Space Exploration Momentum Moves East

by Marsha Freeman

China's stunning 14-minute spacewalk during the three-man Shenzhou VII mission in September, shown live worldwide on television, symbolizes the shift in focus of space exploration from the United States, Russia, Europe, and Japan, to the new space nations of China, India, and South Korea.

Commentators who try to denigrate Chinese space accomplishments say that what China is doing in manned spaceflight, the United States already did in the 1960s. But in an important way, that is precisely the point. Today in China, the strides being made in space have captured the imagination of a generation of young people and increased interest among students in studying science and engineering. Space missions have led to the building of new science museums, increased national pride, and optimism about the future.

A look at what China is doing recalls the U.S. excitement around space during the 1960s Apollo program years. In early November, a full-scale model of the Shenzhou VII spacecraft was displayed at the 7th China International Aviation and Aerospace Exhibition in Zhuhai, Guangdong Province. As shown on Chinese television, visitors—young and old—eagerly climbed inside the model of the module, to see what it was like to be an astronaut.

Then, on Nov. 7, in the Great Hall of the People in Beijing, Chinese President Hu Jintao and Premier Wen Jiabao honored the Shenzhou VII crew. They described the mission as a "moment of joy and pride for the astronauts . . . and those who have contributed to China's historical space-walk mission." With obvious reference to Neil Armstrong's history-making step onto the lunar surface nearly 40 years ago, spacewalk astronaut Zhai Zhingang proudly described his accomplishment as "the first time that a Chinese national left his footprint in space."

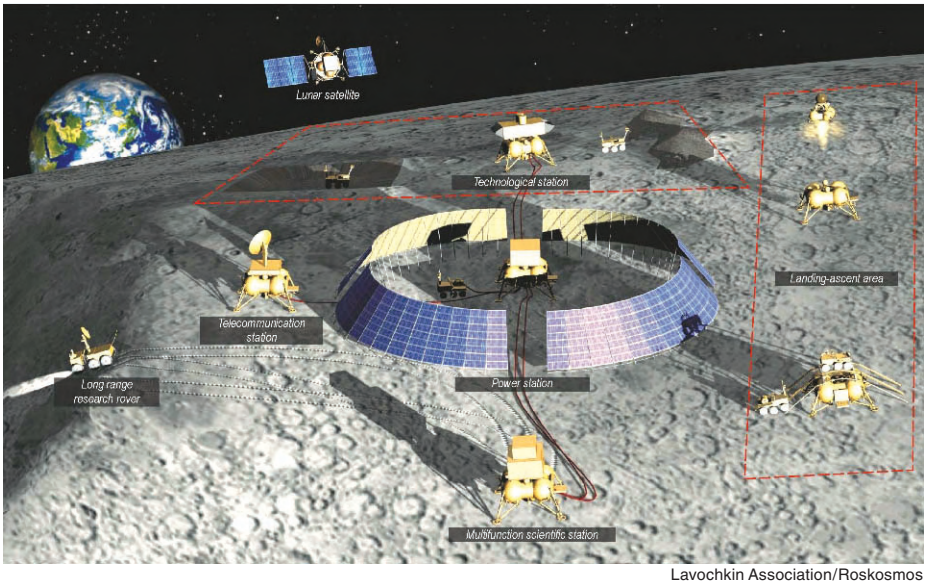
China is just one of the new Asian nations exploring space. India has under way its first deep-space mission to the Moon, Chandrayaan-1. South Korea is also becoming a space power, having sent its first astronaut scientist aboard a Russian Soyuz last April, to spend 11 days on the International Space Station.

During a post-flight visit to Hong Kong, the three Shenzhou VII astronauts talked with students at a public forum, and opened an exhibition about their mission. The success of the brief space walk during the Shenzhou VII mission has prepared China's space program for the next goal—the docking and rendezvous of spacecraft in orbit, and the deployment of a small space station.

Inset: a videograb of a Shenzhou astronaut live in space.

Waking up the 'Old Men' of Space

The Asian focus of space momentum, enthusiasm, and optimism was striking in the presentations at this year's International Astronautical Congress in Glasgow, Scotland, Sept. 29-Oct. 3, which gathered more than 1,000 scientists, engineers, and space policy makers and planners. It was also clear that the impressive accomplishments and ambitious plans of the Asian space powers has goaded the "old men" of space to take a fresh look at



Lavochkin Association/Roskosmos

Russia is planning a three-phase lunar program, which culminates in a manned base. To prepare for men on the Moon, infrastructure will be placed on the lunar surface, including launch and landing areas, a power generating station, scientific platforms, communications links, and rovers, as seen in this artist's rendition.

their own plans.

Russia, the United States, Japan, and Europe are now under pressure to do more from the "young" and emerging space powers in Asia. This has resulted in long-overdue reassesments of future space plans.

Western Europe and Japan bowed out of developing manned launch capabilities in the 1990s, although they already had decades of experience in developing space technology. The European Space Agency is now considering either partnering with Russia on a next-generation manned space vehicle, or man-rating its own Ariane 5 rocket and developing a manned version of the Automated Transfer Vehicle, sent to the International Space Station earlier this year. In the 1990s, Europe stopped development of both the German Sanger spaceplane and the French Hermes design.

Like Europe, Japan has flown astronauts on Russian and American spacecraft, and has built a laboratory for the International Space Station, but in the 1990s, it halted development of its Hope spaceplane. Recently, with China flying taikonauts in space, India joining in deep-space lunar exploration, and South Korea soon to become a space power, Japan, like Europe, has been shamed into trying to regain some momentum.

In March 2005, the Japan Aerospace Exploration Agency released its "JAXA Vision 2025" document. Included for the first time, is the goal to "establish the capability … to transport goods and humans easily to outer space." The Vision document sees Japan's human space endeavor as closely tied to the future utilization and exploitation of the resources on the Moon.

Russia, which saw its civilian space program nearly destroyed during the pre-Putin "IMF years" of economic jihad, is now attempting to rebuild its space design, engineering, and manufacturing infrastructure. It plans to accelerate this effort by embarking on new projects with the help of international partners, including those from Asia.

