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DESIGN AND STANDARDISATION OF ADDITIVE MANUFACTURING FOR SPACECRAFT STRUCTURES

Abstract

The Additive Manufacturing (AM) process Laser Powder Bed Fusion (LPBF) has enabled the manufacture of intricate metal component designs with reduced weight, reduced part numbers and quicker production times. These design opportunities make AM attractive for manufacturing complex metal parts in the space industry. However, design-related issues, such as the inherent surface roughness of LPBF-produced components, could impede part performance, especially from a structural perspective. Costly and or time-consuming post-processing rough surface or support structure removal is an option. Additionally, post-processing can be impossible in cases such as bespoke consolidated part designs as needed for rocket engine turbomachinery. Spacecraft engineers, therefore, require an understanding of how to mitigate or tolerate the effects of surface roughness on part performance and how to consider it during the initial Design for AM (DfAM).

Through an analysis of recent advancements in the use of AM in space applications and the design issues surrounding its adoption in critical spacecraft structures, this paper presents the results of a collation and review of research related to LPBF design methods and AM standards relevant for the design of critical spacecraft structures. The results show that today there is an apparent lack of DfAM guidance available for spacecraft engineers wanting to utilise AM without compromising performance due to design-related issues like surface roughness. Hence suggestions are made towards appropriate design guidance and standards for consideration. In the long term, robust DfAM methods are needed to provide a path to the qualification of AM space-worthy parts by giving guidance on LPBF process factors and their relation to different part properties. The goal being to enable the use of this innovative technology in the creation of low-cost and low-weight reusable rocket engine technology.