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Space architecture

The next big human missions to the Moon, Mars, or elsewhere have not yet arrived on international drawing boards. In the past year, however, the space architecture community has pressed on with habitation designs for these future missions, continuing to envision the engineered cocoons that humans will need to survive on alien and remote surfaces.

In the U.S., NASA has built a prototype called the habitat demonstration unit–deep space habitat (HDU–DSH) and has tested it in the desert north of Flagstaff, Arizona, under the NASA desert research and technology studies (D-RATS) campaign. The habitat is a 5-m-diam. cylindrical shell with the horizontal end caps forming the floor and roof. Inside, it has one level of accommodation to support a three- or four-person crew for 14-30 days. This year NASA held a competition called the X-Hab Academic Challenge to build an inflatable loft for mounting on the habitat's roof to expand the crew accommodation. Three universities competed to build the loft structure. The University of Wisconsin-Madison's Badger X-Loft design was the winner. It will go to Arizona for installation in the next round of NASA field tests.

In parallel, space architects from JPL have developed a small habitat capsule that rides on top of the all-terrain hex-limbed extra-terrestrial explorer, or ATHLETE, that docks with the larger habitat.

In Europe, work continues on long-range studies for fixed and mobile habitats destined for the Moon or Mars. Architect Barbara Imhof and her associates at the Liquifer Systems Group in Vienna, Austria, have been exploring a concept called RAMA (rover for advanced mission applications). Designed with Thales Alenia Space under an ESA study, RAMA incorporates a dual suitport with two surface activity suits sealed directly into the pressurized rover's body. The rear-entry suitport concept was pioneered by architect Marc Cohen and colleagues at NASA Ames. It reduces the problem of dust and other contaminants that are released during the doffing of suits when a conventional airlock is used.

The RAMA concept features innovations in the human factors area, such as a cockpit chair that transforms into a bed and workstation. Rover accommodation is designed to support a two- or three-person crew on a surface sortie of about 40 days.

Seen from inside the HDU-DSH habitat through a porthole, the ATHLETE vehicle bearing the small capsule approaches the stationary habitat for a docking test. Photo: David A. Nixon.

Architecture in the hostile space environment is a field closely related to architecture in extreme environments on Earth. Many of the habitability and human factors challenges are similar if not identical. A good illustration of this is the Halley VI Antarctic research station designed by Hugh Broughton Architects of London, supported by AECOM. Created for the British Antarctic Survey, Halley VI was the result of an international architectural competition. It has a modular design and, like the ISS, is assembled from a prefabricated kit-of-parts that arrives at the operations location ready to be berthed together. Its modules can move to a safer location when the station's local portion of the Brunt Ice Shelf threatens to break off as a giant iceberg. This is equivalent to the periodic reboosting of the international space station's orbit to maintain a safe altitude.

Halley VI fuses cutting-edge engineering with innovative accommodation facilities and outfitting to combat the isolation of life in the extreme Antarctic environment. Hydraulic legs allow the modules to climb above rising snow levels when stationary, while ski-based foundations enable their repositioning on the Brunt Ice Shelf. In the Austral summer of this year (January and February), the construction team moved the individual modules 15 km to their first operational site and linked them together for final construction and handover to the British Antarctic Survey in 2012.

by **David A. Nixon**