Ansys Mechanical Getting Started

Module 04 Student Step-by-Step Guide: Geometry, Materials, and Coordinate Systems

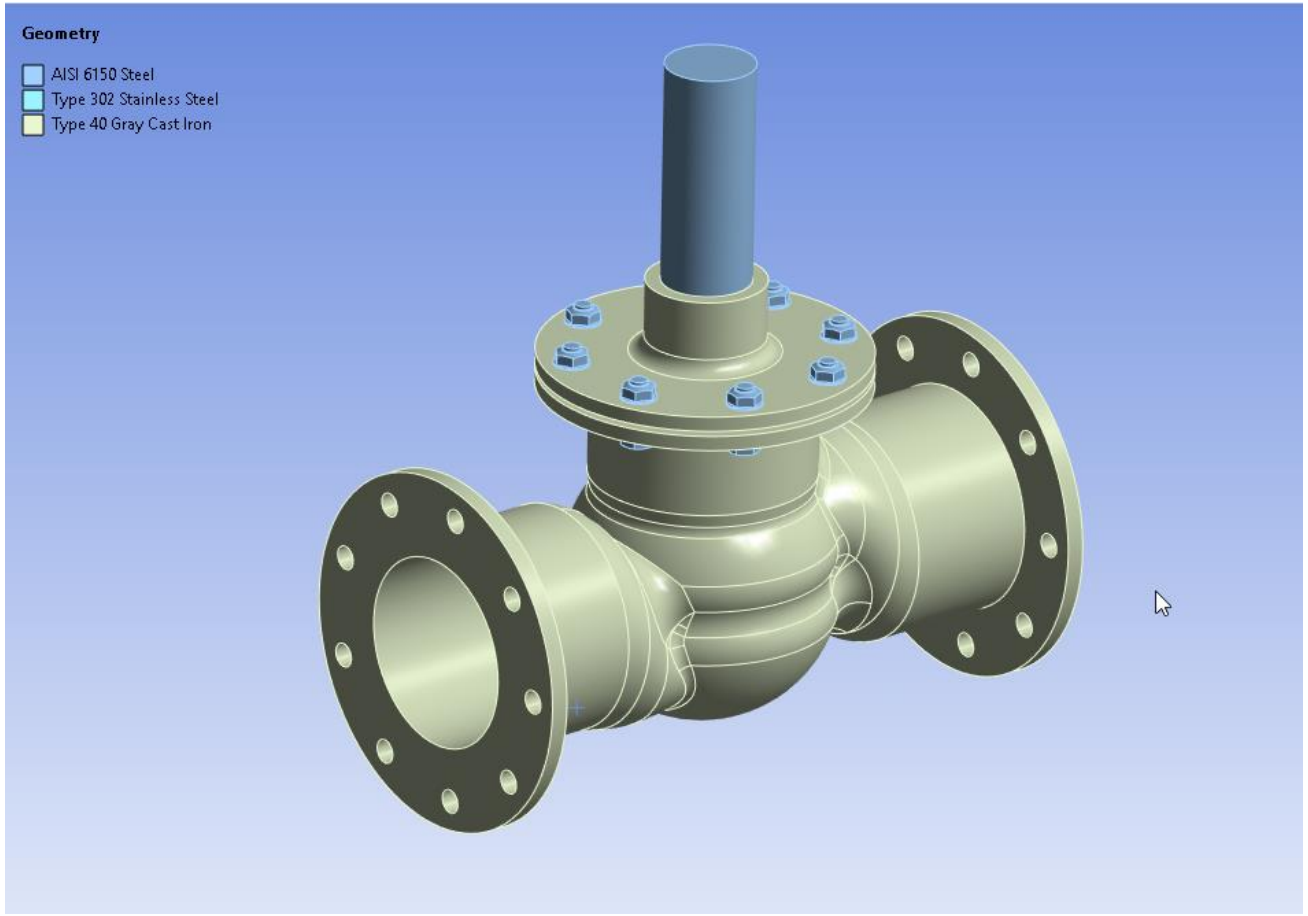
Release 2023 R1

Please note:

- These training materials were developed and tested in Ansys Release 2023 R1. Although they are expected to behave similarly in later releases, this has not been tested and is not guaranteed.
- The screen images included with these training materials may vary from the visual appearance of a local software session.

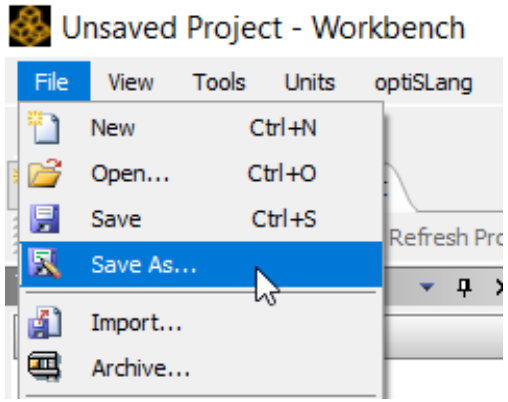
Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- Use this guide to repeat the steps the instructor demonstrated within this module



Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

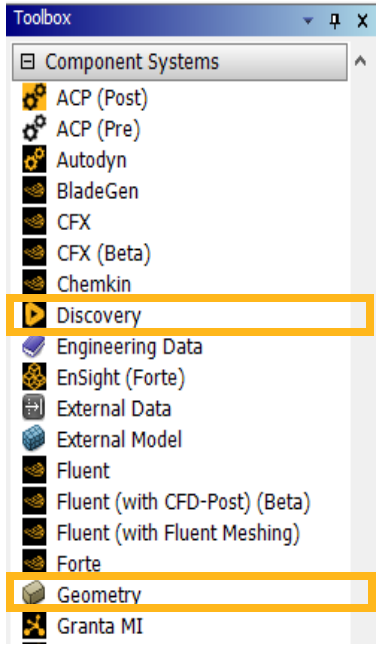
- Open a new Workbench project and save it:
- Start button → All Programs → ANSYS nn.n → Workbench nn.n
- File → Save As …



- Choose an appropriate location on the hard disk and name this project “M04.wbpj”

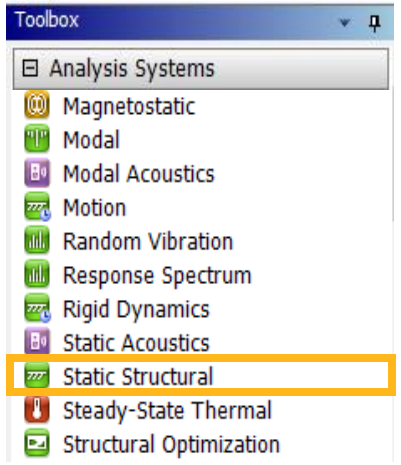
Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- We will firstly create the analysis workflow:
- Insert an Engineering Data component system: Double Click on Engineering Data in the toolbox



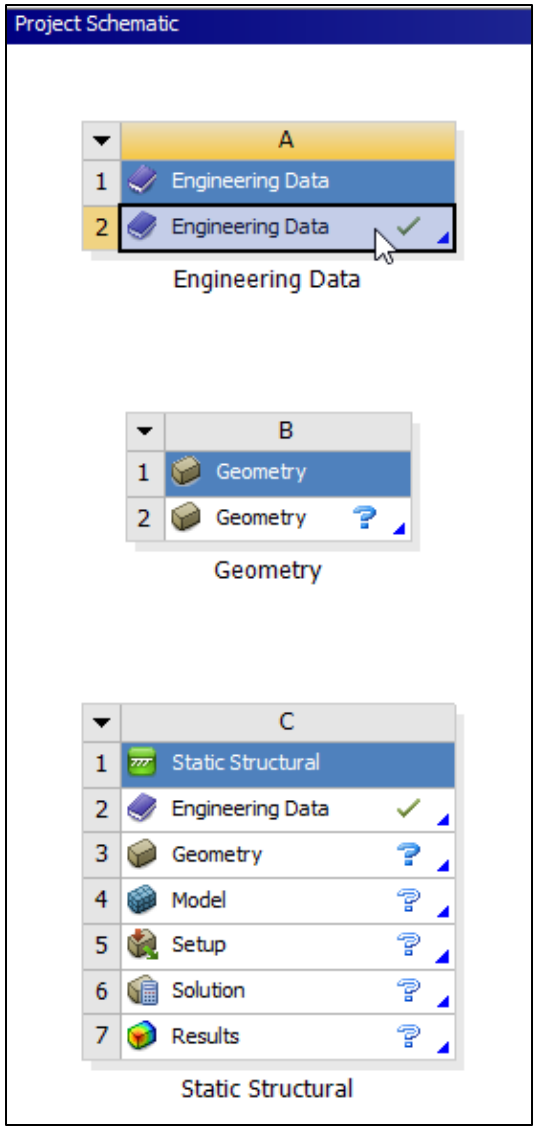
- Insert a Geometry component system, same way as above

