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Simcenter Nastran Advanced Dynamics

Using dynamic analysis to solve structural behavior issues and improve design

Benefits

- Use cost-effective bundle to perform comprehensive dynamic analysis and accelerate product time-to-market
- Solve large models using reduced dynamic models such as superelement and modal representations
- Build system assembly models using a hybrid assembly of finite element components and components based on test measurements or reduced order models
- Customize the solution by making changes to predefined Simcenter Nastran software solution sequence
- Perform flutter analysis, dynamic and static divergent analysis of the structure in the presence of an airstream

Summary
Assessing dynamic response in different operating conditions is critical to the automotive, aerospace and consumer products industries as well as other markets using high tech electronic devices. For example, steering-wheel vibration and road-induced noise and vibration are important influencers for user perception to determine ride quality and comfort in the automotive industry. Similarly, detailed dynamic analysis of aircraft subject to different loading scenarios is important because the safety, reliability and integrity of structural components is critical. Response spectrum analysis is widely used in predicting structural safety of ship structures and structures, such as bridges and buildings, that are subject to wind loading or earthquakes.

Simcenter Nastran® Advanced Dynamics software provides a complete solution for simulating linear dynamic behavior by offering a variety of loading conditions, damping models and solution methods to choose from to reduce development and warranty costs and improve design performance.

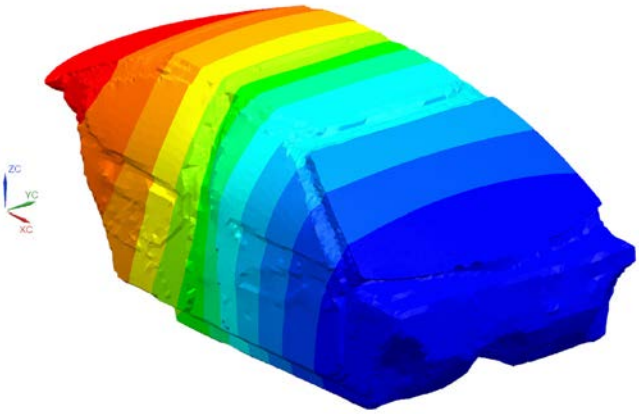
Simcenter Nastran Advanced Dynamics enables hybrid simulation by allowing measured data and finite element (FE) data to be integrated in the same simulation model. Measured loads or a measured component's dynamic description can enhance simulation accuracy, accelerate simulation time or provide a dynamic description when it is difficult to model loads or components using finite elements.

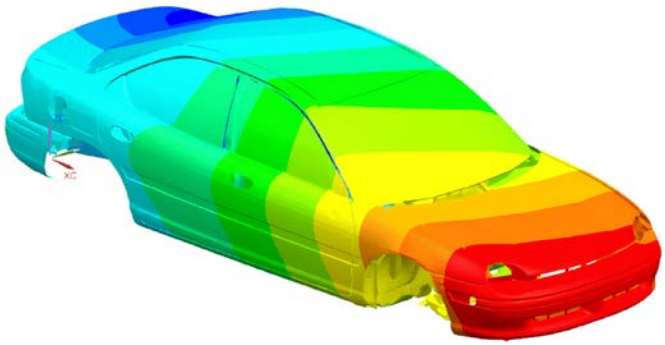
Simcenter Nastran Advanced Dynamics is a cost-effective bundle that combines capabilities that are needed for basic or advanced linear dynamic analysis such as random and shock spectrum. Simcenter Nastran features efficient scalable algorithms for computing normal modes and frequency response analysis so it can be deployed for solving large problems. High-performance solvers that make use of modern hardware architecture are available as part of Simcenter Nastran Advanced Dynamics, which enables the user to address large models.

