December 2013

AEROSPACE AMERICA

Budget battles, test flights, lawsuits...

2013 IN REVIEW

PREEMINENCE AT RISK
AIAA President-Elect Jim Albaugh on the industry's future, **page B5**

A PUBLICATION OF THE AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

Mining, habitats lead space architecture work

by David Nixon

*The **Space Architecture Technical Committee** focuses on the architectural design of the environments where humans will live and work in space, including facilities, habitats, and vehicles.*

NASA's current focus on an asteroid rendezvous mission as human space exploration's next big goal has begun to stimulate ideas from the space community at large. One of these, called the **Robotic Asteroid Prospector**, takes a path different from NASA's. The plan proposes the gradual buildup of a space mining infrastructure paced to coincide with the emergence of a commercial space resources market. A team from Astrotecture, V Infinity Research, and Honeybee Electronics developed the idea under a NASA Innovative and Advanced Concept Grant.

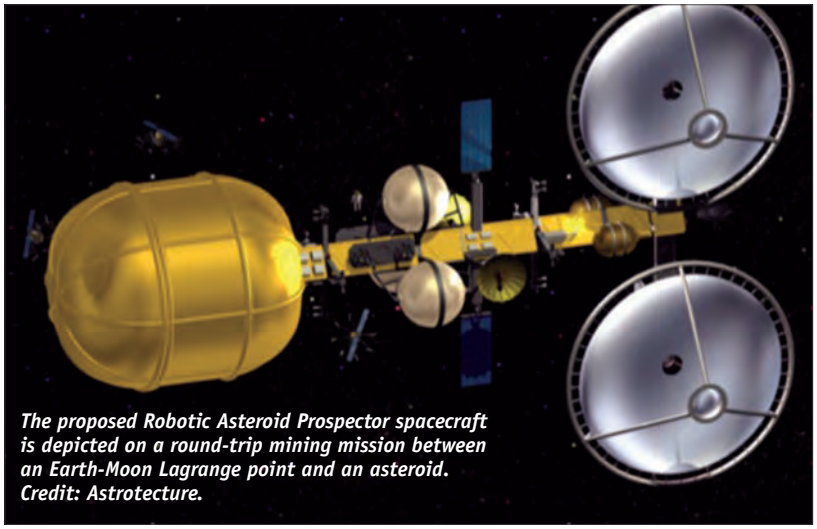
Examples of near-term resources with commercial appeal are **water** and **platinum**. A fleet of mining spacecraft would be staged from an Earth-Moon Lagrange point and returned there from asteroids on a cyclical basis, much like bulk cargo ships on round-trip ocean voyages between distant ports.

The Robotic Asteroid Prospector spacecraft's key design feature is a **solar thermal propulsion** system that would provide propulsive thrust, electricity, and heat for mining and mineral processing. The preferred propellant is liquid oxygen and hydrogen from water. This would allow the spacecraft to refuel at a water-rich asteroid for its return voyage to cislunar space, thus shaving off the mass that must be staged out of the Lagrange point. The spacecraft would rendezvous with an asteroid at its pole, match its rotation rate, and grapple with it to begin mining operations. The Astrotecture team carried out an experiment in extracting and distilling water from frozen regolith simulant as a first step in testing the mission concept's viability.

Architects and engineers who design space habitats are beginning to forge links with those who design air-tight habitats for post-disaster survival on Earth. Through these links, space design and engineering know-how can flow down and help to support design for human survival in extreme conditions including floods, fires, earthquakes, and eruptions. This is a field where space spin-off technology can have real humanitarian benefits.

For example, a consortium is at work in Europe on **Self-deployable Habitats for Extreme Environments** (SHEE), funded under the European Union's Seventh Framework Program. Consortium members are the International Space University, Liquifer Systems Group, Space Applications Services, and the University of Tartu–Institute of Technology, Sobriety, Comex and Space Innovations.

SHEE would comprise a deployable envelope, measuring 5 m in diameter, that encloses a 1.5–2.5-m-diam. rigid core structure. Deliverable by land, sea, or air, SHEE habitats would be particularly useful at bringing support and protection to communities that have been exposed to **natural disasters**. Each habitat would be up to 4 m tall and would include robotically deployed subsystems and an external power generation system. A habitat prototype will be tested as a temporary living module for two people.



The proposed Robotic Asteroid Prospector spacecraft is depicted on a round-trip mining mission between an Earth-Moon Lagrange point and an asteroid. Credit: Astrotecture.

Self-deployable Habitats for Extreme Environments would enable research on the Moon or Mars and shelter people on Earth after natural disasters. Credit: SHEE Consortium.

The use of **robotics** in building construction is a technology at a primitive level of readiness and, despite rhetoric about sustainability, most buildings still rely on traditional infrastructure for consumable utilities supply and waste disposal. SHEE and projects like it can help to show the way out of this dependency. They can reinvigorate architecture's primordial mission to provide safe and secure refuges from the hazards of an uncertain world, while using state-of-the-art technology in an ecologically friendly way.