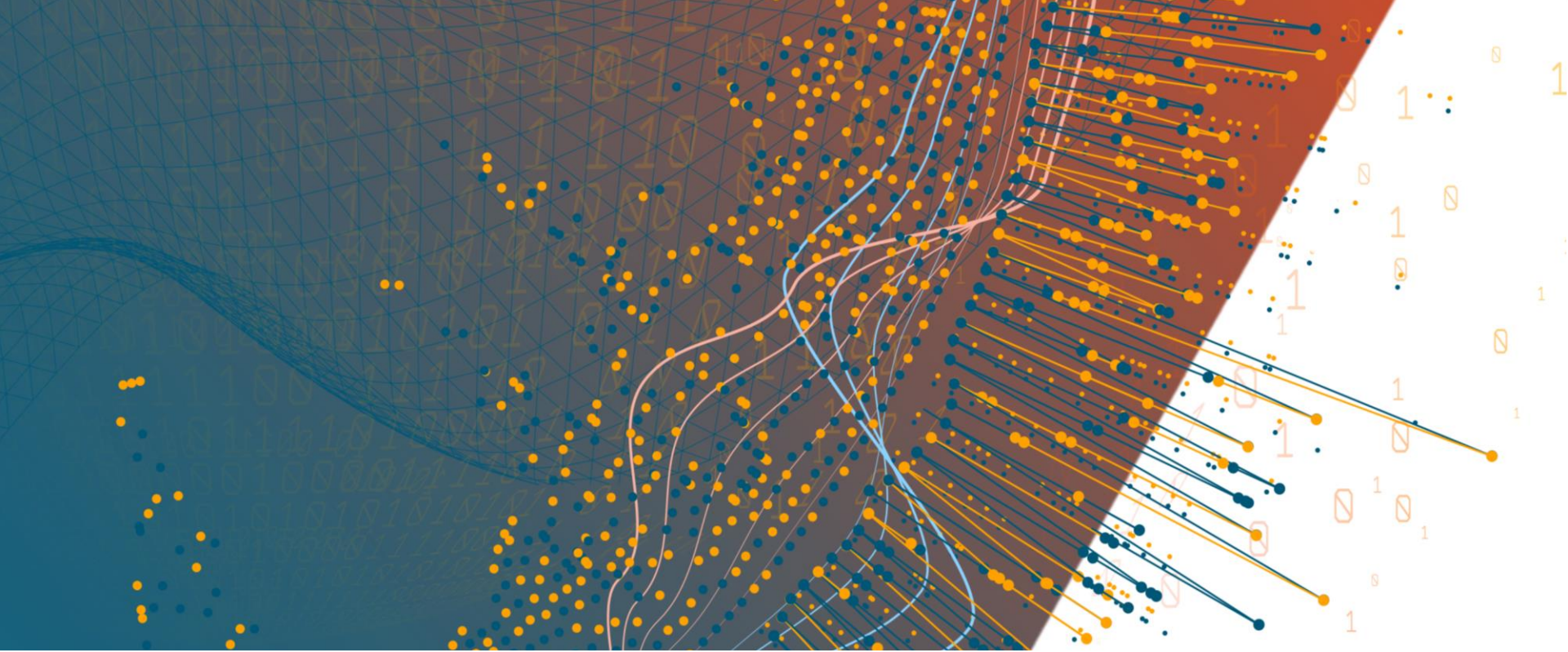

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SIMSOLID QUICK OVERVIEW
MODULE 2 – USER-INTERFACE / MODAL ANALYSIS

Sebastian Karp / Senior Application Engineer / February 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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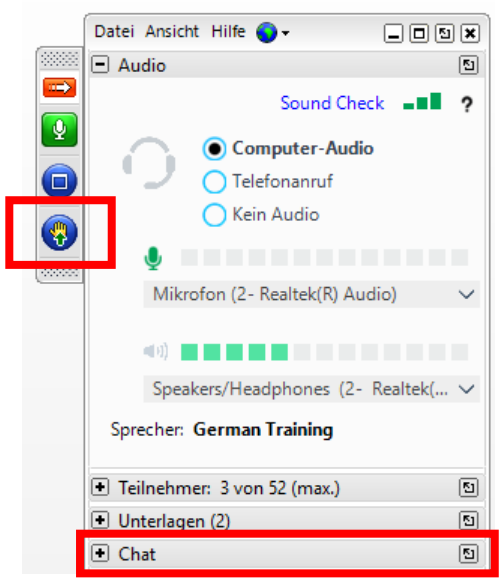
Organisational

- 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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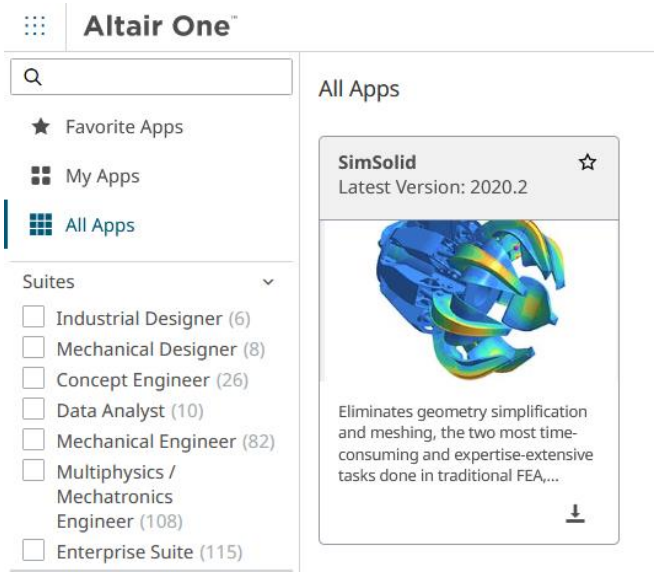
Have a look at…

