SIEMENS

Ingenuity for life

NX Nastran – Optimization

Automate the optimization process to achieve the best product performance

Benefits

- Reduce design risk by better understanding the complex relationships among design parameters and how design changes affect these relationships
- Improve confidence that your product will perform to specifications under a variety of operating conditions and manufacturing tolerances
- Accelerate innovation by determining feasible new designs that satisfy all design requirements
- Shorten time-to-market by automating thousands of simulations that would otherwise have to be performed manually

Summary

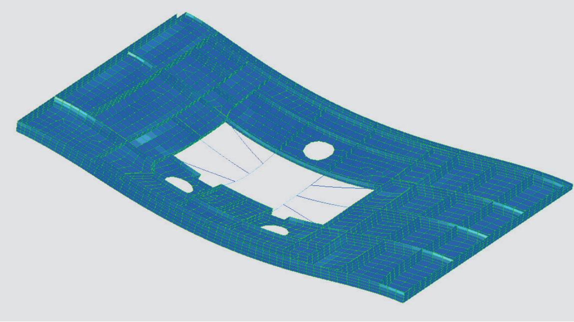
Designing and producing an innovative product that meets its performance criteria is a goal of every manufacturer. Using optimization techniques, an engineer can improve a proposed design, resulting in the best possible product for minimum cost. Because your designs may have hundreds of variable parameters, with complex inter-relationships, finding an optimal design through manual iterations is hit-or-miss at best. NX™ Nastran® – Optimization software relieves the burden involved in improving product designs by automating the iterative process of comparing your design's performance against its performance specifications.

Automating the product performance process

Traditional "build-test-review-improve" product cycles are typically performed using manual iterations. However, manual design sensitivity assessments are typically only based on changing one parameter at a time, to enable you to tell what causes the effects you see. NX Nastran – Optimization streamlines and automates that process by using sophisticated algorithms to search the entire design space and find the right combination of parameters that will yield optimal design or performance.

To help the program know what you mean by "optimal", you specify design or performance objectives for characteristics such as minimum weight, shape constraints or minimum stress or strain. Design parameters that you can vary include geometric, material and connectivity properties.

Examples where optimization can play a key role include weight or stress reductions for aircraft; shape optimization for products with packaging constraints; and multidisciplinary tradeoff studies such as vehicle durability versus vibration characteristics.

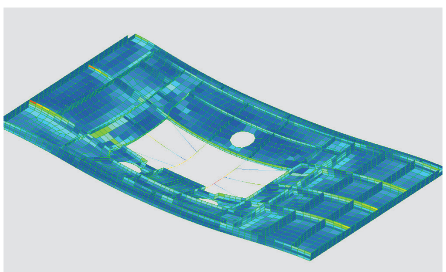


NX Nastran – Optimization

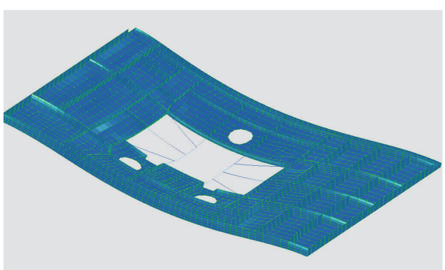
Major capabilities
Design optimization and sensitivity analysis can be applied to many analysis types:

- Linear statics, normal modes and buckling
- Transient response, frequency response and acoustics
- Static aeroelasticity and flutter
- Upstream superelements

Table 1 – Analysis types in optimization	
Basic analysis	Linear statics analysis Normal modes analysis Buckling analysis
Dynamic response	Modal frequency response Direct frequency response Modal transient response Direct complex eigenvalue analysis Modal complex eigenvalue analysis
Aeroelasticity	Static aeroelasticity Static aeroelastic divergence



Initial design - Max stress = 14 MPa.



Optimized design - Max stress = 4 MPa.

All optimization and sensitivity can be done simultaneously in one NX Nastran run. See Table 1 for a complete list.

Design variables are the designer's parameters:

- Shape variables are tied finite element grid points
- Sizing variables are tied to finite element properties
- Shape and sizing variables can both be used in the same run

Efficient optimization algorithms permit the use of hundreds of design variables and responses for large models. Efficiencies include:

- Design variable linking: multiple design variables can be linked
- Approximation methods: three methods are provided
- Robust optimization algorithms: three methods are provided
- Constraint deletion and regionalization: only the critical constraints are retained
- Restarts: optimization can be restarted from a completed design cycle and continued
- Adjustable convergence criteria and move limits: for faster convergence
- Sparse matrix solver: faster speed and minimal disk space
- Adjoint sensitivity analysis
- Mode tracking

Response can be either the design objective or the performance constraints. Responses are:

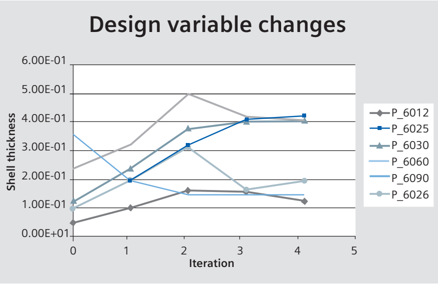
- Present (see Table 2)
- User-defined combinations of the present responses

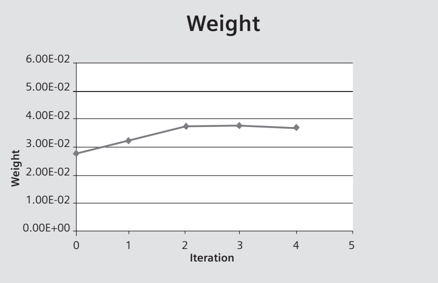
Table 2 – Response types in optimization

Analysis type	Response
All	Weight Volume
Linear statics	Displacement Stress Strain Force Lamina strain Lamina stress Lamina failure criterion
Normal modes	Normal mode number
Buckling	Buckling mode number
Frequency response	Displacement Velocity Acceleration Constraint force Stress Force
Transient response	Displacement Velocity Acceleration Constraint force Stress Force
Static aeroelasticity	Trim Stability derivative
Flutter	Damping level

User-defined equations let you synthesize the objective, constraints and properties, permitting:

- RMS (root-mean-square) type responses
- Cost and other nonstructural objectives
- Model updating to match test data
- Beam properties as a function of sectional dimensions
- Minimization of the maximum response





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