Inflatable space habitat ready for deployment

by Harry H. Hilton

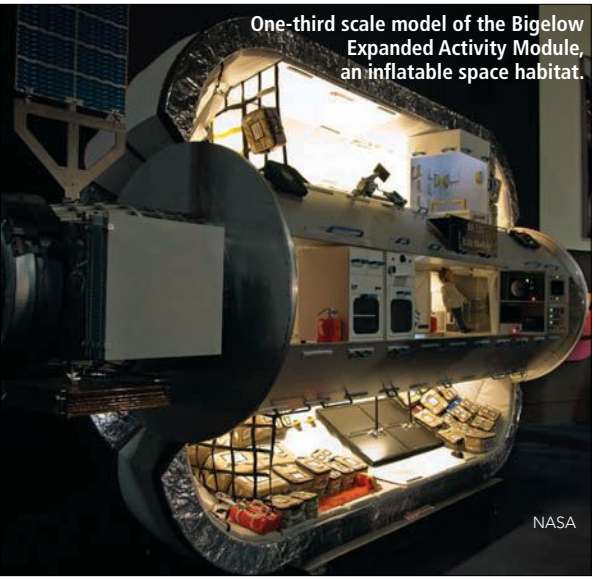
*The **Structures Technical Committee** works on the development and application of theory, experiment and operation in the design of aerospace structures.*

NASA is poised to add an addition to the International Space Station to temporarily expand it from eight rooms to nine. The new room will be like no other on the station, and will be easy to install: It'll connect to a docking port, be filled with compressed air and, voilà, an instant space habitat. This deployment is the result of 15 years of research and development by Bigelow Aerospace of North Las Vegas, Nevada, on the **Bigelow Expandable Activity Module**, or BEAM.

Initially scheduled for a September launch, BEAM's test deployment has been delayed by the June explosion of a SpaceX Falcon 9 rocket on its way to the ISS. Once BEAM reaches its destination, it will undergo two years of intensive testing in what will amount to a trial run for inflatable spacecraft, a technology that could play a significant role in future human spaceflight and low-Earth orbit commercial ventures.

The inflatable spacecraft structures technology was pioneered at NASA's Johnson Space Center in Houston during the 1990s under the **TransHab project**. Bigelow Aerospace licensed the patents and with NASA's help is poised to add this module to the ISS for three years. It is to be the first human-rated inflatable structure ever used in space.

The Adaptive Intelligent Materials & Systems Center at Arizona State University is developing **physics-based multiscale modeling techniques** for composites and nanocomposites, bridging atomistic to structural scale with funding from the Air Force Office of Scientific Research and the Army Research Office. A quantum-mechanics-based molecular dynamics approach is being developed to capture stress-induced covalent bond dissociation. A novel interphase model allows the polymer molecules to entangle and physically interact with the carbon fiber surface, providing an accurate representation of interface properties. The nanoscale information pertaining to covalent bond dissociation is used to define scalable parameters that are further integrated into damage models at higher-length scales with funding from the **Office of Naval Research**.


NASA

One-third scale model of the Bigelow Expanded Activity Module, an inflatable space habitat.

The Air Force Institute of Technology has been researching additive manufacturing of objects made from plastics and metals. Several specimens have been produced and analyzed, such as a projectile considering optimization of the topology and a frame for an icosahedron. The first product was shot into a concrete target and reacted in a very favorable way compared to a projectile produced in the normal fashion. The second project was to analyze the performance under external loading both from a dynamic instability point of view leading to chaotic behavior and from a collapse consideration. Experiments were carried out to determine the correctness of the finite elements procedure.

MIT researchers have developed a composite manufacturing technique that does not require the use of large conventional ovens or autoclaves. This was achieved by integrating an aligned **carbon nanotube film** into the top surface of an aerospace-grade composite structure, and applying current to the carbon nanotube film to process the composite via Joule heating. The team conducted curing experiments with common carbon fiber reinforced composites used in aircraft components and found that the new 'out-of-oven' technique can yield composites of equal or greater quality than conventional oven-based techniques while consuming 99 percent less energy during the curing process. The researchers believe that this new "out-of-oven" approach serves as the new benchmark for energy-efficient techniques for manufacturing aerospace composites.

Manufacturers and engineering firms in the advanced composites sector can now use new software developed at Purdue University to reduce the design cycle of materials and structures, and analyze models too complex for existing methods. **AnalySwift**, a commercial software provider based in Utah, launched SwiftComp, technology that provides efficient, high-fidelity modeling of composites and reduces analysis times without a loss of accuracy, while capturing details of composites that were unreachable using traditional methods. The company licensed the technology, which was developed at Purdue.


Bigelow Aerospace

Artist's rendering of the Bigelow Expandable Activity Module attached to the International Space Station. The module will be launched to the space station on a SpaceX flight.