DESIGN OPTIMIZATION INCLUDING DYNAMICS AND NONLINEARITY

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ABSTRACT

As engineers, we constantly strive for better, lighter, faster, cheaper and even optimal designs. Algorithmic-supported design methods in concert with accurate parametric simulation models represent a powerful tool in engineering development. Lightweight engineering design is a design paradigm characterized by the efficient use of material and exemplified by the Virtuous Circle of Lightweight Engineering Design: With less structural mass, the structural requirements, motorization requirements or both are reduced and therefore the structural mass can in turn be reduced again, continuing to a minimum. Reason-based design space exploration and design optimization are effective tools to enter this virtuous circle.

There are a number of open challenges in the application of design optimization. Such challenges often exist at the intersection of mechanics and optimization and include design problems of systems, which exhibit dynamic and nonlinear behavior. Gradient-based optimization algorithms are efficient methods, especially with large-scale problems. This class of algorithms requires the design sensitivities of system responses with respect to the design variables. The derivation of these terms is a non-trivial, especially in dynamic and nonlinear domains. Surrogate-based design optimization can circumvent the issue of design sensitivities, but this advantage comes with a series of drawbacks.

After discussing these points, the application of design optimization is shown to demonstrate challenges and pose possible solutions. Examples includes design optimization with flexible multibody dynamics and nonlinear stress-constrained topology optimization. The conclusion will summarize and motivate future research in this high-potential area.

BIO

Dr.-Ing. Erich Wehrle leads the Multidisciplinary Design Optimization research group at Collins Aerospace. The team's research focuses on algorithmic support in the design of complex aircraft systems, especially via system architecture exploration and design optimization considering multiple disciplines and physics-based simulation models.

He previously held roles in academia as Assistant Professor at the Free University of Bozen-Bolzano (Italy) and as postdoctoral researcher at the Technical University Munich (Germany) in which his research addressed design optimization of lightweight structures and mechanical systems under a multidisciplinary perspective, including structural analysis, multibody dynamics, crash mechanics and uncertainty. He holds a doctorate and a master in Mechanical Engineering from the Technical University of Munich and a bachelor in Mechanical Engineering from the State University of New York at Buffalo (USA).