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Curiosity on the move

Declassifying the space race: Part 2

High stakes for human-rating spacecraft

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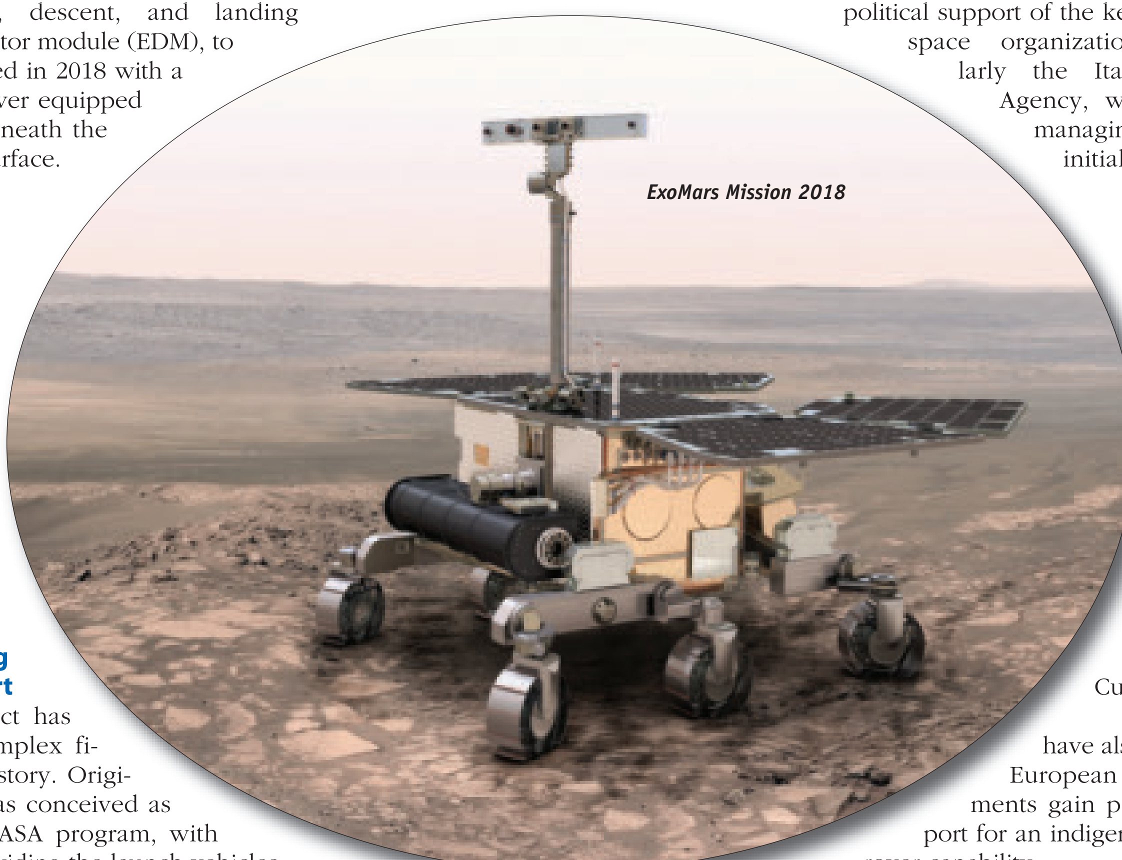
ESA to break new ground with ExoMars

ESA GOVERNMENT MINISTERS ARE DUE to meet in late November to decide on the future of the ExoMars program, a two-mission project to search for evidence of life on Mars. The first mission, due for launch in 2016, comprises a trace-gas-sensing orbiter and an entry, descent, and landing demonstrator module (EDM), to be followed in 2018 with a robotic rover equipped to drill beneath the planet's surface.



ExoMars Mission 2018

Finding support

The project has had a complex financial history. Originally it was conceived as an ESA/NASA program, with NASA providing the launch vehicles for both missions and a share of the design and production work on the rover. But when NASA pulled out earlier this year because of budgetary problems, ESA negotiated with Russia's Roscomos for the use of two Proton launchers to replace the NASA-sponsored Atlas rockets and to supply instruments for the trace gas orbiter.

European space industry experts are quietly confident that the project will go ahead, despite the financial challenges.

According to ESA, "Final agreements to be developed with Russia in the coming months and final program configuration will be submitted to the ESA Council Meeting at Ministerial level in November to approve. Avenues to find some additional money that would be needed to complete the mission as envisaged have been investigated, mainly through redistribution of internal resources."

ESA has already committed substantial sums to the program. It originally budgeted around €1 billion for the project, but this was based on NASA partnering in the rover program and providing the launch vehicles.

