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# India's Cut-Price Space Program

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BANGALORE, India -- Twelve-foot-high electric fences and fortified machine gun posts surround the administrative headquarters of India's space agency.

Although the space program is a civilian effort, it is a symbol of national excellence -- and that makes it an ideal target. But behind the several layers of security, the Indian Space Research Organisation, or ISRO, is abuzz with new projects and excitement.

**India's Space Program**

**India's Rocket Man Powers Up**
Madhavan Nair talks about the country's extraterrestrial self-sufficiency and international cooperation.

**India's Cut-Price Space Program**
The country's space agency is earning a world-class reputation for launching telecom satellites and space cameras on the cheap.

**Gallery: Inside the ISRO**

**India Rolls Its Own Space Tech**
India is quietly making inroads into some of the most sophisticated areas of aerospace engineering and exploration.

In the coming years, ISRO will send its first probe, the Chandrayaan-1, to map and photograph the surface of the moon. The agency will also introduce two new heavy-lifting rockets and establish extensive telecommunications networks that will link even the most remote regions of the country.

I arrived at ISRO on the heels of an announcement that NASA will shed some of its historic reluctance to cooperate with India after tension during the Cold War and contribute a cluster of instruments to the probe's design. There is hope that the maps produced by the mission might one day help locate a moon base or search out minerals to be shipped back to Earth.

For two days I traveled around Bangalore to different research facilities, administrative buildings and security check posts. The agency is awash in chaos. In typical Indian government style, scores of clerks, press officers and executives fought a seemingly unending battle against mounds of bureaucratic paperwork inside the space agency's administrative center. Despite being the public face of the Space Age, ISRO has yet to accept the marvels of computer filing systems, as most of the organization's records are still kept by hand. Every officer I interviewed spoke from behind piles of color-coded folders that resembled medieval fortifications.

Nonetheless, ISRO was the first real technology player in this bustling city, and, despite the slow wheels of government, it exemplifies the ideals of India's now-huge IT sector: provide services to the rest of the world at a fraction of the price.

And Indians pride themselves on their success in space.

Every launch resonates deeply in patriotic nerve centers and causes celebrations throughout the country. Some cities fire off so many fireworks the sky stays thick with smoke for hours. In other places, people pray for the success of the mission in temples and mosques. They may not know what's on board the rocket, but its liftoff certainly lends credibility to India.

Still, India's rocket scientists are humble about their work. Launching missiles with massive payloads into space is a tricky business and things can go wrong at any stage.

After 11 consecutive successful launches, the most recent launch of India's Geosynchronous Satellite Launch Vehicle on July 10 had to be aborted when one of the engines failed. But these sorts of setbacks are par for the course in the space business -- and aren't confined to India. In 2003, a similar satellite launch by Brazil's space agency resulted in disaster when the rocket exploded on the launch pad, killing 21 technicians and briefly forcing the country to suspend its space program.

To keep the odds in their favor, some scientists make pilgrimages to the famous Venkateswara temple in Tirupati, Andhra Pradesh, with a small bronze replica of the payload. The model is sprinkled with holy water and placed in front of an idol of Vishnu to be blessed for success.

"Once you are airborne there is not time to make changes," said Rajeev Lochan, assistant science secretary of ISRO.

"Maybe it helps to have the divine in your corner."

India has had a 30-year run in mastering space telecommunications and Earth reconnaissance, but the moon mission would be the first for purely scientific ends. And it could be the beginning of a new era for the program.

For every other nation in space, the final frontier was first a military frontier: Space programs have emerged from ballistic weapons research. India is different. While the leaders of the free world imagine advanced weapons systems, scientists in India see space technology as a means to help the developing world.

At the beginning of the Cold War, Vikram Sarabhai, the founder of India's space program, laid the groundwork for the country's space presence. After the Russians launched Sputnik in 1957, Sarabhai said: "We are convinced that if we are to play a meaningful role nationally, and in the community of nations, we must be second to none in the application of advanced technologies to the real problems of man and society."

Though more than 50 countries have space programs, very few have the ability to plan and execute their own missions. Outside of Europe and the United States, the only significant players in space are China, Brazil, Japan, Turkey and India.

And, for the last 49 years, ISRO has gone to space not to look at the stars, but to turn its gaze back to Earth. Though it operates on about one-twentieth of NASA's $16.5 billon annual budget, some would argue that on a day-to-day basis ISRO does more to make its advances accessible to its citizens.

"The two organizations have different research priorities," said the current chairman of ISRO, Madhavan Nair. "NASA is interested in interplanetary exploration, looking at galaxies, asteroids and other planets. The ISRO is first and foremost interested in looking at planet Earth and conceiving of applications for space to improve the quality of life down here."

That difference in attitude has been hard-won. Since it doesn't outsource any research to other countries with more developed programs, ISRO has built itself from the ground up.

Remote sensing has been one of those areas where India stands shoulder to shoulder with programs in the United States. Able to launch satellites in both polar and geosynchronous orbits, India can take real-time high-resolution photographs of just about any place on the planet. One satellite launched in 2001 performed so well it made analysts wonder if it would be used to spy on other nations.

But while the satellite can tell the difference between an SUV and a sedan, it lacks the detail of Russian and American spy satellites that can read license plate numbers.

With potential military threats from both China and Pakistan, John Pike of GlobalSecurity.org said that since it doesn't have its own dedicated satellites, "one assumes that the Indian military is (one of ISRO's) big customers" for satellite image data.

But D. Raghunandan, executive secretary of Delhi Science Forum, a nonprofit technology and science think tank, said the issue is overblown.

"ISRO badly wants to preserve its civilian identity and isolate itself from any possible (U.S.) sanctions," he said. "There may not be the impenetrable firewall that the U.S. wants, but there is pretty much a separation between the Defence Research & Development Organisation and ISRO."

For its own part, ISRO claims that the small satellite armada has no military ambitions. Instead, it has been an instrument of change. Not only did it bring television to the entire subcontinent in one sweep in the early 1990s, it has furthered advances in water management, land tenure, archaeology and telemedicine.

Satellites don't turn too many heads these days while NASA sends robots to Mars, but the ISRO is gaining a commercial presence in space.

"We can launch a remote-sensing satellite for half the price of anyone else," said Shridhara Murhi, executive director of Antrix, the commercial arm of ISRO. It's the sort of frugality and ingenuity that has begun to attract international investors.

The demand for space imaging and communications is huge, and yet there are only a few players in the game. Last year, Antrix brought in more than $500 million, which was more than half of the operating budget for all of ISRO. It is aiming for a 10 percent market share in less than a decade.