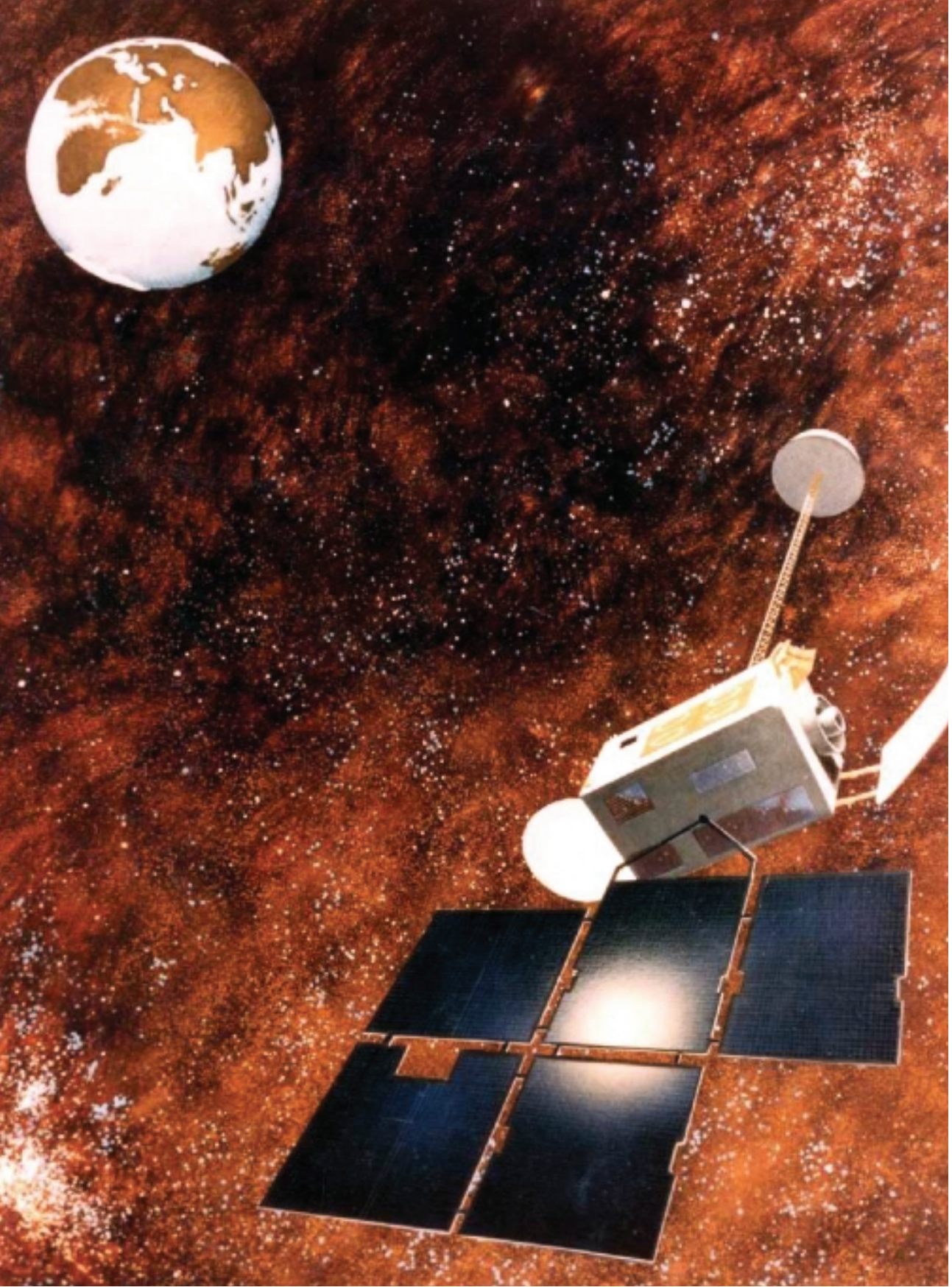


INSAT-1D, the fourth satellite in the Indian National Satellite system, was designed, built and delivered by Ford Aerospace for India's Department of Space