- Insert a Static Structural Analysis System:
- DC on Static Structural from the toolbox



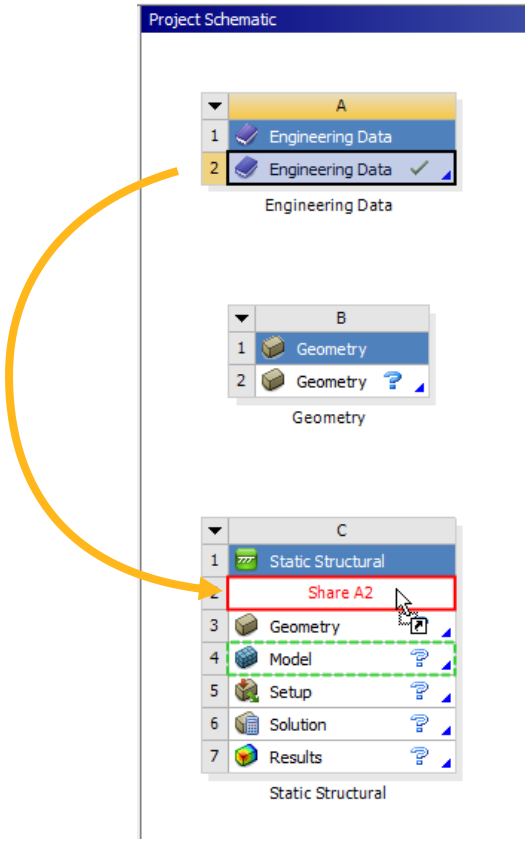
Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

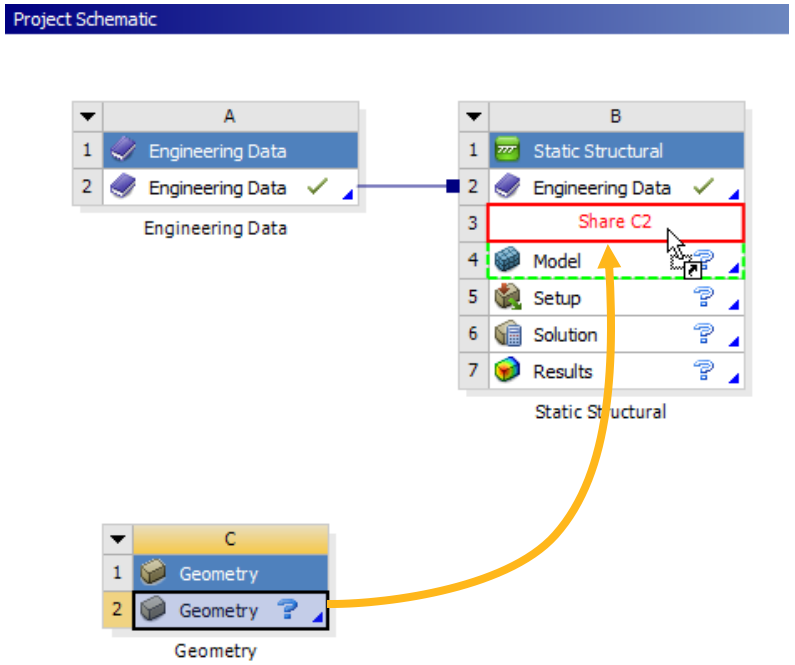
- The project page should look like this:



Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

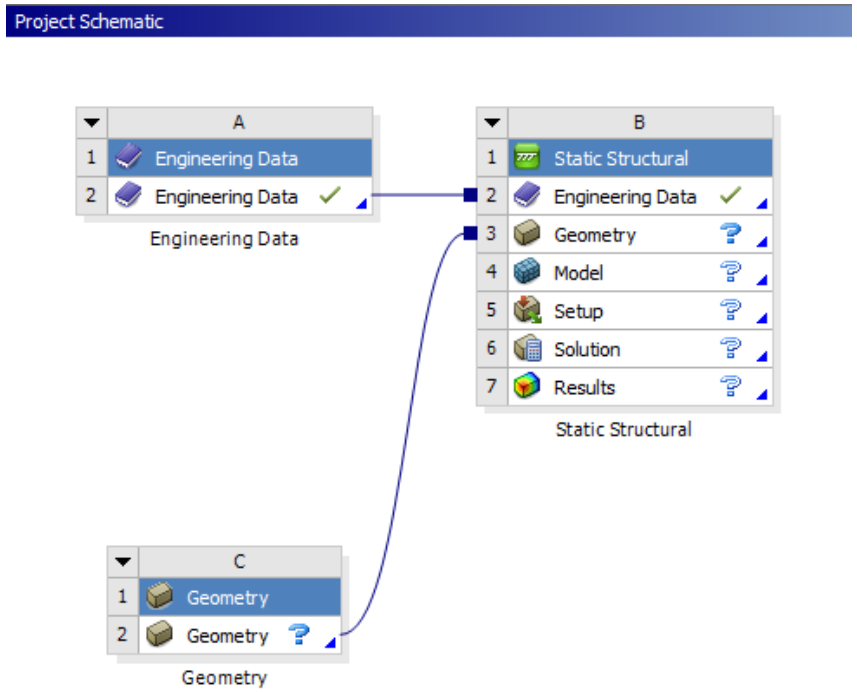
- Define the links between each system:
  - Drag and drop A2 cell from Engineering Data onto C2 cell from Static Structural
  - Drag and drop C2 cell from Geometry onto B3 cell from Static Structural





Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

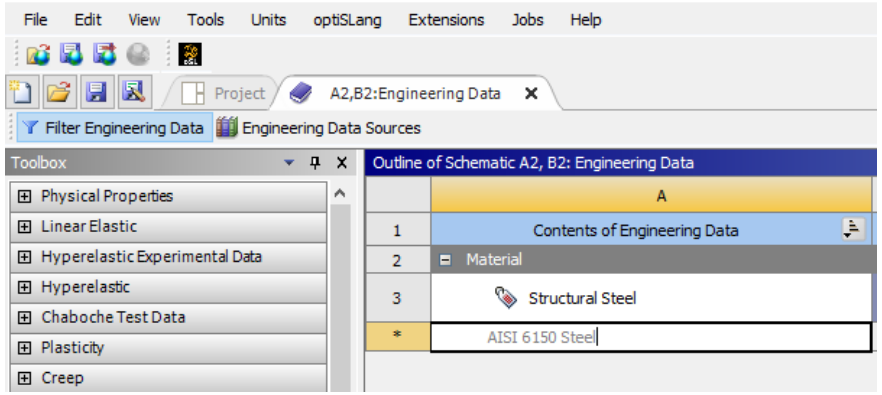
- The Project Schematic should now look like this:



- In this Module, it remains to define Materials and Geometry used in the simulation.

Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

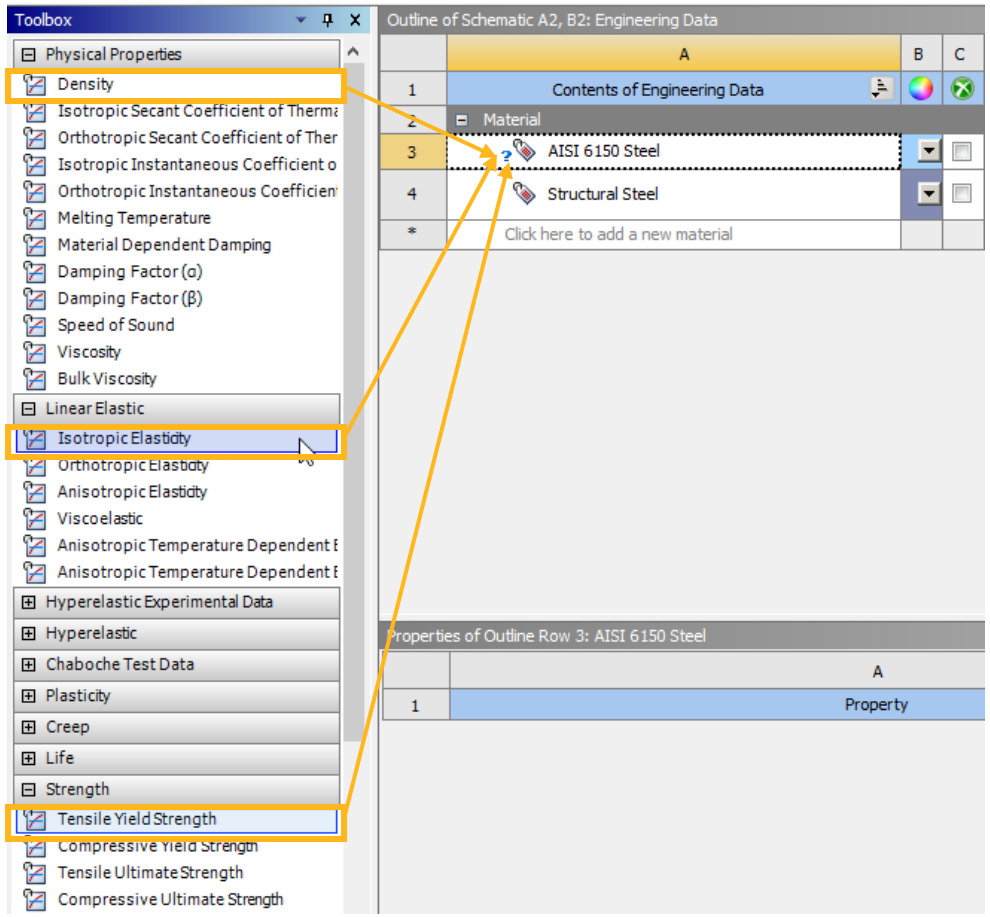
- Double Click on cell **A2** to enter the **Engineering Data** application.
- Click on the bottom line of column A to create a new material.



- Enter the name: **AISI 6150 Steel**

Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- Search for the following properties in the toolbox:
  - **Physical Properties: Density**
  - **Linear Elasticity: Isotropic Elasticity**
  - **Strength: Tensile Yield Strength**
- Drag and drop each property onto **AISI 6150 Steel material**



Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- Fill in the properties values with the following information:

- **AISI 6150 Steel**:
  - Elastic modulus E = 29,700,000 psi
  - Poisson's ratio ν = 0.29
  - Density ρ = 0.284 lbm/in^3
  - Yield strength σy = 74,700 psi

Outline of Schematic A2, B2: Engineering Data

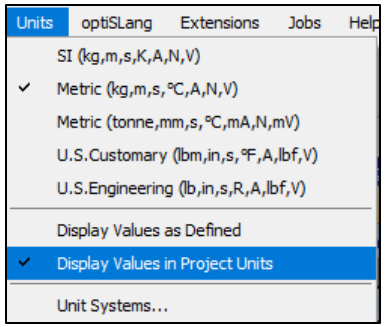
	A	B	C	D	E
1	Contents of Engineering Data			Source	Description
2	Material				
3	AISI 6150 Steel			D:\Mechanical C	
4	Structural Steel			General_Materi	Fatigue Data at zero mean stress comes from 1998 ASME BPV C Div 2, Table 5-110.1
*	Click here to add a new material				

Properties of Outline Row 3: AISI 6150 Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density		kg m^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulus and Poisson's Ratio	
6	Young's Modulus		Pa
7	Poisson's Ratio		
8	Bulk Modulus		Pa
9	Shear Modulus		Pa
10	Tensile Yield Strength		Pa

Note:

- *As needed, you can change the displayed unit system in the Units Menu.*
- *Keep "Display Values in Project Units" checked so that values are automatically converted from one system to another one.*



Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- Repeat the steps to create 2 more materials:

- **Type 40 Gray Cast Iron:**
  - Elastic modulus E = 17,695,000 psi
  - Poisson's ratio ν = 0.29
  - Density ρ = 0.25831 lbm/in^3
  - Ultimate strength* σy = 42,641 psi

- **Type 302 Stainless Steel:**
  - Elastic modulus E = 28,000,000 psi
  - Poisson's ratio ν = 0.25
  - Density ρ = 0.284 lbm/in^3
  - Yield strength σy = 34,800 psi

Properties of Outline Row 6: Type 40 Gray Cast Iron

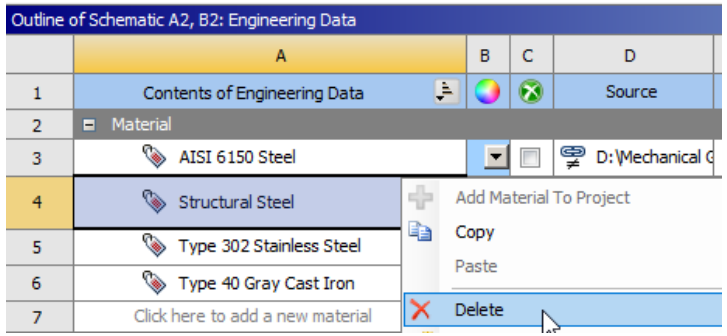
	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	0.25831	lbm in^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulus and Poisson's Ratio	
6	Young's Modulus	1.7695E+07	psi
7	Poisson's Ratio	0.29	
8	Bulk Modulus	1.4044E+07	psi
9	Shear Modulus	6.8585E+06	psi
10	Tensile Ultimate Strength	42641	psi

Properties of Outline Row 4: Type 302 Stainless Steel

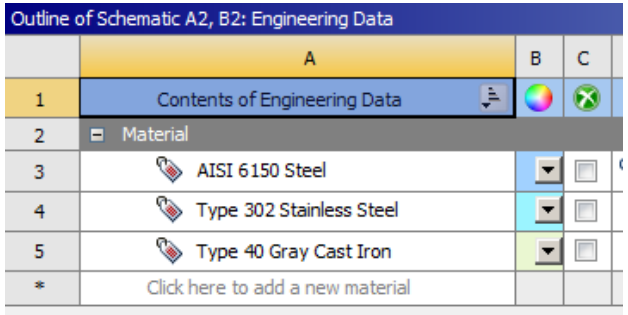
	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	0.284	lbm in^-3
4	Isotropic Elasticity		
5	Derive from	Young's Modulus and Poisson's Ratio	
6	Young's Modulus	2.8E+07	psi
7	Poisson's Ratio	0.25	
8	Bulk Modulus	1.8667E+07	psi
9	Shear Modulus	1.12E+07	psi
10	Tensile Yield Strength	34800	psi

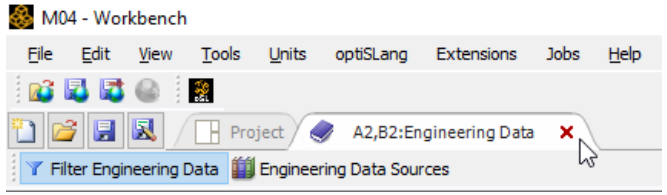
Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- When it’s done, you can delete the **Structural Steel** material from the list. **(RMB→Delete)**



- So that the material list contains all the materials to be used in the analysis.





- Then, you can return to the project page, by closing the Engineering Data tab.

Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

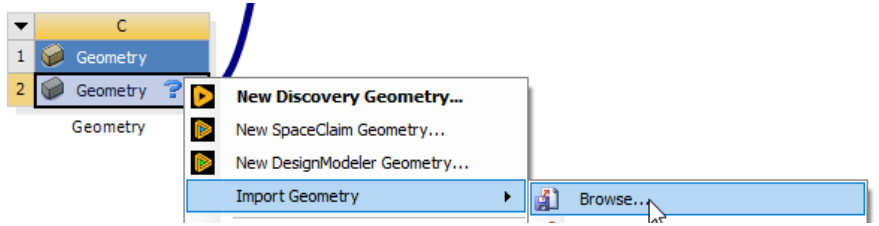
- Next step consists of the geometry import. We'll import the CAD file in the geometry editor to create associativity between the geometry and the Mechanical model.

- Display geometry properties (Right Mouse Button on C2 cell → Properties) and check the Analysis Type is set to 3D.

