Paper ID: 37729
oral
student

28th IAA SYMPOSIUM ON SPACE AND SOCIETY (E5)
Architecture for humans in space: design, engineering, concepts and mission planning (1)

Author: Ms. Christine Fanchiang
Colorado Center for Astrodynamics Research, University of Colorado, United States

# PRELIMINARY MODEL TO QUANTIFY IMPACTS OF SPACECRAFT DESIGN CHOICES ON CREW PERFORMANCE


**Abstract**

Crew performance is an integral part of human spaceflight missions from commercial space tourism, to the demanding journey to Mars and beyond. Spacecraft were historically built by engineers trying to design the vehicle for cutting edge rocketry while assuming that the astronauts could adapt to the design. By and large, this is still the current state of the art. It is recognized, however, that poor human-machine design integration can lead to catastrophic mishaps.

Because of this potential for catastrophe it would be highly informative to forecast crew performance issues as a result of spacecraft design and operations. Such a model could help designers and managers make better decisions throughout the design process, and ensure that the crewmembers are well-integrated with the system from the very start. The result would be a high-quality, user-friendly spacecraft that optimizes the utilization of the crew while keeping them alive, healthy, and happy during the course of the mission. Unfortunately, to date no comprehensive model with this capability has been developed.

To begin addressing this issue, the presented work aims at developing an integrative framework to quantitatively predict crew performance impacts due to various spacecraft design choices. The work presented here uses a basic element resource breakdown approach to defining crew performance in which crewmembers are characterized as having three “buckets” of resources: Physiology, Cognition, and Psychology. Each crewmember’s resource “buckets” are drained or refilled throughout the mission by various Performance Shaping Factors (PSFs). While PSFs can range across all aspects of the mission from specific design choices to high-level management structure, this particular work focuses solely on the spacecraft design PSFs and how they directly affect the required operations and, thus, the crewmember performance.

With the framework established through elemental resource breakdown, the basic mechanics for a mathematical model were developed. This model was informed by pulling from existing metrics and data collected on human performance in space. Representative test scenarios were run to show what information could be garnered and how it could be applied as a useful, understandable metric for future spacecraft design. The mathematical model is limited by the general lack of experimental information available, and at this stage of development, only able to demonstrate the mechanics of the modeling approach without necessarily predicting the correct crew performance. With better experimental data to validate against, the model could be better tuned to produce more realistic results.