But as nervously noted by speakers at the Congress, the world is in the midst of an existential financial and economic crisis. Carrying out the ambitious space exploration missions that are planned, will require new international policies, and a new financial architecture based on investments, not in speculation, toxic waste, and bank bailouts, but infrastructure, science, and new technology.

Building Space Infrastructure

China is not interested in any "flash-in-the pan" space spectaculars, no matter how many commentators say that China is in a "space race." This is evidenced by its multi-decade plans for developing and deploying the full range of infrastructure needed for manned, scientific, planetary, and Earth applications missions, just as the United States has done.

The Shenzhou VII mission tested such new infrastructure. The nerve center of China's space program, the Beijing Aerospace Control Center, for the first time, controlled more than one mission in real time. While keeping track of, and communicating with, the three Shenzhou VII crew members, the Center was also tracking China's Chang'e lunar orbiter. More than half of the technicians working at the Center are under the age of 30, the director, Zhu Mincai, told *Xinhua*.

In order to launch any spacecraft heavier than the current first-generation Shenzhou model, China must develop larger launch vehicles. This is under way. A year ago, China announced that a new series, the Long March 5 rocket, was under development. The rocket, able to carry 25 tons of payload into Earth orbit, will be used to send lunar rovers, large satellites, and stations into space. It will be ready in 2014.

A year ago, China also announced that a fourth rocket launch center would be built on the southern island of Hainan, to be completed in 2012. It will accommodate the larger versions of the Long March rockets. From this southern latitude, China will be able to launch larger spacecraft more efficiently. According to *People's Daily*, the site will include a "space manor," as an auxiliary facility, to house the breeding of mutated seeds that have been in space. And, for the first time, there will also be a visitors' center.

In the early days of Soviet and American manned space flights, communication with crewmen was only possible when a spacecraft was directly over a ground- or sea-based station. During the Space Shuttle program, the U.S. launched as series of Tracking and Data Relay Satellites, to allow nearly uninterrupted communications between the ground and the Shuttle crew. In April, China launched its first geosynchronous relay satellite, Tianlian 1, to improve orbit-to-ground communications. This has increased mission control's contact with

China's astronauts from 12 percent to 50 percent of each orbit.

China has launched a range of Earth-orbiting satellites, for remote sensing, communications, science, and technology development. On Oct. 25, and again on Nov. 5, 2008, research satellites went into orbit, in quick succession. The small Chuangxin 1-02, developed by the Academy of Sciences, will collect and relay hydrological and meteorological data, and be used in disaster relief. The Shiyan Satellite 3, developed by the Harbin Institute of Technology, will test technologies for exploring the atmosphere.

China has in the works a system of navigation satellites, similar to the American Global Positioning System and Russia's Glonass constellation, which it expects to be operational and cover all of Asia, by 2010. The Compass/Beidou system will be compatible with the GPS and Glonass systems, and will have 5 geosynchronous satellites and 30 in a lower-Earth orbit.

The same multi-decade approach that China is using in its Earth-orbital missions (unmanned and manned), is seen in its multi-phase lunar exploration program. At the International Astronautical Congress in Glasgow, for the first time, Chinese scientists released data that have been collected over the past year by its Chang'e lunar orbiter.[1] Although NASA has initiated an International Lunar Network effort for lunar-exploring nations to coordinate their robotic exploration of the Moon and divide up responsibilites for new spacecraft, China is not included. This exclusion has encouraged China to proceed with its own effort, while seeking bilateral cooperation with other nations.

According to the top officials and scientists in its lunar program, China's next step in its three-phase program will be the launch of Chang'e-2. During the early November International Aviation and Aerospace Exhibition in Zhuhai, Yan Zhongwen, from the Academy of Sciences, explained that this second lunar mission would deploy two landers, carrying two rovers, which would be placed at different places on the Moon, "to get a more complete picture of its surface." At that exhibition, visitors watched a model of the rover unfold its solar panels and move around the simulated lunar surface.

At the Glasgow Congress, China National Space Administration (CNSA) head, Sun Laiyan, reported that the next Shenzhou missions will demonstrate the ability to have two spacecraft rendezvous and dock, a prerequisite for assembling a space station in orbit. A small laboratory, he said, is planned for 2011.

On Nov. 12, the Chinese State Administration of Science, Technology, and Industry for National Defense, which oversees the lunar program, unveiled the first full map of the Moon that was created from photographs taken by Chang'e-1 over the past year. Experts described it as the most complete map, and the richest in detail. It was also announced that Chang'e-2 would be launched before the

Shenzhou VII: China's First Space Walk

Coming just two days after the successful completion of a stunning 14-minute spacewalk carried out during the three-man Shenzhou VII mission, the opening of the International Astronautical Congress in Glasgow began with congratulations to China on this accomplishment. A clamor for more details about the Shenzhou VII mission led to the last-minute scheduling of a "late-breaking news" session, Oct.2, presented to a packed auditorium.

Dr. Li Ming, board member of the Chinese Society of Astronautics, explained to the audience that China's interest in manned spaceflight went back to the 1960s. But the studies done in the 1960s, he said, were cancelled in the next decade. Then, starting in the 1990s, he said, the "technology has developed very rapidly."

While showing spectacular film footage of the Shenzhou VII mission, Dr. Li reported that two hours after China's first-ever space walk, a small, less-than 80-pound accompanying satellite, developed by the Chinese Academy of Sciences, was released from the main craft. Subsequent articles describing the mission have noted that this BX-1 subsatellite orbited near the Shenzhou, taking more than 1,000 close-up photographs. After the astronuats had returned to Earth, the BX-1 subsatellite was commanded from mission control to circle the Shenzhou's orbital module, which stays in orbit empty, after the crew leaves.

