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Siemens Digital Industries Software

Simcenter 3D for aerostructures

Streamlining the structural sizing and assessment process from end-to-end

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Solution benefits

- Perform end-to-end aerostructure assessment in a fully integrated environment

- Eliminate mistakes and ramp up productivity with ready-to-use failure prediction methods from reference handbooks

- Customize the solution by integrating your knowhow and tools intuitively and taking advantage of your aerostructure experience

- Reduce effort needed for reporting and streamlining stress report generation

- Facilitate dedicated criticality-focused postprocessing

The Simcenter™ 3D software for aerostructures solution is composed of the Simcenter 3D Aerostructure Environment and Simcenter 3D Margin of Safety modules. The modules run on Simcenter 3D Engineering Desktop and Simcenter 3D Structures and enable you to streamline the structural sizing and assessment process from end-to-end.

The powerful geometry editing and meshing capabilities of Simcenter 3D Engineering Desktop are ideal for pre- and postprocessing models. Using Siemens Digital Industries Software's Simcenter 3D, which is part of the Simcenter portfolio, simplifies the modeling process by integrating high-end finite element method (FEM) tools with geometry capabilities that assist the user in developing analysis models faster than with traditional computer-aided engineering (CAE) preprocessors. Simcenter 3D Margin of Safety enables structural assessment with standard analytical methods and/or company methods.

Simcenter 3D for aerostructures

Efficiently analyze margin of safety

In addition to the detailed finite element models approach, engineers can size aerostructure components using a library of analytical engineering methods. With the capability to generate stress reports using data and simulation results, engineers benefit from a consistent and integrated global process, resulting in time savings over the full design cycle.

With an increasing amount of data and results to be handled and shared between teams, models, simulation results and tools can be managed and traced in Teamcenter® software.

Integrated solution to predict margin of safety

- Dedicated preprocessing enables you to prepare margin-of-safety calculations for numerous load cases simultaneously, which is available in Simcenter 3D, a powerful finite element pre-/postprocessing open environment. All load cases can be tagged with labels such as "limit" or "ultimate" to facilitate the partitioning of assessed failure criteria

- Dedicated postprocessing focuses on the criticality of results, either from a global, failure mode or load case point of view

- Results can be browsed to assess structural integrity thanks to sortable and filterable tables

- Each method provides a log for detailed explanations of assumptions

- Dedicated 3D display of margin values combined with the typical finite element (FE) postprocessing display enables you to graphically locate the areas that need design updates

