

SPACE SYSTEMS SYMPOSIUM (D1)
Interactive Presentations (IP)

Author: Mr. William O'Neill
Purdue University, United States, woneill@purdue.edu

APPLICATION OF ROBUST PORTFOLIO OPTIMIZATION IN ADDRESSING UNCERTAINTY IN
DEEP SPACE HABITATS AND MARS SURFACE OUTPOSTS**Abstract**

The development of modular space systems is complicated by the increasing number of available space systems, the uncertainty in terms of technical and operational risk and the inherent complexity of space systems. Innumerable new and horizon space systems from both commercial entities and international space agencies are currently operational or in the development process. These new, possibly game-changing systems come with varying levels of uncertainty in terms of both mission risk and development risk. These risks often compete and require a trade in terms of risk acceptance. The uncertainty of individual system risk is compounded when these systems are combined. The wide range of possible systems a mission manager can choose from, coupled with the degree of uncertainty of interacting aerospace systems poses a technical challenge in selecting the most optimal combination of systems. Often these systems have strict requirements that must be met to operate which adds another layer of complexity. The goal of any mission designer is to maximize overall system performance and system capabilities while minimizing risk. Robust Portfolio Optimization is a tool that originated from the investment and banking industry that is successful at balancing risk and reward in a portfolio of many investments. This approach, with some modification, provides a method to select the optimal portfolio of systems given complex capabilities and requirements, mission risk and development risk. Specific system requirements and connectivity constraints are satisfied using network theory. Risk is addressed using a parametric approach that models a mission manager's risk aversion. Presented examples include a modular deep space architecture and a Mars surface outpost. Both examples include the selection of technology and hardware at varying levels of development and uncertainty. Risk is assessed using a mission manager aversion criteria. Weighting of specific performance criteria and objectives allows the mission manager to compare a multitude of portfolios against each other.