Paper ID: 52172
oral

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Advancements in Materials Applications and Rapid Prototyping (5)

Author: Mr. Simon Huembert
German Aerospace Center (DLR), Germany, Simon.Huembert@dlr.de

Mr. Volkan Dügmeci
Germany, volkan.duegmeci@trumpf.com
Dr. Jan Haubrich
German Aerospace Center (DLR), Germany, jan.haubrich@dlr.de
Dr. Michael Lengowski
Institute of Space Systems, University of Stuttgart, Germany, lengowsk@irs.uni-stuttgart.de
Ms. Tina Stäbler
German Aerospace Center (DLR), Germany, tina.staebler@dlr.de

TOPOLOGY OPTIMIZATION OF A STAR TRACKER CAMERA BRACKET

Abstract

Topology optimization is a powerful tool in lightweight design and has become increasingly popular with recent advances in additive manufacturing. In the space industry, such optimized and 3D-printed structures have the potential to meet the increasing demand for cost-efficient, flexible design and manufacturing strategies driven by large satellite constellations. In this paper a case study of re-designing a satellite structure is presented, identifying and exploring problems and opportunities throughout the entire process chain. The reference part for this study is a star tracker camera bracket from the academic satellite “Flying Laptop” from the University of Stuttgart, currently operating in orbit. The original part was manufactured using standard machining processes and is used for functional as well as the cost assessment of the optimization approach. The first step of the investigation is a characterization of the printing alloy, AlSi10Mg, focusing on the demands for topology optimization and associated cost-intensive post processing. Tests are used to determine mechanical and metallographic properties for different sample geometries, orientations and heat treatments. This data provides the input for the material model in the optimization process as well as the optimization constraints. Following this step, the mesh-based optimization result is converted to CAD geometry to assess manufacturability. For the optimization validation and cost assessment the bracket is printed three times in one build-job using a Trumpf TruPrint 3000. Printed brackets are assessed for their natural frequency, the dominant design constraint, as well as the geometrical distortion and compared to the analysis results. Finally, design and manufacturing costs of the single part and of a small series of 100 parts is calculated to evaluate economic potential of the optimized and printed design. For the reference part presented in this study, the optimized design is 30 % lighter than the original and exhibits a 43 % higher first natural frequency. Additionally, a considerable scaling effect on the manufacturing costs is shown, keeping additive manufacturing competitive compared to small series machining production.