 Paper ID: 82493
student

IAF SPACE SYSTEMS SYMPOSIUM (D1)
D CATEGORY "INFRASTRUCTURE" - Extra Session (8)

Author: Mr. Ryan de Freitas Bart
Massachusetts Institute of Technology (MIT), United States

ASSESSING THE PERFORMANCE IMPACT OF REUSABILITY IN NEXT-GENERATION SPACE TRANSPORTATION SYSTEMS

Abstract

With the proliferation of outer space activities, there is an ever-increasing need to adopt sustainable practices for these activates to ensure space is useable for years to come. Hardware reusability is a promising solution to increase sustainability while reducing the cost of operating in space, making it an attractive choice for commercial organizations. However, adding reusability to a system typically reduces its performance, specifically usable mass to its destination. Current methods to estimate this reduction during the early design phase of new space transportation systems use rule-of-thumb estimates or high-level factors. It is often not until later design stages, when a detailed system design is available, that the impact of reusability on performance is assessed in more detail.

To bridge this gap, we develop a computational model to estimate the impact of reusability on system performance for low-fidelity designs. Our model is useful for early design stage trade studies and optimization. When using our model, the operator inputs baseline characteristics for the system such as the system type, subsystem features, and reusability characteristics which include the desired level of reusability, which is defined by the number of missions which the systems should accomplish and the amount of refurbishment done between missions, estimated as a percentage of the first unit build cost.

The model estimates the performance loss based on the reusability features used in the systems and their impact on three important characteristics: mass, thrust, and drag. First, the model estimates baseline values for these three characteristics for an expendable baseline version of the system. Next, the model generates a tradespace of different options to achieve the desired level of reusability input by the operator. Each architecture in the tradespace consists of one possible set of design features which will achieve the desired level of reusability. Then the impact on the three characteristics is calculated for each architecture. The model then uses the difference in these three characteristics from their baseline values to estimate the impact on performance as measured by the mass to the destination and choose the design with the lowest difference in mass to destination. We validate our model by applying it to the Falcon 9 launch vehicle where we compare the performance impact values estimated by the model to actual Falcon 9 performance values. Future work will extend to estimate performance loss values for in-space exploration systems.