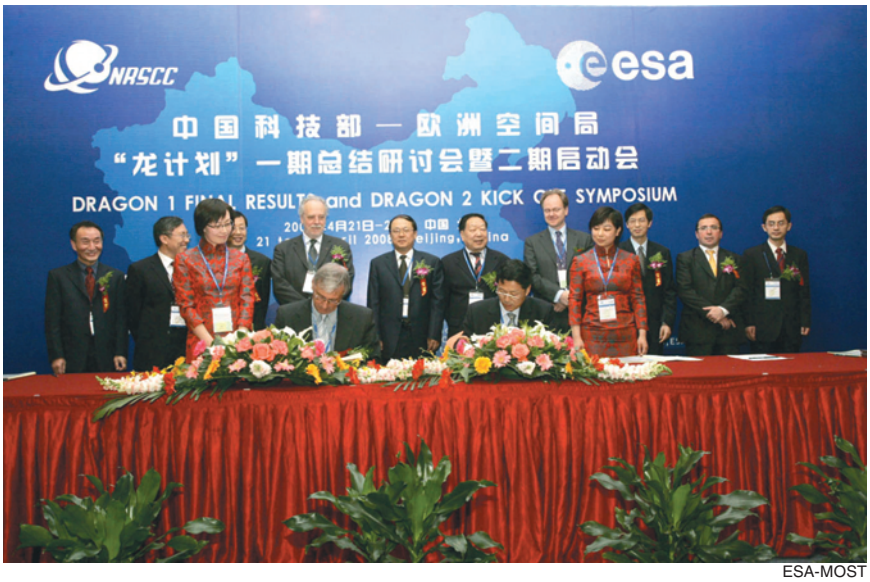
Through this exercise, China demonstrated the ability to fly two spacecraft safely in close proximity; remotely maneuver a spacecraft, with a high degree of accuracy; and use the subsatellite to relay data from the orbital module to the ground.

Although Chinese space officials are not often specific about the next steps in their manned space program, it is generally agreed that China will orbit a small space lab next, known as Tiagong 1. It will receive visits and deliveries of equipment from at least two unmanned Shenzhou spacecraft.

After Tiagong 1 is in orbit, Shenzhou VIII, launched unmanned, will rendezvous and dock with the laboratory. It is possible multiple dockings and undockings will be carried out, for practice. Shenzhou IX would be the second, unmanned ship to dock with the lab, and Shenzhou X would be the next manned mission, delivering a crew to live and work in space.

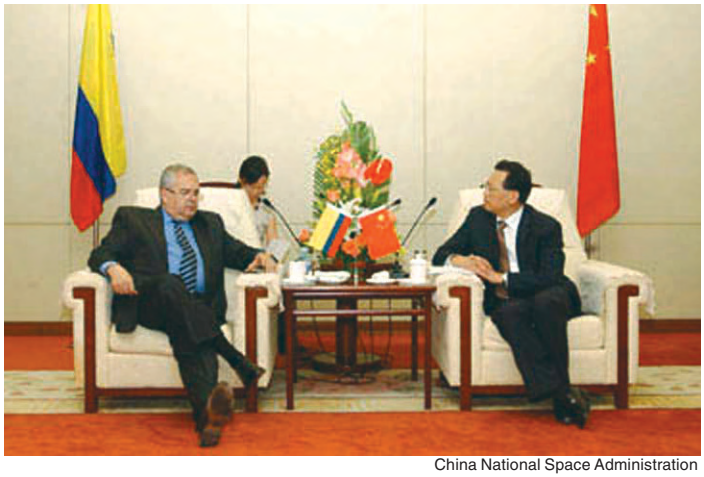
Qi Faren, who designed the Shenzhou craft, told the *Shanghai Daily* in September that the three craft would be launched in quick succession, with intervals of less than a month between them. If all goes according to plan, the three flights should take place in the next two or three years. This first space lab would be manned for short periods of time, or man-tended, and used to master the complex skills needed for a later permanent manned presence in orbit.

1 For details on the scientific goals of the Chinese, Indian, Russian, Japanese, and U.S. lunar missions, see, "Mankind Is Going Back To the Moon!" *21st Century*, Spring-Summer 2007.



ESA-MOST

As part of its international cooperation outreach, Zhang Guocheng, Director of China's National Remote Sensing Center (r), and Stefano Bruzzi, who heads the European Space Agengy's Earth Observation Program Planning and Cooperation Service, signed the protocol for Earth remote sensing cooperation in the Dragon 2 program, in April 2008.



China National Space Administration

Sun Laiyan, Administrator of China's National Space Administration (r), meeting June 4 in Beijing with Carlos den Hartog, Colombia's Ambassador to China. Sun expressed China's interest in cooperation in space technology, as part of its outreach to Ibero-America.

end of 2011, and involve testing five new core technologies, such as soft landings. After the presentation of the map, lunar chief scientist Ouyang Ziyuan called for scientists from Asia to work together, saying that China, India, and Japan have the same goals, and should step up cooperation to "deepen mankind's understanding of the Moon."

International Outreach

China has been able to reap economic rewards for its civilian sectors from its systematic and focussed developments in space exploration. This is something the Soviet Union was never able to master, although this approach led to decades of "spin-off" technologies and real growth, in the U.S. economy.

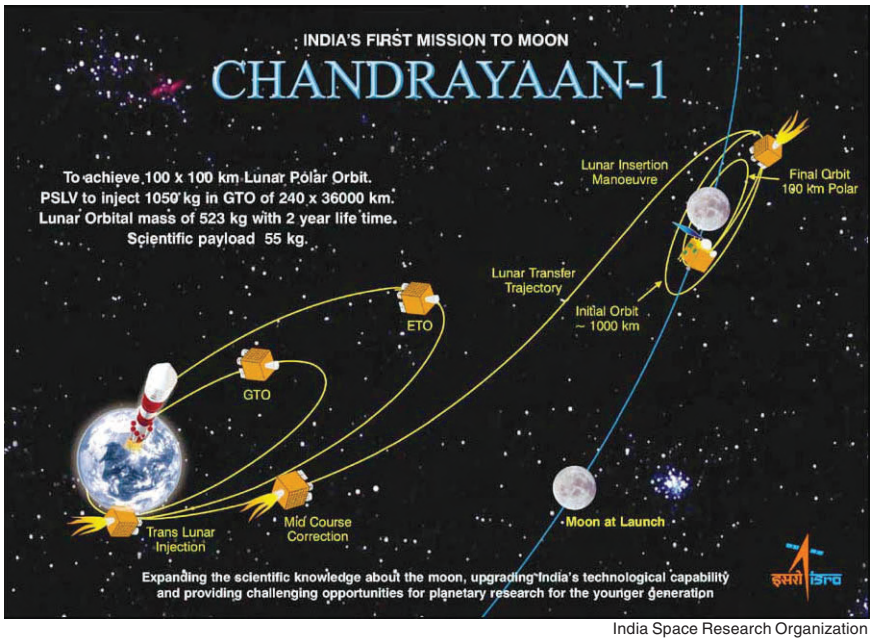
The day after the Shenzhou VII liftoff, *Xinhua* summarized some of the economic benefits. Data from the China Aerospace Science and Technology Corporation (CASC), show that of the more than 1,000 types of new materials China has developed in recent years, 80 percent were driven by the requirements of space technology. Nearly 2,000 items have been transferred from the space program to civilian economic agencies, and at the end of 2007, more than half of the revenue of CASC was from civilian sectors. Specific high-technology bases have been established to transfer space technology to industrial centers. "How much space technology can radiate to civil industries is unmeasurable," an economics professor at Beihang University told *Xinhua*.

