

16. MODERN TOPOLOGY AND SHAPE OPTIMIZATION METHODS FOR PRODUCT DEVELOPMENT

Mark Miller

FE-DESIGN Optimization, Inc

SUMMARY

Modern optimization techniques have become a necessity for today's competitive product development process. Structural optimization software provides engineers with a mechanism to integrate design with analysis, and thus create better product designs.

Conventional optimization methods such as CAD-parameter based schemes require significant initial setup work, are restricted to a limited solution space, and often result in extensive computation times. These disadvantages can be overcome by the use of non-parametric structural optimization software, coupled with commercial FEA solvers.

The paper begins with an introduction to the optimality criteria (OC)-based optimization methodology. With this approach, FEA is expanded from an analysis tool to a design tool.

Topology optimization software can automatically generate design proposals for structures, within a given design space. Material is removed from low stress areas, and retained in areas with higher stress. "Frozen" areas, which will not be altered, can be defined. Many types of design objectives and constraints may be defined. Nonlinear analysis, including large deformations, material plasticity, and contact, is supported. Manufacturing constraints for casting, stamping, and other processes may be added to control the behavior of the optimizer.

Software tools are provided to smooth, re-mesh, and re-analyze an optimized structure. Finally, the optimized geometry can be transferred to CAD systems in a variety of formats.

For maximum benefits, optimized topology is combined with shape optimization. Selected surface nodes of the finite element model are adjusted slightly to reduce stresses and improve fatigue life. Constraints and restrictions can be applied to control nodal movement. Shape optimization software can be coupled to commercial or in-house fatigue analysis codes to reduce local damage, and increase structural life.

Examples from several different industries will be discussed. Beginning with a defined design space, high performance structures can be generated. Results will illustrate weight and stress reduction, and improvements in fatigue life.