Simcenter 3D Structures

Integrating FE modeling and simulation streamlines product development

Benefits

- Speed simulation processes by up to 70 percent
- Perform accurate, reliable structural analysis with integrated NX Nastran solver
- Increase product quality by rapidly simulating design tradeoff studies
- Lower overall product development costs by reducing costly, late design change orders
- Efficiently manage large, complex analysis models
- Capture and automate best practices and commonly used processes
- Easily add multidiscipline simulation capabilities as your analysis needs grow

Summary

Simcenter 3D Structures software is a unified, scalable, open and extensible 3D CAE environment for advanced analysts. Simcenter 3D Structures is a bundle combining the Simcenter 3D Engineering Desktop, NX™ Nastran® environment, and the NX Nastran desktop solver. Together, Simcenter 3D Structures gives you best-in-class simulation modeling with the power to perform basic structural analysis with an industry-standard solver. The Simcenter 3D Engineering Desktop contained within Simcenter 3D Structures speeds the simulation process by helping you to efficiently build the simulation model you need from 3D geometry faster than traditional CAE preprocessors. The integrated NX Nastran environment and NX Nastran solver within Simcenter 3D Structures then let you seamlessly submit analysis models for linear statics, normal modes, buckling, or basic heat transfer analyses. Simcenter 3D Structures also forms the foundation on which you can add additional solutions for advanced structural, thermal, flow, acoustics, motion, optimization and multiphysics analyses, all from a single environment.

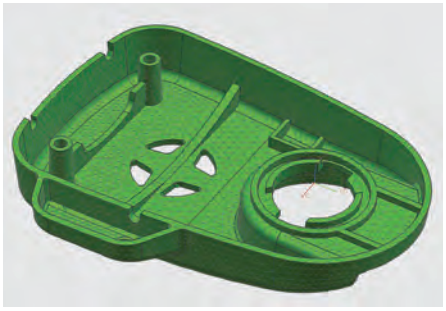
Providing finite element modeling for experienced CAE analysts

Using Simcenter 3D Structures drastically reduces the time you spend preparing simulation models. Simcenter 3D Structures delivers all the advanced meshing, boundary conditions and solver interfaces that experienced analysts expect for high-end analysis. However, what distinguishes Simcenter 3D Structures from all other finite element (FE) preprocessors is its superior geometry foundation that enables intuitive geometry editing and analysis model associativity to multi-computer-aided design (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 FE modeling tools.

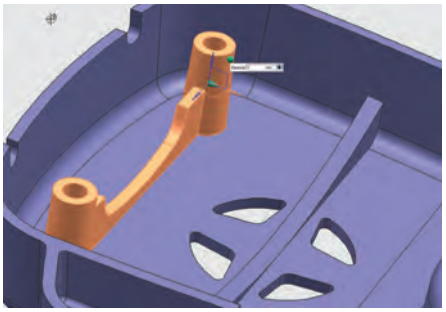
Enabling fast, intuitive geometry editing

Simcenter 3D Structures is built on an industry-leading geometry foundation. By using Simcenter 3D Structures, you can rapidly clean up and prepare geometry from any CAD source through direct modeling. Geometry edits and the complete analysis model remain associated to the base design, which means you can easily update your analysis model each time the design changes. As a result, the Simcenter 3D Structures geometry editor accelerates your design-analysis iterations and improves your overall productivity.

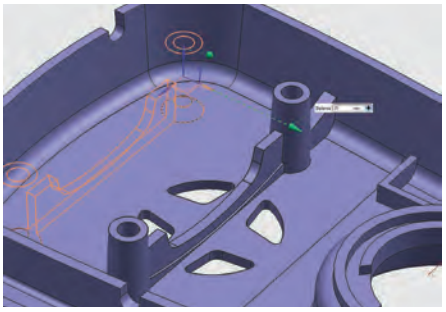
Simcenter 3D Structures



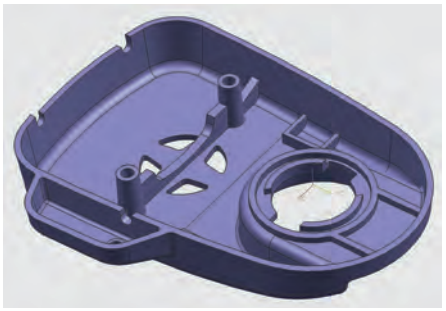
Initial analysis model.



