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TECHNICAL AND ECONOMIC ASSESSMENT OF ISRU AND NON-ISRU LUNAR HABITAT RADIATION SHIELD

Abstract

In-situ resource utilisation (ISRU) is increasingly seen as an essential requirement for the resilient and cost effective exploration of the solar system by human and robotic means. ISRU on the Moon is typically the processing of regolith via thermal or chemical processing techniques into useful materials, such as those required for construction. We provide a simple analysis of two radiation shield concepts, a water blanket and a regolith concrete based system. Specifically, we examine the benefits of ISRU techniques for early-stage human habitation of the Moon. This is important for the space architecture community in laying the foundations for more critical explorations of the most cost-efficient methods available to deploy habitable spaces on the Moon. We test the hypothesis that for small-scale habitats, ISRU techniques are too complex and massive compared to water blankets (and similar). IRSU achieves superiority as the scale increases, owing to lower variable costs. The concepts presented are derived from the literature, namely: ESA's D-Shape and a water blanket concept based on dimensions proposed by Montes et al in 2015. These concepts are sufficient for comprehensive assessment and include sufficient mass and technical detail to draw conclusions regarding economic attributes. Given the immaturity of the proposals and the very high levels of uncertainty true cost appraisal remains elusive, rather we use mass and complexity as proxies for cost. Our goal has been to determine the most economic option for three different size scenarios, approximated by duplicating habitats. We consider the Delta-V penalties of both concepts, based on a specified level of shielding drawn from the literature. The use of duplicate habitats to approximate increasing habitat size further opens up the study to use real-options flexibility approaches in deriving the benefits of regolith concrete concepts versus the non-ISRU approaches. In particular, the increasing size of the habitat can be regarded as an option to be opened early on, with a view to possibly being taken up at some later point. In summary, we consider the benefits of ISRU techniques for construction of a lunar habitat radiation shield and we provide insights helpful to decision-making associated with the construction of lunar habitat at small to medium scales.