Capabilities
Simcenter Nastran Advanced Dynamics combines a set of commonly used and advanced dynamics functionality in the following areas:

- Simcenter Nastran Dynamic Response
- Simcenter Nastran frequency response functions (FRF) representation
- Simcenter Nastran superelements analysis

Simcenter Nastran Advanced Dynamics





- Simcenter Nastran recursive domain (RD) modes
- Simcenter Nastran DMP (distributed memory processing)
- Simcenter Nastran aeroelasticity
- Simcenter Nastran direct matrix abstraction program (DMAP) software

Simcenter Nastran Dynamic Response
Simcenter Nastran Dynamic Response is the core of the Simcenter Nastran Advanced Dynamics product. It enables computing the forced response of a product subject to time or frequency varying excitations. Assessing the dynamic response of a component or an assembly of components subject to different operating conditions is critical to industries such as automotive, aerospace, consumer products and markets using high tech electronic devices.

It is possible to perform numerous what-if studies by virtually investigating the product's performance in various dynamic operating conditions by using the rich analysis tool set supported by Simcenter Nastran Dynamic response. Simcenter Nastran Dynamic Response supports a variety of damping models and efficient methods to compute the dynamic response. Simulate your physical model and save time and cost compared to physical build-test-break cycles.

Supported functionality
Analysis types
- Modal frequency response
- Direct frequency response
- Modal transient response
- Direct transient response
- Complex eigenvalue analysis
- Random response analysis
- Response spectrum generation
- Response spectrum application
- Dynamic design analysis method (DDAM) analysis

Comprehensive list of eigen solvers
- Lanczos
- Householder, modified householder
- Complex Lanczos
- Complex Hessenberg
- Integrated Shur Rayleigh Ritz for complex eigenvalues

Dynamic loading
- All static loads can be applied dynamically
- Enforced displacement, velocity and acceleration
- Initial displacement and velocity
- Initial displacement from static solution
- Time delays, time windows and analytic and explicit time functions
- Each loading or enforced motion can have a different time history

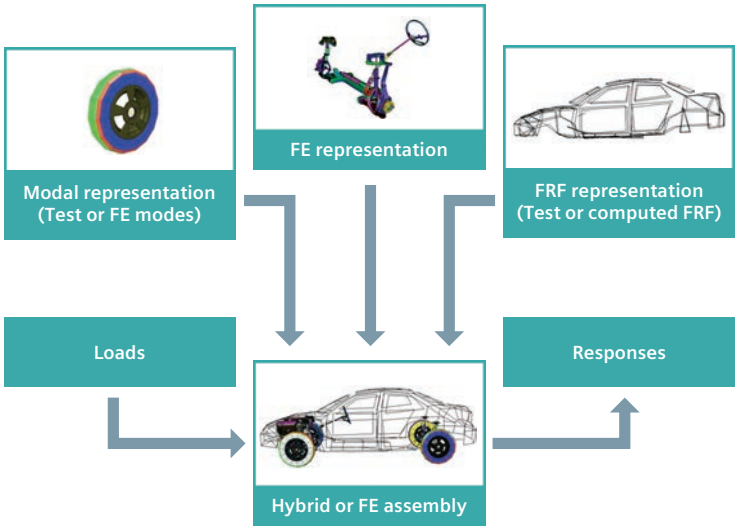
Damping
- Structural damping
- Material damping
- Variable modal damping (viscous or structural)
- Discrete viscous dampers
- Acoustic absorbers
- Direct matrix input
- Frequency dependent damping
- Structural to viscous conversion

Methods to mitigate modal truncation effects
- Residual vectors
- Mode acceleration
- Direct solutions

Efficient dynamic analysis methods
- Modal and direct solution
- Restarts from previously computed solutions
- Reduction methods – Guyan reduction and component mode synthesis

Simcenter Nastran frequency response function representation
Simcenter Nastran allows you to represent a component in the form of FRF, an alternate form of matrix representation of a component. The source of frequency response functions can be from test measurements or an output from a finite element FRF simulation solution. Simcenter Nastran supports a hybrid assembly of components. In a system assembly of components, some of the components can be a finite element representation of the model while the rest of the components can be measured FRFs.

