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Mars Phobos Mission Readied As Russia Weighs Goals

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Phobos sample return readied as Putin's government weighs Moon/Mars goals

Printed headline: Russian Exploration

Russia will change its space policy this year to combine robotic and manned planning for the Moon and Mars as increased funding becomes a reality.

The shift is underway as Russia is beginning advanced development of a robotic sample return mission to the Martian moon Phobos. If successful, the three-year flight planned for launch in 2009 will mark the first round trip between Earth and the direct vicinity of Mars.

The Lavochkin spacecraft for the Phobos mission is also the first version of a modern new planetary mission bus with a design that can also be used on other Mars and lunar missions.

Two failed 1988 Soviet Phobos mission spacecraft each weighed 5.5 metric tons. But with modern materials, new computers and electronics, the new Phobos spacecraft weighs only 2 metric tons and will do far more, says Igor Goroshkov, Lavochkin project manager for the flight. This also allows its launch on the cheaper, simpler Soyuz booster, rather than the larger, more expensive Proton.

The budget and mission-planning changes will strengthen Russian technology development and the country's potency for both cooperation and competition. "Now it seems budgets are coming back to normal, there are positive gradients," says Lev Zelenyi, director of the famed Russian Space Research Institute (IKI).

The new Phobos mission is IKI's largest sensor development project. European Space Agency and French CNES scientists are also participating, as are U.S. researchers. "It is a big international project," says Goroshkov.

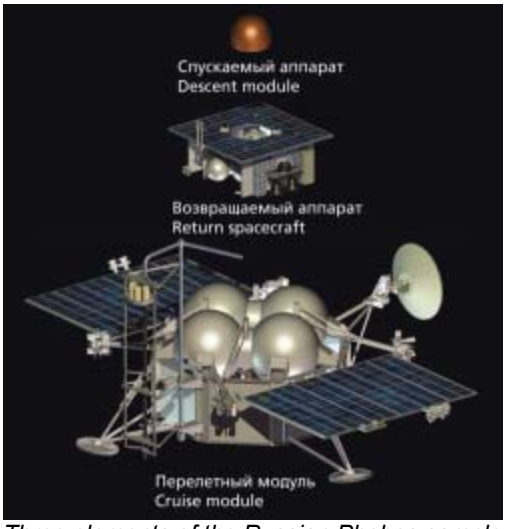
The Russian government has increased the space agency's budget by 30% between 2004-05, and an additional 50% increase over that is planned by the end of 2006, says Yuri Zaitsev, a senior international manager at IKI.

The overall effect of the big increase will be more like an overall 15% annual increase through about 2015, compared with "virtually no funding at all over the last 10 years," Zelenyi said.

Russian manned and planetary flight planning has been separate, but they will be combined under the new plan, much as they are now in the U.S., Zelenyi said.

Most Russian scientists prefer that Mars be given a priority, and the Phobos mission is an indication of that interest. But, as in the U.S., major Russian industry and some government planners under President Vladimir Putin want to focus on lunar development as a steppingstone to manned Mars operations.

That would also hopefully include some cooperative intersection with the U.S. manned lunar program downstream, says Nikolay Moiseev, deputy director of the Russian space agency.



Three elements of the Russian Phobos sample return mission are the cruise stage/lander at bottom, Earth return spacecraft in the middle and the sample return capsule that will ride the Earth return spacecraft back, then dive into Earth's atmosphere. Launch is set for 2009 for a three-year round-trip and Earth landing in 2012. Credit: LAVOCHKIN PHOTOS

Nikolay Sevastiyanov, the president and general director of Energia, Russia's largest space company, told Aviation Week & Space Technology that Energia is specifically pursuing manned lunar engineering concepts. The designs will be a natural transition from plans to replace Russia's Soyuz and Progress spacecraft, he said.

But the Moon/Mars tradeoffs are being made by a special group under the Russian Academy of Sciences. And their recommendations are not likely to be as cut-and-dried as the U.S. lunar direction charted by the Bush administration. For one reason, they are being influenced by other well-placed Russian researchers and CEOs with a Mars preference over the Moon. IKI managers, for example, are beginning to discuss with Putin's officials the possibility of a Russian manned space station in orbit around Mars, Zelenyi said.