To bring additional resources into its civilian space program, to increase its international prestige, and to broaden space cooperation, China has become a provider of satellite and launch technology to developing nations. On Oct. 30, China launched a communications satellite for Venezuela, its first for a nation in Latin America. The satellite, built in China, was monitored from a new control center in Venezuela, staffed by dozens of Chinese and Venezuelan technicians. The spacecraft, which will be used for communications, remote learning, and telemedicine, will have coverage from southern Mexico to Chile and Argentina, with services being offered to neighboring nations.

The satellite development included the participation of 90 specialists from Venezuela, who were trained at the Beijing University of Aeronautics and Astronautics, in a technology transfer program. Last June, the head of China's space agency met with the Colombian ambassador to China in Beijing to discuss space cooperation, and China has a long-standing joint space satellite research program with Brazil. In March, the new head of the Brazilian Space Agency, Carlos Ganem, stated at his inauguration ceremony, that Brazil would intensify its cooperation with China.

Not surprisingly, a major focus of China's international initiatives has been in Asia. It has worked on bilateral projects, such as a new agreement to develop a telecommunications satellite and ground station for Laos. Its regional project is the Asia-Pacific Space Cooperation Organization (APSCO), which was established by China, Thailand, and Pakistan in 1992. Since then, Mongolia, Iran, Peru, Bangladesh, Indonesia, and Turkey have joined, and Argentina, the Philippines, Malaysia, and Ukraine are considering membership. At the International Astronautical Congress in Glasgow, Chinese space head Sun Laiyan said China would include the training of foreign astronauts as part of APSCO's program.

Reflecting on the potential for China becoming a global space power, Russian



India Space Research Organization

When the Chandrayaan-1 spacecraft went into lunar orbit around the Moon on Nov. 8, India became the fifth nation to send a spacecraft to the Moon.

Academy of Cosmonautics corresponding member Andrei Ionon told *RIA Novosti* on Oct. 23: "Today we [Russia] must think about who our key partners in space exploration are. This may be the right moment to start looking eastward, rather than westward."

Russia and China have developed a close cooperative relationship in space development, since 1992. Russia has helped train Chinese astronauts, sold China spacecraft, spacesuits and other technology, and helped China carry out the successful space walk during the recent Shenzhou VII mission. Over the past eight years, Russia and China have signed nearly 100 specific contracts, under 10 cooperative agreements.

Next year, Russia plans to launch a mission to Mars's moon, called Phobos-Grunt (Grunt means soil). China was invited to provide a microsatellite to fly with the Russian Mars spacecraft, which it has named Yinghuo-1 (Firefly). The small Chinese satellite will be released from the Russian Phobos-Grunt ship, and will orbit Mars to study its atmosphere.

India's First Lunar Mission

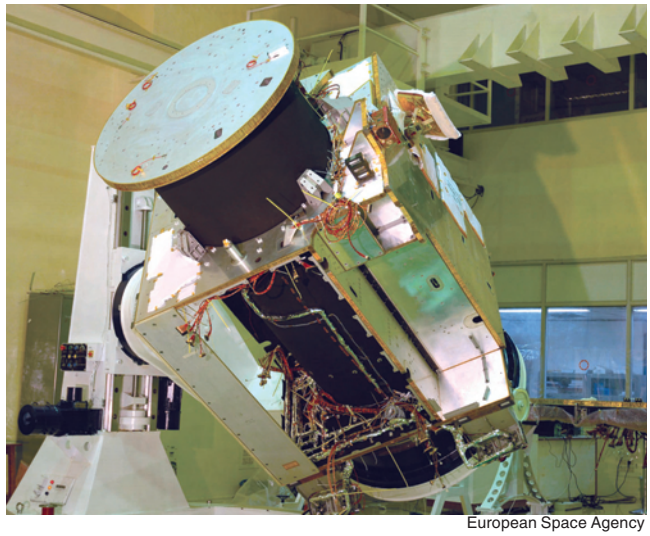
India has had an impressive space program for decades, but, until recently, it has focussed almost exclusively on the application of space technology for the economic development of the nation. These have included the extensive use of Earth-orbiting satellites for weather forecasting, telemedicine, distance learning, communications, and remote sensing.

Just days after the conclusion of the Astronautical Congress in Glasgow, on Oct. 22, the Chandrayaan-1 (Moon craft) spacecraft was sent on its mission to the Moon, launched on an uprated version of India's Polar Satellite Launch Vehicle. With help from NASA, through free access to its Deep Space Network, the Indian Space Research Organization, ISRO, is able to augment its limited space communications capability, enabling it to receive scientific data from Chandrayaan-1 around the clock. More than half of the scientific instruments aboard the spacecraft were contributed by foreign partners.

Also aboard the mother craft was a 64-pound impactor, which was released and

European Space Agency

Before the Chandrayaan-1 spacecraft was launched, it underwant a stringent series of ground tests, to decrease the risk of an unexpected failure during the mission.



European Space Agency

The Indian Chandrayaan-1 spacecraft during the integration of the scientific instruments and components with the main structure. The payload panels, where remote sensing instruments were to be mounted, are at right. The panel that holds the small impact probe is located at the top.

landed on the Moon. It relayed imagery and other data to the mother ship, which relayed it to Earth.

