NX Nastran Advanced Nonlinear – Solution 601/701

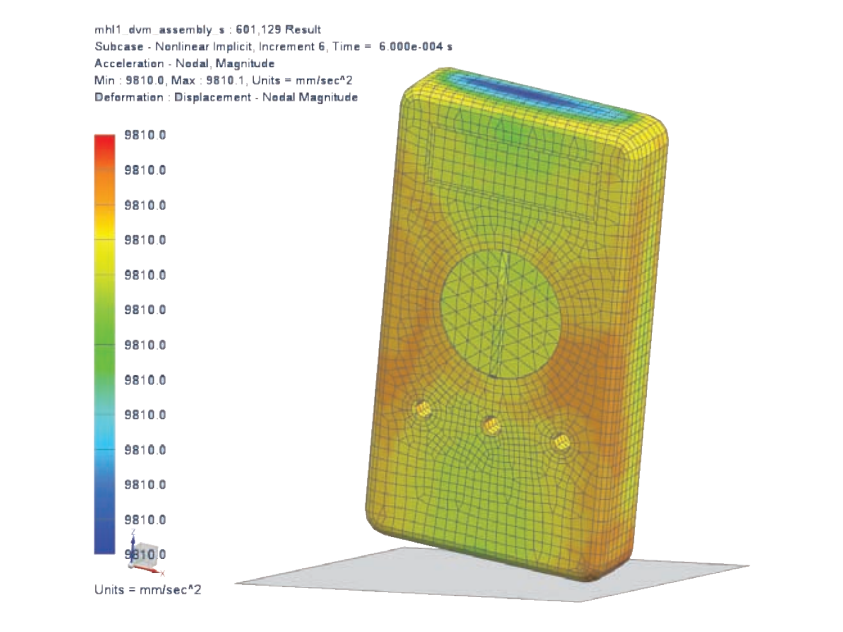
Predict behavior of parts or assemblies with nonlinear contact, material or large deformations

Benefits

- Reduce design risk by using simulation to save time and cost compared to physical build-and-break test cycles
- Accelerate your innovation through rapid iteration and numerous "what-if" studies
- Use the same models already built and analyzed linearly with NX Nastran – Basic
- Improve confidence in final designs by virtually investigating your product's performance under all possible operating conditions
- Obtain more accurate solution results than linear analysis when standard linear assumptions are not valid

Summary

The NX™ Nastran® Advanced Nonlinear software solution enables you to analyze models with nonlinearity from contacting parts, material nonlinearities and/or geometric nonlinearities (that is, large deformations). An add-on module of NX Nastran – Basic, the Advanced Nonlinear solver is an integration of the well-known and highly regarded ADINA solver into NX Nastran as Solution 601 for implicit solutions or Solution 701 for explicit solutions.



Geometric nonlinear effects need to be simulated when stiffness properties or loads change significantly as the result of deformation. Analysis of snap-through buckling is an example in which geometric nonlinearity effects are important. Material nonlinear effects should be modeled when the material properties cannot be considered linear for the loading conditions considered. Example usages are for analyzing hyperelastic (rubber) materials or analyzing

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metals that exhibit plastic behavior because they are stressed beyond yield limits. Advanced contact capabilities allow you to simulate surface contact using either shell or solid elements. Many mechanical simulations involve parts coming into contact under load. With the advanced Solution 601/701 surface contact capabilities, the solver determines the extent of surface contact and load transfer across the contacting surfaces as part of the solution. NX Nastran Advanced Nonlinear also has a very robust solution algorithm and efficiently obtains converged solutions for some of the most difficult and intractable nonlinear models.

The integration of the ADINA solver into Solution 601/701 is transparent to the user because the input and output formats are based on NX Nastran formats. Thus, to the user, the experience and usage of Solution 601/701 is completely Nastran-centric.

Major capabilities

Contact
- Shell and solid element face contact
- Edge contact for axisymmetric modeling
- Single and double sided contact
- Self contact
- Several friction models
- Tied contact
- Several contact algorithms
- Rigid target contact for metal forming
- Compliant (soft) contact
- Contact surface offsets
- Gap elements
- Contact pressures and force results