- Open SpaceClaim: RMB on C2 cell → New SpaceClaim Geometry

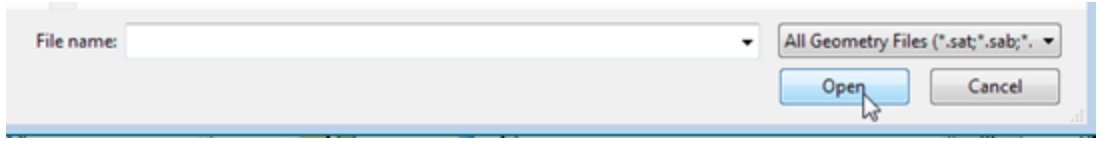
Properties of Schematic B3: Geometry

	A	B
1	Property	Value
2	General	
3	Component ID	Geometry 1
4	Directory Name	Geom
5	Update Condition Parameter (Beta)	None
6	Notes	
7	Notes	
8	Used Licenses	
9	Last Update Used Licenses	
10	Basic Geometry Options	
11	Solid Bodies	☑
12	Surface Bodies	☑
13	Line Bodies	☐
14	Parameters	Independent
15	Parameter Key	ANS;DS
16	Attributes	☐
17	Named Selections	☐
18	Material Properties	☐
19	Advanced Geometry Options	
20	Analysis Type	3D
21	Use Associativity	☑
22	Import Coordinate Systems	☐

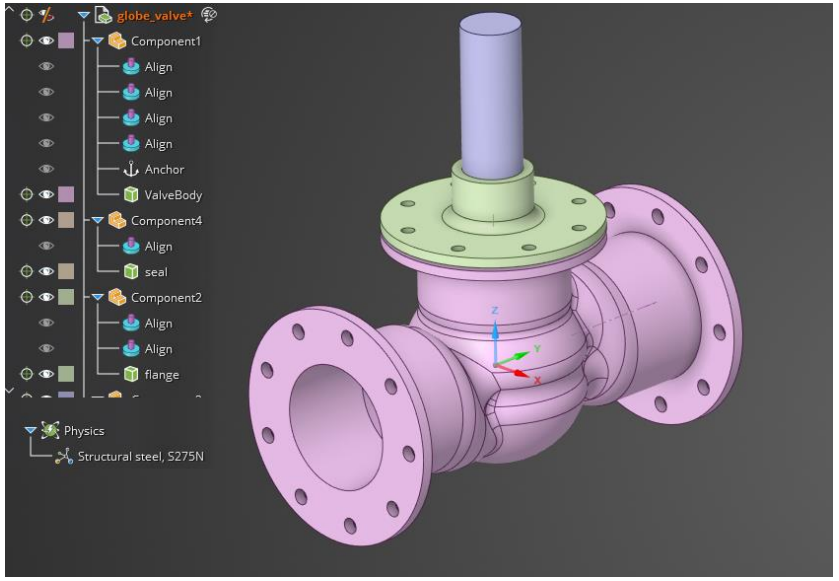


Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- Browse for file globe_valve.scdoc and open it.

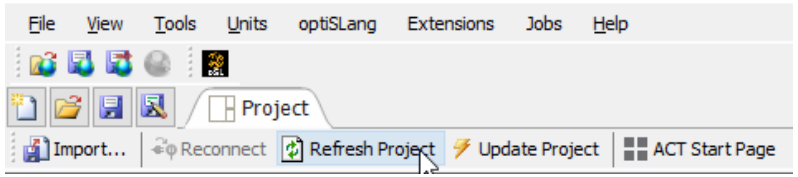


- Open Discovery: RMB on cell C2 → Edit Geometry in Discovery.
- Review the geometry to make sure it has been imported correctly.



Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- Check the geometry had been well imported and contains multiple components.
- Close Discovery and return to the Workbench project page.
- At this stage, the **C2 geometry cell** should contain a green check.
- To prevent importing default material from discovery , uncheck the “Material Properties” option from the Geometry cell properties.
- **Refresh (** **)** the project to transfer geometry and materials into Mechanical.



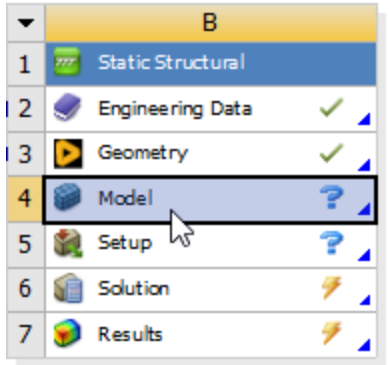
- An intermediate save of the project is recommended.

Properties of Schematic B3: Geometry

	A	B
1	Property	Value
2	General	
3	Component ID	Geometry
4	Directory Name	Geom
5	Update Condition Parameter (Beta)	None
6	Notes	
7	Notes	
8	Used Licenses	
9	Last Update Used Licenses	
10	Geometry Source	
11	Geometry File Name	[redacted]
12	Advanced Geometry Options	
13	Analysis Type	3D
14	Compare Parts On Update	No
15	Smart CAD Update	☑
16	Import Using Instances	☑
17	Basic Geometry Options	
18	Material Properties	☐

Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

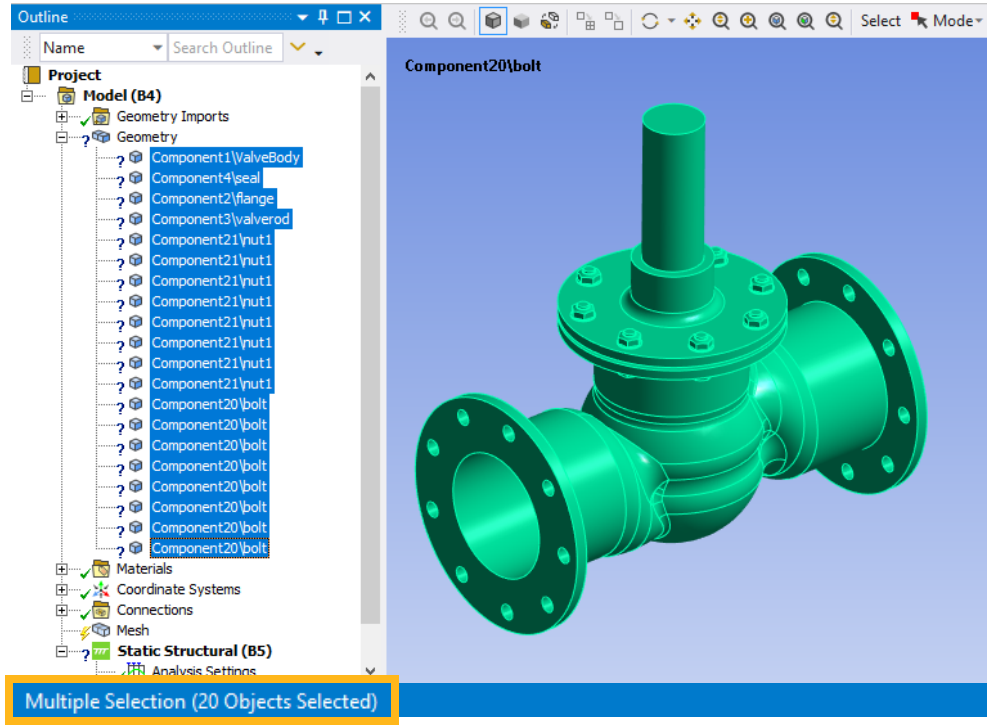
- We will now enter **Mechanical** to assign materials to each body.
- Enter Mechanical by **double clicking on B4 Model cell**.

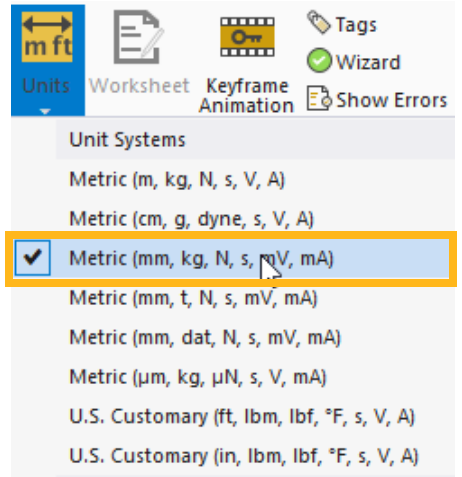


Static Structural

Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- Once in Mechanical, check that 20 bodies have been imported.