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

- Download - www.altairone.com



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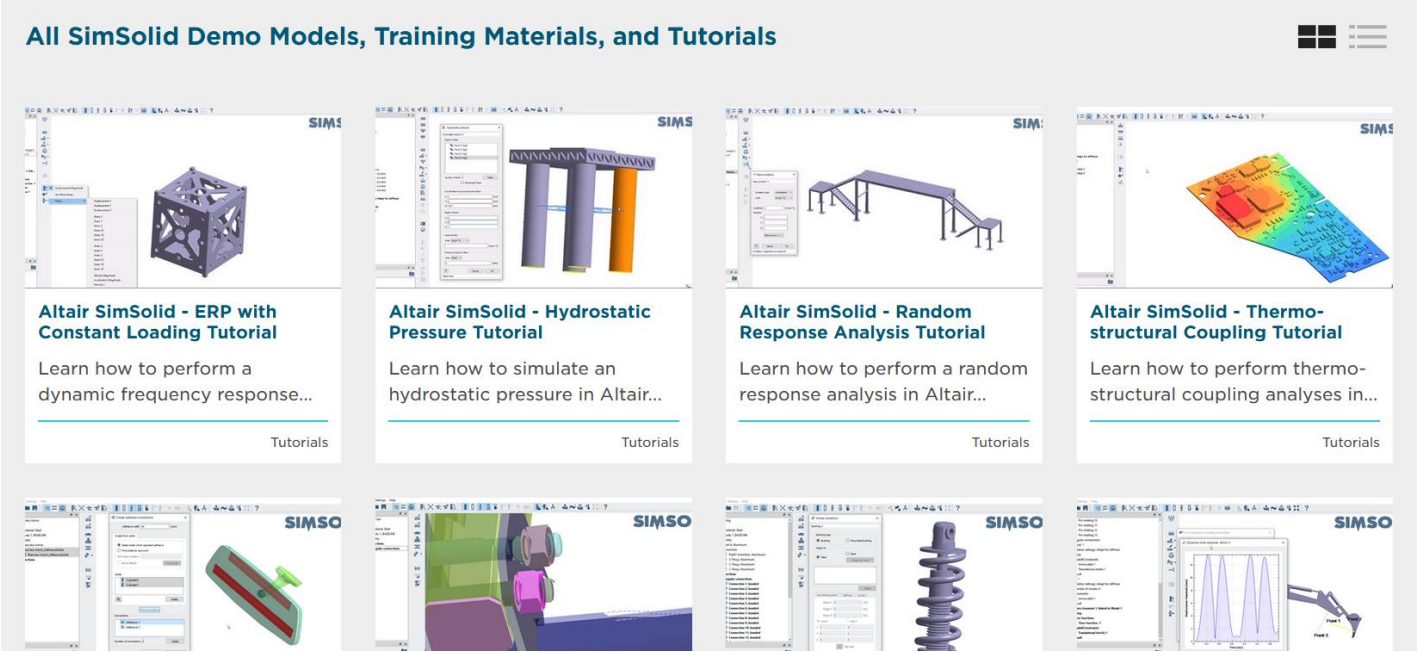
Have a look at…

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



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POLL

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USER-INTERFACE

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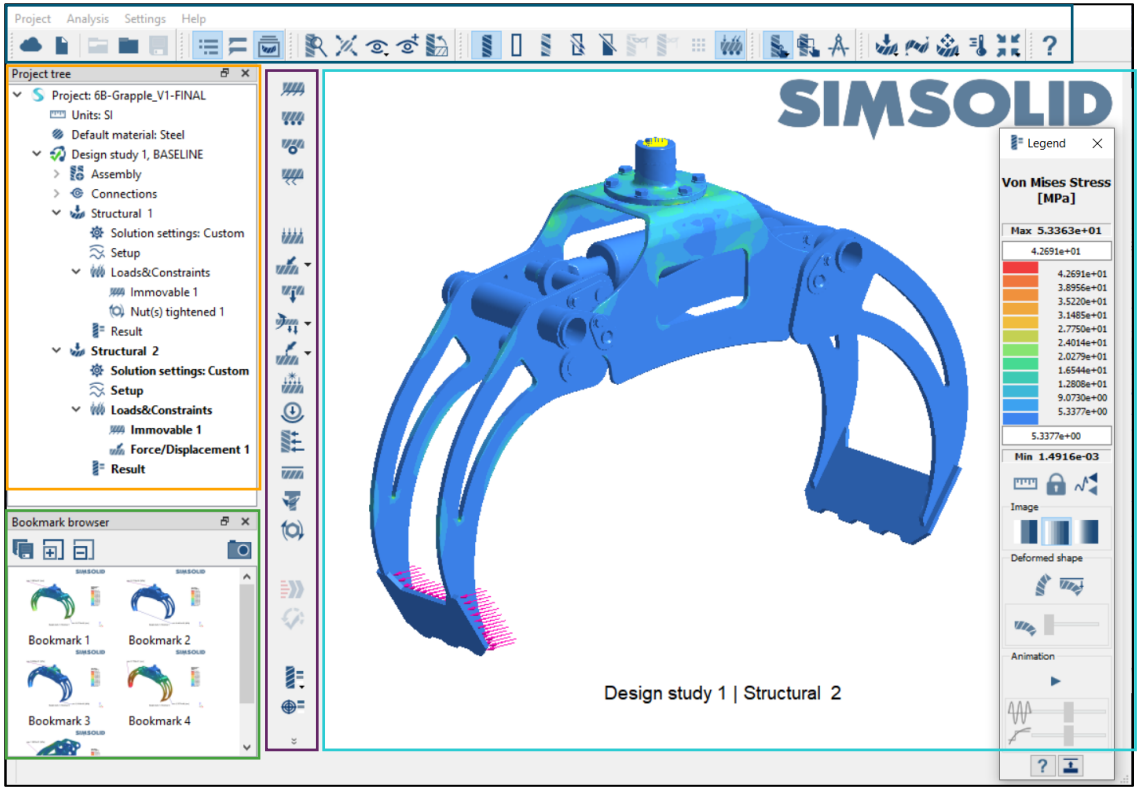
User Interface

- **Main Toolbar** - is used to access the most commonly used tools.
- **Project Tree** - is used to view and manage individual model entities.
- **Bookmark Browser** - is a convenient way to record the simulation and result images.
- **Workbench toolbar** - every workbench has a corresponding vertical workbench toolbar.
- **Graphics Area**



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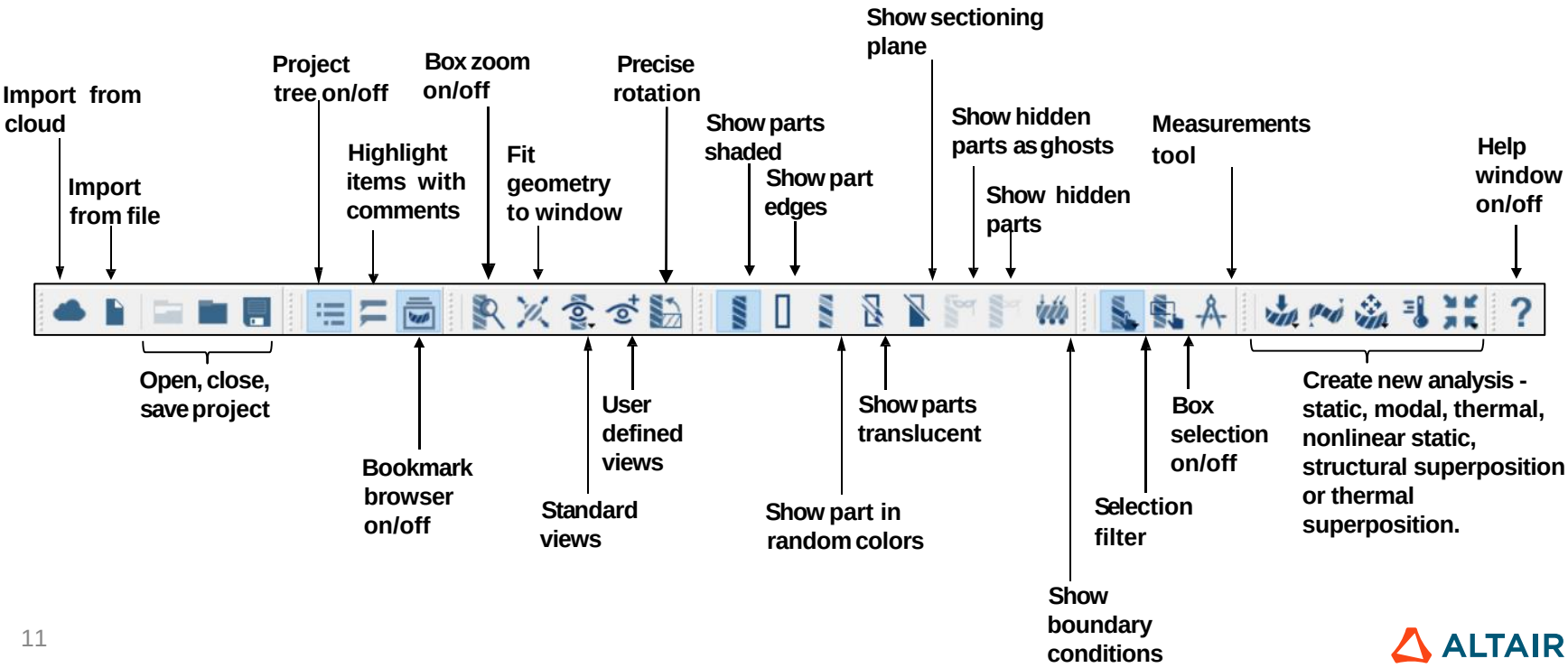
User Interface

