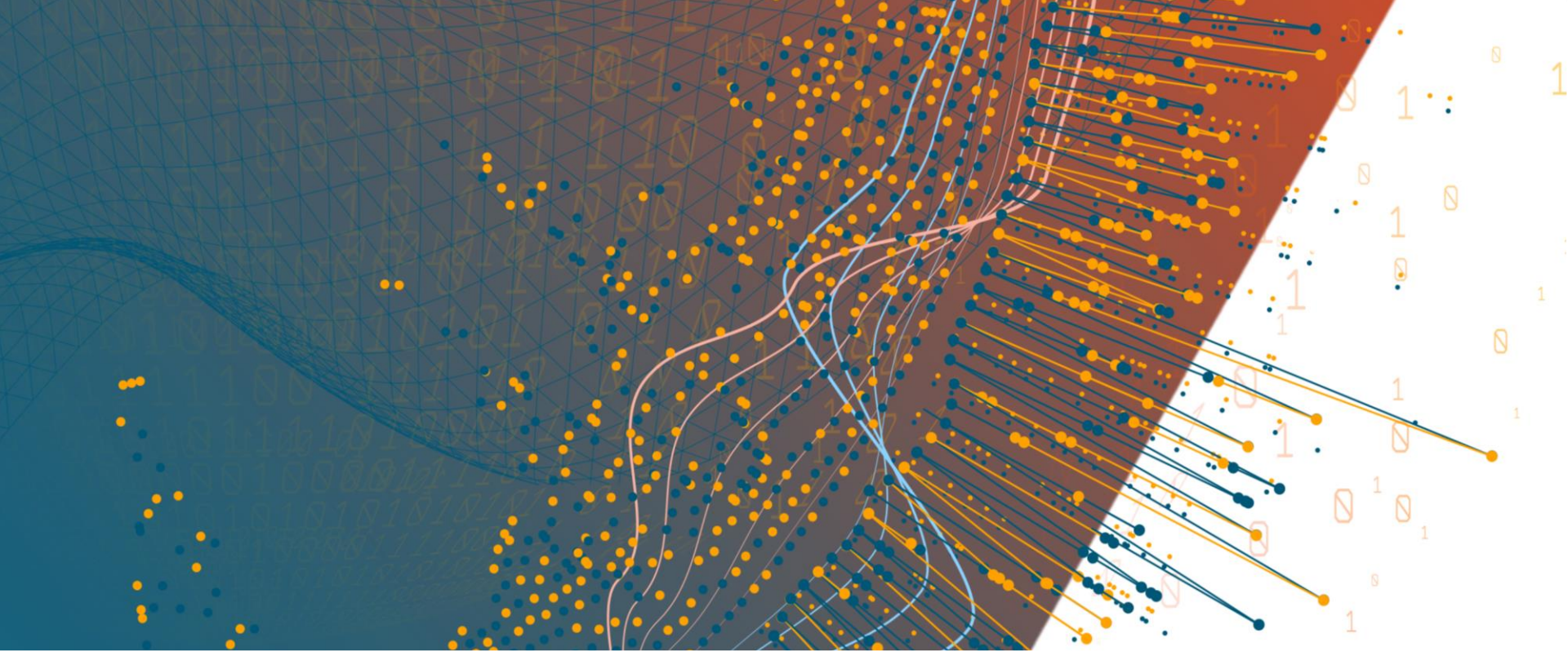

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SIMSOLID QUICK OVERVIEW
MODULE 1 - INTRODUCTION

Sebastian Karp / Senior Application Engineer / February 5th 2021

SimSolid Vision - A new paradigm for simulation

Altair **SimSolid** is **structural simulation** that operates directly on **original, un-simplified CAD assemblies**, **does not create a mesh..**

..and provides results in **seconds to minutes**

Quick Overview Series

• Module 1: Introduction	February 5th 2021
• Module 2: User Interface + Modal Analysis	February 12th 2021
• Module 3: Linear Analysis	February 19th 2021
• Module 4: Non-Linear Analysis	February 26th 2021
• Module 5: Dynamic Analysis	March 5th 2021
• Module 6: Thermal and SimSolid news	March 12th 2021
• Module 7: Inspire/SimSolid Solver	March 19th 2021
	(all Fridays)

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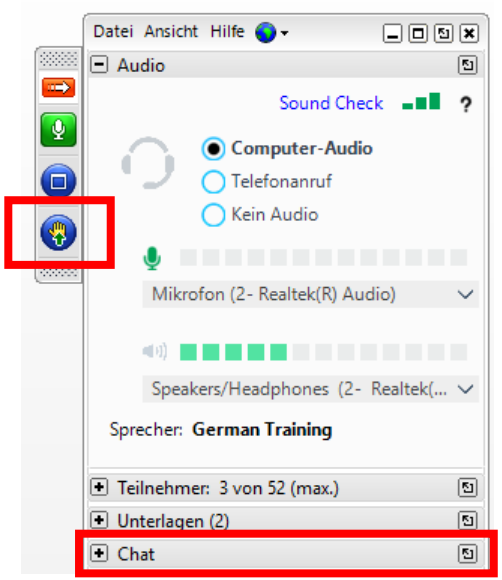
Organisational

- Session is recorded
- Q/A-block at end of session (not recorded)
- Raise hand and audio will be activated or use chat for questions
- Combined presentation of all modules can be shared



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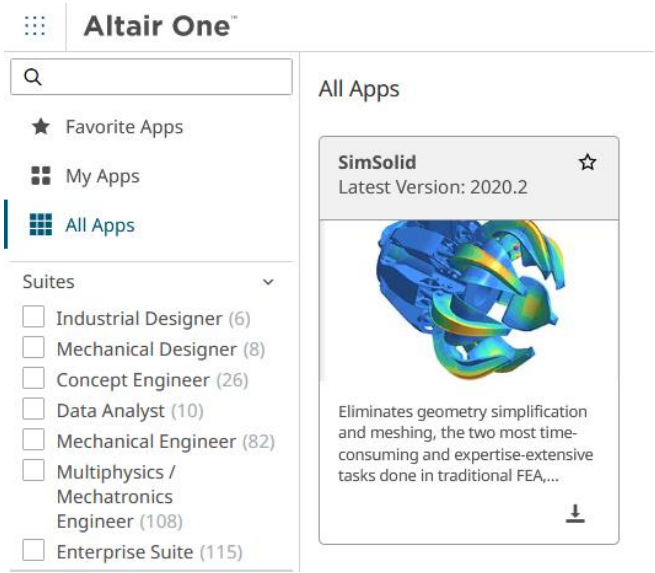
Have a look at…

- Contact us for later communication etc. - trainings@altair.de
- Check out www.altair.com/SIMSOLID

- Download - www.altairone.com



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POLL

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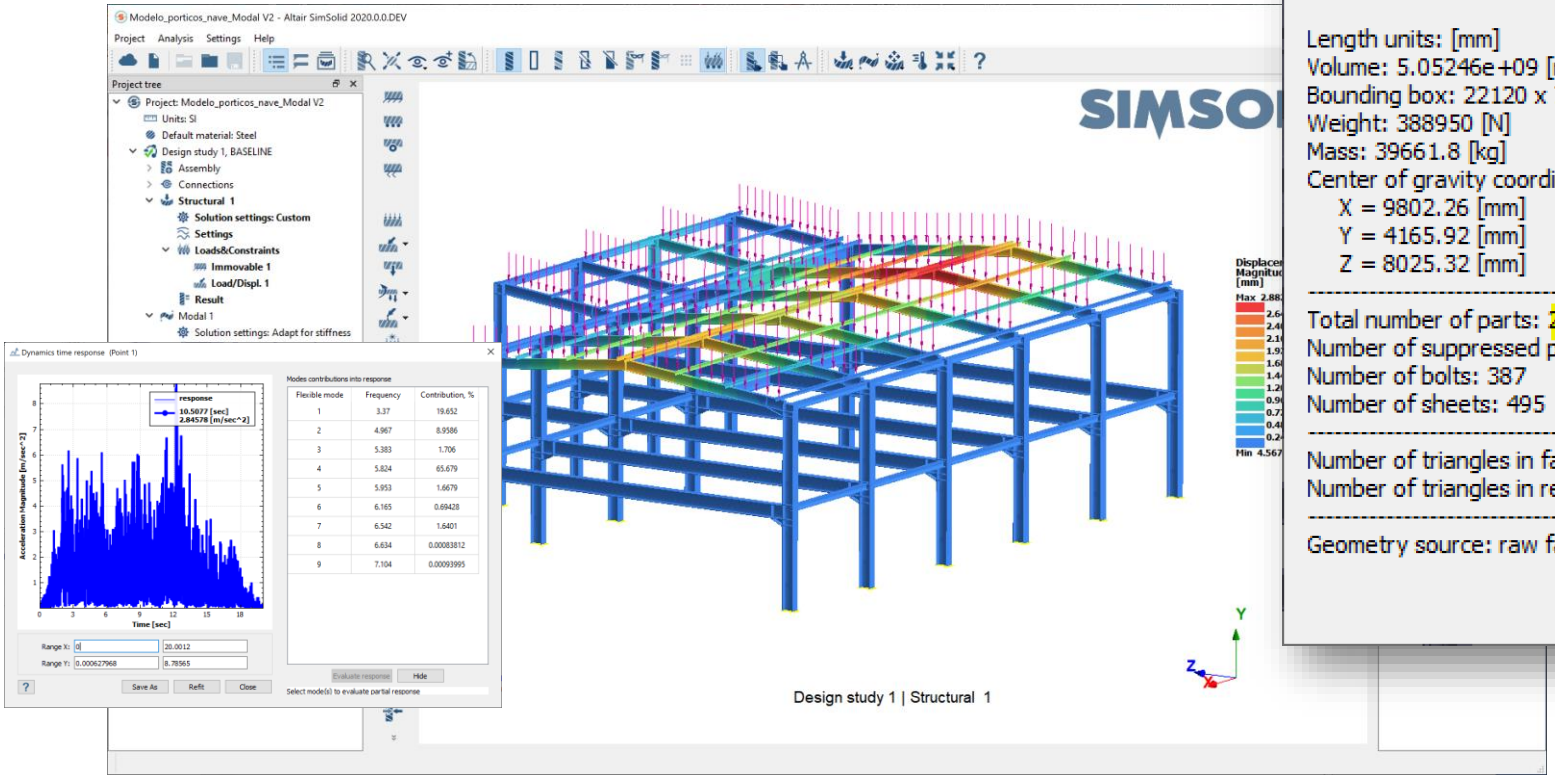
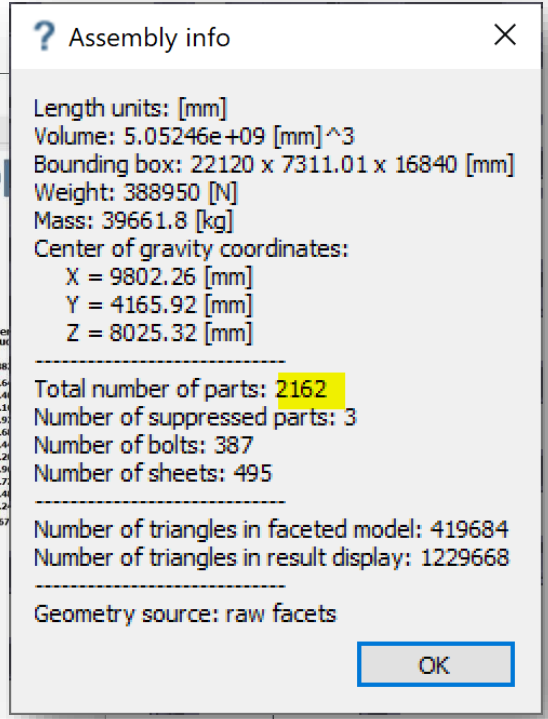
Put more simply…

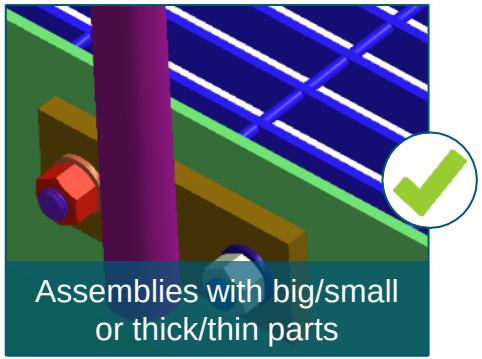
1. Assembly solver with **high fidelity connections**
2. Works on full fidelity CAD
3. **No meshing**
4. Results in minutes