Increase productivity with standard methods

Simcenter 3D Margin of Safety software comes with standard engineering formulas from aerostructure reference handbooks, such as E.F. Bruhn's, "Analysis and Design of Flight Vehicle Structures," M.C.Y. Niu's, "Airframe Stress Analysis and Sizing," National Advisory Committee for Aeronautics (NACA) technical notes, NASA technical memorandums, etc. Each method comes with detailed engineering documentation.
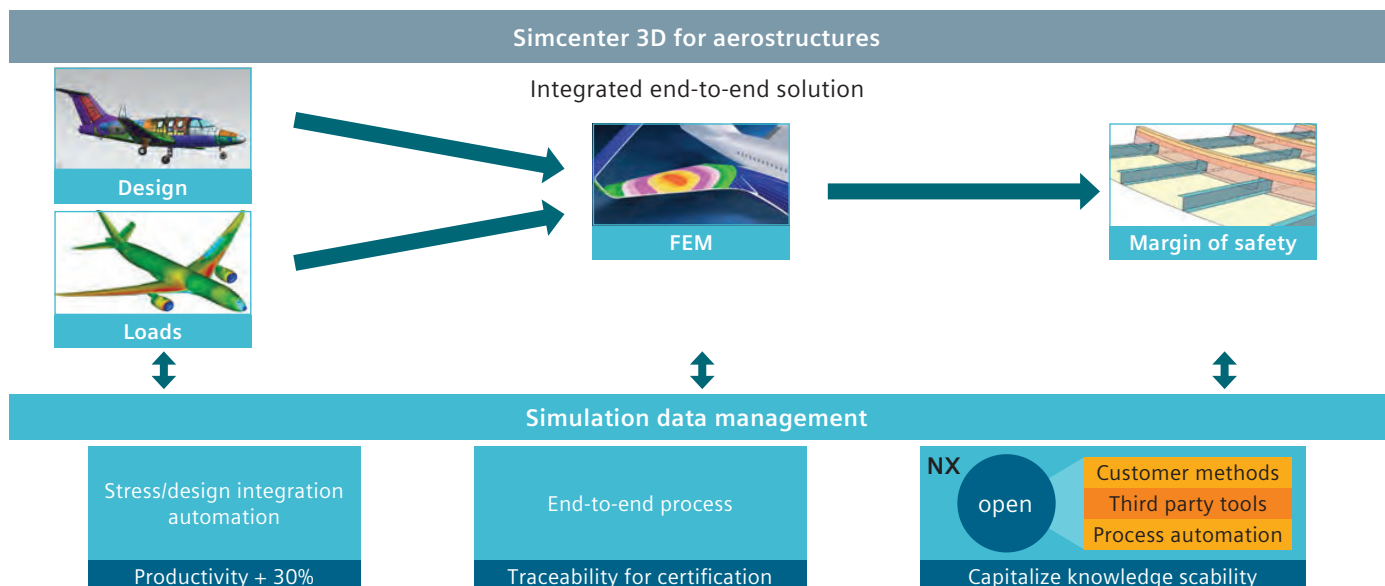
Flexibility to embed user-defined methods

Simcenter 3D Margin of Safety allows you to integrate in-house libraries of methods. The availability of analysis building blocks (for example, ready-to-use engineering formulas, such as buckling and plasticity curves and out-of-the-box standard methods) enables users to save a large amount of time on integrating methods.

Customized reporting

A detailed stress report can be generated in Microsoft Word format from the Simcenter 3D Margin of Safety result and the associated finite element analysis (FEA).

The template is composed of key words, and thus can be tailored to fit company best practices. The template can include user textual feedback, snapshots, summary tables, etc.

Simcenter 3D for aerostructures

Integrated end-to-end solution

| Design | → | FEM | → | Margin of safety |
| Loads | | | | |

Simulation data management

| Stress/design integration automation | End-to-end process | NX open — Customer methods / Third party tools / Process automation |
| Productivity + 30% | Traceability for certification | Capitalize knowledge scability |

Industry applications

Simcenter 3D Aerostructure facilitates full traceability for certification of an end-to-end integrated solution for sizing. It streamlines the structural process from computer-aided design (CAD), FE simulation and margin-of-safety calculations to reporting. Simcenter 3D Aerostructure offers a scalable solution for embedding in-house margin-of-safety methods as libraries.

Therefore, it makes it possible to manage design changes efficiently with CAD/CAE associativity.
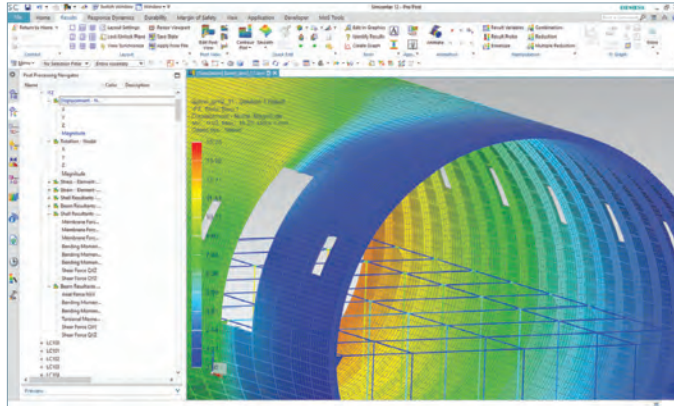
Aerospace and defense

Specific vertical application dedicated to the sizing of frames, wings and the global view of airplanes.