A Martian orbital station could provide manned operational experience, including transit and return at 100-million-mi. distances without simultaneously tackling atmospheric entry, landing and relaunch from the surface. It could also provide real-time human-directed remote sensing of the Martian surface while acting as a steppingstone and node at the planet for later human surface operations.

"My personal point is that Russia should have its own direction which is not necessarily related to the Moon," Zelenyi said. But he noted that "President Bush also influences our politicians here."

"It would appear a decision will be made on what has the most priority for Russia, and in my opinion it will be Mars," says Georgy Polishchuk, director general of Lavochkin and former deputy head of IKI. "But the Moon program should provide a basis for better technical Mars exploration," he said.

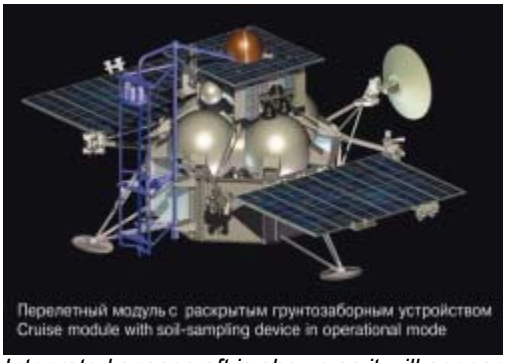
Lavochkin is Russia's primary Earth-orbit and deep-space science-development company with 40 years of planetary mission experience, including 15 successful missions to the Moon. No matter which long-term manned direction is selected, the company is beginning to reenergize its robotic mission capability for both the Moon and Mars. Lavochkin has been specifically tapped by the Russian government to lead all future robotic planetary development at its Khimki campus northwest of Moscow, employing about 5,000 people. The largest project in development is the Phobos sample-return mission, for which IKI is designing the sensor suite.

Planned for launch in October 2009 from the Baikonur Cosmodrome, the spacecraft is being designed to land on Phobos and drill 3.3 ft. below the surface to retrieve nearly a half-pound sample of both soil and rock. If successful, the sample-return spacecraft would land back in Russia in 2012.

The mission is the cornerstone of the new Russian robotics lunar and planetary program under Lavochkin that is also developing a major new lunar penetrator mission for launch to the Moon by 2012 (AW&ST June 5, p. 20). Other missions in the plan are a Mars rover launch as early as 2013, a lunar rover in 2015-16 and a robotic Mars sample return about 2020. Whether they occur on schedule or not, the development of these flights will help revitalize Russian space technology across many disciplines, Polishchuk said.

The Russian robotic Earth-orbit and deep-space science program has been largely suspended since the mid-1990s in the funding crisis that followed the collapse of the USSR.

In addition to the lunar and planetary missions, Russia is completing development of several new astrophysics and other Earth-orbit spacecraft, with IKI and Lavochkin involved in many of these missions.

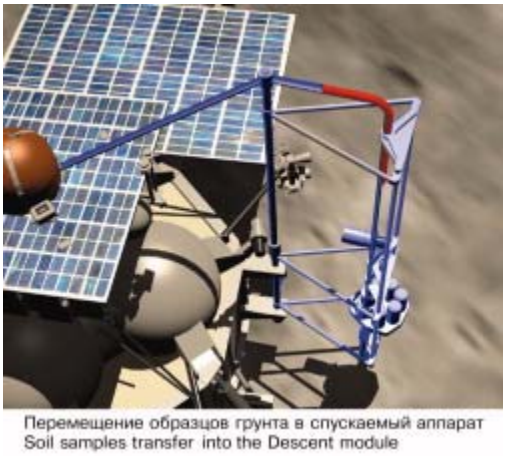


Integrated spacecraft is shown as it will appear on the surface of Phobos, with blue drilling rig mounted on the side. The device can swivel to find the best sample location.

The former Soviet Union, which launched dozens of successful deep-space probes in the 1960s-1980s has not flown a fully successful planetary mission of any kind since the 1984 Vega-2 Halley's Comet/Venus mission. And it has launched no successful missions to the Moon or Mars in 30 years.

In 1988, Russia launched two missions to Phobos, hoping to drop small one-way landers onto its surface. But Phobos 1 was lost due to a software uplink problem. Phobos 2 then died because of an onboard computer error while maneuvering toward the 16 X 14-mi. oblong moon.