SCIENCE

A BRAVE NEW WORLD

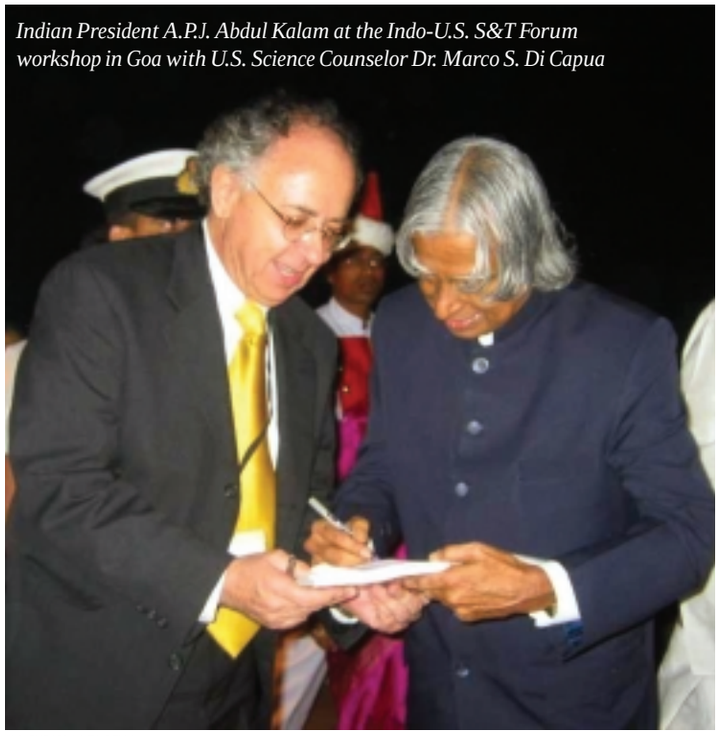
It can be said that the field of science is developing into a North Star for the U.S.-India bilateral relationship. Based on a shared belief in the power of science to enhance relations and improve the quality of life for many of their citizens, the U.S.-India Bilateral Science and Technology (S&T) cooperation is moving the two countries toward expanded engagement in energy, space and trade. In January 2004, President Bush stated that "The vision of U.S.-India strategic partnership that Prime Minister Vajpayee and I share is now becoming a reality." He also said that, "the expanded cooperation launched today is an important milestone in transforming the relationship between the United States and India. That relationship is based increasingly on common values and common interests."

The U.S.-India partnership in science extends back nearly 50 years, and while the bilateral relationship in science has had both high and low points, collaborative initiatives are once again gaining momentum. The U.S. and India presently collaborate in areas as diverse as genomics, agricultural and medical biotechnology, nanoscale science and engineering, weather forecasting, basic research, and information technology. The most critical and enduring result of this cooperation is the development of mutually beneficial science. Through an exchange of knowledge, the two countries share a platform, support innovation and facilitate the creation of cutting-edge technologies.

A recent high point in the long history of U.S.-India scientific interactions was the establishment of the Indo-U.S. Science and Technology Forum in New Delhi, which occurred during President

Clinton's visit to India in 2000. The Forum is funded by approximately Rs. 31.95 crore ($7.1 million) which was presented by then U.S. Ambassador Richard E. Celeste. The operational budget of the Forum includes annual interest earnings of the endowment, matched each year by the Government of India, and earnings and contributions received from non-governmental sources. Today, the Forum is a catalyst for the productive exchange of scientific ideas and for the exchange of scientists in collaborative research projects, capacity building and technology transfer.

The heartbeat of the U.S.-India relationship in science has always been, and continues to be, the ebb and flow of ideas and people that transcend any temporary interval of inactivity. In addition to cooperation on the governmental level, scientific collaboration and exchanges between individuals, scientists, and private-sector businesses are powerful drivers of the bilateral relationship. And it is in this realm of people-to-people contacts where students and post-doctoral fellows are leading the way.



Indian President A.P.J. Abdul Kalam at the Indo-U.S. S&T Forum workshop in Goa with U.S. Science Counselor Dr. Marco S. Di Capua

U.S. EMBASSY, NEW DELHI

Indian Americans have played a key role in pushing U.S.-India ties in the scientific field. The unveiling of the draft human genome sequence in 2001 by the National Institutes of Health and Celera Genomics, a private biotechnology company, showcased team efforts which included several scientists of Indian origin, like G. Subramaniam of Celera and R. Koul of the University of Washington. Another example of an Indian American leader in the field of science is Haren Gandhi, a Ford Motor Corporation technical fellow, who received the National Medal of Technology in 2003 for substituting palladium for platinum in catalytic converters. Gandhi also advises the Ford Company in India to develop emission control systems for local and export markets.

