Design for Additive Manufacturing

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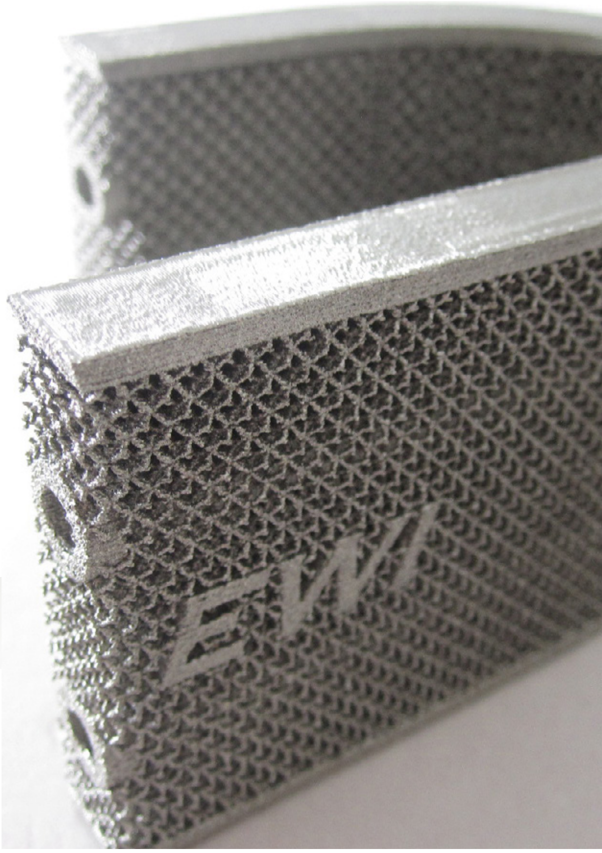
INTRODUCTION

Traditionally, "Design for Manufacturability" (DFM) is defined as the process used to design parts in order to minimize the complexity of manufacturing operations.

However, when designing for additive manufacturing (AM), the flexibility of AM processes and the wide range of available materials become driving factors. "Design for AM" can thus be defined as an approach to design that leverages the many advantages of AM processes to manufacture complex optimized geometries. The rapid growth of the AM industry over the past few years has provided designers with widespread access to these new manufacturing technologies, increasing the need to develop expertise and processes to enable optimized AM-specific designs.



NEW DESIGN CAPABILITIES

A paradigm shift from conventional subtractive manufacturing processes to additive processes in which material is only deposited where required has led to entirely new design strategies. It is now possible to build complex intricate shapes such as naturally optimized cellular structures that offer high strength-to-weight ratios, objects with varying material density, and mechanical metamaterials wherein the mechanical properties of the part are determined by its shape rather than the composition(s) of the material(s) used.

PART CONSOLIDATION

AM technologies become economically viable when their unique capabilities are leveraged. Designing consolidated parts by eliminating the need for large multi-component assemblies leads to faster overall turn-around times by eliminating individual part lead times as well as their logistics and assembly costs. One of the most popular applications of this concept is the General Electric fuel nozzle test case for their next-generation LEAP jet engine, where 18 parts are combined into a single assembly. Utilizing design strategies that harness the benefits of consolidation is just one way to justify the transition from traditional manufacturing techniques to AM.

TOPOLOGY OPTIMIZATION

Topology optimization is the process of identifying the minimal material requirement in a design space to satisfy the defined boundary conditions. Over the years, this field has been an interesting mathematical problem for the engineering community; however, AM processes have now made it possible to build topology optimized components. Many conventionally designed parts are now being topology optimized and redesigned to reduce weight and material consumption (Figure 1). The growing popularity of topology optimization is apparent in the computer-aided design (CAD) software industry, where many companies are now launching their versions of commercial topology optimization software packages.

Figure 1: Part redesign cycle for a topology-optimized aerospace bracket.

CURRENT CHALLENGES

In many ways, AM processes are enabling the creation of never-before-seen innovations. Many designers, however, are still fixated on conventional designs and traditional DFM/DFA (Design for Assembly) practices. These designers are not taking full advantage of the benefits of AM which are realized by designing AM-friendly parts. In addition, available CAD software packages are not fully equipped to design for AM. Every AM process has its own set of unique capabilities, but designers need to creatively design components to see the benefits these processes have to offer. For example, metal powder-bed fusion processes have made it possible to easily manufacture conformal channels, something that would be difficult if not impossible using conventional subtractive methods. However, designers need to ensure that support structures are not required during the build. Designing for AM has made it more important for designers to understand the complete manufacturing cycle, including post-processing as well as post-process inspection of parts, to leverage the benefits of AM. Presently, few guidelines exist to help designers make informed AM design decisions.

EWI CAN HELP

EWI's AM experts have experience in every step of the AM process cycle from design to inspection, along with equipment capabilities for all AM technologies. If you'd like to learn more about how EWI can help you take advantage of the many benefits of AM and create new, cutting-edge designs, **please contact rsamant@ewi.org or fmedina@ewi.org.**