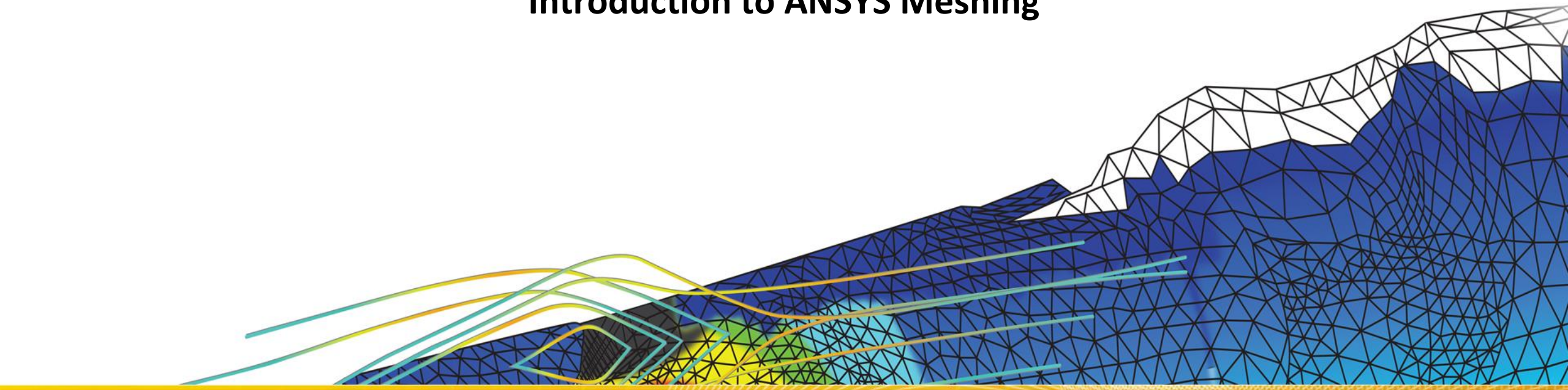
Realize Your Product Promise®

17.0 Release

ANSYS®

Tutorial 7: Global Mesh Controls

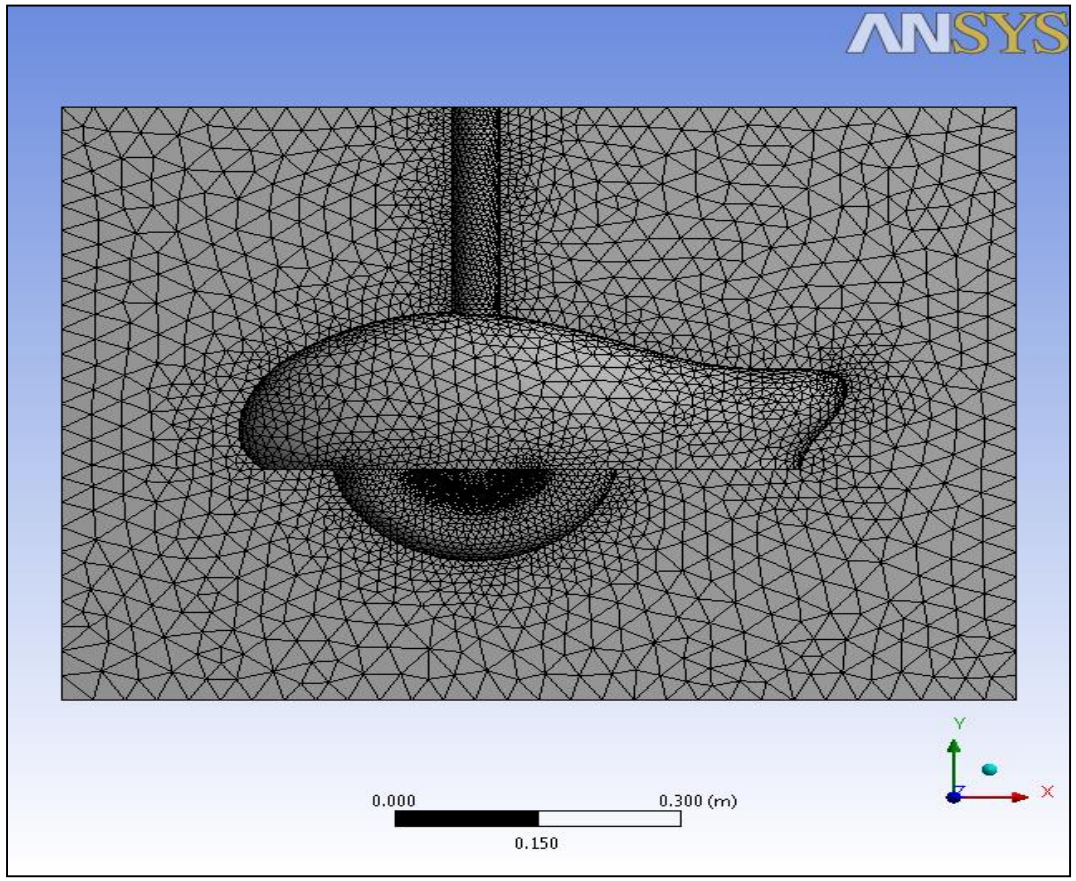
Introduction to ANSYS Meshing



Introduction

Background

- This workshop will demonstrate the use of global controls for mesh sizing and inflation. This workshop will use a CAD file imported directly into the Meshing Application



