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ADVANCED LEAST WEIGHT DESIGN OPTIMIZATION OF ADDITIVE MANUFACTURED SPACE ROVER STEERING BRACKETS

Abstract

This work proposes the use of advanced finite element modelling in conjunction with a state-of-the-art optimization algorithm for carrying out least weight design through topology analysis of space rover steering structural components.

The developed design methodology can be divided into four steps. The first step makes use of MSC Apex to understand how a rough geometry is stressed under operative conditions. After these few iterations, using MSC Nastran with Patran and Workbench Ansys, a series of static topological analyses are performed to better refine the geometry of the components and define lightening position. The last two steps rely on ESTECO modeFRONTIER, an optimization software that allows exploring the design space performing a cycle of FEM analyses on Workbench ANSYS while changing key parameters in the geometry; the first iteration on this software aims to reduce the complexity of the problem performing a sensitivity analysis to investigate which geometrical parameters impact the most on the component weight and stiffness. The very last analysis is performed by changing the few variables highlighted by the previous step; then a multi-criteria decision-making algorithm implemented on modeFRONTIER is used to find an optimal solution.

The optimized components were produced by taking advantage of advanced additive manufacturing technologies which permits unique freedom in components geometry. As a matter of fact, it is demonstrated that the parts designed with the proposed topological optimization method weigh consistently less than the traditional counterparts, still satisfying the required robustness and stiffness requirements.

The entire project is developed in the framework of the DIANA student team from Politecnico di Torino, which compete in the Rover Challenge series, whose objective is to permit students from all the engineering areas, to gain hands-on experience in the space sector through the prototyping of an astronaut assistance rover.