Use synchronous technology and select geometry to move interactively.



Simply drag geometry to a new position.



New design ready to be analyzed.

Direct geometry editing with synchronous technology

Simcenter 3D Structures includes direct geometry editing capabilities powered by synchronous technology, combining the flexibility of direct modeling with the best of dimension- and constraint-driven techniques to provide you with the most control. Analysts can quickly edit geometry in intuitive ways that are not possible in traditional CAE preprocessors or feature-based CAD systems. Direct editing will work on geometry from any source, and analysts can use it to rapidly de-feature or modify geometry prior to meshing, create design alternatives for what-if evaluations, or rapidly generate fluid domain volume geometry.

In addition to synchronous technology, Simcenter 3D Structures delivers a wide range of geometry editing capabilities that are needed to de-feature, abstract and idealize geometry for CAE purposes, such as:

- Geometry healing and repair for gaps and other data inaccuracies
- Mid-surfacing to create surfaces for thin-walled components
- De-featuring tools (geometry repair, feature suppression, stitch surface, remove hole/fillet and partitioning)
- Non-manifold topology generation for volumes
- Creating a surface from an orphan mesh
- Split body and partitioning methods for dividing solid geometry into more manageable sections prior to hex meshing

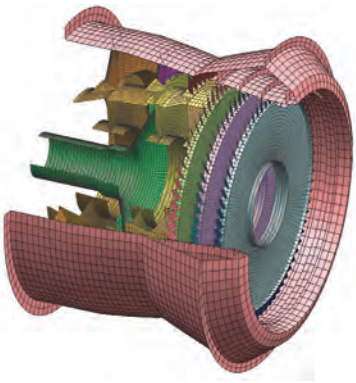
Rapid design-analysis iterations through associativity

User-defined geometry edits, FE mesh and boundary conditions are all associated to the base design. When the design topology changes, Simcenter 3D Structures 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.

Edit facet data

Convergent Modeling is a game-changing tool that allows you to modify and work with facet geometry the same way you work with traditional CAD geometry. For CAE, this means you can quickly edit and simulate scanned models in Simcenter 3D. Additionally, Convergent Modeling gives you the ability bring legacy FE mesh data to life. Now you can turn legacy mesh data into a convergent body, which you can then edit as geometry. After you have made your geometry edits, you can then immediately remesh and re-analyze this new design. This means your designers no longer need to take the painstaking process of recreating geometry by hand based on legacy mesh shapes.

Convergent modeling.



Extensive meshing tools are available for thin-walled parts.

Multi-CAD support

Simcenter 3D Structures supports CAD geometry from a number of formats, and all Simcenter 3D Structures direct editing and idealization capabilities can be used on geometry from all of these formats:

- Direct geometry translators for CATIA V4, CATIA V5 and Pro/ENGINEER (available separately)
- Neutral geometry transfer (IGES, STEP, JT™, Parasolid®)

Delivering comprehensive meshing

Simcenter 3D Structures includes extensive modeling functions for automatic and manual mesh generation of 0D, 1D, 2D and 3D elements, and also numerous techniques for the application of loads and boundary conditions. As mentioned previously, the mesh and boundary conditions are all associated to the geometry to allow you to rapidly update your analysis model when there is a design change. This can save you hours, days or weeks of work depending on the complexity of your model.

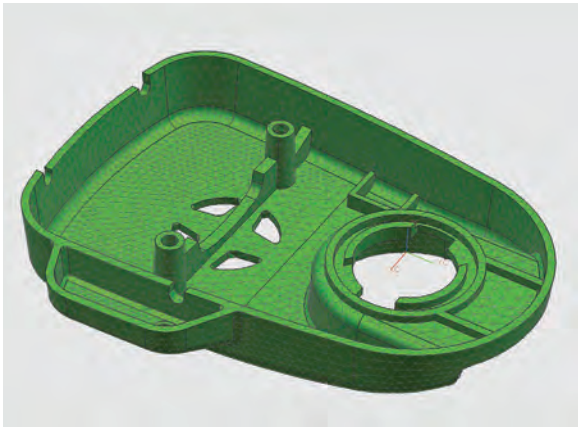
0D and 1D meshing

You can create 1D elements, such as welds, bolts, rigids and beams and other elements with ease. Simcenter 3D Structures can be used to leverage CAD information to help you quickly create beam section properties and facilitate the creation of FE weld connections based on the weld data contained in the CAD assembly.

