HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Going Beyond the Earth-Moon System: Human Missions to Mars, Libration Points, and NEO's (4)

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TRADESPACE EXPLORATION APPROACH FOR ARCHITECTURAL DEFINITION OF IN-SPACE TRANSPORTATION INFRASTRUCTURE SYSTEMS FOR FUTURE HUMAN SPACE EXPLORATION

Abstract

Current planning activities for human spaceflight development are centered on exploration beyond Earth orbit. In order to more effectively define future programs, multiple mission design decisions must be identified and assessed prior to final concept selection. The options for these design decisions can be captured in an extensive tradespace. This paper presents a framework in which the in-space portion of beyond Earth orbit human exploration infrastructures is described by a set of function mappings to habitation and transportation hardware and specification of advanced technology alternatives. A comprehensive set of possible mission architectures is enumerated and explored via quantitative assessment of evaluation metrics. The scope of the tradespace includes multiple mission destinations (Moon, Mars, and Near Earth Asteroids), high-level mission mode decisions, and the selection of specific performance-improving technology options. The large combinatorial space of enumerated architectures motivates moderate-level fidelity studies relative to traditional point design analysis due to cost and resource constraints. Proxy metrics for performance, cost, risk, and cross-destination mission extensibility are used to evaluate the parametric and physics-based model. These metrics can be used to inform system architects and decision-makers about dominant architectural features and technical trade-offs that are important to consider prior to concept down-selection. It will be shown that, as the tradespace is explored and evaluated, a hierarchy of design decisions emerges for each metric. The decision hierarchies indicate the dominance of particular design decisions in terms of the performance metrics. These hierarchies can be used to support the decision process through the creation of an ordinal ranking of decisions. Also demonstrated will be the coupling of decision sets, specifically how some decisions are inherently connected such that the choice of one option strongly affects the potential performance of all other coupled decisions. Finally, the paper concludes by presenting a set of recommended technical decisions that can be used to inform mission designer's current efforts to define future human space exploration programs.