On November 8, ISRO announced that Chandrayaan-1 had successfully entered lunar orbit, after 11 days in flight. The final orbital-insertion maneuver made India the fifth country to send a spacecraft to the Moon.

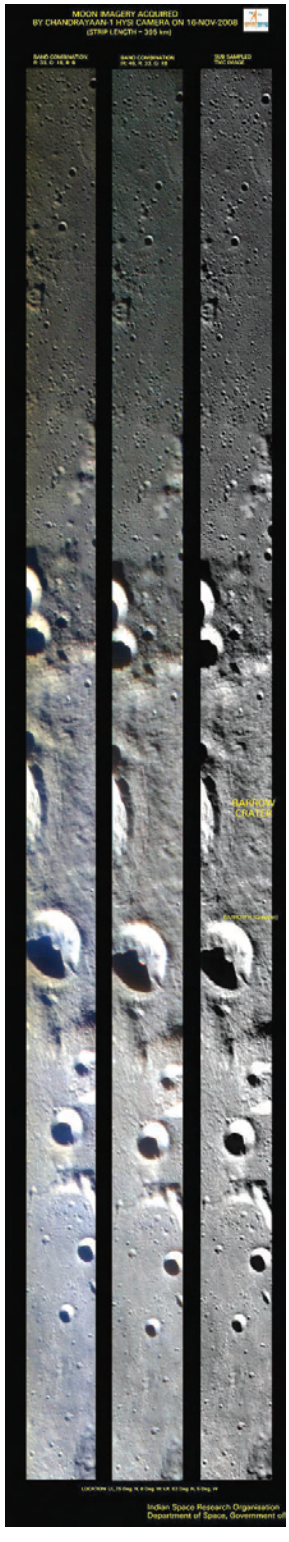
India is now carrying out conceptual studies for its second lunar mission, dubbed Chandrayaan-2. The overall configuration of the mission has been finalized and the scientific instruments the spacecraft will carry will be chosen in the next few months. The project was approved by the Indian Cabinet on Sept. 18. Chandrayaan-2 will consist of both an orbit-

European Space Agency

◀ *(a) Technicians ready the 64-pound impactor that Chandrayaan-1 carried to the Moon. It was jettisoned from the mother craft on Nov. 14, and landed on the lunar surface, marked with the Indian flag.*

European Space Agency

▼ *(b) Fully complete, and wrapped in protective gold foil, the impactor is hoisted to be mated with Chandrayaan-1.*



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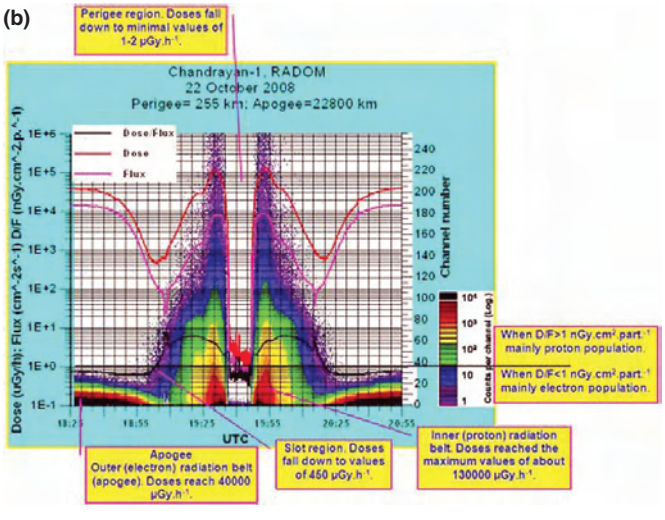


In mid-November, Chandrayaan-1 began taking photographs and collecting data about the Moon. High-resolution photographs (a) were taken in different wavelengths, to highlight various lunar features. The measurement of radon, a daughter of uranium which escapes from the lunar interior (b), will help scientists determine the history of the Moon.

Marsha Freeman

◀ *In April, Dr. Yi So-yeon became South Korea's first space-faring astronaut. She spent 10 days aboard the International Space Station, having arrived on a Russian Soyuz. At the International Astronautical Congress, Dr. Yi was part of a 50-person delegation from Korea. She is shown here in traditional dress, in a "Korea night" reception at the Congress.*

Korea Aerospace Research Institute

To fly on the Soyuz, Yi underwent survival training, as required for all Russian and guest cosmonauts who fly on Russian space vehicles. This includes preparation for an emergency landing at sea.

er and a lander. In November 2007, India and Russia agreed to carry out a joint mission, with Russia building the rover, which will have a robotic arm to collect samples and conduct *in situ* analysis of the soil. Other countries have been invited to participate, and NASA has expressed an interest in providing scientific instruments for the orbiter.

ISRO's Chandrayaan-1 program director, M. Annadurai, reported that for the follow-on mission, ISRO is considering a soft-landing technique, rather than a hard landing, because India "should be working on technologies that will be part of a proposed Moon base. If we are to become a developed country by 2020," he said, "it will be crucial for us to develop such technologies." Chandrayaan-2 is planned for launch in 2011-2012.

India is also planning to extend its exploration of space to Mars; an ambitious extension of the lunar mission. "The science which we plan to do on Mars has to have an international context," Chandrayaan-1 principal scientific investigator, J. N. Goswami, told the Astronautical Congress in 2007, at its meeting in Hyderabad, India. ISRO's Advisory Committee for Space, in its plan to the year 2020, has recommended a Mars orbiter, to be developed in the 2009-2017 timeframe.

ISRO chairman Nair announced Nov. 10 that, building on the success of Chandrayaan-1, India has approved its first mission to the Sun, which is to be a small probe, called Aditya. India's first astronomy satellite, Astrosat, will be launched in 2009, ISRO also reported, to study the X-ray emissions of stars, galactic nuclei, and the core of the Milky Way.

India is on the path to create a broad-ranging space exploration and science program.