Main Menu Toolbar



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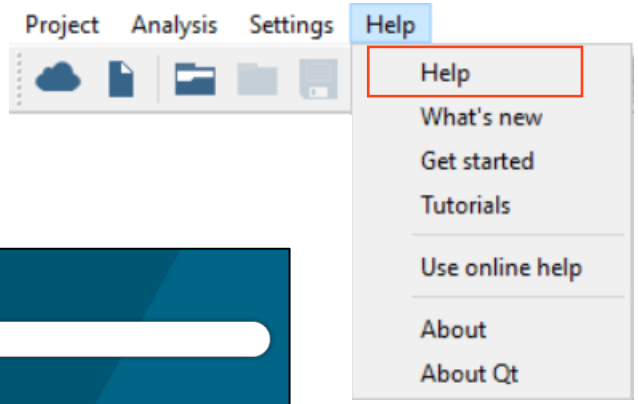
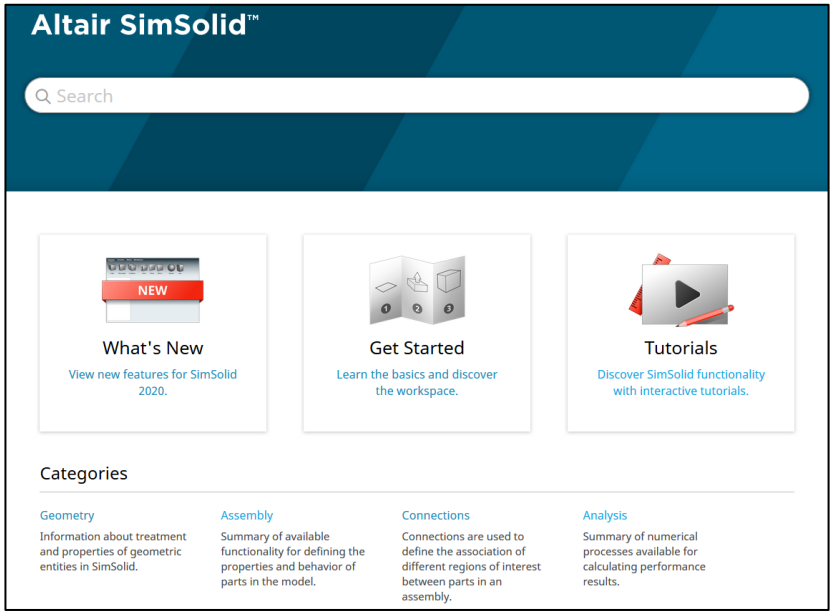
User Interface

Altair SimSolid Documentation

Access Altair SimSolid Help in the following ways:

- In the pull-down menus click **Help** > **Help**.
- In the **Main Menu Toolbar** click on ?
- Click **F1**.





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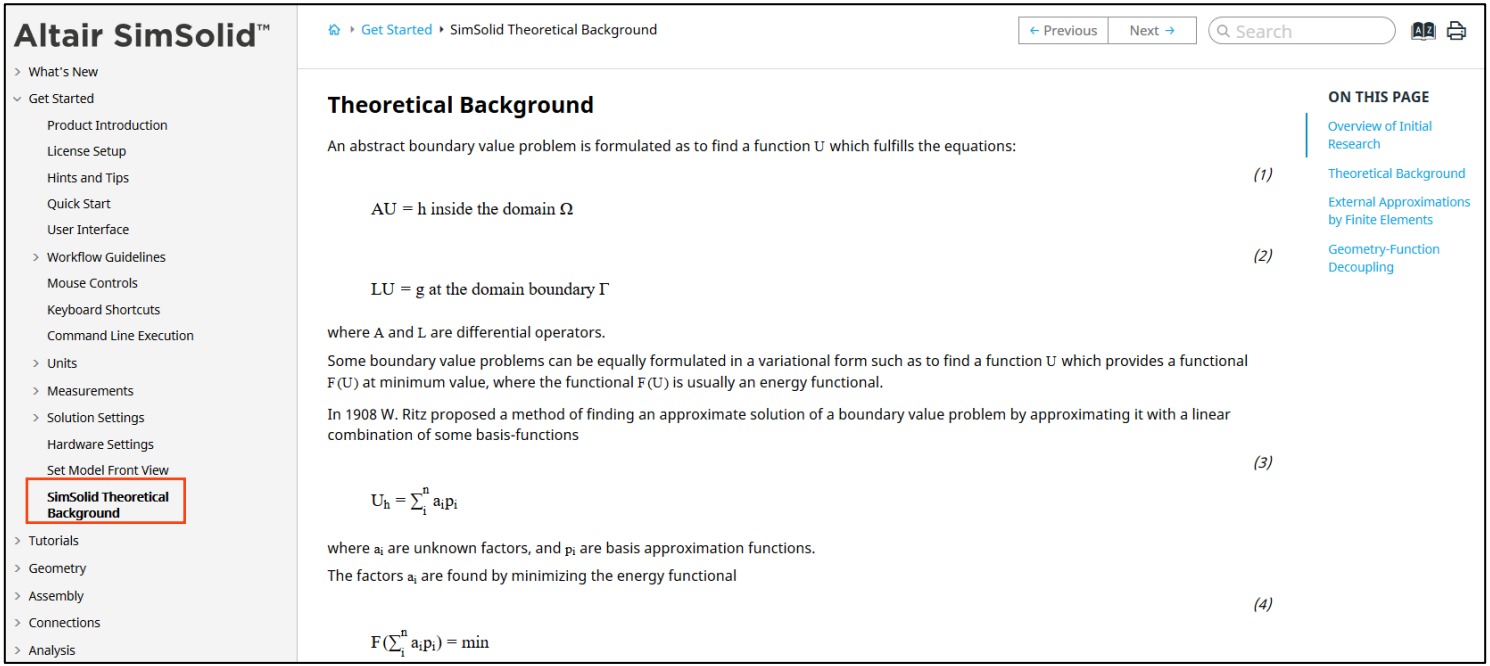
User Interface

Altair SimSolid Documentation

View new features, learn the basics and discover the workspace, also with interactive tutorials.



