14TH IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Novel Concepts and Technologies to Enable Future Building Blocks in Space Exploration and Development (3)

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ADVANCED CONCEPTS FOR MOON EXPLOITATION – A PRELIMINARY STUDY ON LUNAR MASSIVE IN-SITU RESOURCE UTILIZATION TO FUTURE SPACE MISSIONS COSTS REDUCTION

Abstract

In the framework of the Global Exploration Roadmap (GER), the availability of large outposts orbiting in cis- and trans-lunar space to answer different functionalities is a mandatory preliminary step for the future solar system human exploration. The Moon is no longer perceived as a target to reach, but as a starting point and platform to be exploited as a step towards greater objectives.

In this context, the European Space Agency proposed the ESA Moon Challenge, an International Student Contest challenging international teams, composed by University students from at least two continents, to design a mission scenario and operational concept for ESA's HERACLES concept study.

This paper focuses on the main results and original aspects of the mission scenario proposed and designed by the Advanced Concepts for Moon Exploitation (ACME) team: a combination of large-scale lunar surface and trans-lunar space architectures is proposed, to produce and assemble key spacecraft components directly in space, enabling currently unfeasible deep space missions and more efficient Earth servicing space systems building up.

The key motivation being the energetic requirement to launch massive elements from the Moon to be strongly reduced with respect to launch them from Earth.

The mission includes three main building blocks: the automated Moon surface infrastructure, the orbiting manned station, located in the Earth-Moon Lagrangian Point 2 (EML2) and the Earth segment. The first is composed by three further modules: (1) set of robots to collect regolith and feed the (2)In-Situ Resource Utilisation (ISRU) plants to extract the correct chemicals to either feed the (3) 3D printers to produce basic spacecraft structural components (trusses, plates) or to synthetize rocket propellants (H2,O2,metals). The orbiting manned station is conceived to receive the lunar surface products and technologically advanced hardware coming from Earth and assemble them into operational space vehicles aimed to perform different exploration mission scenarios. The EML2 station itself is designed to be modular, to launch from Earth small modules then enlarged and assembled in orbit, exploiting the in-situ produced structures as well.

The paper reports the overall architecture design and operations strategy, pointing out the mandatory requirements; attention is then focused on the Moon surface modules definition and design; their feasibility is critically discussed according to the current Technology Readiness Level and the potential development plan. The cost effectiveness of the proposed scenario is highlighted, supported by the performed economic analysis to assess the validity of the proposed concept.