2D shell meshing

Simcenter 3D Structures provides a number of tools to help you create accurate FE meshes needed for thin-walled components. These tools can be used in conjunction with mid-surface, and the types of 2D meshing methods include:

- Mapped meshing to control the distribution of elements across a surface
- Free (unstructured) meshing for surfaces with more than four sides



Associated mesh updates in a matter of seconds and is ready for immediate analysis.

- Dependent meshes to ensure meshes match in contact or symmetric regions

3D solid meshing

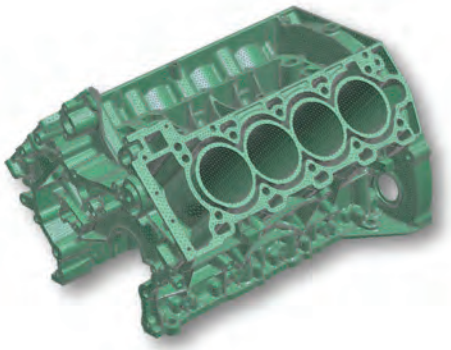
Thick, chunky components are often modeled using tetrahedral or hexahedral elements. Simcenter 3D Structures offers the necessary tools to quickly create solid elements, including:

- Automatic best-in-class tetrahedral meshing
- Swept hexahedral meshing
- Pyramid elements needed to smoothly transition from a hex mesh to a tetrahedral mesh

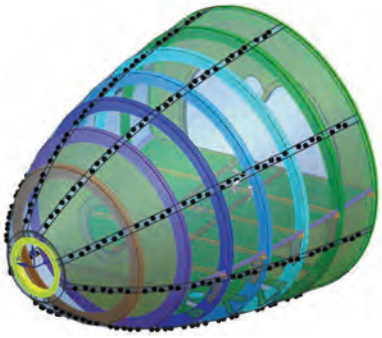
Mesh control and editing

In addition to creating meshes, Simcenter 3D Structures helps you fine-tune and edit meshes to quality criteria and achieve more accurate results. Capabilities include:

- Mesh morphing to modify existing meshes to match new geometry dimensions
- 2D and 3D mesh controls for fillets and cylinders
- Extensive mesh quality checks and reporting



Quickly mesh complex geometry with automatic best-in-class tetrahedral meshing.



Easily build, connect and manage large FE assembly models.

- Local element control for precise mesh generation
- Batch meshing with mesh controls for use in automated processes

Flexibly apply loads and boundary conditions

The geometry engine at the core of Simcenter 3D Structures provides you with the flexibility to apply loads and boundary conditions either to geometry features or directly to the FE mesh, depending on your needs. Load and boundary conditions can be applied in the following manner:

- On geometry (face, edge or curve) to maintain associativity when design geometry changes
- On FE entities (nodes, elements, element faces and element edges), which is useful when working with imported meshes with no underlying geometry
- To local coordinate system
- To groups for easier management
- As axisymmetric boundary conditions for simplifying the study of revolved systems
- As loads automatically obtained from motion analysis in Simcenter 3D Motion
- As time-varying condition sequences for simulating mission profiles
- As defined by expression, array or table input

Facilitating efficient FE assembly management

Simcenter 3D Structures is unique in the way it creates FE assembly models. Unlike traditional CAE preprocessors that were developed for component analysis and require you to build monolithic analysis models, Simcenter 3D Structures' assembly FE model (AFEM) management tool creates large FE assembly models by instancing and connecting FE component models together, similar to a CAD assembly.

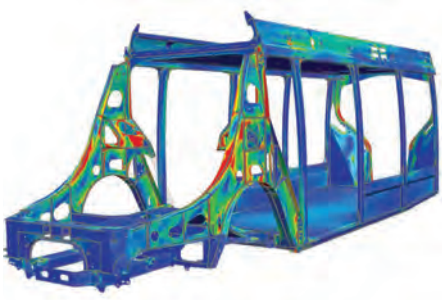
When an FE component is updated later in development, Simcenter 3D Structures updates all instances of that component within the FE assembly, eliminating the need to rebuild and connect a new FE assembly together.