A New Player: South Korea

Although its progress has not attracted too much international attention (with the Western press more interested in manufacturing a "space race" among China, India, and Japan), South Korea is becoming a new space power in Asia. Last April, Korea's first astronaut, scientist Yi So-yeon, went into space aboard a Russia Soyuz, and spent 11 days on the International Space Station. Her flight generated widespread excitement throughout the country. More than 36,000 Koreans had applied for the mission, which was the result of an agreement signed with Russia in 2005.

While he was visiting Russia's Baikonur Cosmodrome for Yi So-yeon's launch, Korean Air Force Chief of Staff, General Kim Eun-gi, said the Air Force will put forward a plan to recruit spacecraft pilots in the next 9 to 12 years. which Korea is discussing with the United States, China, and Russia.

South Korea plans to continue to develop its own space industry and skills, and is in the process of completing a launch facility, the Naro Space Center. It has previously designed and built its own satellites, but until now, they have been launched by other countries.

Also under development, is the two-stage Korea Space Launch Vehicle (KSLV). It is a cooperative venture, in which Russia is building the first stage, based on its new Angara rocket, and Korea is building the upper stage. The KSLV will be launched from the new Naro center. A successful launch would make South Korea the ninth country to launch a satellite from its own soil.

South Korea and the United States annnounced at a meeting in Seoul on Oct. 30, that the two countries signed a

Korea Aerospace Research Institute

Korea has developed an Imager (GOCI) instrument, which will be launched aboard the Communications Ocean and Meteorological Satellite, in June 2009. GOCI was developed in cooperation with France, and the remote sensing satellite will be launched from the European site in French Guiana. Here, an artist's depiction of the satellite.

statement of intent for future space cooperation. Discussions will include possible joint activities in space exploration, Earth science, planetary science, human space flight, and aeronautics. Korea has been especially interested in particpating in the NASA-initiated International Lunar Network (ILN), a multinational project to deploy the next-generation of lunar surface infrastructure. Korea signed a Statement of Intent to participate in the ILN, at NASA's Ames Research Center last July.

Kim Chang-woo, director General for Space Technology at the Ministry of Science and Technology, explained South Korea's intentions in a February article: "The Korean government recognizes space technology as a national strategic stepping-stone. When the Space Development Mid-Term Plan was established in 1996, the space development budget was 59.2 billion won. It was increased fivefold to 316.4 billion won in 2008." Currently there are more than 1,700 people were working in Korea's space sectors.

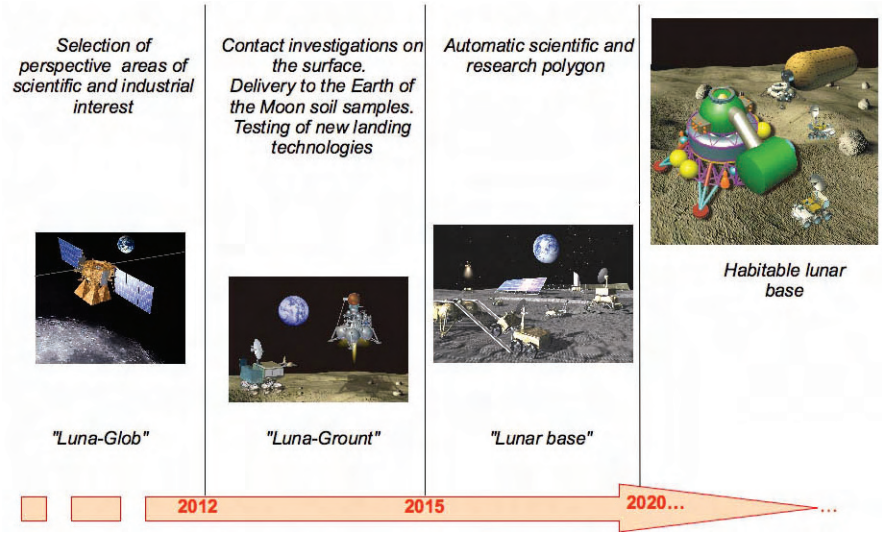
South Korea, Kim stated, has developed a Detailed Roadmap for Space Project Execution which includes the launch of a Lunar Orbiter in 2020, and a Lunar Lander, in 2025. He explained: "It will be difficult for us to launch a lunar satellite.... We are making progress towards further space development step by step.... We want to raise the dreams and hopes of the young generation for the space program."

The Korean government is well aware of the progress being made by its Asian neighbors, which increases international prestige in each case. But South Korea's space program also has a unique political aspect. Before her flight last April, Yi So-yeon said she hoped her flight would encourage closer ties between the divided Koreas, and help reconciliation. "I hope someday they will be one, and I hope the North Korean people will be happy with my flight," she said.

Russia: Rising from the Ashes

One of the great crimes of the international financial institutions, whose advice Russia foolishly followed after the 1989 fall of the Soviet Union, was draconian cuts in Federal spending in science, research and development, and in the space program. Russia's Buran reusable shuttle, and its Saturn-V-class heavy-lift rocket, the Energia, were mothballed. Funding was slashed for space science and planetary missions. Space design bureaus and manufacturing plants tried to hold on to their most precious resource—their people. As the director of Russia's Space Research Institute remarked earlier this year: "With the brain drain of the 1990s, we kind of lost a middle generation who could now transfer their experience to young specialists. It is almost like during the war. We have a kind of generation gap."

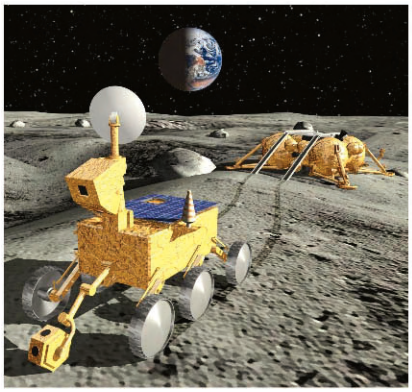
Russia is determined now to rebuild that capability, in a policy that comes directly from the top.



RUSSIAN MOON EXPLORATION ROADMAP

This roadmap for the next two decades of Russian lunar exploration missions was presented by Olga Zaytseva at the IAF Congress. The Luna-Glob orbiter will launch in 2011, followed by landers, rovers, the return of samples of soil, and the initial infrastructure for a manned, habitable lunar base.

