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IMPACT OF LIFE CYCLE ASSESSMENT CONSIDERATIONS ON LAUNCH VEHICLE DESIGN

Abstract

The continuous growth of the small launcher market with the emergence of many new concepts in the past years, combined with the growing need for sustainability in the space sector, raises the question of their environmental impact. Sustainability of space activities is becoming one very important constraint for future space applications. There is a need to integrate sustainability in the framework of micro launchers design since the preliminary phase. The objective of this work is to present a novel methodology that aims at considering the environmental impact of a launcher in its design and optimization making use of Life Cycle Assessment (LCA) and Multi-disciplinary optimization tools (MDAO). The methodology will then be applied on a generic micro-launcher.

The life cycle analysis studies the environmental impacts throughout the launcher life cycle, from the idea to the disposal. This includes the operations, but also among others the development, manufacturing, testing of the launcher, the logistics, the construction and maintenance of ground facilities, as well as the recovery, refurbishment, and recycling if applicable. Of all the environmental impacts, we focus in the present paper above all on greenhouse gas emissions and their influence on global warming.

Multi-disciplinary analysis and optimization (MDAO) has been successfully applied for the design and optimization of space systems, including launchers vehicles. Launchers are usually optimized in order to fulfill a mission while minimizing the overall mass at take-off. The idea developed in the present work is to integrate outputs from the LCA of the launcher in the optimization process. First, the parameters needed to perform the LCA for a generic micro-launcher are identified. Indeed, more than 100 small launchers are either operational or in development. Using the data from NewSpace Index, we sort these launchers by type of technology, operational status, and technology readiness, in order to identify the dominant trends in this industry and to identify the parameters needed for the LCA. Then an example of LCA for a generic small launcher, with different midpoint impacts including global warming potential, is carried out. Finally, the LCA is integrated in the multidisciplinary framework to include ecodesign constraints in the optimization loop, using OpenMDAO. After tuning the framework and selecting the best optimiser, we will analyze the design of the generic small launcher resulting from the MDAO while minimizing its environmental impact, and specifically the global greenhouse gas emissions.