Simulate with embedded structural analysis

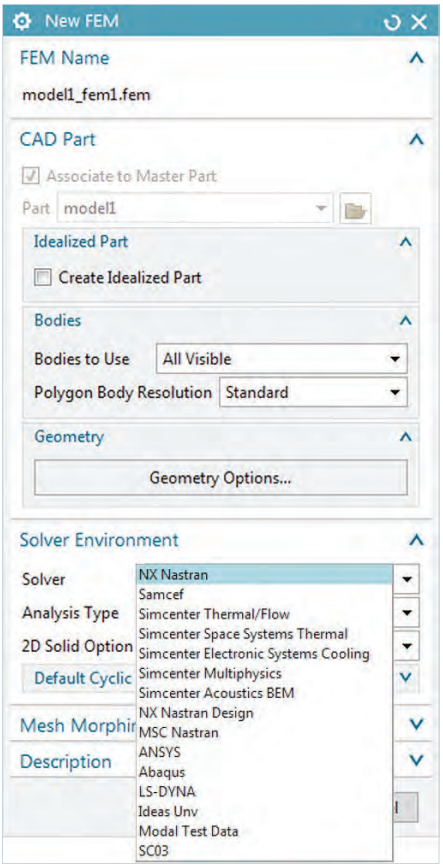
Simcenter 3D Structures includes the NX Nastran Environment and an integrated NX Nastran – Basic desktop solver. NX Nastran – Basic provides access to a broad library of finite element types and material models, robust manipulation of load cases, along with several efficient solution sequences for linear 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 inclusion of large deformation and material nonlinear effects in the solution.

The NX Nastran Advanced bundle can be added on to Simcenter 3D Structures to perform more advanced analyses for:

- Dynamic Forced Response
- Acoustics
- Advanced Nonlinear
- Rotor Dynamics
- Superelement Components
- Design Optimization
- Topology Optimization
- Aeroelastics
- Solution Customization with DMAP



NX Nastran – Basic is integrated in Simcenter 3D Structures for a complete structural analysis solution.



Preprocess analysis models for external solvers.

Preprocess with multi-CAE environments

Simcenter 3D Structures can be used as the primary pre- and postprocessor for Siemens Digital Industries Software solvers, NX Nastran and LMS Samtech Samcef™ software, or for a number of third-party solvers, such as Abaqus, ANSYS, LS-DYNA, and MSC Nastran. This is accomplished through immersive user environments that use the selected solver's terminology, which enables analysts to easily prepare solver-specific analysis models without the need to learn new terminology. Simcenter 3D Structures comes packaged with the pre-/postprocessing environment for NX Nastran. Environments for LMS Samcef, Abaqus, ANSYS, LS-DYNA, and MSC Nastran are available separately.

Postprocess results and create reports

For analysis to drive decisions, results must be presented in an understandable form. Simcenter 3D Structures provides extensive graphics and manipulation capabilities that focus on critical data and present it for review and action. Additionally, the multi-CAE environments for Nastran, Abaqus, ANSYS and LS-DYNA can import result files created by these solvers for easier postprocessing and reporting.

Results displays

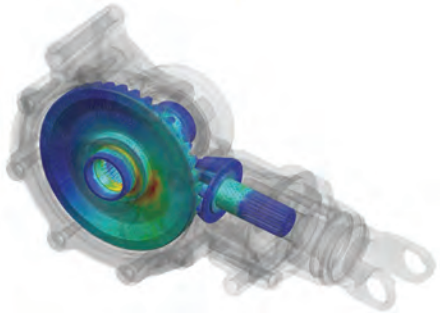
Simcenter 3D Structures includes various ways you can control the display of simulation results, such as deformation, contour plots, isosurfaces, streamlines, animation and text annotations.

XY graphing

Graphing can be critical to understanding how results change over time, frequency, or along sections of your model, and Simcenter 3D Structures delivers extensive XY graphing capabilities from basic scatter plots to plots for complex results. Of course, Simcenter 3D Structures also gives you full control over the appearance of your graphs for reporting purposes.

Reporting and export

With no more than a few mouse clicks, you can easily create and assemble simulation reports inside Simcenter 3D Structures. Simulation reports can be customized to include boundary conditions, material properties, images and graphs, and can be easily exported for sharing with external audiences.