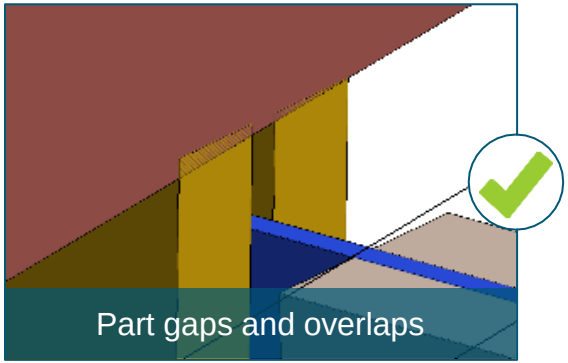
SimSolid is large model capable

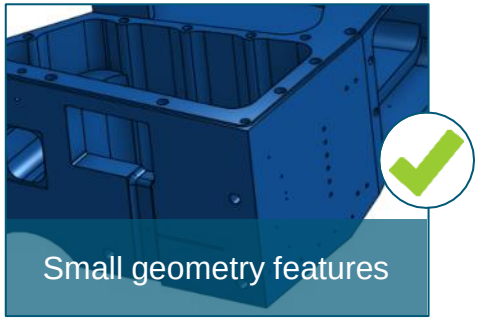


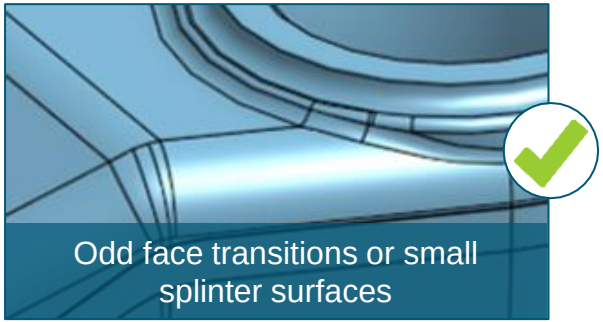


SimSolid Eliminates Traditional FEA Meshing Roadblocks





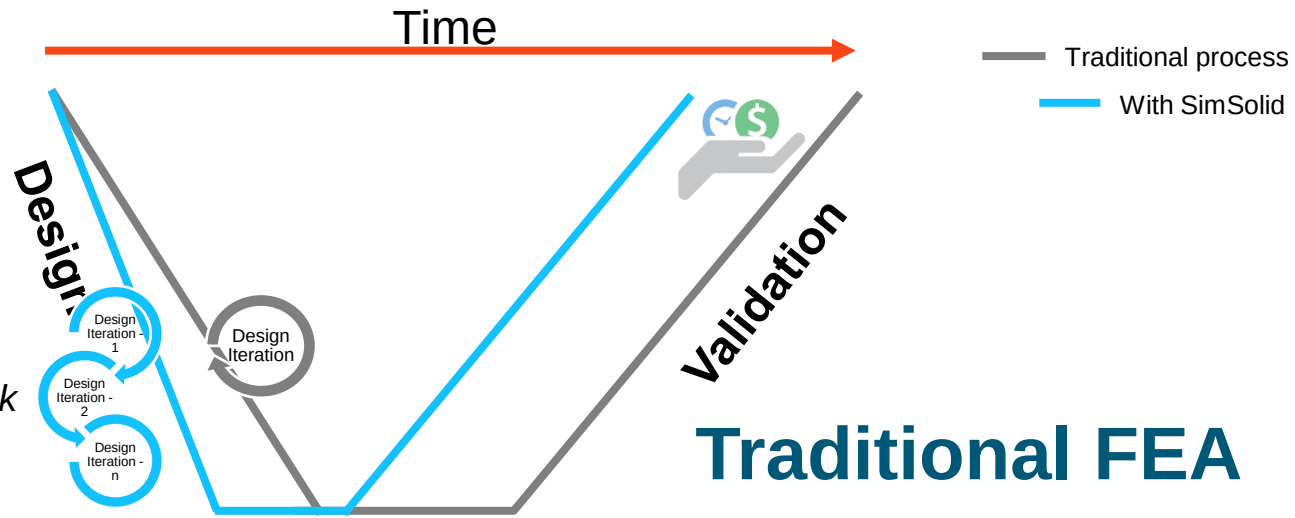




Product Fit – Early Simulation-driven Design

SimSolid

Provides actionable feedback at the "speed of design"



Traditional FEA

Focuses on the when (early), not the who (design engineer vs analyst)

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SimSolid Simulation Capabilities

Solutions

- Modal
- Linear Statics
- Nonlinear Statics
- Frequency Response
- Linear Transient
- Random Response
- Thermal
- Thermal-Stress
- Inertia Relief
- Bolt Pretension
- Linear Superposition
- **Partial dynamic response**
- **Fatigue Analysis**

Materials

- Isotropic
- Elastoplastic
- Rigid
- **Fluid bodies**
- User Extensible

Connections

- Auto-connections
- Bonded, Sliding and Separation with Friction
- Bolts
- Spot Welds
- **Solid Seam Welds**
- Bushings
- Rivets
- Virtual Connectors
- **Adhesives**
- **Joints**

Results

- Contours and Animations
- Displacement, Stress, Strain, **Velocity**, **Acceleration**, **ERP**
- Frequency and Mode Shapes
- XY Plots
- Modal Participation Factors
- Forces: Reaction, Contact, Bolts and Welds
- Safety Factors
- Contact Responses
- Strain Energy Density

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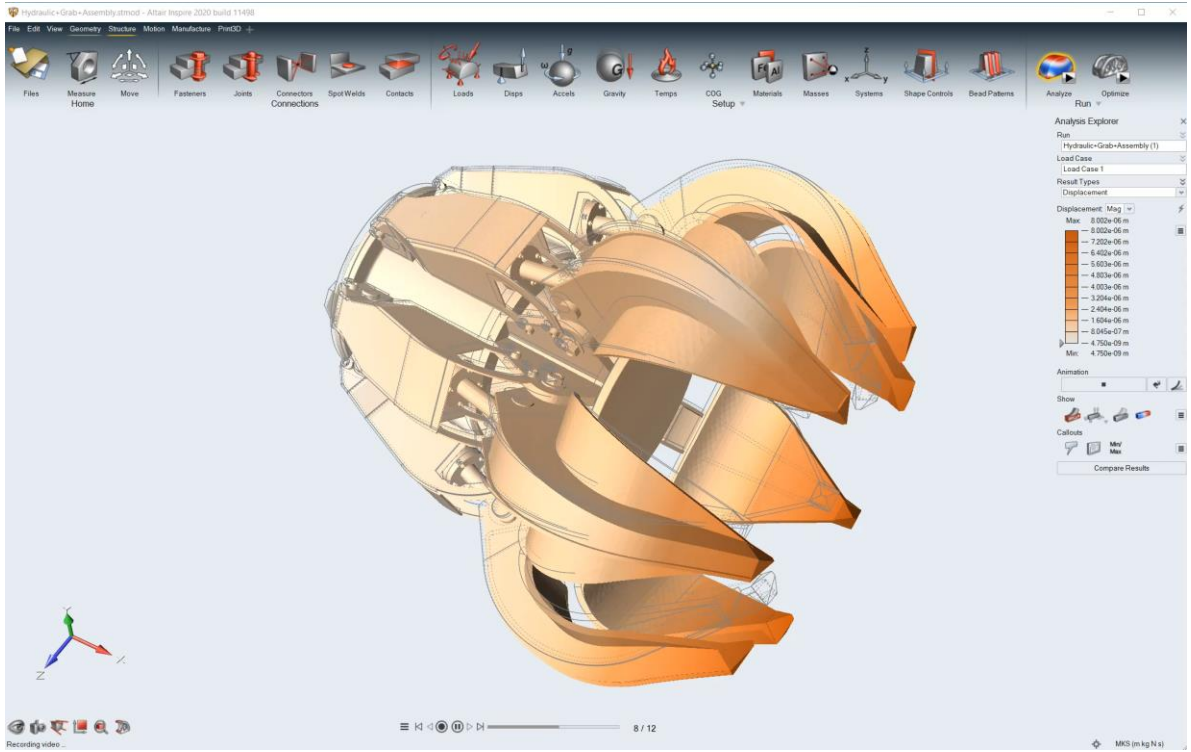
Inspire-SimSolid Integration

- First available in Inspire 2019.4
- Linear statics and modal vibration
- **Rapid analysis iteration with direct geometry modification**
- Supports existing Inspire boundary conditions
- Supports existing Inspire results visualization
- New in 2020 – **Reaction force tables**



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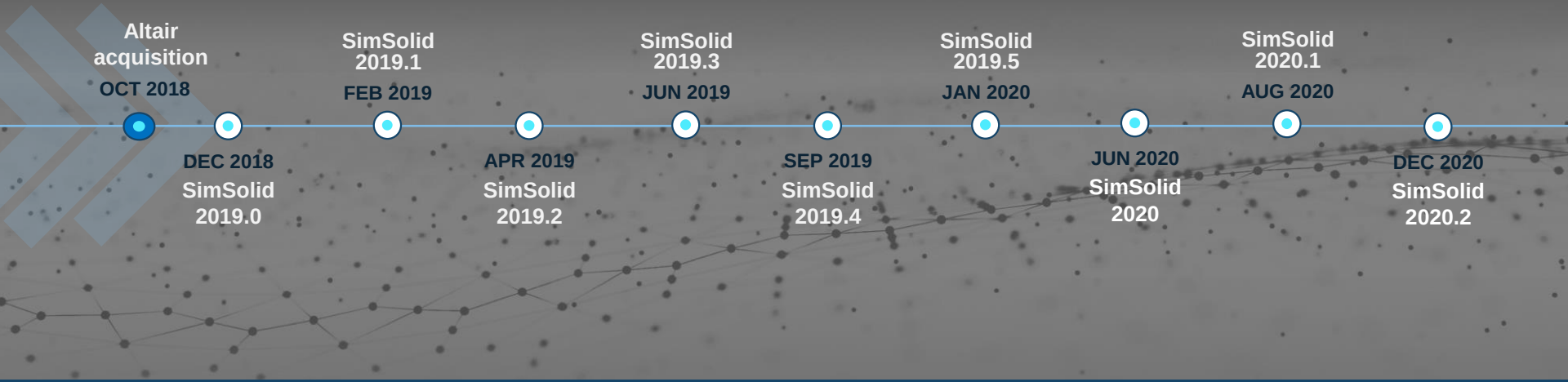
Altair SimSolid Development



New Functionality | Performance | Usability

9 major releases in 2 years

SHORT EXAMPLE
CRANKSHAFT

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TECHNOLOGY OVERVIEW

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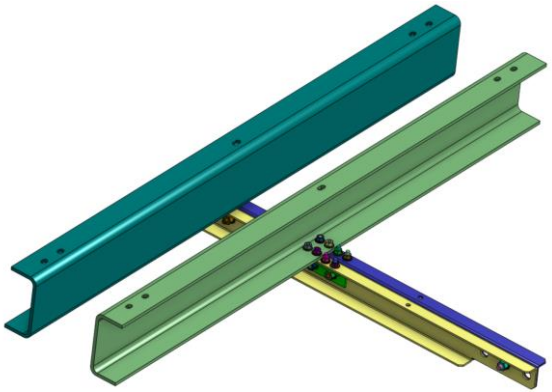
SimSolid Compared to Traditional FEA - Methods

Traditional FEA	SimSolid
Simple regions - TET, etc.	Arbitrary regions - whole part can be a region
DOF is associated with a node - it is point-wise	DOF is not point-wise. It can be associated with volumes, surfaces, lines and/or point clouds
DOF are nodal Ux, Uy, Uz displacements	DOF are integrals over corresponding geometrical objects, not nodal
3 DOF per node	Many DOF per single associated geometry object are possible, depends on solution adaptation
Boundary compatibility is met exactly	Boundary compatibility is met approximately and is adjusted during solution passes
Shape functions are simple low degree interpolation polynomials	Shape functions can be of arbitrary class and are derived during the solution phase

SimSolid Compared to Traditional FEA - Methods

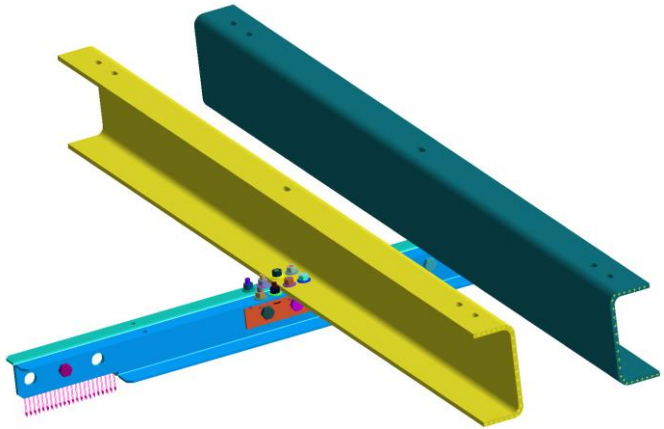
Traditional FEA	SimSolid
Geometry level of detail decision by user	Full geometry detail - modeling errors minimized
Types of elements decision by user	No elements
Mesh density and distribution-based controls decision by user	No meshing
Correct interpretation of analysis settings by user • Solver & solution methods • Tolerances and options	Minimal settings in dynamics and non-linear analyses including separating contact with friction
Solution adaptation is mostly based on local energy density change, it is relative • Rarely used for assemblies	Solution adaptation is based on local energy density change and absolute errors on boundary • Always active • Easy to set both global (whole assembly) and local (part based) solution adaption

SimSolid Technology Steps – Modeling



1. Process geometry
   - Convert to faceted volumes

2. Classify geometry
   - Bolts, nuts, washers, springs
   - Thin sheets
   - Through holes



3. Create connections
   - Contact regions between parts found automatically
   - Auto-specify contact condition (bonding, sliding)
   - User-specify contact condition (separating)

4. Create analysis parameters
   - Analysis type
   - Boundary conditions
   - Material properties (if not inherited from CAD)
   - Solution adaption control

