# SIM SOLID - RAPID ITERATIONS WITHOUT MESHING FOR STRUCTURAL ANALYSIS

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***EXTRACT***

*Altair SimSolid is a structural analysis software developed specifically for rapidly evolving design processes. It eliminates geometry simplification and meshing, the two most time-consuming and expertise-extensive tasks done in traditional FEA, enabling the analysis of fully featured CAD assemblies in minutes without meshing.*

## 1 PRODUCT HIGHLIGHTS

• Eliminate geometry simplification and meshing. With SimSolid, model preparation is done in minutes.

• Analyze complex parts and large assemblies. SimSolid is tolerant of imprecise geometry, and its assembly connections are industry best at handling ragged contact surfaces.

• Advanced automation workflows are built into SimSolid to help setup large models in a few minutes.

• Get results in seconds to minutes, SimSolid is fast, really fast. Hence, multiple design scenarios can be quickly analyzed and compared.

SimSolid can analyze complex parts and large assemblies not practical with traditional FEA and do it efficiently on a desktop class computer. Both fast and accurate, SimSolid controls solution accuracy using a unique multi-pass adaptive analysis.

The computational engine is based on breakthrough extensions to the theory of external approximations. External approximations are a generalization of Finite Element Method (FEM) in terms that:

• Absolutely arbitrary geometrical shapes can be used as “finite elements”

• Basis functions which approximate field of interest in the part volume can be of arbitrary class and are independent of the volume shape

SimSolid does not use the point-wise degrees of freedom (DOF) inherent in traditional FEA.

SimSolid’s DOF are functionals with geometrical support in the form of volumes, areas, line clouds, and point clouds. This provides the ability to handle geometrical imperfections, as well as assembly contact imperfections like gaps, penetrations and ragged contact areas.

SimSolid controls solution accuracy using multi-pass adaptive analysis. Adaptivity can be defined on a global or part local basis and adaptivity is always active. The methodology is fast and efficient. It provides superior performance metrics for computational time and memory footprint that allow very large and/or complex assemblies to be solved quickly on desktop class PC’s.

## 2 BENEFITS

**Eliminate Geometry Simplification and Meshing**

SimSolid’s unique technology completely eliminates geometry simplification and meshing, the two most time consuming, expertise extensive and error prone tasks done in traditional FEA. With SimSolid, model preparation is done in minutes.

**Analyze Complex Parts and Large Assemblies**

SimSolid has been designed to analyze complex parts and large assemblies not practical with traditional FEA. SimSolid is tolerant of imprecise geometry. Its assembly connections are industry

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best at handling ragged contact surfaces with both gaps and overlapping geometry.

**Advanced Automation Workflows**
SimSolid has intelligent workflows that let you create complex connections—spot welds, seam welds, bolted joints, adhesives and more—in minutes. These workflows reduce or entirely eliminate the model setup time when working with multiple design variants. When importing a new design variant, SimSolid automatically maps materials, connections, loads and boundary conditions. The software also allows the mapping of loads from an external file.

**Rapid Design Feedback**
SimSolid is fast, real fast. Solution times are typically measured in seconds to minutes on a standard PC. With SimSolid, multiple design scenarios can be quickly analyzed and compared. And, accuracy can be specified on an individual part level allowing a rapid drill down to any level of detail that is required.

## 3 CAPABILITIES

**Analysis Solutions**
The following simulation types are supported: linear statics, modal, nonlinear statics (contact, material & geometrical), thermal, coupled thermal-stress, linear dynamics (time, frequency and random response).