Although tiny, Phobos holds great interest for understanding the history of Mars and the nature of planetary moons and asteroids. One theory holds that it was formed from material knocked off Mars and that samples could be genuinely Mars-like. Another theory is that it is a captured asteroid and could, instead, provide data on those ancient bodies--although it does not much resemble other asteroids seen so far.



Overhead view of sample device shows it drilling 3 ft. into the surface, then moving sample (red) from the ground into the Earth reentry capsule (top left) that sits atop Earth return spacecraft.

The Phobos surface-science operations, important in themselves, are also part of the science mission redundancy to have a solid science return even if the high-risk sample acquisition and return fails, Zelenyi said.

The Phobos mission consists of three vehicles stacked uopn each other in wedding-cake fashion (see first image). The lower vehicle will be the propulsion and systems bus for the trip to Mars, as well as the launch pad for the return spacecraft. It will then become a long-life science station on the surface of Phobos, equipped with about 20 science instruments and a drilling-rig/manipulator mounted on the side. This rig has a tube mechanism to transfer the sample up the side of the cruise/lander, past the Earth return spacecraft and into the Earth descent module.

The mission's three vehicles will include a large, bottom-mounted cruise module/lander, equipped with traditional wing-like solar arrays and having three key functions. The box-shaped Earth return spacecraft will be mounted on the cruise module. This spacecraft, about the size of a coffee table, has a square top-mounted solar array and propulsion systems to propel it back to the vicinity of Earth. Its cargo will be the Earth descent module carrying the sample. About the size of a basketball, the descent module, positioned atop the return spacecraft, will be a ballistic capsule with ablative reentry thermal protection.

After launch from Earth, the combined vehicles will spend 11 months in transit to Mars. The triple-deck spacecraft will be inserted into Martian orbit, where it will provide imagery and data on Mars and Phobos. After several weeks, it will be maneuvered to fly in formation with Phobos. After extensive imaging to determine a suitable landing site, the spacecraft will be maneuvered to make a gentle landing on the moon. Because Phobos has only 0.0001 of Earth's gravity, the landing gear will fire harpoons into the surface to prevent the

spacecraft from bouncing off.

On which side of Phobos to land has been a quandary. Like Earth's moon, the same side of Phobos always faces Mars. Science managers have wanted to land on this side because debris blasted off the Martian surface over eons may have more chance of being sampled there. Such a landing site would also allow continuous observation of Mars from about 5,800 mi. away. But there is more risk to Earth communications and spacecraft temperature control by landing on that side. Although this is still open for review, it is therefore likely the landing will take place on the side facing away from Mars to enhance mission redundancy, Zelenyi said.

Once on the surface, the first major task will be for the spacecraft to image the stars and Sun to update its navigation platform for an accurate Earth-return maneuver, Goroshkov said.

The cruise/lander stage will also begin imaging of the surface under the lander to pick a spot for sampling. The drilling rig will be able to swivel several degrees left or right to pick a spot suitable for both soil and rock samples.

The drilling and sampling process will require 3-4 days, Goroshkov said. The objective is to acquire 200 grams (0.4 lb.), "but the amount is not as important as getting below the surface and also finding at least one small stone," he said. Preserving the integrity of the core sample is also desirable to show layering.

It is envisioned that the sample system will be similar to the flexible tube used by Lavochkin's three highly successful unmanned lunar sample-return spacecraft launched in 1970, 1972 and 1976. Once filled with material, the flexible tube would be rolled into the Earth descent vehicle (see third image).

The return spacecraft with the descent module would then be ejected off the top of the lander back into its own orbit around Mars, then fired back toward Earth.

As the vehicle approaches Earth at the end of the 11-month transit, the descent module with the samples would separate from the Earth return spacecraft. It would then dive safely through the atmosphere for recovery by ground forces.

Phobos is imaged by the ESA Mars Express spacecraft. Samples of the Martian moon returned by the Russian mission will determine whether it is a captured asteroid.Credit: ESA MARS EXPRESS

Meanwhile, back on Phobos, the lander's instrument suite would be obtaining images and direct compositional measurements to complement and backup the sample return.

The lander is designed to survive on the surface for a year.