Integrating Manufacturing Issues into Structural Optimization

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Abstract

This dissertation aims to advance the field of structural optimization by creating and demonstrating new methodologies for the explicit inclusion of manufacturing issues. The case of composite aerospace structures was a main focus of this work as that field provides some of the greatest complexities in manufacturing yet also provides the greatest incentives to optimize structural performance.

Firstly, the possibilities for modifying existing FEA based structural optimization methods to better capture manufacturing constraints are investigated. Examples of brick-based topology optimization, shell-based topology optimization, parametric sizing optimization and manufacturing process optimization are given. From these examples, a number of fundamental limitations to these methods were observed and are discussed. The key limitation that was uncovered related to a dichotomy between analytical methods (such as FEA) and CAD-type methods.

Based on these observations, a new Knowledge-Based framework for structural optimization was suggested whereby manufacturing issues are integrally linked to the more conventional structural issues. A prototype system to implement this new framework was developed and is discussed. Finally, the validity of the framework was demonstrated by application to a generic composite rib design problem.

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