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A NEW INTEGRATED DESIGN PROCESS BASED ON A DYNAMIC DESIGN STRUCTURE
MATRIX APPLIED TO SPACE SYSTEMS

Abstract

Nowadays, designing an aerospace system entails difficult and broader goals related to issues such as: lifetime sustainability, logistics or the environment. These aggregate contributions exponentially increase the complexity of this task. Currently, a concurrent spiral iterative approach is standard practice, in an ad-hoc conceptual design phase, where only a few set of rules of interaction and system representation are defined. There is no clear process defining how to get from the initial high level requirements to a baseline solution. This paper proposes an integrated process for conceptual design of complex systems is based in the idea that any system can be decomposed in three entities, objects, processes and states that capture all the requirements that need to be fulfilled. Design properties can emerge after a proper decomposition structure into these three entities and judicious decisions. These design decisions should be sufficiently documented and the different subsystem models integrated in an intuitive way for the designer.

The process evolves from a simple objective and a set of requirements/constraints to a final design, through an evolutionary iterative process, looping through an instigation of the quality of the objectives and requirements/constraints, definition of subsystems, mapping of the different system states, design modeling and inherited choices. The designers are not asked for a specific design point solution but for a set of models and constraints that guide their design choices. The process ultimately finishes in the generation of a set of possible design solutions and, through a tradespace exploration strategy, the designers are asked to converge towards the final design.

The basic idea is to make as evident as possible the parameter transactions and choices made throughout the conceptual phase, going as far as possible from a “black-box” philosophy (where the decisions are masked in the tacit knowledge of the designer) while simultaneously increasing the overall performance in terms of design time and/or rework costs. The proposed design process is illustrated by a simplified conceptual design of a telecommunications satellite, emphasizing the impact of this approach on a better architecture definition and management of collaborative interaction in a concurrent engineering environment.