

ESSAY

India's rise to the Moon

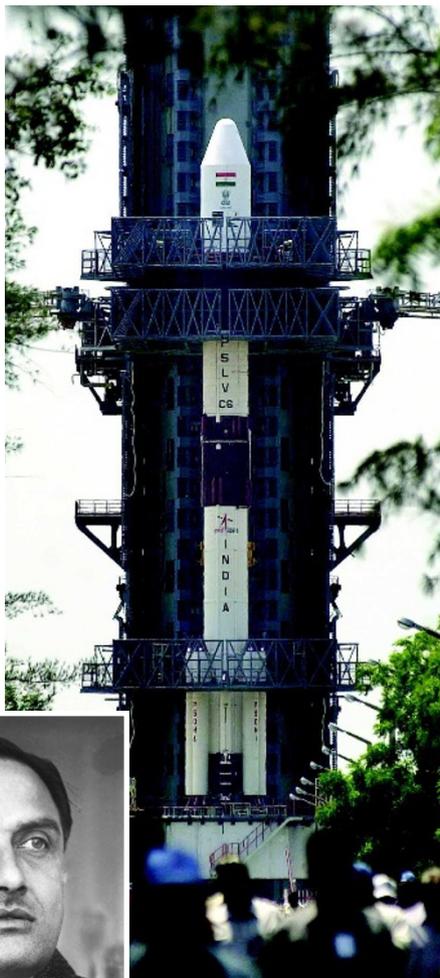
Why does a developing nation have such an ambitious space programme? **Subhadra Menon** traces its foundations back to the work of one visionary physicist 60 years ago.

The space giants of the world are a growing family. This month, India plans to launch its first mission to the Moon: Chandrayaan-1 — Sanskrit for 'mooncraft' — is scheduled to blast off from the island of Sriharikota in the Bay of Bengal between 22 and 26 October. The craft is intended to orbit the Moon for two years, send an impactor to the surface and use remote sensing to produce chemical and topographical maps.

India's space programme has grown against the odds. A few decades ago, it struggled against crippling sanctions imposed by the United States after it exploded a nuclear device in 1974. Yet today, the Indian Remote Sensing satellite system, with its seven active satellites, is the largest family of remote sensing satellites in the world for civilian use. And the country's 11 national communications satellites form the largest such constellation in the Asia-Pacific region. This month's unmanned mission to the Moon marks a leap into more ambitious science-based projects, and the beginning of a string of such missions for the country.

A burst of enthusiasm about space in recent decades has led some to talk about an Asian space race. The motivations of these new players are remarkably similar to those that spurred the first space race: self-reliance, national pride, security and economic gain. India has so far seemingly lagged behind China, but it is emerging as a very strong player, alone and in international partnerships, in what is really more a worldwide endeavour than an Asian race.

There are many who question the role of an ambitious space programme in a nation where roughly 450 million people live below the poverty line. Satellites have brought great benefits to India, including connecting remote patients to medical specialists, hooking up tsunami and cyclone warning systems, allowing for better agricultural management and distance education; the Indian Space Research Organisation (ISRO) claims a return of two rupees on every rupee spent on their satellite programme. But there is no doubt that space technology has raced a few paces ahead of the needed



Vikram Sarabhai saw the utility of space research for India.

social and developmental infrastructure. The bottlenecks are obvious: classrooms equipped with distance-learning satellite linkups are often empty; the ground-based computer linkups required to make telemedicine a reliable option can often collapse. And a Moon mission, unlike the satellite programme, promises no direct good for India's poor.

Yet India's space programme has long benefited from political commitment across party lines. Funding has not been a constraint either. The 2007–08 budget allocates 500 million rupees (US\$10 million) for the ISRO to develop a project report for its manned space initiatives.

How did India end up here? The story begins with the charismatic, trail-blazing father of the Indian space programme — Vikram Ambalal Sarabhai.

Founding father

Sarabhai, born into an illustrious business family in Ahmedabad, Gujarat, was 28 when the country became independent of British rule in 1947. A physicist who had researched cosmic rays with Nobel laureate C. V. Raman and trained at Cambridge, Sarabhai pushed for space-related development in India right from the start. This made all the difference between excellence and mediocrity in a newly independent country grappling with developmental issues of all kinds. In 1947 he founded the Physical Research Laboratory (PRL) in Ahmedabad, using charitable trusts owned by his family and friends to create a centre for research in space and allied sciences. Sarabhai was tireless, and combined a heady mix of creativity and knowledge in both the fine arts and science; in addition to the PRL, he founded the top business school — the Indian Institute of Management Ahmedabad — and helped to set up the National Institute of Design. What made him famous, though, was his vision to see the potential of a space programme for India.

Initially, the PRL focused on researching cosmic rays and the atmosphere. But as space technologies progressed, Sarabhai had the foresight to see how cutting-edge science — particularly communications satellites — could make a real difference to people's lives.

In the late 1950s, the world watched as the Russians sent Sputnik-1 into space, heralding the beginning of a new era and the start of the first space race between the Soviet Union and the United States. India's first prime minister, Jawaharlal Nehru, already had an abiding belief that scientific advancement could solve several of India's problems, and the satellite launch set the country's portals of power buzzing. Nehru asked Homi Jehangir Bhabha, known today as the father of India's atomic-energy programme, to help him craft a scientific policy resolution. Passed in Parliament in early 1958 it stated: "The gap between the advanced and backward countries has widened more and more. It is only by adopting the most vigorous measures and by putting forward our utmost effort into

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the development of science that we can bridge the gap." And so, India became dedicated to matching the world's greatest scientific developments.