In a collaborative design environment, FRFs can be used to exchange data between suppliers and original equipment manufacturers (OEMs). Many companies work on proprietary or secure projects in which models or modeling techniques are highly confidential. Exchange of data can now be done using FRFs that accurately capture dynamics while keeping the model



confidential. This allows suppliers to focus on the design of their components and use FRF representations of the rest of the components to predict system performance. Similarly, OEMs can integrate FRF data provided by suppliers into their FE model to evaluate system performance.

You can combine a finite element representation of a component under development (virtual models of the new parts) with FRFs (computed or measured) from existing components. The resulting hybrid model will have fewer degrees-of-freedom (DOF) and can now be analyzed efficiently. Quick what-if scenarios can be performed, enabling rapid prototyping.

Supported functionality

Supported solutions
- Modal frequency response
- Direct frequency response
- Random response analysis

Assembly
- Computed FRFs
- Test FRFs
- Computed Modes
- Test Modes

Simcenter Nastran superelements

With Simcenter Nastran superelements, a component can be reduced to its matrix representation by retaining the boundary or connecting DOF. As a result, a large component can be represented by a small number of retained DOF. This reduced component can be used in a system assembly that includes other components. Superelements are used for efficiently analyzing large system assemblies such as aircraft, ships and automobiles.

Simcenter Nastran supports superelements (reduction and assembly) in both static and dynamic solutions. For dynamic solutions, Simcenter Nastran supports component mode synthesis (CMS) or the Craig Bampton reduction. It supports fixed, free and hybrid interface DOF for modal reduction. Simcenter Nastran supports both external superelements and internal or part superelements, single and multilevel.

Superelements can also be used in a collaborative design environment to exchange data between suppliers and OEMs. Many companies work on proprietary or secure projects in which models or modeling techniques are highly confidential. The exchange of data can now be done using external superelements while keeping the model confidential.

Supported functionality

Supported solutions
- Modal frequency response
- Direct frequency response
- Modal transient response
- Direct transient response
- Normal modes
- Random response analysis

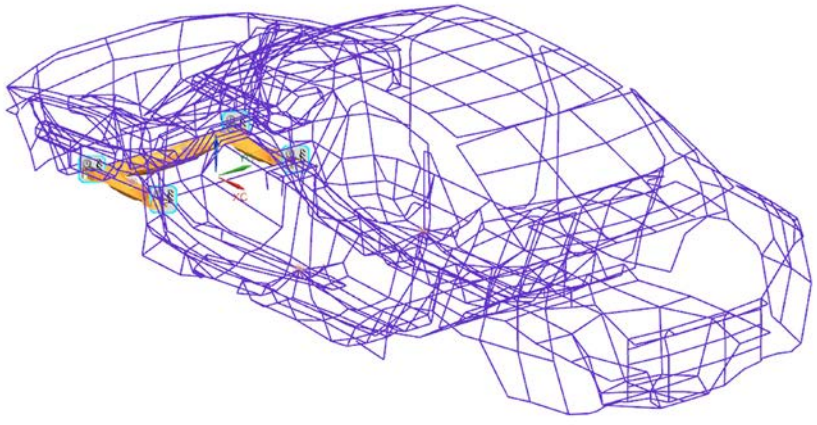
Dynamic reduction boundary condition
- Fixed
- Free
- Mixed (free and fixed)

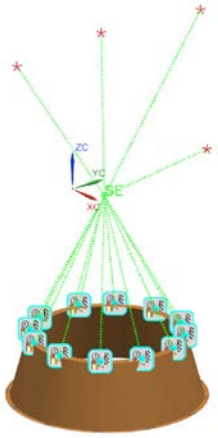
Assembly
- Single or multilevel superelements
- External superelements

