HUMAN SPACE ENDEAVOURS SYMPOSIUM (B3)
How Can We Best Apply Our Experience to Future Human Missions? (2)

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SPACECRAFT CONCEPTUAL DESIGN COMPARED TO THE APOLLO LUNAR LANDER

Abstract

Future human exploration of the Moon will require an optimized spacecraft design with each sub-system achieving the required minimum capability and maintaining high reliability. The objective of this study was to trade capability with reliability and minimize mass for the lunar lander spacecraft. The NASA parametric concept for a 3-person vehicle to the lunar surface with a 30% mass margin totalled was considerably heavier than the Apollo 15 Lunar Module "as flown" mass of 16.4 metric tons. The additional mass was attributed to mission requirements and system design choices that were made to meet the realities of modern spaceflight. The parametric tool used to size the current concept, Envision, accounts for primary and secondary mass requirements. For example, adding an astronaut increases the mass requirements for suits, water, food, oxygen, as well as, the increase in volume. The environmental control sub-systems becomes heavier with the increased requirements and more structure was needed to support the additional mass. There was also an increase in propellant usage. For comparison, an "Apollo-like" vehicle was created by removing these additional requirements. Utilizing the Envision parametric mass calculation tool and a quantitative reliability estimation tool designed by Valador Inc., it was determined that with today's current technology a Lunar Module (LM) with Apollo capability could be built with less mass and similar reliability. The reliability of this new lander was compared to Apollo Lunar Module utilizing the same methodology, adjusting for mission timeline changes as well as component differences. Interestingly, the parametric concept's overall estimated risk for loss of mission (LOM) and loss of crew (LOC) did not significantly improve when compared to Apollo.