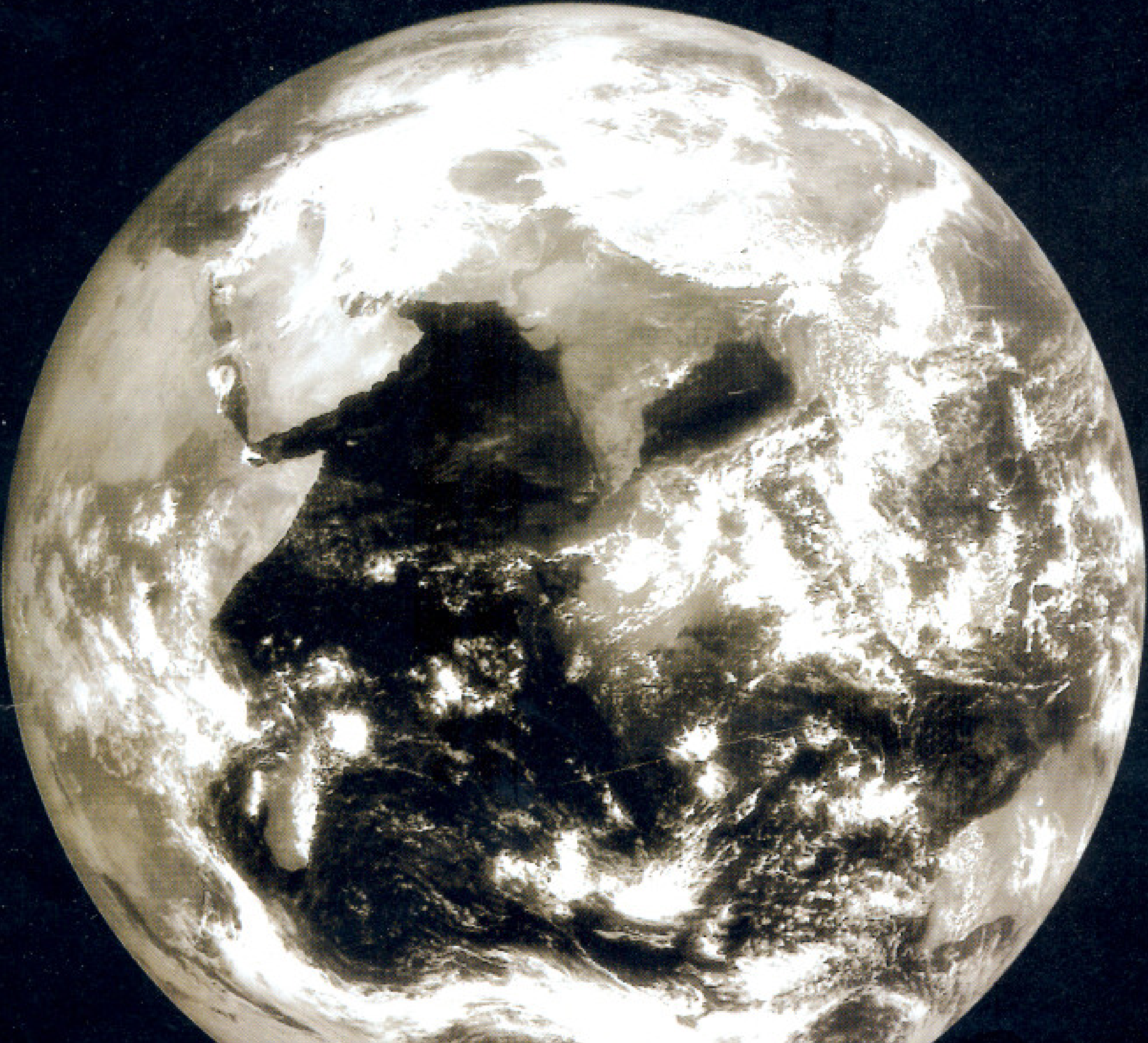
January-March 2003

SPACE india

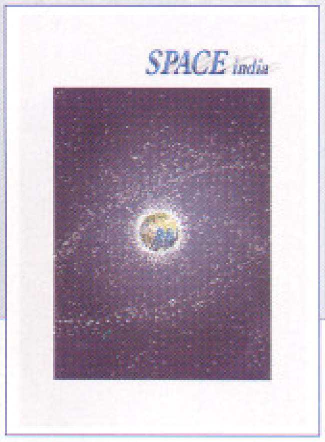
INDIAN SPACE RESEARCH ORGANISATION



Cloud cover picture taken by
India's first exclusive meteorological satellite, KALPANA-1, on March 26, 2003

SPACE india

January-March 2003



Cover Page: *No more spotless! Space Debris around our planet*

CONTENTS

Editors

S Krishnamurthy
V Sundararamaiah
Rajeev Lochan

Editorial Assistance

B R Guruprasad

*'**SPACE india**' is published by the Indian Space Research Organisation for limited circulation. Articles appearing in SPACE india may be reproduced, accompanied by the credit line "Reprinted from SPACE india" along with the date of issue.*

Editorial / Circulation Office
Publications & Public Relations Unit, ISRO Headquarters, Antariksh Bhavan, New BEL Road, Bangalore - 560 094, India. www.isro.org *Printed at: S N Process Pvt. Ltd., Bangalore.*

90TH SESSION
INDIAN SCIENCE CONGRESS
2 0 0 3

Space Summit Held in Bangalore

As a special event of the 90th Indian Science Congress, a Space Summit was organised at Bangalore on Saturday, the 4th of January, 2003.

