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OPERABILITY AS AN EARLY STAGE DESIGN METRIC FOR HUMAN SPACEFLIGHT VEHICLES

Abstract

When creating the initial architecture of a system that involves human operations, either directly or indirectly, there are many interrelated factors that need to be taken into account. Traditional aerospace systems architecting involves designing around measurable performance while trading tangible factors such as volume, mass, power; however, the ability for the system to be easily operated according to the intent of its designers is a core measure of its value. In the last decade, spaceflight systems have increasingly opened up to commercial and civilian operators, while also increasing in complexity. Building a system with operations in mind has long lasting implications for its performance and overall lifecycle. The purpose of this paper is to analyze this factor of "operability" and how it impacts overall safety and usability of a spacecraft. Firstly, this paper defines what "Design for Operations" means in practice and provides an overview of what the tradespace of system operability optimization entails, for human spaceflight systems specifically. Comparisons are drawn from other forward-facing architectural methodologies, like "Design for Manufacturing," and examples from a range of industries that have taken different approaches to operability are analyzed, along with their resultant design implications (e.g. the utilization of autonomy). We then present the foundation of a framework that can be applied to the early stage design of new systems to optimize their operability based on discrete input design criteria, tailored to human spaceflight systems. The benefits of this paradigm are described, as well as a potential roadmap for how aerospace organizations can implement this framework into their workflow.