An example of U.S.-India ties in aviation is Ajay Kumar of Meerut, an Indian origin scientist and member of the NASA Langley Research Center team, who worked on the successful hypersonic flight of an integrated scramjet propelled vehicle. Ajay Kumar went to the U.S. in 1975 as a National Research Council Associate at NASA and stayed on to participate in the XL-43A design that cruises at Mach-7 speed of about 8,260 kilometers per hour.

USEFI

Indo-U.S. S&T Forum has offices in USEFI's historic Fulbright House in Delhi

INDO-U.S. S&T FORUM

THE SCIENCE OF COOPERATION

THE FORUM PROMOTES U.S.-INDIA INTERACTION IN SCIENCE & TECHNOLOGY AT VARIOUS LEVELS

The Indo-U.S. Science and Technology Forum, otherwise known as the "Forum," is housed in a shady oasis at 12 Hailey Road, not far from the historic step well of Uggar Sain's Baoli. With enormous pride, the Forum shares this campus with the United States Education Foundation in India (USEFI) and while USEFI attends to education and academic pursuits in the social sciences, the Forum facilitates and promotes interaction between the U.S. and India in science and technology on government, academia and industry levels. The Forum focuses on issues of common concern and activities of mutual benefit, while exploring trends in science and technology.

One of the Forum's major activities is the support of joint workshops in both countries regarding the conception phase of new areas of science and technology. Since its inception to April 2004, 35 such symposia have been held. Some of the interest areas include Indian Ocean ARGO floats, Nanotechnology, Brain Research, Weather and Climate Modeling, Cancer Networking, Arsenic Contamination and Genotoxicity, Eco-Informatics, Digital Library, Traditional Medicine, Green Chemistry, S&T to counter Terrorism, Biotechnology, Renewable Energy Sources and so on. Other major activities include exchange visits of scientists, in order to promote joint research and development projects, capacity building, and database creation on various aspects of S&T.

The Forum is now in the process of enhancing industry participation, paving the way for an active academia-public-private partnership aimed at generating innovation. The Forum hopes to grow through common interests sustainable through time, and develop scientific entrepreneurship and leadership. Ideas conceived today could mature into the dream of a jointly endowed U.S.-India Binational Science and Technology Foundation to cater to the development of new ideas in the S&T communities of both countries.

MEDIA VISION

Thanks to a U.S. satellite, 2,330 remote villages in India were introduced to television

SPACE COOPERATION

The U.S. and India enjoy an old and important partnership in space cooperation. In 1962, prior to being involved in the Equatorial Rocket Launching Station at Thumba, A.P.J. Abdul Kalam, who is now President Kalam, undertook a six-month NASA training program on sounding rocket launch techniques. On his return, President Kalam participated in India's first rocket launch in November of 1963, with a NASA-made Nike-Apache rocket. This was the first of four NASA rockets launched from Thumba. Following this, with Vikram Sarabhai at the helm of the Indian Space Program, India's dream of building an Indian Satellite Launch Vehicle was begun.

In terms of space-based communications, the Satellite Instructional Television Experiment (SITE), signed with NASA in September of 1969, was the world's first large-scale TV broadcasting experiment. The SITE project, with the reposition and use for one year of NASA's ATS-6 satellite, spearheaded a revolution in broadcasting. At the time, about 2,400 villages spread across India could access TV broadcasts either through direct reception or by All India Radio-TV transmitters linked via an earth station facility.

On the initiative of Sarabhai, a joint study was conducted in the 1970s with the Massachusetts Institute of Technology for the design of the Indian National Satellite System (INSAT). This laid the groundwork for future INSATs. The INSAT system serves the telecommunications sector, and provides very small aperture terminal (VSAT) and mobile satellite services. Today, INSAT has facilitated television broadcasting through more than 1,000 terrestrial transmitters, providing TV access for at least 850 million people in India. INSAT has also helped in improving meteorological services, such as cyclone warning. Of the INSAT series, the INSAT-1 satellites were made in the U.S. and the INSAT-2 series were designed and built in India.

