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COMMERCIAL SUBORBITAL VEHICLE - SYSTEM DESIGN AND MISSION OPTIMIZATION USING CONCEPTUAL MULTI-DISCIPLINARY OPTIMIZATION (CMDO) FRAMEWORK

Abstract

With the growth in space tourism and suborbital flights, aircraft designs that support low-orbital earth missions are gaining interest. The driving objective, for this interest among commercial spacecraft/aircraft companies, is to build a space transportation vehicle with an optimized design-to-cost capability for the growing space sector. Designing such a spacecraft/aircraft involves studying complex interactions between multiple systems simultaneously establishing a balance in achieving all the mission objectives and requirements. As presented in literature, this objective has been under investigation, in all dedicated design studies for High Speed Commercial Airliners, namely, ATLLAS II, LAPCAT I and II, STRATOFLY MR3 (studies conducted by ESA), that are capable of transporting passengers and cargo on anti-podal routes. These studies provide an insight into how the Multi-Disciplinary Optimization (MDO) Processes can be used in designing an aircraft/spacecraft that tries to strike a balance between system complexity and mission requirements.

This paper builds on the work presented in STRATOFLY MR3 and LAPCAT II and applies the MDO process from these studies to the Rocket Based Combined Cycle (RBCC) powered Suborbital Commercial Vehicle - designed as part of the Space Studies Program-21 (SSP2021) Team project (TP) organized by the International Space University (ISU). Initial comparative study was carried out on the mission objectives, mission requirements and functional analysis for all three vehicles, following which Conceptual Multi-Disciplinary Optimization (CMDO) process was applied on the SSP-TP vehicle to obtain high level performance values of the systems. Within the CMDO framework, Propulsion and Thermal systems were considered as output optimization for the SSP-TP vehicle, as these systems play a vital role in designing a sustainable high speed commercial vehicle. Results obtained were compared between all the three aircraft system designs and recommendations are made on modifications to the CMDO process, based on lessons learnt during this study, when propulsion and thermal systems change across different transportation vehicles, especially space vehicles.