With ESA now committed to developing the rover by itself—the first time it will have built a robotic rover—the bill for the mission is climbing. In June ESA announced a tranche of funds to support the program until the end of the year, and the project enjoys the political support of the key European space organizations—particularly the Italian Space Agency, which has a managing role. The initial successes e NASA Curiosity Mars rogram have also helped as European governments gain political support for an indigenous robotic rover capability.

ExoMars rover/ Curiosity comparisons

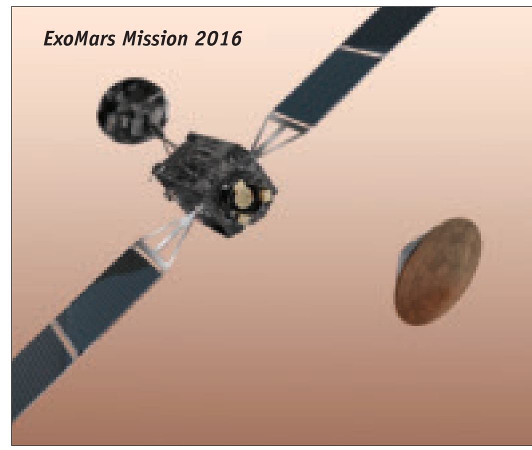
The early collaboration between ESA and NASA on the rover design has yielded some beneficial results. "The time spent working together was beneficial for both sides," according to Mark Roe, the rover vehicle project manager with Astrium U.K. "It has shown our U.S. colleagues that Europe does have unique technologies, and we have learnt from them some of the lessons of their real practical achievements."

But the European ExoMars rover will be a very different kind of vehicle from Curiosity.

"The U.S. rover is significantly bigger—which means in the European version we have to implement a greater level of equipment integration," says Roe. There are a number of design differences. "Within the locomotion system, we both have a six-wheel configuration; but in the European version these are driven through three bogies, which gives us the opportunity to 'wheel-walk,' to move the wheel ahead of the steering, which means that if you are stuck in soft sand it will allow the vehicle to crawl out more easily.

"Our navigation system features a higher level of soft control, which will allow us to perform obstacle guidance in a more intelligent way. And while NASA's Curiosity uses nuclear power, we will use solar arrays, so we have a different thermal challenge. We have to heat our rover with electrical power, and we are concerned with the challenge conserving heat; with Curiosity the challenge is power dissipation. And Curiosity doesn't have a drill—we are building our rover to get samples from beneath the surface with the aid of subsurface radar."

"I think the two rovers are complementary, not competitive," says Sue Horne, space exploration program manager with the U.K. Space Agency. "ExoMars will drill down 2 m below the surface to look for evidence of life, evidence which might have been destroyed by the ultraviolet radiation on the surface of the planet."



The U.K. is contributing the Mars X-ray diffractometer to identify mineral structures, the Raman spectroscope to measure seismic movements, and the life marker DHIP to detect organic molecules deriving from past or present life on Mars in samples collected by drilling.

Program aims and partnerships

The Exo (Exobiology) Mars program will search for signs of past and present life on Mars, examine how the water and geochemical environment varies, and investigate Martian atmospheric trace gases and their sources—especially whether the presence of methane in the atmosphere is a result of biological or chemical processes.

The 2016 mission includes a trace gas orbiter and an entry, descent, and landing demonstrator module (EDM). The orbiter will carry scientific instruments to detect and study atmospheric trace gases. Some of the EDM sensors will evaluate the lander's performance as it descends, and others will study the environment at the landing site. The 2018 mission includes the landing of a rover, equipped with a drill to collect rock samples from beneath the surface of the planet.

The mission will seek to validate a number of technologies for future sample return missions:

•Entry, descent, and landing (EDL) of a payload on the Martian surface.

•Surface mobility with a rover.

•Access to the subsurface to acquire samples.

•Sample acquisition, preparation, distribution, and analysis.

For the 2016 mission ESA will contribute the orbiter and the EDM as well as mission operation control for these elements. Russia will contribute the Proton launcher and other scientific experiments. This will enhance the 'science' value of the 2016 mission more than originally envisaged, according to ESA.

For the 2018 mission, ESA will contribute the carrier, elements of the Russian EDL module, the complete rover including various experiments and a drill, the mission operations, and the rover operations. Russia will provide a Proton launcher, some elements of the carrier, most of the EDL module, some scientific instruments, and experiment contributions to the ESA rover.

The ExoMars prime contractor is Thales Alenia Space-Italy, which is also responsible for the design of the EDM, the development of the analytical laboratory drawer—which includes the Pasteur Payload instruments—its integration on the rover, the onboard computer, and the EDM's radar altimeter. Thales Alenia Space France is responsible for the design and integration of the orbiter module, while Astrium U.K. is producing the rover.

According to the stakeholder meeting held in May, the program is proceeding on schedule for both missions, with the 2016 mission now in the design development phase, following a successful preliminary design review (PDR) in December 2010 and trace gas-orbiter PDR in December 2011. Deliveries for the 2016 mission will start with the engineering/functional models of the avionics test benches and the structural-thermal model of the EDM starting before the end of this year.