The annual Indian Science Congress is organised by the Indian Science Congress Association, Kolkata. The 90th Session of the Congress was hosted by ISRO jointly with Bangalore University during January 3-7, 2003 at the sprawling "Jnana Bharathi" Campus of the University. The Prime Minister of India, Mr Atal Behari Vajpayee, inaugurated the Science Congress on January 3, 2003. It was befitting that this session of the Congress, which had the theme "Frontier Science and Cutting Edge Technologies", had Space Summit as the special event and the President of India, who was also associated earlier with ISRO, addressed the summit. Never before was the Indian Science Congress fortunate enough to be graced by both the President and Prime Minister.

The President of India charmed the audience with his lecture entitled "Vision for the Global Space Community: Prosperous, Happy and Secure Planet Earth", in the afternoon of January 4, 2003. His computer based colourful presentation encompassed aspects related to growth of technologies and their impact on human society and economic growth, transformation of a human society into a knowledge based society and, finally, ensuring prosperity, security and happiness for the entire humanity. The President touched upon issues like dynamics of terrorism, energy and water needs for the future generations, networking of rivers to solve the problems of drought and floods among many others. His graphic presentation convincingly argued in favour of space technology as a powerful tool for implementation of his vision for a prosperous, happy and secure planet earth. While concluding, the President advocated a "Common Minimum Global Space Mission" to address the impending human crises for energy, water and minerals and urged the Summit delegates to identify an immediate strategy to work out a fifty-year perspective for international cooperation and an action plan to move forward.

Inaugurating the Space Summit, Mrs Vasundhara Raje, Minister of State (Space) highlighted the challenges facing the country, especially in terms of population growth and pressure on national resources. She emphasised the role of space

Presidential Vision - Dr A P J Abdul Kalam addressing the Space Summit technology for shaping life on earth, even in the least developed countries. She said that India had already made significant strides in the development and application of space like establishing INSAT and IRS systems, which are now used for communication, meteorology, educational broadcast and resources monitoring. The minister underlined the Indian government's commitment to the continued advancement of space science and technology for the humanity. Stressing the need for participation by non-governmental agencies and private entrepreneurs, she called for a paradigm shift in the roles of government and industry. She expressed confidence

The Prime Minister, Mr Atal Behari Vajpayee, who inaugurated the 90th Indian Science Congress on January 3, 2003, also released a book "The Shaping of Indian Science"

that the Space Summit would provide a unique forum for the scientists, administrators, industrialists and others to exchange their views and suggest appropriate means for adopting high technology inputs into the sustainable developmental planning and to stimulate thoughts for ensuring newer applications of direct social relevance.

In a message to the Space Summit, Mr Norman P Neureiter, US Co-Chairman of the Indo-US Science and Technology Forum and Science and Technology Adviser to the US Secretary of State, referred to the common vision expressed by the US President George Bush and Indian Prime Minister Vajpayee in November 2001 to "expand and broaden dialogue and cooperation" in the area of civilian space and subsequent renewal of the Memorandum of Understanding between India and US on cooperation in earth and atmospheric sciences. He also added that, following the last year's World Summit On Sustainable Development, there is a loose global agenda for building public-private partnership to address real developmental needs in energy, agriculture, clean water, health, etc. Solutions to the challenges in each of these areas must be based on sound science and technology thus providing the Indian Science Community a special opportunity for global leadership. More importantly, space technology could take on many of these challenges directly.

Prof M G K Menon, Vikram Sarabhai Distinguished Professor of ISRO, reminisced his long association with the Indian space programme and said that it truly represents the theme of 90[th] Indian Science Congress - Frontier Science and Cutting Edge Technologies.

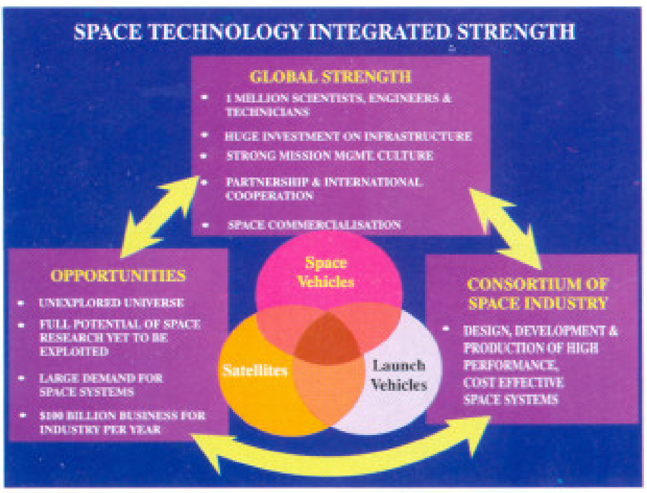
Mr Eric Cerf-Mayer, Advisor to President of French Space Agency, CNES, highlighted the European and French solutions to meet the demands for sustainable development using space technology. He highlighted the policy of CNES for a worldwide cooperation for sustainable development.

