Overview of Space Programs of Brazil, India, and Israel

Although we were not able to obtain chapters written specifically by experts on the space programs of these nations, in the interest of providing a sense of their efforts, the following pages present concise overviews of current activities based on media sources.

Brazil

The Brazilian Space Agency, in Portuguese: Agência Espacial Brasileira (AEB), is the civilian authority in Brazil responsible for the country's growing space program. It operates a spaceport at Alcântara and a rocket launch site at Barreira do Inferno. The agency has given Brazil a leading role in space in Latin America and has made Brazil a partner for cooperation in the International Space Station.

Brazil's space program was controlled by the country's military until 1994 when it was transferred into civilian control.

It suffered a major setback in 2003, when a rocket explosion killed 21 technicians. Brazil successfully launched its first rocket, a VSB-30 on a sub-orbital mission on October 23, 2004 from the Alcântara Launch Center. Several other successful launches have followed.

On March 30, 2006, AEB astronaut Marcos Pontes became the first Brazilian and the first native Portuguese-speaking person to go into space, where he stayed on the International Space Station for a week.

The Brazilian Space Agency has pursued a policy of joint technological development with more advanced space programs. Initially it relied heavily on the United States, but after meeting difficulties with technology transfers, Brazil has begun working with other nations, including China, India, Russia and Ukraine.[1]

Alcântara Launch Center

According to Douglas Messier, writing for The Space Review, the Brazilian spaceport Alcântara Launch Center (Centro de Lançamento de Alcântara, or CLA, in Portuguese) could become one of the busiest launch sites in the world, and one of the most lucrative. Alcântara is sequestered from the surrounding cities and only accessible by air or boat. Launching a rocket near the equator decreases the amount of fuel needed as the rotation of the Earth at the equator gives launch vehicles a boost relative to sites further away from the equator, resulting in as much as a 500 km/h increase in velocity. This increase in velocity decreases the fuel cost necessary to place an object in orbit, and as the Alcântara site lies a little less than 3 degrees away from the equator, it is the perfect place for launching geosynchronous satellites.

International partnerships

Brazil has launched sounding rockets, but its does not have rockets that can send a payload into orbit. It is now undertaking cooperative programs with Ukraine and Russia to build six rockets that could launch everything from small satellites into low Earth orbit (LEO) to heavy geosynchronous communications satellites.

Ukrainian Space Agency head Yuriy Alekseyev said recently that more funding is required to complete the project. “Today around $280 million has been spent and around $260 million more will be required. Unfortunately, Brazil has invested $50 million more in the project compared to Ukraine,” he said. Ukrainian Prime Minister Mykola Azarov was recently quoted as saying that the partners are looking to complete the launch complex at Alcântara by 2014.[2]

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1 http://en.wikipedia.org/wiki/Brazilian_Space_Agency

2 Messier, Douglas. “Will a new space power rise along the Atlantic?” *The Space Review*, August 15, 2011.

Brazil is also interested in partnering with its South American neighbors. Argentina recently proposed the creation of a South American Space Agency, an initiative which was supported by host Brazil during a Defense seminar in Sao Paulo.[3]

Israel is also in talks with Brazil, with a focus launching satellites from Alcântara, as Israel's geographic position makes domestic launches difficult. A 2000 agreement between Brazil and the United States also allows for private US corporations to launch from Alcântara if they desire.

In 2009, Brazil and Russia agreed to create and launch five rockets as part of the Southern Cross Project. The largest, Epsilon, will carry a payload weight of four tons. The Southern Cross project will create five additional launch pads and oversee up to a dozen launches a year. The project is on pace to make its first launch in 2022.

Creating the workforce

Brazil's Science without Borders programs aims to spend $2 billion to educate 75,000 students who would pursue advanced degrees in engineering and physical sciences at home and abroad, with hope that some of those students will return to Brazil and provide the necessary workforce.[4]

India

The Indian Space Research Organisation (ISRO) is the primary space agency of the Indian government, and is amongst the six largest government space agencies in the world, along with NASA, RKA, ESA, CNSA and JAXA.

Established in 1969 and headquartered in Bangalore, ISRO superseded the erstwhile Indian National Committee for Space Research (INCOSPAR). ISRO is under the administrative control of the Department of Space, Government of India.

India’s first satellite, Aryabhata, was built by ISRO and launched by the Soviet Union in 1975. Rohini, the first satellite to be placed in orbit by an Indian-made launch vehicle, SLV-3, was launched in 1980. ISRO subsequently developed two other rockets, the Polar Satellite Launch

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3 “Argentina, with Brazilian support proposes a South American Space agency” Mercopress. September 1, 2011.

4 Vernese, Keith. “Could Brazil be the next space superpower?” March 9, 2012. http://io9.com/5891721/could-brazil-be-the-next-space-superpower

Vehicle (PSLV) for putting satellites into polar orbits, and the Geosynchronous Satellite Launch Vehicle (GSLV) for placing satellites into geostationary orbits. As of early 2012, the Polar vehicle has a strong of 19 consecutive successful launches.[5] These rockets have launched numerous communications satellites, Earth observation satellites, and, in 2008, Chandrayaan-1, India's first mission to the Moon, and the first spacecraft to detect water there. ISRO's satellite launch capability is mostly provided by indigenous launch vehicles and launch sites.