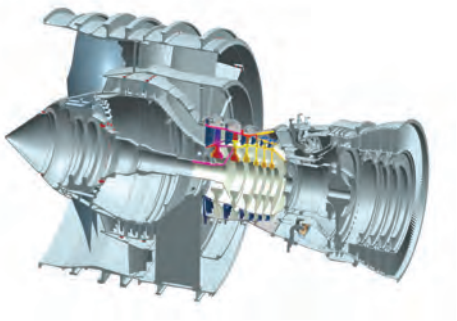
Robust postprocessing capabilities for graphics, results probing, graphing and reporting.

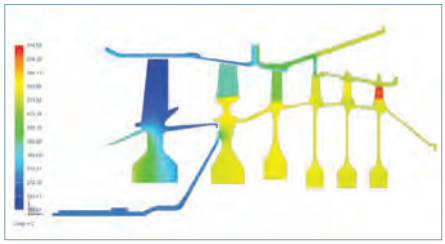
Providing a platform for multidiscipline simulation

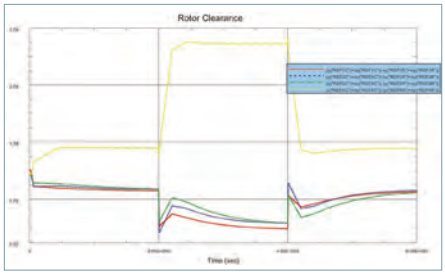
Many organizations use multiple, disconnected analysis tools to cover the variety of analysis needs for product development. However, using multiple tools adds costs and complexity because each analysis product has its own user interface and workflows. In addition, incompatible models and manual file transfers consume time and create errors, which sometimes hinder the multidiscipline studies necessary to correctly understand product performance.

Simcenter 3D Structures is a modern simulation environment that can be extended to support solutions for more advanced structural, durability, thermal, flow and multiphysics analyses, and the modules shown in the table on the right are available as add-ons to the Simcenter 3D Structures environment.

Analysis type	Available add-on modules for Simcenter 3D Structures
Solver environments	Simcenter 3D Environment for LMS Samcef Simcenter 3D Environment for Abaqus Simcenter 3D Environment for Ansys Simcenter 3D Environment for MSC Nastran Simcenter 3D Environment for LS-Dyna
Structural	Simcenter 3D Margin of Safety
Durability	Simcenter 3D Durability Wizard Simcenter 3D Advanced Durability
Dynamic response	Simcenter 3D Response Dynamics
Laminate composites modeling Laminate composites draping	Simcenter 3D Laminate Composites
Thermal analysis	Simcenter 3D Thermal Simcenter 3D Advanced Thermal Simcenter 3D Space Systems Thermal Simcenter 3D Thermal/Flow DMP
CFD or flow analysis	Simcenter 3D Advanced Fluid Modeling Simcenter 3D Flow Simcenter 3D Advanced Flow Simcenter 3D Thermal/Flow DMP
Acoustics	Simcenter 3D Environment for BEM Acoustics Simcenter 3D Acoustics BEM Solver Simcenter 3D Acoustics ABEM Simcenter 3D ATV Simcenter 3D Meshing for Acoustics Simcenter 3D Acoustics HPC Simcenter 3D Noise and Vibration Modeling
Motion	Simcenter 3D Motion Modeling Simcenter 3D Motion Solver Simcenter 3D Motion Flexible Body Simcenter 3D Motion Control Simcenter 3D Motion Standard Tire Simcenter 3D Motion CD Tire Simcenter 3D Motion MF Tyre Simcenter 3D Motion MF Swift
Flexible pipe analysis	Simcenter 3D Flexible Pipe Standard Beam + Shell Simcenter 3D Flexible Pipe Standard Beam Simcenter 3D Flexible Pipe Linear Dynamic Simcenter 3D Flexible Pipe Non-Linear Dynamic Simcenter 3D Flexible Pipe Optimization Simcenter 3D Flexible Pipe Advanced Beam Simcenter 3D Flexible Pipe Standard Shell
Multiphysics	
• Coupled thermo-fluid analysis	Simcenter 3D Electronic Systems Cooling Simcenter 3D Flow/Advanced Flow with Simcenter 3D Thermal/Advanced Thermal
• Coupled thermal-mechanical analysis	Simcenter 3D Thermal with NX Nastran
• Vibro-acoustics	Simcenter 3D Acoustics Modeling with NX Nastran Advanced Acoustics
• Motion-structural analysis (motion with flexible bodies)	Simcenter 3D Motion Modeling + Simcenter 3D Motion Solver + Simcenter 3D Motion Flexible Body + NX Nastran
Physical test to analysis correlation	Simcenter 3D FE Model Correlation Simcenter 3D FE Model Updating







The multiphysics environment streamlines bi-directional thermal-structural coupling to study blade clearance in an aircraft engine.