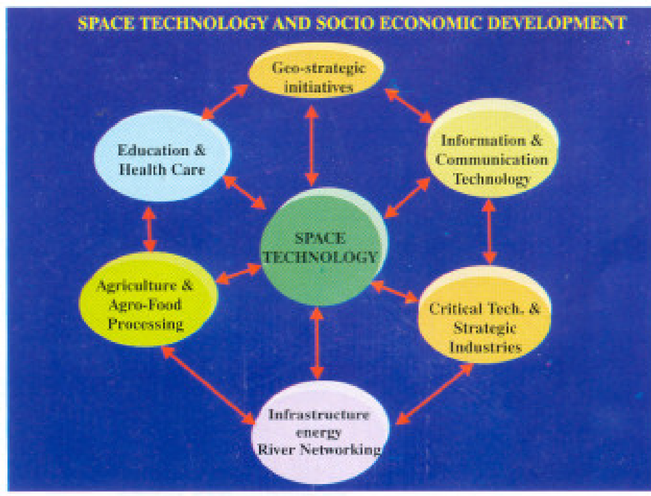
Mr Suvit Vibulshresth, GISTDA, Thailand, presented the progress made in Thailand for using satellite data, including those from Indian satellites, for optimal management of natural resources. He took pride that GISTDA has been providing high speed access to information for the government including the Prime Minister and the King of Thailand.

Dr M G Chandrasekhar of Worldspace highlighted the role of audio broadcast via Worldspace's satellites – AFRISTAR and ASIASTAR — in providing vital information to the remotest corners in Africa and Asia, enabling creation of social awareness on different aspects such as AIDS. Dr Chandrasekhar also informed that Indian classical music had gained popularity in other countries largely due to the CD quality broadcast received through Worldspace radio receivers.

Mr Sergio Camacho, Director of the UN Office of the Outer Space Affairs, Vienna, highlighted the actions taken in implementing the recommendations of the UNISPACE-III held at Vienna in July 1999. Out of the 33 recommendations, 11 are being implemented under the voluntary leadership of several countries and many others participating in their implementation. He lauded the Indian

the advanced communication satellites for the INSAT-5, INSAT-6 and INSAT-7 series, providing larger bandwidth of upto 50 GHz by 2025, DTH and theme-specific satellites such as EDUSAT and HEALTHSAT. Similar theme-specific satellites in the area of remote sensing such as AGRISAT, disaster management satellites (DM-SAT), etc, are on the anvil. Mapping, integration, information systems and knowledge extraction through the National Spatial Data Infrastructure are in various stages of evolution. In the launch vehicle technology, post GSLV-MK III launch vehicles for use beyond 2010 are also being conceptualised covering reusable launch vehicles and air-breathing technologies among many others.





The President used colourful graphics to convey his vision for space

leadership efforts in implementing the recommendation on empowering countries in the use of space for natural resources monitoring.

Chairman of ISRO, Dr K Kasturirangan, who had earlier welcomed the delegates to the Space Summit, presented his paper "Space Applications for Sustainable Development – The Vision for the Future". His lecture captured the various stages of evolution of the Indian space programme – the initiation phase of the 70's, experimental phase of 80's, operational phase of the 90's and the present expansion phase. Taking pride of the user involvement in the Indian space programme, he articulated the vision for Indian space programme for the future, especially underlining

Dr Kasturirangan also elaborated mechanisms to harness the capabilities and strength of industry, academia and relationship with the user community. Indian efforts to become a major player in the commercial space market were also dwelt upon.

Convincing demonstrations of Telemedicine on space bridge conducted by Dr Devi Shetty and also of developmental communication conducted by the ISRO on Andhra Pradesh Net, made the afternoon session a memorable event.

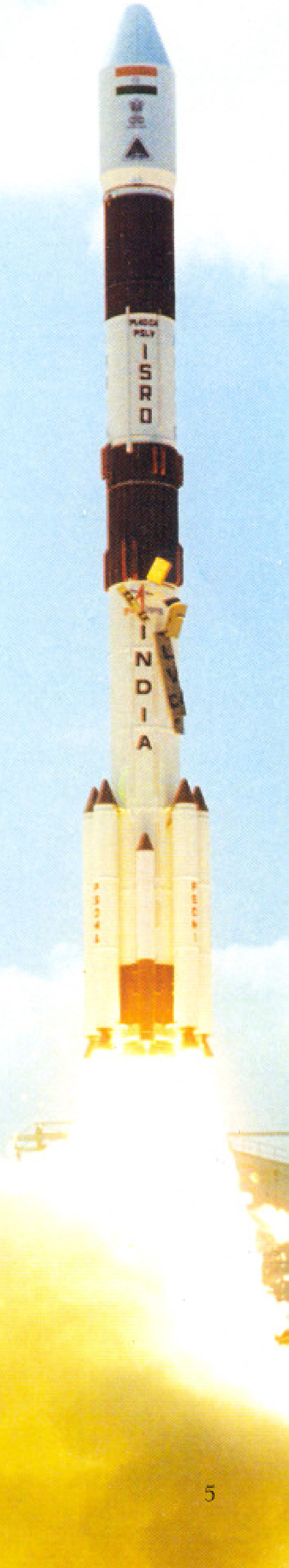
The Space Summit concluded with a befitting Panel Discussion on "Space Technology and Applications – Perspective for the Future".