**Supported Connections and Boundary Conditions**
- Assembly Connections: Smart auto connections, bonded, sliding, separating with friction, bolted, spot & laser welds, fillet/seam welds, bushings, adhesives and virtual connectors
- Loads & BC's: Immovable constraint, sliding constraint, hinge constraint, enforced displacement, force, pressure, gravity, thermal, inertia relief, bolt/nut preload, dynamic loads, hydrostatic loads, bearing loads, and remote loads

**Material Properties**
- Isotropic
- Incompressible
- Elastoplastic with NL stress vs strain curves
- Rigid
- User extensible

**CAD Connectivity**
- Direct data integration to Cloud-based CAD systems
- Standard STL output from any CAD system
- Direct file support for mainstream CAD systems: CATIA, NX, Creo, SOLIDWORKS and Inventor
- Direct file support for common neutral formats: STEP, ACIS and Parasolid, etc.

**Post-Processing and Reporting Result types**
- Contour plots with displacements, stresses, strains and energy densities
- Deformed shape animation
- Max/min labels
- Point probes and datum point sets
- XY plots
- Reaction/contact forces
- Nonlinear contact response including contact pressure and openings
- Bolt/nut forces
- Spot weld forces
- Frequencies and mode shapes
- Modal participation factors, effective and cumulative mass
- Partial dynamic response
- Safety factors

**Reporting**
- Image thumbnails and captions associated with model graphics state, part visibility, and results display
- Synchronized model and results browsing
- Results are exported as full resolution image files

**General Usability**
- Able to process mixed (SI and IPS) units
- Measurements (distance, ray probe, local coordinates)
- Global and local coordinate systems
- Default views (front, back, left, right, top, bottom)
- Custom saved views

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**“SimSolid is extremely impressive. It allows our team to go beyond the limitations of CAD embedded simulation. We now accurately evaluate our structures in minutes, gain confidence early and save loads of time!”**
- Richard Reeson, Senior Engineer
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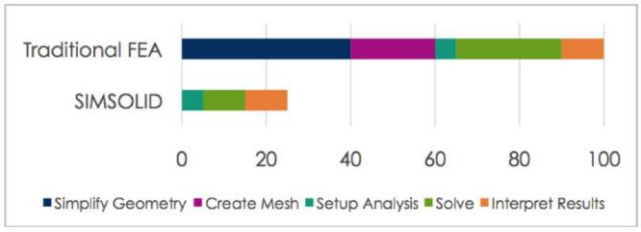
SimSolid eliminates the two most time-consuming and expertise extensive tasks of geometry simplification and meshing. These two steps typically take between 30% and 70% of the total modeling and analysis time, so this represents significant process improvement. More important, these tasks represent the bulk of the training requirement for traditional FEA. Not only is less time required but also less training means that a larger pool of users can take advantage of the benefits that design simulation provides.



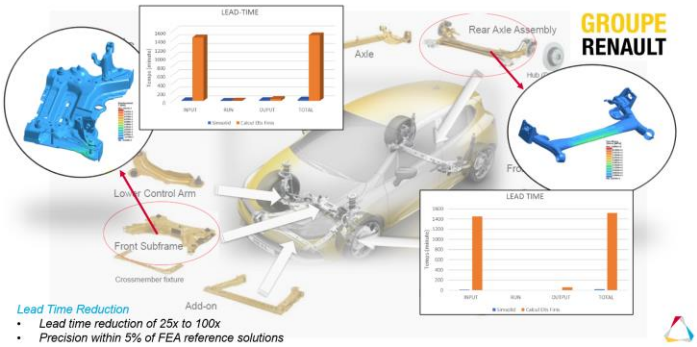

The second benefit is expanding the possibilities of what is practical to solve. Instead of reducing the assembly to one part or a small context of a few parts, a more complete assembly can be solved, simplifying the model setup and load and constraint specification. Many models that are not practical to use with traditional FEA can be solved using SimSolid.

Here are some examples of our customers using SimSolid, also NAFEMS have tested SimSolid and made a report with their results.