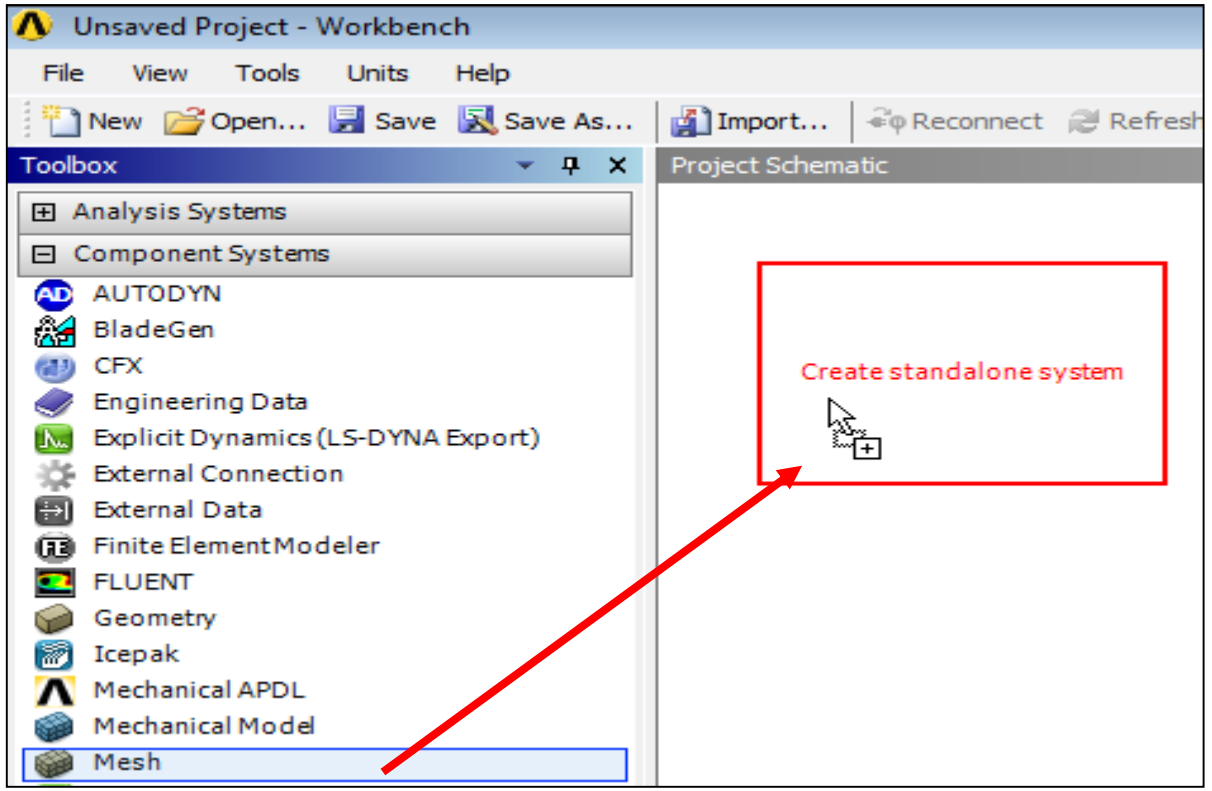
Objectives

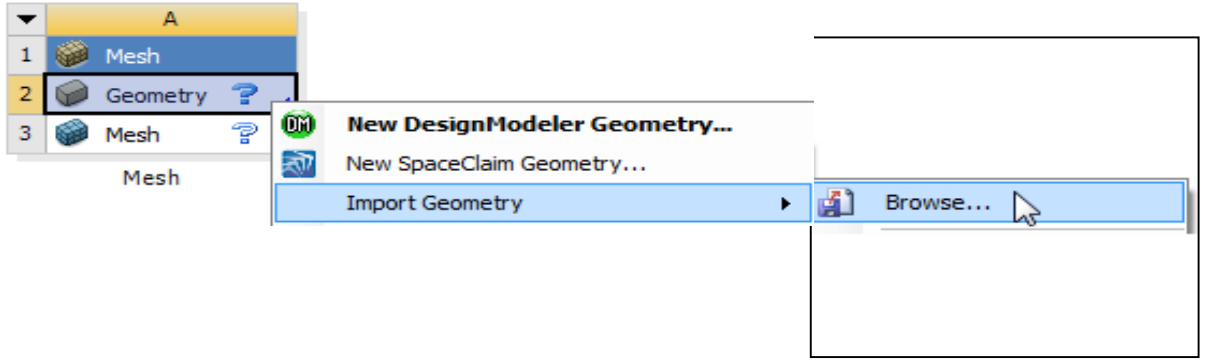
- Starting ANSYS Meshing
- Generating a mesh
- Using Advanced Size Functions
  - Curvature
  - Proximity
- Inflation

Project Startup

Create the Project

- Start Workbench
  - Start → All Programs → ANSYS 17.0 → Workbench 17.0
  - Drag and drop a Mesh Component System into the Project Schematic
- Right click on the Geometry cell (A2) and select Import Geometry → Browse
- Locate the file “main-gear-clean.stp” in the Meshing workshop input files (Module03) folder and select it. The geometry cell will show a check mark indicating it is up to date
- Double click the mesh cell (A3) to start Meshing

