GENESIS

Structural Design Optimization Software

GENESIS is a fully integrated structural finite element analysis and design optimization software package. Analysis capabilities include: static, normal modes, direct and modal frequency analysis, random response analysis, heat transfer, and system buckling calculations.

Design optimization is based on the advanced approximation concepts approach to find an optimum design efficiently and reliably. Actual optimization is performed by the well established DOT and BIGDOT optimizers, also from VR&D. Design capabilities include: shape, sizing, topography, topometry and topology optimization.

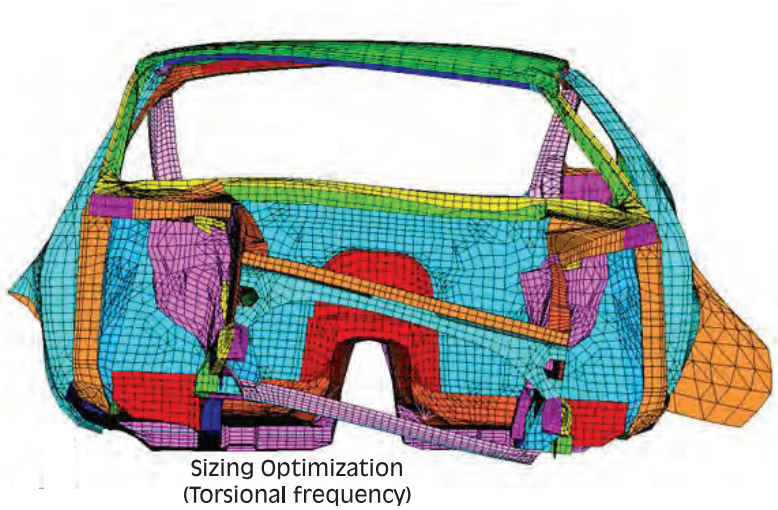
Image Courtesy of
GRM-Consulting, UK

- Fast, reliable, and accurate finite element analysis
- GENESIS provides improved designs at reduced cycle times
- Topology optimization at early stage of design
- Shape, sizing, topometry, and topography optimization for detailed design
- SMS Eigen Solver runs eigensolutions 2 to 10 times faster than the conventional Lanczos method
- BIGDOT optimizer solves problems in excess of 100,000 design variables. For example, topology optimization problems are currently being solved in excess of 2.5 million design variables and are getting bigger everyday

MODELING OPTIONS

- Analysis
  - Linear static analysis
  - Inertia relief analysis
  - Dynamic normal modes
  - Buckling analysis
  - Frequency response
  - Random response analysis
  - Heat transfer analysis
  - Sensitivity analysis

- **Design Optimization**
  - Multi-objective and hybrid optimization capability
  - Shape, sizing, topometry, topography, and topology optimization



Sizing Optimization
(Torsional frequency)

SUPER FAST EIGEN SOLVER

GENESIS uses our SMS eigenvalue solution algorithm for lightning fast normal modes analysis. SMS allows eigensolutions to run from two to ten times faster than the conventional Lanczos method.

MODELING FEATURES

- No fixed problem size limit
- Blocked profile and sparse matrix equation solvers with automatic bandwidth optimizer
- SMS, Lanczos, and subspace iteration eigenvalue solution algorithms
- Design sensitivities calculated analytically in most cases
- Optimization is performed using the latest approximation methods for maximum efficiency
- Topology optimization finds the optimum shape with the specified mass
- Structural design variables control the shape, as well as member dimensions

FINITE ELEMENT ANALYSIS

- Reliable Element Library

- Multiple Material Properties
  - Isotropic
  - Orthotropic
  - General anisotropic

- Multiple Loading Conditions
  - Point, pressure, thermal, gravity and centrifugal static loads
  - Thermal loads from solution of heat transfer analysis
  - Enforced displacements and deformations
  - Enforced temperatures
  - Heat flux and convection
  - Point, pressure and gravity dynamic loads

