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FRAMEWORK FOR LOW-COST, LARGE-SCALE MARS ANALOG MISSIONS

Abstract

As commercial high-capacity launch vehicles become available, large-scale missions present exciting new options for surface exploration. New analog capabilities will be necessary to test crew dynamics, governance, emergency response, and unique psychosocial aspects of large-scale missions. Most Mars analogs target small 4-7 person crew sizes, and the cost of developing a large-scale analog facility could be prohibitive. Here we present a framework for low-cost, large-scale analog field tests. This framework includes feature approximation of key mission elements including Mission Control (Mars-based, within the analog crew), asynchronous Mission Support (Earth-based, staffed outside the analog), ISRU systems, dual professional specializations for each crewmember (one survival-related and one expression-related), a token economy, and a multi-village habitat and governance structure. This paper presents the new framework for a first test in a crew of 30 students simulating a Mars homesteading mission, complete with simulated contingency events to evaluate the emergency response and crew recovery procedures for large groups, as well as psychosocial and behavioral studies. The cost for transportation, room, and board in this mission tallies at $40/person/day, whereascomparablesmall - scaleMarsanalogmissionsstartat143$/person/day. This framework provides more opportunities for students and professionals to become a crewmember due to the intentionally large number of crewmembers in these missions. Lowered costs further increase the ability to engage students, particularly those from areas underrepresented in space exploration. Additionally, these missions can occur outside of current analog structures, reducing availability constraints. Results are necessary to provide insight into the challenges and future development work needed to enable effective large-scale missions. Emergency recovery capabilities in particular are expected to be significantly improved over small-scale missions, as even a complete habitat failure in one village is recoverable by the other villages and does not result in a need to abort the mission. This low-cost framework for large-scale missions can be implemented to develop mission concepts, leading to advances in technology and architecture development to enable safe, large-scale missions to explore Mars.