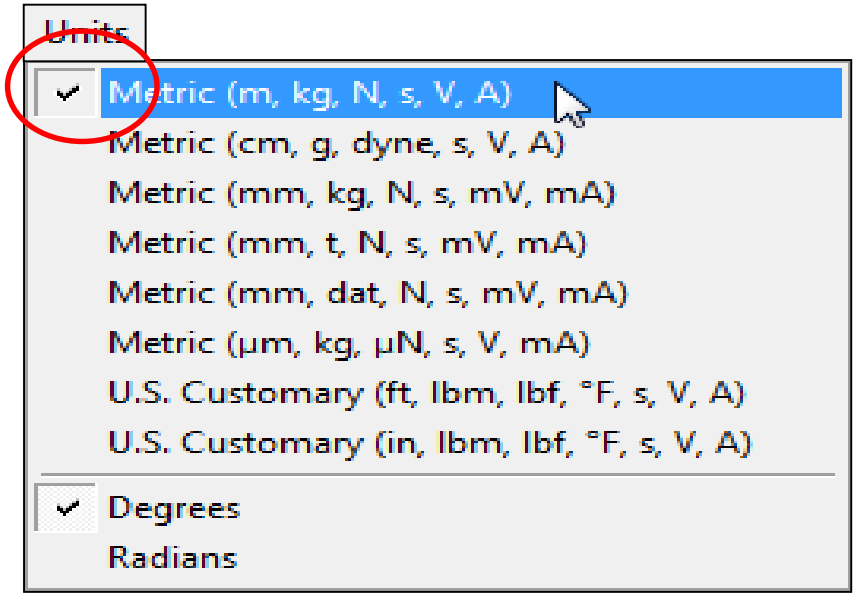




Units

Set Units

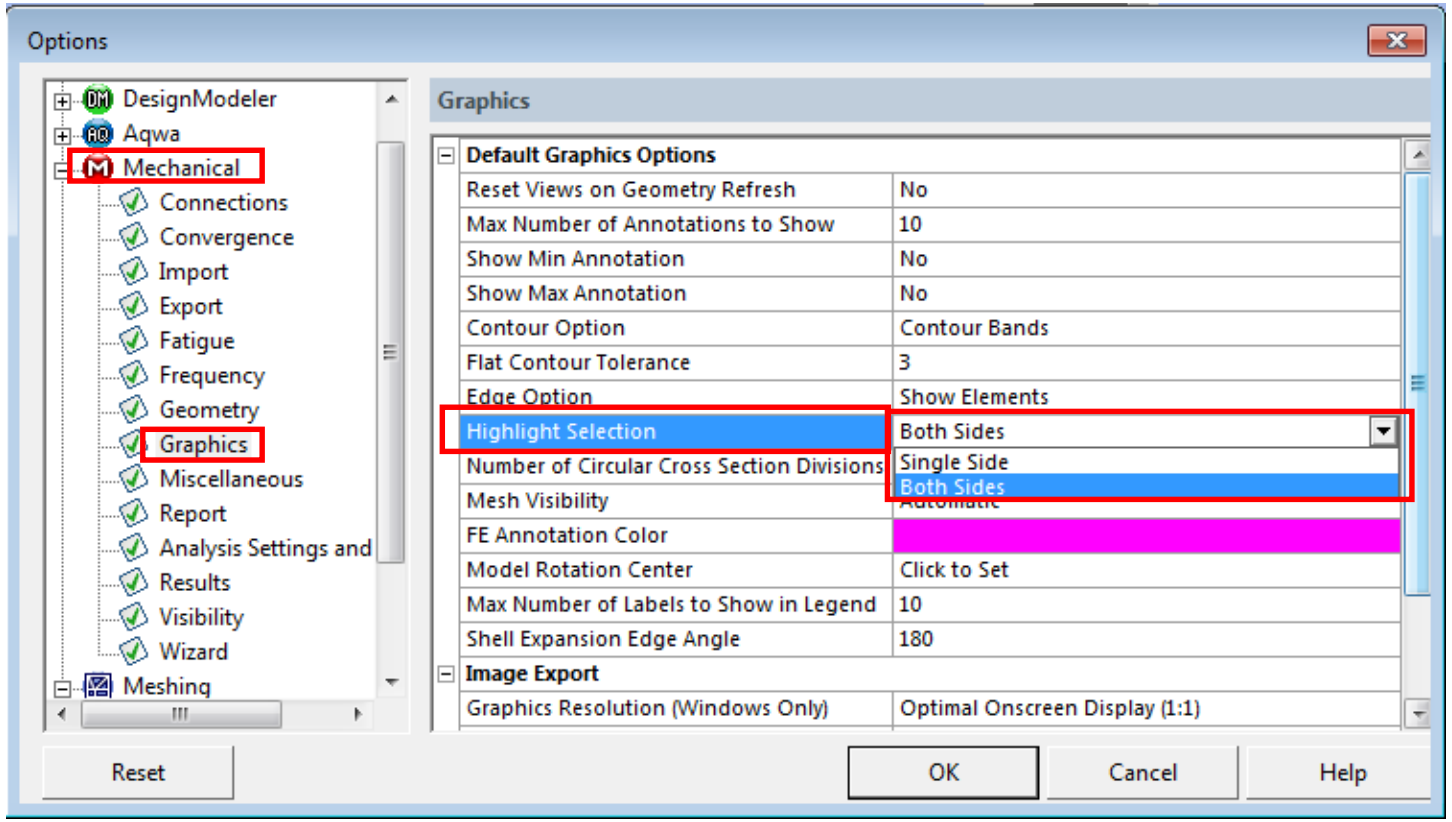
- **From the main menu select Units and, if it is not already set, specify Metric (m...)**



Options (1)

