57th IAA SYMPOSIUM ON SAFETY, QUALITY AND KNOWLEDGE MANAGEMENT IN SPACE ACTIVITIES (D5)
For a successful space program: Quality and Safety! (1)

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IN-HOUSE STRUCTURE DESIGN FOR STUDENT CUBESAT MISSIONS: STRATEGIES, SOLUTIONS, AND LESSONS LEARNT

Abstract

The conception of a SpaceCraft (S/C) structure involves the competencies of a multidisciplinary engineering team, to work within a loop of design iterations, analysis and testing, with the final scope of ensuring the success and best performance of the mission.
When this concept is applied to a Cubesat structure, the relatively straightforward nature of the design process gains complexity from the combination of manufacturing limitations, other subsystems' constraints and the extremely compact nature of the S/C. For this reason, many student teams involved in similar missions opt for an off-the-shelf (OTS) structure. The 6S Cubesat mission requirements pushed the team to adopt an in-house designed and built structure, enhancing the educational value of the project. This choice presented numerous challenges in design, analysis, and component manufacturing, which needed

to be addressed.
The goal of this paper is to assess the common issues that arise in a student project and to provide possible solutions, based on the experience gained from the 6S mission, with an emphasis on the lessons learnt.
The initial section of the paper discusses the design process in terms of manufacturing, budget, and development-timeline limitations. A design philosophy based on the acquired experience is proposed, with the goal of mitigating possible issues arising from the aforementioned constraints. Insights on workflow management are provided; possible strategies for managing structure development using CAD software are discussed, as well as methodologies for managing and sharing the output data. In addition, suggestions for using a 3D printed Development Model are made to support and accelerate the design and functionality testing process.
The second section of the paper presents the solutions adopted during the study of the structure's behaviour. The Finite Element Model (FEM) of the S/C was built on Abaqus in compliance with the limitations imposed by the student software edition and the available computational power. The tuning of the model's parameters and the many simplifications applied are presented, such as the proper modelling of realistic and computationally low-cost bolt connections and boundary conditions. Moreover, a strategy to deal with problems related to the lack of specific information regarding the mechanical properties and internal composition of OTS components are addressed.
This paper presents the common challenges faced during the design, analysis and manufacturing of a Cubesat structure. By sharing practical insights and lessons learnt, it aims to inform and support future student-led projects in the field of space engineering.