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Space Architecture: Habitats, Habitability, and Bases (1)

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DESIGN EXPLORATION FOR A MARTIAN HABITAT THROUGH A DIGITAL TOOL FOR PARAMETRIC INTERIOR ARCHITECTURE

Abstract

Space exploration has always granted the achievement of great accomplishments in research and has provided innovative techniques that have improved technological advancements. For this reason, this paper focuses on the field of space architecture, a discipline that concerns the planning of structures in space. Research in this field makes it possible to update the methods usually followed by traditional architecture, thus finding novel and more technological approaches.
Designing a resilient and sustainable infrastructure for manned missions on Mars is a new challenge that requires new conceptual design approaches, this concerns both the materials selection and the tools used to develop the project.
Architecture in Space, as the synthesis of scientific domains that organize the life of humans, relies on some fundamental pillars that are intrinsically interconnected: space sciences, engineering, robotics, industrial design, ergonomics, medicine, psychology, and art. The extreme environmental conditions are a major technological challenge, but also an opportunity of exploring new construction methods using alternative materials, enabling architecture to progress and update traditional methods.
In this paper, a habitat on Mars, E.L.L.E., an Extreme Livable Lightweight Environment, for 6 astronauts and a mission of 600 days has been designed within a cross-disciplinary environment at different scales, from architecture to interior design, and built on the knowledge and technologies developed for space applications. Challenging both space and terrestrial architectures to consider the relationships between human activities and the resources which support them.
Previous research concerning human factors was crucial to make choices for the interior design process. Several psychological and physical factors must be considered because long stays in Mars' environment in isolation condition can have negative effects on people, therefore architecture must respond to these needs, by developing smart solutions to reduce the undesirable effects. In this paper the relationships between individual-environment and individual-individual have been analyzed and taken into consideration to develop an interior architecture strategy, using a parametric software, and creating a script in Grasshopper, which is an algorithmic modeling program. This is an adaptive script, and it describes the organization of the interiors of the habitat, that can change according to the parameters selected.
A computational design approach has been applied to perform multi-objective optimization and form-finding analysis to support the decision making process for E.L.L.E. and future Martian habitats.