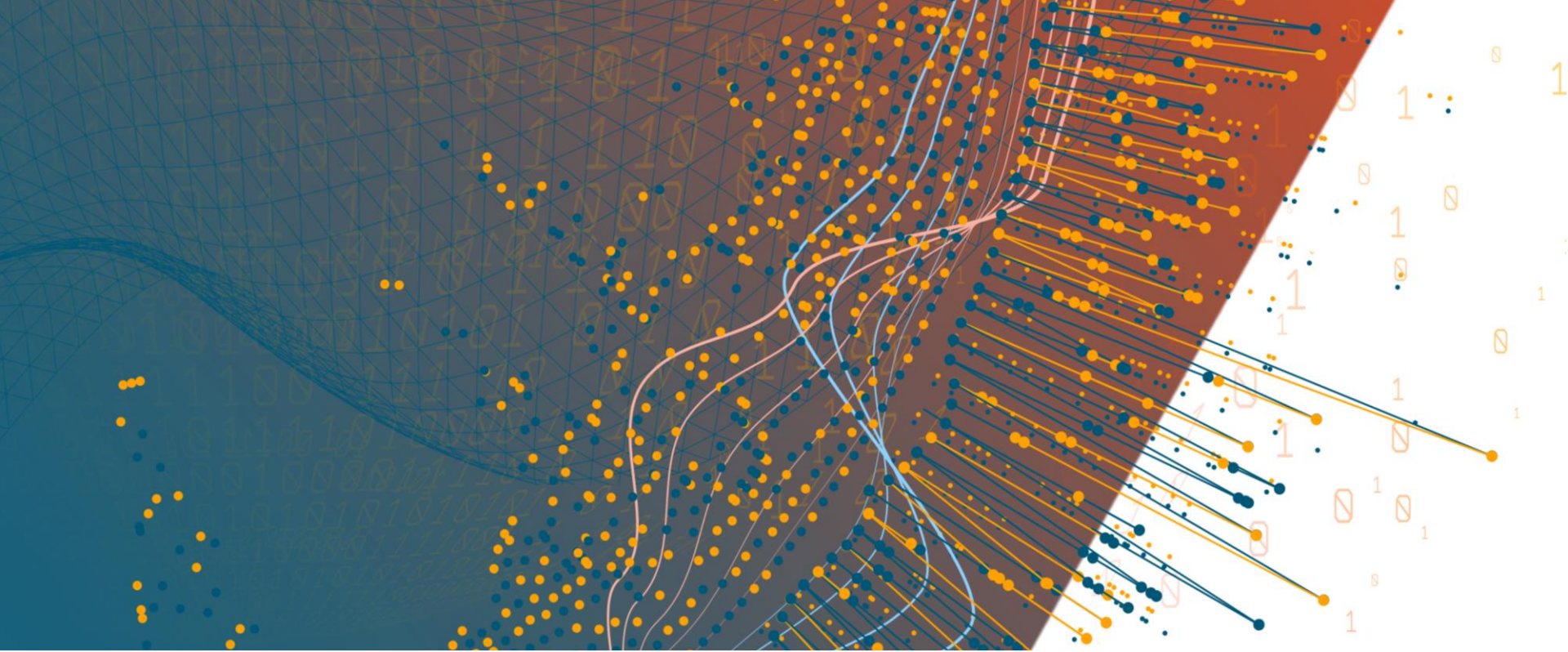

SimSolid Quick Overview
Module 6: Thermal Analysis / SimSolid News

Sebastian Karp ● Senior Application Engineer
Arthur Schubert ● Senior Technical Consultant
March 12th 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**

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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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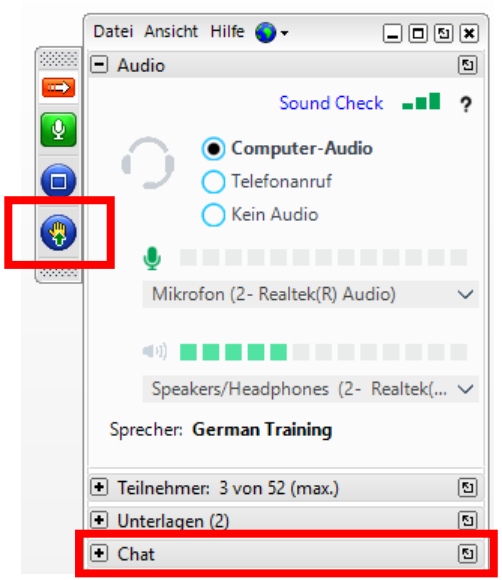
Organisational

- 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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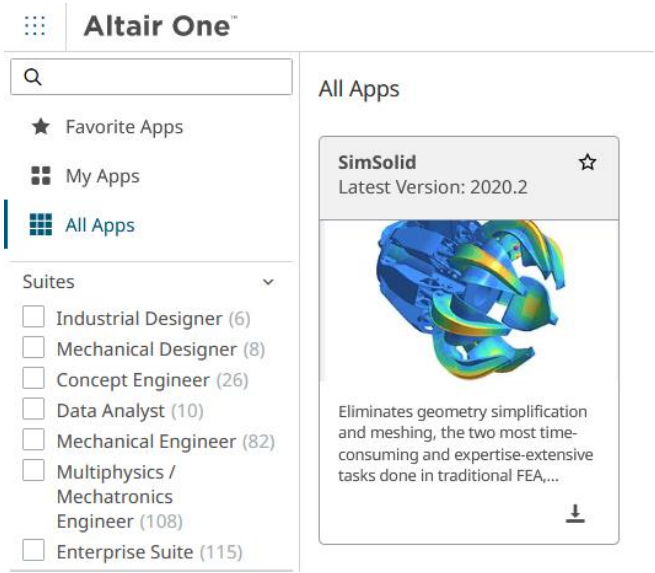
Have a look at…

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

- Download - www.altairone.com



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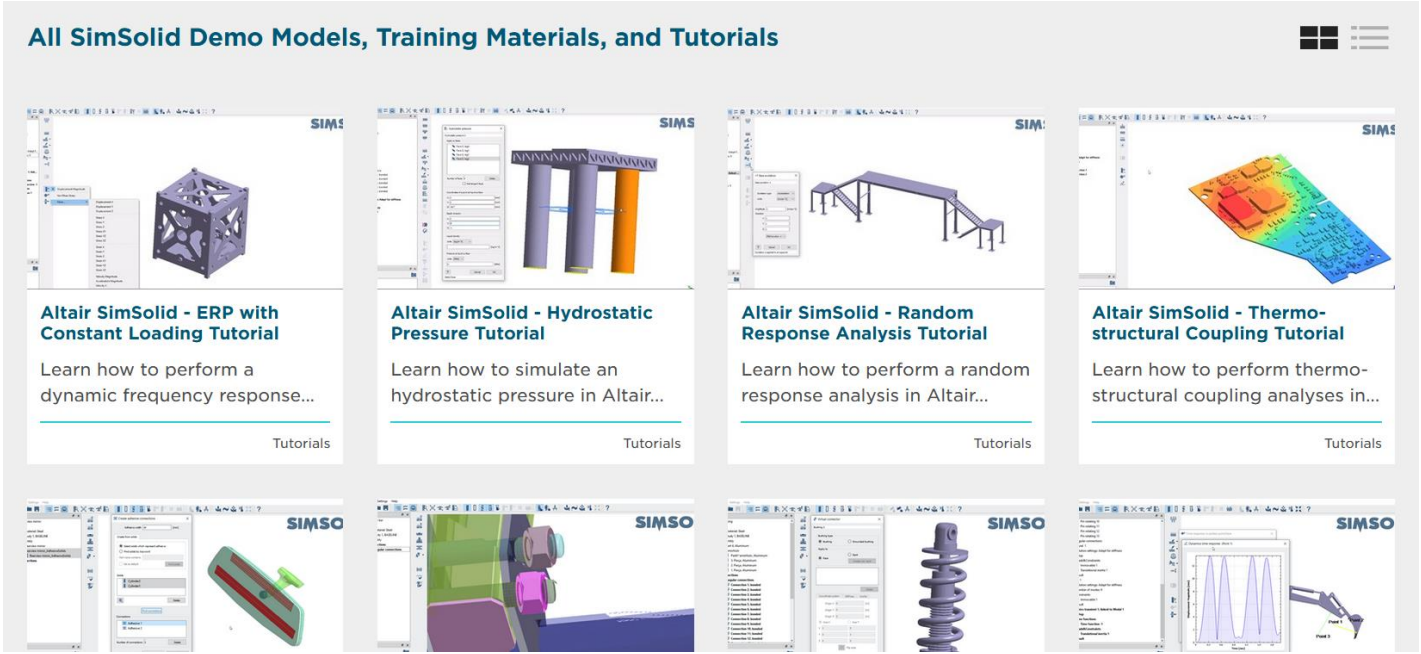
Have a look at…

