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MODELING THE PARALLELISMS AND INTERCONNECTEDNESS OF SPACE TECHNOLOGY R&D AND MISSION SEQUENCING

Abstract

Effective space portfolio management is becoming an increasingly complex issue. There exists a constant debate as to whether mission selections "pull" technology growth or technology growth "pushes" mission selection. In reality, there is a complicated mixture of both. Greater understanding of this interconnectedness can lead to a more nuanced view of the implications that various types of decisions in one stream has on the other, which is an area that remains largely unexplored. As noted by the Augustine commission, effective R&D spending is critical to NASA's future.

Given the complexity of constantly evolving technologies and mission concepts, understanding the impacts of particular decisions can prove difficult, if not impossible to fully understand. Building on prior empirical work by the authors (presented in past IAC sessions), this paper seeks to expand links between portfolio decision-making and organizational design as they apply to both R&D as well as mission formulation. In doing so, the goal is to hasten the development of the required permutations of technologies as well as choose more optimal combinations of missions. Additionally, this new approach will help to characterize the distribution of NASA's portfolios of technology investments and missions.

First, a so-called Garbage Can Model of Organizational Choice is developed, linking technology choices to problems and solutions as a function of organizational design. The effort required to generate various combinations of solutions as a function of discreet time steps is explored. This provides an understanding of how organizations can consider solving combinations of problems. The results of these choices are mapped to design changes at the system level, using a design structure matrix (DSM), in order to measure the overall impact of combinations of possible decisions on spacecraft architecture. Parallel portfolios of R&D investments and possible mission selection portfolios are evaluated both in terms of size of investment as well as their distributions, with physical systems architectures representing the strongest links between them. Organizational and technical relationships are examined in order to gain a clearer understanding of the R&D picture.

These combinations are iterated over time to understand possible technology combination evolutions. Examining the results of varying decision combination possibilities can help to understand which choices lead to more rapid advancement both in terms of specific systems in addition to the broader architecture. NASA's portfolios of planetary science scientific instruments and missions as well as previous case studies into NASA's technology development are captured to provide realistic structure.