Source: Russian Robotic Lunar Exploration Program, Dr. Gregory Poloschuk, et al., Lavochkin Association



Scientific tasks	Contact in-situ investigations in the near-Pole region of the Moon
Launch year	2012 (TBD)
SC composition	– lander – rover
SC mass	1200 kg
Rover mass	58 kg
Rover lifetime	1 year

'LUNA-GLOB/2' LANDING MISSION

The second Lunar-Glob mission, tentatively projected for the 2012 timeframe, would place a lander near a lunar pole, which would deploy a rover.

Source: Russian Robotic Lunar Exploration Program, Dr. Gregory Poloschuk, et al., Lavochkin Association

In line with former Russian President, and now Prime Minister, Vladimir Putin's stress on the rebuilding of industrial and scientific infrastructure, the Russian space agency Roskosmos announced in July that the agency's budget for 2009 would be double that of the previous year. In addition to funding for the manned program, support for Earth remote sensing and space science will increase.

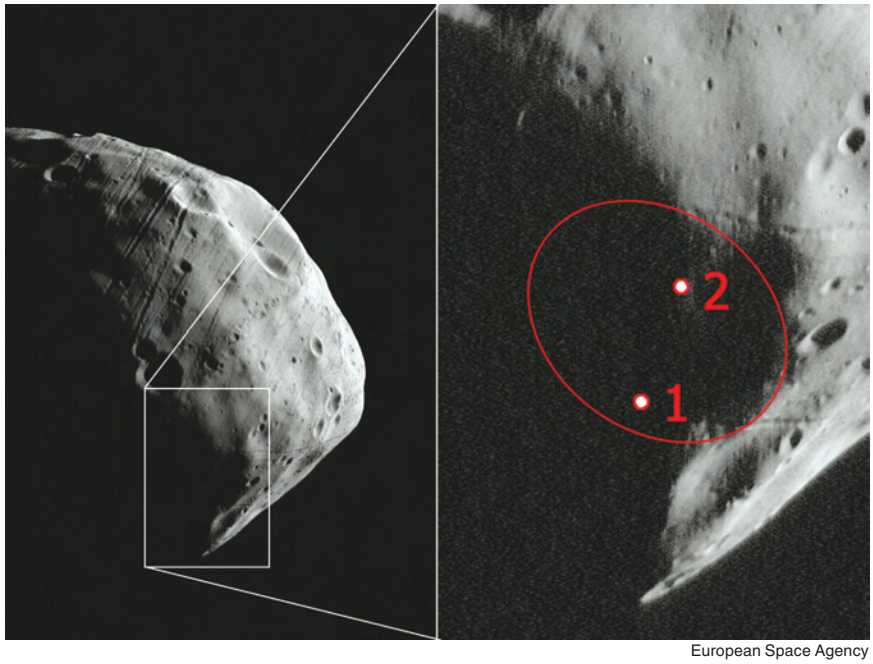
At a meeting on Oct. 21, Prime Minister Putin emphasized the importance of the Russian space industry for the development of the domestic economy. He cited examples where technological advances are being applied in the transport sector, agriculture, and manufacturing, but stressed that this has not been applied "on a systematic basis." He pledged that over the next three years, more than 200 billion rubles ($7.68 billion) would be allocated from the Federal budget for the space industry.

In addition to meeting its commitments to the International Space Station, a high-priority program is the construction of a new launch facility at the mothballed Svobodny military site, to be called Cosmodrome Vostochny (the name means Eastern). As part of the overall plan to refocus development on Russia's far east, new space infrastructure is being built, and the launch of the first rockets is scheduled for 2016. In 2018, Russia hopes to shift manned launches there, from Baikonur in Kazakhstan.

The workhorse of the Russian manned space program for the past 50 years—the Soyuz—will be replaced by a more modern version, and eventually, by an entirely new spacecraft. Russia is also now completing its navigational satellite constellation, Glonass, and will launch its first weather satellite, Meteor-M1.

Until recently, there have been mixed signals about what Russia is planning to do in space exploration. At the International Astronautical Congress, a concrete, and exciting perspective for Russian lunar and Mars exploration was put forward by government space representatives. As Alexander Medvedshikov, the deputy head of the Russian space agency, Roskosmos, said in Glasgow, the more expensive endeavors, such as manned landings on the Moon, will be pursued through international cooperation, at the same time that Russia is rebuilding its domestic infrastructure.

During a session at Glasgow on "Moon Exploration," Olga Zaitseva, deputy director for planetary exploration at the Lavochkin Design Bureau, which builds Russia's robotic spacecraft, outlined the upcoming Russian lunar missions. The first Lunar-Glob craft, scheduled to be launched in 2012, will send an orbiter to the Moon. This mission will also include a set of four small penetrators to study the subsurface of the Moon, which may



European Space Agency

The European Space Agency flew its Mars Express orbiter to within 60 miles of the moon's surface to take photographs, in order to help the Russian Space Agency find a suitable landing spot on Mars's tiny moon, Phobos. The inset at right shows potential landing regions and sites for Russia's Phobos-Grunt sample return mission.

be developed with Japan. Technology from the Phobos-Grunt mission to Mars will be applied to the lunar mission, to the maximum extent possible, Zaitseva said.

There will be a second Lunar-Glob mission, Zaitseva said, which will deploy a lander and a rover, for a one-year mission. The landing site will be at the south pole of the Moon, with investigations to detect water ice, and to study surface magnetic anomalies. Russia will make use of its extensive lunar experience in the 1970s, in developing the lander and rover. International cooperation is also expected in this second Lunar-Glob mission.

The major, second phase of Russian lunar exploration, termed Lunar-Grunt, will begin with the delivery of a heavy long-range rover that will be equipped to collect soil samples, and do primary chemical processing. It will also include a robotic complex to transfer the samples to a future vehicle, and it will deploy a radio beacon to aid in precision landing of a second craft to follow. In the second phase of the Lunar Grunt series, samples that have been collected from the Moon will be transferred to an ascent vehicle, which will take off from the Moon's surface and deliver the samples to Earth. This two-mission Lunar-Grunt second phase is envisioned in the 2014-2015 time frame.

