Optimization-based Design for Manufacturing

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ABSTRACT

Advances in manufacturing continue to increase the available design space. While this creates exciting possibilities in realizable designs, it also creates a trade space between functional performance (design freedom) and manufacturability (design certifiability) that is difficult to navigate. We describe a new effort to create design software that will allow engineers to compute optimized designs that respect the limitations of various manufacturing processes and enable informed decisions about the trade-offs between functional performance and ease/cost of manufacture.

In the current AM workflow, parts are realized in two distinct stages – design and manufacture. Producers rely on highly-skilled technicians to successfully manufacture parts and provide feedback regarding the "printability" of designs. Iterations are typically required between the designer and AM expert to arrive at a design and associated process parameters that result in an acceptable scrap rate. This manual cycle is slow and relies on engineering heuristics to guide design modifications. Simulation-based software tools are beginning to appear in industry that help with the selection of process parameters to mitigate process limitations, but these tools do not directly influence the incoming design. The current effort is to integrate fast, accurate AM process simulation into optimization-based design to provide predictions of the distortion and residual stress *during optimization*. This will result in designs that accommodate the limitations of AM and are therefore optimally printable.