The 2018 mission is now in the 'feasibility' phase, to culminate in March 2013 with the system requirements review. The design of the rover is currently in a 'chilled' rather than strictly 'frozen' status, according to Astrium U.K.'s Mark Roe, with agency-level reviews next year to clarify the design baseline. Those will include how the rover will be deployed within the Russian-built carrier, which is to deliver it safely onto the Martian surface.

Mars exploration beyond NASA and ESA

India plans to launch its first Mars orbiter in November 2013, using Polar Satellite Launch Vehicle PSLV-XL, with a 25-kg scientific payload to measure climate, geology, and the possibilities of life. Other non-U.S. missions to the planet include MetNet, led by the Finnish Meteorological Institute (FMI) and comprising a consortium including FMI, Lavochkin Association, the Russian Space Research Institute, and Spain's Instituto Nacional de Técnica Aeroespacial to deploy several semi-hard-landing craft carrying "a versatile science payload focused on the atmospheric science of Mars." China's first Mars satellite, Yinghuo-1, was lost on the 2011 Russian Phobos-Grunt mission. Japan sent the orbiter Hope to Mars in 1998, but ground controllers were unable to direct it into Mars orbit.

International dimensions

The ExoMars project is different in other ways, too. It marks the start of a new era of international cooperation on Mars missions, with a focus on combining more small-scale national programs into a wider global effort. Nations such as China and India are developing their own Mars missions, which means the next sample return mission beyond ExoMars is likely to be a truly global event, with new design philosophies for rover activities. One of the key mission objectives of ExoMars is to demonstrate a number of essential flight and enabling technologies required for an international Mars sample return mission.

"The focus on Mars exploration will be increasingly international," says Horne. "We've looked at the results of several studies which have examined the benefits of operating with two or more smaller rovers, or risking everything by putting all your eggs in a single basket.

"Scientists always want more—and the balance of probabilities is that in the future you will see rovers working in cooperation, collecting a wide suite of samples and bringing them back to a base on the planet for further analysis, where many different studies will be possible," he says.

Beyond the U.S., small-scale national missions to the planet have had a mixed success rate at best. Some of the technologies being applied by Russia to the ExoMars program have their origins in the failed 2011 Phobos-Grunt mission, which was designed to return samples from Mars' larger moon, Phobos. The mission was also carrying China's first Mars satellite. However, the launcher failed to propel the payload beyond LEO, and it eventually crashed back to Earth.

ESA sent the Mars Express mission to the planet in 2003. It had two elements, an orbiter (for high-resolution imaging, mapping, and surface and subsurface structural analysis) and the Beagle 2 lander. While Beagle 2 failed to land intact on the planet's surface, the orbiter has been successfully performing scientific measurements since 2004. In August the orbiter supported NASA's Curiosity rover program by tracking signals during the entry and descent phase of the mission.

But the U.S. is the only nation to have successfully landed a rover and instruments on the Martian surface. If ExoMars does succeed in landing a rover on the planet, it will give Europe a new capability in planetary exploration, which until now has been the preserve of the U.S.

The initial success of NASA's Curiosity rover program in the dramatic landing on the Martian surface has captured the imagination of Europe's public and, significantly, its politicians. "If we had not had the success of the U.S. rover program, and its achievements had not been visible for all, I don't think we would have got this far," says one of the European scientists involved in ExoMars.

Philip Butterworth-Hayes
Brighton, U.K.

Events Calendar

OCT. 1-5
Sixty-third International Astronautical Congress, Naples, Italy.
Contact: www.iafastro.org

OCT. 11-12
Aeroacoustic Installation Effects and Novel Aircraft Architectures, Braunschweig, Germany.
Contact: Cornelia Delfs, +49 531 295 2320; cornelia.delfs@dlr.de; www.win.tue.nl/ceas-asc

OCT. 14-18
Thirty-first Digital Avionics Systems Conference, Williamsburg, Virginia.
Contact: 703/264-7500

OCT. 17-18
International Symposium for Personal and Commercial Spaceflight, Las Cruces, New Mexico.
Contact: 703/264-7500

OCT. 22-25
International Telemetering Conference, San Diego, California.
Contact: Lena Moran, 575/415-5172; www.telemetry.org

NOV. 5-8
Twenty-seventh Space Simulation Conference, Annapolis, Maryland.
Contact: Harold Fox, 847/981-0100; info@spacesimcon.org; www.spacesimcon.org

NOV. 6-8
Seventh International Conference Supply on the Wings, Frankfurt, Germany.
Contact: Richard Degenhardt, +49 531 295 2232; Richard.degenhardt@dlr.de; www.airtec.aero