tion of pest resistance, cotton farmers prefer not to waste this valuable land on susceptible varieties. The consequences of such decisions are not yet known. If there is a significantly enhanced risk of evolution of pest resistance that we as a society do not want to happen, then it seems to me that we cannot 'let the users decide the fate of *Bt* cotton'.

GEETHA BHARATHAN

Department of Ecology and Evolution, State University of New York Stony Brook, NY 11794-5245, USA
e-mail: geeta@life.bio.sunysb.edu

NEWS

GSLV launched successfully*

Indian Space Research Organization (ISRO) successfully carried out the first developmental test flight of India's Geosynchronous Satellite Launch Vehicle (GSLV), on the evening of 18 April 2001 from SHAR Centre, Sriharikota, marking a major milestone in the Indian space programme.

Sriharikota Range (SHAR), about 100 km north of Chennai, is the launch station for GSLV. The SHAR complex located at 80 km north-east of Chennai (latitude: 13°N, longitude: 80°E) is ideally positioned in the east coast of India. The vehicle and spacecraft preparations, integration, checkout and launch operations are carried out in the Launch Complex facilities at SHAR.

With this launch, India has demonstrated its capability to launch communication satellites into geostationary transfer orbits with perigee (nearest to the earth) of 180 km and an apogee (farthest to the earth) of 36,000 km. This paves the way for end-to-end capability of application-spacecraft launching in the area of communication also.

The 401 tonne, 49 m tall GSLV, carrying an experimental, 1540 kg, satellite, GST-1, lifted off from Sriharikota at 3.43 PM IST. Seventeen minutes after lift-off, GSAT-1 was successfully placed in an orbit of perigee 181 km and an apogee 32,051 km with the orbital inclination of 19.2 degree with respect to the equator. The injection of the satellite into orbit occurred about 5000 km from the launch centre.

It may be recalled that the first launch attempt of GSLV was aborted one second before the lift-off on 28 March 2001 by the Automatic Launch Processing System (ALS) after it detected that one of the strap-on boosters did not develop the required thrust. After detailed analysis and in 18 days the vehicle was made ready for re-launch by replacing the faulty engine in the strap-on stage.

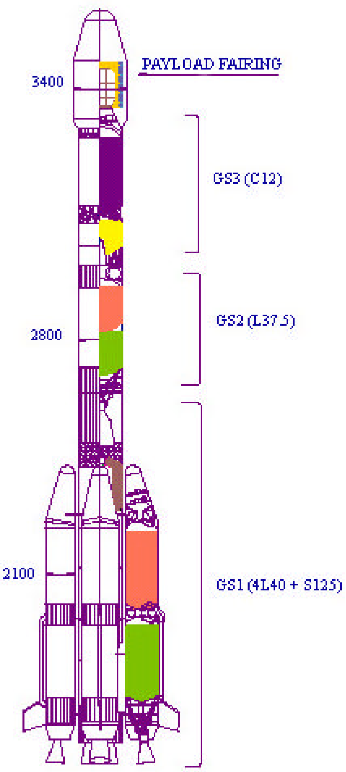
The successful accomplishment of GSLV-D1/GSAT-1 mission is the culmination of a decade of efforts by ISRO centres in design and development and supported by several educational, academic as well as R&D institutions in the country. Many of the GSLV hardware, including motor cases, inter-stages, heat shield, engine components and electronic modules were manufactured by about 150 public and private Indian industries. The mission heralds a significant milestone towards the establishment of indigenous capability for launching communication satellites like INSAT. Having already established indigenous capability for launching IRS class of remote sensing satellites through PSLV, the launch of GSLV makes the Indian space programme even more self-reliant, while tuning the programme towards national development. The launch of GSLV thus fulfils the vision of Vikram Sarabhai to make the Indian space programme a self-reliant one.

A view of SHAR complex.

India's GSLV.

*This news item is edited from material available at www.isro.org with permission from ISRO.

Details of GSLV's internals.



Four stages of GSLV.

