January 2016

AEROSPACE AMERICA

EXCLUSIVE INTERVIEWS

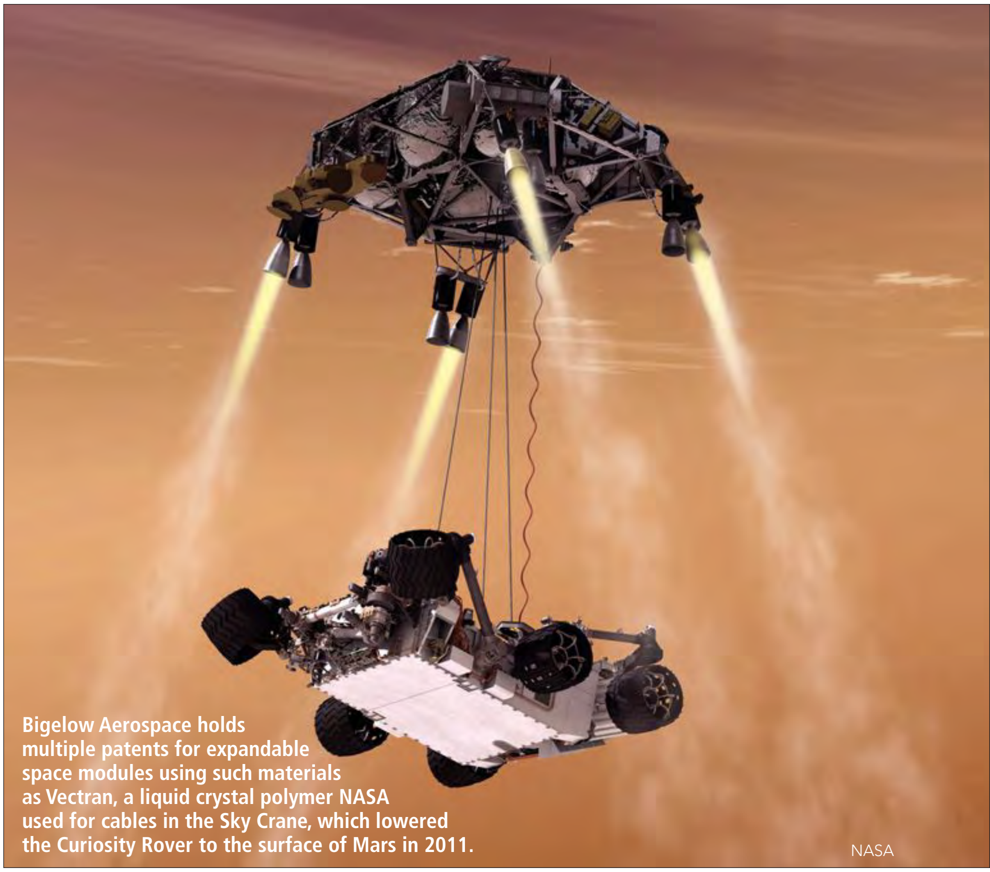
CHALLENGER'S LEGACY

The loss of invincibility, the cultural shakeout and the lessons that shaped today's NASA

Page 18

A PUBLICATION OF THE AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

Bigelow module poised to join space station



Bigelow Aerospace holds multiple patents for expandable space modules using such materials as Vectran, a liquid crystal polymer NASA used for cables in the Sky Crane, which lowered the Curiosity Rover to the surface of Mars in 2011.

NASA

NASA is on the verge of testing a non-metallic space habitat for astronauts, the Bigelow Expandable Activity Module, or BEAM. The test could lead to widespread use of similar structures if the new module proves to be as good or better than metal spacecraft at protecting crews from micrometeoroids, orbital debris and radiation.

NASA plans to send BEAM to the International Space Station on the next flight of the SpaceX Dragon cargo capsule. The module will be stowed inside Dragon's unpressurized trunk, and in orbit it will expand to four meters long and nearly three meters wide.

