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Author: Mr. Luca Levrino
Politecnico di Torino, Italy

Mr. Giacomo Gatto
Politecnico di Torino, Italy
Mr. Eugenio Gargioli
Thales Alenia Space Italia, Italy
Ms. Sherrie Hall
Massachusetts Institute of Technology (MIT), United States
Prof. Jeffrey Hoffman
Massachusetts Institute of Technology (MIT), United States
Mr. Paolo Maggiore
Politecnico di Torino, Italy
Dr. Nicole Viola
Politecnico di Torino, Italy
Dr. Maria Antonietta Viscio
Politecnico di Torino, Italy
Ms. Janelle Wellons
Massachusetts Institute of Technology (MIT), United States

HUMAN LIFE SUPPORT IN PERMANENT LUNAR BASE ARCHITECTURES

Abstract

The future of human space exploration relies on many different requirements that must be fulfilled if man intends to expand his presence beyond Low Earth Orbit (LEO). Indeed, a major factor affecting deep space mission architectures resides in the ability to cope with a hostile environment, which is very different from the one found in LEO. With the aim of attaining the ultimate goal of taking humans to Mars, there are several technological limitations that need to be overcome in order to sustain human life in such harsh conditions. In the context of an evolutionary path, which would see the incremental employment, testing, and validation of new elements for future Mars expeditions, a lunar mission can be considered as an inevitable and paramount milestone.

Even though several astronauts have already set foot on our natural satellite, it was only for short sorties, whose architectures would need to be radically altered in case long stays were envisioned. The present paper investigates human factors related to long permanence on the lunar surface, and proposes solutions to support human life. The main aspects to be tackled regard: crew size, tasks analysis, habitable and laboratory modules, radiation shielding, airlocks and EVA systems. Moreover, the integration of these elements in an original architecture is proposed, providing explanations of the main choices.

The crew is sized starting from the analysis of tasks and activities to be performed, as well as accounting for psychological and social aspects. For the assessment of the habitat configuration, particular attention has been given to the definition of a highly reliable, closed-loop environmental control system. Moreover, to respond to the need of a self-sustaining lunar outpost, most of the consumables necessary for life support, such as oxygen and water, are envisaged to be produced in-situ. In-situ resource utilization is also taken into account for radiation shielding purposes: covering the modules with regolith is in fact the

best way to reduce launch masses. Additionally, the present study also embraces the analysis of critical technologies that match the specific subject areas of life science, like advanced space suits to enable humans to conduct surface exploration outside habitats and vehicles, and the utilization of inflatable structures for crewed surface base modules.