# NX Advanced Simulation:
# FE modeling and simulation

**NX CAE**

**Benefits**
- Speed simulation processes by up to 70 percent
- Increase product quality by rapidly simulating design trade-off studies
- Lower overall product development costs by reducing costly, late design change orders
- Simplify CAE geometry editing processes with intuitive direct modeling
- Rapidly update analysis models when the design geometry changes
- Consolidate CAE preprocessing into a single environment supporting the most commonly used solvers
- Efficiently manage large, complex analysis models through assembly FEM management
- Capture and automate best practices and commonly used processes
- Link results to product requirements to make smarter product decisions

**Summary**
NX™ Advanced Simulation software combines the power of an integrated NX Nastran® desktop solver with NX Advanced FEM, a comprehensive multi-CAD FE model creation and results visualization tool. Extensive direct geometry editing using synchronous technology, idealization and abstraction capabilities enable the rapid development of complex 3D mathematical models that allow design decisions to be based on insight into real product performance. NX Advanced Simulation enables a true multi-physics environment via tight integration with NX Nastran and available add-on solutions for thermal and flow analyses, as well as the ability to support other industry standard solvers such as Abaqus, Ansys, MSC Nastran and LS-Dyna.

**A modern CAE environment**
NX Advanced Simulation directly addresses the challenges you face with simulation today through a modern and completely integrated environment that delivers significant benefits. NX Advanced Simulation does not require NX CAD and can be used as a standalone FEA pre/postprocessor with support for multi-CAD geometry. Although not required, when used in conjunction with NX CAD, NX Advanced Simulation enjoys the added benefit of seamless data transfer between the design and analysis teams.

NX Advanced Simulation drastically reduces the time you spend preparing analysis models. It delivers all the advanced meshing, boundary conditions and solver interfaces that experienced analysts expect for high-end analysis.



But what makes NX Advanced Simulation unique among all other prepro-cessors is it's integration of a superior geometry foundation which enables more intuitive editing of geometry and analysis model associativity to
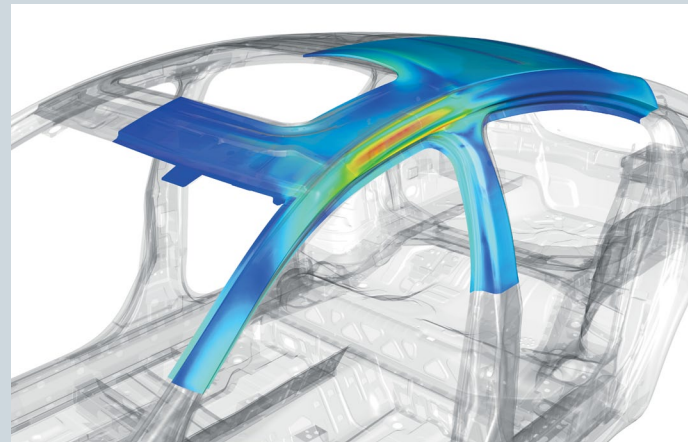
## NX

**SIEMENS**

# NX Advanced Simulation

multi-CAD data. The tight integration of a powerful geometry engine with robust analysis modeling commands is the key to reducing modeling time by up to 70 percent compared to traditional analysis modeling tools.

**Geometry Preprocessing**

**Reduce time spent editing geometry**
One of the main issues analysts face is the need to clean and defeature imported geometry. Features like small holes, small steps and surfaces impact meshing speed and quality but can be irrelevant to engineering performance. On average, for each design iteration, engineers spend an entire day or more on geometry cleanup activities when using standalone CAE preprocessors. This wastes time that could be better spent doing real engineering.

NX Advanced Simulation is built on the same leading geometry foundation that powers NX. Integrating strong geometry capabilities with CAE preprocessing results in enormous productivity gains for analysts.