As the count down for the launch proceeded, at count zero, the mammoth 125 tonne solid propellant first-stage motor was ignited and GSLV blazed into the evening sky. The first stage burned for 100 s, while the liquid propulsion strap-on stages continued thrusting up to 162 s from lift-off, taking the vehicle to an altitude of 75 km (Box 1). The second stage which carried 37.5 tonnes of liquid propellant, took the vehicle to an altitude of 126 km. When the vehicle was at an altitude of 116 km and thus cleared the dense atmosphere, the heat shield that protects the spacecraft from the aerodynamic heating, was discarded.

After the separation of the second stage, the cryogenic stage (procured from Russia and interfaced with ISRO-developed electronics), which carried 12.5 tonnes of liquid hydrogen and liquid oxygen was ignited. This third stage took the satellite and vehicle equipment bay to an altitude of 195 km. The velocity of the vehicle was increasing at each stage, finally reaching a value of 10.17 km/s as required for placing the satellite in the geostationary transfer orbit. The stage was separated from the spacecraft at about 1036 s from lift-off, at an altitude of 202 km, about 5000 km from the launch pad at Sriharikota. After the separation of the spacecraft, the cryogenic stage was reoriented to avoid any collision with the satellite and passivated.

All through the flight, the vehicle was guided by the inertial navigation and guidance systems. The performance data of the GSLV was tele-metred to the ground stations in Sriharikota, Port Blair and stations at Brunie and Biak in Indonesia which were networked with SHAR centre.

The realization of launch vehicle involves many branches of science and engineering, sophisticated infrastructure and innovative management techniques. Even today, only a few countries possess the technology of launch vehicles. The subsystems in a launch vehicle should withstand hostile flight environment, should be of light weight, cost-effective and should be realizable within reasonable time. Years of developmental efforts are put to test in a few minutes of flight, requiring performances with practically no margin for error.

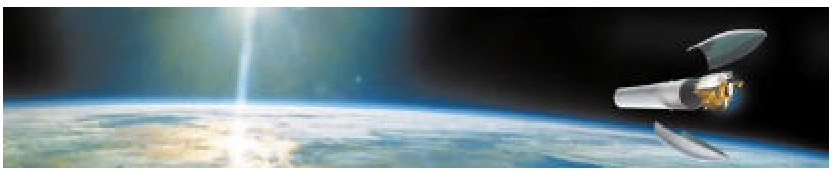
In India, rocket development began with the establishment of Thumba Equatorial Rocket Launching Station near Thiruvananthapuram in 1963 for

Box 2.

Vehicle launch	Date	Result
SLV-3 E1	10 August 1979	Partially successful
SLV-3 E2	18 July 1980	Successful
SLV-3 D1	31 May 1981	Successful
SLV-3 D2	17 April 1983	Successful
ASLV-D1	24 March 1987	Unsuccessful
ASLV-D2	13 July 1988	Unsuccessful
ASLV-D3	20 May 1992	Successful
ASLV-D4	4 May 1994	Successful
PSLV-D1	20 September 1993	Unsuccessful
PSLV-D2	15 October 1994	Successful
PSLV-D3	21 March 1996	Successful
PSLV-C1	29 September 1997	Successful
PSLV-C2	26 May 1999	Successful

Box 1.

Overall length: 49 m
Lift-off weight: 401 t
No. of stages: 3
Payload (GSLV-D1): GSAT-1 (1530 kg)
Orbit (GTO): 180 × 36,000 km



An artist's view of the satellite in geosynchronous orbit.

carrying out scientific experiments in aeronomy and astronomy, using rockets brought from outside. India's first sounding rocket was the small 75 mm diameter *Rohini*, RH-75. Today, India operates a family of sounding rockets of diameter ranging from 200 to 560 mm and capable of carrying up to 200 kg payloads to an altitude of 300–400 km to conduct scientific experiments. In February–March 2000, 45 rockets were launched on consecutive days, for a major scientific campaign, namely Equatorial Wave Campaign. Box 2 lists the history of several launch vehicles in India.