- **www.altair.de/resource/altair-simsolid-tutorial-projects**



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POLL

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THERMAL ANALYSIS

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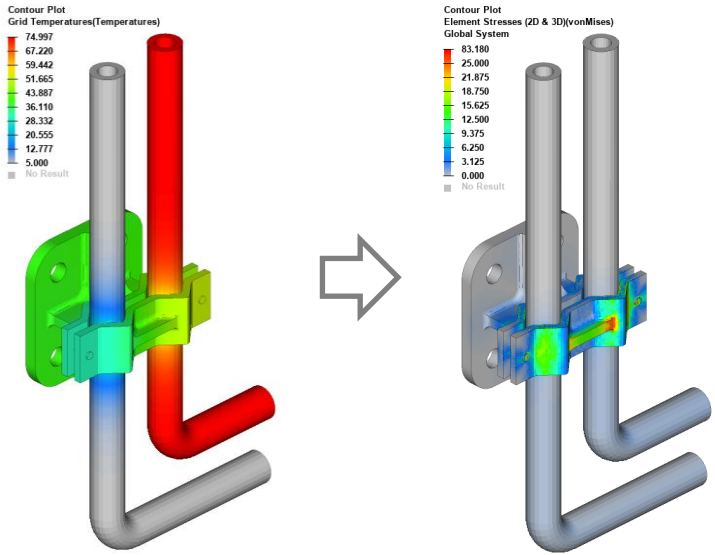
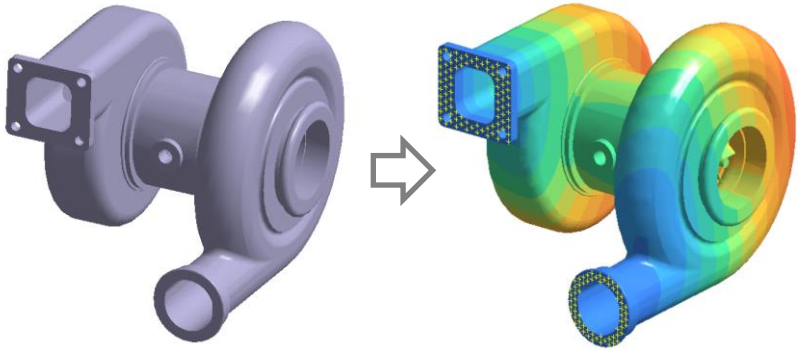
Motivation

- Temperature distribution
- Thermal induced stresses





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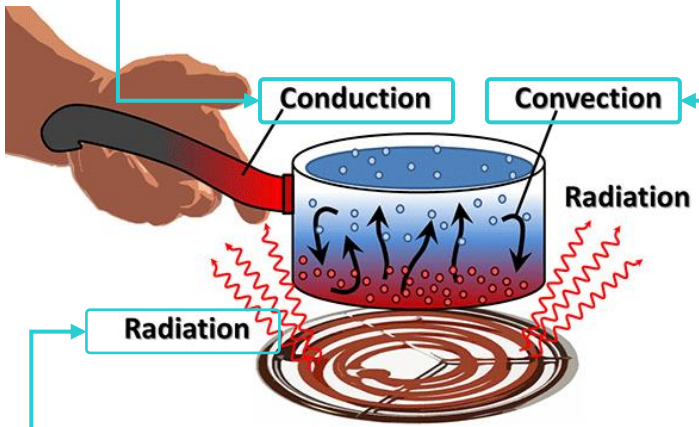
Definitions

transfers between objects in contact via direct molecular collision

transfer between an object and its environment due to fluid motion



heat transfer by the emission of electromagnetic radiation

Supported solutions

- Steady State
  - Temperature and fluxes at the final thermal equilibrium state are of interest
  - Thermal loads time-invariant
- Supported in OptiStruct

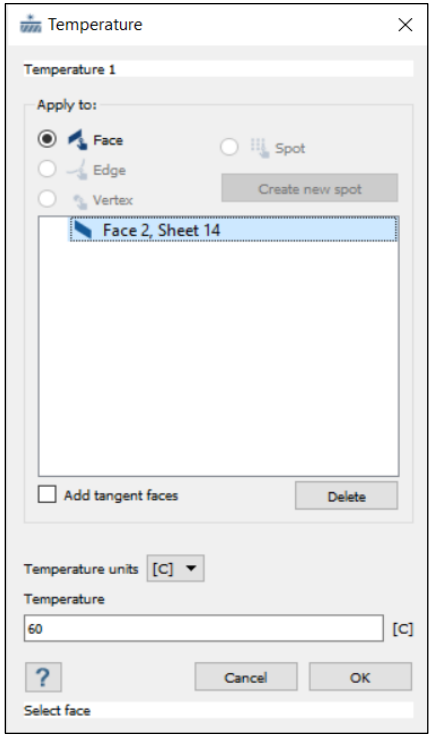
- Transient
  - Thermal behavior of a system over a specific period of time
  - Thermal loads time-invariant or -dependent
- Supported in OptiStruct

- Linear
  - Material properties such as conductivity, capacity and convection coefficient are temperature independent
- Supported in OptiStruct

- Nonlinear
  - Material properties such as conductivity, capacity and convection coefficient are temperature dependent
- Supported in OptiStruct

Boundary conditions

- Temperature
  - Definition of fixed temperature
  - Applied to: face, edge, vertex or spot
  - Specified as: °C



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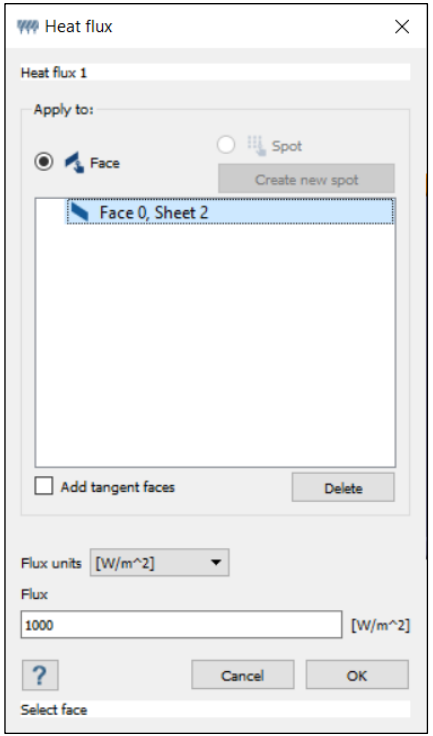
Boundary conditions

- Heat flux
  - Rate of heat energy transfer through a given surface per unit time
  - Applied to: face or spot
  - Specified as: W/m²



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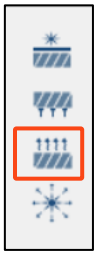
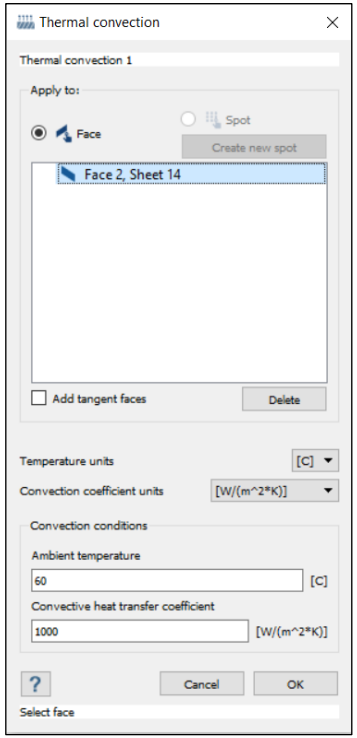
Boundary conditions

- Convection
  - Rate of heat transfer between the bulk fluid (liquid or gas, buoyant or moving) and a surface of your model
  - Applied to: face or spot
  - Specified as: W/(m²*K)
  - Ambient temperature : constant temperature of the bulk fluid

Flow type	W/(m²·K)
Forced convection - low speed flow of air over a surface	10
Forced convection - moderate speed flow of air over a surface	100
Forced convection - moderate speed cross-flow of air over a cylinder	200
Forced convection - moderate flow of water in a pipe	3000
Forced convection - molten metals flowing in tubes	2000 to 45000
Forced convection - oil flowing in tubes	300 to 1700
Forced convection - boiling water in a pipe	50000
Gases in free convection	5 to 37
Water in free convection	100 to 1200
Oil in free convection	50 to 350





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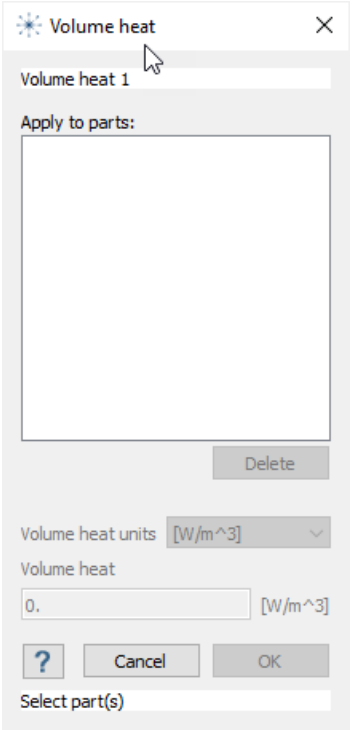
Boundary conditions

- Volumetric heat
  - internal heat generation (heat source) and internal heat absorption (heat sink) in volumes
  - Applied to: part
  - Specified as: W/(m³)
  - A positive volume heat value indicates a heat source and a negative volume heat value indicates a heat sink



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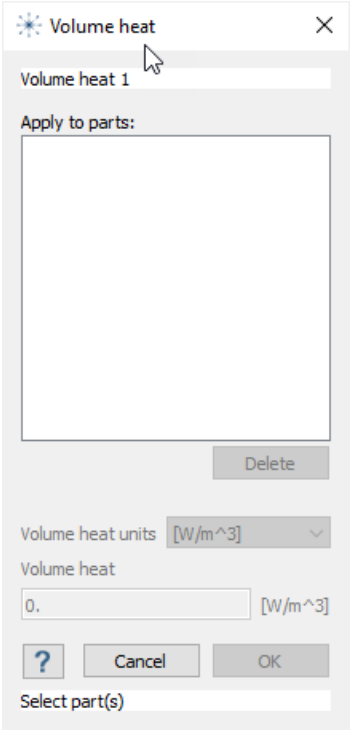

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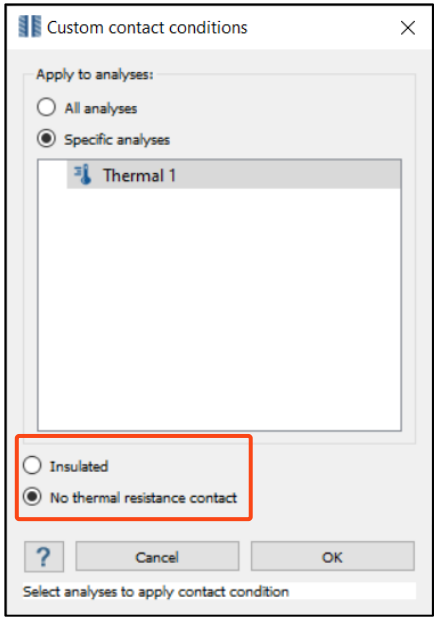
Boundary conditions

- Thermal contact conditions
  - Thermal specific contact conditions between parts
  - No thermal resistance - default condition. Indicates full heat transfer will occur through the part connection.
  - Insulated - Insulated means the opposite. No heat transfer will occur.