**Synchronous technology revolutionizes geometry editing** NX Advanced Simulation includes direct geometry editing capabilities powered by synchronous technology developed by Siemens. Analysts can quickly edit geometry in intuitive ways that are not possible in traditional CAE preprocessors or feature-based CAD systems. Direct editing works on geometry from any source, and analysts can use it to rapidly modify geometry prior to meshing, create design alternatives for "what-if" evaluations, or rapidly generate fluid domain volume geometry.
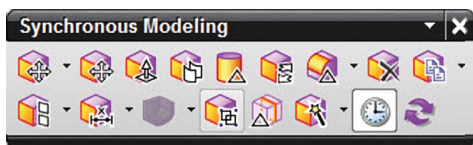
**Analysis model to geometry associativity** User-defined geometry edits, mesh and boundary conditions are all associated to the base design. When the design topology changes, NX rapidly updates the existing analysis geometry, mesh, loads and boundary conditions as required, avoiding the need for the analyst to manually recreate the analysis model. This approach greatly reduces downstream modeling time which is compounded across a project's many design-analysis iterations.
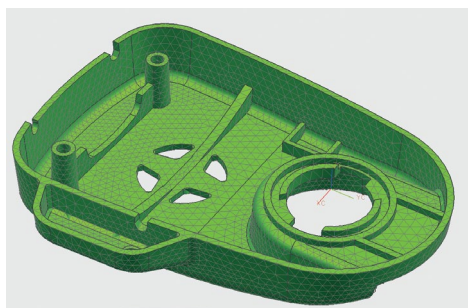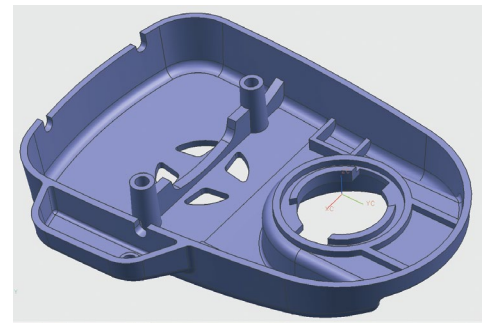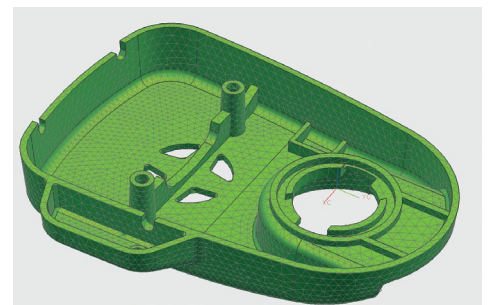
*1. Plastic case initial analysis model.*
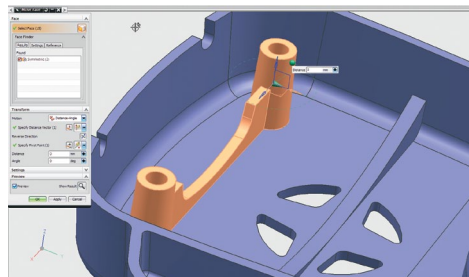
*2. Select geometry to move.*
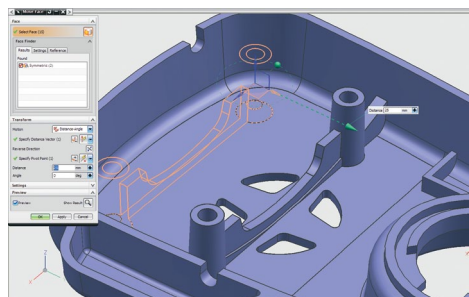
*3. Drag geometry to new position.*

*4. New design ready for analysis.*

*5. Updated analysis model ready for simulation.*

Geometry editing capabilities available in NX Advanced Simulation include:

*Multi-CAD geometry interfaces*
NX Advanced Simulation supports CAD geometry from a number of formats, and all NX Advanced Simulation direct editing and idealization capabilities can be used on geometry from all of these formats.
• Direct geometry translators available (CATIA V4, CATIA V5, Pro/E)
• Neutral geometry transfer (IGES, STEP, JT™, Parasolid®)

*General geometry modeling*
Features like small holes, small steps and slivers impact meshing speed and quality but can be irrelevant to engineering performance.
• Parasolid geometry kernel
• Parametric solid and surface modeling
• Direct geometry modeling with synchronous technology
• Feature modeling
• Assembly structure creation

