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U.G. Convocation Address at IIT Kanpur

Space Technology in India-The emerging Frontiers

BY

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on

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I deem it my proud privilege to be part of this momentous event, and to deliver the 46th convocation address of this great Institution. I am fascinated by the illustrious array of alumni who have made a difference to this motherland through their pioneering contributions. They made the brand IIT Kanpur, something which every young person in the country would and should cherish. I take this opportunity to offer my special greetings to the students who are receiving their degrees from this prestigious institute that has a legacy of 55 years, as one of the best academic institution in the country.

1. Friends, convocations are milestones. It recognizes, not only the accomplishment of a significant goal, but also the promise of an exciting future. As you look to that future, I wish you to consider the option of engaging on the key technical, social or environmental issues that our country is facing today. Please bear in your enlightened minds that we make a living by what we earn; we make a life by what we contribute. I am sure with the kind of education and training you have gone through, you would prove worthy to be contributing in building a modern India.

2. Friends, more than four decades ago, I too came out of a graduation process like any one of you. It was when space science and technology in the country was still in its formative phase. I was fortunate to join the movement, and chose to continue to be engaged in this exciting, challenging and rewarding field.

3. Today, in front of you, I represent an organization that is passionate and committed to make a difference for this country and nothing is more gratifying than this feeling. Let me dwell a bit on the emerging frontiers of space

technology in India, in all its facets. It began with setting up of Indian National Committee on Space Research in 1962. On November 21, 1963, a sounding rocket (Nike Apache) took off from Thumba, a small fishing hamlet near Thiruvananthapuram, located very close to Earth's magnetic equator. Driven by the indomitable vision of Dr. Vikram A. Sarabhai, and the seminal organisational edifices created by Professor Satish Dhawan, the Indian Space Programme thrived in pursuit of being 'second to none' in the application of advanced technologies to solve the real problems of people and society in India.

4. Over the past five decades, Indian Space Programme gained national significance and international prominence by establishing (i) operational space systems and services for education, health services, sustainable development of natural resources, environment, climate change studies and disaster management support; (ii) concomitant self-reliance in space technology and (iii) exemplary feats in space exploration, breaking the barriers of technology.

5. The launch of India's first Satellite Aryabhata on April 19, 1975 was the beginning of a new history for India. India accomplished 113 space missions. The recent past has been exhilarating as ISRO scaled several frontier technologies, enhanced space-based strategic capability, established a host of novel application programmes and accomplished an unprecedented surge in execution of space missions, including the successful GSLV-D5 with Indian Cryogenic Stage as well as the path-breaking Mars Orbiter mission. Further, 45 missions are planned till 2017

to augment capacity and enhance capability of India's Space Infrastructure for communications, navigation and remote sensing.

Satellite Communications

6. India currently has a constellation of 10 INSAT/GSAT communication satellites providing a capacity of nearly 200 transponders for strategic communication, television broadcasting, data connectivity, news gathering, meteorological data dissemination, emergency communication and other societal applications. This national capacity is complemented by 90 transponders leased from foreign satellites.

7. During 2014-17, ten Communication Satellites are planned to be realised and orbited to (a) provide 180 more transponders for in-orbit replacement of ageing satellites and enhancement of national capacity and (b) enable introduction of new communication capabilities such as broad-band data connectivity and digital multimedia.

8. Communication satellites in the higher frequency bands (Ka band; 18-31 GHz) with about 15 kW of power and data handling capability in the range of 100 Giga bits per second (100 GBPS) can meet the ever growing demands in the country towards broadband internet, rural telecom connectivity, etc. Such satellite systems are quite advanced and therefore would call for development of both Satellite platform and payload technologies. ISRO is in the process of developing various technologies and also is in the process of finding a suitable foreign

industrial alliance to acquire the technology and upgrade ISRO's current satellite platforms to meet the future demand.

Earth Observing Satellites

9. India, presently, has a constellation of 13 Earth Observation satellites (including INSAT-3A that has a meteorological instrument) providing a host of space based application service including land & water resource management, high resolution cartographic applications, oceanographic studies and weather & climate related observations.