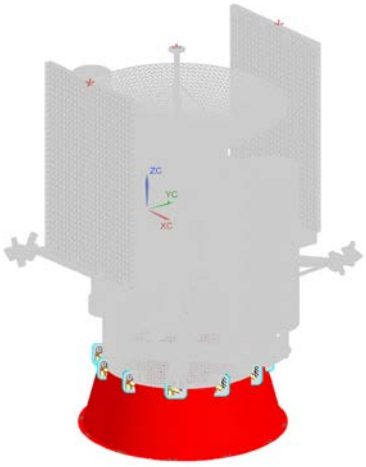
Data recovery
- Residual
- Superelements

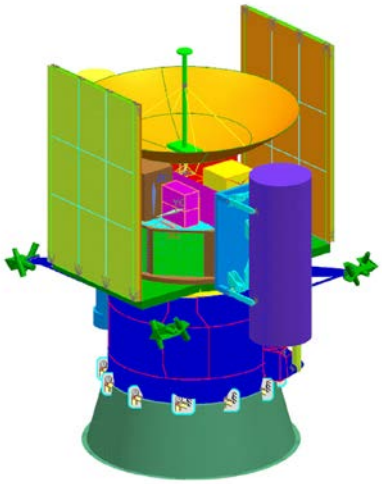
Simcenter Nastran recursive domain normal modes

Simcenter Nastran recursive domain normal modes (RDMODES) enables you to efficiently compute normal modes of a large structural or acoustic domain when









a large number of modes are sought; for example, a noise, vibration and harshness (NVH) analysis or modal analysis of ship structures or aircraft assemblies.

Large models consisting of more than 300 modes can be efficiently solved using RDMODES. Computation of modes using RDMODES in conjunction with parallel processing is highly scalable, especially when using parallel processing.

Supported functionality
Analysis types
- Modal frequency response
- Modal transient response
- Normal modes
- Random response analysis

Features
- Supports sparse data recovery
- Supports efficient residual vector computation
- Scales well with shared and distributed memory computations
- Low incremental cost per eigenvalue when large number

Simcenter Nastran DMP
Simcenter Nastran DMP allows you to significantly reduce the solution throughput time by using multiple processors and computing resources.

A distributed computing environment can consist of a cluster of compute nodes with dedicated hardware resources such as memory, disk, etc., or can be a single thick node with large hardware resources. Using Simcenter Nastran DMP enables you to leverage a higher level of parallelism and provides better scalability than shared memory processing (SMP).

Supported functionality
Partitioning options (dynamics)
- Matrix partitioning for computing modes
- Frequency partitioning for computing modes and frequency response
- Hybrid partitioning
  - Matrix partitioning and frequency partitioning for computing modes
  - Frequency partitioning for computing response
- RDMODES for modal computation

Supported solution types (dynamics)
- Modal frequency response
- Direct frequency response
- Eigenvalue computation
- Modal transient

Simcenter Nastran aeroelasticity
Aeroelastic analysis is a capability that enables the user to analyze structural models in the presence of an airstream. This product offers subsonic aeroelastic analysis capabilities, providing access to static capabilities for stress, load, aerodynamic and control system analysis and design.