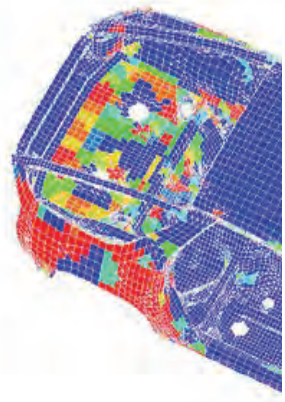
- Multiple Boundary Conditions
  - Single and multipoint constraints

- Rectangular, cylindrical and spherical coordinate system

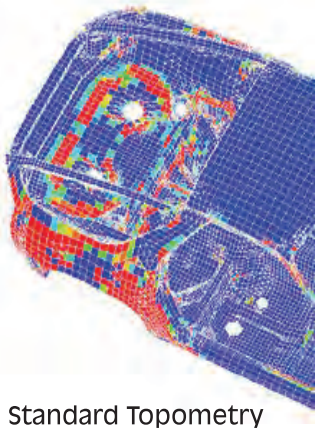
TOPOMETRY DESIGN

- Element by element optimization

- Coarse Topometry Optimization
  - Allows group-by-group sizing optimization
  - Fabrication constraints:
    - Mirror
    - Cyclic
    - Extrusion Constraints



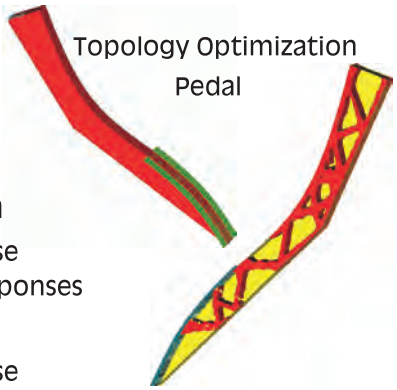
Coarse Topometry
4090 variables



Standard Topometry
34560 variables

TOPOLOGY DESIGN

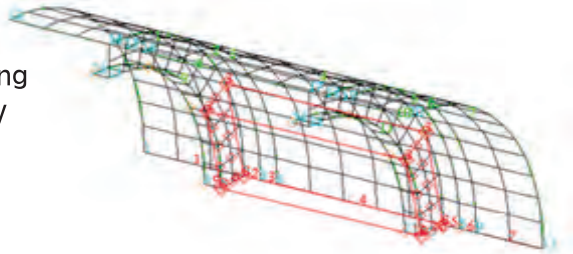
- Automatic generation of design variables
- Enforced symmetry available
- Built-in responses:
  - Mass Fraction
  - Strain Energy
  - Displacement
  - Frequency
- Objective Function
  - Any built-in response
  - Combination of responses
- Constraints
  - Any built-in response
- Isodensity Surfaces
  - Helps visualize the topology results
  - Used to create new FEA mesh for analysis and/or shape and sizing optimization
- Isodensity Translator
  - GENESIS can create isodensity surfaces using existing optimization results



Topology Optimization
Pedal

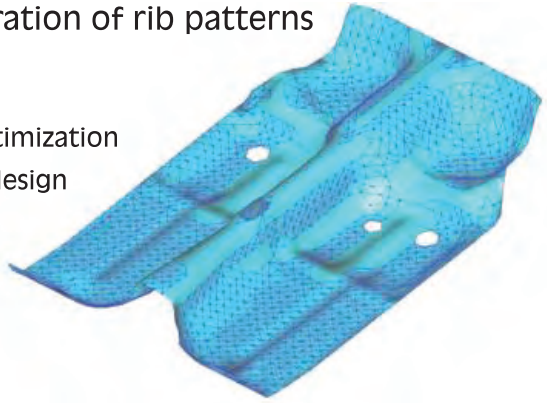
SHAPE, SIZING & TOPOGRAPHY

- Simultaneous design of member dimensions and grid location
- Linear and nonlinear design variable linking
- Semiautomatic basis shapes and grid perturbations:
  - Greatly simplifies input required for shape optimization
  - DOMAIN elements define how perturbations vary throughout the model
  - Natural basis vectors



Shape & Sizing
- Missle Body

- Automatic generation of topography perturbations
- Automatic generation of rib patterns