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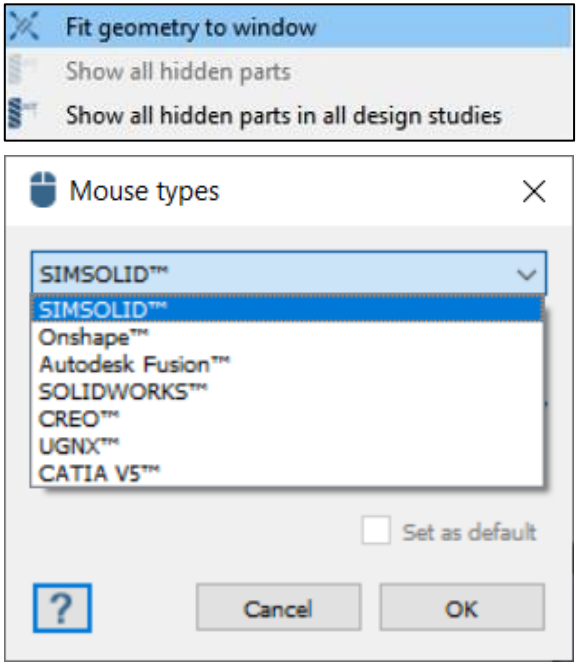
User Interface

View Manipulation

- **Model Rotation:** click and drag to rotate model.
- **Model Translation:** click and drag to pan model.
- **Model Zoom:** rotate to zoom the model.
- **Model Zoom Extents (Fit):**
  - pick on the main toolbar
  - click in the window background with and select **Fit geometry to window.**
- **Box Zoom:**
  - use from the main toolbar then click and drag box, using .
  - Hold Shift + .
- Alternative CAD system mouse mappings are available from **Settings > Mouse settings** menu.



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User Interface

Shortcut Keys

File management:

Shortcut Keys	Function
Ctrl + I	Import CAD file
Ctrl + O	Open project
Ctrl + S	Save project
Ctrl + W	Close project
Ctrl + Q	Quit application

Interface:

Shortcut Keys	Function
F	Fit View
H	Hide selected parts
I	Isolate selected parts (hide all other parts)
S	Suppress selected parts
U	Suppress unselected parts
D	Delete selected parts
A	Show all parts
B	Create new bookmark
Esc	Cancels any open dialog

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User Interface

Shortcut Keys

Show/hide:

Shortcut Keys	Function
Ctrl + F1	Show/hide welcome dialog
F1	Show/hide help
F2	Show/hide project tree panel
F3	Show/hide bookmark browser panel
F4	Show/hide project comments

View:

Shortcut Keys		Function
Shift + drag box		Box zoom
Shift + 1	Ctrl + F7	Front view
Shift + 2	Ctrl + Shift + F7	Back view
Shift + 3	Ctrl + Shift + F8	Left view
Shift + 4	Ctrl + F8	Right view
Shift + 5	Ctrl + F6	Top view
Shift + 6	Ctrl + Shift + F6	Bottom view
Shift + 7	Ctrl + F9	Isometric view

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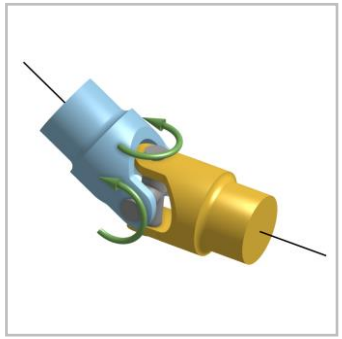
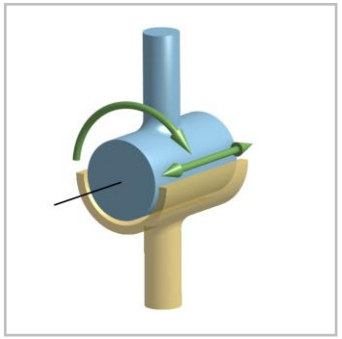
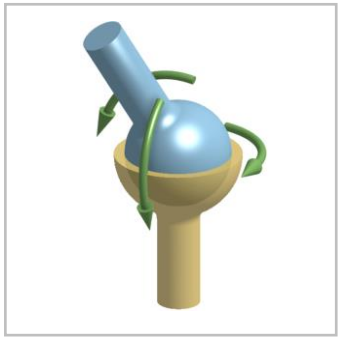
Virtual Joints v2020



