



A FLAWLESS DEMONSTRATION OF ADVANCED TECHNOLOGICAL CAPABILITY

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India's Indian Space Research Organisation (ISRO) planned the country's first mission to Mars in 2012 and within 15 months fabricated the spacecraft and launched it to intercept the red planet. On 24 September 2014 Mangalyaan or the Mars Orbital Mission (MOM) achieved successful entry into the planned Mars orbit. This success stands in sharp contrast to similar attempts by other countries and serves to showcase India's technological prowess.

Background

Space activities in India commenced in the early 1960s with the launch of imported sounding rockets from Thumba. Space activities were initially coordinated by Indian National Committee for Space Research (INCOSPAR). ISRO was formed in 1969 and superseded this earlier organisation. ISRO is headquartered in Bangalore (Bangaluru). ISRO progressed from launching imported rockets towards fabrication of its own satellites, which were launched on Soviet and European rocket boosters till in the early 1980s ISRO succeeded in developing its first Satellite Launch Vehicle (SLV) in form of the SLV-3. Thereafter, ISRO has developed ever more powerful launch vehicles in form of the Augmented SLV (ASLV), Polar SLV (PSLV) and the Geosynchronous SLV (GSLV). The organisation has also developed advanced satellites many of which were launched on foreign rocket boosters till Indian boosters became available. Today ISRO operates the world's largest constellation of operational Earth Observation satellites.ⁱ ISRO made headlines when it succeeded in its Chandrayaan-1 mission, which was launched on 22 October 2008. Chandrayaan successfully achieved its intended lunar orbit and carried out its planned

observations and experiments. These observations involved high resolution mapping of the moon's surface as well as spectrometric analysis to determine the presence or absence of water on the moon's surface. The spacecraft carried a total of 11 scientific payloads from the UK, Bulgaria, USA, Germany and Sweden in addition to those made in India.ⁱⁱ While planned for a life of two years on completion of its planned scientific observations while orbiting the moon the spacecraft fired its Moon Impact Probe (MIP) into the moon's surface on 14 November 2008, in the process planting the Indian flag, which was painted on the MIP on the moon.ⁱⁱⁱ On 05 November 2013 ISRO launched its most ambitious project since its formation. This was its Mangalyaan-1 mission also called the MOM, which intended to place a satellite into Mars orbit in order to carry out scientific experiments. ISRO lacked a proven high energy booster such as those possessed by the US, China, Russia, Japan and the European Space Agency (ESA) to enable use of brute force to reach Mars quickly. This forced ISRO to select a minimum energy trajectory for Mars intercept. Such a trajectory could be achieved by the MOM spacecraft if launched aboard a modified PSLV launch vehicle, Chandrayaan-1 had also left earth on a PSLV which is ISRO's most proven launch vehicle. MOM required very precise release from the PSLV in order to achieve the planned orbit around earth and thereafter MoM needed to build up energy progressively to escape earth's gravitational influence and coast on an intercept path towards Mars. Approaching Mars after a near 10 month journey through space MOM required to fire its on board engines to reduce its velocity at a very precise location in order to allow Mars' gravity to capture it and to enter the planned orbit around Mars. Even small errors could have resulted in loss of the spacecraft. The path chosen by ISRO for MOM indicated the Indian ability to use innovative solutions to overcome limitations in order to achieve desired objectives.

Advanced Space Missions

MOM has followed a textbook trajectory from its launch in November 2013 till its entry into Mars orbit in the early hours of 24 Sep 2014. This has displayed India's ability to achieve world beating results through application of scientific prowess in fields of advanced scientific endeavour. ISRO's achievement in MOM is even more noteworthy in view of the fact that of the 51 missions to Mars attempted till date only 21 have succeeded. Moreover, even the US failed in its first attempts to reach Mars. After initial failures the third US mission and the fourth Soviet mission ended in the spacecraft concerned entering the Mars orbit.^{iv} Successful Mars orbit entry

by MOM makes India the fourth country in the world after the US, Soviet Union, Europe's ESA to reach Mars, the first Asian country to reach Mars and the only country till date to achieve success in a mission to Mars on the very first attempt.^v