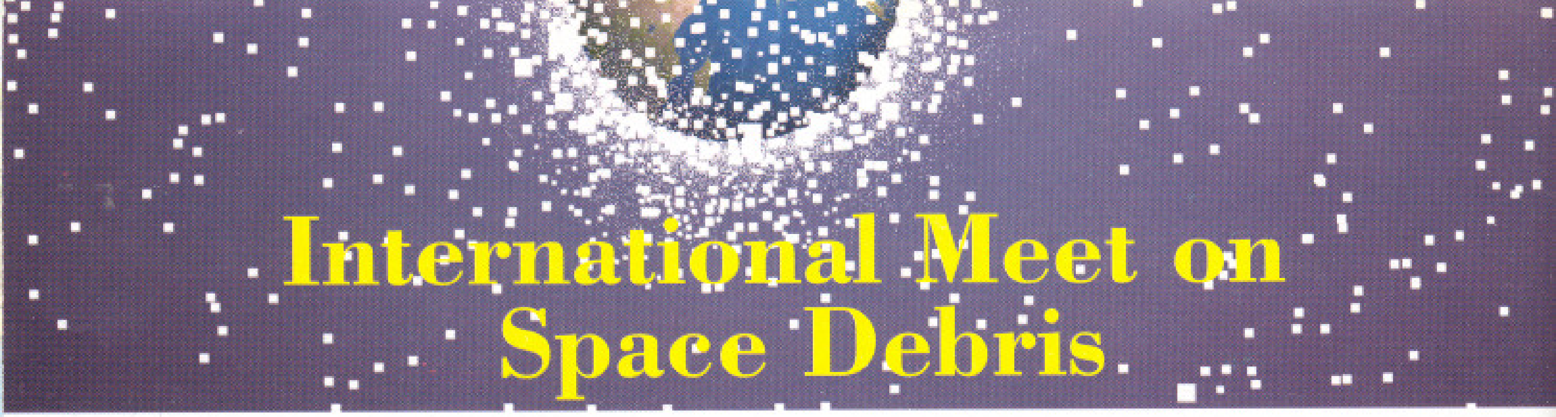
PSLV to Launch Singapore University Satellite

Antrix Corporation of the Department of Space and Nanyang Technological University, (NTU), Singapore signed an agreement on January 24, 2003, under which ISRO's Polar Satellite Launch Vehicle (PSLV) will launch X-Sat of NTU. The 100 kg class X-Sat, being developed by NTU, Singapore, is a remote sensing micro-satellite for earth observation and imaging in the visible spectral bands. The satellite will be used for land and coastal observations employing multi-spectral imaging. The three-axis stabilized spacecraft will have deployable solar panels.

X-Sat is the fifth satellite for which Antrix Corporation is providing launch service using ISRO's PSLV. The satellites launched earlier by PSLV are: PROBA of Belgium, BIRD and DLR-TUBSAT of Germany, and KITSAT-3 of Korea. Under the agreement signed, besides launching X-Sat on one of the forthcoming launches of PSLV during 2005/06, Antrix will also provide NTU with the necessary support for testing the satellite.

Launching a Relationship! Mr K R Sridhara Murthy, Executive Director, Antrix Corporation (Left) and Prof Er Meng Hwa, Deputy President, Satellite Engineering Centre, NTU, Singapore exchanging the documents after signing the contract. Dr K Kasturirangan, Chairman, ISRO looks on





International Meet on Space Debris

The 21st meeting of the Inter-Agency Space Debris Co-ordination Committee (IADC) was hosted by ISRO at Bangalore during March 10-13, 2003. International experts, including those from Indian Space Research Organisation (ISRO), deliberated upon matters of utmost international importance related to sustainable exploitation of outer space for humanity. The topics included monitoring of objects reentering the earth's atmosphere and formulation of guidelines for mitigation of problems of space debris, among many others.

The Bangalore Meet was inaugurated on March 10th by Mr G Madhavan Nair, Member, Space Commission and Director, Vikram Sarabhai Space Centre, Thiruvananthapuram. Apart from ISRO, which is playing a significant role in the IADC, experts from Italian Space Agency (ASI), British National Space Centre (BNSC), the French National Space Agency (CNES), China National Space Administration (CNSA), German Space Agency (DLR), The European Space Agency (ESA), Japan, the National Aeronautics and Space Administration (NASA) of USA, the National Space Agency of Ukraine (NSAU), and the Russian Aviation and Space Agency (Rosaviakosmos) participated in the deliberations.

IADC is an international governmental forum for the worldwide co-ordination of activities related to the issues of man-made and natural debris in space. The primary objectives of IADC include exchange of information on space debris among space agencies, facilitating opportunities for co-operation in debris research, review of the progress of ongoing co-operative activities, and identification of debris mitigation options. The IADC comprises of a Steering Group and four specialised Working Groups covering the subjects of measurements, environment and database, protection and mitigation.

Space Debris – Shouldn't We Do Something About It?

