Anthariksh Yatri** *(First Indian Cosmonaut)* by Mr. Jai Prakash Bharti and published by Pitambar Publishing Co., New Delhi - 2nd Prize of Rs. 3,000/-

(2) **Anthariksh Main Bharat** *(India in Space)* by Mr. Sukhdeo Prasad and published by Cyanodaya Publications, Allahabad - 3rd Prize of Rs. 2,000/-.

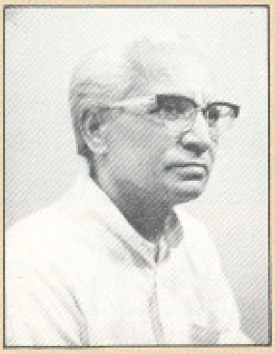
(3) **Mangal Ki Yatra** *(A Trip to Mars)* by Mr. Jogendra Saksena and published by Hind Pocket Books (P) Ltd., Delhi - consolation prize of Rs. 1,000/-.

About the Authors

Mr. **Jai Prakash Bharti** is the editor of a leading children's Hindi magazine, *Nandan.* He writes his editorials in story form, drawing heavily from *The Ramayana* and *The Mahabharata* to portray many shades of human endeavour. His book *Heeron Ka Haar (A Necklace of Diamonds)* containing 26 selected stories won the Hans Anderson Diploma for children's literature awarded by the International Board on Books for Young People (IBBY). His prize-winning manuscript *Chalo Chand Par Chalen (Let's go on the Moon)* written 15 years ago has a character named Rakesh. Mr. Bharti has written over 35 books. *Bharat Ka Pratham Anthariksh Yatri (First Indian Cosmonaut)* gives a vivid account of the manned space mission in which the first Indian cosmonaut, Sq. Ldr. Rakesh Sharma, participated.



Mr. **Sukhdeo Prasad** was born on the new year day of 1957. Son of a teacher and a double post-graduate in 'Vanaspathi Science' and in Hindi from the Allahabad University, Mr. Prasad is a prolific writer. He is the Director of the Vigyan Vychariki Academy, Allahabad and a freelance writer. He writes with a missionary zeal. He has over 30 books and hundreds of popular articles on general science to his credit.



A retired information officer of the Indian Council of Scientific and Industrial Research (CSIR), Mr. **Jogendra Saksena** has written extensively on art, culture, history and science in leading Hindi and English journals. He has also planned and organised two museums - one in Rajastan and the other in Roorkee. He is noted for his specialised works on Rajastan folk arts and folk culture. Considered to possess a unique gift of combining literary enthusiasm with the talent of an artist, Mr. Saksena has published scores of studies in reputed journals including *Nostra* and *UNESCO Courier* from Paris. The subjects of his books range from floor decorations and biographies to inter planetary travels□

"VIKRAM SARABHAI AWARD" FOR ORIGINAL BOOKS IN HINDI FOR 1985 & 1986

To promote Indian authorship on books on Space Science and Technology in Hindi, Department of Space has a scheme for awarding prizes to Indian authors writing original books in Hindi on Space Science and Technology.

The subjects relating to Space Science and Technology identified are given below:

* Rockets
* Satellites
* Space Applications
* Satellite Communications
* Remote Sensing
* Aerial Survey
* Meteorology
* Astronomy
* Geodesy
* Astrophysics
* Space Medicine
* Space Engineering

VALUE OF AWARDS: Every calendar year one award of Rs. 10,000/- will be given to the best entry.

The winner of an award as above will not be entitled to claim any other advantage or assistance from the Department. Only books of standard appropriate for Degree/University level classes, would be considered under the scheme.

In the event, that in any year, no book is considered upto the standard, the Department of Space will take appropriate decisions regarding the award, which shall be final.

Only original works in Hindi published during the year 1985 and 1986 will be eligible for consideration.

The books submitted during a calendar year, will be assessed by an Evaluation Committee set up by the Department of Space for recommendations. The final decision will rest with the Secretary, Department of Space (DOS).

Books which have received any award, subsidy or any other financial assistance under any other scheme operated by the Government of India, any State Government or Private body would not be eligible for consideration of an award under this scheme.

(A) NO AUTHOR MAY BE AWARDED MORE THAN ONE PRIZE FOR ONE CALENDAR YEAR

(B) THE BOOKS SELECTED MAY BE RECOMMENDED FOR BULK PURCHASES IN DOS/ISRO CENTRES/UNITS.

Employees of DOS/ISRO will also be allowed to participate in the above scheme, but the books written in Hindi by the employees of DOS/ISRO shall be judged with reference to the special facilities available to them.

Other Government servants who wish to participate in the said scheme will have to obtain necessary permission of the competent authority concerned for receipt of award before submission of the entries for consideration.

Application alongwith original books may be sent to the Director, Publications and Public Relations Unit, ISRO HQ, Cauvery Bhavan, K.G. Road, Bangalore 560 009, before June 30, 1987.

INSAT-IB satellite images taken of a cyclone on February 1, 1987. A deep depression in the Bay of Bengal intensified into a cyclonic storm on February 1, an unusual phenomenon for this time of the year. In the 110 years that the India Meteorological Department has been keeping track of cyclones there is just one instance, in 1944, of a storm crossing the Tamil Nadu coast in the month of February. The 1987 storm, however, changed direction the next day and moved slowly towards north without causing any damage in the coastal regions.