Cost Effective Science

Chandrayaan-1 was executed within a budget of a mere \$ 74 million which compares very favourably with the Japanese Selene mission to the Moon which cost \$ 279 million. Moreover \$20 million of the total \$ 74 million spent on Chandrayaan-1 went towards reusable infrastructure making the achievement even more impressive.^{vi} MOM has been executed at a cost of a mere \$ 73 million. This is just one tenth of the money it has cost the US to undertake its current Mars mission dubbed MAVEN at the same time.^{vii}

Implications and Analysis

ISRO's track record over the years and its landmark achievements of development of a range of robust launch vehicles, satellites and executing precise launch of as many as ten satellites in a single mission precede the latest successes. The low price tag successful missions to the Moon and Mars have helped establish India, through ISRO, as a country with the ability to undertake advanced and complex scientific tasks with élan and without going beyond limited budgets. The term 'frugal engineering' has been coined to capture India's unique ability to do more with less. This is an ability that is displayed in ISRO's flagship space exploration missions, and also in other fields such as TATA Motors' development of its low cost Nano small car platform amongst other such achievements. This string of impressive successes opens up the possibility of countries with advanced space research programs willingly entering into collaborative projects with ISRO for mutual benefit. Such collaborations could provide ISRO with the opportunity of absorbing advanced technologies that have as yet not been developed in-house. On a more important note, the recent spectacular successes of ISRO missions hold out hope for the early successful completion of other projects such as the two stage to orbit (TSTO) reusable spacecraft as well as the GPS aided geo-augmented navigation (GAGAN), and Indian Regional Navigation Satellite System (IRNSS). Both these projects would enhance India's prestige further while also giving a boost to the country's security. The transplanting of the ISRO model in other fields of scientific endeavour could lead to similar spectacular success in those fields.

Conclusion

ISRO, since its formation in the late 1960s has many achievements to its credit. ISRO has helped put India in the select group of countries with the ability to undertake advanced space missions as well as to apply space technology for the benefit of the people at large. The success of ISRO's Chandrayaan-1 mission in 2008-2009 has been surpassed by the very recent success achieved by Mangalyaan-1. The fact that these missions have been achieved at one tenth the cost of similar missions by the US and substantially lower than such missions by even other Asian countries brings out the Indian ability to do more with less even in cutting edge spheres of scientific endeavour. These demonstrations by ISRO hold out promise for early achievement of other flagship programs such as IRNSS and the TSTO spacecraft.

(Disclaimer: The views and opinions expressed in this article are those of the author and do not necessarily reflect the position of the Centre for Air Power Studies (CAPS))

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i "About ISRO", <http://www.isro.org/scripts/Aboutus.aspx>, accessed on 24 Sep 2014.

ii "Chandrayaan-1", <http://www.isro.org/satellites/chandrayaan1highlights.aspx>, accessed on 24 Sep 2014.

iii "India's Flag is on the Moon", <http://www.spacetoday.org/India/IndiaMoonFlights.html>, accessed on 24 Sep 2014.

iv Vasudevan Mukunth, "In depth: India's Mars Orbiter has made it to the top, but is it a one-hit wonder?", http://www.thehindu.com/sci-tech/science/in-depth-indias-mars-orbiter-has-made-it-to-the-top-but-is-it-a-onehit-wonder/article6440733.ece?homepage=true&utm_source=Most, accessed on 24 Sep 2014.

v Vanita Srivastava et al, "Mars meets MOM: Red-letter day for India as Mangalyaan reaches Red Planet orbit", <http://www.hindustantimes.com/specials/coverage/marsorbitermission/marsorbitermission/final-countdown-begins-as-mangalyaan-looks-set-to-slip-into-martian-orbit/sp-article10-1267726.aspx>, accessed on 24 Sep 2014.

vi Raja Murthy, "It's all go for moon-struck India", http://www.atimes.com/atimes/South_Asia/JJ22Df02.html, accessed on 24 Sep 2014

vii Scott Neuman, "Why India's Mars Mission Is So Much Cheaper Than NASA's", <http://www.npr.org/blogs/thetwo-way/2013/11/04/243082266/why-indias-mars-mission-is-so-much-cheaper-than-nasas>, accessed on 24 Sep 2014.