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DELTA-SAT: THE CONCURRENT PRE-PHASE A DESIGN OF A THERMOSPHERIC EXPLORATION MICROSATELLITE

Abstract

The 'Microsatellite Engineering' Master course at the Faculty of Aerospace Engineering of the Delft University of Technology aims to bridge the gap between education and professional engineering practise by using a project-based approach to space systems engineering education. The course comprised of a mission and microsatellite design project, using collaborative engineering methodologies to achieve the design of a thermospheric exploration microsatellite. This paper details design process and resulting technical design of this microsatellite, 'DELTA-Sat'.

By dividing the class into sub-teams, each responsible for two subsystem and/or mission elements, students developed a project management structure in order to obtain a coherent end product. Design activities occurred in sub-team meetings, and team meetings in which design iterations and subsystem interfaces were dealt with. The software infrastructure used was a collection of common documents and Excel-based spreadsheet tools. The project work entailed the simultaneous conceptual design of the physical and functional architecture of a microsatellite intended to perform measurements in the lower thermosphere using a drag-free technology payload. Emphasis was placed on payload requirements and engineering of the spacecraft bus functionalities, with design activities occurring within a rigorous systems engineering framework. Further work also addressed overall mission design to support the development and operations of DELTA-Sat.

During the project, students gained experience in customer-contractor communication, inter-group communication, and the impact of design trade-offs on the various subsystems. Furthermore, students gained more in-depth knowledge of at least two subsystems and learned about the specifics of microsatellite design and drag-free technology. The technical result of the DELTA-Sat exercise was the preliminary stage (Phase 0/Pre-Phase A) design of a microsatellite and supporting mission architecture as a result of subsystem trade-offs. Subsystem designs were defined for payload, propulsion, attitude determination and control system (ADCS), structural, thermal, communication, electrical power system (EPS), and command and data handling system (CDHS) aspects of the spacecraft. Additionally, mass and power budgets, a launch segment, and a life cycle cost estimation were also defined. The resulting system makes innovative use of drag-free technology to undertake measurements in the lower thermosphere, while enjoying the advantages of reduced cost and development time offered by microsatellites.

In conclusion, the DELTA-Sat project allowed students to gain valuable experience in systems engineering methodologies by designing a novel microsatellite mission. The resulting DELTA-Sat design benefits from increased sensitivity to subsystem interdependency and customer requirements, resulting from the collaborative nature of the design process.