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**Budget battles,
test flights,
lawsuits...**

2013 IN REVIEW

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



Although recent years have not brought development or even unified planning of integrated infrastructure components to enable future **space settlement**, 2013 has seen small steps toward that goal. The most visible aspect of expanding the human economy throughout the Earth-moon system, known as cislunar space, is the continuing commercialization of space services.

The International Space Station is currently the primary focus of commercialization. **SpaceX** and **Orbital Sciences Corp.** delivered **cargo** to the station through their Commercial Cargo contracts. Most importantly, SpaceX's Dragon also returned equipment to Earth. A relative abundance of vehicles has been bringing supplies and experiment hardware to the station, but no return capability had been available since the space shuttle's final flight in 2011. Dragon has begun to relieve the backlog of experiment results waiting for return to Earthbound researchers. Orbital Sciences' Cygnus spacecraft, after delivering cargo to the ISS, was loaded with items no longer needed by the station's astronauts. They then used a robotic arm to detach the craft for its destructive reentry, which took place as planned in late October.

Progress toward on-site manufacturing in space is scheduled to begin in 2014 with NASA and space manufacturing company Made in Space planning to send a **3D printer** to the ISS. The 3D Printing in **ZeroG** Experiment will have astronauts printing test samples to demonstrate the potential of additive manufacturing in a zero-gravity environment. Use of this technology in space would start with the construction of parts, tools and small **CubeSats**, but in a longer timeline could allow the creation of larger structures, spacecraft, and habitable bases. The ability to manufacture in zero gravity, using raw materials found on space missions, would circumvent the cost issues and launch requirements inherent in creating similar items on Earth.

Commercial **crew services** to ISS are also in development, with contracts awarded to Boeing for its CST-100 spacecraft and to SpaceX for a human-rated version of Dragon, with a smaller contract to Sierra Nevada for its Dream Chaser spaceplane. The current contracts continue development into mid-2014; NASA is soliciting proposals for the next phase of the program, which may involve a downselect to one or two contractors through initial flights. An indication of the importance of moving supplies to and

from ISS is the requirement that commercial crew craft also carry cargo.

The ISS itself is also commercializing its services. CASIS, the Center for the Advancement of Science in Space, was established to manage ISS as a U.S. national laboratory and bring **non-traditional users** to the station. Already established or in the works are partnerships with Merck, Novartis, Cobra Puma, Baylor College of Medicine, M.D. Anderson Cancer Center, and the Boston Museum of Science. CASIS offers seed money to help fund promising research projects and assistance with payload development, system integration, and access to launch providers. The organization's emphasis on looking to space for innovative technologies has potential for finding an economic imperative that may eventually lead to large-scale industry in space.



Early work toward colonization

by Anita Gale, Ron Kohl, and Mike Snyder

The Space Colonization Technical Committee promotes the development of advanced concepts, science, and technology to enable and enhance permanent human presence in space.

Large structures for space settlements might be printed and assembled in space. Credit: Made in Space.

An initiative more clearly associated with future space settlement was announced by **A.P.J. Abdul Kalam, former president of India**, at the National Space Society International Space Development Conference in May: He is encouraging the U.S., India, the U.K. and Japan to form a partnership for development of solar power satellite technologies. A focus is on the environmental benefits of **solar power from space**. Early activity associated with the concept primarily involves a series of international conferences. One goal is to eventually involve the G8 and G20 nations, the world's top eight and top 20 leading economies, respectively.

Film and **literary** works also helped to maintain public awareness of space colonization. Late summer saw release of the movie **Elysium**, whose plotline included a major space settlement. The 2012 book *The Visioneers* by W. Patrick McCray described the development of early space settlement concepts by Gerard O'Neill and others during the 1970s. ♠