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Author: Ms. Cristina Poleacovschi
University of Alabama in Huntsville, United States

Dr. Paul Collopy
University of Alabama in Huntsville, United States

A STRUCTURE FOR STUDYING THE DESIGN OF COMPLEX SYSTEMS

Abstract

Spacecraft and launch vehicles are complex systems involving multiple disciplines each with its own expertise. Traditional system designs are requirement-based, which can be performance or cost centric. As a result of such constraints, another feasible design is chosen instead of the best design. A better approach to system design is by assigning a value to the design, which reflects all the system benefits, less costs. This framework can include all the feasible choices and selects the best option through optimization.

The design of complex systems becomes more feasible when it is partitioned into smaller subproblems by any of several methodologies for hierarchical coordination such as Analytical Target Cascading, Bi-Level Integrated System Synthesis, or Concurrent Subspace Optimization. The purpose of this paper is to build such a detailed design hierarchy for a complex system for space applications and use the hierarchy in simulation, where coordination and optimization are not separate mechanisms. The hierarchy will reflect the decomposition of the space system into physical parts, with a design team assigned to each part. The goal of the simulation is to observe the effectiveness of coordination at lower and higher levels, and how this changes when different methods are employed to affect coordination.

The next question that arises is how these design teams will be represented. Multiple approaches will be investigated; nevertheless the function-behavior-structure (FBS) model will be examined as the initial approach (Gero, 2004)*. In the FBS model, function represents the purpose of the artifact, behavior is the attributes of a structure by which the artifact achieves its function and structure is the elements of the artifact.

The overall goal of the research described in this paper is to improve the effectiveness of processes and organizational methods for designing complex systems, particularly in space applications.

*Gero, JS and Kannengiesser, U (2004) "The situated Function-Behavior-Structure framework", Design Studies 25 (4): 373-391