Autorib Optimization
- Car floor design

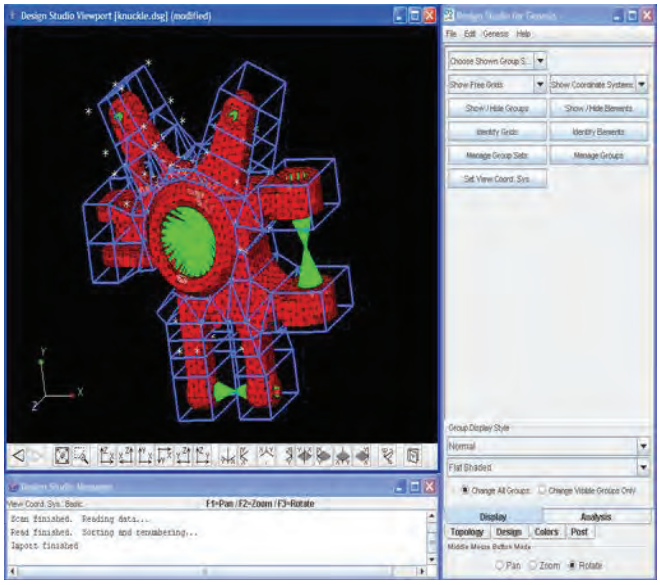
- Library of Beam and Plate Elements
  - Relates design variables directly to member dimensions, not just section properties
  - Built-in beam cross-sections: Square, Rail, I-beam, Circle, Tee, Angle, Spar, Tube, Box, Rectangle
  - Built-in plate element models: Solid, Sandwich, Two thickness sandwich
- Custom Cross-sections
  - Allows nonlinear equations to relate design variables to section properties
  - Allows the use of external user routines
- Wide Range of User Selectable Responses:
  - Built-in responses: Stress, strain, strain energy, force, buckling load factor, natural frequency, eigenvector, displacement, velocity, acceleration, temperature, distance, length, area, volume, angle, mass, inertia
  - Custom responses: User defined equations or external routines
  - External routines linked with GENESIS
- Flexible Objective Selection:
  - Minimize or maximize any response(s)
  - Match selected response(s) to target value(s)
- Lower and/or upper bound constraints on any response
- Automatic generation of stress constraints
- Automatic mode-tracking for frequency and/or eigenvector constraints
- Automatic mesh smoothing
- Stress ratio option

VR&D

PRE AND POST PROCESSING

Design Studio for GENESIS

Design Studio for GENESIS is a design oriented pre- and post-processor graphical interface for the GENESIS program.



Design Studio for GENESIS – Domain Morphing

Design Studio for GENESIS features:

- Built-in and easy to use trails makes it easy to create objectives and constraints
- Contour plots and animations for stress, displacement, and thickness etc.
- Deformed shape plots and animations
- On the fly isodensities for topology
- Able to export CAD (STL, IGES) representation of topology results
- Frequency response plots
- Helps to create reports and presentations
- Allows you to make pictures (png format)
- Allows you to create movies (avi format)

OTHER VR&D PRODUCTS AVAILABLE

SMS eigensolver

The SMS eigensolver may be added to existing NASTRAN installations to offer significant performance advantages over the default method when a large number of eigenmodes is required for a system with many degrees of freedom. Benchmark tests and user experiences have seen solutions times anywhere between 2-5 times faster when using SMS. SMS may also be embedded into your product/software. Contact us for details.

VisualDOC

VisualDOC is a software system that simplifies adding optimization to almost any design task. It uses powerful, intuitive graphical interface, both gradient based and non-gradient based optimization, response surface (RS) approximate optimization, and design of experiments (DOE) methods. VisualDOC interfaces easily to your own code or third-party analysis programs.

DOT – Design Optimization Tools

DOT is a general purpose numerical optimization software library which can be used to solve a wide variety of nonlinear optimization problems. If you require only an optimization engine to incorporate into your design software, DOT will serve that purpose.

BIGDOT

BIGDOT is intended to solve very large, nonlinear, constrained problems where gradient information is available, and function and gradient evaluation is efficient. BIGDOT is capable of solving continuous, discrete/integer or mixed variable problems. Problems in excess of 100,000 variables have been solved by BIGDOT.

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