Operational Lessons Learned from NASA Analog Missions

Larissa S. Arnold

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ABSTRACT

National Aeronautics and Space Administration's (NASA) efforts in human space flight are currently focused on the Space Shuttle and International Space Station (ISS) programs, with efforts beginning on the future exploration opportunities.

Both the Space Shuttle and ISS programs are important to the development of a capability for human exploration beyond Low Earth Orbit (LEO). The ISS provides extensive research capabilities to determine how the human body reacts to long duration stays in space. Also, the ISS and Shuttle can serve as a limited testbed for equipment or entire systems that may be used on missions to the Moon, Mars, or to a near-Earth asteroid.

It has been nearly 35 years since the Apollo astronauts visited the Moon. Future space explorers will have to re-learn how to work and live on planetary surfaces, and how to do that for extended periods of time. Exploration crews will perform a wide assortment of scientific tasks, including material sampling and emplacement of automated instruments. Surface mission operations include the activities of the crew living and working, mission support from the Earth, and the operation of robotic and other remotely commanded equipment on the surface and in planetary orbit. Other surface activities will include the following: exploring areas surrounding a habitat; using rovers to collect rock and soil samples; setting up experiments on the surface to monitor the radiation environment and any seismic or thermal activity; and conducting scientific analyses and experiments inside a habitat laboratory. Of course, the astronauts will also have to spend some of their surface time "doing chores" and maintaining their habitat and other systems.

In preparation for future planetary exploration, NASA must design the answers to many operational questions. What will the astronauts do on the surface? How will they accomplish this? What tools will they require for their tasks? How will robots and astronauts work together? What vehicle and system capabilities are required to support the activities? How will the crew and the Earth-based mission control team interact? During the initial phases of manned planetary exploration, one challenge in particular is virtually the same as during the Apollo program: How can scientific return be maximized during a relatively short surface mission?

Today, NASA is investigating solutions to these challenges by conducting analog missions. These Earth-based missions possess characteristics that are analogous to missions on the Moon or Mars. These missions are excellent for testing operational concepts, and the design, configuration, and functionality of spacesuits, robots, rovers, and habitats. Analog mission crews test specific techniques and procedures for surface field geology, biological sample collection, and planetary protection. The process of actually working an analog mission reveals a myriad of small details, which either contribute to or impede efficient operations, many of which would never have been thought about otherwise. It also helps to define the suite of tools, containers, and other small equipment that surface explorers will use.

This paper focuses on how analog missions have addressed selected operational considerations for future planetary missions.