Ready to analyze

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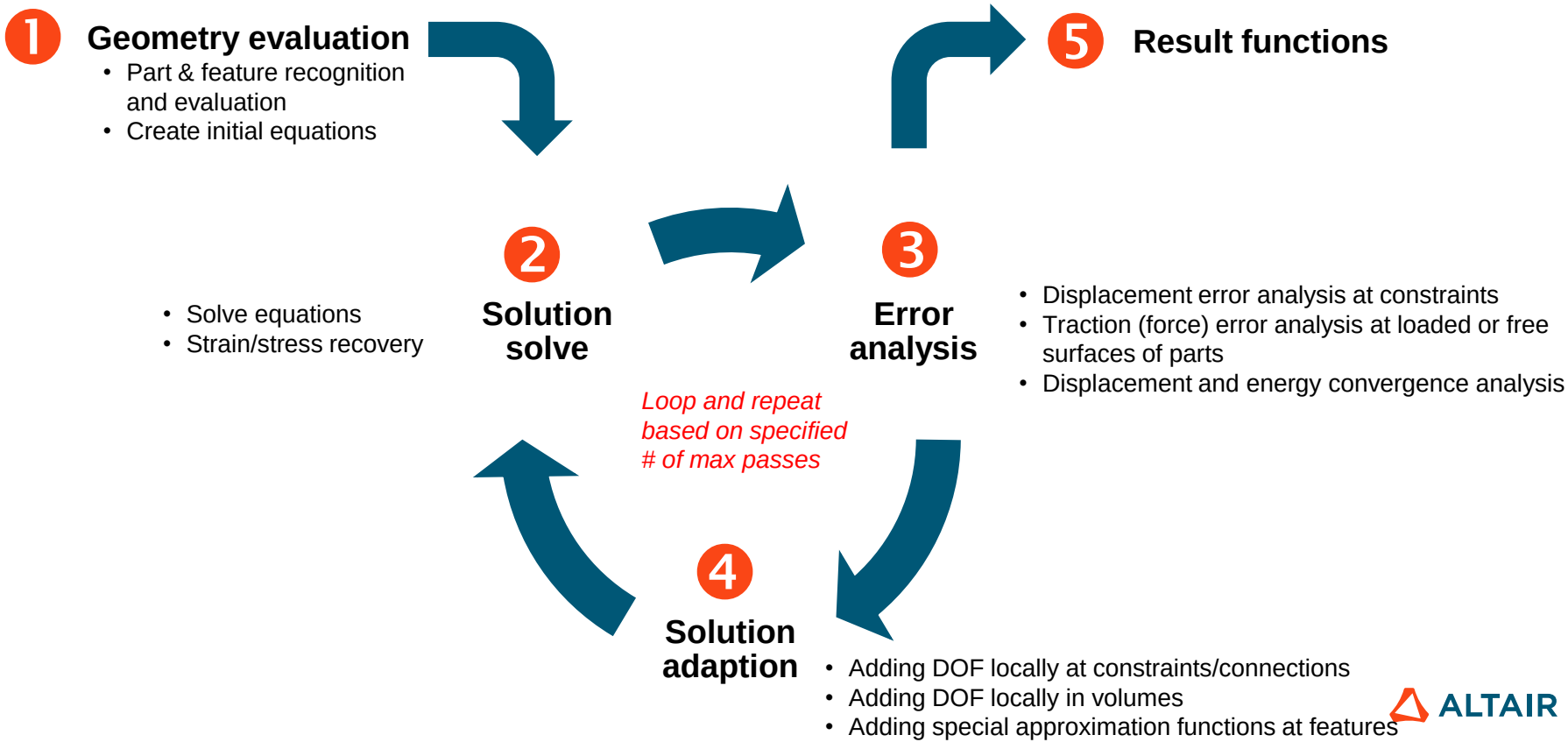
SimSolid uses Unique Adaptive Solver Technology



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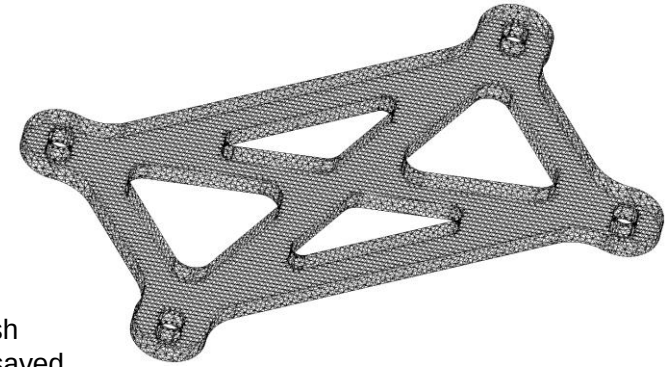
SIMSOLID technology steps – Results

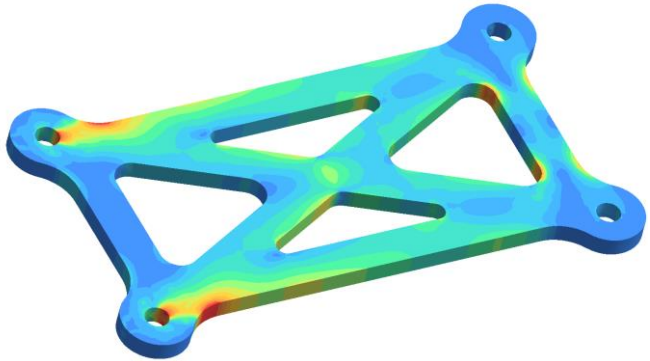
1. Create response mesh
   - Used to map result functions to design geometry
   - Can be redefined on-the-fly

2. Evaluate quantities of interest to contour plot
   - Values determined at the nodes of the response mesh
   - Very fast - done on-the-fly, the nodal values are not saved

3. Display reactions
   - At supports
   - At connections
   - Parts resultants

4. Fast re-analysis
   - SIMSOLID remembers response mesh and incremental analytic functions
   - Re-analysis typically processes faster





5. Efficient coupled analysis
   - Results of one analysis are directly used in analytical form in other analyses
   - Thermal-stress, nonlinear analysis, dynamics

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INDUSTRY VERTICAL EXAMPLES

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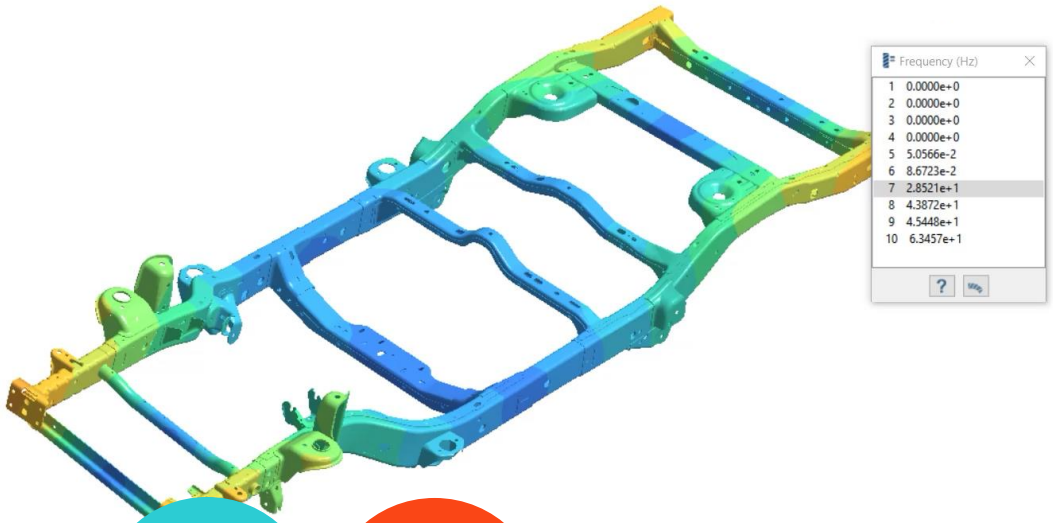
Automotive