10. In recent times, India has witnessed several technology marvels in this domain. RISAT-1, launched in 2012 is India's first Microwave Imaging Satellite capable of all weather imaging. This satellite carries a C-band (5.35 GHz) Synthetic Aperture Radar which enables applications in agriculture, particularly paddy monitoring in kharif season and management of natural disasters like flood and cyclone. INSAT-3D satellite, launched in 2013 is an advanced weather satellite configured with improved Imaging System and Atmospheric Sounder. INSAT-3D is designed for enhanced meteorological observations, monitoring of land and ocean surfaces, generating vertical profile of the atmosphere in terms of temperature and humidity for weather forecasting and disaster warning. The two Indo-French joint satellite missions viz. Megha-Tropiques (launched in 2012) for tropical climate studies and SARAL (launched in 2013) for oceanographic studies have distinctly enhanced India's Earth Observation

capability, while making a significant contribution to global efforts in this direction.

11. Several new Satellites are planned to replace the ageing satellites, enhance the observation capability to the level of 0.25 m spatial resolution and also to provide new capability for imaging from Geo-stationery orbit with 50 m spatial resolution. Further, ISRO is also partnering with Jet Propulsion Laboratory of NASA to jointly realize a dual frequency microwave imaging satellite in the 2019-20 timeframe. In this scheme of alliance, ISRO is responsible for the overall satellite platform, S band Synthetic Aperture RADAR and launch of the satellite by GSLV.

Satellite Navigation

12. Indian Satellite Navigation Programme is based on a two pronged approach. Firstly, the GPS Aided GEO Augmented Navigation (GAGAN) is a Satellite Based Augmentation System (SBAS) to provide satellite-based navigation services with accuracy and integrity required for civil aviation applications and to provide better air traffic management over Indian airspace. The GSAT-8 and GSAT-10 satellites carry onboard the GAGAN navigation payloads. The Directorate General of Civil Aviation (DGCA), India has certified GAGAN for en-route navigation and non-precision approaches over Indian air space. India became the fourth country to offer space-based satellite navigation services to aviation sector in the world.

13. Secondly, Indian Regional Navigation Satellite System (IRNSS) is being realized as an independent regional

navigation satellite system with a seven-satellite constellation by 2015. It is designed to provide accurate position information service to users in India as well as the region extending up to 1500 km from its boundary. Two satellites in the IRNSS constellation are already operational in orbit and two more are expected to be launched during 2014. IRNSS satellites are small, identical in configuration and therefore, have a smaller turn-around time. IRNSS constellation, as per the present plan, consists of three satellites in Geo-stationary orbit and four satellites in the inclined Geo-synchronous orbit. For expansion of coverage areas and enhanced accuracy, it is also being considered to augment the constellation from seven to eleven satellites.

Indian Launch Vehicles

14. India has made tremendous strides in launch vehicle technology to achieve self-reliance in satellite launch vehicle programme with the commissioning of Polar Satellite Launch Vehicle (PSLV) and more recently with the Geosynchronous Satellite Launch Vehicle (GSLV).

15. PSLV is one of the best launch vehicles of the world in its class (1.5 T) with unparalleled reliability of 25 consecutively successful launches. With its three different configurations, PSLV has proved its multi-payload, multi-mission capability in a single launch and also its geosynchronous launch capability. PSLV also has an enviable record of launching 35 foreign satellites from 19 countries including Canada, France, Japan.

16. Development of GSLV with capability to launch 2 tonne-class satellites, into Geo-synchronous Transfer Orbit (GTO) was undertaken by ISRO, initially using Russian cryogenic engine & stage. Development of indigenous cryogenic engine & stage for GSLV was also taken up in 1992. The spectacular success of GSLV with Indian Cryogenic Engine & Stage achieved on January 5, 2014 is truly a landmark in India's technological progress.

