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Space Architecture: technical aspects, design, engineering, concepts and mission planning (1)

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FABRICATION AND SELF-ASSEMBLY PROCESSES ON THE MARS SURFACE

Abstract

The paper explores a rich combination of hybrid techniques required to construct, operate and maintain the structural and building infrastructure of a Martian colony. The colonization plan is devised for the active involvement of 40 people with diverse backgrounds and expertise. In light of the possibilities given by contemporary robotics, the project combines 3d printing, autonomous multi-agent systems and smart materials to complementary create an extra-terrestrial fabrication and self-assembly system. A specific social model dictates the overall plan and facilitates the emergence of the necessary spatial arrangements and requirements. The colony complex involves the arrangement of four main types of buildings, which host living quarters, social spaces, work places, support and technical infrastructure, as well as special buildings, such as vehicle-drone hangars. The construction logic manages the excavation of areas and the utilization of the extracted regolith for 3d-printed structures on the surface. Complementary, small robotic operators perform the same activities for construction details and small-scaled elements, while smart materials self-adjust according to environmental and operating conditions. Robotic swarms are also responsible for the assemblies. The proposal is supported by a series of experimentations with scaled prototypes, finite element analysis and simulations to provide a solid proof of concept for the approach. The paper is based on the collaborative work of a large interdisciplinary team of students from the Technical University of Crete and the University of Houston.