IAF SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Science, Instruments and Technologies (3B)

Author: Mr. Aldo Schirripa Spagnolo
ASI - Italian Space Agency, Italy

3D MARS, MARTIAN RECOVERY STRUCTURE

Abstract

The Lunar Landing of 1969 highlighted how space exploration allows us to develop and test processes, materials, tools to be used also on Earth, these researches have repercussions on experimentation and technological evolution, therefore on our daily life.

Nowadays, Mars represents a hot topic for space exploration also considering the recent results of the scientific research programs of space agencies around the world. Although the topic of building on Mars is a long-term reachable issues, it's important to understand how current computational design and digital fabrication tools can answer this question. Within digital fabrication, large-scale 3D-printing with local material allows us to remotely perform automated processes, able to faithfully respond to the indications of the project file.

This research aims to define an integrated digital workflow for the construction on-site of recovery structure for ExoMars2022. Thanks to computational-parametric design methodology, this workflow is flexible and adaptable to different and future design needs. It allows us to collect and reuse the data obtained to have a starting point, a "Case 0" for future space research. It would be the first real construction approach on an extraterrestrial planet.

With this methodology and iterative process, we designed a 3D-printed structure with digital form-finding and structural-optimization workflow techniques. Our aim is to generate a parametric design through a process based on the use of algorithms and visual-scripting able to define an architectural form on Mars Surface.

The landing site is Oxia Planum, an area with significant scientific value and with abundant reserves of phyllosilicates (fine-grained clay).

In order to solve the problems due to space transport, we decided to use materials collected on site by robots which will bring it inside the Lander. The materials will be processed creating a mixture to be directly transferred into the printer through a pumping system.

The workflow is based on the rover's footprint, according to the parameters we have established. We obtained a surface based on the size of the ExoMars2022 Rover. Given that local Martian-clay does not have good tensile strength, we decided to use a computational-parametric software for the form-finding process in order to obtain a shape resistant to compression-only. After obtaining the resulting shell, we shall use it as the initial input for the next phase of structural-optimization, where we shall define further parameters such as gravity, material, loads, and type of constraints.