And it is important to note that U.S.-India cooperation in space sciences extends to the private sector as well, as the Indian space fraternity has established commercial space links with NASA and U.S. aerospace companies. This led to the building of complex communication satellites in the early days of the evolution of the Indian space effort. The old bond is being renewed with the forthcoming Joint Space Conference on Space Science, Applications, and Commerce to be held in Bangalore in the summer of 2004. The co-organizers are the Astronautical Society of India and the American Institute of Aeronautics and Astronautics. In January 2004, President Bush spoke of the next steps in implementing a shared vision for science, including "ways to enhance cooperation in peaceful uses of space technology" and "steps to create the appropriate environment for successful high technology commerce." Thus, the space conference will be another important step in setting the pace for expanded U.S.-India cooperation in science.

EARTH AND ATMOSPHERIC SCIENCES COOPERATION

India is vulnerable to disasters such as earthquakes, landslides, floods, drought, cyclones and industrial accidents. In the period from 1993 to 2002, approximately 78,000 people were killed, and nearly 800 million were affected by natural disasters. This vulnerability has only increased due to population growth, poor natural resource management and the development of human settlements in hazard-prone areas. In an effort to predict and prevent the catastrophe caused by these natural events, the sharing of information and technology for disaster management systems, especially in the areas of climate forecasting systems, earthquake safety and disaster initiatives, has become a crucial element of the bilateral partnership.

IINDIAN SPACE RESEARCH ORGANIZATION 2004

Scientists at the ISRO Satellite Assembly facility in Bangalore use U.S.-made equipment to test circuits for EDUSAT

In the mid-1980s Indian scientists made extensive use of NASA's Landsat and the National Oceanic and Atmospheric Administration (NOAA) satellite data for

natural resources survey and management. India also used data from NOAA series satellites for drought monitoring and for the creation of a Vegetation Index Map. Under a mid-1990's commercial agreement with a U.S. company, data from the Indian Remote Sensing Satellite (IRS) was used for the reception and marketing of IRS data worldwide. More recently, ANTRIX Corporation Ltd., the commercial arm of the Indian Space Research Organization, has established long-term contracts with U.S. companies.

A solar telescope, installed in 1995 at the Udaipur Solar Observatory through an international program called the Global Oscillations Network Group (GONG), was sponsored by the National Science Foundation and coordinated by the National Solar Observatory, USA. This telescope yields digital solar velocity images once every minute and full disc magnetograms every hour, as a probe to the solar internal surface.

Today, an MoU exists for scientific cooperation in earth and atmospheric sciences. The MoU was first signed in December 1997 and was extended in 2002 for another five years. The MoU has been signed between the Department of Space and the Department of Science and Technology on the Indian side and with NASA and NOAA on the U.S. side.

NUCLEAR SCIENCE COOPERATION

In the 1960s, Homi Jehangir Babha believed that, in order to develop India's nuclear program, the country would need to gain experience in operating nuclear plants. Then U.S. Ambassador to India, J.K. Galbraith, convinced the Indian Atomic Energy Commission to allow USAID to bear some of the cost for a boiling water reactor nuclear power plant at Tarapur, built by General Electric and Bechtel Engineering. The Tarapur reactors became the first two reactors in Asia to deliver electric power. The U.S. and India signed a nuclear cooperation agreement in 1963, which lapsed 30 years later in 1993.

NRC Chairman Meserve (left) with Indian officials at the Bhabha Atomic Research Centre

DEPARTMENT. OF ATOMIC ENERGY, GOVT OF INDIA

The scope of civilian nuclear cooperation in the area of nuclear safety is a consequence of the discussions between President Bush and Prime Minister Vajpayee in November 2001. The U.S. Nuclear Regulatory Commission (USNRC) and the Indian Atomic Energy Regulatory Board (AERB) are involved in the dialogue. Richard Meserve, Chairman of NRC, visited India in early 2003. This was the first time in five years that a senior U.S. Government official had come to India to discuss civil nuclear cooperation. Meserve visited the Tarapur Atomic Power Station, which still bears the USAID logos, and the Bhabha Atomic Research Center (BARC), and met with officials of the Department of Atomic Energy, the AERB and the Nuclear Power Corporation of India Limited (NPCIL).

