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LUNAR WORM: DESIGNING A HYBRID CLASS HABITATION MODULE INSPIRED BY NATURE

Abstract

Space exploration has always been a desired field for multidisciplinary teams all over the world. These days more than ever humanity is close to a real step towards extended lunar exploration and possibilities for long-term missions on Earth's satellite. Designing potential habitat solutions that would sustain human presence on the lunar surface represents an important challenge to be addressed. Lunar Worm is a hybrid class II and III module for long-term habitation that aims at increasing human research and settlement capabilities through a biomimetic approach inspired by annelids. The chosen location for the mission is the Shackleton crater which became a target for multiple space and lunar research groups mainly due to the perpetual sunlight and the presence of frozen water. For the initial step of the mission, a proposal of a limited village is determined, which is composed of two deployable modules designed for a crew of 4 members. Inspired by the annelids, Lunar Worm's main feature involves a deployment system based on the expansion of a series of segments of a composite inflatable solution, enclosed between two rigid shells. Regarding the materials, high-strength, impact-resistant, and advanced composite materials are chosen for the envelope: the front bumper is to be made of Kevlar reinforced polymer composites whereas the other layers include Nextel and Kevlar fibers. Overall, the rigidity and the structural resistance of the module is guaranteed by the aluminum frame, which possesses low mass and high stiffness and minimizes transportation costs and volume. The inner layers of the inflatable system integrate the use of innovative solutions such as mycelium, cyanobacteria, and ice to provide insulation as well as radiation protection. Furthermore, the fabrication through 3D printing of a lunar regolith radiation shielding has been envisioned during robotic precursor missions, aimed at site preparation for human arrival. The organization of the module allows for the deployment both in vertical and horizontal directions, increasing

its flexibility. The interior distribution of the modules has similar facilities that offer structurally stable, psychologically comfortable, and mission targeted design solutions, taking into consideration both the technical requirements and suggestions for the optimal physiological performance of the crew. Modularity and redundancy both at a module and at a settlement level are taken as key design principle to create a system that allows for an incremental expansion to serve larger crews over time and become a permanent lunar habitation and research village.