- on one or more parts > Review part contact conditions > Edit



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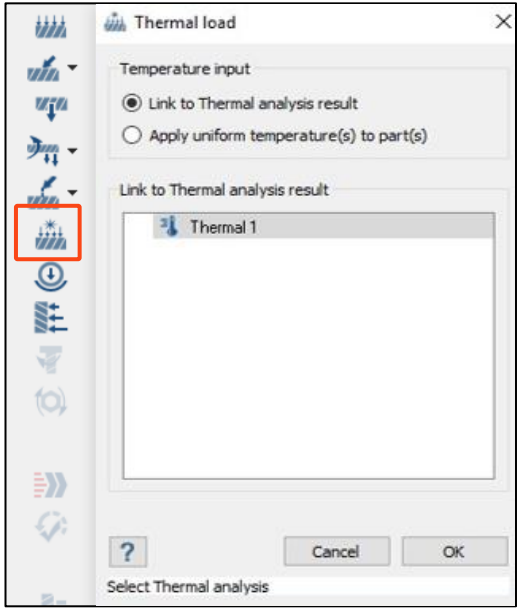
Boundary conditions

- Thermal loads
  - Thermal analysis results can be used in a subsequent structural static analysis as thermal loads
  - Uniform temperature field:
    a single temperature is assumed to be uniform over the entire model.
  - Part based temperature field:
    temperatures are applied to individual parts.
  - Thermal analysis result field:
    the temperatures are imported from an existing Thermal analysis.



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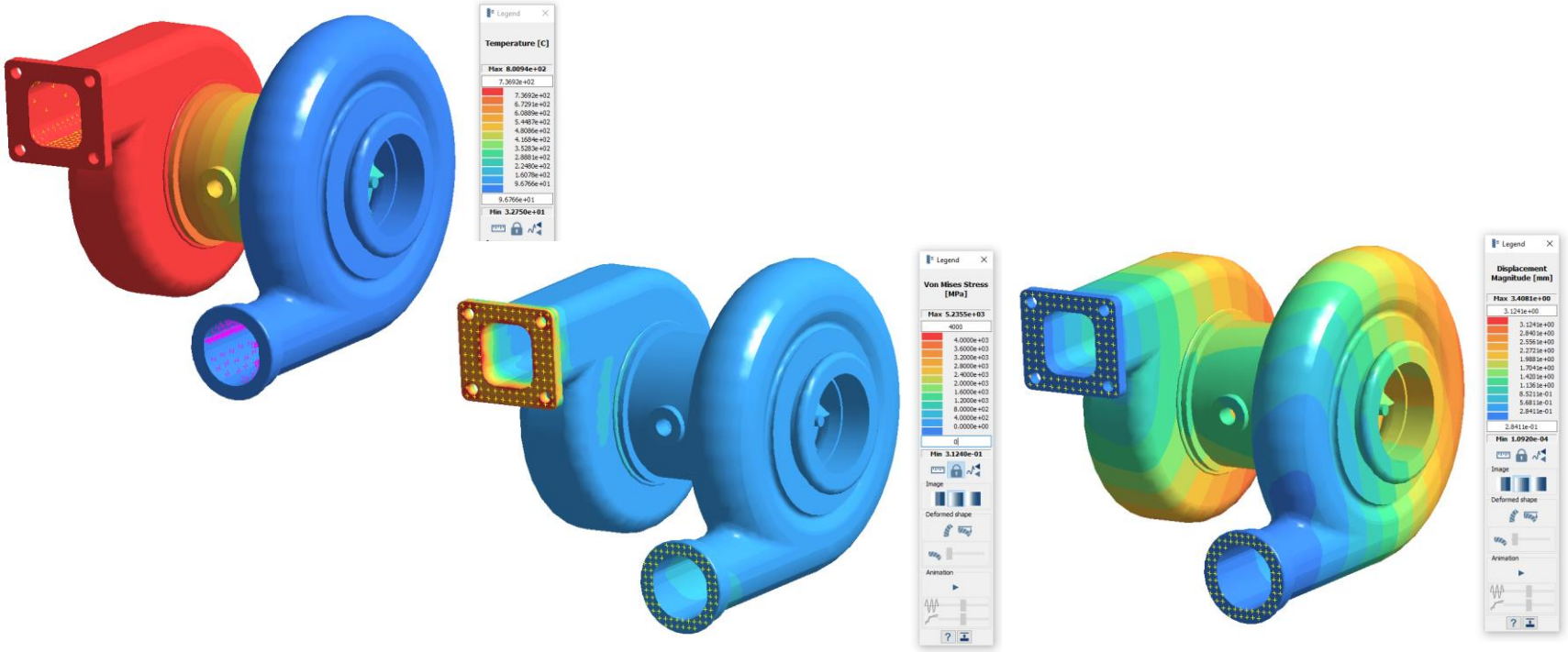
Thermal analysis

- Demo



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SIMSOLID FEATURES 2020.X AND NEWS

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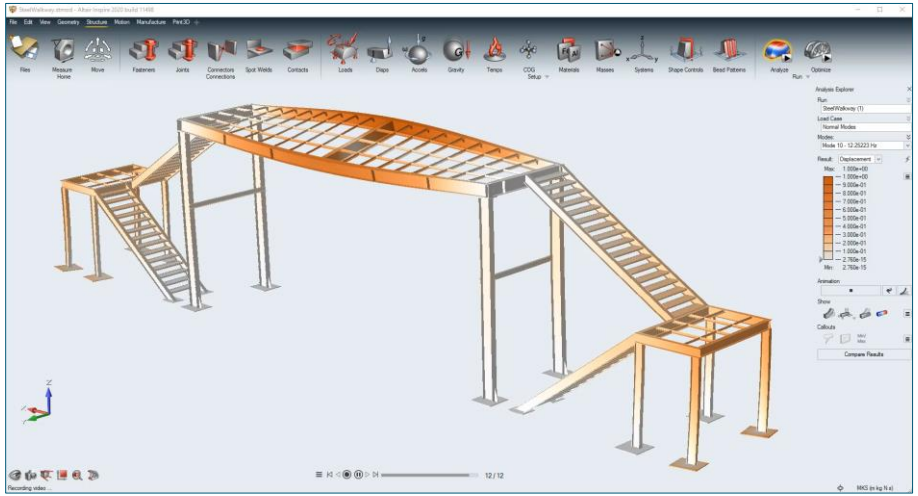
→ Module 7 – next week !!

SimSolid Solver in Inspire

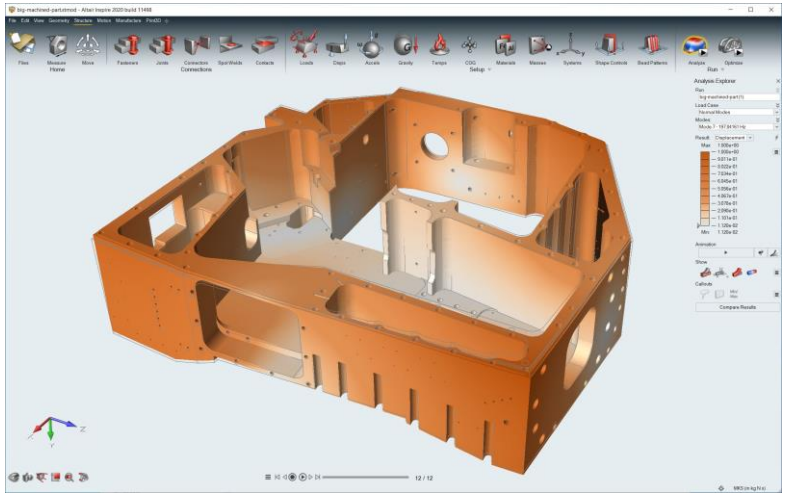
Inspire enables easy and quick geometry modification for iterative design studies



393 parts

10 modes

2 min solve



1200 faces

5 modes

<1min solve

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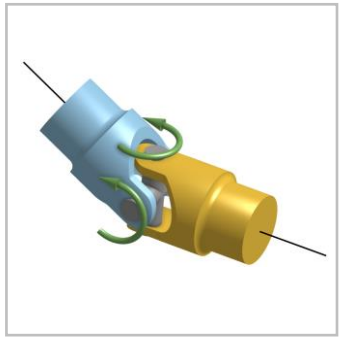
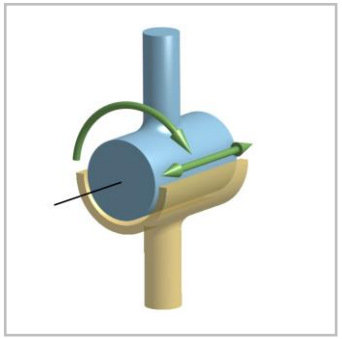
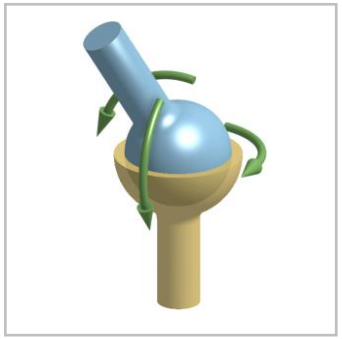
2020: New SimSolid Virtual Joints