Simcenter 3D Aerostructure Environment

Simcenter 3D Aerostructure Environment provides a set of tools dedicated to simulation. It is a prerequisite for Simcenter 3D Margin of Safety.

Module benefits

- Manage meaningful sets of load cases to help structurally assess criticalities
- Provide a harmonized environment for structural assessment, thus decreasing the learning curve as well as democratizing assessment throughout the engineering community
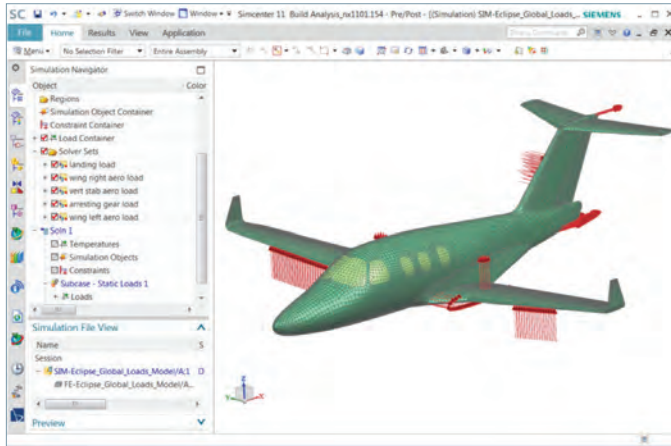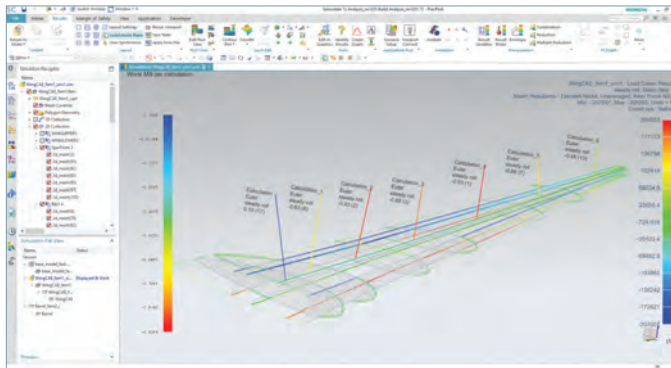
Key features

- Load case tagging and partitioning: All load cases can be tagged with labels such as "limit" or "ultimate" to facilitate the partitioning of assessed failure criteria

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Simcenter 3D Margin of Safety

Simcenter 3D Margin of Safety brings a streamlined, traceable and enterprise-wide approach to aerostructure sizing so you can calculate everything from static loads to margins of safety.

Module benefits

- Traceability for certifying an end-to-end integrated solution for aerostructure sizing

- Streamline the structure process from CAD, FE simulation and margin-of-safety calculations to reporting

- Scalable solution for embedding in-house margin-of-safety methods and libraries

- Manage design changes efficiently with CAD/CAE associativity

Key features

- Dedicated preprocessing enables you to prepare margin-of-safety calculations for numerous load cases simultaneously, which is available in Simcenter 3D, a powerful finite element pre-/postprocessing open environment

- Dedicated postprocessing focuses on criticality of results, either from a global, failure mode or load case point of view

- Results can be browsed to assess structural integrity thanks to sortable and filterable tables

- Each method provides a log for detailed explanations of assumptions

- Dedicated 3D display of margin values combined with the typical FE postprocessing display enables you to graphically locate the areas that need design updates

