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AEROSPACE

A M E R I C A

**Budget battles,
test flights,
lawsuits...**

2013 IN REVIEW

PREMINENCE AT RISK
AIAA President-Elect Jim Albaugh
on the industry's future, **page B5**



Mission termination is an inevitable phase of space operations. Often, however, when a primary mission ends, a new one can follow. This is the hope for the **Kepler Space Telescope**. In 2013, after a remarkable four years discovering planets beyond the solar system, that phase of Kepler's career came to an end. The telescope's ability to home in on target stars with the required precision was lost when the second of four reaction wheels failed in May; three are needed. Efforts have now turned to finding new scientific missions that use hybrid attitude control, which would employ the two remaining wheels in concert with the spacecraft's thrusters.

Space operations farther out in the solar system focused on **Mars**. The Mars Science Laboratory rover Curiosity marked its first year of surface operations in August after driving about 1.6 km and sending back more than 190 gigabits of data, including 36,700 full images. The rover also performed the first drill sampling on another planet; the results hint at evidence of a past Martian environment that could have supported life. The Mars Exploration Rover Opportunity, not to be outdone by its younger cousin, became NASA's leader in beyond-Earth driving, passing the 37 km traveled on the lunar surface by the Apollo 17 Lunar Roving Vehicle in 1973. Opportunity is now behind only the Soviet Lunokhod 2 rover; analysis this year of NASA Lunar Reconnaissance Orbiter images showing the rover's tracks calculated that the Soviet rover traveled over 42 km in 1973.

The **Voyager 1** spacecraft reached an even more historic milestone: In September, scientists analyzing data from the craft determined that it has officially left the solar system and crossed into interstellar space. Extrapolating the results backward in time showed that the transition actually occurred in August 2012.

Other space **science** activities in 2013 included launches of IRIS, or Interface Region Imaging Spectrograph, which is studying the Sun's lower atmosphere; and LADEE, or Lunar Atmosphere and Dust Environment Explorer, which is preparing to gather data on the Moon's atmosphere and the region near the lunar surface. GRAIL, the Gravity Recovery and Interior Laboratory mission, ended in December 2012 when controllers directed the two lunar orbiters, Ebb and Flow, to an impact with the Moon's surface.

NASA's **commercial** partners made

progress in 2013. Orbital Sciences' Antares launch vehicle delivered a mass simulator to orbit in April, setting the stage for the September launch of their Cygnus cargo craft, which delivered supplies to the International Space Station. Cygnus is expected to join SpaceX's Dragon in the fleet of commercial spacecraft supporting ISS.

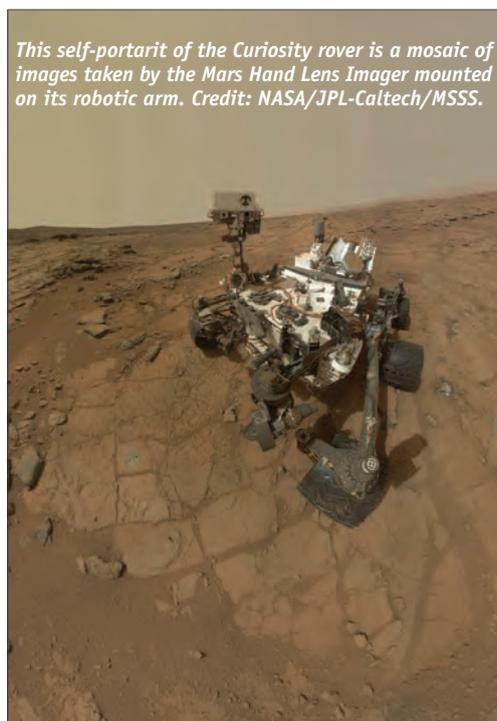
The **time** needed for a crew to reach ISS was dramatically reduced this year. The Russian Soyuz TMA-08M, launched in March, docked with ISS less than 6 hr after liftoff, instead of the two days it used to take, using a new expedited rendezvous procedure for the first time for a crewed vehicle. One of the studies performed on board ISS this year advanced on-orbit satellite servicing with the first robotic fluid transfer, tested as part of the Robotic Refueling Mission. The **Chinese** continued development of their own space laboratory, Tiangong-1, with the Shenzhou-10 mission launched in June. This three-person flight included the second female Chinese astronaut and set a new Chinese duration record of 15 days.

The number of **countries** operating satellites grew by four this year, with Azerbaijan (Azersat), Austria (TUGSAT-1/UniBRITE), Ecuador (NEE-01 Pegaso), and North Korea (ESTCube-1) all sending up first satellites. North Korea and South Korea also executed their first successful orbital launches. ♣

Going beyond mission limits

by Michael Squire

The Space Operations and Support Technical Committee focuses on operations and relevant technology developments for manned and unmanned missions in Earth orbital and planetary operations.



This self-portrait of the Curiosity rover is a mosaic of images taken by the Mars Hand Lens Imager mounted on its robotic arm. Credit: NASA/JPL-Caltech/MSSS.



An Orbital Sciences Antares rocket takes off from NASA's Wallops launch site in Virginia. Credit: NASA TV.