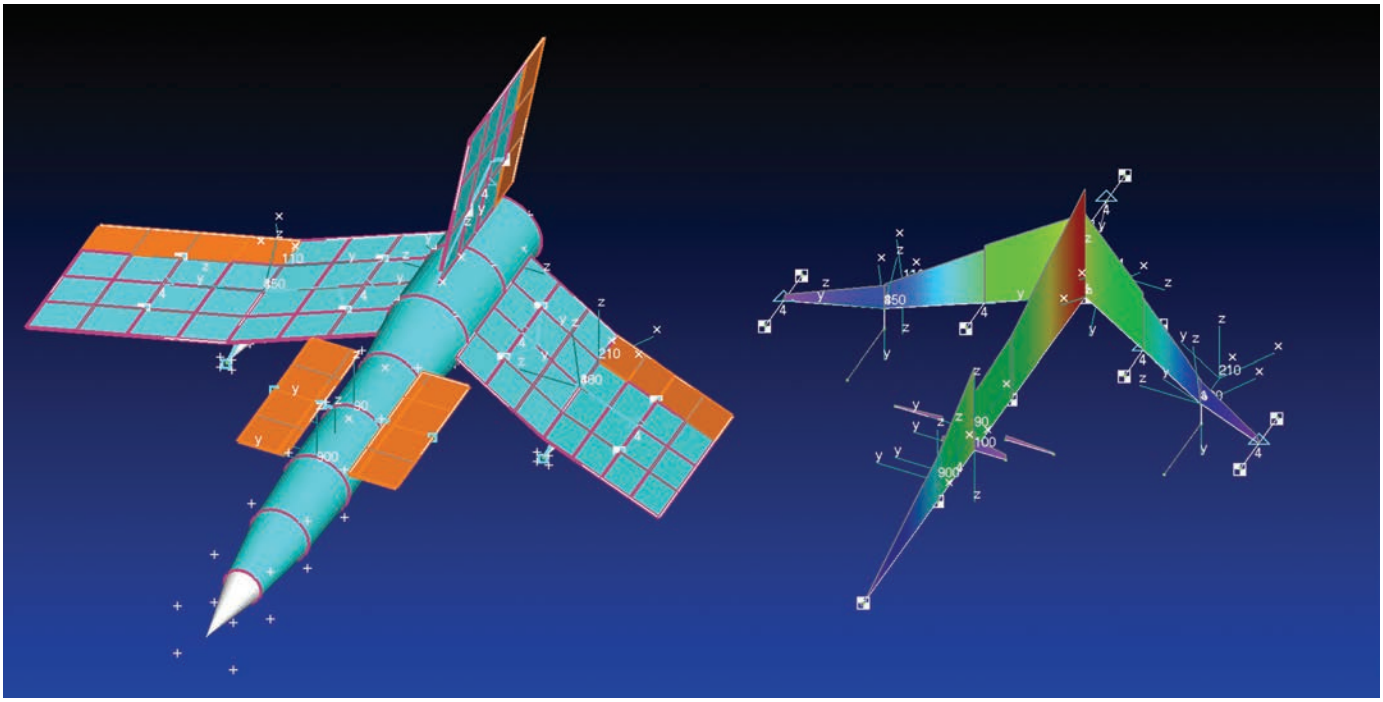
Automated restart features allow a simple and cost-effective way to independently investigate changes in the structural or aerodynamic models, or to perform additional analyses without regenerating basic structural and aerodynamic matrices. Supplemental analysis allows groups working in different organizations, companies and/or countries to generate analyses and integrate them into a full vehicle design.

Dynamic aeroelasticity response can be applied to a variety of unsteady loading including wind gusts. Simcenter Nastran can be used to compute gust loads automatically and evaluate response. You can also perform random response analysis with stochastic loading conditions.

Simcenter Nastran aeroelasticity provides a flutter analysis toolbox to perform critical analysis.

Supported functionality
Supported analysis
- Static aeroelastic divergence analysis
- Flutter
- Aeroelastic dynamic response
- Design sensitivity and optimization of aeroelastic response

Methods
- Subsonic double lattice
- Strip theory
- Supersonic mach box
- Supersonic piston theory



- Flutter analysis
  - K method
  - PK method
  - KE method

Simcenter Nastran direct matrix abstraction program

Simcenter Nastran DMAP allows you to expand Simcenter Nastran capabilities by making changes to Simcenter Nastran standard solutions in a customized way. DMAP is a programming language that lets users interact with Nastran to insert or retrieve data; for example, input or output Simcenter Nastran matrices or tables and perform math operations on the data.

Simcenter Nastran provides a variety of prewritten solutions. These consist of a series of DMAP statements to perform a set of tasks. You can modify the out-of-the-box solution sequences to change both the data and the flow of data as needed to accomplish a particular task. You can capture the company-specific workflow or analysis process and extend the value of your investment. You can additionally leverage some of the custom DMAPs.

Supported functionality

- Provides a high-level scripting language with its own rules
- Allows loops and logicals
- Supports tables and matrices
- Supports expressions and operators
- Allows creation of function units that can be re-used

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