As Russia's Yuri Gagarin became the first man in space in 1961, India got down to working out the nuts and bolts of its own space programme. In 1962, Sarabhai took charge of the Indian National Committee for Space Research, under the overall guidance of Bhabha. At Thumba, a village in the deep south of Kerala, work began on the Thumba Equatorial Rocket Launching Station that saw its first launch — of a US rocket — in 1963. The aerospace engineer A. P. J. Abdul Kalam, one of the country's original missile men, and later president of India, was part of a small knot of space dreamers who sweated and slogged with Sarabhai in the early sixties — often out of shacks, tin-roof sheds and even an old village church. He still speaks of Sarabhai as one of India's most extraordinary leaders.

Within a few years, the Indian space programme began to focus on the capability to build as well as launch satellites. Sarabhai founded the Space Science and Technology Centre in Thiruvananthapuram, Kerala (now called the Vikram Sarabhai Space Centre) to pursue this work, which culminated in the country's first successful launch into orbit of an Indian satellite in 1980. As well as a great leader, Sarabhai was also a great maker of teams. His work laid a firm foundation for future ISRO leaders to build on.

The Moon mission stands apart from the application-focused satellite programme. Its inception can be traced to Krishnaswamy Kasturirangan, member of parliament and head of the ISRO from 1994 to 2003. Kasturirangan's geniality and easy demeanour is a perfect foil to his sharp and intense vision as a scientist, which gave early shape to the idea of India going to the Moon in 1999. After a series of stakeholder meetings and consultations between 1999 and 2003, a group of 100 eminent scientists officially recommended that India set its sights on the Moon. Their stated goals were to expand human knowledge, and to challenge India to go beyond geostationary orbit, thereby potentially attracting young talent to the space sciences and into the country's space programme.

A new space race is emerging globally, and India clearly wants to be part of that. China and nations within the European Space Agency (ESA) are awaiting

approvals for manned missions to the Moon. South Korea is building its first space centre. The Chinese Shenzhou VII, the country's third manned mission into space, took off in September, following its first Moon orbiter in 2007. The United States has cranked up its Moon mission machinery after three decades, and the Russians are developing new generation spacecraft intended for manned missions to the Moon and Mars. Mylswamy Annadurai, project director for Chandrayaan-1, has written: "Decades from now, human colonies on the Moon could become a reality. India should also be in the forefront of this challenging and exciting endeavour."

Grand ambitions

Kasturirangan calls Chandrayaan-1 a "forerunner of more ambitious planetary missions in the years to come". On its heels is Chandrayaan-2, an Indo-Russian robotic rover planned to be deployed from a lunar orbiter in 2011–12, to probe the Moon's surface for geological data and look for helium-3, a potential fuel for futuristic fusion reactors. A manned mission to the Moon is part of the long-term plan, along with an unmanned mission to Mars slated for 2015, and a future mission to an asteroid. The Aditya mission is aimed at the Sun for 2014.

India knows that the name of the game in space science is international collaboration, and there are signs that others will cooperate with the country. In September 2007, NASA administrator Michael Griffin told Pallava Bagla, my co-author on our book *Destination Moon*: "India and the United States are not racing to go to the Moon. We can hope to go together."

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But as rocket technologies are closely-guarded national secrets, the country sees the need for its own low-cost access to space. As G. Madhavan Nair, chairman of the ISRO and the man who delivered the Moon mission, says: "Twenty years from now, when space travel is likely to become mundane like airline travel today, we don't want to be buying travel tickets on other people's space vehicles." Chandrayaan-1 carries 11 payloads: five Indian, two from NASA, three from the ESA and one from Bulgaria. But it will be launched with the all-Indian technology of the Polar Satellite Launch Vehicle. In the country's other main launch technology — the Geosynchronous Satellite Launch Vehicle — a vital section originally provided by Russia has now been re-made in India, aiming to eliminate reliance on foreign

countries for launch capabilities.

More than four decades ago, Sarabhai remarked: "There are some who question the relevance of space activities in a developing nation. To us, there is no ambiguity of purpose." He saw the great benefits to be gained from satellites aiding in the development of the country, as do the heads of the space programme today. But Sarabhai went on: "We do not have the fantasy of competing with the economically advanced nations in the exploration of the Moon or the planets or manned space-flight."

Whether there still is no such fantasy is difficult to tell. India is now aiming at these loftier goals, but often in co-operation, rather than competition. Sarabhai died suddenly in his sleep at the age of 52, succumbing, some say, to the rigours of his career. But reading his lectures and writings, it would be fair to assume that he would be happy with the direction of India's current space programme. His main goal was for his country to be at the cutting edge of space science and technology. Moon missions are now part of that. No wonder Kasturirangan says: "It is not a question of whether we can afford to go to the Moon. It is whether we can afford to ignore it." ■

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Watch www.nature.com/news for updates on the Moon launch.



Millions struggle to survive, yet India invests heavily in its space programme.