Set Display Options

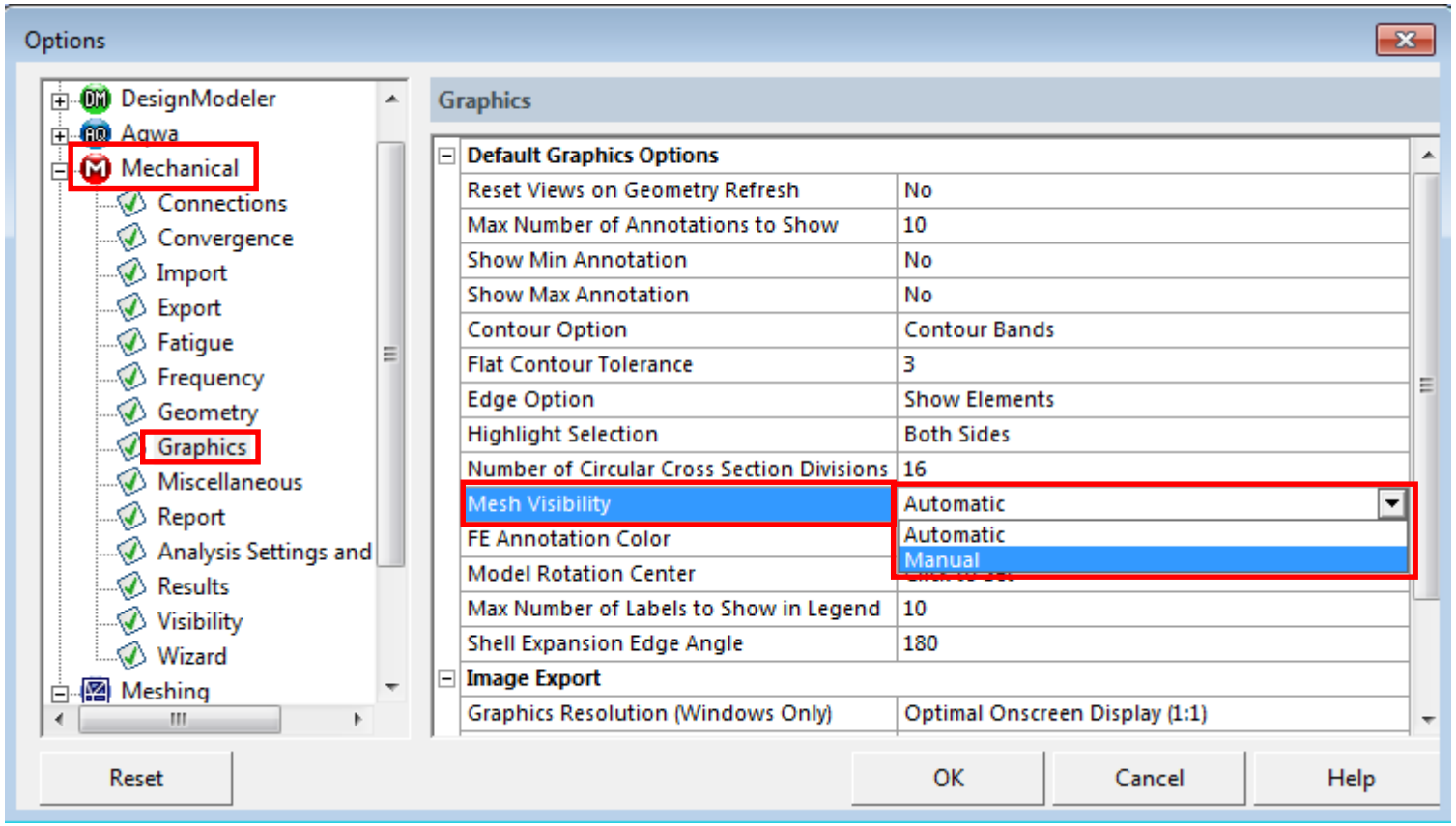
- From the Main Menu, select Tools → Options
- In the Options Panel expand Mechanical and select Graphics
  - Set the Highlight Selection option to Both Sides



Options (2)

Set Display Options

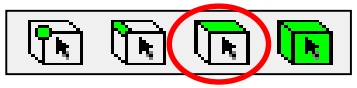
- In Graphics options, make sure that “Mesh Visibility” is set to “Manual” and Click OK