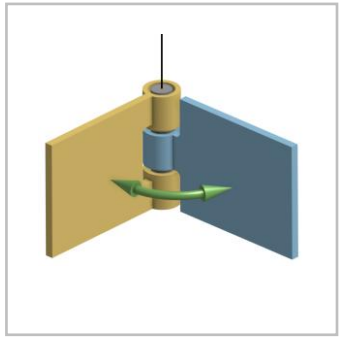
Universal
2 DOF, 2 axes



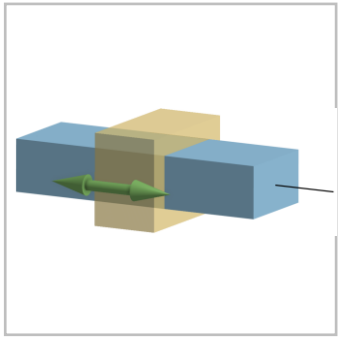
Cylindrical
2 DOF, 1 axis



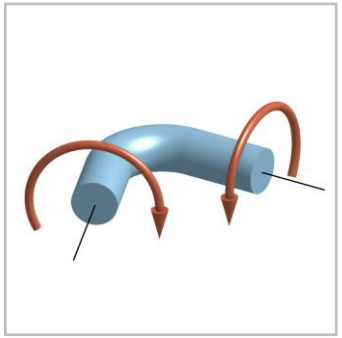
Ball
3 DOF, no axes



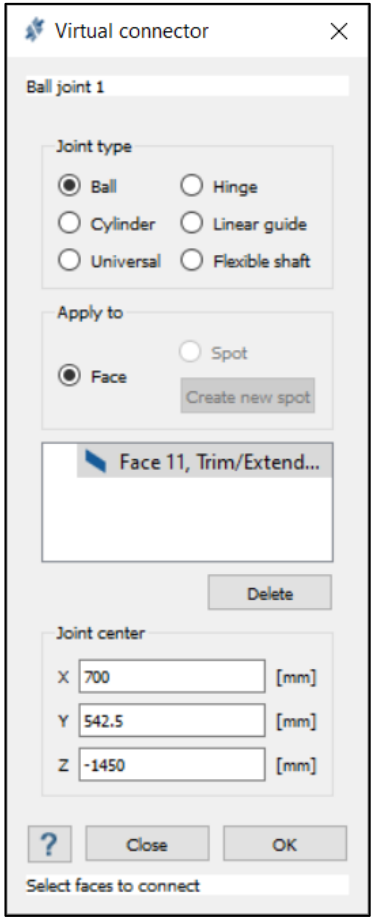
Hinge
1 DOF, 1 axis



Linear guide
1 DOF, 1 axis



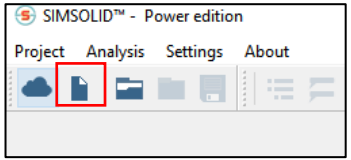
Flexible shaft
5 DOF, 2 axes

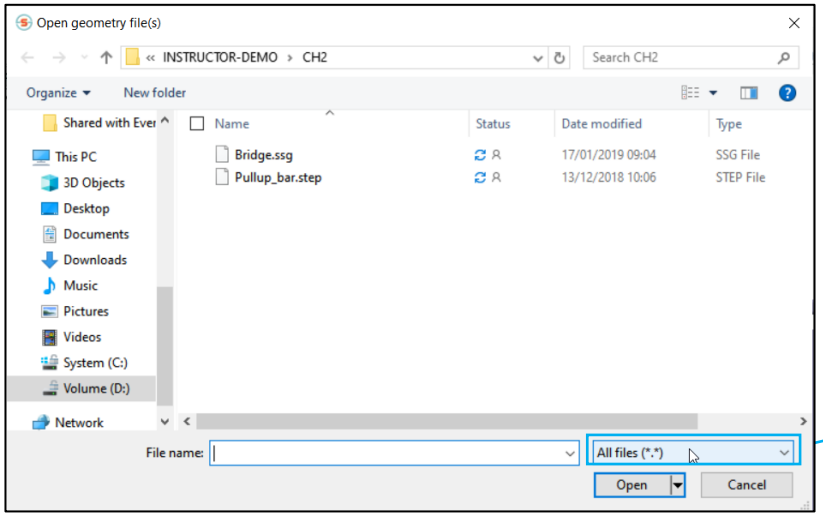


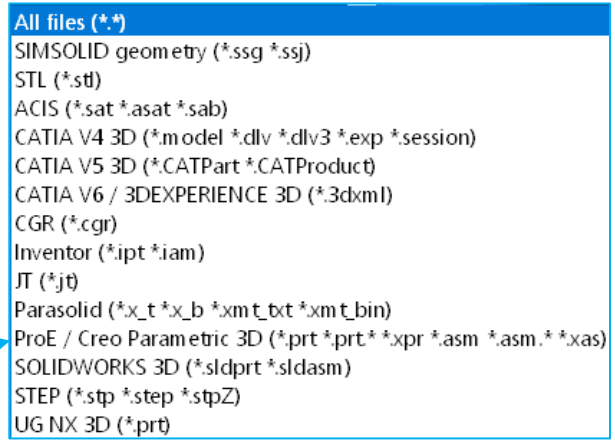
Geometry Import

Direct geometry import from CAD files

- SimSolid provides **integration** to the **SolidWorks**, **Fusion 360** and **Onshape** CAD systems as well as **direct access** to all popular CAD formats
- You can directly import geometry, by clicking on **Import from file.**
- Select the CAD file type from the **selection filter** and press **Open** button.





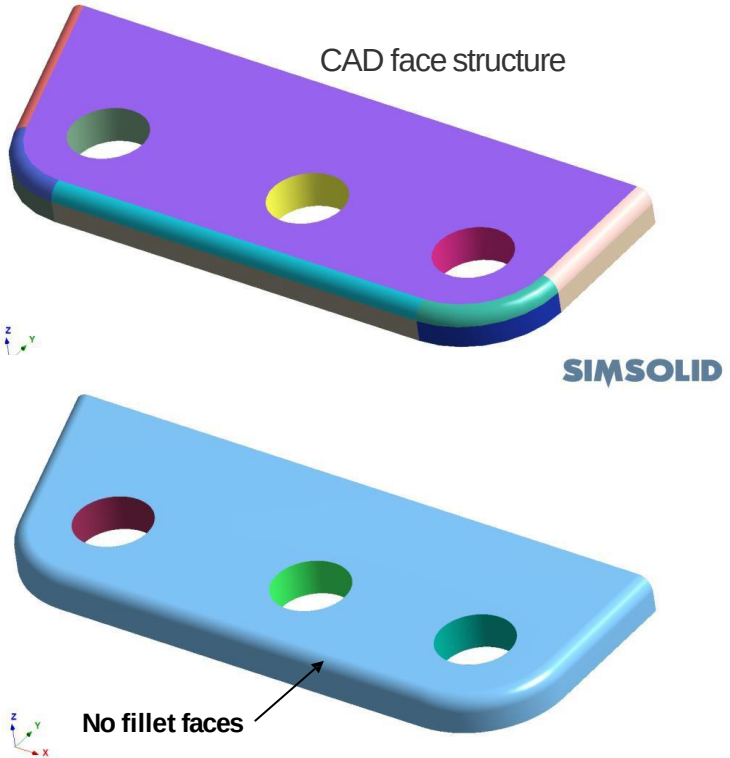


Geometry Considerations

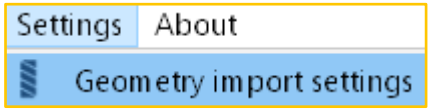
SimSolid does not import CAD surface or solid geometry. Instead it uses a more efficient faceted geometric approach.

- From **CAD** (SolidWorks, Fusion 360 or Onshape)
  - Full CAD hierarchical assembly tree structure used
  - CAD part faces used (preferred)
  - Facets are based on CAD add-in faceting parameters

- From **STL**
  - Multi-body STL used. Flat assembly tree structure only
  - **SimSolid** determined part face structure based on surface curvature (will miss fillet faces, see example on right)
  - Facets are based on STL file export parameters (must take care, as some CAD system export poor quality STL)