Over the years, ISRO has conducted a variety of operations for both Indian and foreign clients. Future plans include indigenous development of GSLV, manned space missions, further lunar exploration, and interplanetary probes. ISRO has several field installations as assets, and cooperates with the international community as a part of several bilateral and multilateral agreements.[6]

New support for Indian science

A recent feature article in *Science* magazine described past and current developments in Indian science in detail.

> "After the nation's first atomic bomb test in 1974, the United States and other countries slapped sanctions on India that squeezed its supply of high-tech equipment and materials. Over the next 3 decades, India grew an indigenous civilian nuclear power industry and a space program on par with those of leading nations. In 2008, a landmark civilian nuclear pact between India and the United States beckoned Indian scientists in strategic sectors to come in from the cold; access to imported precision instruments is allowing India to make up ground in areas such as nanotechnology and supercomputing.
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> "Now the government intends to lift all disciplines on a rising tide. At the Indian Science Congress in Bhubaneswar last month, Prime Minister Manmohan Singh pledged to hike R&D expenditures during the 5-year plan that begins this spring, from around $3 billion last year to $8 billion in 2017.
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> "The windfall is meant to turbocharge initiatives under way to create elite research institutions, bring expatriate Indian scientists home, enrich science education, and equip smart new laboratories.

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5 Bagla, Pallava. "Ad Astra, With a Uniquely Indian Flavor." Science Magazine, Vol 335, February 24, 2012, p 906.

6 http://en.wikipedia.org/wiki/Indian_Space_Research_Organisation

Over the next 5 years, an estimated $1.2 billion in public funds will be funneled to a new National Science and Engineering Research Board modeled after the US National Science Foundation.

"Researchers will have to clear some daunting hurdles, though. India's legendary bureaucracy can snarl grant proposals and expenditures in red tape for months. The anticipated R&D budget boost 'will be useless if structural reform is not undertaken,' warns vaccine specialist Maharaj Kishan Bhan, secretary of the Department of Biotechnology, the central government's main conduit for supporting applied biology in India. Another woe is that scores of universities are deteriorating or riddled with corruption. Says Raghavendra Gadagkar, a sociobiologist at IISc Bangalore. 'Our system creates followers, not leaders. That's our biggest problem.'"[7]

An interview with the prime minister

Science Magazine editor-in-chief Bruce Alberts, editor Richard Stone, and correspondent Palleva Bagla's interview with Indian Prime Minister Manmohan Singh was published in *Science* on February 24, 2012. These are some pertinent excerpts from their discussion.[8]

> Q: You mentioned your feeling that China has overtaken India in science. Are you competing with China?
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> M.S.: *Well, we are competing, yes and no. India and China are engaged in a stage of development where we have both to compete and cooperate. We are the two largest developing countries and the two fastest growing countries. China is our great neighbor. Now, we've had in the past problems way back in the 1960s, but we are finding pathways to promote cooperation.*
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> Q: India has invested very large amounts of money in space.
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> M.S.: *And it has paid off.*
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> Q: The country wants to put astronauts in space. Indian astronauts from Indian soil using Indian rockets. Is that something you support?

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7 Stone, Richard. "India Rising." Science Magazine, Vol 335, February 24, 2012, p 904.

8 Bagla, Pallava and Richard Stone. "India's Scholar-Prime Minister Aims for Inclusive Development." Science Magazine, Vol 335, February 24, 2012, p 907.

M.S.: *We supported the Chandrayaan lunar missions. And satellite technologies, rocket technologies—those are, I think, highly favorable outcomes of the Indian space program, and we need to do more.*

Q: But what about the astronaut program? The Indian Space Research Organisation is asking for $2.5 billion. You talk of inclusive growth. In that inclusive growth, how does human space flight fit in?

M.S.: *Ultimately science and technology must be viewed as an instrument of raising the standard of living of our people. Now, if information technology can be seen to promote the development of our country, particularly in the inclusive style of development, I think people will see space technology also as a new way of dealing with the ancient scourges of poverty, ignorance, and disease. Science and technology are the ultimate salvation for finding meaningful new pathways of developing our economy.*

Israel

Israel's efforts in space became evident in 1988 with the launch of Ofeq 1 by the Shavit launcher, enabling the country to become the eighth country to launch a self developed satellite with its own rocket. Geographical constraints and safety considerations have led the Israeli space program to focus on very small satellites with payloads of high sophistication.

Currently Israel is developing its third generation of satellites. In addition to panchromatic satellites for Earth observation and picture downloading, a new radar satellite is currently being developed that will have a SAR payload capable of taking images at all weather conditions.