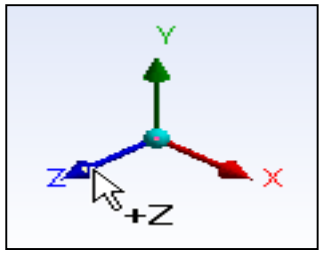
Geometry

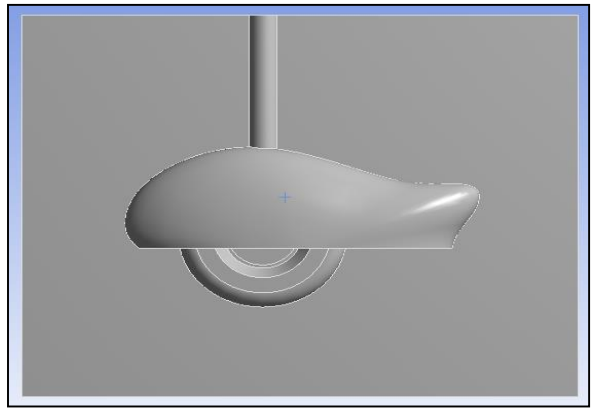
View the Geometry

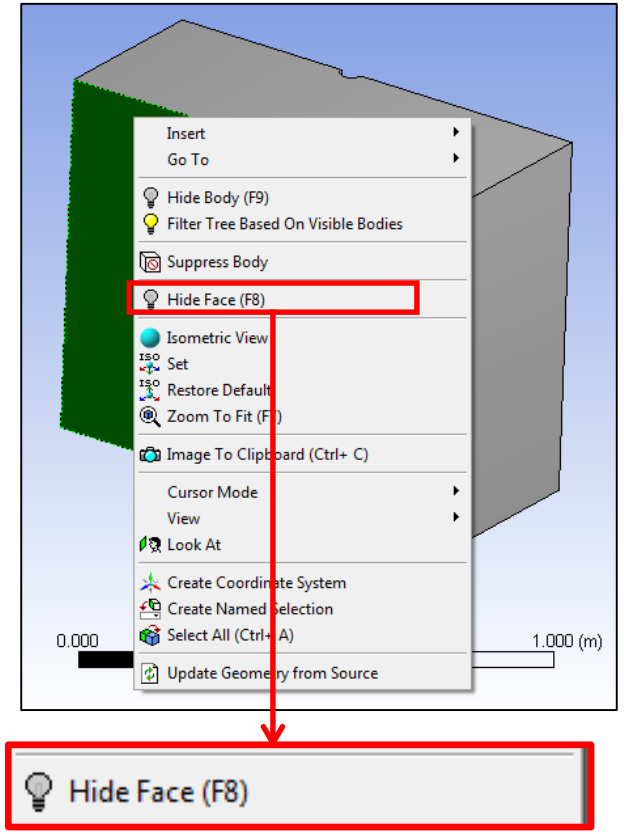
- Select the Face Selection Filter



- Left click to select the face then right click and select Hide Face from the context menu as shown OR press F8
- Snap the view to the +Z Axis using the Axis Triad as shown (below)



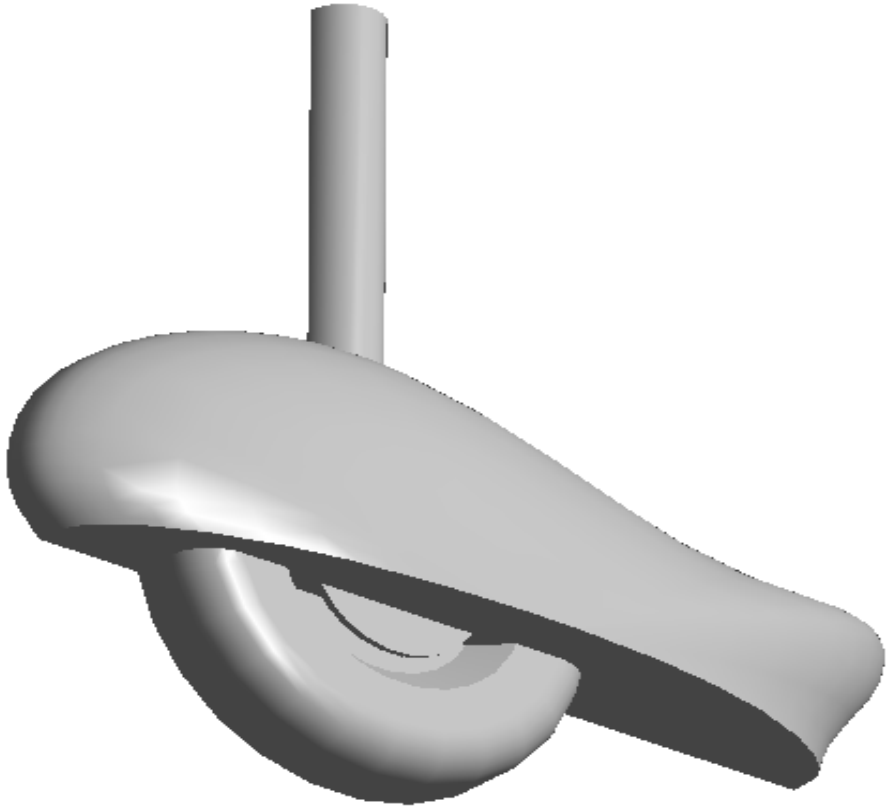




Preparation

Planning

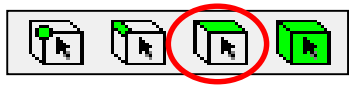
- This CAD file contains a single body streamlined main landing gear geometry
  - Symmetry is assumed
- The arrangement of the geometry and presence of complex curved surfaces would make decomposition into hex sweepable volumes impractical
- The Tetrahedrons Method combined with Advanced Size Functions to capture curvature would be a good candidate for this application
- Since the CAD is of a good quality the Patch Conforming Algorithm will be used
- Inflation will be used as the mesh is intended for an external aerodynamic analysis where boundary layer resolution will be required



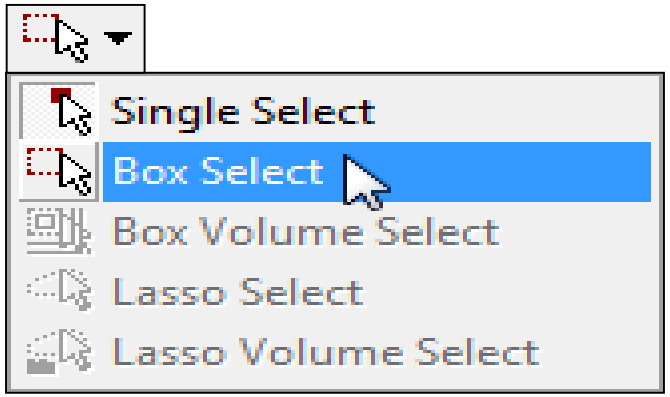
Named Selections (1)