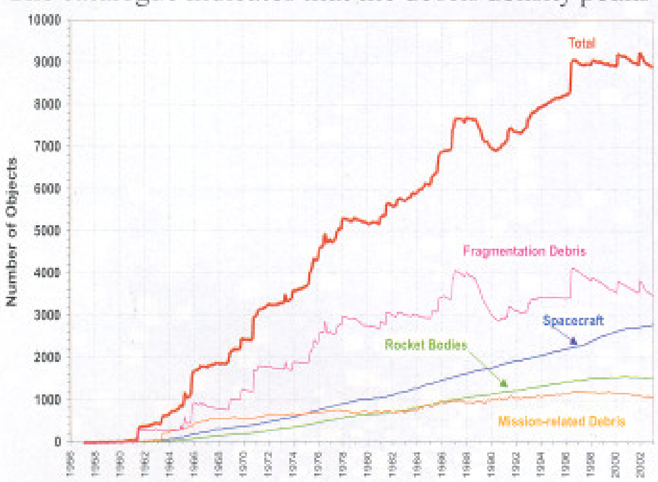
Man-made space debris has become a large and relatively lesser-explored aspect of space exploration. The origin of space debris problem coincides with the beginning of the space activity itself in 1957 when the first artificial satellite of the Earth "Sputnik-1" was launched. Since then, the ever growing man-made debris deposition in space, because of its cumulative effect, has become a major concern and is causing potentially harmful space environmental pollution.

The rapidly increasing probability of space debris colliding and damaging functional spacecraft, the distinct possibility of re-entry of large pieces of debris into inhabited areas and the debris causing interference with radio observations can become a real threat to future space activities. Within a few decades after the launch of Sputnik-1, space has become an extremely important piece of real estate holding in place a variety of satellites providing invaluable services to mankind. However, activities in the space arena are increasingly at risk due to the uncontrolled production of space debris.

Currently, more than 9000 catalogued objects are orbiting the earth. The operational spacecraft represent only 5 percent of the catalogued objects in the earth orbit. The remainder constitutes varying types of orbital debris, which essentially consists of the operational debris, deterioration debris, fragmentation debris and solid rocket motor ejects. On-orbit fragmentation is the primary source contributing to the increase in the number of catalogued objects. In the past, at least one hundred and sixty man-made satellites have broken up into smaller fragments.

This apart, there are over 80,000 pieces of useless, possibly hazardous space debris, each at least the size of a golf ball, that orbit the earth. A much larger number of objects of size one centimetre or more are in orbit as well. In addition, there are also billions of tiny pieces, such as small specks of paint. Some of these pieces eventually fall to the earth. However, more space debris is being formed than falls to the earth. Thus, the total amount of debris is continuously increasing. The problem of space debris is multi dimensional indeed.

The catalogued population is an important observable parameter for the prediction of the future state of the debris orbital environment. The catalogue indicates that the debris density peaks



Growth of Catalogued Objects

at the 800 km, 1000 km and 1500 km altitude bands, the ones which are used for remote sensing applications.

The orbital lifetime of objects is a function of atmospheric density and ballistic coefficients. Satellites in circular orbits at altitudes in the 200-300 km range re-enter the atmosphere within a few months. At 400-900 km orbital altitudes, orbital lifetime ranges from a few years to hundreds of years depending upon the mass and area of satellites. The contributions to the present debris environment continue to be essentially proportional to the level of space activity by space faring nations.

The measurement and modeling of the space debris environment is very complex and uncertain. A good share of our present understanding of the phenomenon of creation and evolution of debris, particularly the small-sized debris, is enabled by the mathematical models relating to fragmentation and collision, *in-situ* measurements, and laboratory experiments – largely due to the limitations of the ground based radar and optical sensors used for tracking tiny objects.

Thus, mathematical modeling plays the bridging role in characterizing the debris environment between the trackable and the untrackable population. The models being developed have limitations depending upon the underlying assumptions made and the approaches adopted.

Orbiting space debris can very easily collide with the Space Shuttle, Space Stations and artificial satellites disturbing vital services. Most of the smaller pieces originate from the explosions of satellites in near earth orbit. Even debris of the size of a thumbtack can be dangerous. If a piece of metal which is of the size of a thumbtack orbiting the earth at 28,000 km per hour collides with a space shuttle that is moving with the same speed in the opposite direction, a substantial amount of damage can occur. Obviously, even greater damage can occur if the object is larger. In addition, the dangers to space walk could increase since even microscopic pieces of debris might have enough momentum to puncture a space suit.

A good percentage of debris is yet untracked and is hazardous to operational spacecraft. Of those which are tracked, removal strategies through active means are still inadequate and prohibitively expensive. Therefore, shielding of spacecraft can constitute a useful strategy not only to protect the active spacecraft but also to reduce the creation of further debris. Collision of any of these objects with an operational spacecraft may lead to damage or even its functional loss because of the large amount of kinetic energy involved.

