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Author: Mr. Daniel Inocente
Skidmore, Owings and Merrill LLP, United States, daniel.inocente@som.com

Prof. Jeffrey Hoffman
Massachusetts Institute of Technology (MIT), United States, jhoffma1@MIT.EDU
Dr. Advenit Makaya
European Space Agency (ESA), The Netherlands, advenit.makaya@esa.int
Ms. Marlies Arnhof
Advanced Concepts Team, ESA, The Netherlands, marlies.arnhof@gmail.com
Ms. Hanna Läkk
European Space Research and Technology Centre, ESA-ESTEC, The Netherlands, hanna.lakk@esa.int
Dr. Aidan Cowley
ESA, Germany, aidan.cowley@esa.int
Mrs. Claudie Haigneré
European Space Agency (ESA), France, claudie.haignere@esa.int
Dr. Markus Landgraf
European Space Agency (ESA), The Netherlands, Markus.Landgraf@esa.int
Mr. David Binns
European Space Agency (ESA), The Netherlands, david.binns@esa.int
Mr. Piero Messina
European Space Agency (ESA), France, piero.messina@esa.int
Dr. Valentina Sumini
Massachusetts Institute of Technology (MIT), United States, vsumini@mit.edu
Mr. Georgi Petrov
Skidmore, Owings & Merrill LLP, United States, georgi.petrov@som.com

MASTER PLANNING AND SPACE ARCHITECTURE FOR A MOON VILLAGE

Abstract

The European Exploration Envelope Programme (E3P) integrates ESA's space exploration efforts in Low Earth Orbit, the Moon and Mars. In line with the resolution "Towards Space 4.0 for a United Space in Europe" adopted by the ESA Council, E3P will also aim at "developing new concepts for international exploration activities, encompassing novel cooperation opportunities open to all nations and industrial actors". Future missions to the lunar surface should be driven by cooperation and sustainability. The "Moon Village" concept presented by the ESA Director General is a vision for an open architecture based on global cooperation between multiple nations and multiple partners combining their various expertise for the common objective of enabling long-term exploration of the lunar surface. Key to achieving this goal is the establishment of an infrastructure on the Moon, relying on a myriad of architectures and system capabilities. As part of this, a strategic alignment with NASA's 2018 Strategic Plan to "extend human presence deeper into space and to the Moon for sustainable long-term exploration and utilization" would be essential. With the advancement of new and emerging capabilities supported by commercial expertise, transferring proven technologies toward addressing challenges in space will result in the construction of an

early outpost for safe, flexible and efficient human exploration. Achieving this would produce operational experience for the planning and extensive development of a lunar ecosystem. Skidmore, Owings Merrill is investigating with the European Space Agency and faculty from the Massachusetts Institute of Technology concepts for the first permanent human settlement on the lunar surface. This collaboration aims to demonstrate the potential of an international private-public partnership to advance human space exploration through cross-disciplinary cooperation. The paper presents an holistic approach to planning a lunar development, centering on the need for singular habitation systems, designed as adaptive space systems to enable an ecosystem of versatile surface operations. The designed multi-functional structural concepts, optimized for performance, safety, and utility, leverage emerging technologies including a combination of structural pressurized vessels, regolith structures for radiation shielding, and adaptive infrastructure planning. Located on the south pole near the "peaks of eternal light, the development maximizes In-Situ Resource Utilization (ice deposits and energy). Phasing strategies are explored for evaluating the evolutionary steps of the settlement to harness future ISRU-based construction activities. By expanding on the capabilities and the collaboration of both commercial and government entities, addressing large-scale architectural systems for human space exploration can be accelerated.