December 2012

AEROSPACE AMERICA

2012

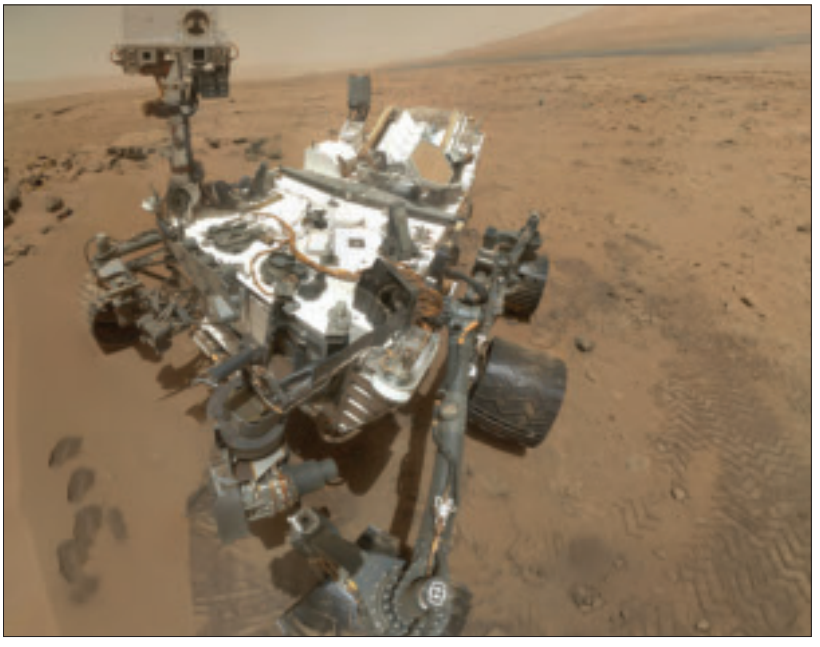
Year in review

A PUBLICATION OF THE AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

Space automation and robotics

This year has been a strong one for space robotics. With the successful landing of the Curiosity rover on Mars, on-orbit demonstrations by the Robotic Refueling Mission, Robonaut's continued presence on the space station, and the initialization of the DARPA Phoenix program, the field of space automation and robotics continues to move forward with exciting developments.

In the most widely covered space science mission of the year, the Mars Science Laboratory successfully landed and delivered the Curiosity rover to the surface of Mars on August 6, 2012. After deploying the mast and checking out the rover's systems, Curiosity drove away from its landing site and began its trek across Gale Crater. Curiosity's robotic arm has scooped several surface samples for analysis, and pictures from its cameras have already revealed further evidence of a wet past on Mars as the rover makes its way upstream in what appears to be an ancient riverbed.



On October 31, Curiosity used its hand lens imager to capture a set of 55 high-resolution images, which were stitched together to create a full-color self-portrait. The mosaic shows the rover at 'Rocknest,' the spot in Gale Crater where the first scoop sampling took place. Four scoop scars can be seen in the regolith in front of the rover. The Martian landscape appears inverted within the round, reflective ChemCam instrument at the top of the rover's mast.

Meanwhile, elsewhere on the planet, the Mars Exploration Rover Opportunity continues to return scientific data to Earth while investigating clay minerals on the inside rim of the Endeavour Crater. Opportunity has driven over 35 km on the surface of Mars and continues to be active after over eight years of hard work.

On March 8, NASA's Robotic Refueling Mission (RRM) demonstrated the first use of specialized tools for intricate satellite servicing tasks in orbit. The tasks for the demonstration called for extremely precise robotic movements, which Canada's Dextre robotic arm performed by using the RRM multifunction tool to remove the launch locks securing four RRM tool adapters. This demonstration also verified the ability of a robotic system to overcome the challenges of dynamic on-orbit lighting conditions and jitter and allowed NASA to improve its machine vision algorithms. Then Dextre proceeded to use the RRM wire cutter tool to cut two thin wires and remove gas fittings that are common for filling spacecraft with special coolant gases or propellant.

RRM was developed and is managed by NASA Goddard's Satellite Servicing Capabilities Office. The RRM module launched in July 2011 aboard the final space shuttle flight, STS-135, and is attached to the EXPRESS Logistics Carrier 4 on the ISS as an external investigation. RRM has several specialized tool adapters designed to perform specific servicing tasks. Demonstrations will continue with the highly anticipated refueling activity, during which Dextre will open a fuel valve and transfer liquid ethanol through a fueling hose. Additional planned servicing activities include thermal blanket manipulation, screw removal and electrical cap removal.

Also on the station, Robonaut 2 (or R2) continues to perfect its duties as a robotic crew member on board. R2 not only looks like a human, but was designed to have dexterity and movement abilities similar to a human's. Over the past year, R2 has practiced accessing task panels using tools that ISS crewmembers use and performing 'housekeeping' chores. R2 has been on the ISS for over a year and a half and continues to perform admirably. It is leading NASA to new advances in dexterous robotic operations and demonstrating ways that humans and robots can work together in space.

DARPA has a new satellite servicing program under way called Phoenix, which will seek to demonstrate the capability of capturing and reusing or repurposing space assets that already exist near geosynchronous orbits. Although the program's first flight mission is not scheduled until 2015, technology development initiatives and trade study efforts have been increasing throughout 2012. This will be an interesting program to watch out for as further developments unfold.

by **Kate Stambaugh** and **Gregory P. Scott**