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IN REVIEW



TWO BAD DAYS
Questioning conventional wisdom after Antares, Virgin Galactic/Page 4

NASA announced in January that **International Space Station** operations will be extended through 2024 to allow more time to conduct human research in microgravity and test critical exploration technologies, such as life support systems, to reduce the risks for long-duration missions. To ensure continuity of ISS operations for the next decade, NASA selected Boeing and SpaceX to provide commercial crew transportation services to ISS starting in 2017.

The first test flight of Lockheed Martin's **Orion** deep-space crew capsule is scheduled for December aboard a Delta 4 rocket. The primary objective of the unmanned mission is to test Orion's heat shield. After two orbits, Orion will re-enter the Earth's atmosphere at almost 20,000 miles per hour.

NASA made progress on the **Asteroid Redirect Mission** to capture a small near-Earth asteroid and redirect it into a stable orbit around the moon, where astronauts launched aboard Orion will visit it around 2025. A mission formulation review was completed in April and several candidate asteroid targets were identified. NASA awarded 18 contracts for industry-led studies of asteroid capture systems, rendezvous sensors and a solar electric propulsion module based on an existing commercial spacecraft bus. A subscale inflatable asteroid capture system was designed and tested, a modified space suit for exploring the asteroid was demonstrated in underwater tests, and a new portable life support system for the suit was tested with a human in the loop.

In robotic space exploration, in December 2013 China became the third nation to soft land a spacecraft on the moon. The **Yutu rover** deployed on the Chang'e 3 mission survived for one lunar night at its landing site in the Sinus Iridum crater.

On Mars, NASA's **Curiosity rover** completed its first Martian year (687 Earth days) of operations on June 24. One of Curiosity's first major findings was an ancient riverbed at its landing site, known as Yellowknife Bay, in Gale Crater. The analysis of samples obtained from two mudstone slabs revealed that crater was once a lakebed with mild water and was habitable for simple life forms. **MAVEN**, the Mars Atmosphere and Volatile Evolution spacecraft, went into orbit around Mars in September on a mission to study the evolution of the planet's upper atmosphere.

The **InSight** mission, to be launched in 2016 to investigate the inner structure of Mars' core, mantle and crust, completed its critical

design review in May. And in July, NASA announced the seven instruments selected for the Mars 2020 rover, which will search for habitable environments and cache samples for eventual return to Earth. One of the payloads will demonstrate the production of oxygen from the Mars atmosphere to enable in-situ propellant production for human missions.

After a 10-year, 6.4-billion-kilometer journey, the European Space Agency's **Rosetta** became the first spacecraft to rendezvous with a comet when it reached 67P/Churyumov-Gerasimenko. Rosetta deployed the Philae lander, which touched down on the comet on Nov. 12 to image and sample the comet's nucleus.

NASA's Pluto-bound **New Horizons** spacecraft, launched in January 2006, has crossed the orbit of Neptune, nearly 2.75 billion miles from Earth, on its way to make a close encounter with Pluto in July 2015. In space exploration technology, NASA tested a prototype low-density inflatable decelerator and 33.5-meter supersonic ring sail parachute for landing heavier payloads on Mars. The test vehicle was dropped from a high-altitude balloon.

Morpheus, a vertical-takeoff-and-landing planetary lander, demonstrated an autonomous landing and hazard avoidance system in flight tests at NASA's Kennedy Space Center.

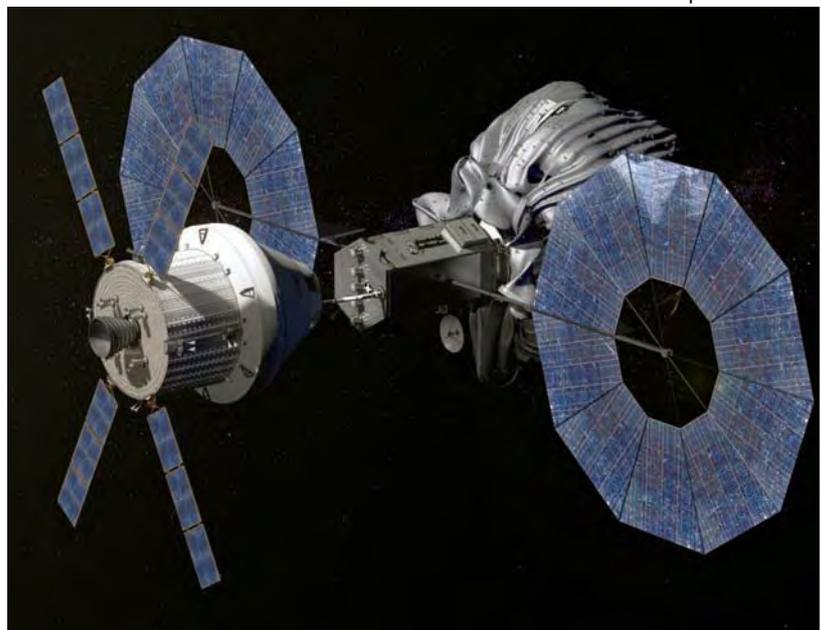
In August, a 5.5-meter diameter composite cryogenic fuel tank filled with 30,000 gallons of liquid hydrogen completed structural loads tests at the Marshall Space Flight Center. The project is exploring the use of composite materials to produce lightweight fuel tanks for rockets. ▲

Human, robotic exploration make strides

by Chris Moore and Surendra Sharma

The Space Exploration Program Committee brings together experts on topics relevant to future human and robotic exploration missions.

This conceptual image shows the Orion spacecraft approaching the robotic asteroid capture vehicle.



NASA