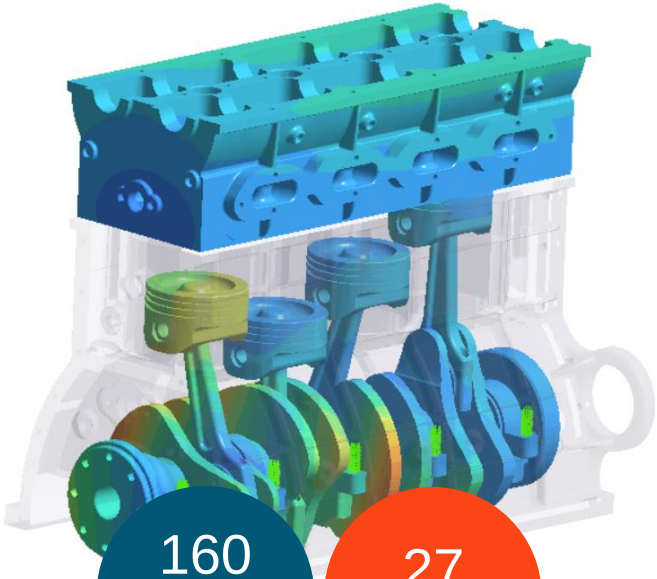
Frame - Modes



70 assembly parts

4 min solve on CPU

Engine – 50 modes

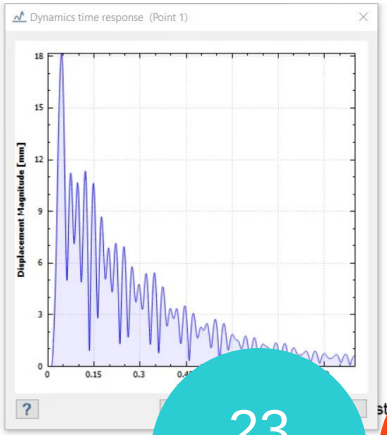


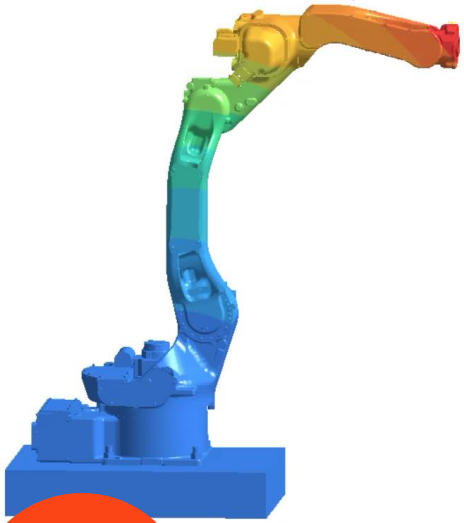
160 assembly connections

27 min solve on CPU

General Machinery

Robot - Transient



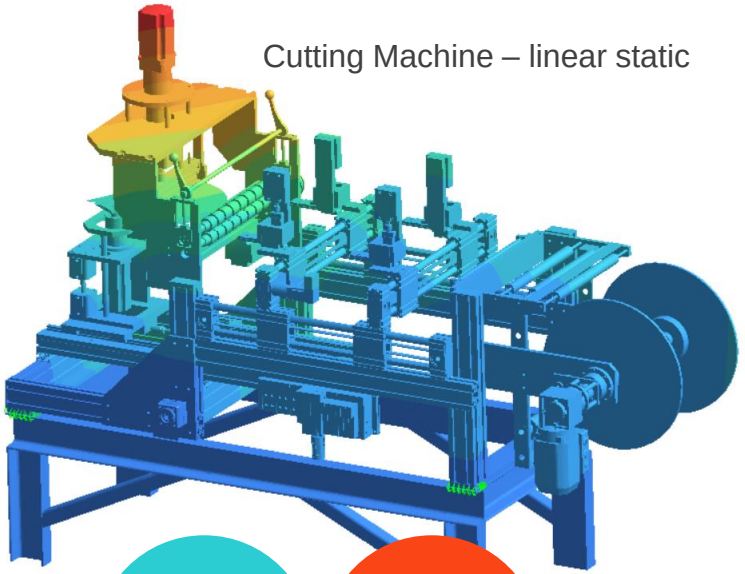


1, linked to Modal 1

23
assembly parts

0.5
min solve on CPU

Cutting Machine – linear static

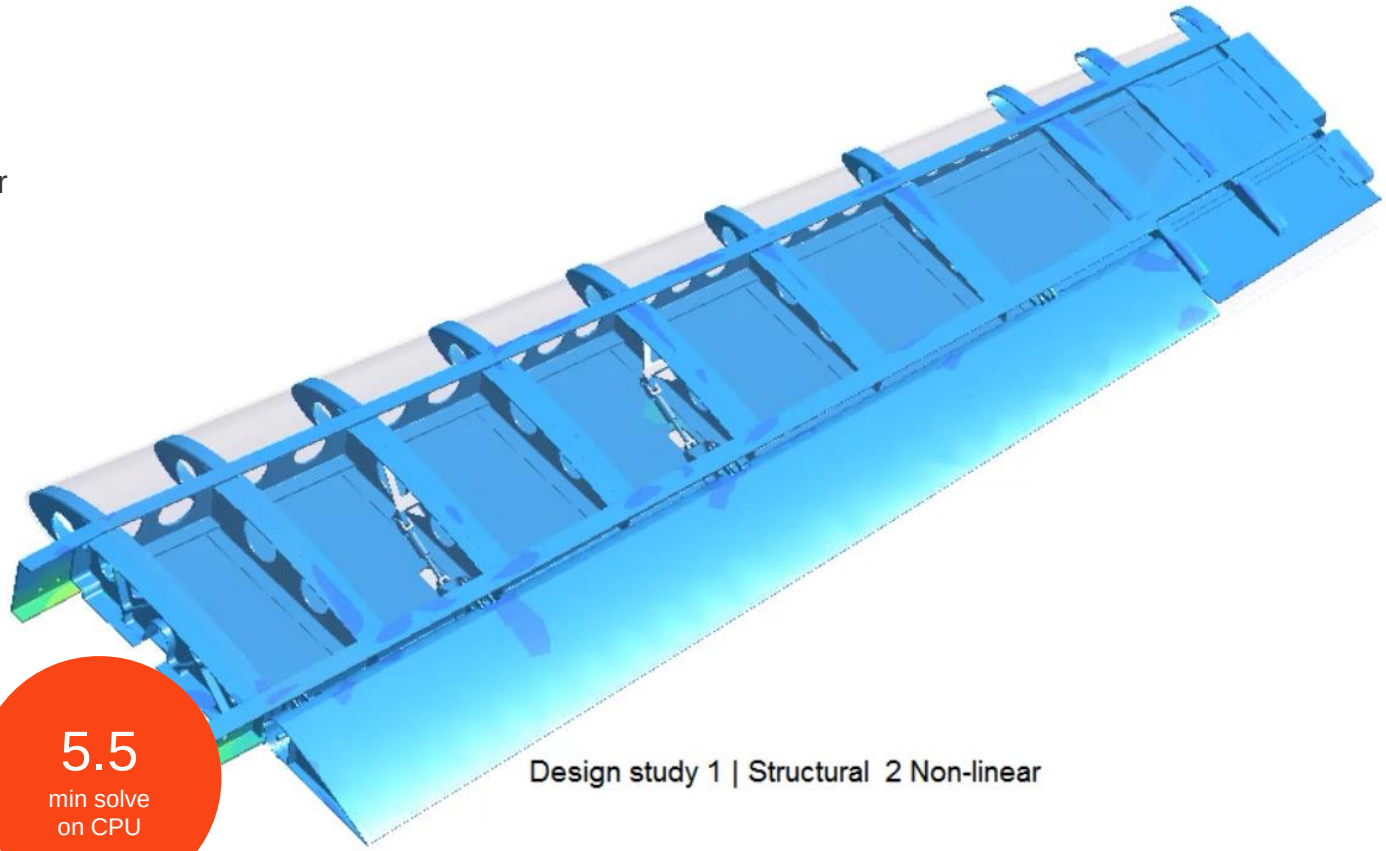


344
assembly parts

0.5
min solve on CPU

Aerospace

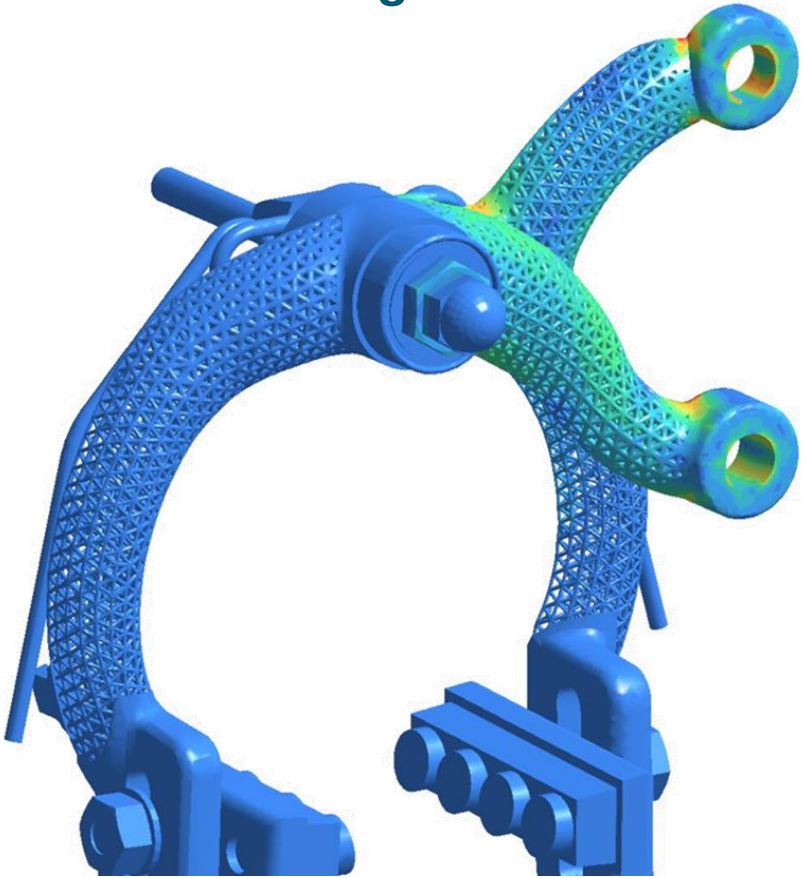
Wing - Nonlinear



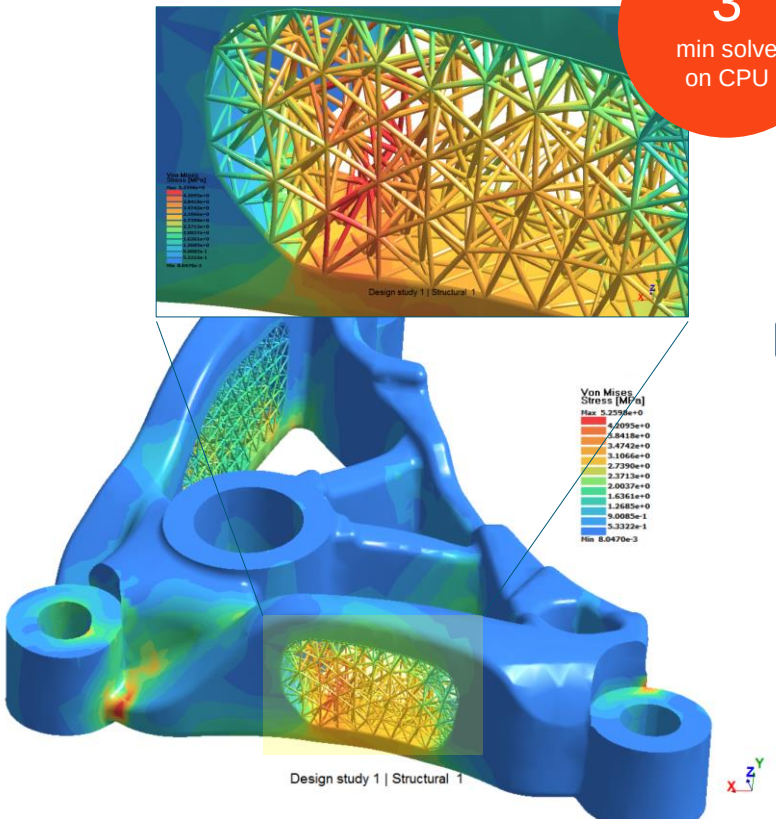
2100
assembly connections

5.5
min solve on CPU

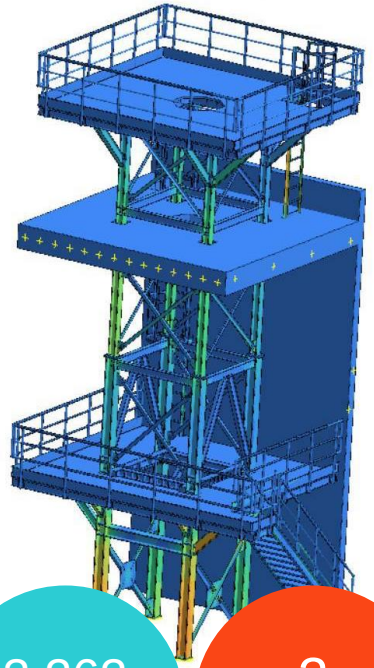
Additive and Organic Structures



3
min solve
on CPU



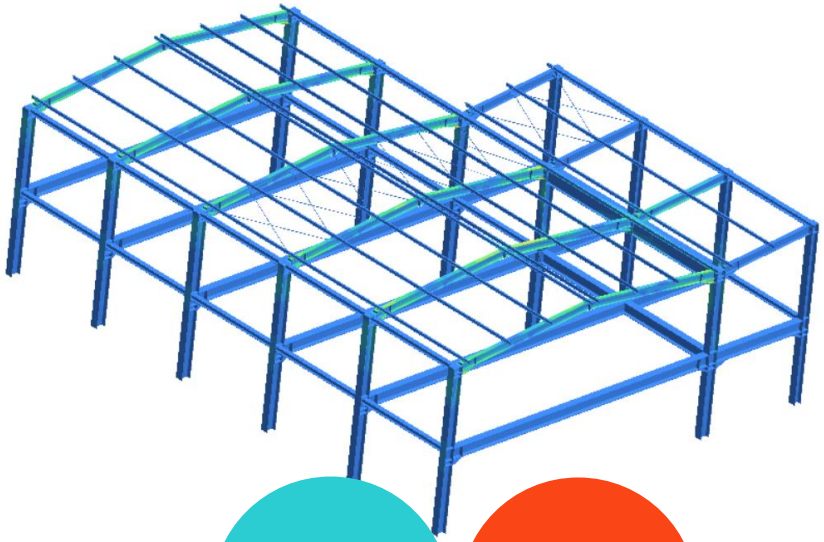
Architecture and Constructions



3,262
assembly parts

2
min solve on CPU

Warehouse - linear

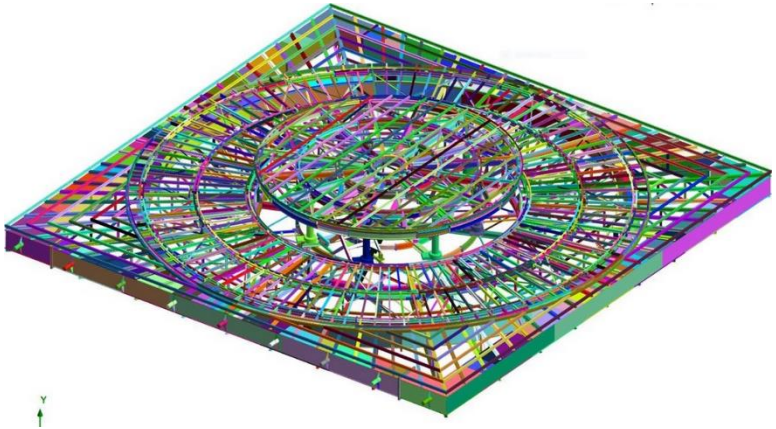


2,517
assembly parts

0.9
min solve on CPU

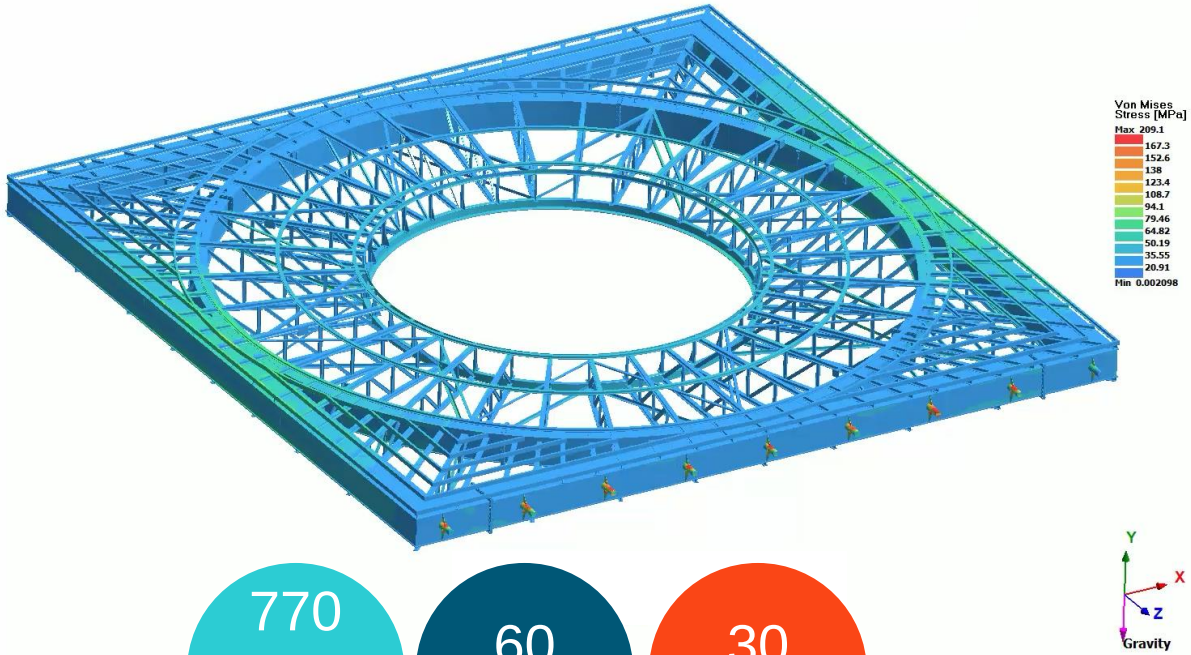
Stage Wagon of "Qintai Culture & Art Center" (China)

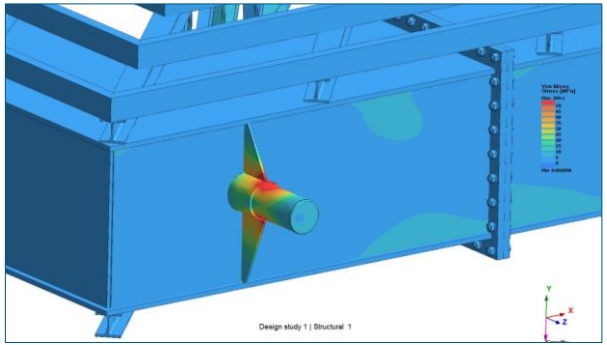
Image source: SBS Bühnentechnik GmbH

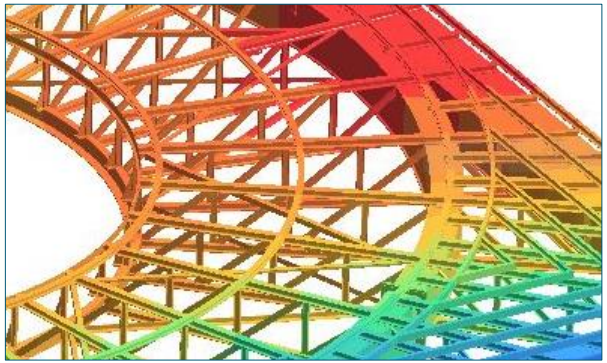


Assembly consists of **7,738** parts

From CAD to Analysis in Minutes!