Accelerating multiphysics analysis

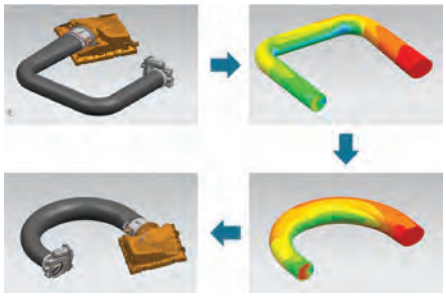
In addition to being a platform for multidiscipline simulation, Simcenter 3D Structures includes a multiphysics environment to help you connect two or more solvers to streamline the process of performing complex, multi-physics simulation. This environment delivers a consistent look and feel for performing multiphysics simulations so you can easily build coupled solutions on the same mesh using common element types, properties and boundary conditions, as well as solver controls and options.

The initial release of the multiphysics environment provides the ability to solve thermo-mechanical problems in loosely (one-way) or tightly-coupled (two-way) modes. Coupled thermal-structural analysis enables you to leverage the new NX Nastran SOL 401 multi-step nonlinear solver and a thermal solution from the Simcenter 3D Thermal solver.

Using Simcenter 3D Structures, you can more easily tackle complex simulations, such as blade clearance analysis within aircraft engine systems, or structural analysis of automotive powertrain components within high-temperature environments. Other applications for electronic components and metalworking processes are also well suited for the multiphysics environment.

Optimizing geometry to drive design

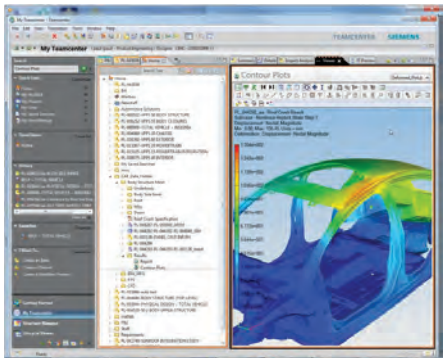
By leveraging the powerful geometry engine within Simcenter 3D Structures, you have access to a large number of geometry parameters that can be used to drive optimization processes. Design variables can include feature and sketch dimensions and expressions as well as some FE parameters, such as section properties for one-dimensional elements, and shell properties for two-dimensional elements. You can also define geometric design variables on "dumb" imported geometry by using the synchronous technology commands in Simcenter 3D Structures.



Drive design through simulation-based geometry optimization.

Managing simulation data for the analyst

Simcenter 3D Structures seamlessly integrates with the entire Teamcenter® software 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, processes and workflows as part of a wider product development environment. This reduces waste by promoting re-use of existing designs and engineering knowledge. It also synchronizes data and makes it readily accessible through data mining, visualization and reporting.



Simcenter 3D Structures seamlessly integrates with Teamcenter Simulation Process Management.

Capturing knowledge and automating processes

Simcenter 3D Structures allows engineering organizations to capture the expertise of senior analysts and make it available for others in the organization to use in the form of wizards or templates. CAE processes can be captured and automated using NX Open, an open framework for automation and programming. Analysts can capture the steps in a CAE process using journaling, and then develop scripts and easy-to-use dialog boxes so others can use the same process. Since Simcenter 3D Structures is built on top of the same platform as NX CAD, designers who use NX continue to work in a familiar environment when they perform CAE work.

Leveraging a scalable and open simulation platform

Siemens Digital Industries Software 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 Simcenter 3D Structures is open and flexible enough to allow you to incorporate those tools into your simulation processes. Simcenter 3D Structures supports a number of commercial CAE solvers through available environments, or you can develop your own interfaces using NX Open.

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