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REMOTE SUPPORT OF ADDITIVE MANUFACTURING ON MARTIAN ANALOGS AND MANNED MARS MISSIONS

Abstract

The logistics of remotely supporting an additive manufacturing capability was explored during an 8-month long Mars analog mission at the HI-SEAS (Hawaii Space Exploration Analog and Simulation) habitat.

An in-situ manufacturing capability could be used during a manned Mars mission to reduce the number of spare parts that would need to be brought (and therefore reduce weight) and help solve unanticipated issues (à la Apollo 13) that are bound to occur during the long term operation of complex spacecraft.

This work, which occurred during mission V, is a continuation and extension of previous work which occurred during HI-SEAS mission III. Previously all modeling work was done by in-simulation crew members. While this has advantages over having external support personnel perform modeling work (e.g. not having to discuss/describe part requirements over high latency communication links) it also requires large amounts of astronaut time. In current space operations available astronaut time is extremely limited. In order to minimize astronaut time requirements design and prototype work would be given to experts on the ground with astronauts having a more limited role (except perhaps in some limited circumstances). Expert designers will also be available on the ground. The purpose of this study was to explore this more realistic operating mode.

Crew members determined the need for new parts and communicated the requirements to the remote support team. The necessary parts were designed and prototyped by remote support personnel before the part files were sent to the crew for local manufacture. Communications between the crew and remote support personnel had a 20 minute delay imposed in each direction, simulating the communication latency between Earth and Mars.

Additive manufacturing allows for a large variety of parts to be produced from the minimum of raw materials and equipment due to its inherent flexibility. This study utilized consumer level fused deposition modeling type machines, one located in the habitat and one located outside the simulation. These machines are capable of using a number of types of plastic (e.g ABS, nylon, PET and PLA). These materials were useful in a Mars analog, but aren't well suited to either the vacuum of space or the environment of the Martian surface due to extreme temperatures and low pressures. Other additive manufacturing technologies and materials can be used in their place but similar coordination between astronauts and mission support will be required.