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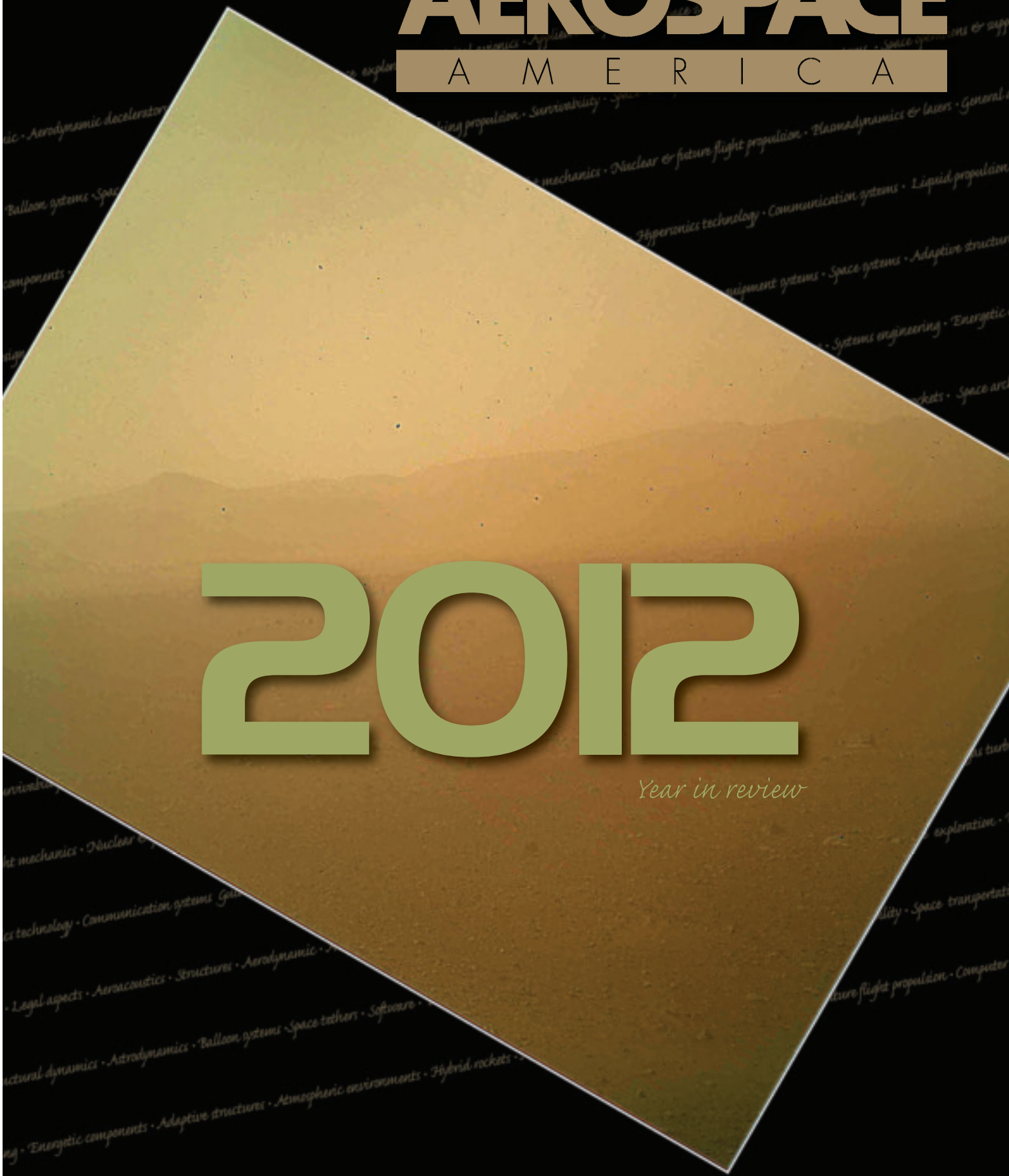

2012

Year in review

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Design engineering

Exploration of Mars continues following the successful launch of the Mars Science Laboratory (MSL) spacecraft from Cape Canaveral AFS on November 26, 2011, and the Curiosity rover's subsequent landing.

One of the major trends in aviation design is greater autonomy for vehicles, from remotely piloted aircraft to vehicles with entirely autonomous operations. The MSL spacecraft demonstrated this with its completely autonomous entry, descent, and rover landing. Entry of the MSL began with separation of the cruise stage from the descent stage. The descent stage then steered itself through the Martian atmosphere with a series of S-curve maneuvers, followed by the use of a parachute, jettisoning of the heat shield, jettisoning of the parachute and back shell, retrorocket firing, and finally, while hovering over the Martian surface, the unfolding of Curiosity, which the descent stage lowered to the surface by a tether, afterward flying away and landing in a separate location.

For the rover landing, use of the Sky Crane and tether maneuver rather than the previous airbag landing system was necessary because Curiosity weighed over 1 ton (much more than previous rovers) and because of the desire to be much more precise in where it landed. If not for this improved precision—about five times better than that of previous missions—the Gale Crater landing site would have been considered unsafe because of its close proximity to the crater wall.

The descent stage's structure is a lightweight space-efficient truss and stiffened panel design. The MSL faced severe design challenges from mass limits, launch vehicle payload dimensional constraints, and launch site integration of the cruise stage, back shell, descent stage, rover, and heat shield.

Curiosity did inherit many design elements from previous rovers, such as a six-wheel drive, a rocker-bogie suspension system, and mast mounted cameras. The rover can roll over obstacles up to 65 cm (25 in.) high, and can travel up to about 200 m (660 ft) per day on Mars.

The U.S. government's shift toward using commercial space companies for space access reached a major milestone in May when a SpaceX Falcon 9 rocket boosted a SpaceX Dragon supply capsule into orbit, where it successfully berthed with the ISS. The capsule later returned to Earth and was recovered after performing a parachute landing into the Pacific Ocean. With the new generation of commercial space capsules, the design philosophy for safety is changing from redundancy to quick-acting escape mechanisms to achieve fail-safe reliability. The new commercial capsules are also attempting to achieve cost efficiencies through dual-use propulsion systems that can be used for both launch escape and on-orbit maneuvers.

An artist's rendering depicts the Sky Crane lowering Curiosity to the Martian surface. Image credit: NASA.

The X-47B is an example of the trend toward autonomous vehicles. Courtesy: Northrop Grumman.

Another example of the trend toward autonomous vehicles is the X-47B. This tailless strike fighter-class unmanned aircraft was developed by Northrop Grumman as part of the Navy's Unmanned Combat Air System Carrier Demonstration program. The company, which was awarded the development contract in 2007, has designed, produced, and is currently flight testing two X-47B aircraft. The plane made its first flight from Naval Air Station Patuxent River in July, and these aircraft will be used in 2013 to demonstrate the first carrier-based launches and recoveries by an autonomous unmanned aircraft. In 2014, the X-47B is scheduled to demonstrate autonomous aerial refueling.

by **Jerry Brown**