Add Named Selections

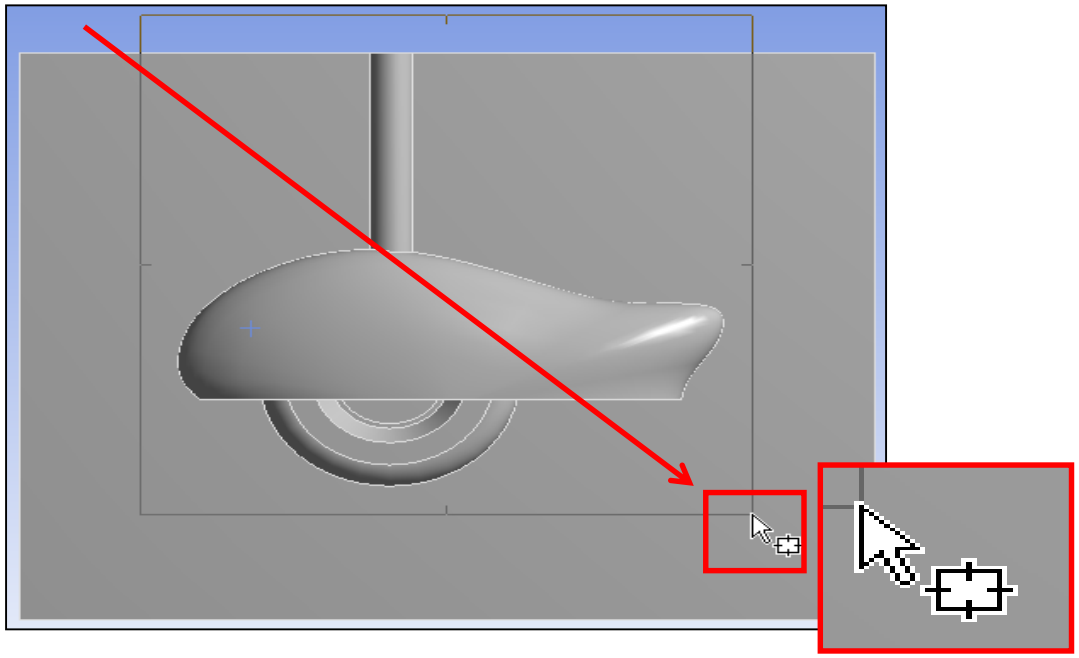
- Select the Face Selection Filter

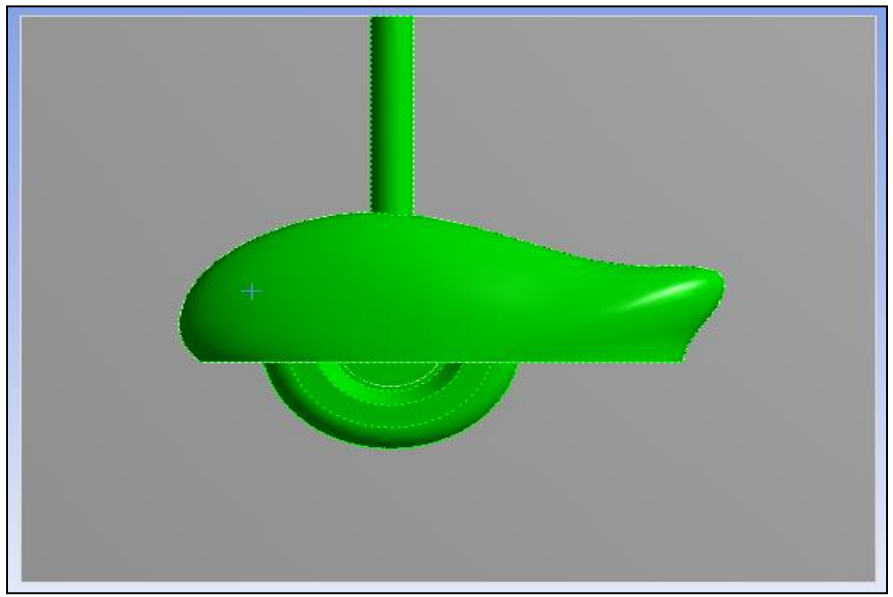


- Select Box Select



- Click, drag and release from top left to bottom right to draw a box around the landing gear surface as shown (right)
  - The landing gear surfaces will be selected