Unlike the flimsy fabric structure where Mark Watney worked in the novel and film "The Martian," BEAM is composed of multiple layers of high-strength materials that form a hull nearly half a meter thick. Citing proprietary data and export control restrictions, Bigelow Aerospace declined to discuss the precise combination of materials used in the cylindrical module, but the company has obtained multiple patents for expanding space modules that use Kevlar, the synthetic fiber used in bulletproof vests; Vectran, a liquid crystal polymer that strengthened the cables NASA used to lower the Curiosity Rover to the Martian surface from the Sky Crane in 2011; Nomex, a flame-resistant polymer used in protective clothing worn by astronauts, fire fighters and race car drivers; and Nextel, a woven ceramic fabric designed to remain strong and flexible at temperatures up to 1,100 degrees Celsius.

These materials offer strength without the weight of metal, but most did not yet exist when NASA began evaluating the potential merits of inflatable space stations in the 1960s and '70s.

"Materials have advanced to where they are more capable to withstand the space environment and able to handle the loads from inflation pressures," says Judith Watson, a senior structures research engineer at NASA's Langley Research Center in Virginia.

BEAM's outer skin is a shield for micrometeoroids and orbital debris covered with multiple layers of foam insulation to break up debris particles and slow them down so successive layers can prevent them from entering the crew compartment.

Bigelow has been preparing for humans to ride in its modules for more than a decade. In 2006, the company launched an unmanned prototype module called Genesis 1, followed by Genesis 2 in 2007, to test technologies for the commercial space stations the company ultimately plans to launch. Bigelow engineers conducted hypervelocity-impact tests before the Genesis missions to compare the company's micrometeoroid and orbital-debris protection with a space station debris shield loaned by NASA's Johnson Space Center.

"The tests proved our micrometeoroid and orbital debris layer is as good if not better than what exists on the ISS today," says Mike Gold, director of Washington, D.C., operations and business growth for Bigelow.

There is still a chance that debris can breech any spacecraft hull. If that happens BEAM is designed to leak air rather than burst. The module's interior gas bladder, which will hold pressurized air, is covered by a restraint layer reinforced with an aluminum alloy frame. BEAM's hatch also will seal it from the rest of the space station, ensuring that any air leak will be isolated to that node.

NASA and Bigelow officials declined to discuss BEAM's aluminum frame, but Robert Bigelow patented the design in 2001 for a soft tubular structure with aluminum elements to add strength, rigidity and anchor points for equipment, docking ports and hatches. Bigelow, a hotel and real estate entrepreneur, spent about $275 million of his personal fortune developing expandable space habitats before NASA awarded his company a $17.8 million contract for the BEAM test flight in 2013.

During BEAM's two-year mission, astronauts plan to open the hatch leading into BEAM once every three months to inspect it and gather data from sensors measuring structural loads, temperature, pressure, microbial growth and radiation. NASA plans to equip BEAM with two types of radiation sensors: The Radiation Area Monitors used throughout the space station to reveal the number and type of charged particles and relay that information to mission control and Radiation Environment Monitors. And small battery-powered dosimeters like those used in nuclear power plants to provide immediate readings on a person's radiation exposure.

Those measurements are likely to show that BEAM protects astronauts from radiation as well if not better than the space station's metal modules, because the average thickness of BEAM's hull is about .46 meter, says Ronald Turner, a radiation expert at Anser, a nonprofit research institute in Virginia. BEAM's exterior fabric is unlikely to scatter charged particles inside a spacecraft the way metal structures do, he adds.

If BEAM performs well during its trial run, NASA and commercial companies envision a bright future for expandable modules. Bigelow is eager to develop commercial space stations and NASA is exploring the use of such modules in cislunar orbits between the Earth and moon, or as habitats on the moon or Mars.

Debra Werner
werner.debra@gmail.com