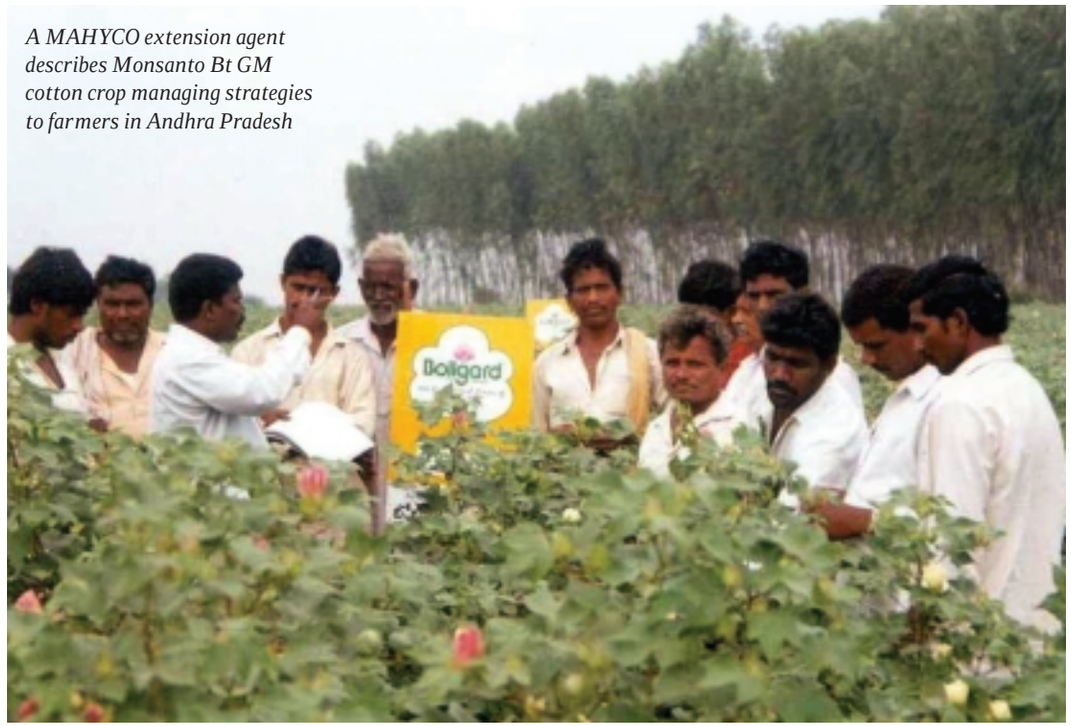
This exchange continued when, during the 2nd NRC-AERB Nuclear Safety Projects Meeting in September 2003, an Indian delegation visited the National Institute of Standards and Technology, the University of Maryland, and the Surry Nuclear Power Plant. The most recent meeting was held in early 2004, in Mumbai, and helped to further strengthen the dialogue between the U.S. and the Government of India's independent nuclear regulatory agencies on nuclear safety issues, such as license renewal, aging and fire safety. This was followed by an NRC technical team visit to the Madras Atomic Power Station (MAPS) near Chennai. The team recieved an overview of how the NPCIL has addressed fire protection and seismic concerns in MAPS.

LIFE SCIENCES COOPERATION

The first U.S. patent for a living organism was given to Ananda Mohan Chakravarty, a scientist of Indian origin. The patent dealt with genetically modified bacteria and was granted on grounds of inventiveness and novelty.

The Department of Science and Technology-U.S. National Science Foundation (DST-NSF) Science and Technology Cooperation Program has several ongoing projects, including life sciences. Life science projects cover the study of areas such as fungi, bacterial haemoglobin, gene products, ligand interactions with DNA, microbe-mineral interactions useful in environmental control, fauna of

MAHYCO MONSANTO BIOTECH INDIA LIMITED



A MAHYCO extension agent describes Monsanto Bt GM cotton crop managing strategies to farmers in Andhra Pradesh

KALPANA CHAWLA

AMONG THE STARS

A SMALL-TOWN INDIAN GIRL BECAME THE FIRST INDIAN AMERICAN TO GO INTO SPACE. KALPANA CHAWLA HAS BECOME AN INSPIRING SYMBOL OF INDO-AMERICAN SCIENCE LINKS.

The word "Kalpana" means dream or imagination in Hindi. It is a fitting name for an ordinary young woman from small-town India who dared to dream about the seemingly impossible, and had the courage and imagination to follow those dreams. Those dreams led her to the U.S. Her short, eventful life as the first Indian-born NASA astronaut inspired millions in both her native and adopted homeland to literally reach for the stars.