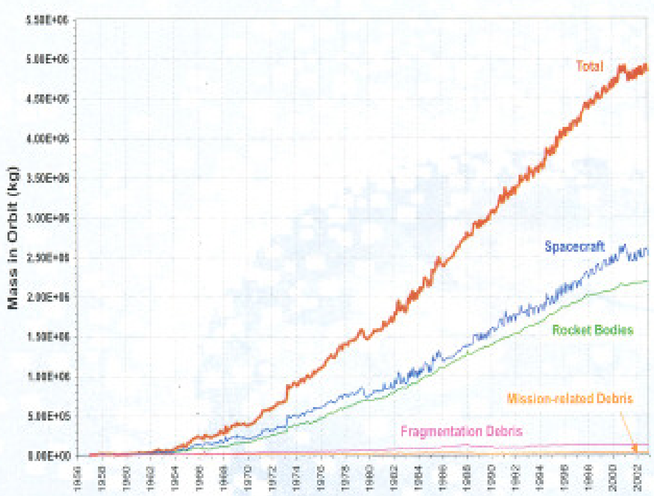
The evolution of the orbital debris environment cannot be precisely predicted due to the possibilities of increased launch rates by a growing number of space powers, especially in light of new *smallsat* technology and the advent of constellations of satellites for communication applications in the low earth orbits. The uncertainty in the future environment is also increased by the uncertainty in the frequency of future explosions and collisions. A collision between two objects may result in the creation of numerous fragments whose number and size depend on a variety of factors, such as mass of colliding bodies and collision velocity.

Mean Time between impacts on satellites with Cross-section area of 100 square meters

Orbital Altitude (km)	Objects 0.1 – 1 cm	Objects 1- 10 cm	Objects > 10 cm
500	1-10 years	350-700 years	15,000 years
1000	0.3-3 years	70-140 years	2,000 years
1500	0.7 - 7 years	100-200 years	3,000 years

Space operations at certain altitudes will be severely hampered due to the present use of communication satellites in the low earth orbits, adding another dimension to the problem. Multi-satellite constellations clustered in narrow altitude bands may be more sensitive to population densities leading to collisions and breakups.

The individual satellite system designers and operators need to pay careful attention not only on how to deploy, operate and dispose at the end of a satellite mission but also on the actions of other users in neighboring regions of space. Options like passivating the spent rocket stages, de-orbiting spacecraft at the end of useful mission life, re-orbiting of geosynchronous satellites and others are being implemented by space-faring nations as part of their national mitigation policy.



Satellite Mass in Earth Orbit

ISRO launchers, PSLV and GSLV, passivate their last stages after injecting the spacecraft into the orbit. Also, no operational debris are deposited in space. Close approach study between active spacecraft and space debris are routinely carried out at Master Control Facility and ISTRAC. In the design of Geostationary spacecraft, adequate margins are planned for re-orbiting the spacecraft at the end of their mission life.

Today, nations, which are active in using space, are focusing their attention towards improving the debris detection capability. Some are planning to fly debris detectors in their spacecraft for a better understanding of the small-sized debris population. At the same time, the modeling efforts are aimed at synthesizing the work carried out by various agencies with a view to evolve a universally acceptable standard debris environment model. The hyper-velocity impact tests, now being conducted, are yielding results, which are supplementing the modeling and spacecraft shielding studies.

Mitigation measures, particularly the preventive steps being adopted by various nations, seem to be holding the center-stage of discussions at the Committee of Space Research (COSPAR), International Academy of Astronautics(IAA), International Astronautical Federation(IAF), Inter-Agency Debris Coordination Committee(IADC) and other fora in which "space debris" is identified as a topic worthy of a separate session.

These days, the problem of space debris has become more serious than many people would like to believe. The continued use of space for remote sensing, communication, navigation, meteorology and a host of other applications dictate the need to preserve the space environment within reasonable risk levels. There are a few ways to attempt to solve this growing problem. Mankind can live with the problem or attempt to solve it completely. The best choice is to solve this problem with a judicious combination of both ideas. That is the only way we can hope to solve this highly underestimated difficulty and make the space environment safe for future generations too.

It is clear that all space faring nations, in their own interest, have to focus their attention on evolving adequate preventive measures to minimize the space debris hazard and also to agree upon appropriate national/international codes for ensuring the safety of future space activities.

(This article was contributed by A.S. Ganeshan, Flight Dynamics Division, ISRO Satellite Centre, Bangalore).

ISRO and Canadian Space Agency to Strengthen Co-operation

ISRO signed a Memorandum of Understanding with the Canadian Space Agency (CSA) on March 27, 2003 reaffirming pursuit of international space cooperation for peaceful purposes while working towards economic and social development of both countries. The MOU was signed by Dr K Kasturirangan, Chairman, ISRO, and Dr Marc Garneau, President CSA at Antariksh Bhavan, the Headquarters of ISRO in Bangalore.

On the occasion of signing the agreement, Dr Kasturirangan said that India and Canada shared common needs for telecommunications, meteorology, disaster warning as well as natural resources management and environmental monitoring. Dr Garneau appreciated the scope and breadth of India's space programme and noted that the Memorandum layed the framework for continuing cooperation in projects and activities in which ISRO and CSA shared a common interest. The Memorandum will foster the study of cooperative programmes in satellitecommunications, satellite remote sensing and space science as well as encouraging cooperation in the exploration and use of outer space by the private sector and academia in both countries.