*Geometry idealization and abstraction for FEA*

- Direct geometry editing with synchronous technology
- Geometry healing and repair for gaps and other data inaccuracies
- Mid-surfacing (constant and variable thickness)
- Defeature tools (geometry repair, feature suppression, stitch surface, remove hole/fillet, partitioning)
- Merging/splitting/stitching of edges and faces for controlling mesh boundaries
- Non-manifold topology generation for volumes
- Automatic topology abstraction
- Manual topology modification tools
- Create surface from mesh face
- Split body and partitioning methods for dividing geometry into more manageable sections
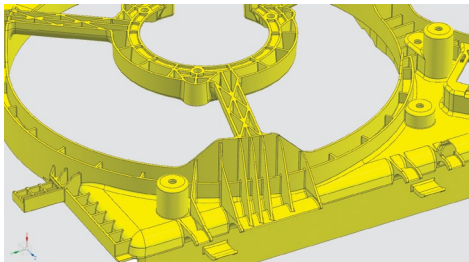


*1. Solid geometry of thin-walled part.*
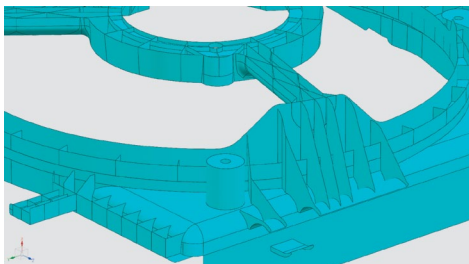


*2. Mid-surface generated from solid geometry.*
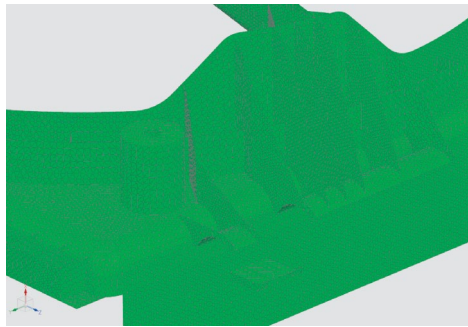


*3. Shell mesh on mid-surface geometry.*

**Additional benefits for NX CAD customers** Businesses using NX CAD for design also achieve additional benefits when they use NX Advanced Simulation for CAE:

- Seamless transfer of geometry from CAD designers to CAE analysts eliminates transfer errors and results in cleaner geometry for analysts to use
- Geometry changes made by CAE analysts during "what-if" analyses can be given directly to the designer to incorporate into the master model
- Analysts know immediately when the base design geometry has changed and can automatically update their analysis model through associativity

**FE Preprocessing**

**Comprehensive meshing tools** NX Advanced Simulation includes extensive modeling functions for automatic and manual mesh generation of 1D, 2D and 3D elements. Create 1D elements such as welds, bolts, rigids and more with ease. Shell meshing is used for modeling thin-walled parts and can be used in conjunction with mid-surfaces. NX Advanced Simulation includes hexahedral meshing capabilities in addition to its "best-in-class" tetrahedral meshing.

Meshing capabilities include:

1D mesh
- Beam
- Beam section properties defined from a standard set of sections or directly from CAD geometry
- Automated bolt connection meshing
- Rigid
- Spring
- Gap
- Damper
- Automatic weld meshing
- Lumped masses
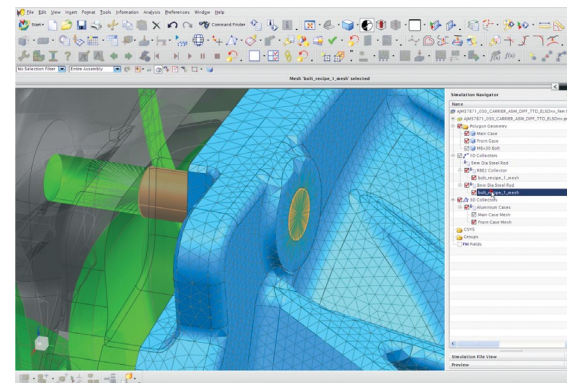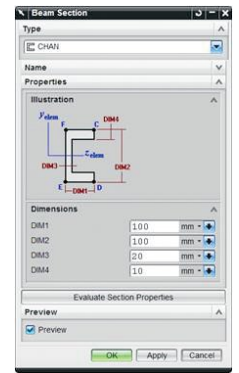




2D mesh (shell mesh)
- 2D mapped meshing
- 2D free meshing
- Sweep meshing "paver"
- 2D meshing boundary
- 2D dependent boundary
- Quad-only meshes
- Linear or parabolic

