Strategic application of digital tools to enhance lifecycle cost: product design and optimization in metal based powder bed fusion

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Additive manufacturing has undergone different phases of technological change from mere toy printing method, prototyping, tooling to functional end use parts. The different subcategories of AM allow the creation of unprecedented product designs that are otherwise impossible using conventional manufacturing methods. The layer by layer approach to design and printing enable the creation of components with hollows and overhangs which often require sacrificial support structures that are removed after a build is completed. Widespread adoption of AM is hindered by factors such as poor part quality, high investment cost, low material efficiency, long manufacturing time and so forth. Factors sch as need of support structures, need of post processing, numerous affecting process parameter, lack of understanding of laser-material interactions hinder the adoption of laser based powder bed fusion (L-PBF) of metals.

Technological advances in AM have helped users to reduce or omit some of the limitations to adoption, for instance the need of support structures for better material efficiency. Simulation driven tool is one means offering a means to time efficient product development and to more superior structural components amidst the raw material and cost reductions. Here, we elucidate the means by which such benefits are feasible via the use of simulations tools. Simulation driven optimization of the product design, process and manufacturing are revealed to change the amount of support structures and post processing that may be required to bring parts to the required reliability. Virtual planning of the manufacturing also gives a prior understanding of how process parameters such as laser scan velocity, laser power, scanning strategy, hatch distance and others can be controlled to achieve optimal laser-material interaction for the required scan quality. Simulation-driven design for additive manufacturing (DfAM) allow for quick and easy customize products based on design parameters and rules, boosting productivity and design speed. This research developed a universal life cycle cost (LCC)-driven DfAM tool which potentially improves service life and life cycle cost. The results provide insight into the simulation-driven DfAM of laser based PBF and demonstrate the potential for LCC-based approaches to improve confidence in components produced by L-PBF.