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SPACECRAFT DESIGNERS' GUIDE TO USING ADDITIVE MANUFACTURING PROCESSES FOR LARGE METALLIC SPACECRAFT STRUCTURES

Abstract

Innovative design solutions are being suggested for many of the space industries mechanical challenges, many of which are unable to be manufactured through conventional methods. However now with Additive Manufacturing (AM) or a combination of traditional subtractive methods of manufacturing and AM these solutions can be realised. AM is a process of producing parts through the building of material layer by layer from a computer model, AM has had an increasing involvement in the manufacturing of components for many industries and has been said to be ushering in a 3rd industrial revolution. Over the last half century AM technology implementation has led to vast reductions in material waste, lead time and energy use in manufacturing and prototyping, whilst also improving the part design and efficiency of many components.

Through an assessment of the design, manufacturing and economic considerations specifically for spacecraft designers, this paper looks in to the current capability of AM processes in the production of large scale metallic structures for use in the space industry. Via reviewing the use of AM in the aerospace industry the technological capability of current AM processes has been assessed and evaluated for their merits and downfalls. Two studies have been conducted to evaluate the current capability of three of the most promising AM technologies Electron Beam Melting (EBM), Wire + Arc Additive Manufacturing (WAAM), and Selective Laser Sintering (SLS). The first case study assesses theoretically manufacturing a Secondary Payload Adaptor Ring (STP-1 ESPA), a large scale aluminium launch vehicle structure, via WAAM and EBM. The second study assesses and compares the use of SLS in the manufacturing of two CubeSat configurations, a standard 1U CubeSat structure and the FoldSat, an AM optimised CubeSat structure to investigate the use of AM in the more publicly accessible space craft industry.

Through weight and material savings in redesign for AM and the great potential of its use in integrated circuitry, it was found that the use of AM in the manufacturing process can currently significantly benefit the construction of relative small scale space components e.g. CubeSats and structural supports. However the scale of operational metallic components which can be built by the majority of qualified AM processes is still quite small, leading to a trade-off in part quality as scale increases. It has been recommended that for the creation of complex metallic space components EBM is the AM process most suitable at this time.