770 0 assembly parts

60 min model setup

30 min solve on CPU

SHORT EXAMPLE
VERTICAL LIFT

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VALIDATION EXAMPLES

Verification Manual

NAFEMS about SimSolid

SimSolid in the News

https://www.nafems.org/publications/resource_center/bm_jan_20_1/

Benchmark	Description	Quantity	Target Solution	SimSolid Results	SimSolid 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%

A summary of results for all benchmarks(NAFEMS)

Check for Other Media Testimonials:

DE247 Digital Engineering

https://www.digitalengineering247.com/article/altair-simsolid-walkthrough/simulate

DEVELOP3D

https://www.develop3d.com/reviews/review-altair-simsolid-simulation-CAD-design-engineering

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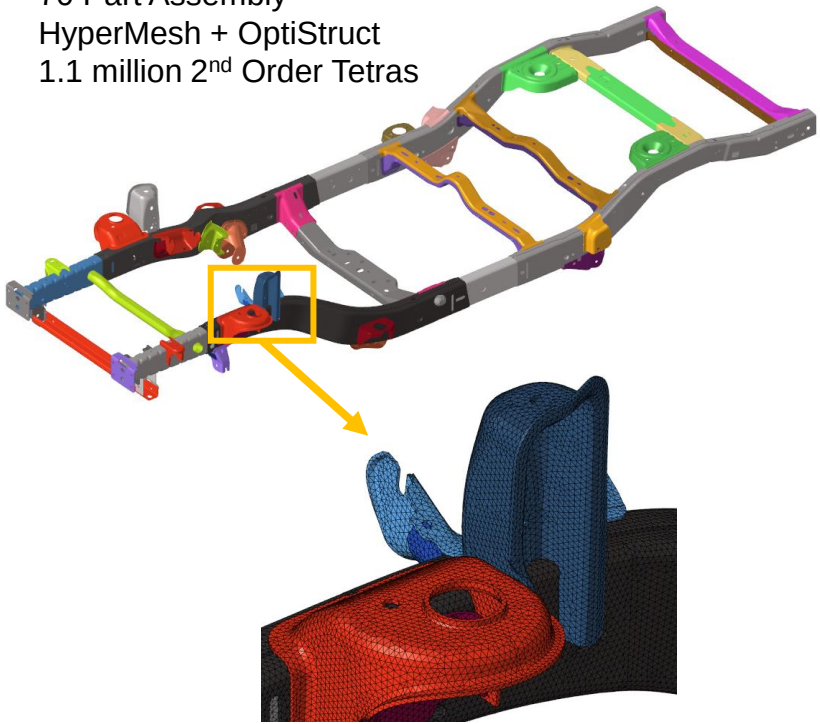
Validation Example – Auto Frame

Reference Solution

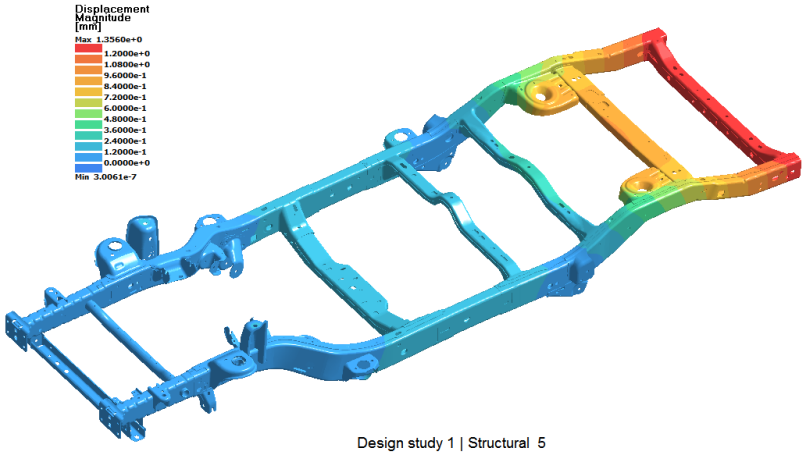
- 70 Part Assembly
- HyperMesh + OptiStruct
- 1.1 million 2nd Order Tetras



Mode	SimSolid	OptiStruct
1	33.732 Hz	33.749 Hz
2	41.501 Hz	41.992 Hz
3	59.170 Hz	59.439 Hz
4	64.644 Hz	63.811 Hz
5	79.403 Hz	80.317 Hz
6	80.094 Hz	81.729 Hz
7	94.660 Hz	95.598 Hz
8	100.35 Hz	103.20 Hz
9	114.48 Hz	117.88 Hz

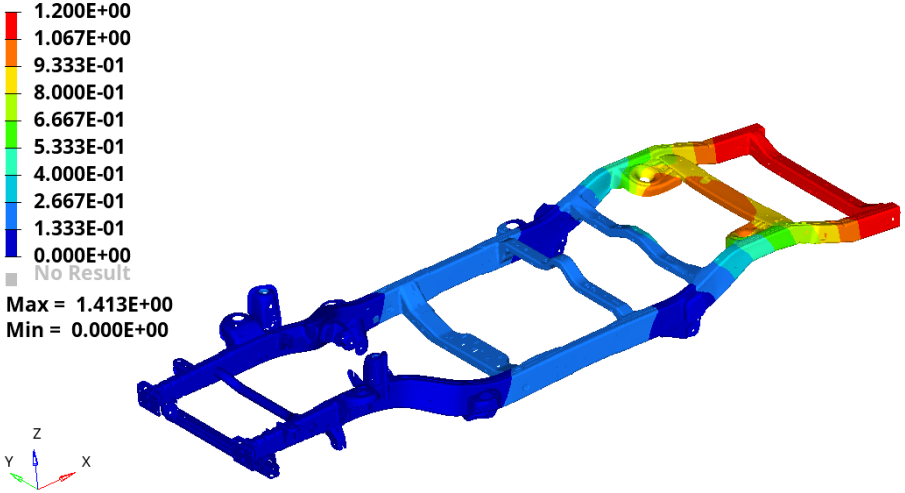
Frame – Linear Static Analysis

SimSolid Max Disp ~ 1.36 mm



6 solution passes, Adapt to thin solids

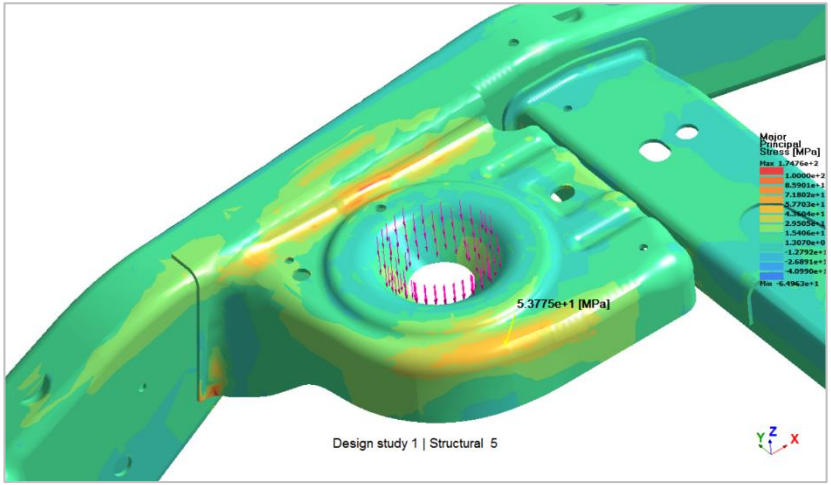
OptiStruct Max Disp ~ 1.41 mm



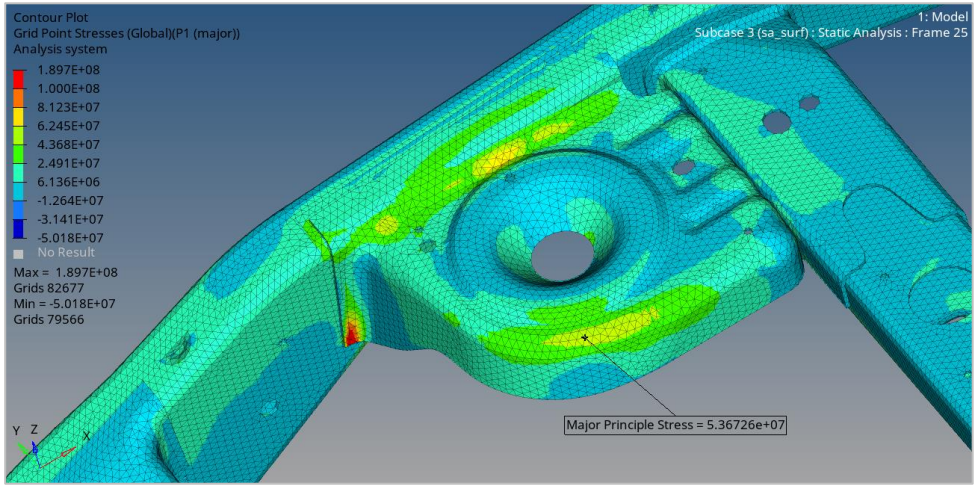
1.1 million 2nd Order Tetras

Frame – Linear Static Analysis

SimSolid Major Principal Stress



OptiStruct Major Principal Stress



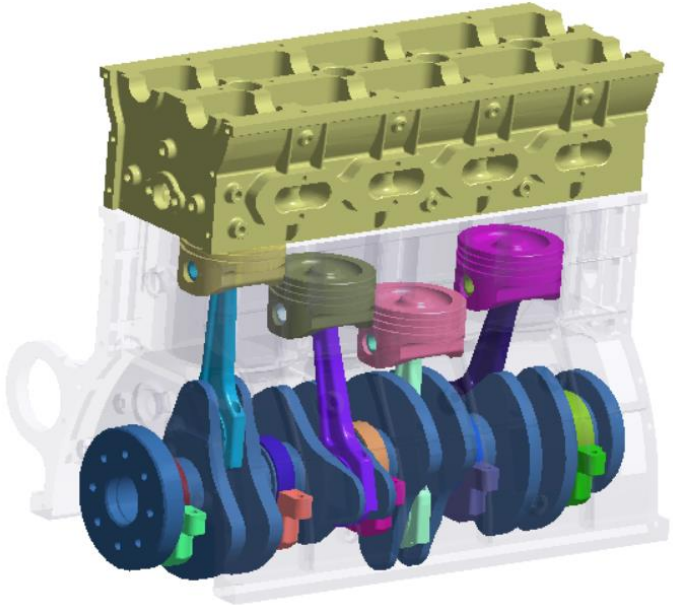
6 solution passes, Adapt to thin solids

1.1 million 2nd Order Tetras

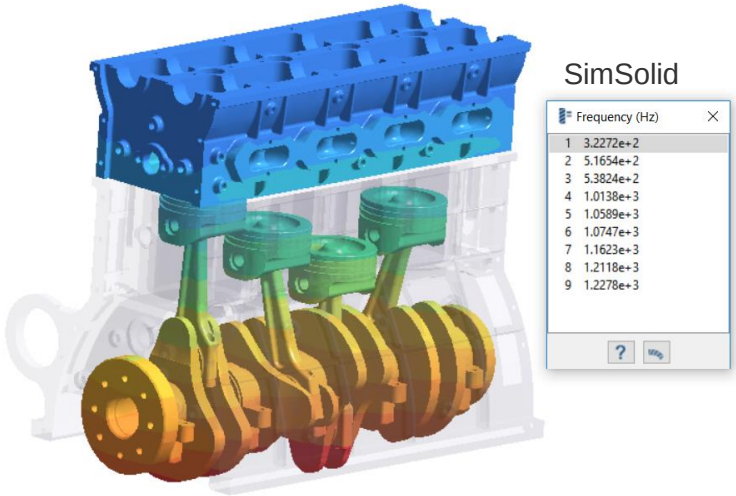
Validation Example – Engine

Reference Solution

- 44 Part Assembly
- HyperMesh + OptiStruct
- 700,000 2nd Order Tetras
- Bonded Connections

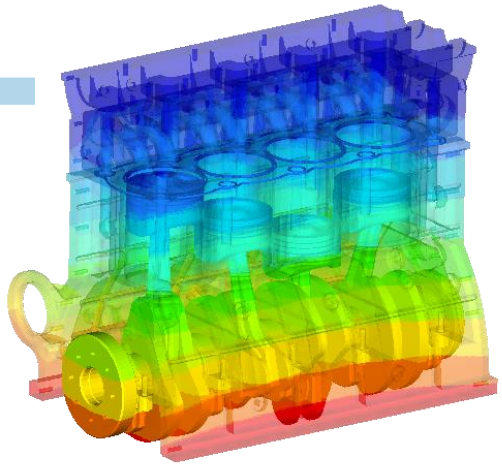


SimSolid

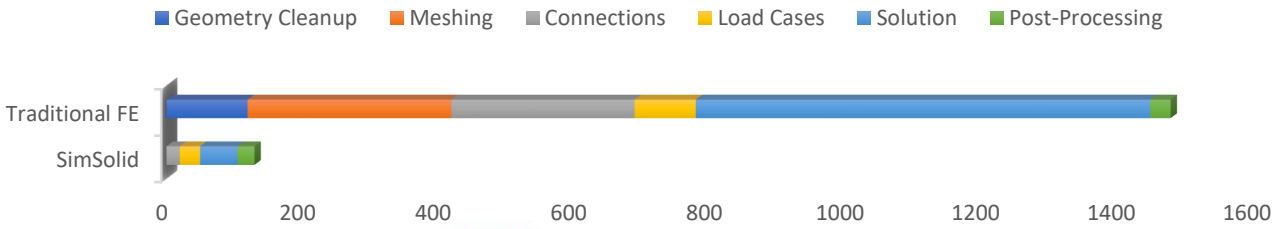


OptiStruct

Mode 1 - F = 3.146697E+02
Mode 2 - F = 5.153883E+02
Mode 3 - F = 5.370159E+02
Mode 4 - F = 1.018273E+03
Mode 5 - F = 1.049172E+03
Mode 6 - F = 1.061735E+03
Mode 7 - F = 1.160738E+03
Mode 8 - F = 1.197509E+03
Mode 9 - F = 1.255972E+03
Mode 10 - F = 1.341970E+03