The vision of the Israeli Space Agency (ISA) stems from the understanding that Israel should promote innovative scientific projects based on international collaboration. Amongst the projects is the renewal of the TAUVEX (Tel Aviv University Ultra Violet Experiment), a UV telescope for astronomical observations which is intended to be hosted on the Indian Geo-Synchronous satellite G Sat-4, and would be jointly operated and utilized by Indian and Israeli scientists.[9]

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[9] Adapted from http://www.most.gov.il/English/Units/Israel+Space+Agency/About+ISA.htm

The Israeli Government Perspective

The following excerpt from a *Scientific American* blog authored by John Matson describes his conversation with Daniel Hershkowitz, Israel's Minister of Science and Technology.[10]

> "Hershkowitz notes that the Israeli space program is a minuscule operation compared to NASA or the European Space Agency—not surprising for a nation with about the land area and population of New Jersey. 'The Israeli Space Agency does not have its own industries,' Hershkowitz says. 'It's just a very small body that coordinates in the activities of the other industries, and also coordinates between the civilian and the military applications.' To do that, he says, the agency has an annual budget of about $50 million.
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> "Israel's presence in space is defined primarily by a network of Earth observation, communication and reconnaissance satellites. But Hershkowitz notes that his nation takes the overall enterprise of scientific research quite seriously. Israel leads the world in terms of percentage of GDP spent on research and development, and he notes that by some criteria its space program is fairly advanced.
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> "As in most countries of the world that have space programs, things started from the military, mainly observation satellites. The focus on surveillance continues today. Israel is certainly not alone in accessing the ultimate high ground for observation purposes, nor in entangling its defense needs with its peaceful aims. NASA's Space Shuttles ferried 10 or so secret Department of Defenses payloads to orbit during the 1980s and 1990s, even as the shuttles carried out other unclassified missions for scientific aims. Hershkowitz estimates that 'close to half of what we invest nowadays in space has to do with scientific applications and civilian applications,' such as monitoring water pollution and soil conditions for agriculture. But he acknowledges that Middle East turmoil will ensure that reconnaissance remains a top priority.
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> "Israel fielded its first astronaut, Israeli Air Force colonel Ilan Ramon, in 1997, but the mission ended in disaster when space shuttle Columbia broke up over Texas in 2003, killing all seven crewmembers. According to Hershkowitz, Israel has no immediate plans to recruit a second astronaut.

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[10] Matson, John. "Israel's Science Minister on Space Technology–for Peaceful and Militaristic Aims." Scientific American, May 10, 2012. http://blogs.scientificamerican.com/observations/2012/05/10/israels-science-minister-on-space-exploration-for-peaceful-and-militaristic-aims/

"Usually the public is very fascinated by human missions, and by astronauts. But you know, one of the reasons that the United States has decided to abandon its human programs and does not use the Shuttles anymore, and as I said, when they have to send astronauts to the International Space Station they use Russian shuttles, the reason is that I would say scientifically and even technologically, manned missions have ceased to be interesting. Of course, you know, it's nice to have an astronaut, but it really doesn't help the strategic needs of the state of Israel. It is possible that in a certain stage we will have another Israeli astronaut ... but we don't have right now much interest in that. We have other priorities."

A civilian space program

Nevertheless, in 2010 Israel announced plans to invest $77.5 million over five years to accelerate its civilian space program. Israeli President Shimon Peres, a strong supporter of Israeli aerospace initiatives for years, said he expects the industry to develop into a major source of business, Haaretz reported Friday.[11]

Peres and Prime Minister Binyamin Netanyahu tasked government officials to develop a national space program to help the 25 Israeli firms in the civilian space sector expand their market. The plan was drafted by a team of scientists and economists that includes Prof. Haim Eshed, head of the Defense Ministry's Space Division, and the director-general of the Science and Technology Ministry, Menahem Greenblum.

The international space industry is undergoing major changes, including privatization, Israeli officials noted, adding the civilian space market is worth an estimated $250 billion a year. Sources within the Defense Ministry told Haaretz Israel could capture up to 5 percent of the market. Despite Israel's advanced technology, sales of its space platforms over the last 20 years have totaled less than $2.5 billion.

An article in the Jerusalem Post notes that the multi-year plan calls for the government to annually increase support for space research and development. This investment would focus on new platforms – primarily Israel's niche market in "mini satellites" – intended to yield billions in sales.[12]

"We have the assets, but we are not marketing them," said Eshed.

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11 http://www.space-travel.com/reports/Israel_to_launch_civlian_space_program_999.html

12 Katzlast, Yaakov. "PM set to okay space R&D program." *The Jerusalem Post*, August 13, 2010.

The plan envisions stepped-up sales beginning by 2015. However, Israel will not sell its top-of-the-line payloads and platforms; these it will retain for the Israel Defense Forces.

Miniaturization of satellites

Much of the investment will focus on the miniaturization of satellites and their payloads. Israel is also developing nano satellites, and plans to launch the "Incline," its first nanosatellite, which will weigh a mere 12 kg. This prototype will serve as a relay for data transfers, but could also carry miniature cameras in the future.

Recently ISA and CNES of France reached an agreement to jointly work on a new project to design and construct an innovative micro-satellite and a ground station for scientific purposes. The micro-satellite would incorporate a multi-spectral camera for Earth observations and a ground station for imaging processing, and demonstration of an electrical propulsion thrust system examining its maneuverability potential.[13]

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[13] Adapted from http://www.most.gov.il/English/Units/Israel+Space+Agency/About+ISA.htm