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A REVIEW OF ADDITIVE MANUFACTURING TECHNOLOGIES FOR PLANETARY CONSTRUCTIONS

Abstract

Human exploration of the space of the heliosphere (and beyond) is strongly linked to the ability to use local resources. Despite the trend that sees a progressive growth in the useful payload of the new generation carriers, establishing a constant human presence and growth in the volumes of buildings on the lunar and Martian surface is possible only through mastery in the use of materials offered by the surrounding environment. Building on or below the surface requires a deep knowledge not only of the properties of materials and construction techniques but also of the form factor of pressurized and non-pressurized constructions. The environmental conditions and properties of the regolith between the moon and Mars, although very different, characterize the need to automate the construction processes right from the exploration phase. Studying the construction of the structures built with In Situ Resources Utilization (ISRU) therefore also means developing a family of vehicles and robots capable of supporting the preparation of the site, the collection and processing of materials up to construction and maintenance. Since the diffusion of additive manufacturing for large-scale applications, Space Agencies like NASA and ESA have explored different strategies to address the topic, and many earth-based technological demonstrators have been tested, with support from the private construction sector. Academic and private research entities are currently developing similar projects, using innovative techniques and near-future technologies. This paper aims to review and analyze the state of the art of space structures built with ISRU to define an abacus of techniques and technologies for the efficient use of resources in situ, to build a methodology of approach to the design of structures suitable for welcoming human crews on the lunar and martian surface.