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A M E R I C A



The year in review

Space colonization

Progress toward future space settlement is measured in small ways, mostly as incremental changes in perception and advances in targeted applied engineering that supports infrastructure development. The past year continues this trend.

It has long been recognized that although space settlement/colony development may be technically feasible, it is economically and politically unlikely in the foreseeable future. Several books published just this year indicate a more general acceptance of the concept that space settlements are natural extensions of human civilization. These include *Living in Space* by the Aerospace Technology Working Group, *Lunar Outpost—The Challenges of Establishing a Human Settlement on the Moon* (Seedhouse; Springer/Praxis), and *Space Enterprise: Living and Working Offworld in the 21st Century* (Harris; Springer/Praxis). The recently concluded *Review of US Human Spaceflight* also reports on a strong consensus to "...the ultimate goal: charting a path for human expansion into the solar system."

Evidence of popular acceptance of space settlement concepts is increasing. The AIAA-sponsored International Space Settlement Design Competition involved more than 1,000 high school students worldwide in designing large space settlements in Earth orbit, in lunar orbit, and on the lunar surface. Similarly, the Space Design Contest, a competition organized by the National Space Society (NSS), attracted hundreds of entries, primarily from individual students.

Space settlement concepts and infrastructure supporting future space settlement were featured topics at the AIAA Space 2009 Conference, the 47th AIAA Aerospace Sciences Meeting, and the NSS International Space Development Conference. A Space Elevator Conference provided conceptual design refinements for a transportation system that could reduce costs to GEO to \$3,000/kg, although some challenges were identified. These include space debris and the realization that carbon nanotubes may not be as strong as originally thought.

Private and commercial projects press forward toward enabling more people to visit LEO and live above the Earth's atmosphere. Bigelow Aerospace advocated an "Orion Lite" spacecraft to enable tourist visits to LEO. The Mars Society's simulated missions in arctic Canada are becoming more sophisticated—these

included UAV flights, remote rover operation, and an in-situ resource utilization demonstration recovering water and plaster of Paris from local minerals.

Automated ISS resupply capability demonstrated by European and Japanese space vehicles are welcome signs of cooperation and cost-sharing in these tough economic times. Similarly, the launch of remote sensing missions to the Moon by other nations new to the space arena is refreshing. Tantalizing evidence of the presence of surface water on the Moon was found recently, and the eagerly awaited results from the NASA Lunar Crater Observation and Sensing Satellite mission may provide a new boost to the Moon-first scenario for space exploration.

As space shuttle operations prepare for another year and start to wind down, work continues on the Ares I and Ares V vehicles,



Although space settlement may be technically feasible, it is still economically and politically unlikely in the foreseeable future. (Image produced for NASA by John Frassanito and Associates.)

and a test flight has been conducted for the Ares I-X mission. Work continues on the Altair lunar lander and its ascent and descent engines. The year also brought progress in work on evaluating the benefits of a small nuclear reactor to provide surface power on the Moon. Any long-term lunar mission will clearly benefit from augmented power for future lunar surface operations.

In the short term, the most significant influences on U.S. national space policy will likely come from responses to recommendations by the Augustine commission, which have had a mixed reception in the public forum. The one consistent theme in the commission's work—that NASA budgets are insufficient to do everything the agency is presently attempting, and only barely enough to do useful parts of it—is right on target. These discussions are of critical interest to the space settlement community: Space infrastructure is an initial condition for establishing space settlements, and decisions made today establish the foundations of tomorrow's space infrastructure. ▲

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