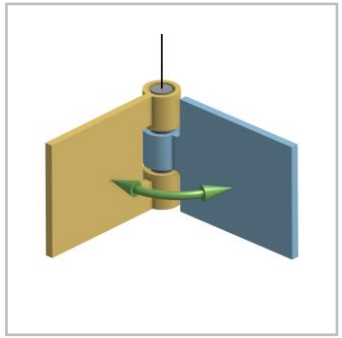
Universal
2 DOF, 2 axes



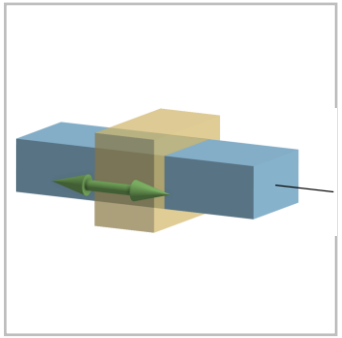
Cylindrical
2 DOF, 1 axis



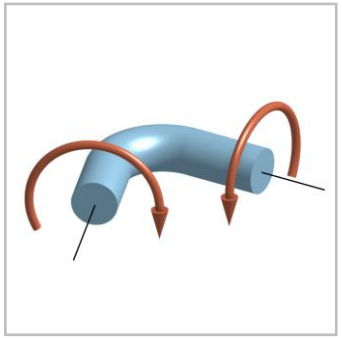
Ball
3 DOF, no axes



Hinge
1 DOF, 1 axis



Linear guide
1 DOF, 1 axis



Flexible shaft
5 DOF, 2 axes

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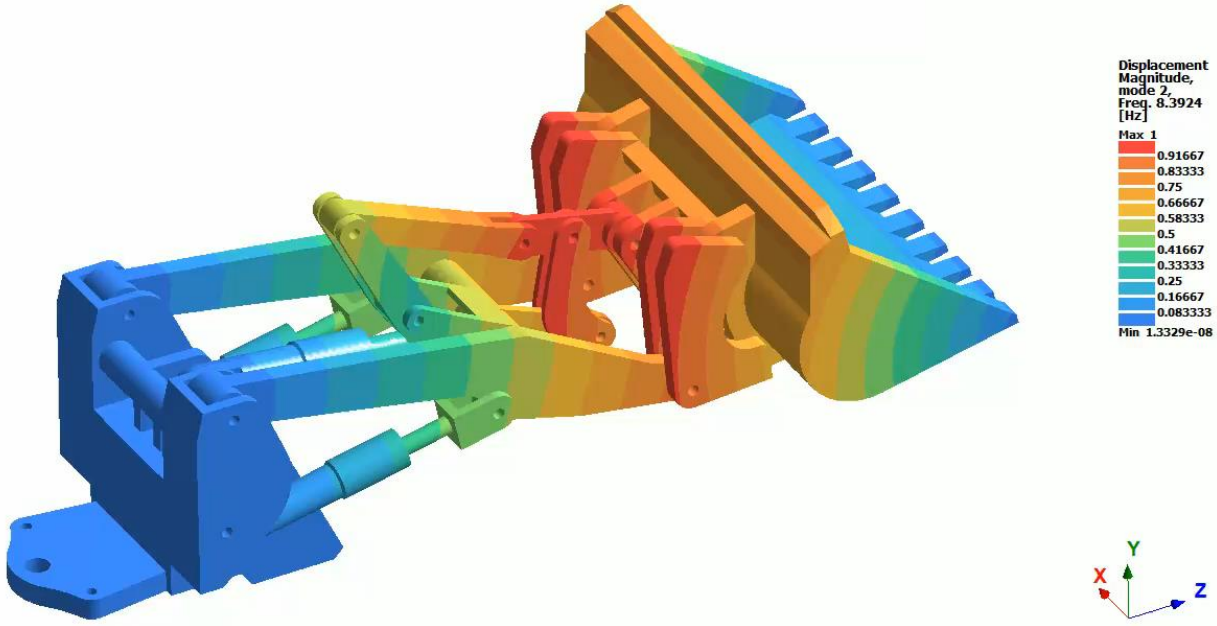
2020: New virtual joints

SIMSOLID



Design study 1 | Modal 1

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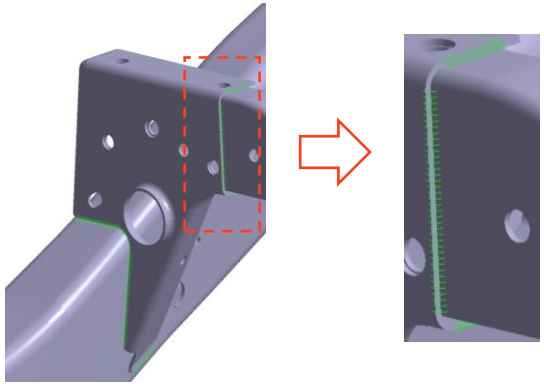
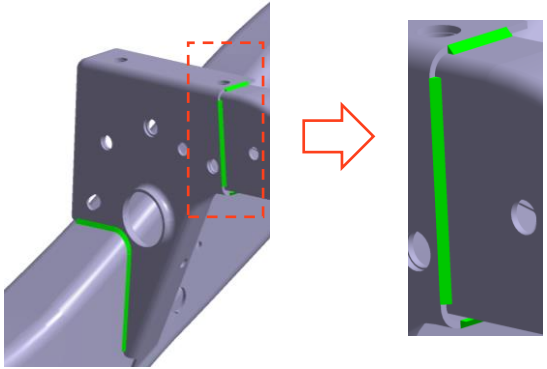
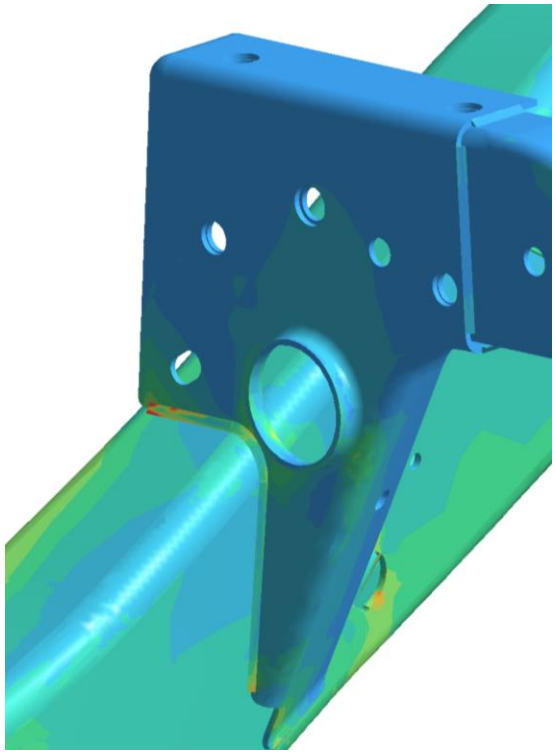
2020: New 3D solid seam welds



Previous – Connection based welds



Release 2020 – 3D solid based welds



Release 2020 - Weld stresses

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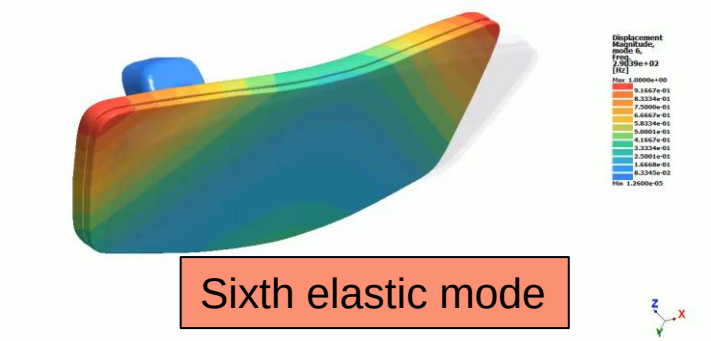
2020: Adhesive Joints

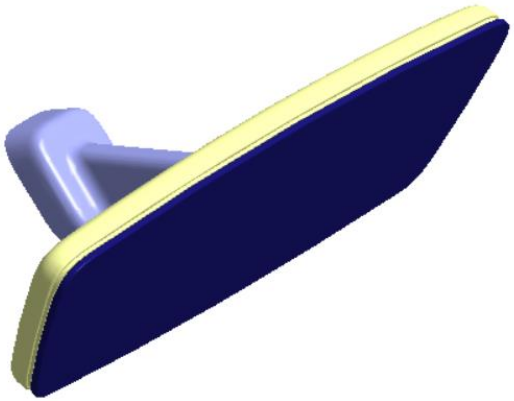
SIMSOLID

Represents sealants and structural adhesives

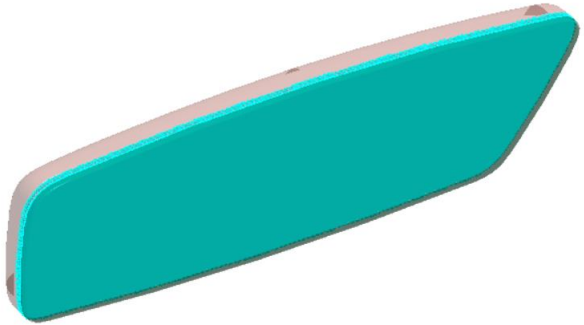
- Adhesives from Connections
- Adhesives from Tubes