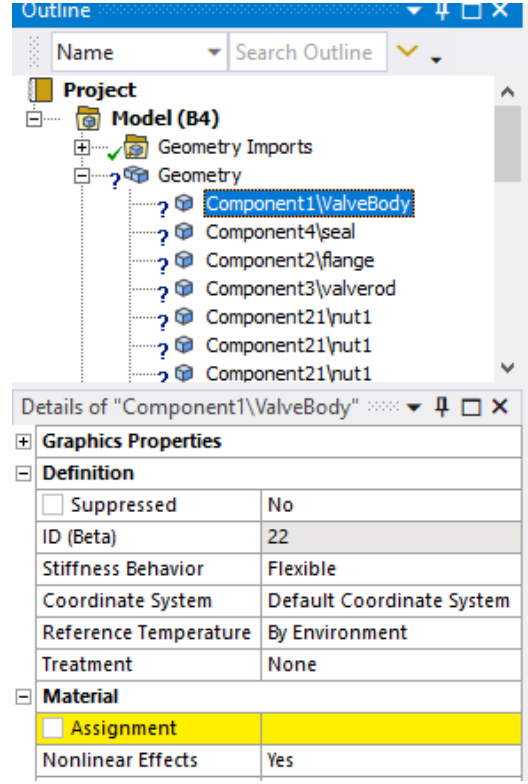




- Check that the Units System is **Metric (mm, t, N, s, …)**
- If not, change it in the Units menu in the Home tab

Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

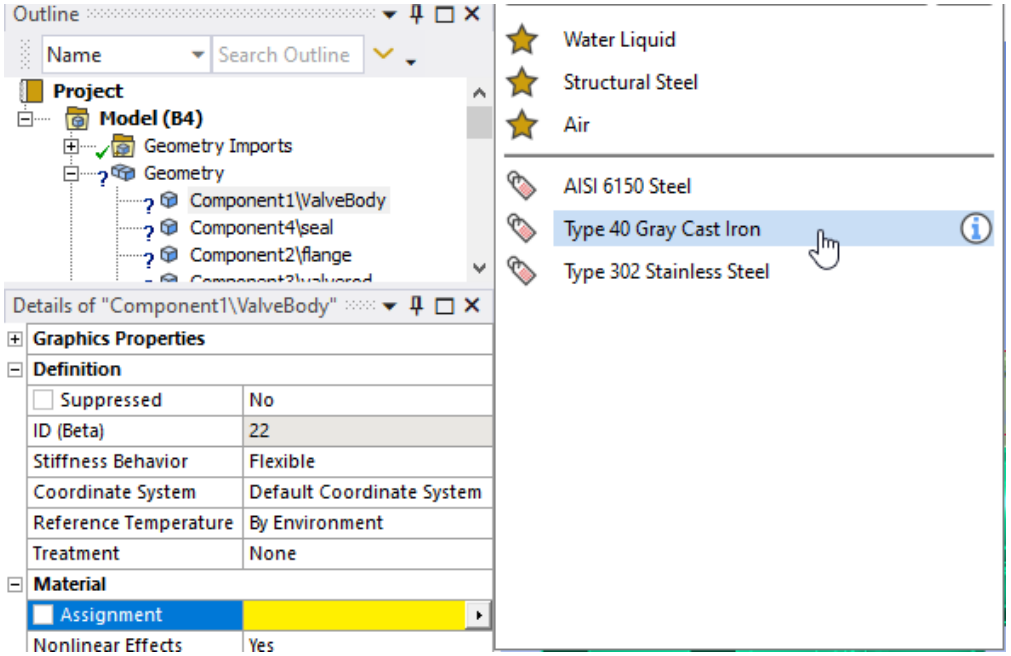
- Note that question marks are present in front of each body line in the tree.
- If you click on the first body in the Mechanical tree, you'll see a yellow line in the details. This means there is a missing information that needs to be provided.
- We need to define the Material assignment for each body.

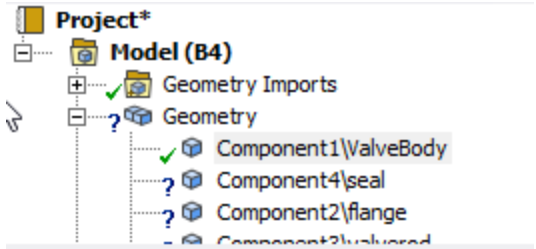


<u>Note:</u> by default, Structural Steel is automatically assigned to all bodies. Because, we have deleted Structural Steel material from the project's material list, material assignment becomes undefined for all bodies.

Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- The valve body is in Type 40 Gray Cast Iron.
- To assign this material, select the body named **“Component1\ValveBody”** and change the **Material assignment** to Type 40 Gray Cast Iron in the details window.
- Verify the green mark is now present in front of the body line in the tree.

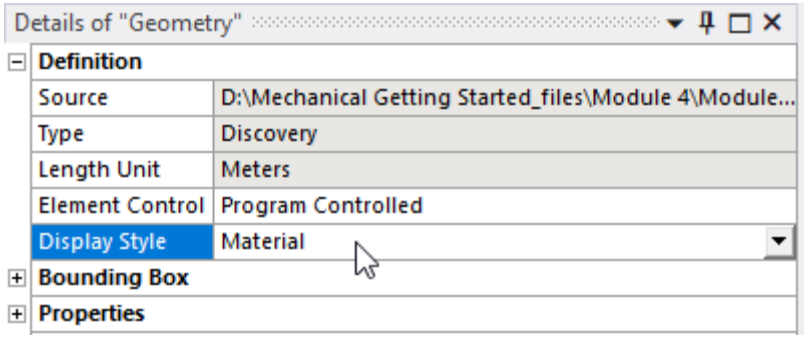




Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

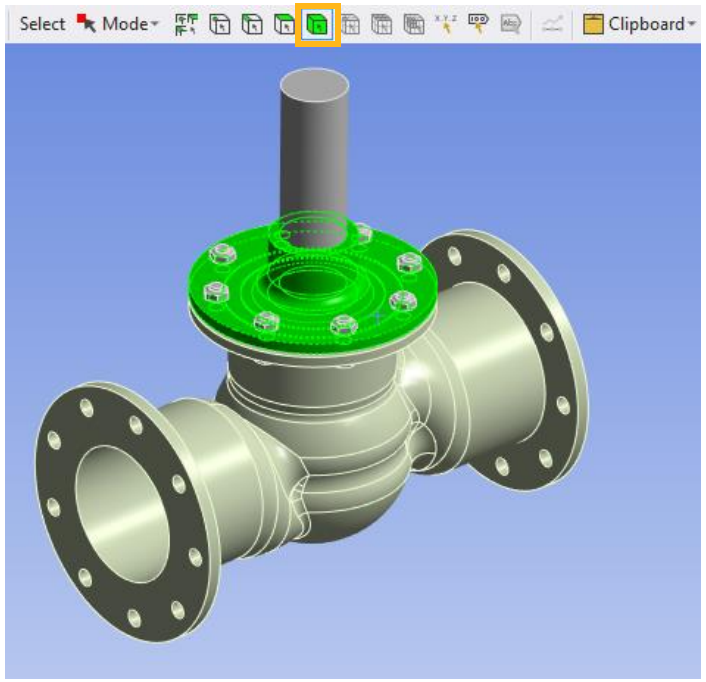
- Repeat the steps to define the following information:
  - Flange: Type 40 Gray Cast Iron
  - Valve seal: Type 302 Stainless Steel
  - Valve rod: AISI 6150 Steel
  - Bolts: AISI 6150 Steel
  - Nuts: AISI 6150 Steel

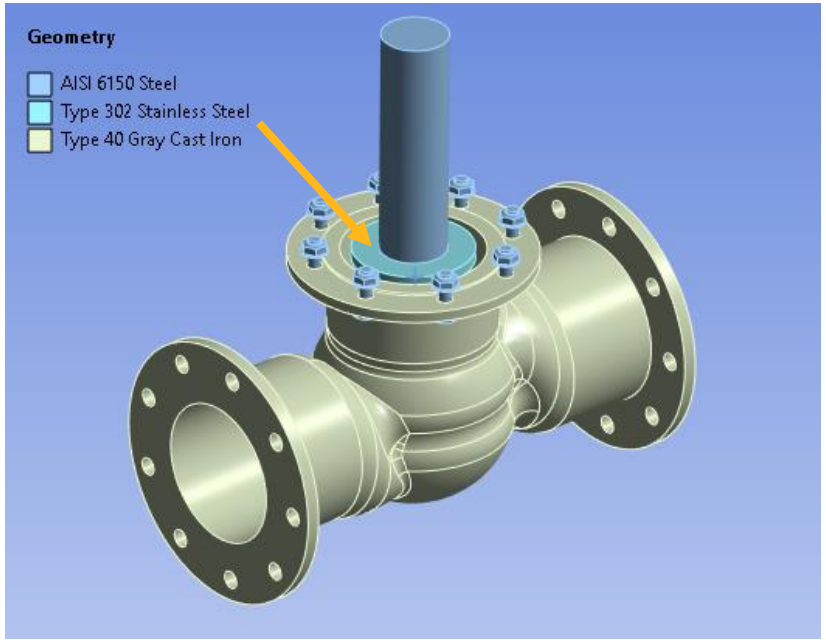
- You can change **the Display Style** in the **Geometry branch** to **“Material”** to graphically see the material assignment for each body.



Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

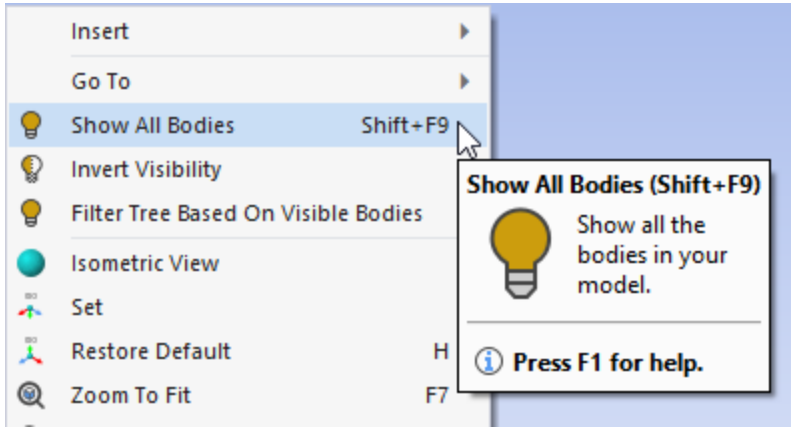
- Select the **body filter** in the selection tools and click on the flange body to select it.
- Press **F9 key** on your keyboard to hide this body, so that you can graphically see the seal material.





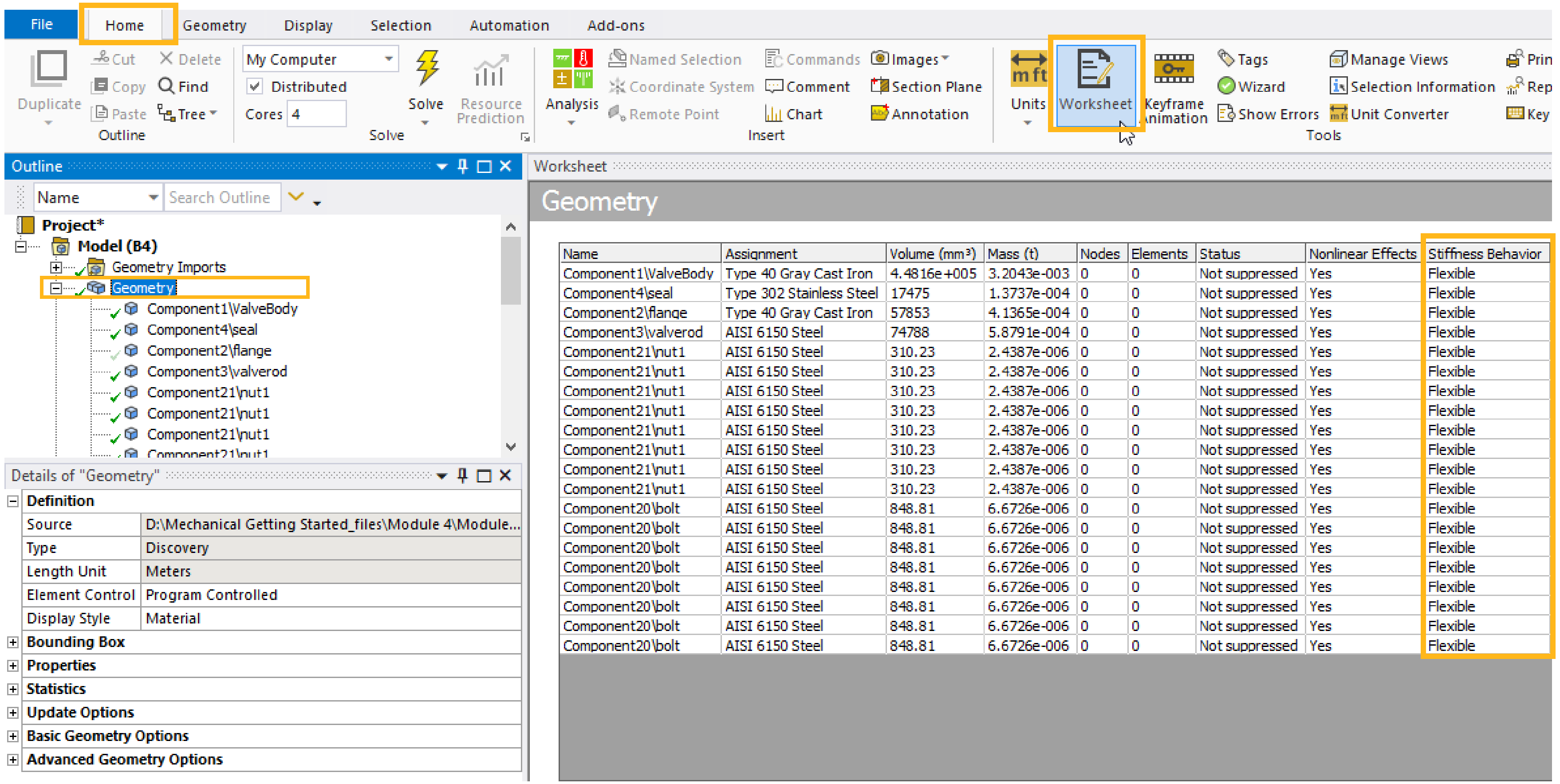
Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- **RMB** in the graphics window → **Show all bodies** to return to restore the view.



Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

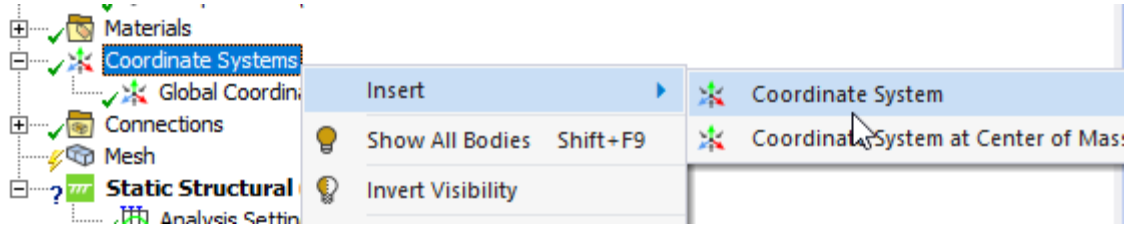
- Check all bodies have flexible stiffness behavior. You can use the Worksheet feature: click on the Geometry branch and then on Worksheet in the toolbar.



