Multidisciplinary optimization of microsatellite launchers

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Abstract

This work is part of the New Space Portugal project, a consortium of 39 entities, dedicated to enhancing the Portuguese space sector and launch a constellation of Earth observation satellites (Atlantic constellation). This project aligns with the "New Space", directed towards achieving faster and more cost-effective access to space.The private space industry has increasingly prioritized the use of small satellites and dedicated launch services. Simultaneously, increasing concerns regarding climate change have pushed research efforts towards the considerations of the environmental impact of space launches.
In response, Portuguese universities, including Instituto Superior Técnico (IST), are collaborating with the industry to align their space curricula with emerging trends by developing research initiatives and educational programs that address these evolving demands. Reflecting the key interests of the New Space paradigm, IST will introduce the courses "Space Sustainability" and "Space Vehicle Design" as part of its master's degree in aerospace engineering.

To comply with these objectives, 2 PhD theses are being developed at IST, aiming to create the foundation of knowledge and useful tools for these new courses. The main objective of the theses is to create a multidisciplinary optimization framework for the eco-design of next-generation space vehicles. Expertise regarding the application of sustainability consideration within the early phases of the design, and specifics of the overall design process of space vehicles will be acquired. The framework being developed will provide a basis for possible designs of the complete vehicle in terms of subsystems, performances, environmental impact, and, possibly, cost analysis, according to specific design choices and objectives. This framework could serve as a foundation for the study of the newly created courses, with insight into the design process, the various components, and the interactions between subsystems.
In particular, the author's thesis will focus on the preliminary design of a microsatellite launcher targeting Sun-Synchronous orbits due to the advantages of placing Earth Observation satellites in these orbits. To achieve this objective various building blocks have been developed for the framework, such as: a 6 Degrees-of-Freedom flight simulator, aerodynamic coefficient estimation for subsonic and early supersonic regimes, mass and sizing relationships, and an environmental impact module. Current efforts are directed towards the enhancement of the propulsive module to simulate a pressure-regulated hybrid engine.

Keywords: Microsatellite launcher, Space vehicle design, Multidisciplinary design optimization, New Space, Space sustainability

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