Mission Operations Involvement in the Desert Research and Technology Studies Analog Mission

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The NASA Desert Research and Technology Studies (Desert RATS) is an annual field test of advanced concepts, prototype hardware, and potential modes of operation to be used on human planetary space exploration missions. For the 2009 and 2010 NASA Desert RATS field tests, NASA incorporated various engineering concepts and operational exercises into mission timelines and executed in a simulated mission framework similar to current space shuttle and International Space Station missions.

The field test for 2009 revolved around a 2-week lunar exploration simulation using a single two-person Lunar Electric Rover (LER). In 2010, the field test again centered on planning and executing a simulated 14-day lunar surface mission, but increased the number of LERs to two, and incorporated docked operations with a pressurized excursion module. The tests were conducted in a once-active volcanic region north of Flagstaff, Arizona, where Apollo crews formerly trained in field geology.

The LERs are conceptual two-person rovers containing an enclosed cabin with extravehicular activity (EVA) access via twin aft bulkhead suit ports. Each LER carried a deployable portable utility pallet containing a communications relay system, suit port transfer module stowage, and geology tools and sample stowage. The EVA equipment for the field tests included geology tools and additionally, for the 2010 field test, an electronic cuff system capable of displaying procedures, recording field notes, and providing navigation. The pressurized excursion module was a mock-up of a design for a pressurized habitat module that contained science, maintenance, and medical workstations, as well as an airlock and multiple LER docking locations.

The field test included the crew, the mission operations team, a geological science team, a mission management team, engineering teams, and a communications and data support team. For these field tests, each LER crew consisted of one systems expert (astronaut or engineer) and one field geologist. The mission planning, team integration, crew training, and test execution were all led by the mission operations team. This team consisted of certified NASA Mission Operations Directorate flight controllers, and provided the core of the Desert RATS mission control team executing the simulated lunar missions. Their backgrounds were in the areas of EVA, mission integration and timeline development (OpsPlan), onboard mechanical systems and maintenance, and robotics. With the simulated EVA operations, mechanized operations (the rover), and need for timeline re-planning, these flight control disciplines were especially well suited for the execution of the 2009 and 2010 Desert RATS field tests.

The mission operations team pulled from their "plan, train, fly" experience in the Mission Operations Directorate to integrate test objectives from multiple organizations and NASA centers. Leading up to the actual simulation at the field test, the operations team members worked closely with the science, hardware, and research teams to produce a mission plan complete with timeline, executable procedures, flight rules, training, and reference manuals. The timelines, procedures, and flight rules all went through multi-team reviews, analogous to space shuttle and International Space Station processes. The coordination of the training of not only the crew members, but also cross-training between the teams to increase cross-disciplinary knowledge and to provide for a more integrated simulation, was also provided by the operations team. During the field test, the mission operations team then executed the mission plan in a flight-like manner, coordinating and integrating among the teams.

With respect to the simulated mission control architecture, the mission operations and science teams operated from a mobile Mission Control Center (mMCC) (figure 1) and several engineering support transport cargo containers were outfitted as science backrooms. All were located at a base camp in the area of operation. In all, approximately 30 positions were filled and set up in a mission control-type architecture. Of these positions, the mission operations team manned the traverse director, assistant traverse director, capsule communicator, and operations planning positions within the mMCC.

The operations team led the mission simulation via the role of traverse director. This position was analogous to a combination of a flight director, simulation supervisor, and Neutral Buoyancy Laboratory test director. Each rover had a traverse director in the mMCC and on the chase team

Fig. 1. *Desert RATS Mission Operations Team working inside the mobile Mission Control Center.*

who coordinated between the science and engineering teams, and the crews.

The OpsPlan position had the responsibilities of developing the daily timeline that integrated the mission operations and science team objectives, creating daily reference materials, and coordinating with the LER support position to transfer electronic files between the mMCC and the LER. Additionally, this person captured the actual execution of the activities in contrast to the pre-mission plan.

The third position filled by the mission operations team was that of capsule communicator. This position's responsibility, just as in actual spaceflight, was to be the voice of the control team to the crew for the non-science activities. During science activities, this responsibility was handed over to a SciCom position that was filled by one of the geologists supporting the simulation.

Although this was not specifically a test of operational techniques, but rather an engineering field test supported within a realistic mission scenario, the inclusion of an operations team has provided the benefit of giving NASA mission operations flight control personnel the opportunity to begin examining operational mission control techniques, team compositions, and mission scenarios for lunar exploration. It provided the mission operations team the opportunity to gain insight into functional hardware requirements via lessons learned from executing the Desert RATS field test simulated lunar missions.

This knowledge will be applied to future Desert RATS field tests to continue the evolution of manned space operations in preparation for human planetary exploration. It is important that operational knowledge for human space exploration missions be obtained during Earth-bound field tests to the greatest extent possible. This allows mission operations personnel the ability to examine various flight control and crew operations scenarios in preparation for actual space missions.