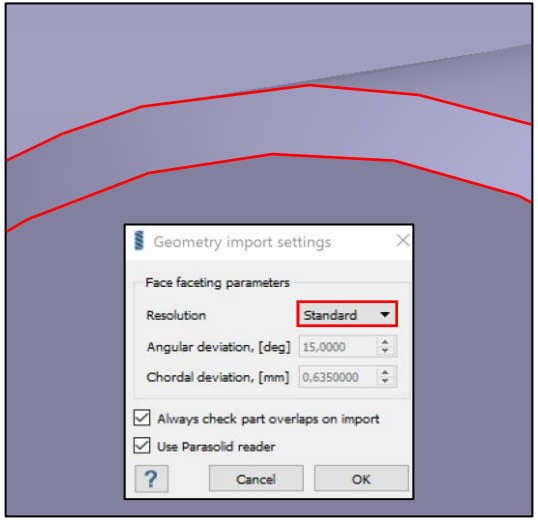


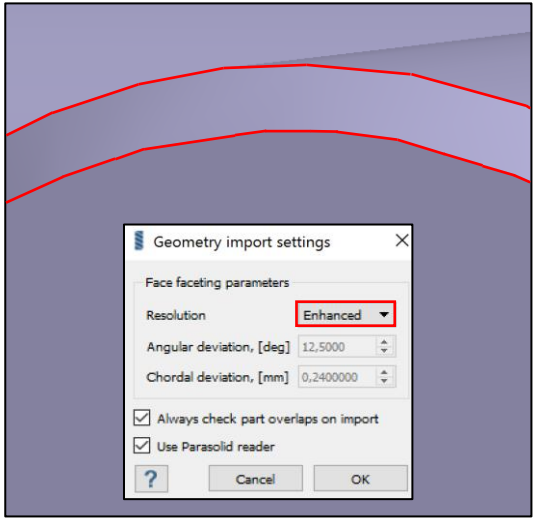
GEOMETRY CONSIDERATIONS - Facet Settings

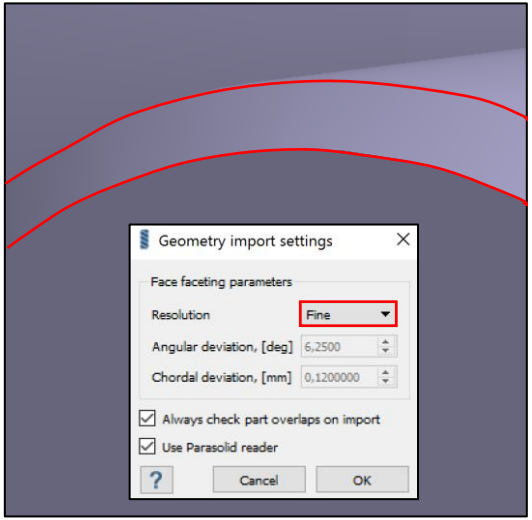


Resolution

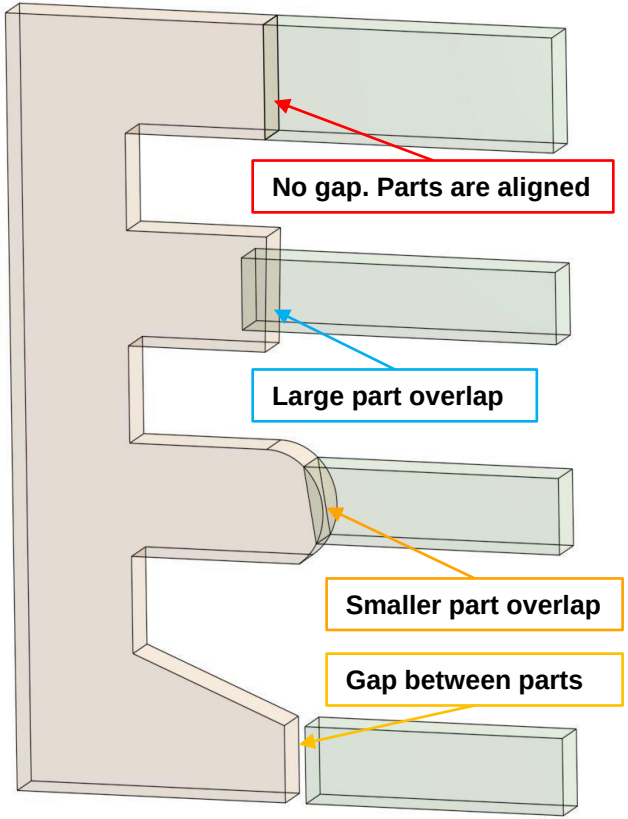
- **4 levels**: standard (default), enhanced, fine, custom.
- Increasing the level of resolution the run time increases, so should be used only when necessary.
- **Faceting best practice** - use a level of tessellation that is sufficient to capture the general part shape but not be overly fine. Too much detail does not improve the solution accuracy and only slows down the solution sequence.



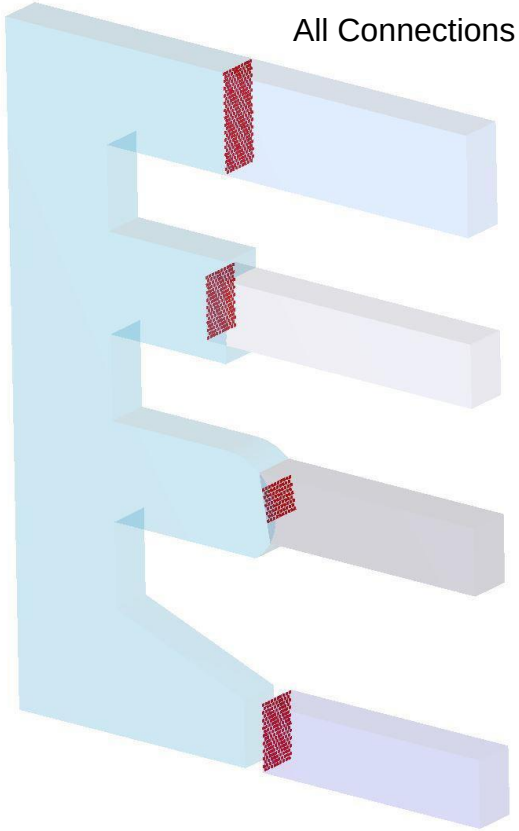




Examples of Permitted Connections



All Connections found



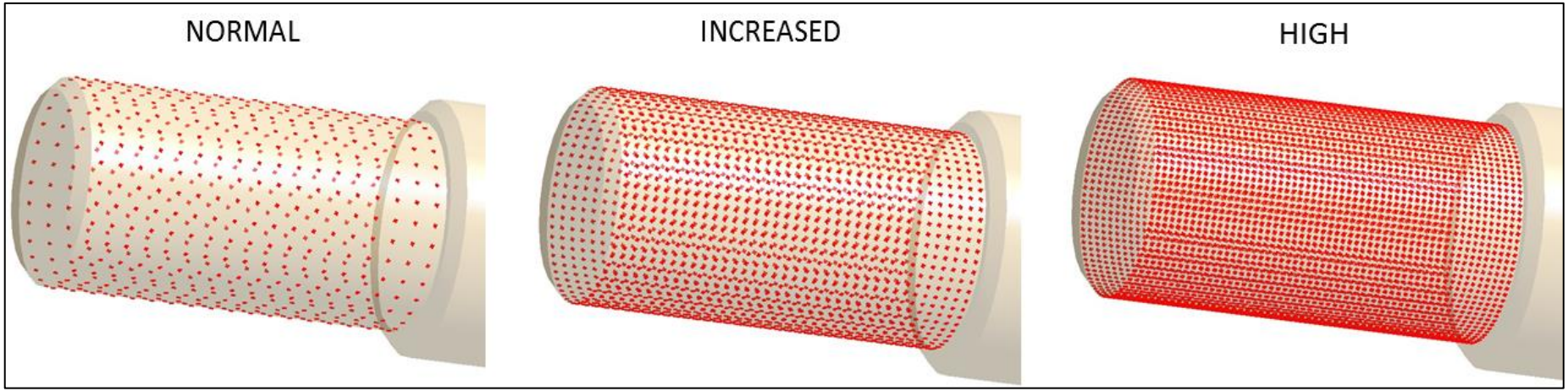
- **SimSolid** is tolerant of geometry gaps and overlaps.
- Can find connections automatically more often than other systems.
- **SimSolid** accepts CAD geometry “as is” without the need for tedious cleanup and repair.

