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Space exploration

When the final mission of space shuttle Atlantis ended on July 21, a remarkable 30-year era in human spaceflight came to a close. The shuttles flew 135 times, ferrying 355 astronauts into orbit, completing assembly of the ISS, docking with Russia's Mir space station, servicing the Hubble Space Telescope, and conducting numerous research experiments that have vastly expanded our knowledge and our spaceflight capabilities. This year's three shuttle missions delivered the Alpha Magnetic Spectrometer, a robotic refueling experiment, and supplies to the ISS. As the shuttle orbiters head off to museums, it is also the beginning of a new era that will carry humans far beyond Earth.

To enable deep space human exploration, NASA proceeded with development of the Space Launch System (SLS) and the Orion multipurpose crew vehicle (MPCV). In September, the agency announced the design configuration for SLS, the new heavy-lift launch vehicle authorized by Congress in 2010. The initial version will be capable of launching 70 metric tons into orbit, with future versions evolvable to 130 metric tons. To minimize development costs, the new rocket will use shuttle-derived hardware. The core stage will be based on the shuttle external tank, and will be powered by an expendable version of the shuttle main engines. For initial flights, shuttle-derived solid rocket boosters will be attached to the core stage, and a competition is planned to select advanced solid or liquid boosters. A J2-X engine upgraded from the J2 engine used on the Saturn V will power the SLS upper stage.

Testing of components for the SLS is under way. The J2-X engine was fired for the first time at NASA Stennis, and ATK conducted a third test of the five-segment solid rocket motor. The initial flight of SLS is targeted for late 2017.

Lockheed Martin completed acoustic testing of the Orion MPCV capsule and launch abort system. A series of water landing splash tests of the capsule took place at NASA Langley in a new hydro impact basin. Navigation sensors for Orion's autonomous rendezvous and docking system were tested in orbit on the STS-134 mission. Construction of the first space-bound Orion capsule began at the Michoud Assembly Facility.

Space-X launched its Dragon capsule on December 8, 2010, and became the first company to recover a capsule reentering from orbit. NASA awarded $270 million to four companies to continue the development of commercial rockets and spacecraft designed to fly astronauts to the ISS. In August, a launch failure of Russia's Soyuz rocket threatened to cause a situation in which the crew would have to abandon the ISS temporarily, and highlighted the need for multiple crew transportation options in the post-shuttle era.

NASA signed a cooperative agreement with the nonprofit Center for Advancement of Science in Space to operate the ISS as a national laboratory for basic and applied research, to stimulate STEM (science, technology, engineering, and mathematics) education, and to generate economic benefits.

Exploration technology development activities included teleoperation of Robonaut 2 on the ISS, testing of portable life support system components for an advanced spacesuit, demonstration of a prototype deep space habitat in desert field tests, and industry studies for cryogenic propellant storage and solar electric propulsion flight demonstration missions.

The 14-nation International Space Exploration Coordination Group issued the first iteration of a global exploration road map that outlined a common strategy for deep space exploration. It identifies two alternate pathways to Mars: humans first exploring either the Moon or near-Earth asteroids. Each pathway is defined by a notional mission scenario describing a logical sequence of human and robotic missions that will cover a 25-year period.

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by **Chris Moore**