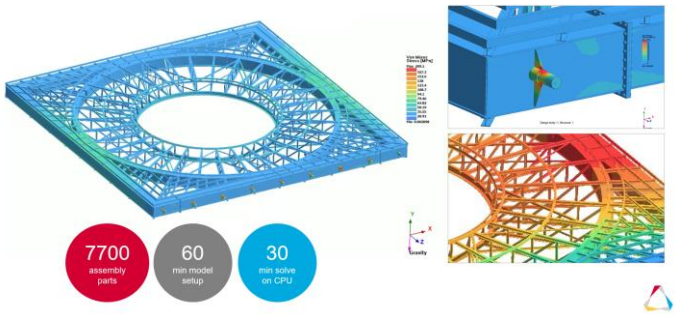
The Renault Chassis department has been working with Altair’s solutions since 2010, using Altair HyperWorks units to access Altair OptiStruct™, Altair HyperMesh™, Altair SimLab™, and Altair Inspire™. When Anthony Reullier, digital simulation specialist and CAE leader in the Renault chassis team and welding referent for Renault, heard about the new solution Altair SimSolid™ at the ATC 2018 in Paris, he was interested from the start.

Supported by Jules Tamdjo from Ecole Polytech Lille, the CTC evaluated SimSolid’s accuracy and ability to be integrated in Renault Chassis design process to reduce time to market and give more flexibility to designers to evaluate their solutions faster. Their goal was to provide their designers with a software tool which enables them to design quickly in total autonomy based on their calculations results.

“To us, Altair SimSolid means efficiency. While the software quickly provides accurate simulation and optimization in one step it does not require any expert knowledge. No expertise in analysis is necessary and especially no meshing is required,” said Anthony Reullier. “Also, SimSolid helps our designers to develop with confidence as we can rely on the results.”




Another great example of large structure analysis is the stage wagon of “Qintai culture & art center” – Wuhan, China.




This structure has over 7700 parts, model import and setup were made in 60 minutes and the solving part was done on 30 min, on a normal computer.

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A set of benchmarks were performed by NAFEMS and the results were very much appreciated. A summary of results is presented in the picture below:

| Benchmark | Description | Quantity | Target Solution | SimSolid | |
|---|---|---|---|---|---|
| | | | | Results | Discrepancy |
| 1 | Pressure component | Von Mises stress | 534MPa | 532MPa | <1% |
| 2 | Coil spring | Spring rate | 20.8N/mm | 20.76N/mm | <1% |
| 3 | Skew plate | Maximum principal stress | 0.82MPa | 0.82MPa | <1% |
| 4 | Plate with hole | Maximum principal stress | 314MPa | 325.7MPa | 3.7% |
| | | Minimum principal stress | -114MPa | -117.9MPa | 4.2% |
| 5 | U-shaped notch | Maximum principal stress | 48.2MPa | 47.6MPa | 1.2% |
| 6 | Cantilevered plate | Mode 1 | 0.42Hz | 0.42Hz | <1% |
| | | Mode 2 | 1.02Hz | 1.02Hz | <1% |
| | | Mode 3 | 2.58Hz | 2.56Hz | <1% |
| | | Mode 4 | 3.29Hz | 3.27Hz | <1% |
| | | Mode 5 | 3.75Hz | 3.72Hz | <1% |
| 7 | Cantilever under pure bending | Sxx | 221MPa | 221.7MPa | <1% |
| | | Uz | 0.0247m | 0.0247m | <1% |
| 8 | Cantilever realistic support | $S_{VM}$ | 356.5MPa | 366.5MPa | 2.8% |

“For the benchmarks considered in this study the maximum discrepancy between the target and SimSolid solution is 4.2%. While the benchmarks are intentionally simple, the correlation is surprisingly good considering that the time-consuming process of meshing has been removed. The software is easy to use and all the benchmarks took a matter of minutes to set up and analyze.

The sort of testing that has been performed here should just be one small part of the software evaluation process. I’ve only considered a limited number of problems, and the tests were deliberately simple in nature. I would encourage readers to evaluate the software using their own representative benchmarks.” said Ian Symington, Technical Officer at NAFEMS.

The details of these benchmarks can be downloaded from here:
https://www.nafems.org/publications/resource_center/bm_jan_20_1/