MSC.Nastran™ Topology Optimization

Optimizing Design Topology Using Your Finite Element Models

OVERVIEW

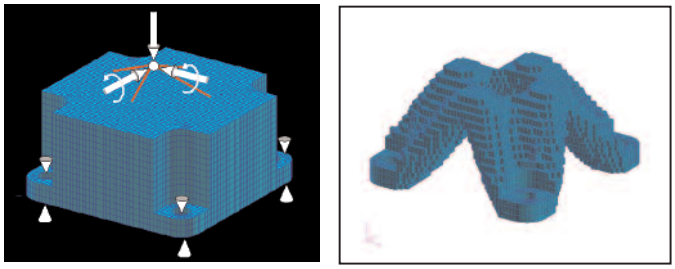
SimOffice™ is a stand-alone environment in which engineers can build, test, review, and improve their designs. SimOffice gives product development engineers the shared technologies they need to assess product performance and accelerate innovation.

The MSC.Nastran™ product family is modular, enabling you to analyze products ranging from simple components to complex structures and systems. This also enables you to start simply and to grow your analysis capabilities as your Virtual Product Development (VPD) needs expand. As part of your VPD process, you can use MSC.Nastran to assess many functional aspects of your products, such as the structural response (displacement, strain, stress, vibration, and temperature) due to its material properties and the loads and boundary conditions that are applied to it during operation.

MSC.Nastran™ Topology Optimization

The MSC.Nastran™ Topology Optimization product module provides the capability to find an optimal distribution of material, given the design space, boundary conditions, loads, and required design performance. It complements the MSC.Nastran Design Optimization product module and extends MSC.Nastran's optimization capabilities beyond sizing and shape optimization. MSC.Nastran Topology Optimization is built on the density method and mathematical programming to solve not only the classical topology problems but also general multi-disciplinary topology optimization problems. The new product module is able to generate a conceptual design proposal that can be used as an initial design for detail sizing and shape optimization. MSC.Patran supports the pre- and postprocessing of MSC.Nastran Topology Optimization models.

Topology Optimization of a Spare Tire Mount



Before

After

The MSC.Nastran Design Optimization product module delivers the ability to optimize size and shape with the Automated Design Systhesis (ADS) and VR&D's DOT (Design Optimization Tools). The MSC.Nastran Topology Optimization module extends the optimization process with the embedded BIGDOT optimization algorithm to design structures with an optimum distribution of material, given the package space, loads, and boundary conditions. With improved performance over the DOT optimizer, the BIGDOT optimizer efficiently calculates a near-optimum discrete solution for very large-scale design optimization problems with up to two million linear and nonlinear constrained and unconstrained design optimization variables.

Available by itself or in combination with the Design Optimization product module, the Topology Optimization product module greatly enhances your ability to perform design optimization.

PRODUCT LINE

SimOffice™

Product Family

MSC.Nastran™

CAPABILITIES

- Topology Optimization for:
  - Defined 2-D or 3-D Geometric Design Space Combined with Load and Boundary Condition Requirements.
  - Topology Designable Element Types for All 1-D / 2-D / 3-D Elements Referencing Isotropic Material.
- General Multi-Disciplinary Topology Optimization for:
  - Linear Statics, Normal Modes, Buckling.
  - Direct / Modal Frequency Response.
  - Complex Eigenvalue.
  - Static Aeroelasticity.
  - Aeroelastic Flutter.
- Large Scale Topology Optimization Featuring:
  - Two Million Design Variables and Constraints with a Built-In BIGDOT Optimizer from VR&D Inc.
  - Density Method.
  - Adjoint Design Sensitivity Analysis.
  - Advanced Approximation Techniques.
  - Filtering Techniques to Combat Checkerboard-Like Material Distribution.
  - Minimum Member Size to Control Manufacturing Simplicity.
- Design Responses as Design Objectives and Constraints.
  - MSC.Nastran Built-in Responses.
  - External Response Input Directly or Generated by an Intermediate Spawned Process.

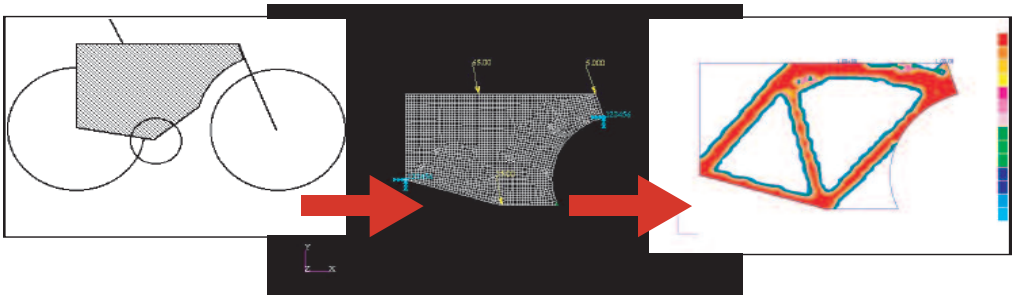
BENEFITS

- Generate Efficient Design Proposals for Load Paths in the Conceptual Design Phase.
- Significant Material Reduction in Insignificant Areas for a Given Design Space, Boundary Conditions, Loads, and Required Design Performance.
- Determination of Rib Patterns to Improve Load Path Distribution Designs with Reduced Weight.
- Solve Topology Optimization Problems with a Greater Number of Design Variables and Constraints Using the Built-In BIGDOT Optimizer from VR&D for Superior Upfront Product Designs.

MSC SOFTWARE®

SIMULATING REALITY

Topology Optimized Bicycle Frame



Design Area Domain **Applied Load and Constraints** **Resulting Optimized Shape**

Why Topology Design Optimization?

Topology optimization is a method of determining the optimum material distribution (shape) over a prescribed design space (area or volume) meeting a set of objective functions. From a block of material, structural shape can be optimized for optimal stiffness at minimum weight for a given loading environment. However, several objective functions can be involved in determining the best structural shape for a product that operates in a dynamic, nonlinear environment. Many different objective functions need to be considered for different load conditions and constraints at the same time to produce an optimum shape. In addition, optimum shape may change based on material selection. Therefore, topology optimization can be used to optimize shape for the purposes of weight reduction, minimizing material requirements or selecting cost effective materials, and analyzing composite material characteristics that deliver the optimal mechanical performance of design concepts. Topology optimization can be used to determine initial design concepts but can also be used to refine existing structural components and systems. This leads to a highly efficient initial product design concept analyzed in less time resulting a higher quality product with lower overall development cost.

EXTEND YOUR INVESTMENT

MSC.Software recommends MSC.Patran™ or MSC.SOFY™ for an integrated modeling and analysis environment.

MSC.Patran Topology Optimization Support Includes:

- Pre- and Postprocessing for 2-D and 3-D Part Designs.

MAXIMIZE YOUR RETURN ON INVESTMENT

MSC.Software provides the most comprehensive training, support, and professional services with offices worldwide to provide local and centralized support. Investing in MSC.Software gives you access to extensive client support through comprehensive documentation, direct technical expertise, and customized onsite and offsite training classes taught by experienced engineers.

To find your local MSC.Software office or to learn more about our company and our products, please contact:

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