The GSLV project was initiated in 1990 with the objective of acquiring launch capability for geo-synchronous satellites. The first developmental test flight, GSLV, placed a 1540 kg experimental satellite, GSAT-1, in a geo-synchronous transfer orbit (GTO). In its present configuration, GSLV is a three-stage vehicle. It is 49 m tall and weighs about 401 tonnes at a lift-off. The vehicle configuration makes use of several systems that have been flight-proven through India's Polar Satellite Launch Vehicle, PSLV.

In addition to the cryogenic stage, the other major new elements in GSLV are the liquid strap-on stages, a heat shield with larger diameter than PSLV (3.4 m compared to 3.2 m in PSLV) and the vented inter-stage between first and second stages. Mission design and simulations, realization of test and launch complex facilities, including servicing of cryogenic stages, launch hold and release mechanism, etc. were also involved in GSLV.

While the first developmental test flight was primarily intended for validating the vehicle design and its performance parameters as well as the associated ground infrastructure, the flight opportunity was also made use of to place an experimental satellite, GSAT-1, weighing about 1540 kg. Though the satellite could not be placed in the final geostationary orbit due to excessive propellant consumption during orbit raising operation and fuel shortage of 10 kg, it was used to prove new spacecraft elements like ten Newton Reaction Control Thrusters, Fast Recovery Star Sensors and Heat Pipe Radiator Panels to validate them before use in ISRO satellites like IRS and INSAT. GSAT-1 also carried two C-band transponders employing 10 W Solid State Power Amplifiers, one C-band transponder using 50 W Travelling Wave Tube Amplifier (TWTA) and two S-band transponders using 70 W TWTA. However, it may be difficult to conduct these experiments in its present orbit which is a 23 h orbit against the intended 24 h orbit.

FROM THE ARCHIVES

Vol. IV] SEPTEMBER 1935 [NO. 3

The Indian Institute of Science

In view of the impending appointment of the second Quinquennial Reviewing Committee, a brief survey of the development and activities of the Indian Institute of Science, Bangalore, during its life of twenty-five years, may assist in creating sympathetic and enlightened public opinion. This will provide a favourable background, rendering the task of the Committee perhaps less tedious and more congenial; it may even be found indispensable to the formulation of a definite policy for promoting schemes of reform and expansion, such as the Committee may deem desirable to recommend on the conclusion of their labours. The first Quinquennial Reviewing Committee have, in more than one section of their report, drawn attention to the prevailing public ignorance of the work and resources of the Institute, and have also adversely commented on the general misconception among members of the Court regarding the economic activities of the different departments. Such ignorance and misunderstanding, if allowed to persist, would favour the growth of public prejudice affecting the character and fair reputation of the Institute, although there is ample testimony of honourable work steadily pursued in a spirit of disinterested service to the country. It is true that the Pope Committee reported in 1921 abundant evidence that there existed in many quarters 'a strong feeling of disappointment and dissatisfaction' with the then existing condition of the Institute; and if such a feeling still prevails in the public mind, it must be almost entirely due to general ignorance of the steps that have since been taken to remove partially or entirely the causes which led the Committee to record the adverse comment. If, however, there is still a source of dissatisfaction either within the precincts of the Institute or outside, we think it must arise from defects inherent in its organisation as well as from lack of a sound and definite policy, understood by all concerned, in regard to both the academic and the administrative spheres of this great foundation. In a short contribution on the Indian Institute of Science published in this *Journal* (October 1932), Alchymist observes that 'with this provision (resources becoming available) the future, to which we now look for progress and expansion at least comparable with those of the last fifteen years, is hopeful'. Manifestly the writer of the article is favourably impressed by the advances made by the Institute during this period in the different branches of its activity. Sometime ago it was pointed out in an article in *Nature* (April 29, 1933) that 'even if such an Institute were established in Great Britain, where the distances are not of the same continental order, it may be doubted if it would attract as many science graduates taking courses of advanced study and training for research as are now at Bangalore'. This is a disinterested testimony to the increasing popularity and sound reputation of the Institute.

The question of the status of the Institute is discussed by the Sewell Commit-