A fascinating proposal for a possible third phase was also described by Zaitseva of a lunar base, or "polygon," which would be delivered unmanned to the Moon. This automated technology complex would be used to support later manned missions, and could include transportation, communications, and power-producing functions, and perform "housekeeping" tasks to keep the base in working order until people arrive. It could also include scientific modules, with autonomous scientific stations, long-range rovers, and telescopes.

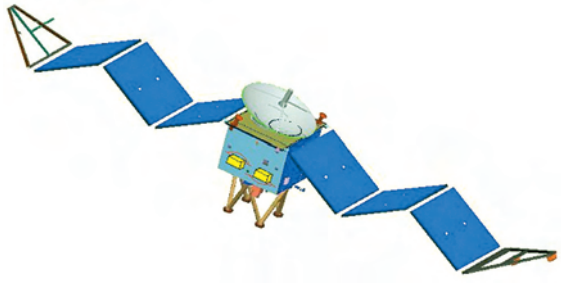
On to Mars!

Russia has suffered an overwhelming number of failures in its robotic Mars program, and nothing has been attempted since the mid-1990s. The Phobos-Grunt mission, slated for liftoff in October 2009, will be Russia's effort to regain momentum in planetary exploration.

NASA

NASA Administrator Mike Griffin, who is passionate about the importance of the human exploration of space, explains that it is not simply a program, but helps define the greatness of nations, and requires a long-term vision, a multi-generational commitment. He is photographed here at the Kennedy Space Center in Florida.

It is an ambitious mission, to land on the tiny moon of Mars, collect samples of soil and rock, and return three to five ounces of the samples to Earth. Through the mission, Russian scientists expect to learn about the early period in the Solar System, when the asteroid belt between Mars and Jupiter was formed, and small bodies, such as the Martian moons Phobos and Deimos, were scattered about.



China's diminutive Yinghou orbiter is hitching a ride to Mars aboard Russia's Phobos-Grunt spacecraft. It will be China's first deep space mission.

From the beginning of the planning for the Phobos-Grunt Mars mission, Russia invited international cooperation in the complex project. In 2006, Russia announced that China would participate, supplying a microsatellite to be carried on the Russian spacecraft. The Chinese Yinghuo-1 will be sent into orbit around Mars before Phobos-Grunt lands on Phobos, and will study the planet's atmosphere. In March 2007, cooperation was affirmed in a formal cooperative agreement, and joint groups were assigned by the two nations to carry out the project.

The French space agency CNES has supplied a gas-analysis instrument package for the mission, to study the molecular composition of Phobos's soil. The European Space Agency (ESA), has also lent a hand. In an effort to help the Phobos-Grunt mission succeed, Europe's Mars Express orbiter took close-up photographs of Phobos, in a series of five flybys this year, the final one skimming just 60 miles above the surface. The high-resolution photographs will be used to help find a suitable landing site for the Russian spacecraft.

Russia has extensive space cooperation with ESA, including the construction of a new launch facility at ESA's space center in Kourou, French Guiana. The new Soyuz lunch pad will provide Russia with a near-equatorial launch site, which increases the amount of payload a rocket can carry, using the same propulsive power. This will allow the launch of heavier geosynchronous satellites than can be lofted from Russia's Plesetsk and Kazakh Baikonur sites. The first two Soyuz-ST rockets are scheduled to be launched from Kourou in early 2009.

For decades, the Soviet Union used its manned access to space to invite foreign nations to fly to Earth orbit. More than 20 years ago, India's only astronaut flew to the Salyut space station. In March 2008, India and Russia announced that Russia has offered to fly one or two Indian astronauts on a Soyuz by 2011. India will need to create new infrastructure to be used in its future manned space program, and the training that the Indian astronauts will receive in Russia will help them in this effort.[2]

In April, the Indian Space Research Organization submitted its formal proposal

2. See "India Takes Its First Step to Put a Man Into Space," *EIR*, Feb. 23, 2007.

JAXA

Using the most sophisticated high-definition technology, Japan's Selene/Kaguya spacecraft took a series of photographs of the Earth rising above the lunar horizon. Click on the link to see the 59-second movie that JAXA created from these stunning images: http://space.jaxa.jp/movie/20080411_kaguya_movie01.e.html

to the government for a first manned mission in 2015, which is awaiting approval. ISRO chairman Madhaven Nair explained that it would use India's geosynchronous satellite launch vehicle to put a crew into low-Earth orbit.

The Challenge

And the United States? The only nation to have landed men on the Moon, robotically visited every planet in the Solar System, and peered into the universe with space telescopes, has been given a "vision," but inadequate resources to carry it out. Lack of support—both political and budgetary—from the Bush Administration has left NASA's Moon/Mars program punctuated with a question mark.

NASA Administrator Mike Griffin has explained to Congress and the Administration what the agency faces: deadlines will not be met in the Moon/Mars program; thousands of highly skilled jobs will be lost during the growing gap between the retirement of the Space Shuttle and the flight of the next vehicle, Orion; other critical infrastructure will be laid to waste; space science and planetary exploration missions will be scaled back, or even cancelled.

In a presentation in Washington on Sept. 24, to celebrate the 50th anniversary of NASA, Griffin remarked that if China successfully launched its Shenzhou VII spacecraft the next day, the number of Chinese people in space would "outnumber the number of Russians and Americans in space," referring to the joint Russian/American crew on the International Space Station. Griffin, who visited China's space facilities two years ago, believes that using the technology already under development, China could launch a manned mission to orbit the Moon, before the United States is ready to return, by 2020.

In an interview with the BBC during a trip to London in July, Griffin added that "it is possible that if China wants to put people on the Moon, and it if wishes to do so before the United States, it certainly can. As a matter of technical capability, it absolutely can."

Grasping at straws, in response to the seriousness of the situation, Congressional representatives and other supporters have tried to concoct a threatening "space race" between the U.S. and China, to try to motivate legislators to support NASA. That is not the reason to explore, as China, India, South Korea, and other nations recognize.

As Griffin has often stated, great nations lead great projects. The commitment that nations make to explore space is one measure of that greatness.