Both the agencies also signed a letter of intent referring to several projects and activities in which they have a joint interest. These could include: the possible participation in a Moon Orbiter mission, an agreement for providing mutual support for telemetry, tracking and command operations for satellites, Canadian support for the United Nations Centre for Space Science and Technology Education which has been set up by India at Dehra Dun and; collaboration in development of scientific instruments that could be flown on Indian satellites.

Reinvigorating relationship - Dr K Kasturirangan, Chairman, ISRO and Dr Marc Garneau, President, CSA signing the MOU

The Canadian Space Agency (CSA) was established in 1989 with its headquarters in Saint-Hubert, Quebec. CSA co-ordinates all aspects of the Canadian space programme. Through its space knowledge, applications and industry development business line, the CSA delivers services involving earth and the environment, space science, human presence in space, satellite communications, space technology, space qualification services, space awareness and education. The CSA is at the forefront of the development and application of space knowledge for the benefit of Canadians and the humanity.

Dr Marc Garneau, President CSA, is an astronaut and he has flown three times on US Space Shuttle - in 1984, 1996 and in 2000. During his visit to Bangalore, Dr Garneau shared his space flight experience during an interview by four students of Bangalore University. The interview was telecast by the Indian national television, Doordarshan.

An ISRO-CSA workshop was also organised on March 25, 2003 in which about 60 experts from ISRO and the Canadian Space Agency including representatives of their industries participated. The workshop was presided over by Dr Kasturirangan and Dr Mark Garneau. Two parallel sessions prominently featured the developments undertaken by both the space agencies in remote sensing and satellite communications. The application programmes of ISRO in the field of remote sensing were widely acclaimed by CSA. The satcom projects in the area of telemedicine and disaster management and the lead taken by the CSA in this were also highlighted. The one-to-one meeting between Indian and Canadian industries outlined further action needed for identifying future commercial possibilities for the benefit of both the sides.

Cherishing the memory of Kalpana Chawla

— ISRO Satellite Named as Kalpana

In a solemn function held at the Parliament House on February 5, 2003, Prime Minister Mr Atal Behari Vajpayee named METSAT, India's first exclusive meteorological satellite as KALPANA-1 in the memory of Dr Kalpana Chawla, the Indian born American Astronaut killed in the US space shuttle Columbia disaster on February 1, 2003. KALPANA-1 was launched by ISRO's Polar Satellite Launch Vehicle in its seventh flight (PSLV-C4) on September 12, 2002.

Addressing the august gathering, Mr Vajpayee expressed the hope that February 1, the day of the disaster, would be fittingly observed to immortalise the spirit of adventure she symbolised. The Vice President, Mr Bhairon Singh Shekhawat, suggested that Kalpana's biography be published and her saga included in school syllabus, so that her sacrifice can inspire successive generations. The Lok Sabha speaker, Mr Manohar Joshi, recalled that each year, Kalpana used to facilitate visits of our students to the National Aeronautics and Space Administration. The leader of opposition Mrs Sonia Gandhi, said that Kalpana's achievements have captured the imagination of the entire country and it epitomised the spirit of adventure. While paying an emotional tribute to Kalpana, the first space traveller from India, Mr Rakesh Sharma, said that even in death, Kalpana and her six astronaut colleagues had worked to make space travel safer in future. Dr K Kasturirangan, Chairman, ISRO, said that India's entire space community expressed its grief on the demise of Kalpana and her six colleagues. He was convinced that she had fired the minds of a new generation and that was her gift to India. Earlier, the Minister of Parlimentary Affairs, Mrs Sushma Swaraj, formally began the proceedings by inviting the dignitaries to offer floral tributes to Dr Kalpana Chawla.

Dr Kalpana Chawla, who was killed with six other astronauts in the Columbia disaster, was born in Karnal, Haryana. An ardent aviation enthusiast from childhood, Kalpana graduated in Aeronautical engineering from the Punjab engineering college. Later, she went to the United States and obtained her Masters and Doctoral degrees in Aerospace engineering from the University of Texas and the Colorado University, respectively.

While in America, she devotedly took up glider and aeroplane flying activities and became a licenced flying instructor. Her daring nature made her to take up aerobatic stunts too. Kalpana persevered a lot to pursue her lifelong interest in aviation. She took up American citizenship and married Jean Pierre Harrison, himself a flying instructor.

Kalpana's tryst with the American space programme started in 1988 when she worked for the NASA's Ames Research Centre in the area of powered lift computational fluid dynamics. Later, she served briefly in a California based private company as its vice president and research scientist.

The career of an Astronaut was a natural destination for Kalpana's unbridled enthusiasm for aeronautics and astronautics. When the opportunity arose, she applied for that NASA position and got selected in December 1994 amidst tough competition.

Kalpana's first sojourn to space occurred in November 1997 and when she was part of a crew of six astronauts in the space shuttle, Columbia. During that microgravity mission (STS-87) lasting more than two weeks, she, as mission specialist and prime robotic arm operator, performed many experiments in the weightlessness of space. She orbited the earth 252 times and thus travelled 10.5 million kilometers thereby logging 377 hours in space. She returned to earth safely along with her astronaut colleagues on December 5, 1997.