Sixth elastic mode



Rearview Mirror



Adhesive connection between the mirror/frame

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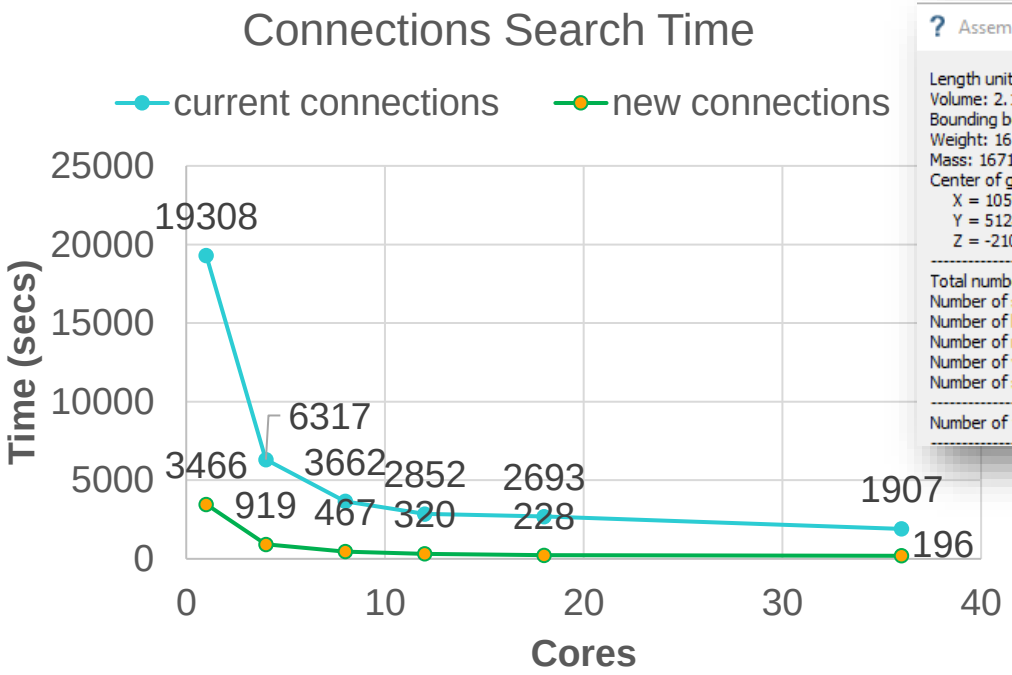
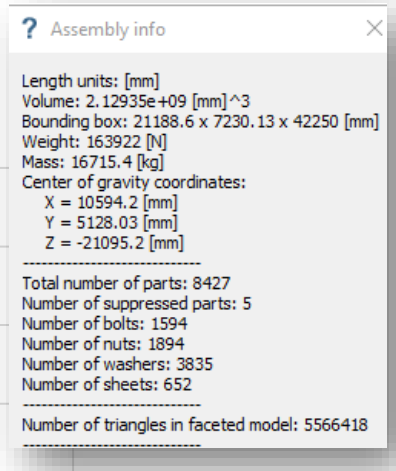
2020: Performance improvements

Regular Connection Search TIME - 24,000 Connections





Current connection search
7x speedup with 18 cores
10x speedup with 36 cores

New connection search
15x speedup with 18 cores
18x speedup with 36 cores

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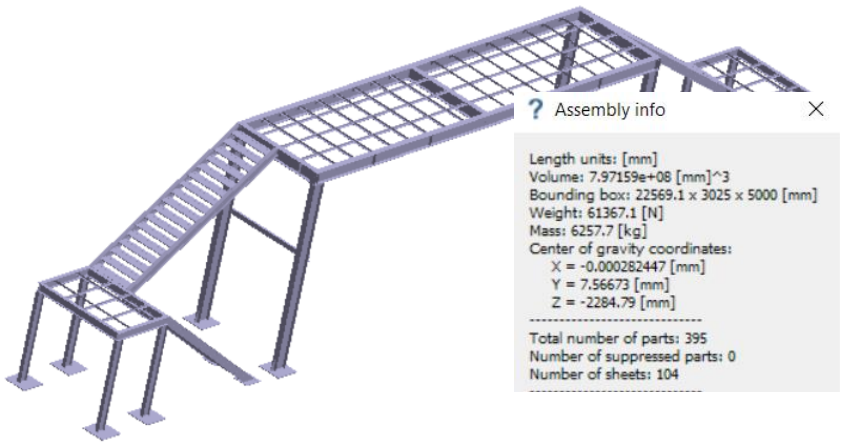
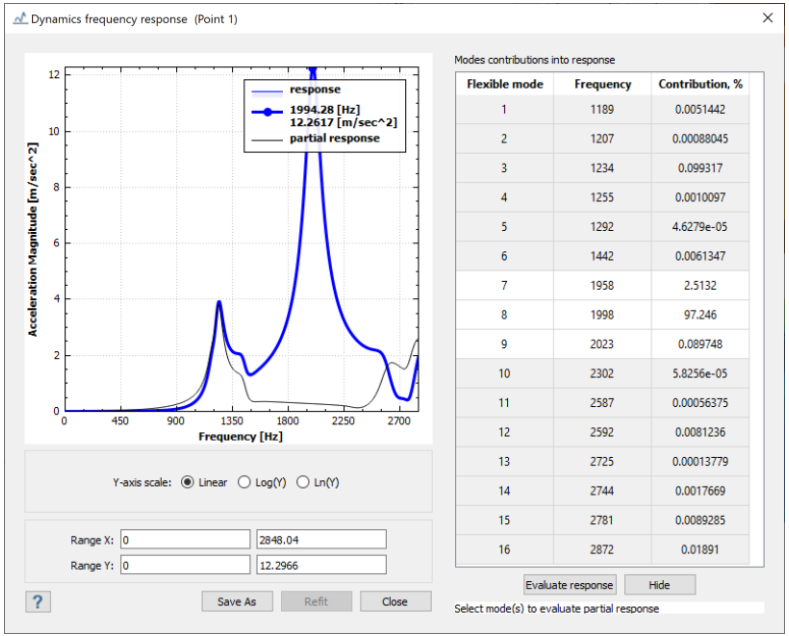
2020: Partial dynamic response

- Modal contributions into response
- Partial dynamics response





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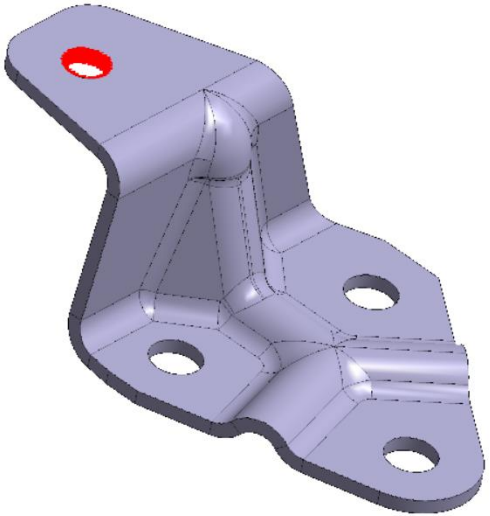
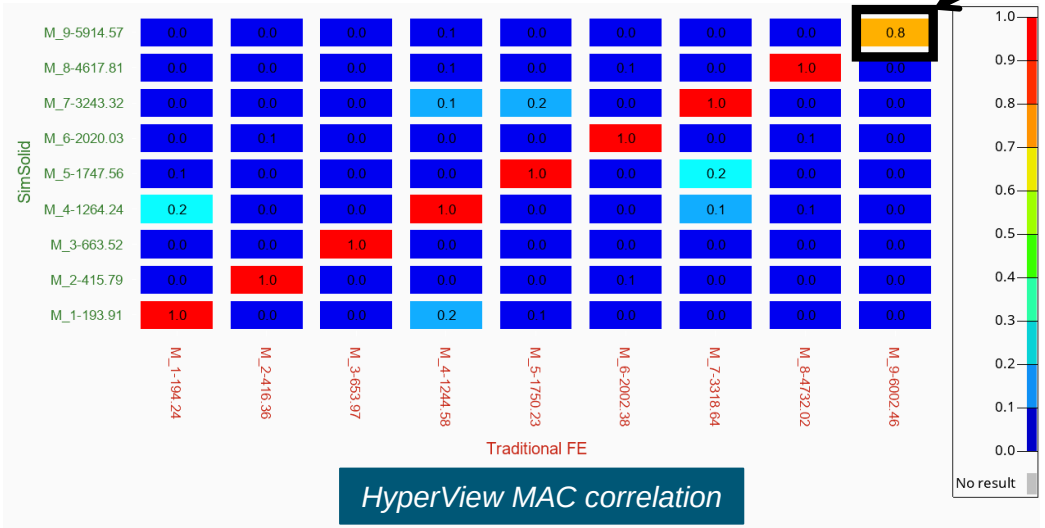
2020: Mode shape export

- **Mode shape export** – mode shapes can now be exported in Universal file (UNV) format at a given set of datum points.



Modal correlation study of a bracket



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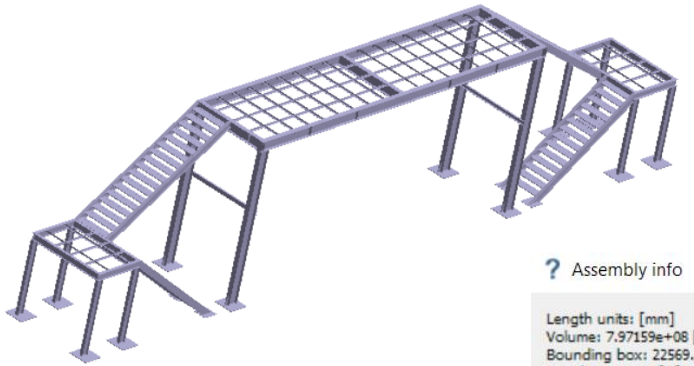
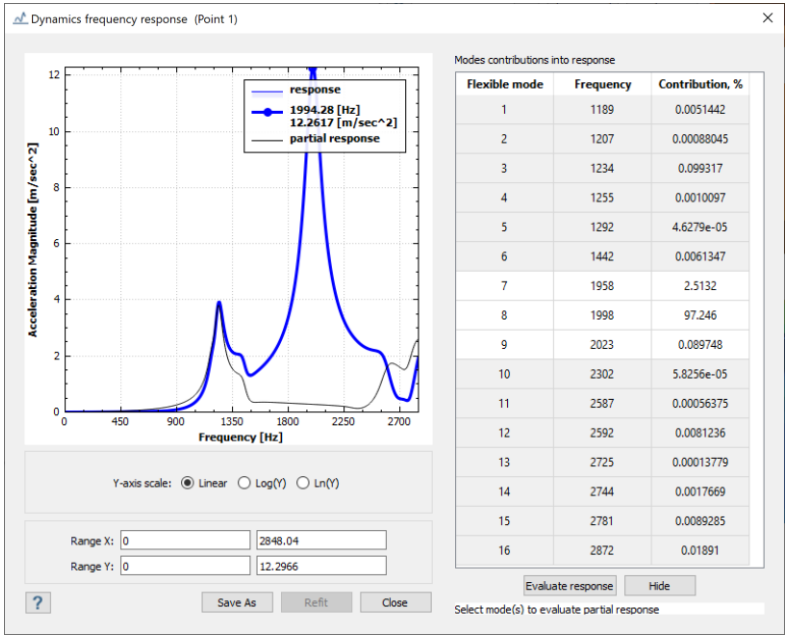
2020: new Dynamic results

- **New Dynamic results** – New velocity, acceleration and equivalent radiated power (ERP) results available for frequency response analysis.