Note: While these contact are permitted, it is not a good practice to have excessive overlap in areas where stress detail is desired.

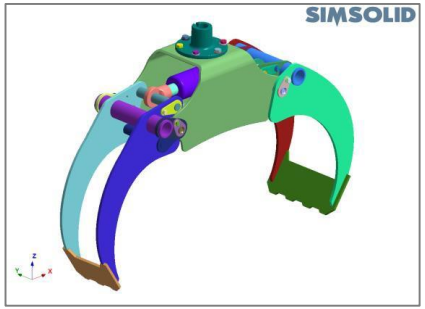
Automatically Create Connections - Resolution

Resolution

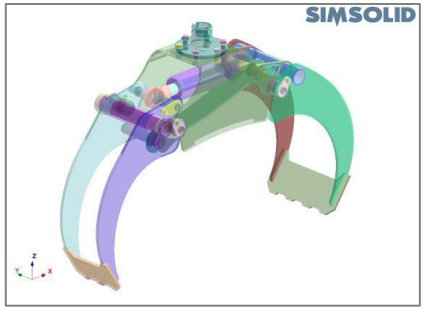
- Connections resolution is visualized by icon density.
  - Make sure there is adequate coverage in thin or curved regions.
  - Connections that are too weak may lead to mechanisms (rigid body motion).



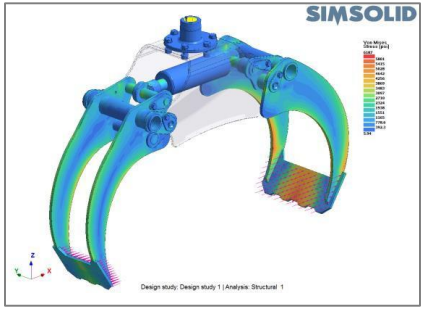
Visualization Examples



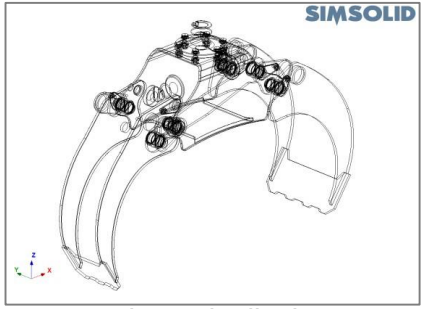
Random colored parts



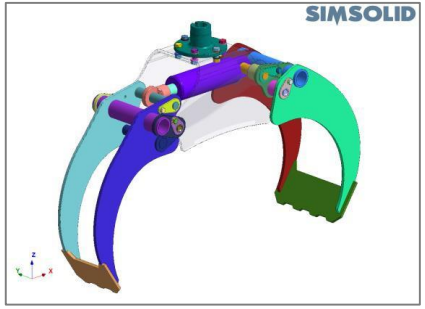
Translucent parts



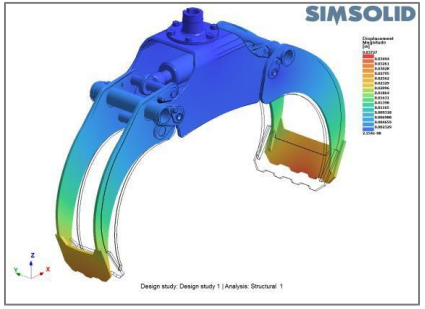
Results plot with hidden parts shown as ghosted



Edge only display



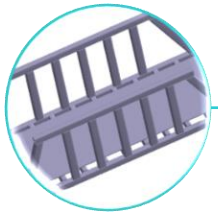
Hidden parts shown as ghosted (light transparent)



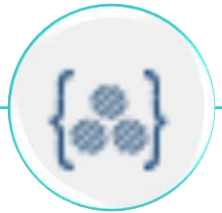
Edges on (undeformed), deformed shape with continuous contour plot

MODAL ANALYSIS

Modal Analysis - General Workflow

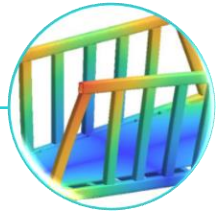


Import CAD file
Automatically
create connections



Apply material
property

Create Modal
Analysis & run



Examine
frequencies and
mode shapes

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Modal Participation Factors

Every structure has the tendency to **vibrate at a given set of natural frequencies**.
Each natural frequency is associated with a **shape**, or **mode shape**, that the model tends to assume when vibrating at that frequency.

In dynamic analysis, two related topics need to be considered:

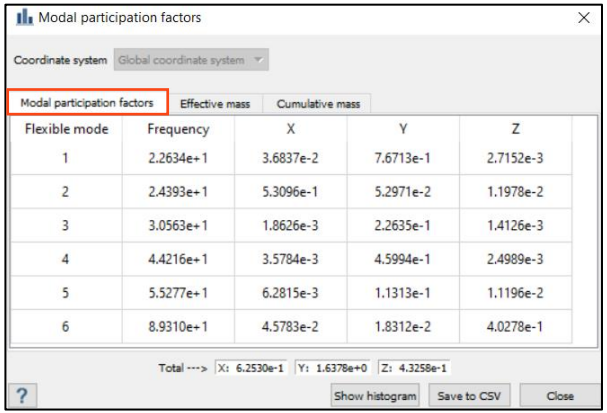
1. **Resonance -** occurs when the input load excitation frequency matches one of the natural frequencies of the structure. In this case, the load amplifies the mode and large displacements can result.
2. **Participation Factor -** is a measure of how strongly a given mode contributes to the response of the structure when subjected to force/displacement excitation in a specific direction.

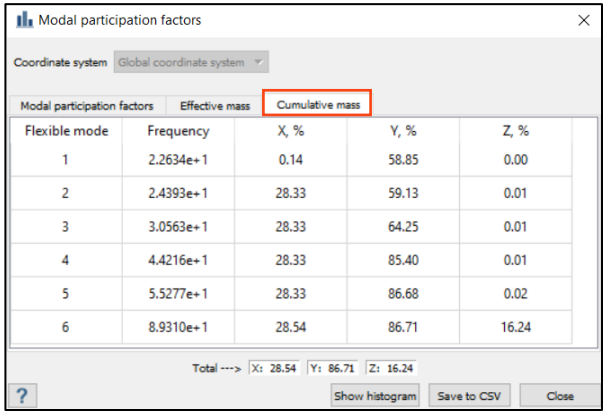
So, it is possible that the excitation could match a natural frequency (i.e. a resonance condition), but if the participation factor of the mode is close to 0, then no energy will get into that mode and no dynamic response will occur.