Capabilities chart

General capabilities	Specific capabilities	Simcenter 3D Aerostructure Environment	Simcenter 3D Margin of Safety
	Margin of safety calculation		
Link to CAD/FE	CAD/FE/stress associativity for geometry update or load update	+	•
	Retrieve data from CAD (geometry)	+	•
	Retrieve data from FEM (geometry, internal load)	+	•
	Geometry and load idealization		•
Margin of safety calculation	Analytical methods from reference-standard methods or end-user methods		•
	Simcenter metallic methods		•
	Simcenter composite methods		•
Margin of safety post-processing	Dedicated postprocessing for margin of safety		•
	Stress report automated generation	+	•
	Margin of safety preprocessing		
	Geometry		
Source for geometry	Geometry data from CAD		•
	Geometry data from FE model		•
	Geometry data from the user input		•
	Massive geometry data populating through journaling		•
Geometry idealization	Predefined idealization		•
	Configurable idealization		•
	Loads		
Load source	Load extraction from static linear FEM analysis (Simcenter Nastran® software SOL101)		•
	Load extraction from static linear FEM analysis (MSC Nastran SOL101)		•
	Load extraction via freebody		•
	Load data from the user input		•
	Load data from external load files		•
Loads preparation	Group load case (load case set)	+	•
	Combined load cases	+	•
	Loads case (LC) envelop (filtering/selection of LC by result values)	+	•
	Strength requirement of load case (example: ultimate/limit)	+	•
Load idealization	Predefined load idealization		•
	Configurable load idealization		•

General capabilities	Specific capabilities	Simcenter 3D Aerostructure Environment	Simcenter 3D Margin of Safety
	Material		
Metallic material	Metallic static (isotropic, othotropic, anisotropic)		•
Composite material	Composite (unidirectional long fiber)		•
	Margin of safety analysis		
Type of calculation	Analytical calculation		•
	FEM calculation		•
Stress discipline	Metallic static		•
	Composite static		•
Solve	Manage calculation of margin of safety		•
	Batch		•
	Simcenter metalic methods (fully integrated)		
Strength failure mode	Tension/compression/shear		•
	Tresca (plane stress)		•
Buckling from Bruhn manual	Plate (flate/curved) buckling analysis under different loads (compressive/shear/bending/mixed interaction)		•
	Column buckling analysis (Euler/Euler-Johnson, Euler-Engesser)		•
	Torsional buckling		•
	Profile cripling analysis		
Bolt/fastener from Bruhn and Nasa	Inter-rivet buckling		•
	Shear, bending, tension, interaction of a bolt		•
	Bolt/load redistribution		•
Material properties calculation	Plasticity (plastic reduction factor charts, stress from strain in plastic domain)		•
	Material law (shear yield stress allowable estimation Fsy, secant/tangent modulus, stress F0,7)		•
	Simcenter composite methods (fully integrated)		
Buckling	Plate buckling analysis under different loads (compressive/shear/mixed interaction)		•

General capabilities	Specific capabilities	Simcenter 3D Aerostructure Environment	Simcenter 3D Margin of Safety
	Dedicated postprocessing for margin of safety		
	3D postprocessing of critical margin of safety, load case, failure mode		•
	Table of critical margin of safety, load case, failure mode		•
	Detail log of the analysis run		•
	Stress report automated generation		
	Structured templated document	•	•
	Critical margin of safety table		•
	3D snapshots (CAD, FE results, etc.)	•	•
	Material summary	•	•
	Openess		
Methods integration	Integration of customer methods: legacy analysis codes or launch of executable		•
	On-the-fly mathematical formulation definition		•
	Automation of high-level process (for example, automate series of clicks) through journaling	•	•
	Add user defined material	•	•
	Add user defined material properties (for example, allowables)	•	•
	Add user defined profile cross-section	•	•
	Integration of specific postprocessing of margin of safety (including results files in external viewer)		•

General capabilities	Specific capabilities	Simcenter 3D Aerostructure Environment	Simcenter 3D Margin of Safety
	Documentation		
	End-user documentation	•	•
	Methods formulation documentation		•
	Method integration documentation		•
	Deployement		
Deployement to end users	Redistribute nonnative methods		•

Legend:
• = included in module
+ = additional product required

Note: Simcenter 3D Engineering Desktop is a minimum prerequisite for all Simcenter 3D products. Other dependency or prerequisites may apply for individual products.

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