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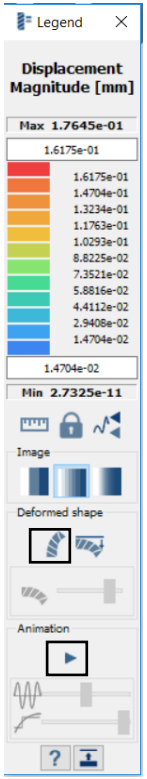
2020: animation improvements

- **Static animation improvements** – New in frequency response analysis, static animation of results are now available for each frequency



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2020: Equivalent Radiated Power (ERP)

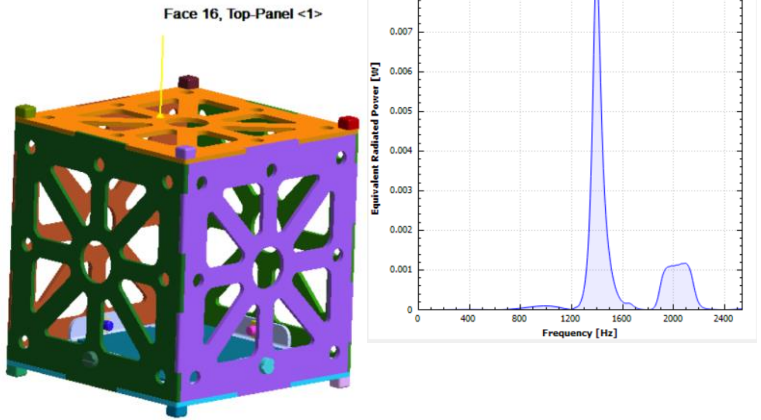
Background: ERP helps in understanding the acoustic contribution of a vibrating structure without running a full-blown acoustic simulation.

$$ERP = ERPRLF * (0.5 * ERPC * ERPRHO) \int V^2 dA$$

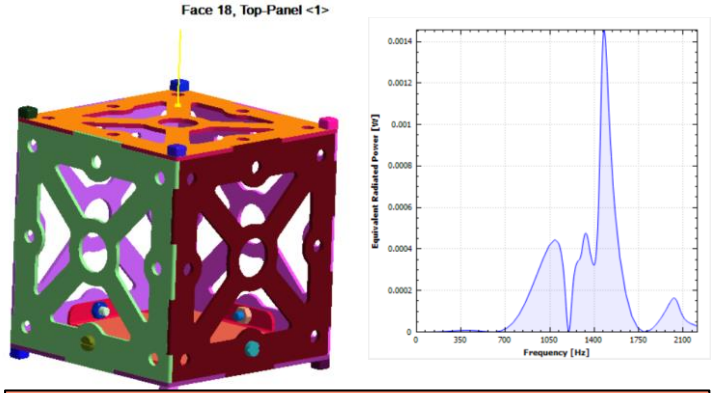
V is the normal velocity of the picked point

ERPC (speed of sound in air) = 343 m/s

ERPRHO (density of air) =



Design 1: Peak Panel ERP = 8 e-3 W



Design 2: Peak Panel ERP = 1.4 e-3 W

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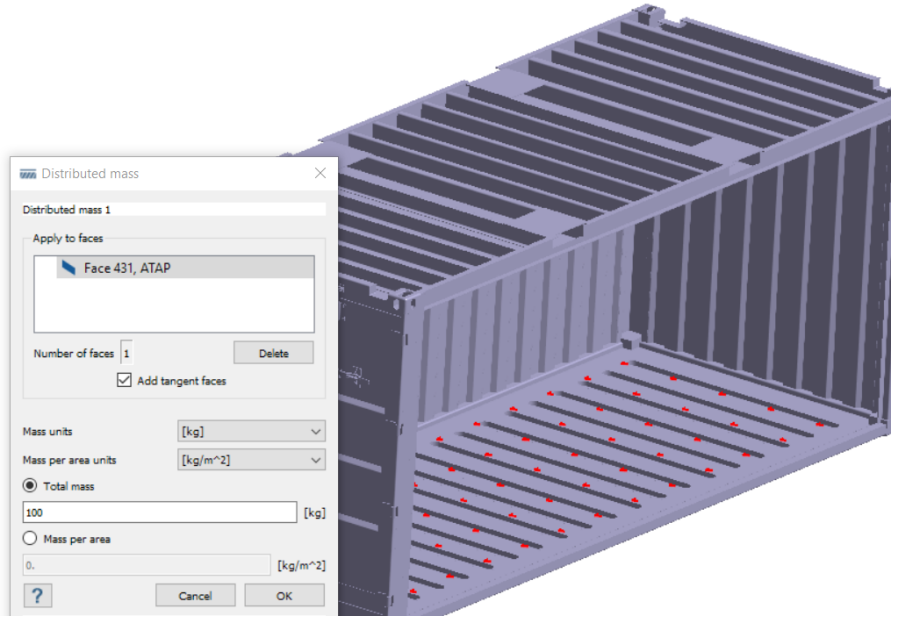
2020: Distributed Mass and Liquid Body

- Distributed mass in now available in static and dynamic analysis
- Fluid mass representation is also supported
  - Adds distributed mass to the structure and, therefore, changes its inertia and dynamics.
  - Incompressible fluid can significantly change vibration modes and general deformations at fluid enclosure because the volume of the enclosure is always preserved.



Distributed mass applied to container's floor

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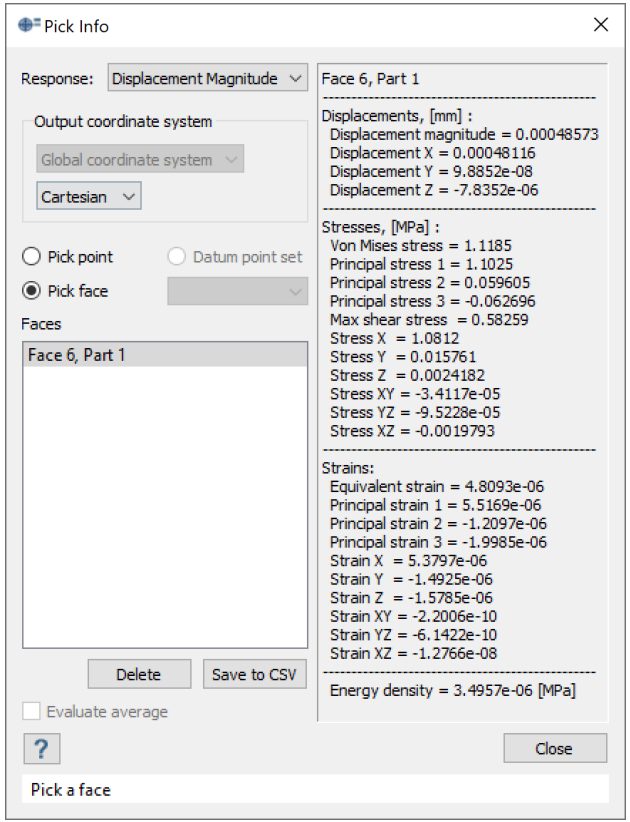
2020: Pick Info improvements

- New selection by face option. This provides an average of the result value over the selected face.
- In addition to average values, total face values are provided for:
  - thermal flux
  - equivalent radiated power (ERP)



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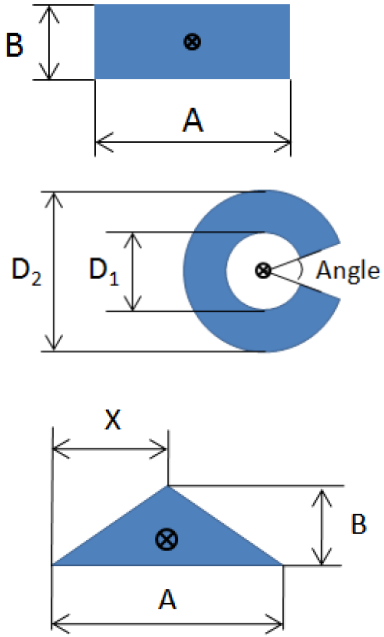
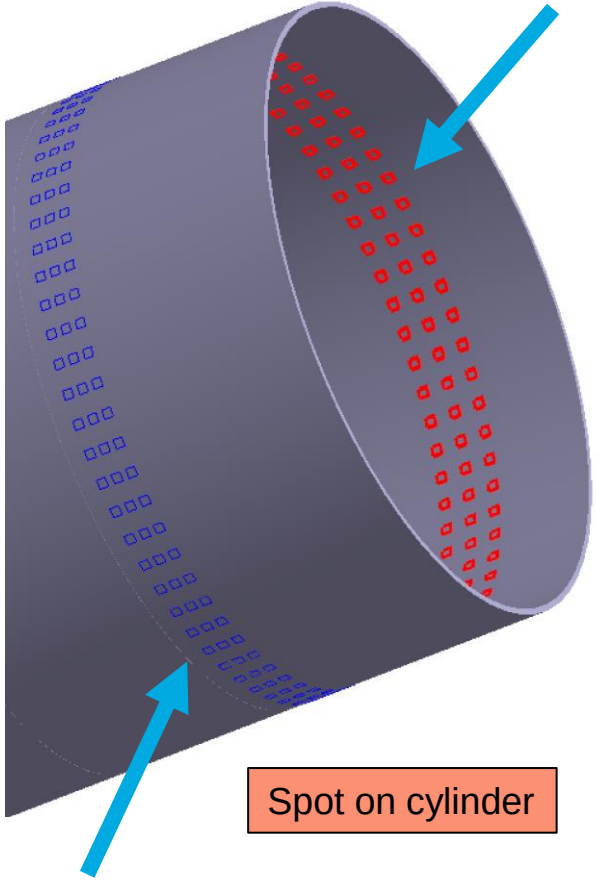
2020: Spots' improvements

