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CONSTRUCTION OF SURFACE INFRASTRUCTURE FOR RETURNING TO THE MOON TO STAY & COLONIZATION OF MARS

Abstract

Long stays on the Moon and Mars, especially in the context of colonization and development of Space, require continuous logistics as well as infrastructure emplacement, operations, and maintenance. In situ resources offer an opportunity to reduce the amount of items brought from Earth when exploring moons and planets. Converting those resources to usable products requires energy that comes with a cost that varies depending on the availability of energy at the mission site. In the case of human missions to Mars, trading surface power for launch mass is beneficial for propellant and consumables required to sustain human pioneering and settlement on the planet's surface. However, sustainable colonization of Mars requires far more than tapping sources of water and oxygen on Mars. In Situ Resource Utilization (ISRU) aims to exploit abundant resources available at the destination, however they may exist in the regolith and in the atmosphere. As a guide, NASA's roadmap identifies six (6) areas of ISRU: Prospecting, Extraction, Processing, Construction, Manufacturing, and Energy.

Over the years, NASA has developed some capabilities and technologies for prospecting, extraction, and processing carbon dioxide and water on Mars into propellants, life support consumables, and plastics. However, that is a small subset of the ISRU needs that are coming to light with NASA's push to return to the Moon for extended periods of time. For instance, astronauts require shielding from Galactic Cosmic Rays and nuclear radiation and protection from the low temperatures and pressures in Space. Surface assets including crew, landers, and ascent modules can be damaged by surface ejecta during landing and launch operations on the Moon and Mars. Creating shielding, berms, foundations, dust free zones and launch/landing pads requires movement of large volumes and stabilization of regolith in the context of a civil engineering construction project.

Anticipation of these civil engineering tasks led to the creation of a framework for construction requirements and some construction equipment concepts for excavation and grading of surface regolith and some testing capabilities to simulate an operational environment on the Lunar surface. The purpose of this paper is to illustrate and organize in-situ construction systems in the context of the multidisciplinary nature of the aerospace systems, and the test capabilities necessary to develop them during NASA's plans to return to the Moon to Stay and to prepare for Mars.