Modal Participation Factors

SimSolid calculates **modal participation, effective mass** and **cumulative mass** factors for each mode in a specified global or local coordinate reference frame.

- **Modal participation factors** are **scalars** that measure the interaction between the modes and the directional excitation in a given reference frame.
  - Larger values indicate a **stronger contribution** to the dynamic response.
- **Cumulative mass** for mode “n” is the **sum of the Effective mass factors** for modes 1 through “n”.
  - A common rule of thumb for linear dynamic analysis is to include sufficient modes such that the Cumulative mass is at least 80% in the predominant direction of excitation vibration.





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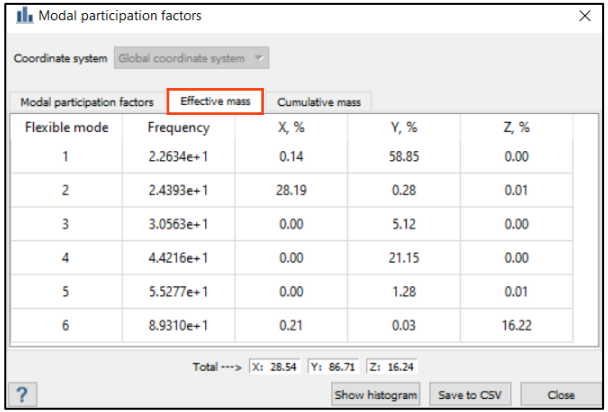
Modal Participation Factors

SimSolid calculates **modal participation, effective mass** and **cumulative mass** factors for each mode in a specified global or local coordinate reference frame.

- **Effective mass factors** associated with each mode, represents **the amount of system mass** participating in that mode in a given excitation direction.
  - This value is given as a **percentage of the total system mass**. Therefore, a mode with a large effective mass will be a significant contributor to the system's response in the given excitation direction.
  - A common rule of thumb for linear dynamic analysis is that a mode should be included if it contributes more than 1-2% of the total effective mass.



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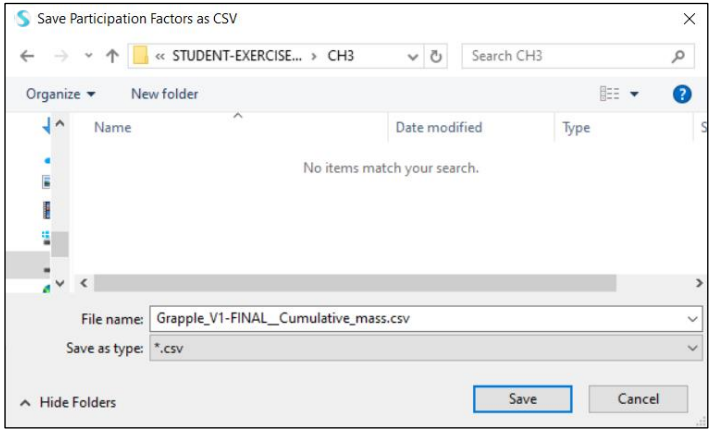
Modal Participation Factors

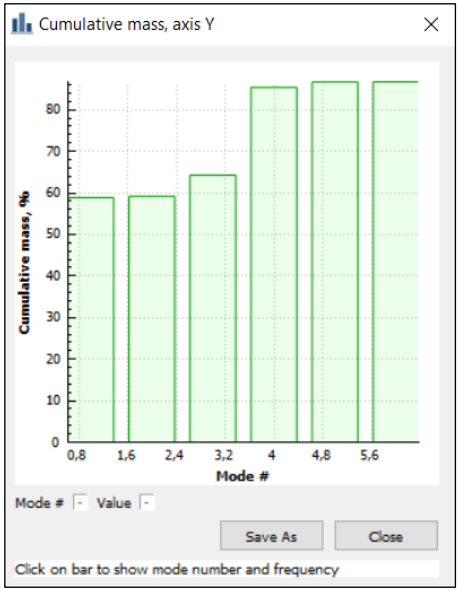
Plotting

Histogram plots of modal contribution versus mode number can be easily displayed for a given factor and direction.

- Simply **pick the column header label** of the desired contribution direction (for example y), then select the **Show Histogram** button.
  On the histogram plot, you may select any individual bar to display its value and mode number details.

Save to csv

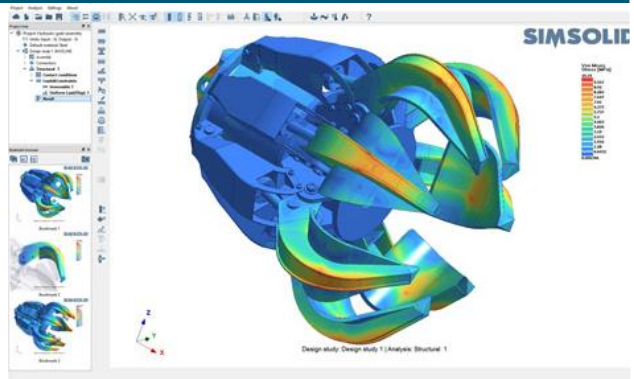




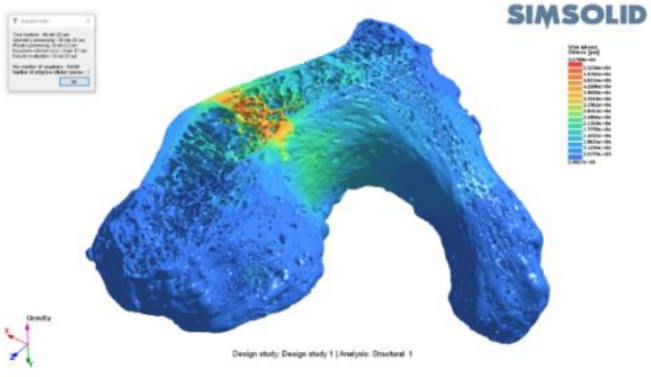
ALTAIR

JOIN THE SIMULATION REVOLUTION

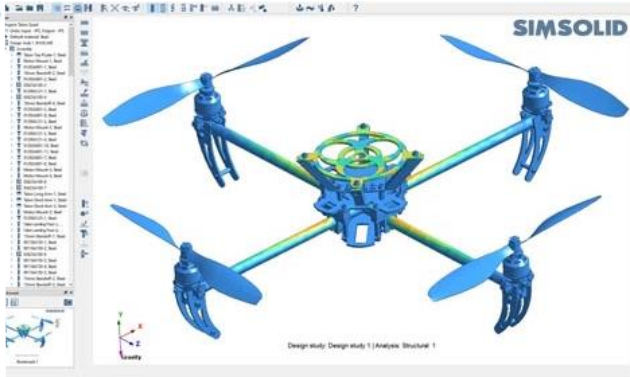
Fast, Easy to Use & Accurate



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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