- Spots define local boundary condition region
- Broad range of existing shapes – rectangle, circle, triangular
- New for 2020 – spot section on cylinders and import from CSV now available
  - Spots can be created on internal or external cylindrical faces
  - Circular spots can be imported from a CSV file





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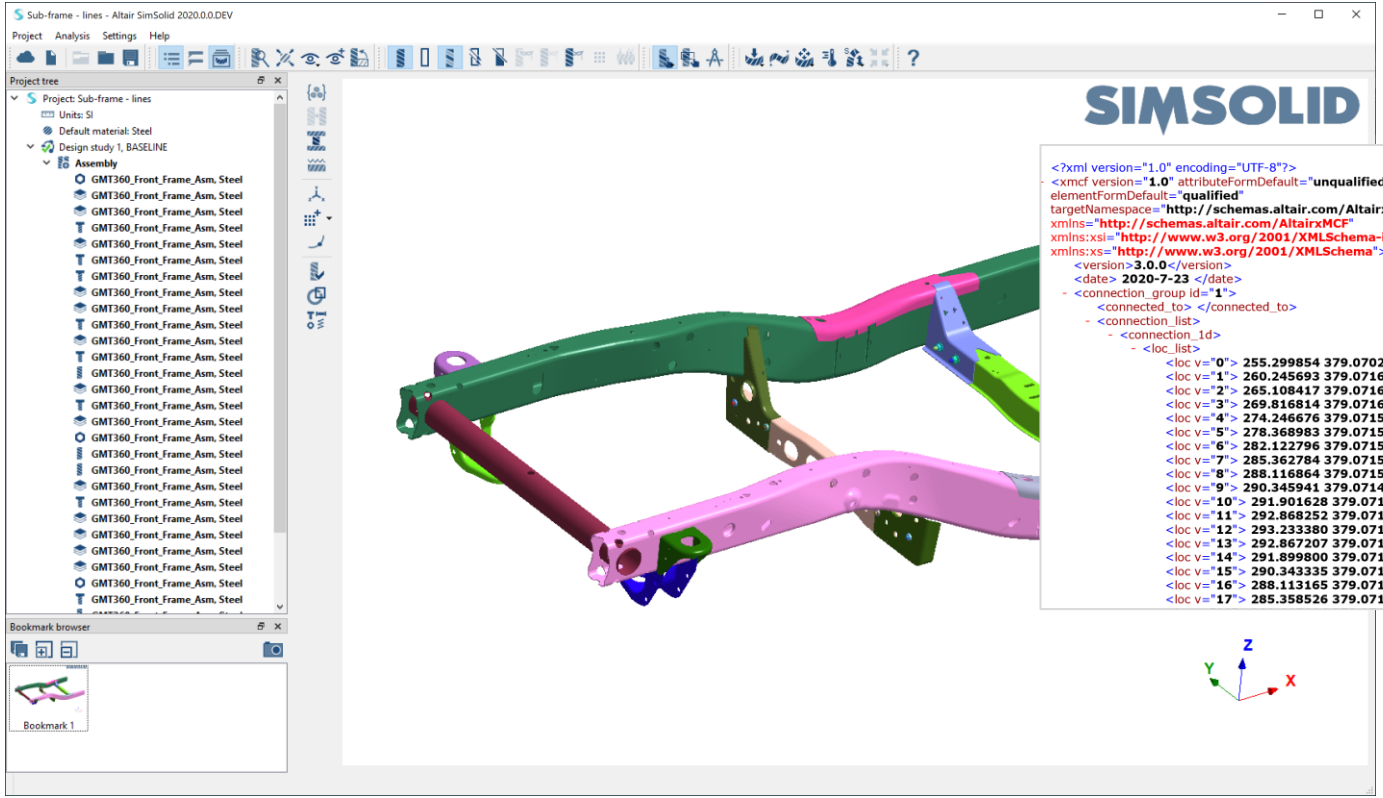
2020.1: Welds from xMCF xml file workflow



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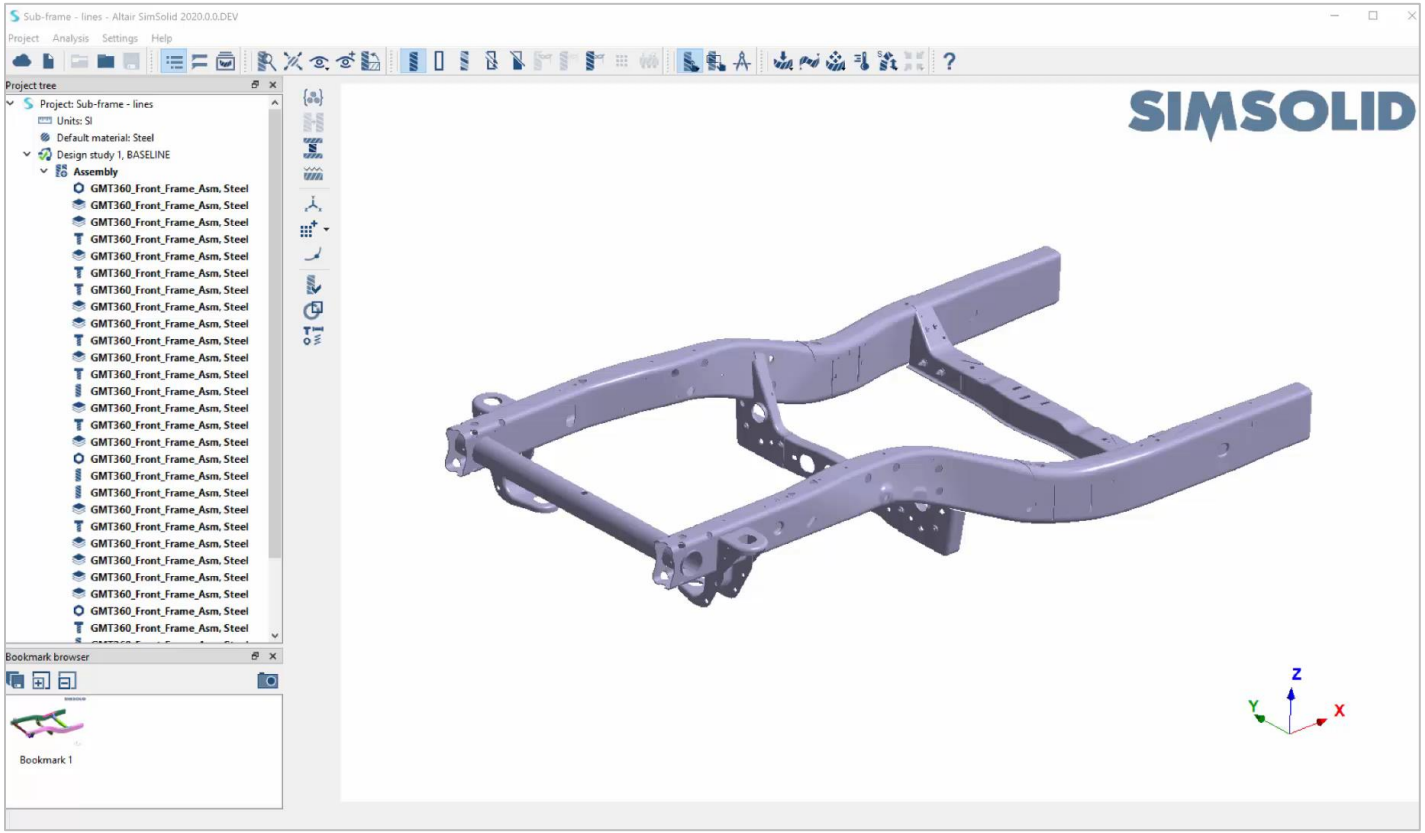
2020.1: Welds from xMCF xml file workflow



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2020.1

- old connection-based seam welds are automatically converted to 3D solid welds wherever possible
- Additional seam weld info on geometry dialogs and other seam weld related info options

- New SSP file format → 3x – 4x smaller filesize
- Enhanced equation solver → Performance improvement of 2x – 5x for each equation solve (once each solution pass)

- New Reverse displayed parts hot key
- Multiple fixes

2020.2

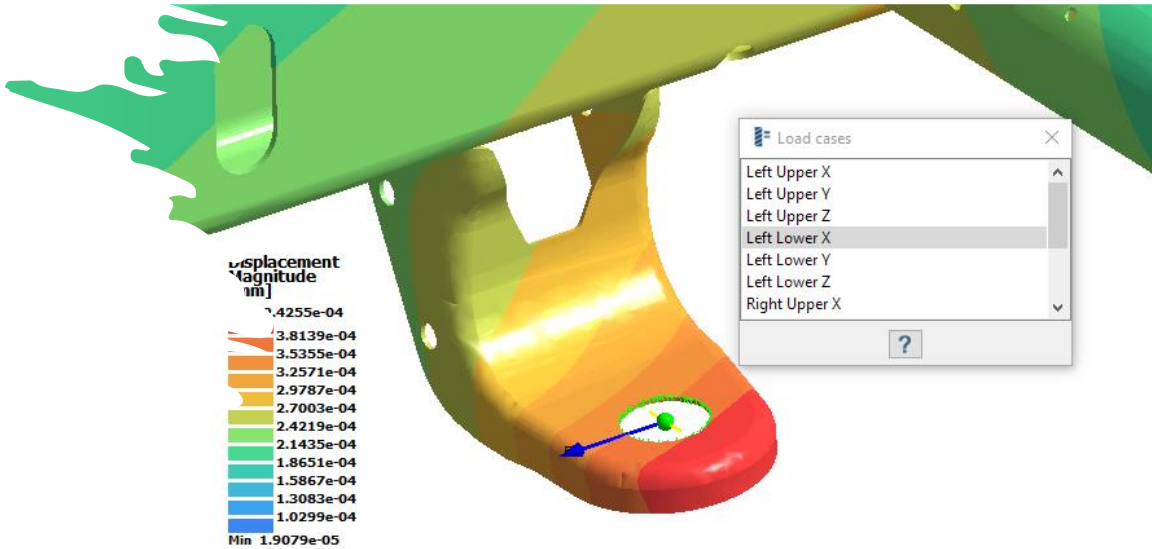
- Fatigue analysis
- Teamcenter integration
- Multi-loadcase workbench
- Weld material assignment
- Seam welds on curvature
- Lighter, faster response mesh
- Faster modal solver