**3D mesh (solid elements)**
- Automatic tetrahedral meshing
- Swept hexahedral meshing
- Pyramid elements needed to smoothly transition from a hex mesh to a tetrahedral mesh
- Linear or parabolic
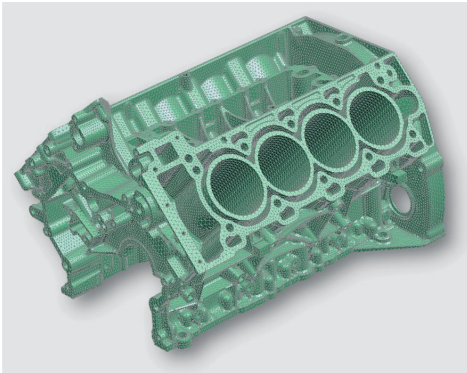


*Mesh control*
- Transition meshing from fine to coarse for 2D and 3D free meshing
- User controlled automatic abstraction during meshing
- Ability to define allowable distortion for tetrahedral elements before meshing
- Local element control for precise mesh generations
- Number of elements on edge
- Chordal tolerance
- Geometric progression
- Association of mesh generation settings with geometric features (updates occur with design geometry changes)
- Surface coating
- Axisymmetric meshing
- Batch meshing
- Mesh quality checks
- Grouping

*Material definitions*
- Material property creation and management
- Mass property calculations
- Physical property creation and management
- Variable element thickness

**Loads and boundary conditions** NX Advanced Simulation provides extensive capabilities to define loading and boundary conditions to correctly simulate operating environments.

*Load and boundary condition control*
- Apply on geometry (face, edge, or curve)
  - Associativity of geometry-based loads and restraints that is maintained through design geometry changes
  - Ensure a node is placed at the location during automatic meshing
- Apply on FE entities
- Apply to local coordinate system
- Apply on groups
- Axisymmetric boundary conditions
- Automatic contact detection and setup
- Automatically apply loads obtained from motion analysis in NX Motion
- Time-varying loading and boundary conditions to correctly simulate nonlinear loading conditions
- Define loads by expression, array or table input
  - Spatially varying loads can be quickly and easily defined via expression or by ASCII file import
  - Same is true for time, frequency and temperature dependent loads

*Load and boundary condition types*
- Surface-to-surface contact definitions
  - Surface-surface glue contact
  - Automatic face pairing
  - Coupling
  - Automatic coupled DOF
  - Manual coupled DOF
- Constraints and restraints, including nodal displacement

- Structural loads
  - Nodal forces and temperatures
  - Element face and edge pressures
  - Acceleration (gravity, translation, rotation)
  - Ambient and reference temperatures
- Heat transfer loads
  - Nodal and distributed heat sources
  - Face and edge fluxes, convection and radiation
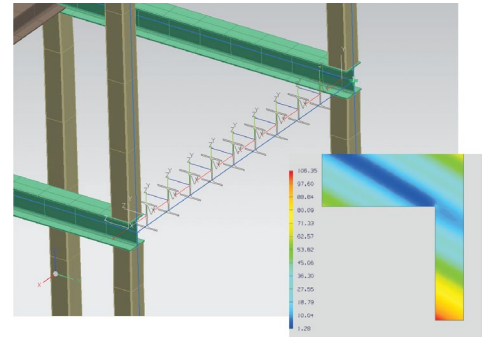


**Complete model checking tools** NX Advanced Simulation provides a full set of graphical and mathematical tools to help verify that a model is complete and correct before you submit it for solution.
- Coincident node and element checks eliminate duplications
- Free-edge and face checks avoid unwanted cracks in a model
- Shrink element display verifies that elements are located properly
- Element shape checks (distortion, warping, etc.) verify that elements do not violate limits and can produce accurate results
- Element thickness display to check that shell thickness is correct
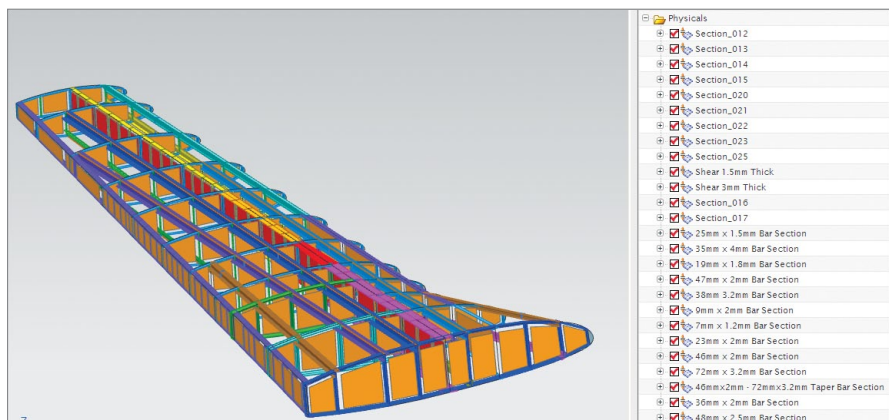
**Efficient FE assembly management**
As products become ever more complex, performing simulation at just the component level is not enough. NX Advanced Simulation has the tools needed to efficiently build and manage complex analysis models and assemblies. NX Advanced Simulation is unique in the way it creates finite element assembly models. Unlike traditional CAE preprocessors that were developed for component analysis and require you to build large monolithic analysis models, NX Advanced Simulation was developed to create large FE assembly models by instancing and connecting FE component models together, similar to a CAD assembly.