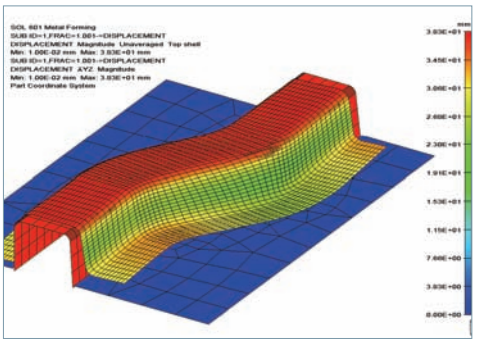
Material nonlinear
- Hyperelasticity models
  Mooney-Rivlin
  Ogden
  Hyperfoam
  Arruda-Boyce
  Holzapfel
  Ogden-Roxburgh (Mullins effect)
- Gasket material model
- Gasket pressure and state results
- Nonlinear elastic
- Elasto-plastic
- Thermal elasto-plastic
- Creep
- Plasticity
  Von Mises yield criterion
  Isotropic hardening
  Kinematic hardening
  Mixed hardening
- Rupture
- Strain measures: engineering, Green-Lagrange, logarithmic
- Stress measures: engineering, Cauchy
- Combined Creep and elasto-plastic

Geometric nonlinear
- Large deformations
- Large strain
- Snap-through analysis (post-buckling)
- Follower forces

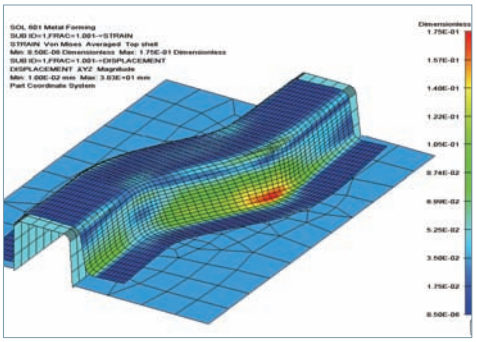
Other modeling capabilities
- Glue connection
- Element birth and death
- CBUSH element support
- Plane stress and plane strain element support
- Variable thickness for plane stress elements

Robust solution methods
- Full Newton iterations, with or without line searches
- Load displacement control (LDC) method
- Automatic time stepping (ATS) method
  Low-speed dynamics effect option
- Energy, force and deformation convergence criteria
- Dynamic solution with Newmark method for direct implicit integration
- Sparse solver and iterative multi-grid solver
- Stiffness stabilization for static solutions

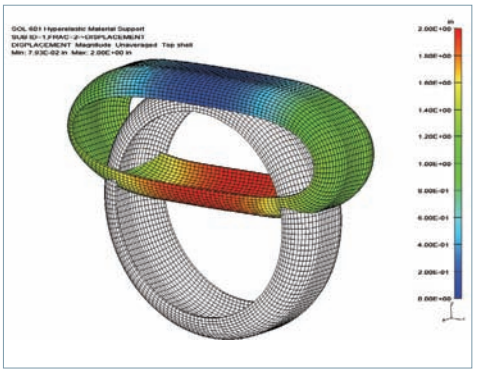
Easy transition from linear to nonlinear analysis
- Add only a few nonlinear-specific entries to the linear model
- Input and output formats are similar
- Supports many advanced NX Nastran features
  Elastic isotropic, orthotropic materials
  Composites
  Axisymmetric modeling
  Plane strain modeling
  Material temperature dependence



Displacement results from a metal forming example. A planar sheet is formed into an S channel.



Strain results from a metal forming example. A planar sheet is formed into an S channel.



Hyperelastic materials: displacement results from a tire model being squeezed between two plates.

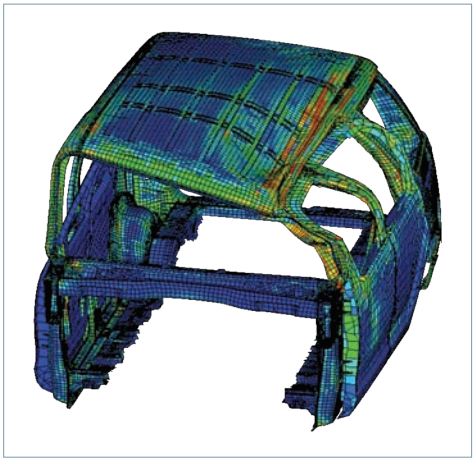
- Supports many load conditions
  Bolt preload
  Concentrated loads
  Follower loads
  Pressure and distributed loads
  Inertia loads
  Enforced motion
  Applied temperatures
  Initial conditions for displacement, velocity and temperature
  Edge load support for plain stress and plain strain elements

Static and transient dynamic analysis

- Model setup is the same for static and dynamic analysis
- Doesn't require separate licenses for static and dynamic analysis

Implicit and explicit solutions

- Implicit solver for static analysis and low speed dynamic analysis
- Explicit solver option for impact simulation or metal-forming simulation
- Can switch from implicit to explicit and vice versa with restarts



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