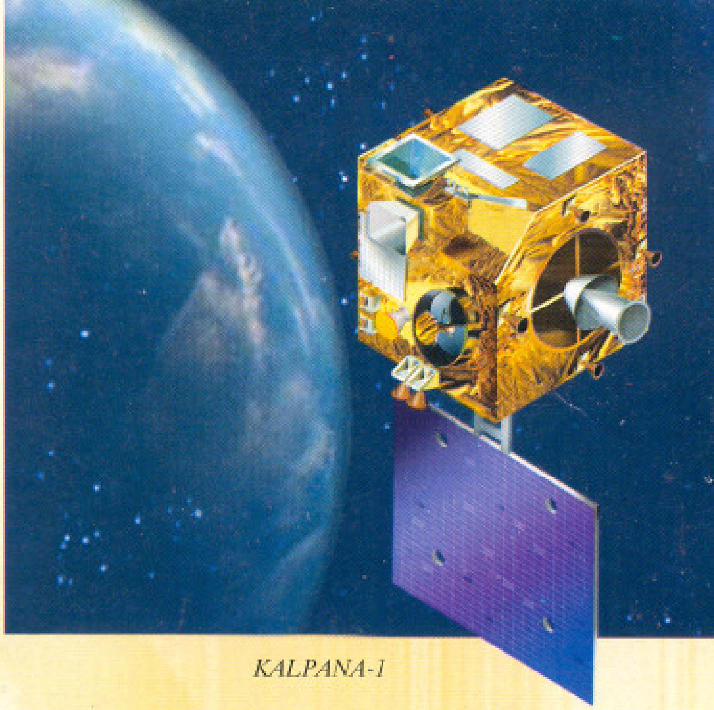
Kalpana's second spaceflight mission started on January 16, 2003 in Columbia, the same space shuttle orbiter in which she had travelled earlier. The next

The Vice President Mr Bhairon Singh Shekhawat (left) and the Prime Minister Mr Atal Behari Vajpayee paying homage to Dr Kalpana Chawla

sixteen days of the mission were almost uneventful. Kalpana and her colleagues performed many experiments related to the behaviour of various materials and organisms in the environment of weightlessness.

On February 1, 2003, they were in an elated state expecting their return to earth that very day. After a perfect de-orbit burn, Columbia reentered the Earth's atmosphere as scheduled. But, at an altitude of 63 kilometers and a velocity of 20,000 km/hr, Columbia disintegrated killing Kalpana and her six colleagues.

The entire world mourned the death of those seven brave astronauts. A state of shock pervaded all over



KALPANA-1

India at the death of Kalpana who is much admired for her single minded determination and perseverance in achieving her career goals. In this very special context, India decided to name METSAT as KALPANA-1.

KALPANA-1 is stationed at 74 deg East longitude in the 36,000 kilometer high geo-stationary orbit. The 1050-kg satellite is providing valuable weather pictures through its Very High Resolution Radiometer (VHRR). VHRR is capable of imaging the earth in the visible, thermal infrared and water vapour bands of the electromagnetic spectrum. KALPANA-1 also carries a data relay transponder, which receives the meteorological data from automatic data collection platforms and relays the same to the Meteorological Data Utilisation Centre at Delhi.

Thus, the satellite serves to perpetuate the memory of Kalpana who sacrificed her life to the cause of peaceful uses of outer space.

Second Master Control Facility to be Set up at Bhopal

At a function held in Bhopal on February 18, 2003, the Chief Minister of Madhya Pradesh, Mr Digvijay Singh, laid the foundation stone for the second Master Control Facility of ISRO that will complement the primary Master Control Facility at Hassan in Karnataka. Master Control Facility (MCF) is a Unit of ISRO that operates, controls and maintains all the satellites of ISRO located in Geo-Synchronous Orbit (GSO) and at present it controls seven satellites. With ISRO planning to launch six more satellites into GSO in the next two to three years, the augmentation of the primary MCF with the second Master Control Facility at Bhopal assumes significance.

The Indian National Satellites (INSAT) are used for telecommunication, television broadcasting, meteorology and disaster warning. They are placed in the GSO, about 36,000 km above the earth. India has six orbital slots where these satellites are positioned. MCF carries out satellite station keeping operations, their management during earth's eclipse, configuring the payloads to meet user requirements and tracking and ranging. When commissioned, MCF-Bhopal will help in these operations. Initially, MCF-Bhopal will be configured with capability to monitor and control three satellites.

MCF-Bhopal will mainly consist of: Satellite Control Centre; Telemetry, Telecommand and Tracking Earth Stations; Computer Systems and other electronics to process the satellite data; Communication links with MCF-Hassan and ISRO Centres at Bangalore; Power Station capable of providing uninterrupted power to the Facility and Captive Power generation systems. MCF-Bhopal will be established in a 45 acre land. The construction of the buildings will be carried out by Madhya Pradesh Housing Board. The Master Control Facility-Bhopal is expected to be commissioned in the first half of 2004.

Mr Digvijay Singh, Chief Minister, Madhya Pradesh, addressing the gathering

Insat-3A Launched

Insat-3A was successfully launched on April 10, 2003 by the European launch vehicle Ariane-5

Model of Master Control Facility to be set up at Bhopal