When an FE component is updated later in development, NX Advanced Simulation updates all instances of that component within the FE assembly, eliminating the need to rebuild and connect a new FE assembly together.

**Multi-CAE environments** NX Advanced Simulation offers immersive user environments to support a variety of common solvers used by analysts including NX Nastran®, MSC Nastran, Abaqus, Ansys and LS-Dyna. The solver environments immerse the user in the language of the selected solver's terminology which enables analysts to easily prepare solver-specific analysis models without the need to learn new terminology.
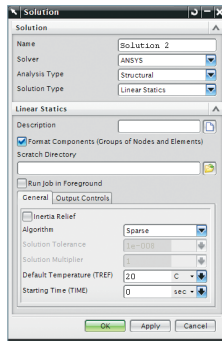
*Export analysis models and import results for these external solvers:*
• Abaqus
• Ansys
• LS-Dyna
• MSC Nastran
• NX Nastran (enterprise)

**Postprocessing** For analysis to drive decisions, results must be presented in an understandable form. NX Advanced Simulation provides extensive graphics and manipulation capabilities that focus on critical data and present it for review and action.
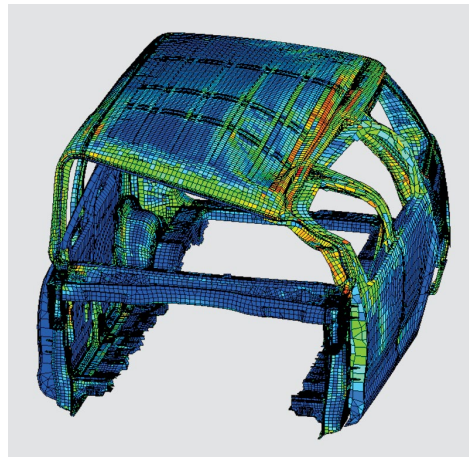
Using NX Advanced Simulation, you can perform a variety of postprocessing functions:

*Display*
• Deformed geometry
• Contour displays
• Beam cross-section contour displays
• Vector displays
• Isosurface displays
• Cutting planes
• Streamlines, ribbons and bubbles for flow results

• Advanced lighting control
• Animations with stepped or smooth-shaded displays
• Complex dynamic response results
• Multiple results simultaneously
• Multiple viewports
• Probing of results on nodes
• Postprocessing data table with sort/criteria
• 3D and 2D text annotations
• Templates of display options for repeated use
• Results listings
• Transparency display
• Local coordinate system
• Groups of elements using search criteria

*Graphing*
• XY graphing
• Bar graphing
• Synchronized contour and XY plotting displays
• Annotated graphs

*Output*
• Image output (JT, JPEG, BMP, PNG, GIF, Animated GIF, TIF)
• Export single or multiple result sets to Excel for further manipulation
• HTML customized reports for model data and results inspection
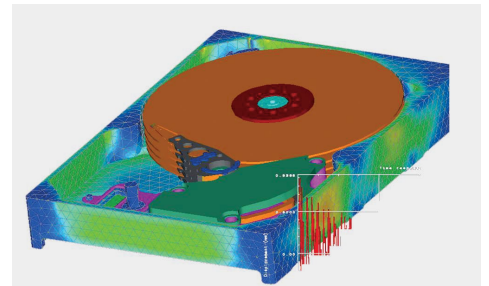
**Embedded Simulation**

**NX Nastran included** The Advanced Simulation bundle includes a license of the NX Nastran – Basic desktop solver integrated with a desktop license of the NX Nastran Environment. NX Nastran – Basic provides access to a broad library of finite element types and material models, robust manipulation of load cases, along with several efficient solution sequences for linear statics, buckling and normal modes analyses on models of unlimited size. A heat transfer capability provides solutions to steady-state and transient thermal analysis and design problems. A basic nonlinear capability enables including large deformation and material nonlinear effects in the solution.