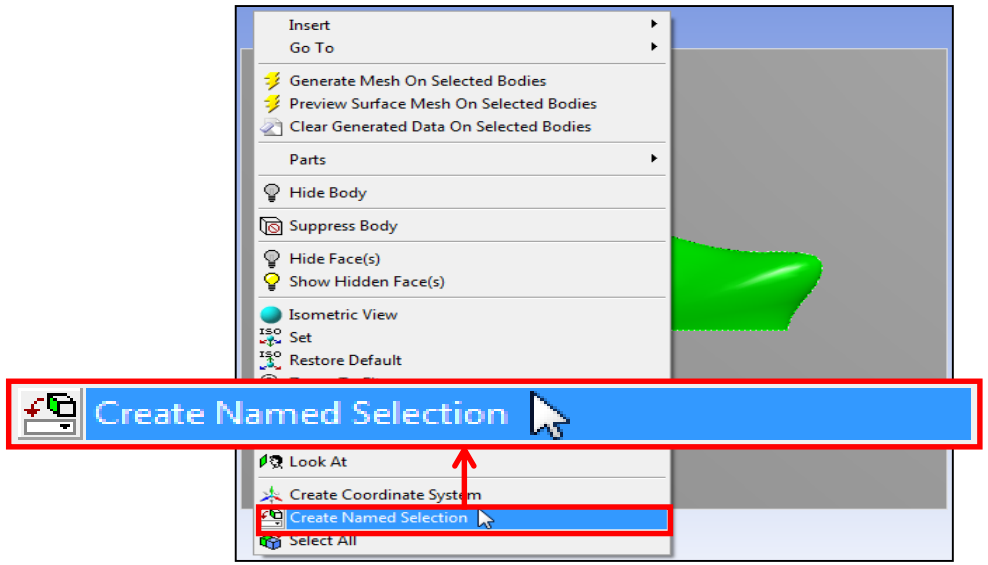


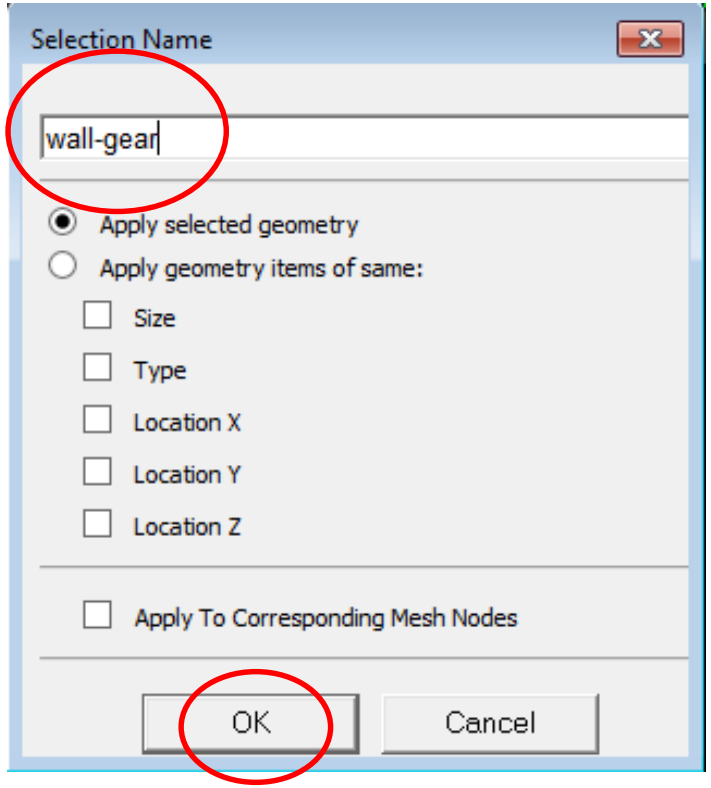


Named Selections (2)

Add Named Selections (Continued)

- Right click and select Create Named Selection from the Context Menu as shown (below)



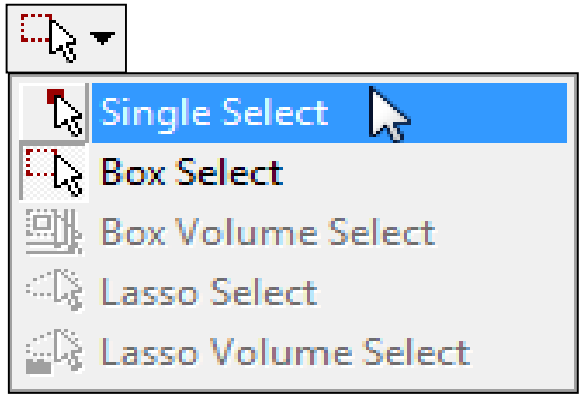


- In the Named Selection Dialog Box type the name “wall-gear” as shown (right)
- Click OK

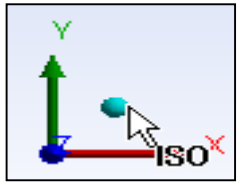
Named Selections (3)

Add Named Selections (Continued)