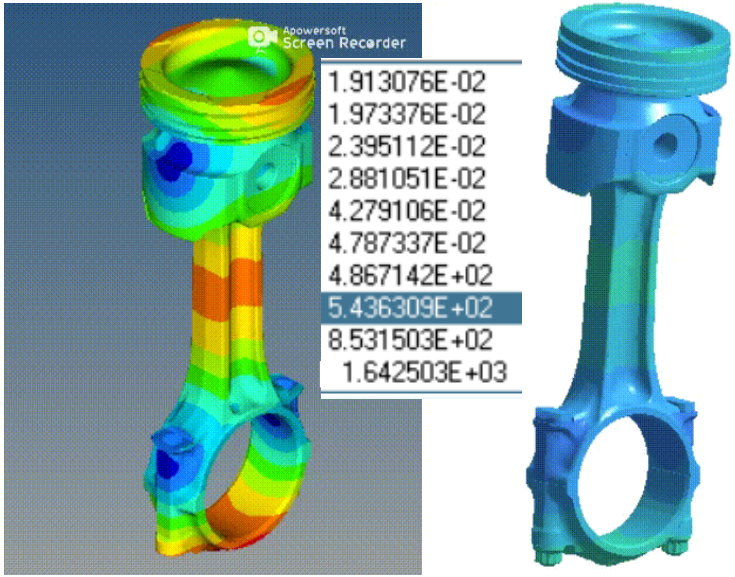


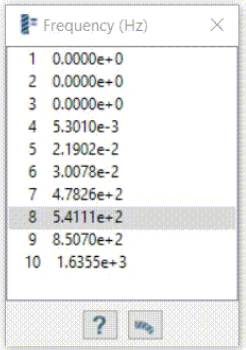
Validation Example - Piston Assembly



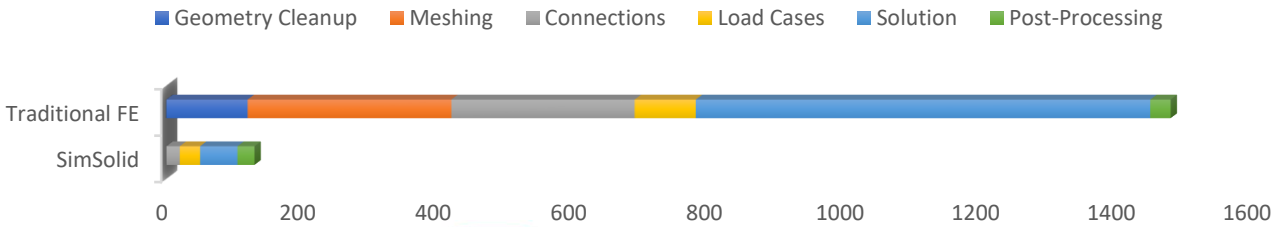
Piston-Connecting Rod Assembly
- 8 Parts
- 2 Bolts and Nuts

Modal Analysis
- **10 Modes**



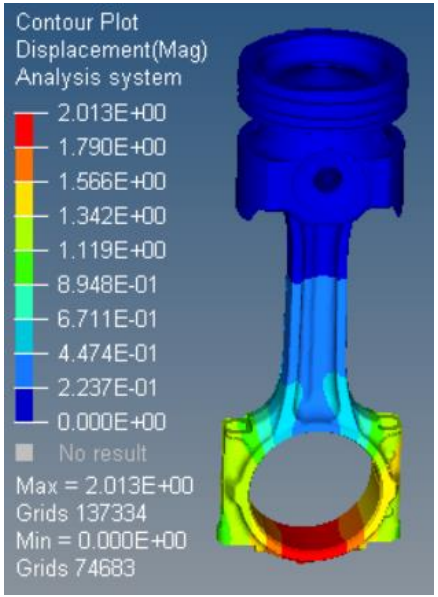


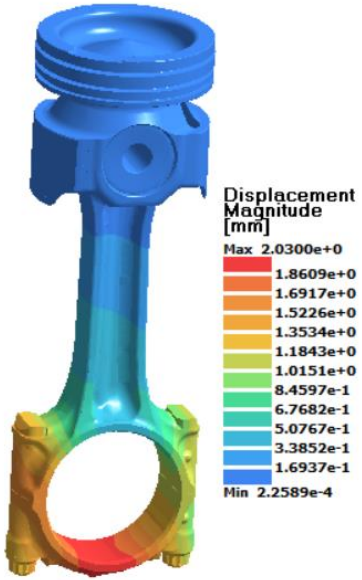
Validation Example - Piston Assembly



Piston-Connecting Rod Assembly
- 8 Parts
- 2 Bolts and Nuts

Linear Static Analysis
- **Pressure load on the cap**



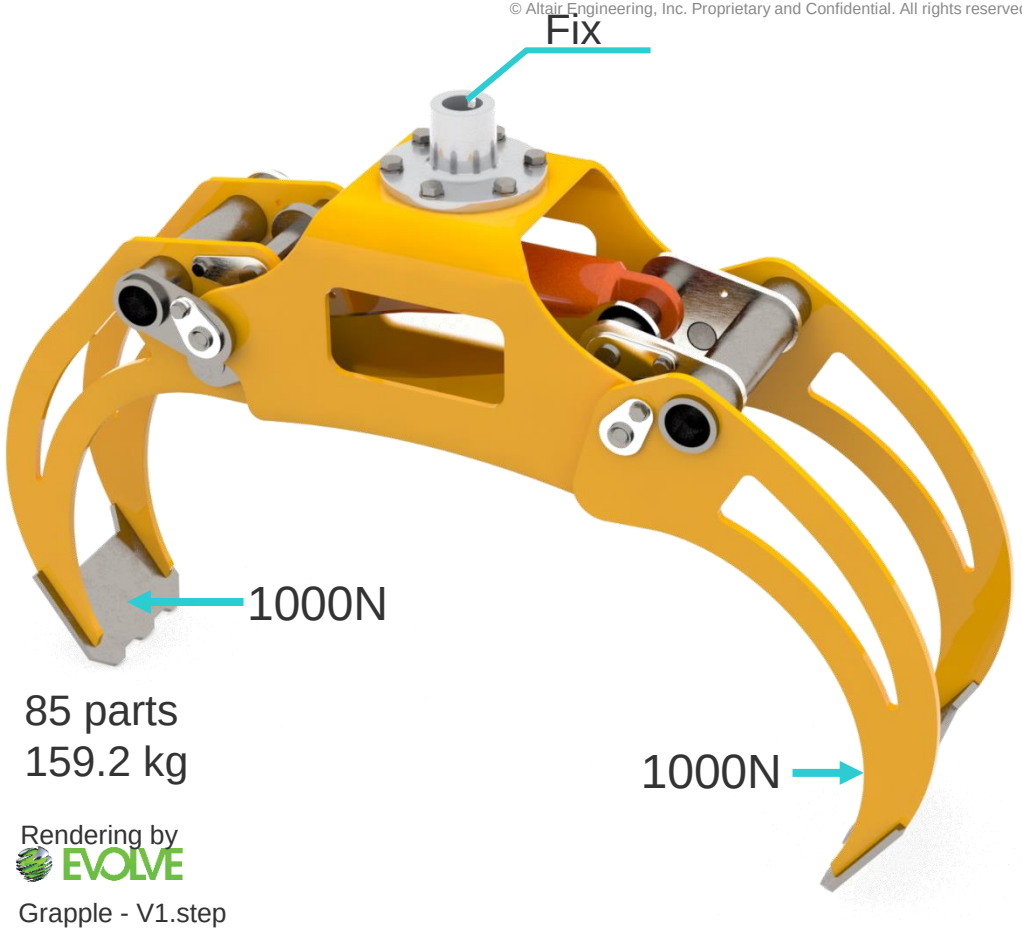


Grapple

- Material (Steel equivalent)
  - E=210000 MPa
  - Nu=0.3
  - Rho=7.85E-9 ton/mm^3

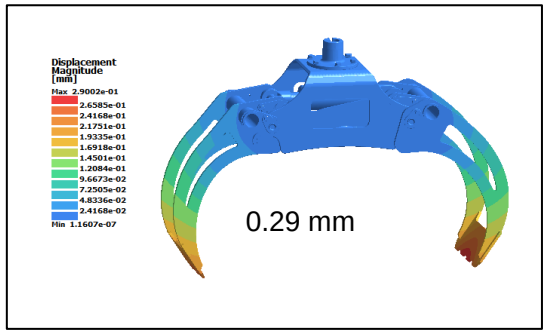
Linear Statics

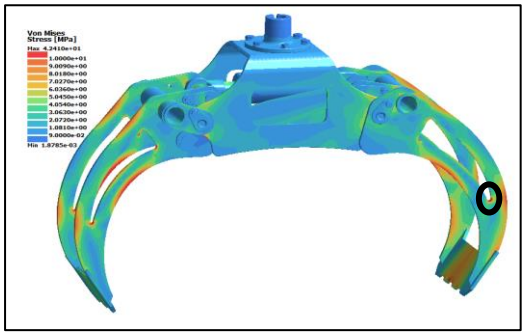
- Load
  - Fx= +/-1000N
- Constraint
  - Fixed Upper hole
- Contact
  - Bonded all

