

**A MULTIDISCIPLINARY FRAMEWORK FOR THE DEVELOPMENT OF LUNAR
PRESSURIZED ROVERS**

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ABSTRACT

This research introduces a novel multidisciplinary conceptual methodology for the design and development of lunar pressurized rovers (LPR) for human exploration and scientific activities on the Moon. This work addresses the emerging need for advanced rover technologies at a time when interest in pressurized lunar vehicles is experiencing a strong revival. The methodology contributes to addressing the limited focus that LPR for lunar operations have received in recent aerospace engineering research. The design process is initiated with a rigorous analysis and selection of top-level requirements, target mission and constraints. These include considerations related to available technological capabilities, the characteristics of launch vehicles, and the challenges posed by the lunar environment. Following the requirements analysis, the methodology proceeds to the evaluation of the general vehicle layout. Both internal and external configurations are explored through comparative studies aimed at identifying the optimal design that ensures operational efficiency, fulfillment of the requirements, and adaptability to the lunar terrain. This phase is critical in balancing the functional aspects of the rover with the practical limitations imposed by the mission environment. Key components of the design framework include the primary structural sizing, the selection of internal habitat subsystems, the mobility system definition, comprising wheels, suspension, and powertrain elements, and the design of the docking system for LPR coupling with permanent lunar bases. Each subsystem is subjected to thorough sizing activities and mass estimation procedures, to achieve a complete final design and defined layout for the LPR. The proposed approach is inherently modular and interdisciplinary, allowing for the integration in the framework of diverse physical characterizations, and of different levels of fidelity, such as vehicle dynamics, terramechanics, and powertrain performance. This modularity facilitates iterative refinements, enabling the design to evolve in response to emerging challenges and new technological developments. In doing so, the methodology not only ensures technical feasibility but also provides a scalable framework adaptable to a variety of mission scenarios and requirements. By presenting this integrated design framework, the research demonstrates that a structured, systems-based approach can effectively address the complex challenges associated with the development of next-generation LPR. The results indicate promising potential for enhancing human lunar exploration capabilities and supporting long-duration scientific operations on the Moon. This research is developed within the Space It Up! program.

Comments: *(Space It Up! Session)*