The NX Nastran – Desktop Advanced bundle and/or individual modules for NX Nastran listed below can be added on to a seat of NX Advanced Simulation.

**Optimization** Optimization is a process that helps the analyst arrive at the best solution for a given design goal. NX Advanced Simulation allows the user to create an optimization solution process. The user can define a goal such as the mass of a part or component, a constraint such as maximum allowable Von Mises stress and the design parameter(s) to vary on the component. The optimization solution process runs based on the design criteria while varying the design parameters to enable the design engineer to determine if there is a better structural design alternative vs. the original baseline design.

| NX Nastran analysis feature and capabilities | Basic bundle | Advanced bundle* | Available separately* |
|---|---|---|---|
| Basic analysis capabilities | | | |
| Linear static analysis | • | | |
| Normal modes analysis | • | | |
| Buckling analysis | • | | |
| Heat transfer analysis (steady-state and transient) | • | | |
| Basic implicit nonlinear analysis | • | | |
| Spot weld analysis | • | | |
| Advanced analysis capabilities* | | | |
| Distributed memory parallel capability (DMP)** | | • | • |
| Dynamic response analysis module | | • | • |
| Advanced nonlinear analysis module | | | • |
| Superelements analysis module | | • | • |
| Direct matrix abstraction programming (DMAP) | | • | • |
| Design optimization module | | | • |
| Aeroelasticity analysis module | | • | • |
| Advanced aeroelastic module | | | • |
| Rotor dynamics | | | • |

\*  Basic bundle is a prerequisite for all add-on modules and the Advanced bundle. The Advanced bundle is not available in the desktop version that is integrated with Femap™ software, but the individual advanced analysis modules can be purchased as add-ons to Femap and NX Nastran Basic.

\*\* DMP is not available in desktop versions.

**Multi-discipline simulation** The need to use multiple analysis products adds costs and complexity because each analysis product has its own user interface and workflows. In addition, incompatible models and manual file transfers consume time and create errors which sometimes hinder the multi-discipline studies necessary to correctly understand product performance.

Additional analysis capabilities available as add-ons to NX Advanced Simulation are shown in this table:

**Simulation data management and automation**

**Data management designed for the CAE analyst** NX Advanced Simulation seamlessly integrates with the entire Teamcenter® data management portfolio, including the simulation process management module. Simulation data management capabilities work "out of the box", and companies can implement a complete environment for managing CAE data, process and workflow as part of a wider product development environment.

This reduces waste by promoting re-use of existing designs and engineering knowledge. It synchronizes data and makes it readily accessible through data mining, visualization and reporting.

**Linking simulation results to product requirements** NX Advanced Simulation lets you link simulation results directly to specific product requirements and can alert project managers when requirements are not being met. Project managers and other product decision makers can then view the 3D simulation results in an intuitive way using JT™, a light-weight visualization tool.

**Automating simulation processes** CAE engineers can increase productivity by automating redundant processes with NX Open, the common foundation for automation and programming in NX. Using NX Open, expert CAE users can capture, author and publish simulation processes to guide less experienced engineers or designers to accelerate the development process, while ensuring modeling and results accuracy.

