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INNOVATIVE MDO METHODOLOGY TO DESIGN SPACE LAUNCH SYSTEM - APPLICATION TO ALTAIR AIR-LAUNCH SYSTEM

Abstract

This paper presents the methodology used to preliminary design a future cost-effective air launch system for small satellites, studied in the frame of the H2020 ALTAIR project (Air Launch space Transportation using an Automated aircraft and an Innovative Rocket). This methodology relies on the use of design to cost associated with multidisciplinary design optimization (MDO) techniques. The particularity of this system is to use a reusable unmanned aircraft carrier designed specifically for the air-launch mission associated with an expendable, low cost, launch vehicle. The methodology used to design the space launch system relies on collaborative engineering between sub-system design tasks and sustained application of design-to-cost techniques and multidisciplinary design optimization strategies. Risk mitigation, cost savings, reliability and performances are major drivers in the development of the final system, leading to a delicate balance between technological innovation, low cost solutions and maturity level. The main difficulty for a design of a new vehicle is to establish a first feasible design, due to the sensitivity on the various design parameters. To ensure a good optimization of the vehicle satisfying design constraints, simplified models have been elaborated and combined in an optimization platform using different optimization algorithms at different steps of the process (genetic, BFGS...). The originality of the methodology put into place is to target cost-effectiveness at every levels of the design system: at sub-system level and also at system level through an integrated carrier/design optimization process, with the main coupling variables being the launcher release conditions. The paper provides the results obtained at the end of the final design loop of the system. Finally, the paper illustrates how this methodology can help and foster the design of new space launch vehicle to manage safety margins, reduce design duration and to achieve a low cost space system.