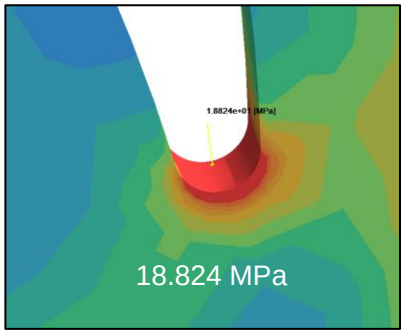


Linear Static Analysis

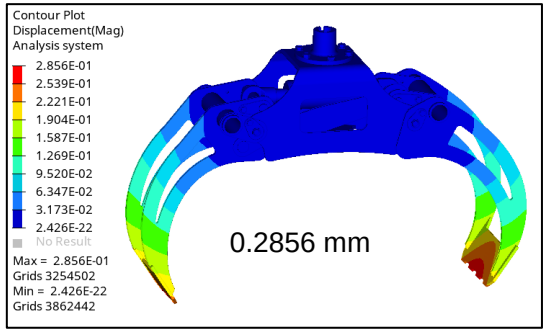
SimSolid

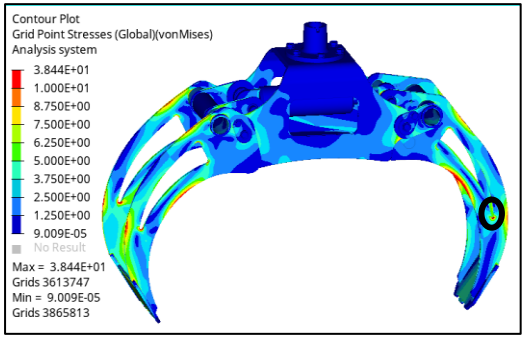


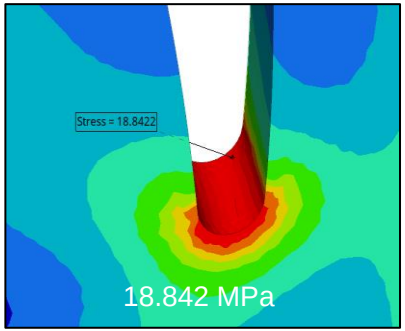




OptiStruct

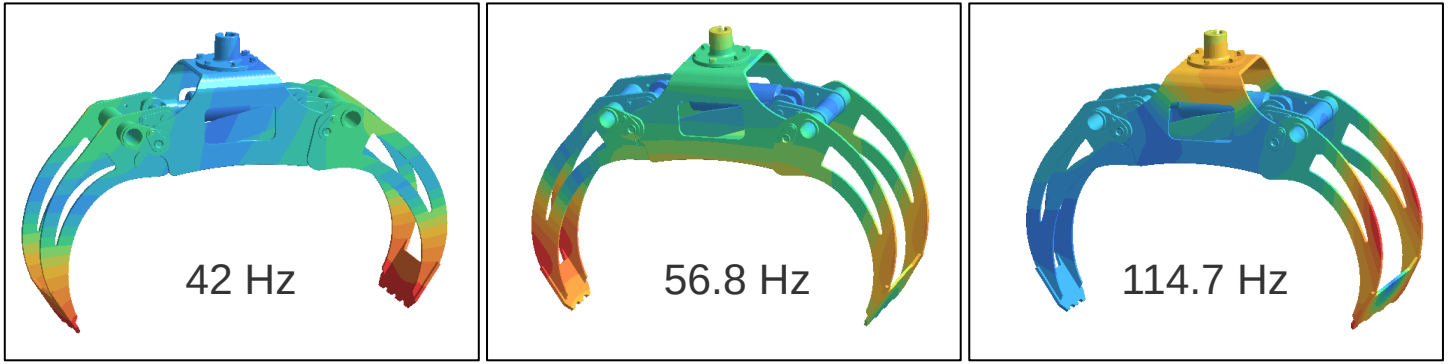




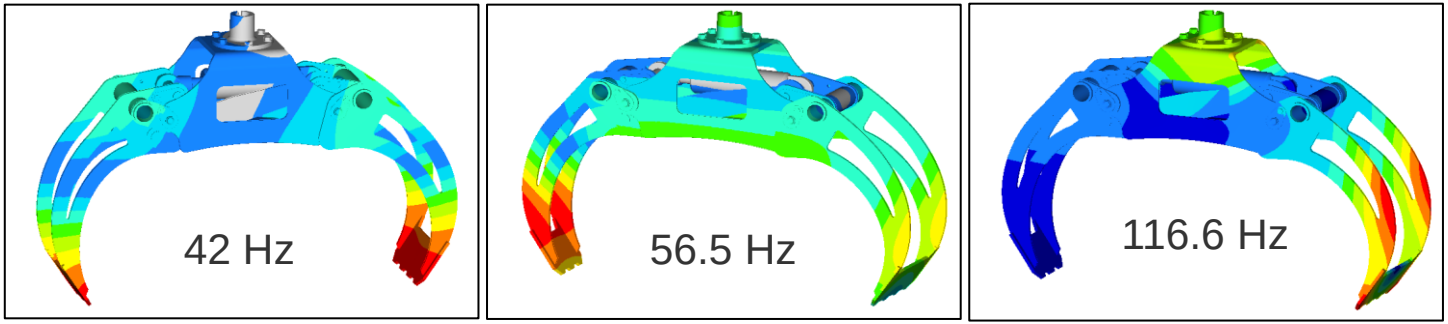


Eigenvalue Analysis

SimSolid



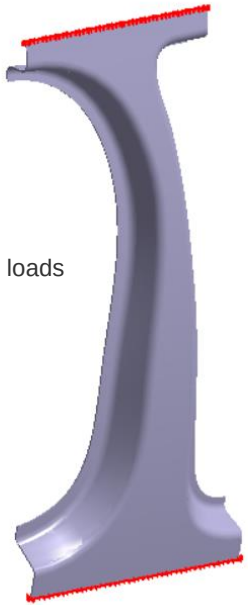
OptiStruct



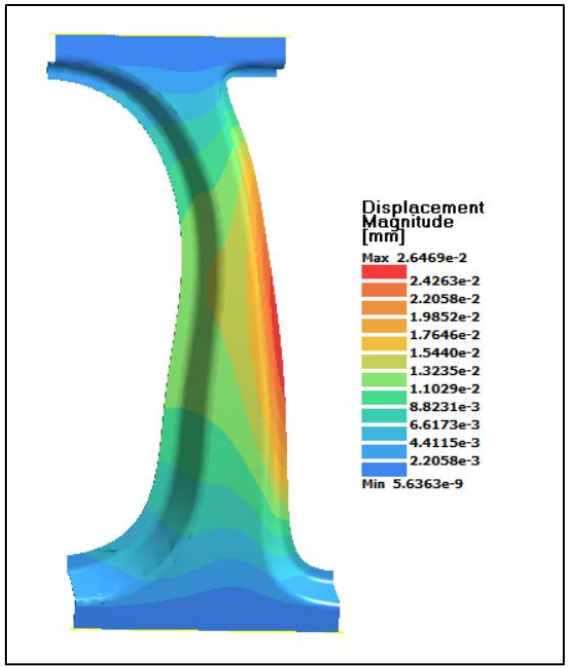
B-pillar Static Analysis

Constrained Top & Bottom

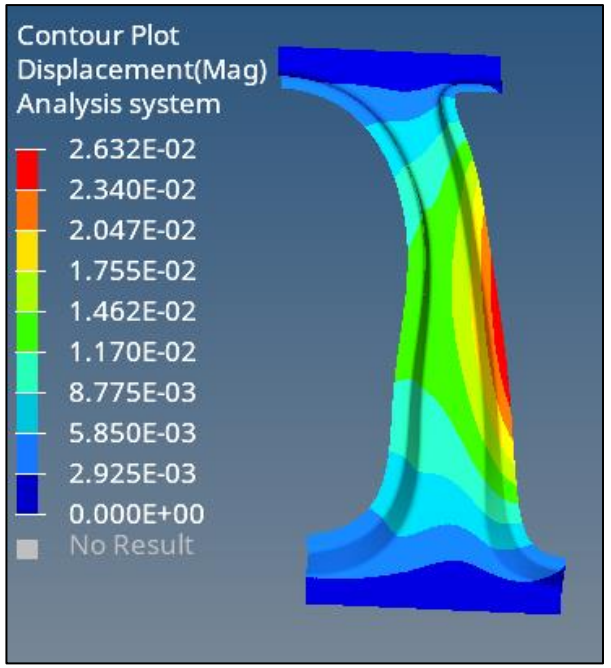
10 g loads



SimSolid

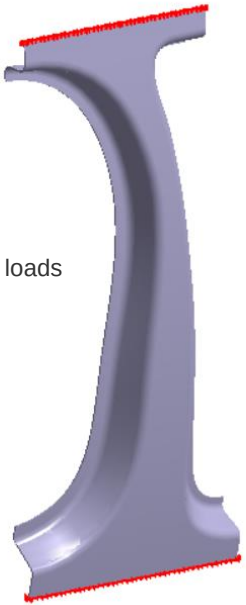


OptiStruct



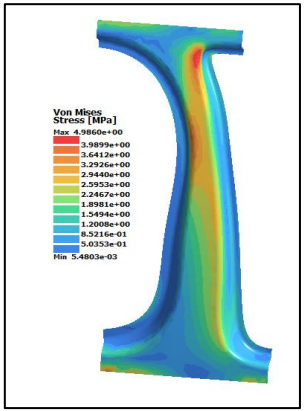
B-pillar Static Analysis

Constrained Top & Bottom

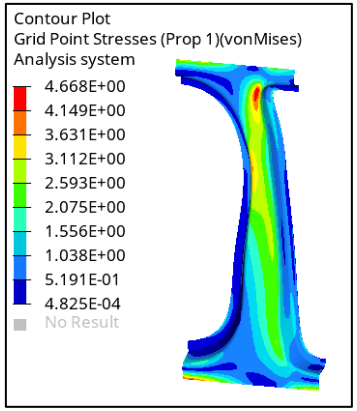


10 g loads

SimSolid



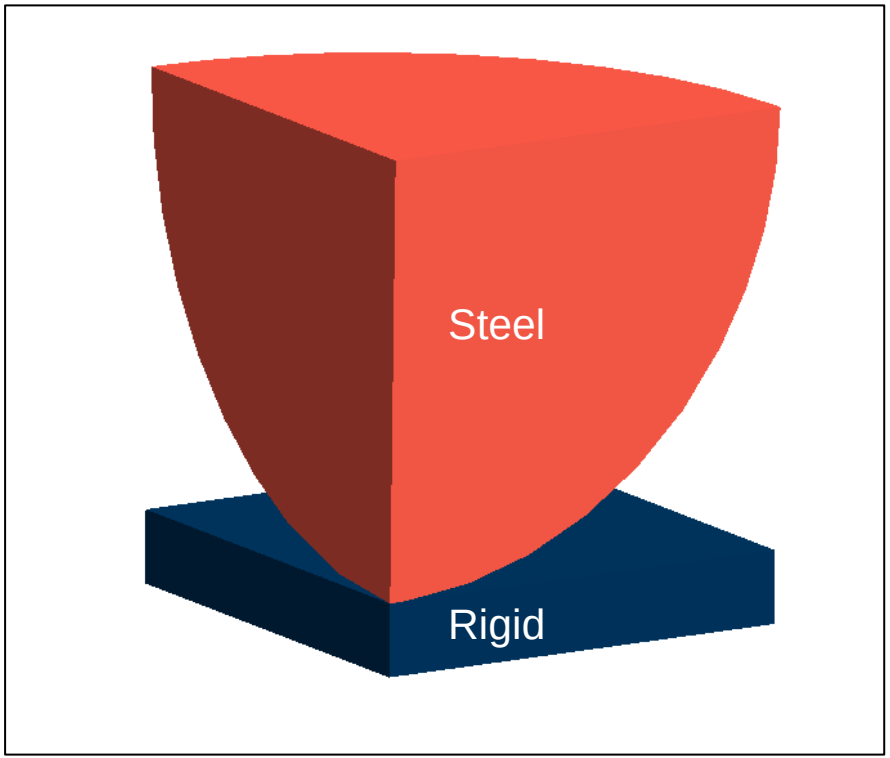
OptiStruct



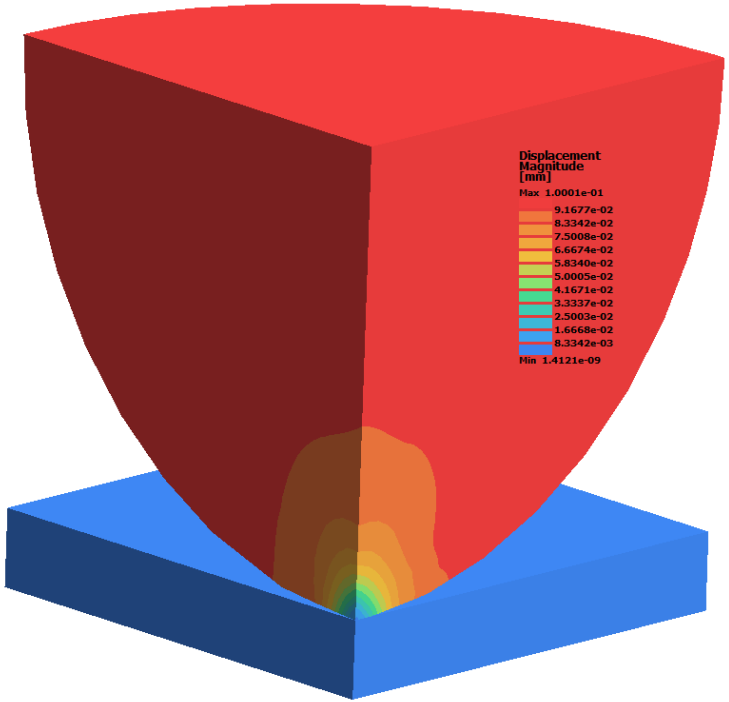
Results	SimSolid	OptiStruct
Displacement	2.64 E-2 mm	2.63 E-2 mm
Stress	4.98 MPa	4.67 MPa

Hertz Contact

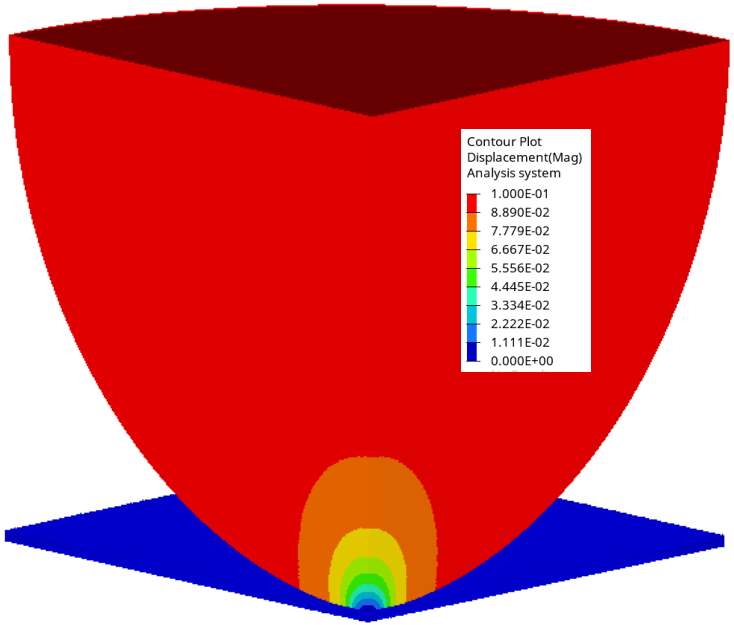
- 2 parts
- Nonlinear contact
- Setup
  - Bottom plate constrained
  - Enforced displacement on the block



Nonlinear Static Analysis



SimSolid



OptiStruct

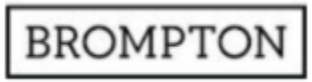
Nonlinear Static Analysis

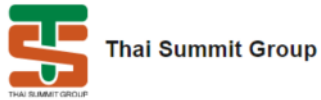
SOURCE	REACTION FORCE (0.1 mm deformation)
SimSolid	13,282 N
OptiStruct	13,730 N
Theory	13,323 N

