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SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

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Abstract

This paper is the conclusion of six months of project work, completed by a multidisciplinary team of 27 graduate students from 10 different countries, as part of the ninth edition of the 'SpacE Exploration and Development Systems' (SEEDS) Master's programme. This year the team has been hosted by Politecnico di Torino (Italy), ALTEC (Italy), ISAE-Supaero (France), the University of Leicester (United Kingdom), and the Concurrent Design Facility at ESA/ESTEC (Netherlands). ESA's support of the project work aligns with their ongoing research into the lunar architecture required to realise the moon village aspiration, as a stepping stone to the eventual human exploration of Mars.

The implementation of In-Situ Resource Utilisation (ISRU) is necessary for the development of space exploration, and increasing accessibility for commercial enterprises beyond low Earth orbit. The ability to produce propellant, oxygen, water, and structures in-situ reduces launch costs enabling larger, more complex systems to be conceived. ISRU technologies and methods currently in development are at the forefront of human space exploration and are are expanding the horizons of missions within the solar system.

This paper presents an analysis of availability and accessibility of lunar resources, and trade-off studies into the architecture required to maximise their utilisation. Methods of resource extraction and their required surface building blocks are detailed, comprising autonomous systems and a human-tended lunar outpost. Finally, a systems level design is presented incorporating on surface production, storage and transfer methods to a cislunar station (derived from previous SEEDS students and industry studies) to provide a continuous supply of resources. The successful implementation of the methods presented could pave the way for a station that is fully independent of Earth resupplies, opening opportunities for humans to explore the solar system, beyond our nearest neighbour.