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# Printing Cost and Time Minimization Using Concurrent Topology and Build Orientation Optimization

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High cost is a major concern limiting the adoption of additive manufacturing in aerospace and automotive industries. Additionally, a significant time investment is needed to redesign existing components to take advantage of increased design freedom and to consider design for additive manufacturing principles. Traditional topology optimization design generation tools produce highly complex geometries with improved performance, but do not consider support structure requirements, which can increase part cost and print time and can vary significantly based on the selected print orientation. This work presents a combined topology and build orientation optimization method that streamlines the additive manufacturing design process and achieves superior designs compared to existing approaches. Print orientation and component geometry are optimized simultaneously, minimizing additive manufacturing cost by considering three physical properties of the design: support structural volume, overhang area, and build height. These cost-driving metrics are calculated as a function of element density and build orientation design variables and are integrated in a multi-objective problem statement. The approach is implemented in a custom code that interfaces with commercial finite element analysis software to solve real-world problems with complex geometry and loading. The tool is demonstrated through the design optimization of an aircraft seat leg structure with additive manufacturing. A baseline topology optimization solution is quantitatively and qualitatively compared to designs optimized for support structure, overhang area, and build height, to showcase the effectiveness of the approach. Each optimization produced significantly different geometries and build orientations, demonstrating the importance of considering additive manufacturing cost during the topology optimization design process. Ultimately, the presented methodology and design tool can accelerate the additive manufacturing design workflow and generate improved designs over currently available approaches.