CUSTOMER TESTIMONIALS

ALTAIR

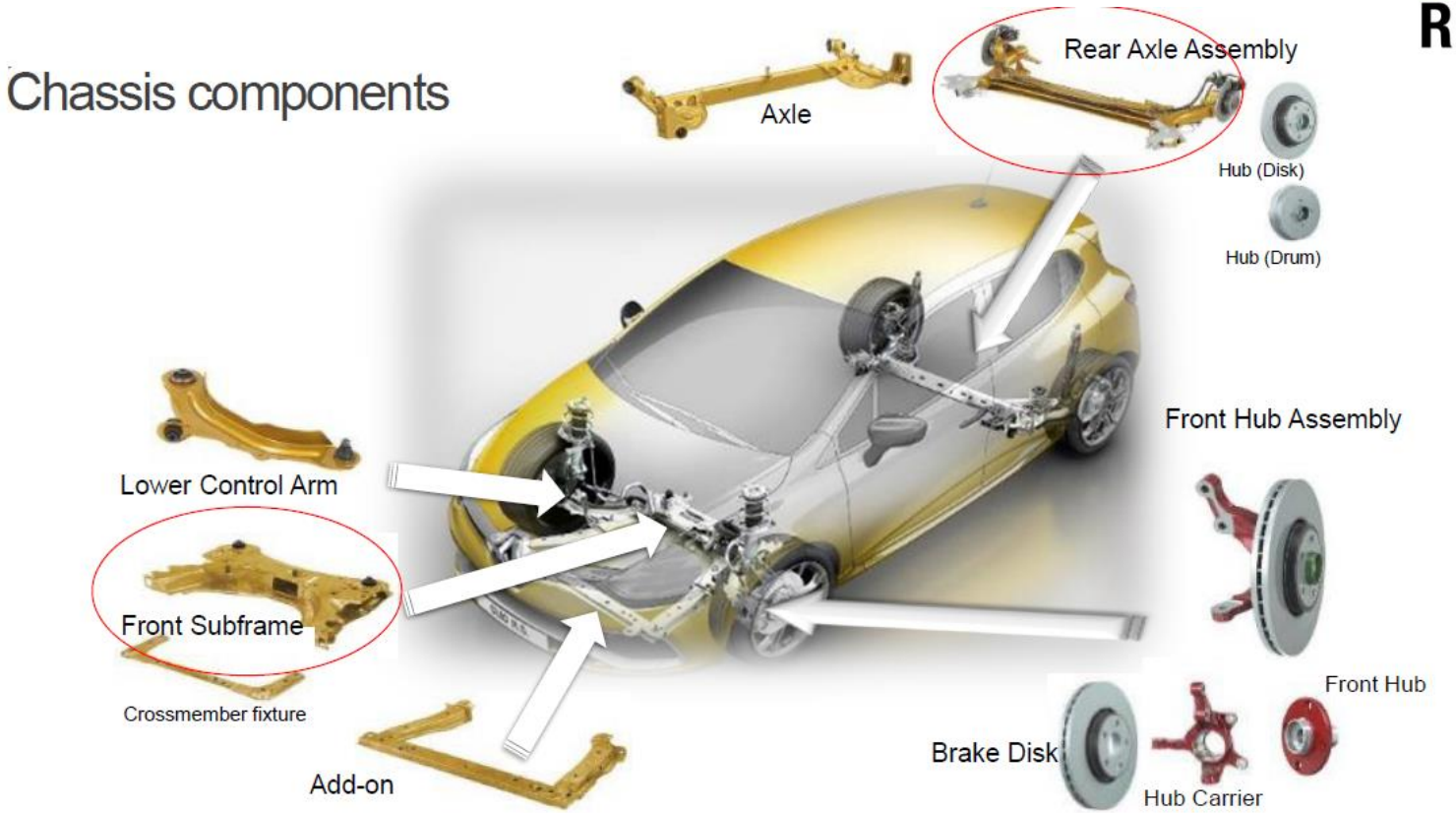
Select Customer References





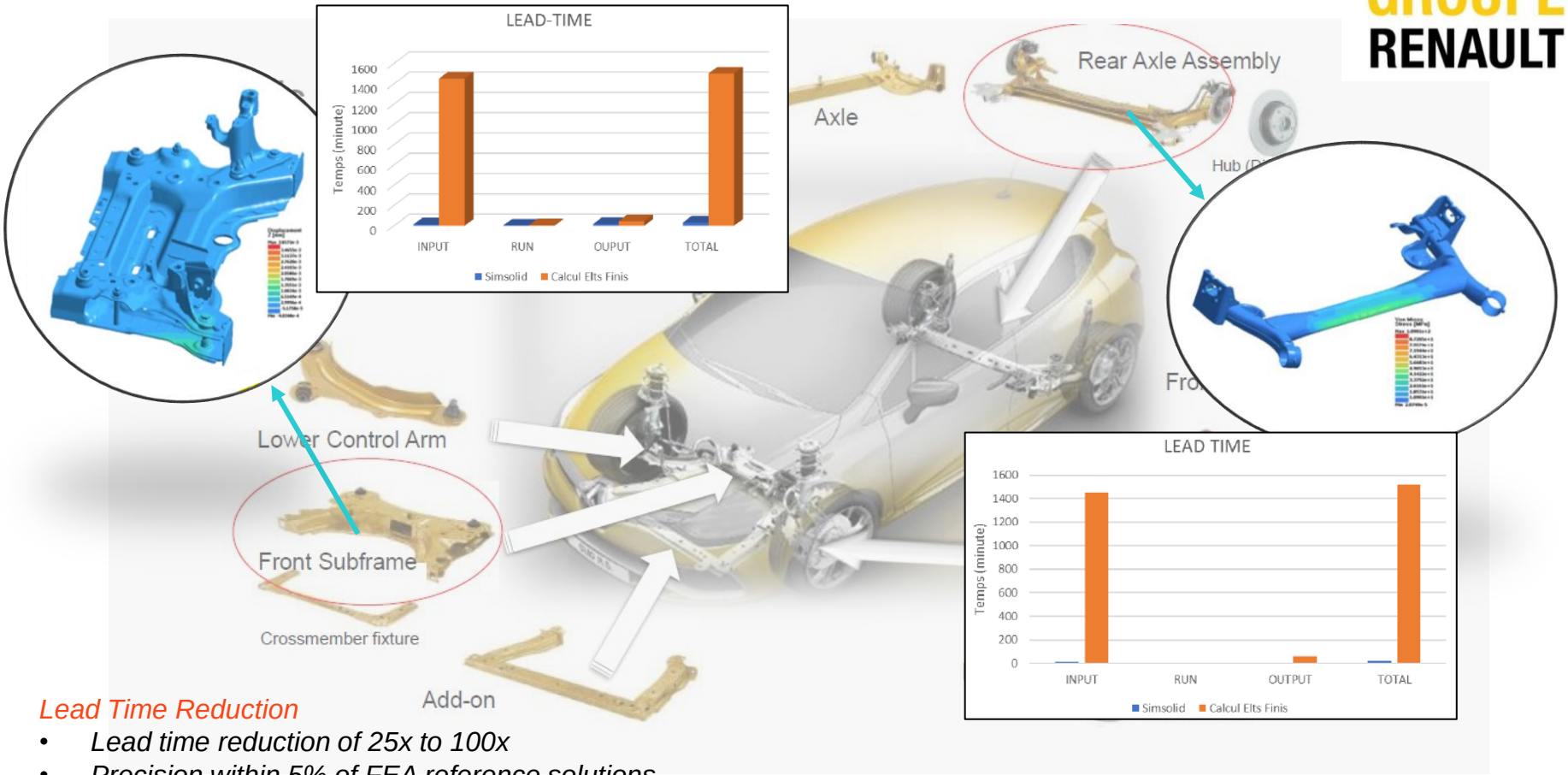
CUSTOMER EXAMPLE

GROUPE RENAULT



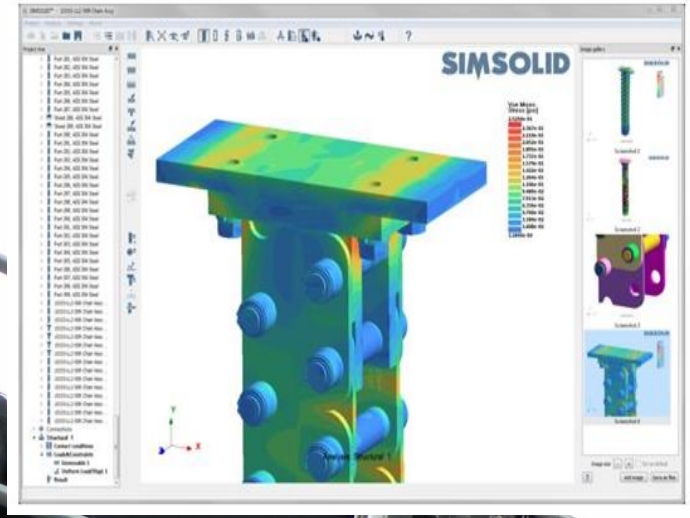
CUSTOMER EXAMPLE

GROUPE RENAULT



Lead Time Reduction

- *Lead time reduction of 25x to 100x*
- *Precision within 5% of FEA reference solutions*



SERAPID
RIGID CHAIN TECHNOLOGY

324 part chain assembly
871 part full platform assembly
15 mins CAD to Results

“When we are ordering tons and tons of the raw materials for our chains, a pound here and a pound there starts becoming important, so that's where we spend a lot of time trying to optimize our product. Applying SimSolid to this challenge in the long run will **make us a lot of money** .”

– Bob Adams, Engineering Manager - Serapid, Inc.

90
min CAD
to results

Andron Handling

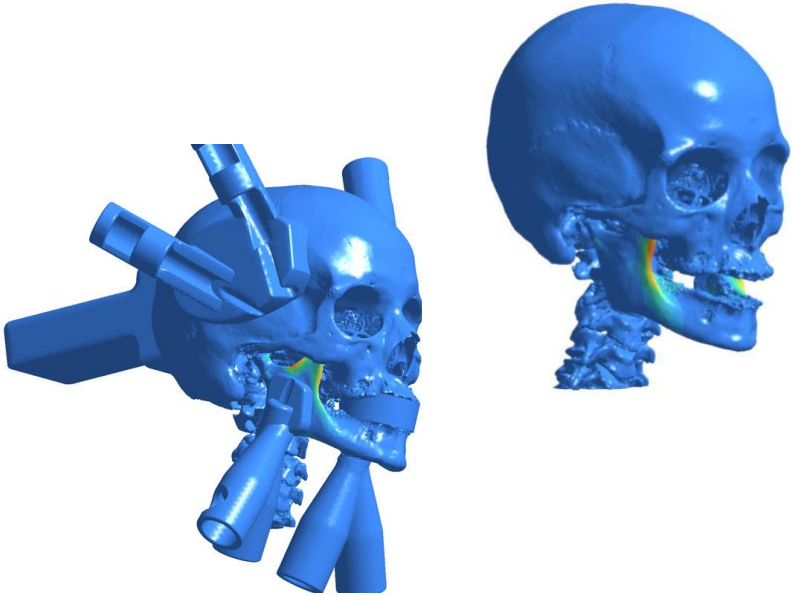
Using **SimSolid** I was able to quickly model this in a very realistic manner with sliding connections, a clamping force on the piston and a matching reaction on the cylinder body. I'm really pleased with the results, and they are inline with our expectations.

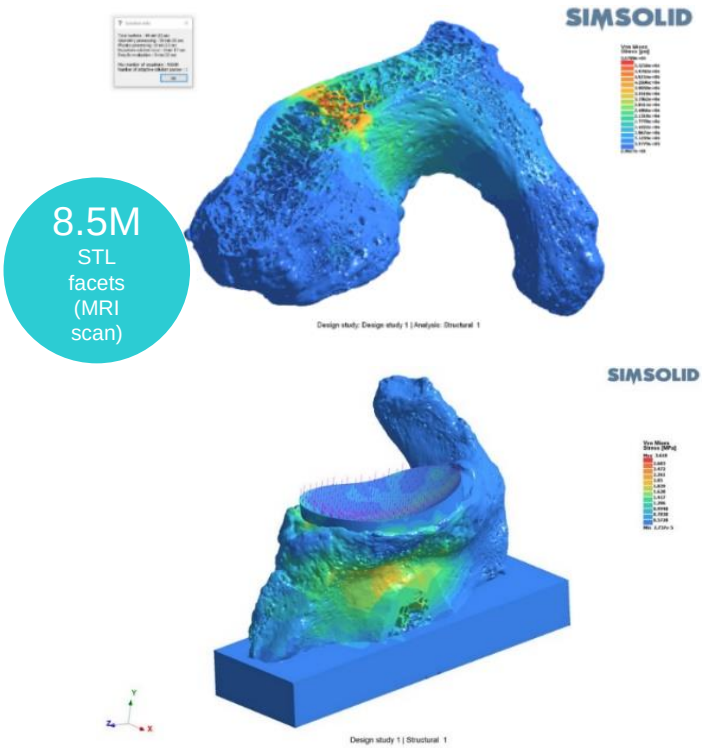
Total time from start to finish including all setup/preparation and fixing some errors in the CAD model – 1.5 hours.

We wouldn't even consider analysing with the below method in a traditional mesh based system – it would take too long to get any useful information out. We would have ended up splitting the assembly into multiple parts, and running separate simulations for each - this would easily consume a day, and likely be less accurate.

Tony Jones
Andron Handling

Western
UNIVERSITY · CANADA





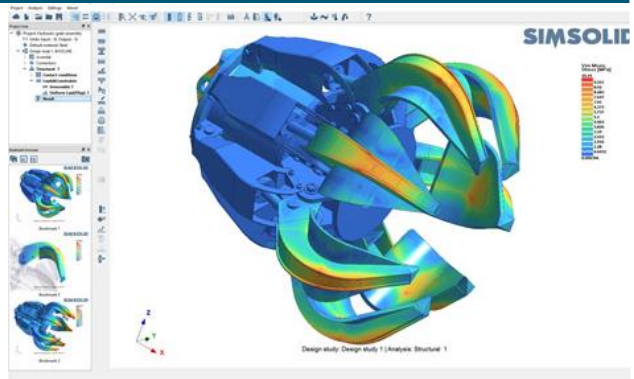
8.5M STL facets (MRI scan)

"We have found SimSolid to be an invaluable aid to our research work. Its ability to analyze complex bone geometry is a capability that is not practical with other FEA methods."

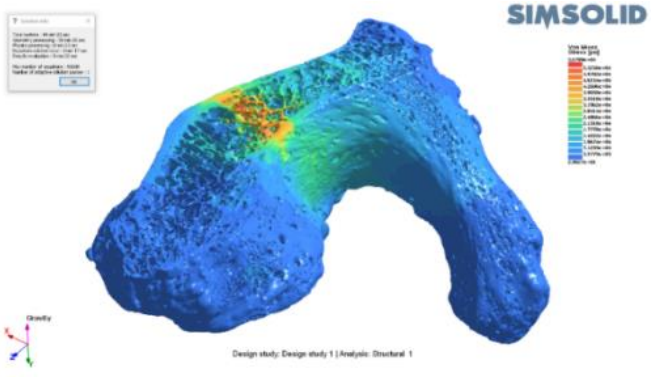
– Louis Ferreira, Associate professor – Western University, Canada

JOIN THE SIMULATION REVOLUTION

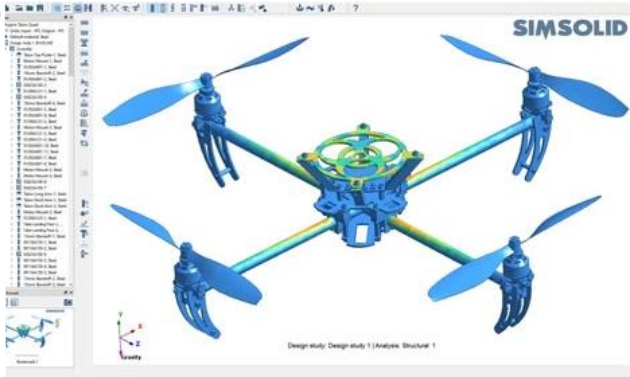
Fast, Easy to Use & Accurate



Expand What is Possible to Solve



Enables Simulation Driven Design



Quick Overview Series

• Module 1: Introduction	February 5th 2021
• Module 2: User Interface + Modal Analysis	February 12th 2021
• Module 3: Linear Analysis	February 19th 2021
• Module 4: Non-Linear Analysis	February 26th 2021
• Module 5: Dynamic Analysis	March 5th 2021
• Module 6: Thermal and SimSolid news	March 12th 2021
• Module 7: Inspire/SimSolid Solver	March 19th 2021
	(all Fridays)

- Contact: **trainings@altair.de**
- or give feedback after meeting finished

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QUESTIONS / ANSWERS

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THANK YOU

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#ONLYFORWARD

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