

Topology-Optimized Aircraft Seat Leg Structure Considering Metal Additive Manufacturing Build Volume

Anuj Patel¹, Hansu Kim¹, Luke Crispo¹, Nicholas Galley¹, Si Mo Yeon², Yong Son², Il Yong Kim^{1*}

¹Department of Mechanical and Materials Engineering, Queen's University

²Advanced Joining & Additive Manufacturing R&D Department, Korea Institute of Industrial Technology, Siheung-si, Republic of Korea

*Email: kimi@queensu.ca

The aerospace industry is constantly exploring lightweight design. Especially, aircraft seat design is a key research area due to its complex structural design and the potential for significant mass reductions from the system level viewpoint. Metal additive manufacturing can help to achieve lightweight seat designs because of its ability to manufacture complex and organic metallic structures. To leverage the capabilities of metal additive manufacturing, parts must be designed specifically for additive manufacturing. Topology optimization enables this goal by determining the optimal material distribution within a design domain that maximizes performance subject to design requirements. However, aerospace applications of topology optimization and metal additive manufacturing in literature designed topology-optimized components without considering the metal additive manufacturing build volume, which is an important aspect of printability or manufacturability. To address this gap, this work presents the practical design problem of an aircraft seat leg structure whose dimensions are larger than the metal additive manufacturing build volume. Here, topology optimization is performed and the material distribution of the optimized seat leg structure is compared under different mass fractions constraints. Real-world load cases are used in the topology optimization, outlined in the SAE Aerospace Recommended Practice documents. In addition, part decomposition is performed to divide the topology optimization result into a set of parts that fit within the metal additive manufacturing build volume. Ultimately, this work seeks to demonstrate the practical capabilities of topology optimization and part decomposition for metal additive manufacturing through a real-world aerospace application.