Born in 1961, the youngest of four children in a traditional middle class family in Karnal, Haryana, she had every reason to lead a typical middle class Indian life. She chose not to. In an intensely male-dominated society, she opted to study aeronautical engineering then defied family pressure and went to the U.S. to pursue her ambition. Her thesis advisor at the University of Texas, Arlington recalls that, "she just refused to take no for an answer."

This dogged determination, combined with a passion for her work, took her much further than a Masters and Doctorate in aeronautical engineering. It led her to a series of firsts: the first Indian American and the first Indian woman to fly in space. But while her ambition was single minded, her mind was far from uni-dimensional. She was a talented Bharatanatyam dancer who enjoyed flying, hiking, backpacking, and reading. Her choice of music on her last flight aboard the space shuttle Columbia reflected the ease with which she embraced and absorbed the best of east and west, Thelonius Monk and Steve Vai competed for space with Ravi Shankar, Hari Prasad Chaurasia and Nusrat Fateh Ali Khan.

In 1994 NASA selected Kalpana Chawla for a rigorous, one-year training program to serve as a mission specialist on board shuttle missions, one of the most coveted positions for anyone harboring plans of being an astronaut. A successful 16-day space mission in 1997 made her a natural choice for the ill-fated trip on the space shuttle Columbia in February 2003. "I'm a citizen of the milky way," Kalpana Chawla once said. Now she is at home there, with the stars.

In February 2003, Indian Prime Minister Vajpayee, on behalf of the Indian Government, renamed the METSAT satellite as the Kalpana satellite in recognition and honor of Kalpana's contributions to space. The Kalpana series comprise India's first exclusive meteorological satellites.

COURTESY: NASA

Kalpana Chawla is a role model for many budding astronauts

Kutch, the origin of whales, salinity stress in rice and the study of transgenic plants.

Since its inception, the Indo-U.S. S&T Forum has supported workshops in life sciences and health. Brain research, cancer networking, biodiversity evaluation and conservation, arsenic contamination and genotoxicity, agricultural biotechnology, eco-informatics, functional genomics, traditional medicine, molecular toxicology and health, green chemistry and infectious disease R&D are just some of the areas covered.

NANO TECHNOLOGY AND MATERIALS SCIENCE

There is great potential for future cooperation between the U.S. and India in the area of nanotechnology. By manipulating atoms and molecules as building blocks, nanotechnology creates surfaces, devices and even systems with desired functional properties in scales a thousand times smaller than 1/40 of the diameter of the human hair. The U.S. has made big strides, both in research and on the business front, in the area of nanotechnology and has several nanotechnology companies in operation. However, in India, this field is still at a relatively early stage of development and few commercial enterprises have been established. Important areas of nanoscience that have the potential for increased collaborative initiatives are nanostructures and ensembles, nanoscale assemblies, nanoscale device development, nanomanufacturing, integration of nanoscience and biology, nanoelectronics and nanotechnology in the domain of earth and planetary sciences. In order to help further development in many of these areas, the Department of Science and Technology of the Government of India will invest Rs. 90 crore ($20 million) over the next five years for the Nanomaterials Science and Technology Initiative.

The Indo-U.S. S&T Forum sponsors and facilitates many bilateral exchanges in the nanoscience area. In 2001, a nanotechnology workshop was held in Santa Barbara. At Thanjavur, two workshops have been held, one in Nanocomputing in 2001 and the other in Nanotechnology and Health Care in 2003. Two additional conferences in nanotechnology were held in late 2003 and early 2004 in Chandigarh and Bhubaneshwar.

Nanotechnology has enormous market potential, particularly due to the increased need for portable systems for the agricultural and medical sectors and energy generation, storage and distribution initiatives. These joint scientific U.S.-India exchanges provide a platform for opportunities and developments in this important new area of science.

Space and civilian nuclear cooperation will leap forward with the implementation of the Next Steps in Strategic Partnership (NSSP), announced in January, 2004. The agreement provides for expanded cooperation in civilian nuclear energy, civilian space cooperation and high technology trade. And expectations in India and the U.S. are high, in the hopes that the implementation of the NSSP will bring back the glory days of pioneering space and nuclear cooperation.