SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems Concepts (1)

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TOTAL SYSTEM APPROACH - TSA: A NEW APPROACH FOR THE DEVELOPMENT OF SPACE SYSTEMS

Abstract

This paper presents a new Systems Engineering approach for gathering space system mission requirements; namely "Total System Approach", seeks the concurrent development of the space system, processes and the organizations involved. The Total System Approach (TSA) takes into account all the space system life cycle from the time it is considered a product itself, just after the system is assembled, verified, qualified and accepted to the time it is decomissioned. Moreover, the life cycle processes encompass all the procedures before, during and after the launching and operational phases, including space system non-operation and operation processes, such as, disassembling, handling, storing, transporting, preparing for launching, launching, operating, reentering in Earth Atmosphere, rescuing, analyzing, refurbishing, reusing and discarding. The Total System Approach, as the name suggests, comprises the development of the whole system where the space system is inserted. In addition, it is to be applied in the earlier phase of the system development. The application of TSA starts with the stakeholders' analysis, which corresponds to the identification and description of the stakeholders and further with the statement of their objectives. After that, the system life cycle processes are identified and modeled. Thus, each identified life cycle process, must be detailed into a second level process, which means to model it into a FFBD and an IDEF0 diagram. The results of those diagrams are converted into mission requirements. The FFBD (Functional Flow Block diagram) depicts the processes and the functions performed by the system along a timeline, reproducing sequential or parallel process flows. Moreover, the IDEF0 diagram is used to indicate the process input and output flows and the process control and mechanism flows needed to accomplish each function or process. The IDEF0 control flows are derived into mission assurance and the IDEF0 mechanism flows are derived into the mission organizations, both representing a section of the mission requirement documents. As the control and mechanism flows are identified through the life cycle processes, it covers all the mission assurance and mission organization, from the time the space system exists to the time it is discarded. The mission architecture, another section of the "Mission Requirement Documents", is also determined through the TSA concept of mission. Thus, the approach goes beyond the traditional architecture with launching, launch support systems and payload. It includes, AIT (assemble, integration and test), logistic support, ground, launching, trajectory, experiments, reentry, recovery, rescue, data acquisition and C3 (command, control and communication systems), since the beginning of space system development. This paper presents the Total System Approach processes associated with a study case, the SARA (SAtélite de Reentrada Atmosférica – Atmosferic Reentry Satellite) Suborbital System. The processes describe how to gather mission requirements, mission architecture, mission assurance and mission organizations. SARA Suborbital System is a reentry satellite, being developed by the Institute of Aeronautics and Space (IAE) in Brazil. The results obtained for the elaboration of the SARA Mission Requirement Documents by using the traditional approach and the Total System Approach, are briefly compared. TSA is proposed to revive the logic behind the System Engineering activity. With time, the elaboration of document requirements has become only a formality. The use of template doc-

uments, copying and pasting transformed systems engineering into a document producing and passing activity. In conclusion, TSA aims to comprise simultaneously the development of a product, its life cycle processes and the organizations involved, reviving the logic and purpose of systems engineering activities and enhancing project productivity.