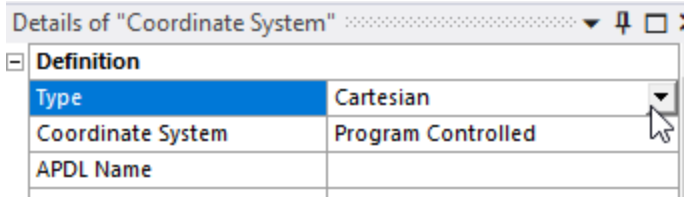
Name	Assignment	Volume (mm³)	Mass (t)	Nodes	Elements	Status	Nonlinear Effects	Stiffness Behavior
Component1\ValveBody	Type 40 Gray Cast Iron	4.4816e+005	3.2043e-003	0	0	Not suppressed	Yes	Flexible
Component4\seal	Type 302 Stainless Steel	17475	1.3737e-004	0	0	Not suppressed	Yes	Flexible
Component2\flange	Type 40 Gray Cast Iron	57853	4.1365e-004	0	0	Not suppressed	Yes	Flexible
Component3\valverod	AISI 6150 Steel	74788	5.8791e-004	0	0	Not suppressed	Yes	Flexible
Component21\nut1	AISI 6150 Steel	310.23	2.4387e-006	0	0	Not suppressed	Yes	Flexible
Component21\nut1	AISI 6150 Steel	310.23	2.4387e-006	0	0	Not suppressed	Yes	Flexible
Component21\nut1	AISI 6150 Steel	310.23	2.4387e-006	0	0	Not suppressed	Yes	Flexible
Component21\nut1	AISI 6150 Steel	310.23	2.4387e-006	0	0	Not suppressed	Yes	Flexible
Component21\nut1	AISI 6150 Steel	310.23	2.4387e-006	0	0	Not suppressed	Yes	Flexible
Component21\nut1	AISI 6150 Steel	310.23	2.4387e-006	0	0	Not suppressed	Yes	Flexible
Component21\nut1	AISI 6150 Steel	310.23	2.4387e-006	0	0	Not suppressed	Yes	Flexible
Component21\nut1	AISI 6150 Steel	310.23	2.4387e-006	0	0	Not suppressed	Yes	Flexible
Component20\bolt	AISI 6150 Steel	848.81	6.6726e-006	0	0	Not suppressed	Yes	Flexible
Component20\bolt	AISI 6150 Steel	848.81	6.6726e-006	0	0	Not suppressed	Yes	Flexible
Component20\bolt	AISI 6150 Steel	848.81	6.6726e-006	0	0	Not suppressed	Yes	Flexible
Component20\bolt	AISI 6150 Steel	848.81	6.6726e-006	0	0	Not suppressed	Yes	Flexible
Component20\bolt	AISI 6150 Steel	848.81	6.6726e-006	0	0	Not suppressed	Yes	Flexible
Component20\bolt	AISI 6150 Steel	848.81	6.6726e-006	0	0	Not suppressed	Yes	Flexible
Component20\bolt	AISI 6150 Steel	848.81	6.6726e-006	0	0	Not suppressed	Yes	Flexible
Component20\bolt	AISI 6150 Steel	848.81	6.6726e-006	0	0	Not suppressed	Yes	Flexible

Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- Create a local coordinate system:
- **RMB** on **Coordinate System branch → Insert → Coordinate System**

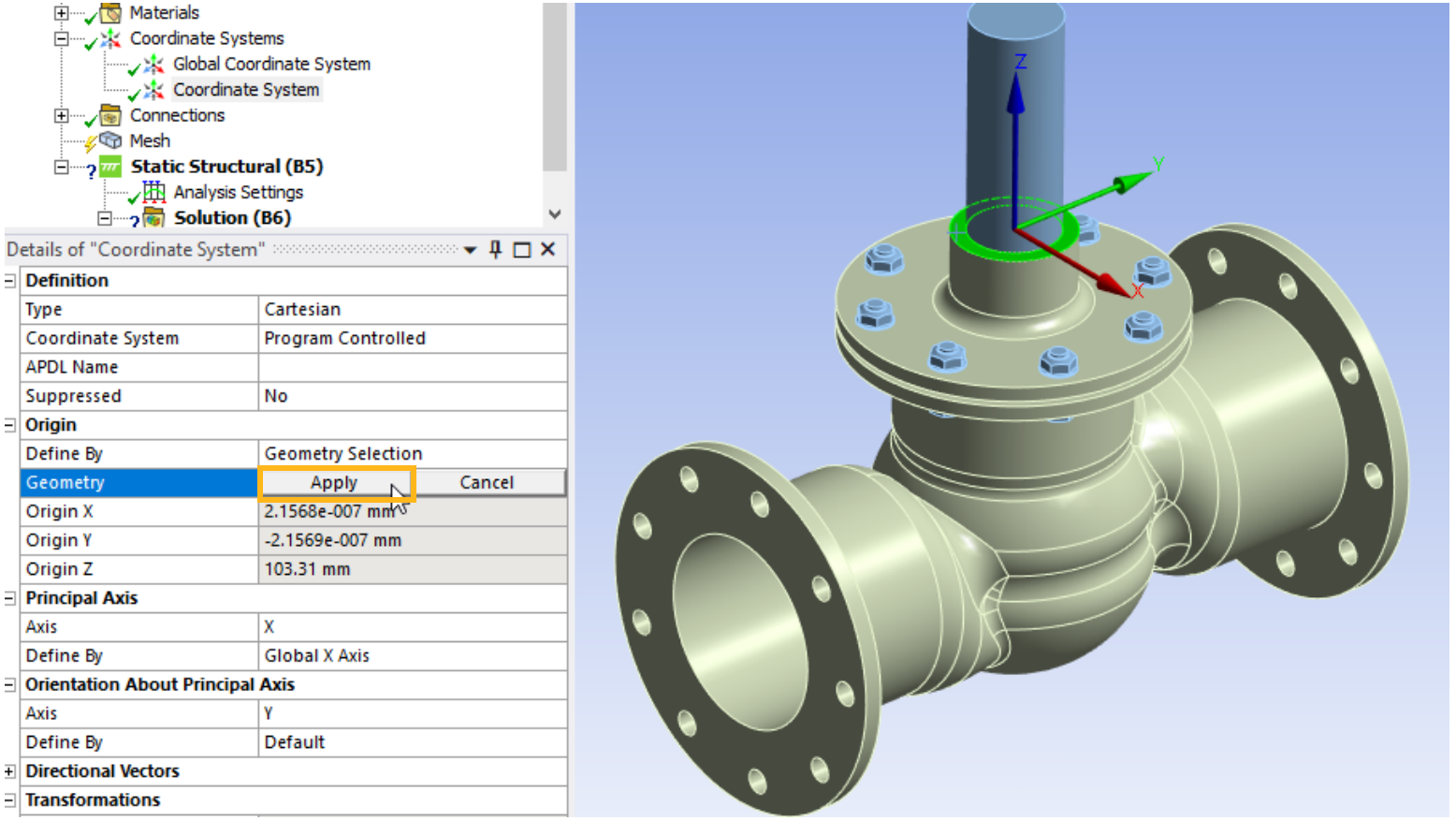


- Select **Type Cartesian**



Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

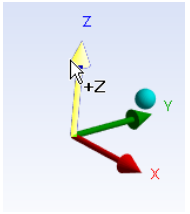
- Chose a geometry object for the origin definition. Select the face as shown on the image, and apply the selection:

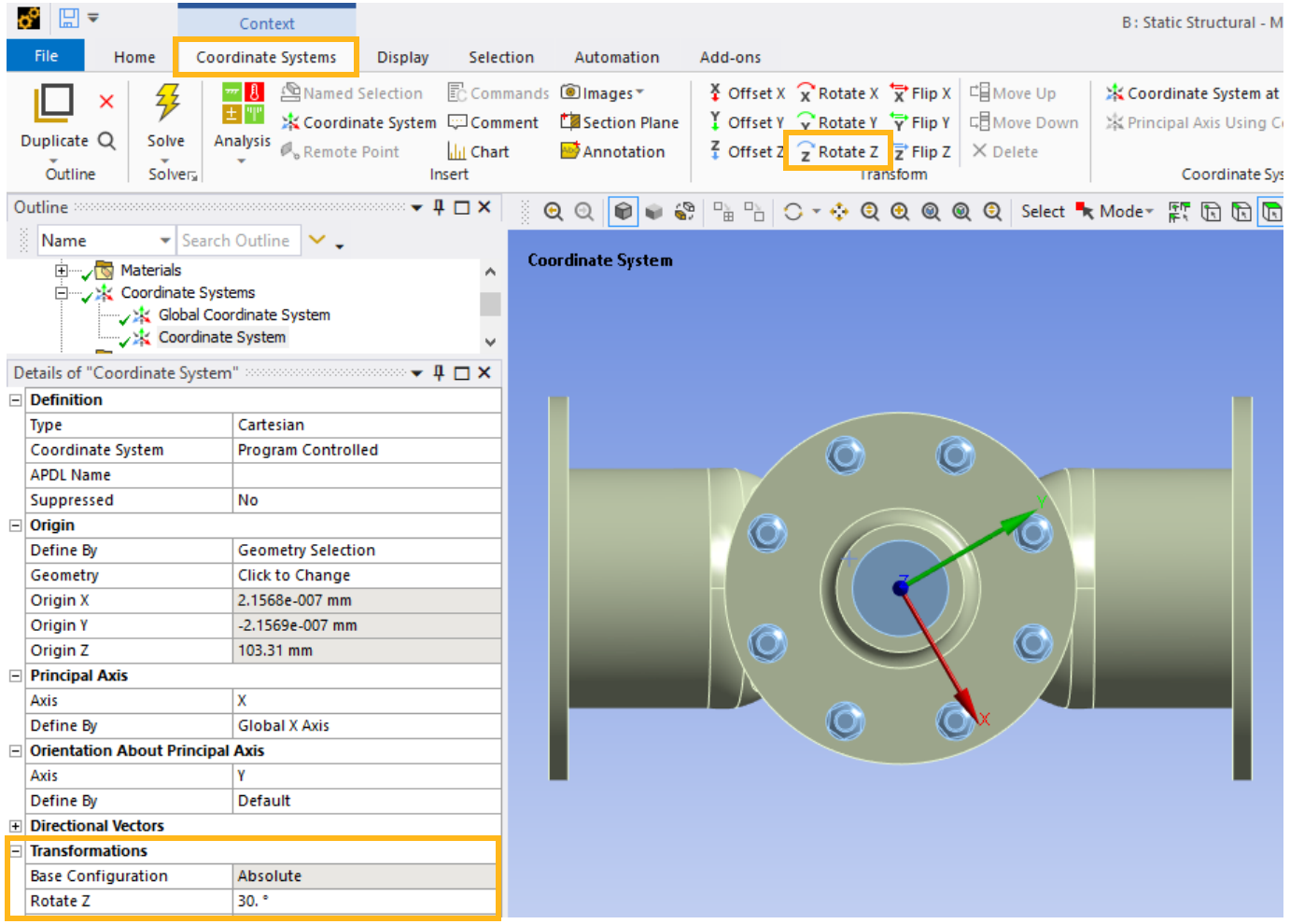


Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- Rotate the coordinate system around local Z axis, with a 30 ° angle:
  - Add a rotation around Z
  - Define the transformation equals to 30°

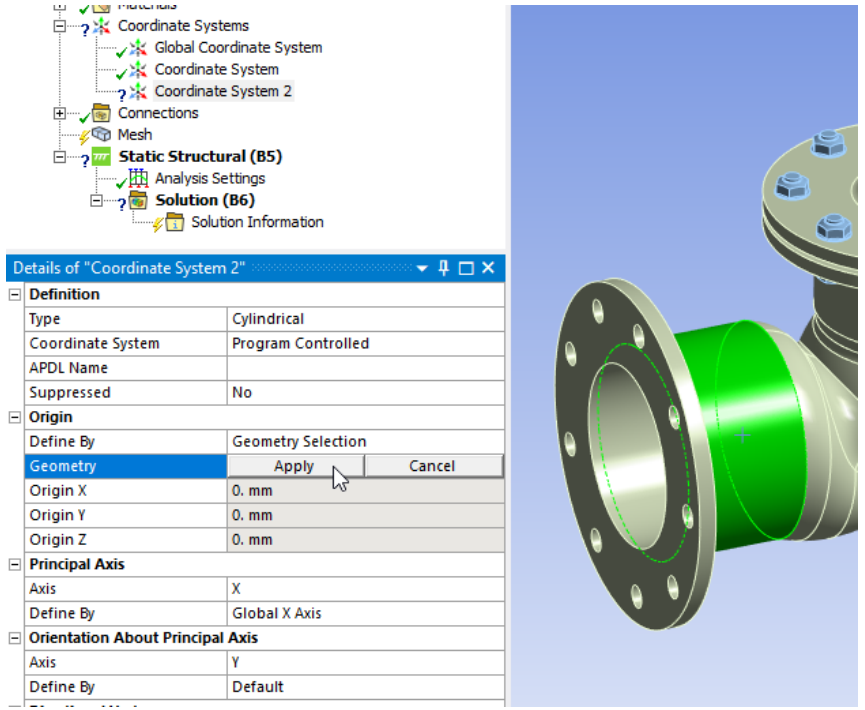
- Observe the new created local coordinate system
- Observe the new created local coordinate system
- Orientate the view normal to global +Z axis for a better rendering





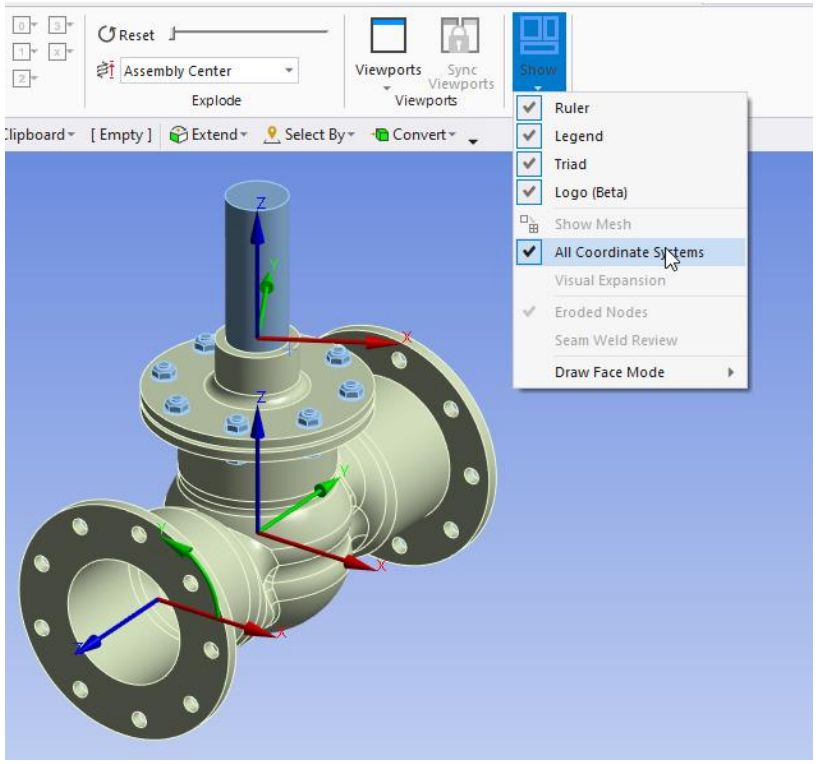
Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

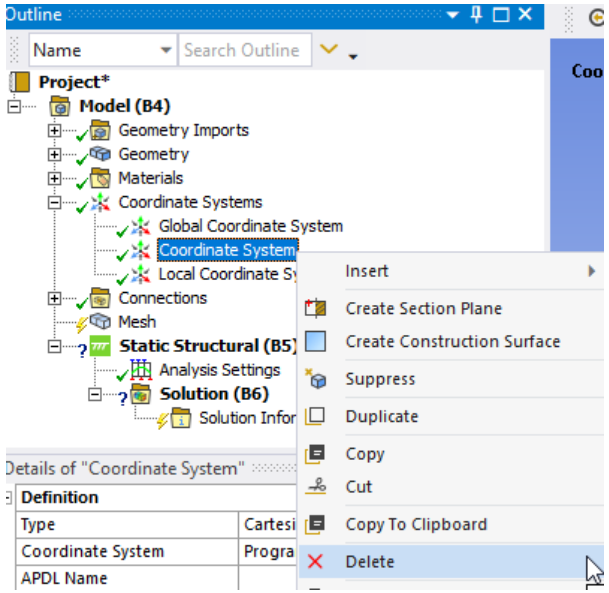
- Create local cylindrical coordinate system at outside surface of Valve Body
- Set Type to Cylindrical
- Select the outer surface of one valve body
- Rename it as “ Local Coordinate System”
- Change the orientation of the system so that the Y direction is circumferential



Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

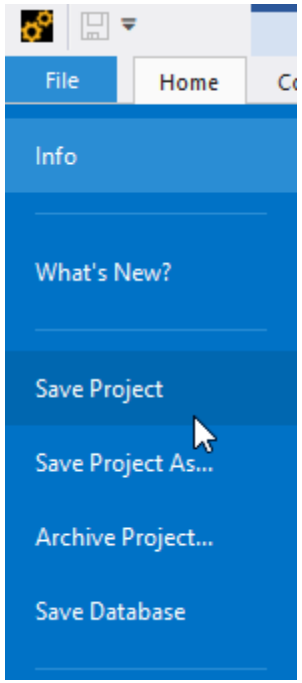
- You can display all the coordinate systems of the model by clicking on Show all coordinate systems in the display tab
- You can also delete a coordinate system by RMB → Delete





Step-by-Step Guide 04: Materials, Geometry, and Coordinate Systems

- Save the project for possible future use.



End of presentation