2020.2: Fatigue Analysis

- Stress-life
- Sequential and time-series history
- Mean stress corrections

Multi-loadcases Workbench

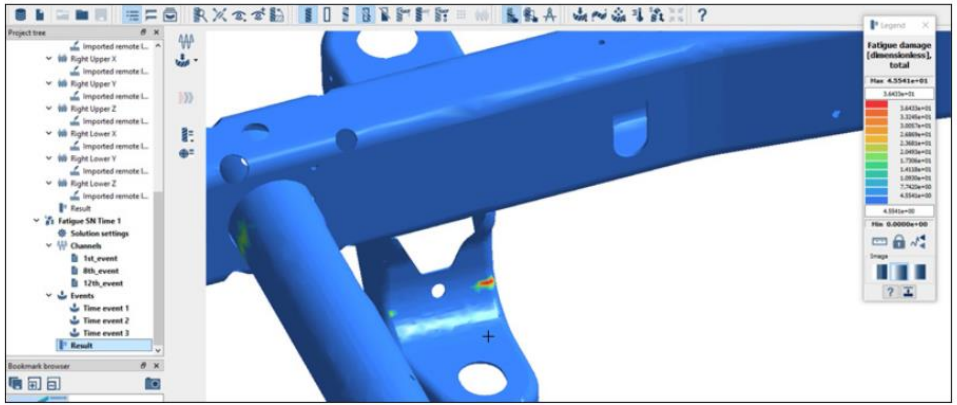
- Multiple static load cases
- Linked to fatigue analysis



2020.2: Fatigue

- Webinar on Demand: “Fatigue Assessment at the Speed of Design”

  https://web.altair.com/2021-fatigue



This session is ideal for designers and design engineers who want to rapidly explore the fatigue life of their designs during the early CAD stage of development. Join us and see first-hand how new fatigue assessment capabilities within Altair SimSolid can allow you to set up and run a fatigue analysis with multiple load cases in seconds.

Attend & Learn:

- Quickly import and setup large and complex models
- Automatically create loading events and repeats
- Identify damage and product life from loading history

Watch On-Demand

Performance & Robustness

Response Mesh

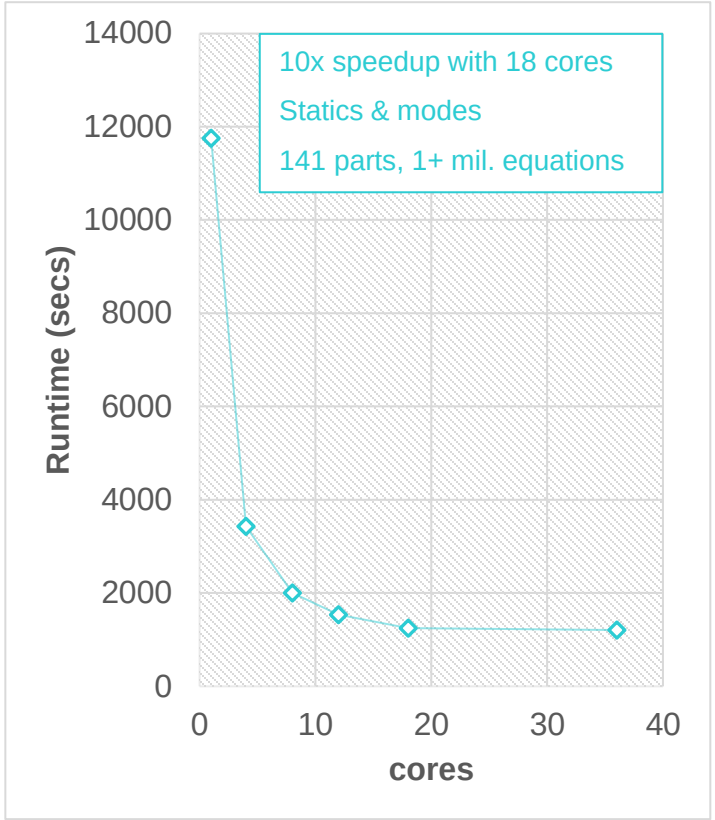
- Up to 16X Faster
- 2X-6X Lighter
- Ability to refine

Equations solver

- Up to 2-10X Solution speedup
- Reduced memory requirement
- Modes, linear and nonlinear statics

New SimSolid project file format

- Up to 3-4X lighter
- Faster to write



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Development Progress

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Solution Breadth

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
- Linearized stresses

Materials

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

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
- Total strain energy

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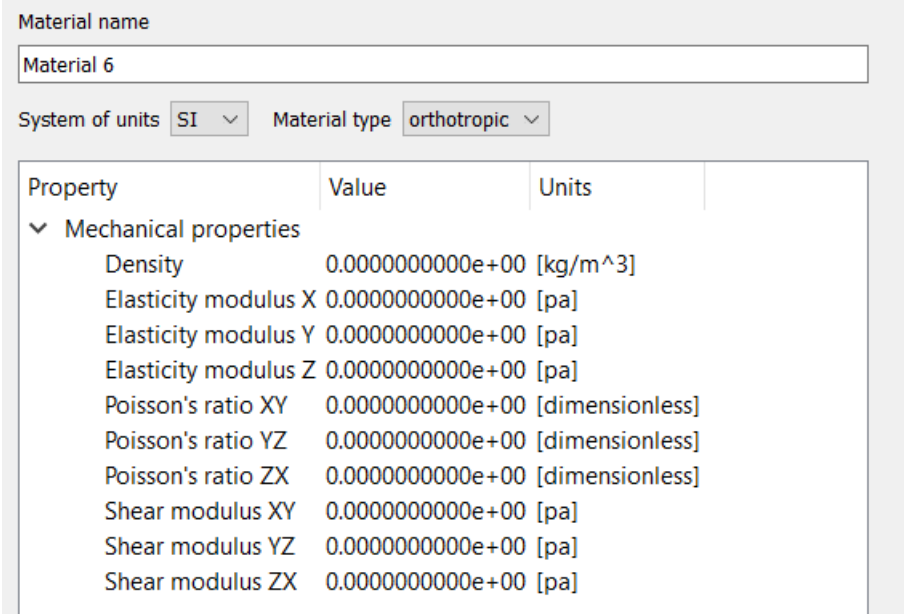
2021 New

- Stress linearization
- Strain-life Fatigue (EN uniaxial / multiaxial)
- Material Orthotropy
- Batch mode
- Sheet repair
- Multiple version install



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2021 Enhancements

- Material database
  - input of user defined SN / EN curves (Fatigue)
- Total Strain Energy result
- Absolute acceleration output
- Adhesive mass output
  - reviewing mass of the adhesives in model through info dialogue
- Weld export
- Coordinate System
  - rotate local axis at an angle

2021 Enhancements

- Animation of geometrical-non-linear results
- Bearing loads
  - can now be applied to any surface of revolution. Allows input of axial load / torque additional to radial.
- Sheet/face recognition improvement
- International keyboard decimal

VERIFICATION VS. FE

Verification Manual

NAFEMS about SimSolid

SimSolid in the News

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

DEVELOP3D

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

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

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

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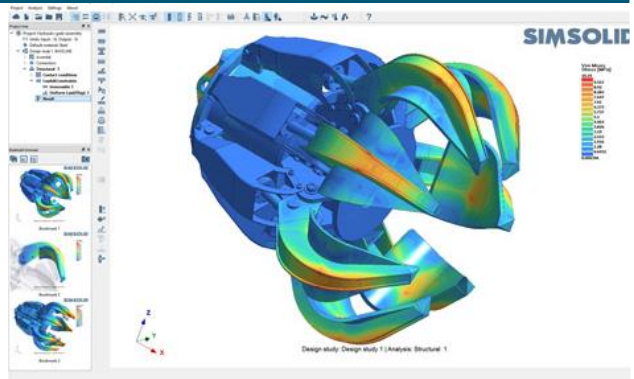
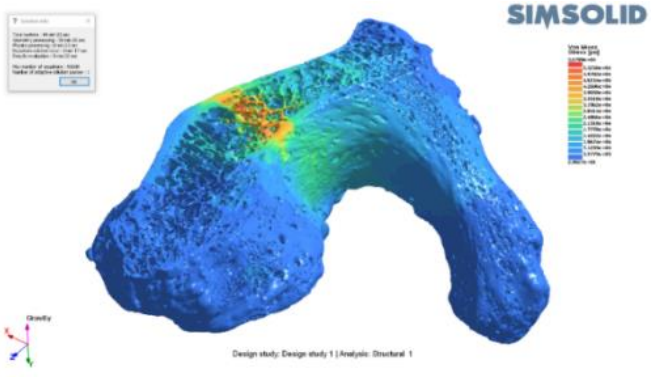
JOIN THE SIMULATION REVOLUTION

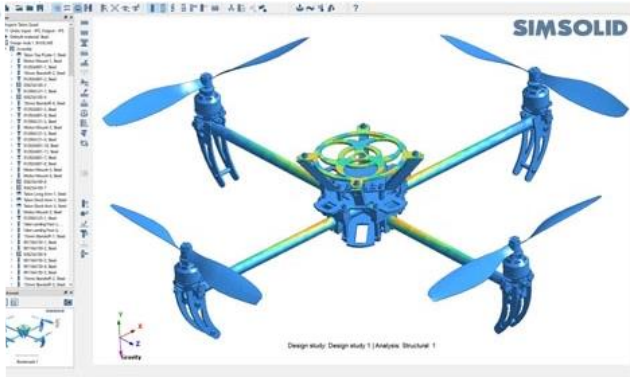
Fast, Easy to Use & Accurate



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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