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TOWARDS A HUMAN-CENTRED FRAMEWORK FOR CONCEPTUALIZATION OF LUNAR SURFACE SOLUTIONS

Abstract

It has been 50 years since astronauts last walked on the lunar surface during the Apollo program. The aim of NASA's lunar exploration program, Artemis, to which the European Space Agency (ESA) and several national space agencies are contributing, is to establish a sustainable human presence by 2028.

The goal is to "go forward to the Moon" and use what is learned on and around the Moon to take the next giant leap, sending astronauts to Mars.

A team of ESA engineers is currently preparing the development of a European Large Logistics Lander (EL3). The EL3 is being designed to allow various missions with different options for its payloads, such as scientific payloads, crew supplies, or unpressurised rovers to support human expeditions. A cargo deployment solution that fulfils EL3's mission requirements and allows easy interaction by astronauts has yet to be designed, however it is essential to the success of future missions. The lunar surface poses several challenges due to its unique environmental conditions such as reduced gravity levels, harsh thermal conditions, peculiar illumination, limited field of view and range of motion due to the extravehicular activity suits, as well as mental and physical fatigue. All these challenges need to be considered and tackled when designing technology for future lunar and planetary explorers.

This paper aims to present possible solutions for future reliable logistics supply systems. The following design process was adopted; first, several concepts were generated during group brainstorm sessions, after that a trade-off analysis was performed to narrow down the set of concepts in a systematic manner. The weighted trade-off criteria included: operations risk, development risk, safety and feasibility. Feedback was gathered through a multiple stakeholder approach including operations engineers, astronaut instructors, managers and scientists from the European Astronaut Centre (EAC) and the EL3 team. The concepts were then refined iteratively to finally select one viable cargo deployment concept, whose operations could then be tested in a representative virtual reality environment. This work provides a framework for future design studies, allowing operational assessments of the EL3 concept early in its development.