17. ISRO's next generation launch vehicle, GSLV-Mk III, with a capability to launch 4 tonne class satellites to geo synchronous transfer orbit, was initiated in 2002, with a target for first developmental flight by 2007-08. The S-200 solid propellant strap-on stages (one of the largest solid stage in the world, with 200 tonne solid propellant), the twin-engine L-110 liquid core stage (110 tonnes of liquid propellants), avionics and other vehicle systems have been developed and qualified for flight. The progress in the recent past towards development of the high power Cryogenic Stage gives confidence for taking up first developmental flight in 2016-17. In the meantime, an experimental flight with passive Cryogenic Stage is scheduled in August 2014 to study the crucial atmospheric phase of the flight.

Lunar and Planetary Exploration

18. ISRO's maiden mission of 2008 to the Moon, navigated to a distance of 4 lakh km from Earth and placed in a circular orbit of 100 km around Moon, became a significant milestone in Indian history. The spacecraft, carrying 11 scientific instruments developed by India, Bulgaria,

Germany, Sweden, UK and USA, mapped the lunar surface and collected data during its orbital life of 312 days. The discovery of water molecules in the lunar North Pole from Chandrayaan-1 data has been a significant scientific achievement.

19. The country witnessed with pride, as Mars Orbiter Spacecraft, India's first inter-planetary probe, was launched by PSLV-C25 on November 5, 2013. Subsequent to the six orbit-raising manoeuvres, the crucial Tran-Mars Injection Manoeuvre was precisely executed on December 1, 2013 and the Spacecraft was placed on course to the Red Planet along a helio-centric path of 680 million km. The Mars Orbiter Spacecraft has traversed nearly 70% of its designated path to the Red Planet. The next crucial operational milestone is the Insertion of the Spacecraft into the Martian Orbit on September 24, 2014 when it is expected to be nearly 500 km away from the Planet Mars. If successful, India would be first Asian country to orbit a Spacecraft around Planet Mars, and the first country in the world to achieve it in the first attempt.

20. **Chandrayaan-2**, initiated in 2008 as a joint mission of India and Russia for in-situ studies of lunar surface, underwent programmatic re-alignment during 2010-12. Apart from the orbiter spacecraft and launch (by GSLV) envisaged earlier, India had to undertake development of Lander module and lunar Rover. The mission is targeted for 2016-17, considering the complexity of the new technology elements to be realised.

21. **Astrosat**, to be launched by PSLV in 2015, is a multi-wavelength space-borne observatory that would enable simultaneous observation of the celestial bodies in ultra-violet, visible and x-ray bands. The six scientific instruments onboard Astrosat are developed by ISRO, Tata Institute of Fundamental Research and Indian Institute of Astrophysics. The Canadian Space Agency collaborates for development of one of the scientific instruments.

22. I have no doubt that the technology dimension of the Indian Space Programme is intellectually challenging, professionally exciting and emotionally rewarding for any Technologist. Several alumni from this Institute have played seminal roles in shaping the Indian Space programme. I can only state that you may like to keep this in mind when you make crucial decisions about your career, now or later.

23. My friends, before concluding, may I remind you that success - both personal and professional - are determined by three things: How you think, how you act and what you believe in. On this momentous occasion of your convocation, I would like to pass on some thoughts for you to ponder over:

    a) Inculcate the spirit of inquisitiveness and trait of learn ability in you. The academic distinction which you are receiving today should make you a better learner.

b) Always maintain your focus on the big picture while keeping an eye on the details. The main thing is to keep the “main thing” the “main thing”.

c) Have passion for whatever you do. Remember, perpetual optimism is a force multiplier.

d) Always set for yourselves the highest standards of professional excellence and personal integrity. You are all bestowed with high intelligence quotients. It is equally vital to develop the emotional and spiritual quotient.

e) Most importantly, you must learn to share credit. It is amazing how much you can accomplish when it doesn't matter who gets the credit. Remember, there is no “I” in Teamwork and success is a highly collaborative process.

I would like to conclude by re-iterating my heartfelt best wishes to this bright audience. I earnestly hope that you will be ever eager to embrace challenges arising out of continually changing scenario and that you will work innovatively, engaging the credo of inclusivity, cooperation and solidarity in the midst of a fiercely competitive world. It was indeed a pleasure being with you today, in your moment of glory. I sincerely thank the Institute for this kind invitation extended to me.

Thank you all and Good luck.