**An open platform** Siemens understands you often need to use other software tools, either developed internally or from other vendors, to get the answers you need to support critical development decisions. That's why NX Advanced Simulation is open and flexible enough to allow you to incorporate those tools into your simulation processes. NX Advanced Simulation supports a number of commercial CAE solvers through available environments, or you can develop your own interfaces using NX Open.

| Analysis Type | Available add-on products for NX Advanced Simulation |
|---|---|
| Topology optimization | NX Topology Optimization |
| Durability | NX Durability Wizard<br>NX Advanced Durability |
| Laminate composites modeling<br>Laminate composites draping | NX Laminate Composites |
| Response simulation | NX Response Simulation |
| Thermal Analysis | NX Thermal<br>NX Advanced Thermal<br>NX Space Systems Thermal |
| CFD or flow analysis | NX Flow<br>NX Advanced Flow |
| Multi-physics | |
| Coupled thermo-fluid analysis | NX Electronic Systems Cooling<br>NX Flow or Advanced Flow with NX Thermal or Advanced Thermal |
| Coupled thermo-elastic analysis | NX Thermal with NX Advanced Simulation |
| Motion-structural (motion flexible bodies) | NX Motion and NX Flexible Body Dynamic Solution with NX Advanced Simulation |
| Physical test to analysis correlation | NX FE Model Correlation<br>NX FE Model Updating |
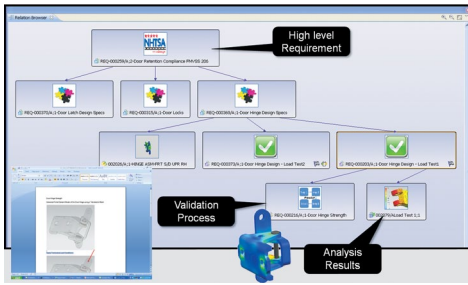
**Product availability** NX Advanced Simulation is the core module in the NX CAE suite of applications. It is a prerequisite for all other add-on solutions such as NX Topology Optimization, NX Advanced Durability, NX Durability Wizard, NX Flow, NX Advanced Flow, NX Thermal, NX Advanced Thermal, NX Electronic Systems Cooling, NX Space Systems
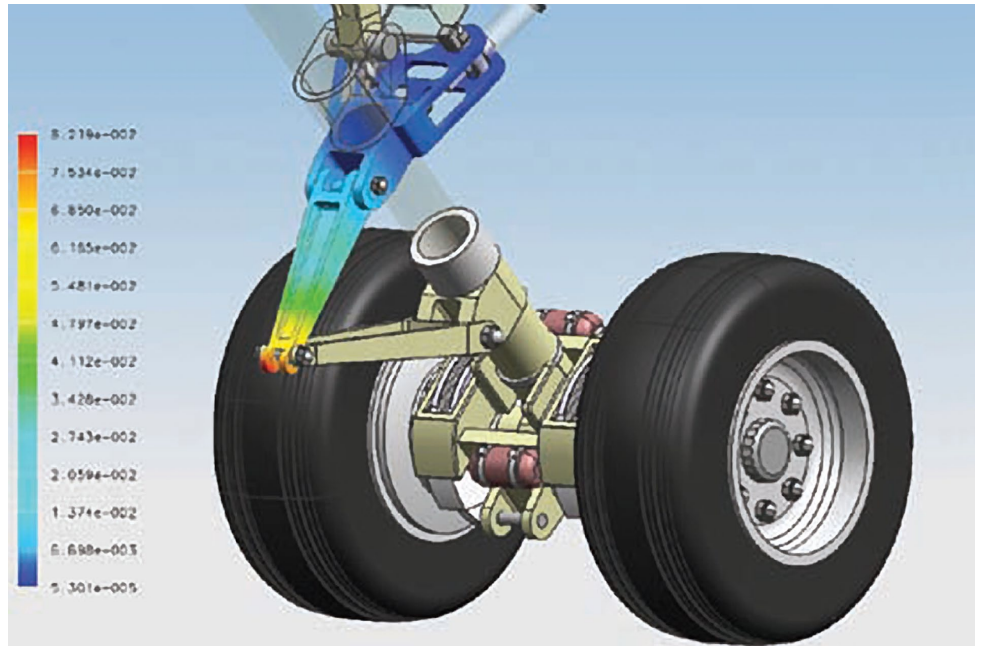
Thermal, NX Response Simulation, NX Laminate Composites, NX FE Model Correlation, NX FE Model Updating and the customized solver environments for Abaqus, Ansys, LS-Dyna, and Nastran.

NX Advanced Simulation is available on 32- and 64-bit Windows and also on 64-bit Linux systems.

**User Interface**

**Intuitive and configurable UI** A modern CAE environment requires a modern user interface.
- Organized and intuitive commands
- Customizable menus and toolbars
- Contextual menus using right-mouse button show only the most appropriate commands
- Use roles to tailor the UI based on user profiles to show only the commands the user needs