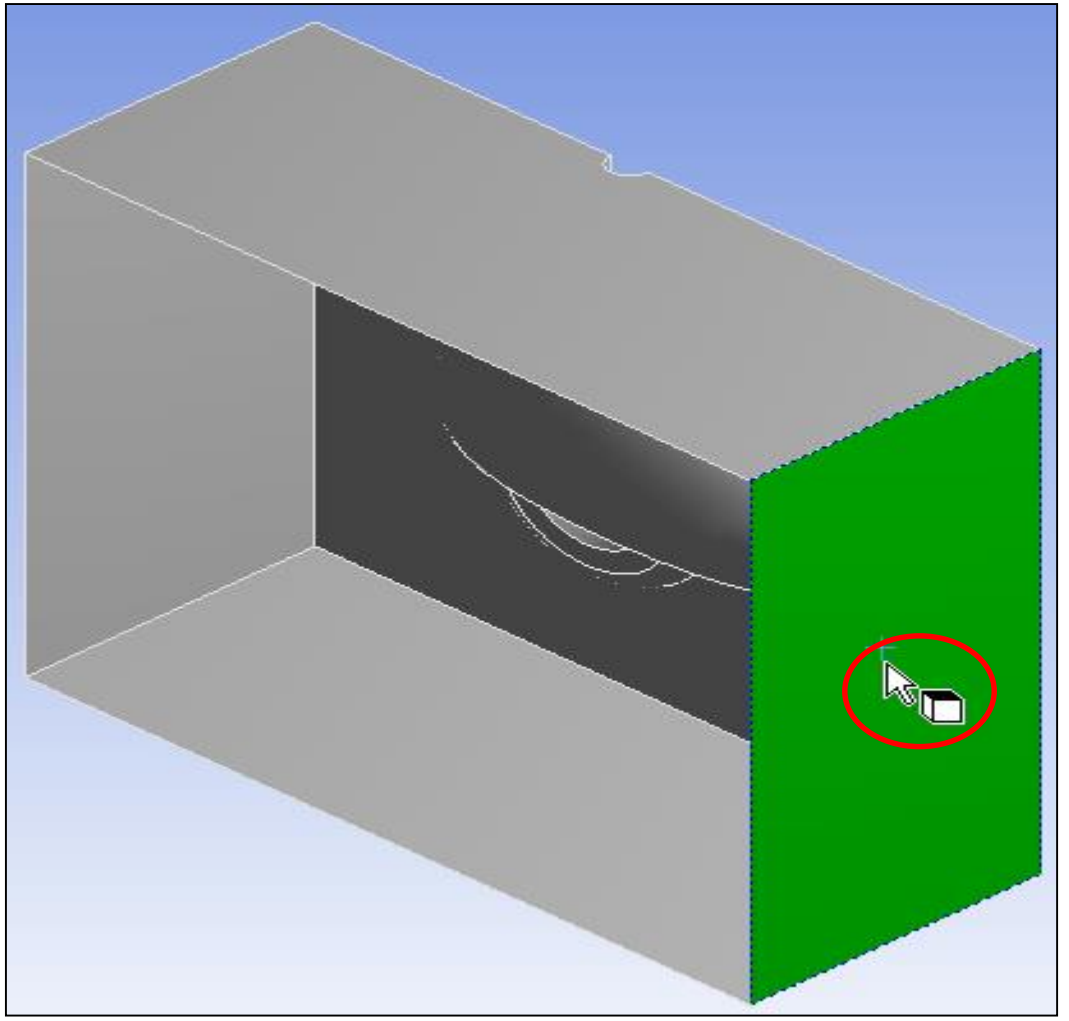
- Revert back to Single Select



- Snap the view to isometric using the iso-ball



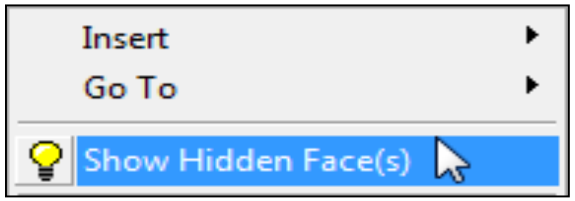
- Select the face as shown and, using the same method, create a Named Selection “outlet”

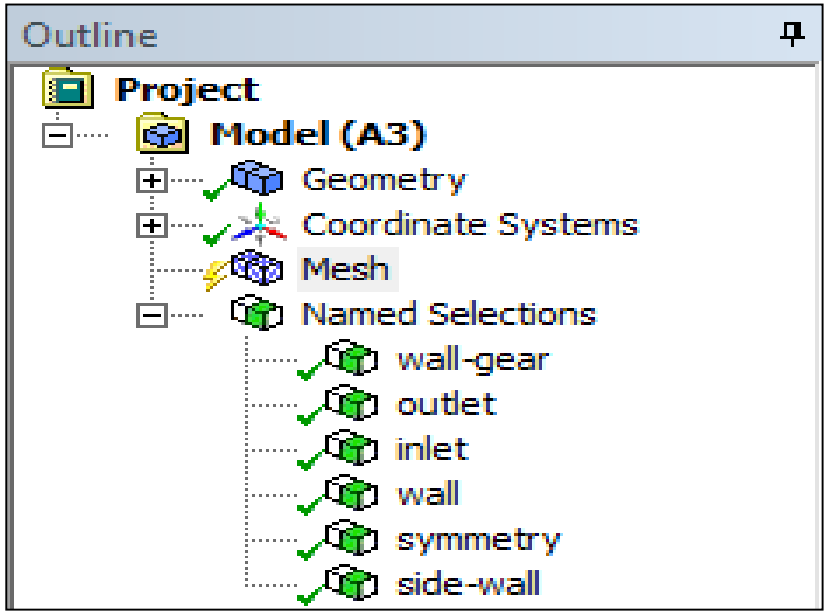


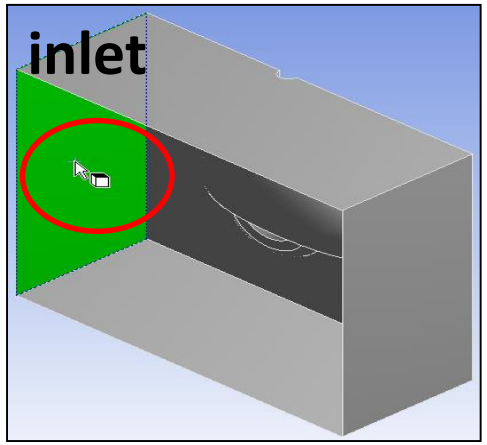
Named Selections (4)

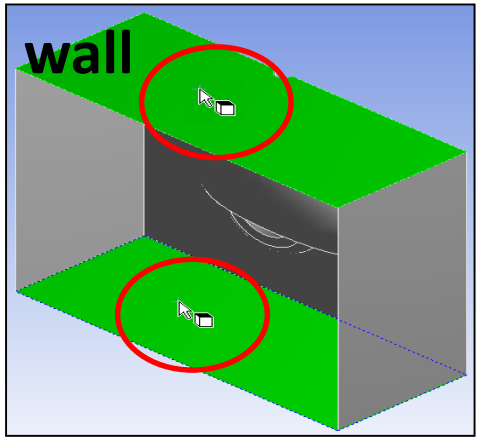
Add Named Selections (Continued)

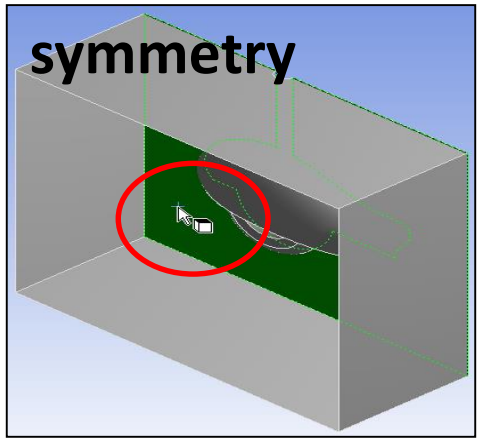
- Create further Named Selections as shown (below)
  - For multiple face selections hold down the CTRL key while selecting
  - For the last selection right click and select Show Hidden Face(s) to restore the face hidden earlier

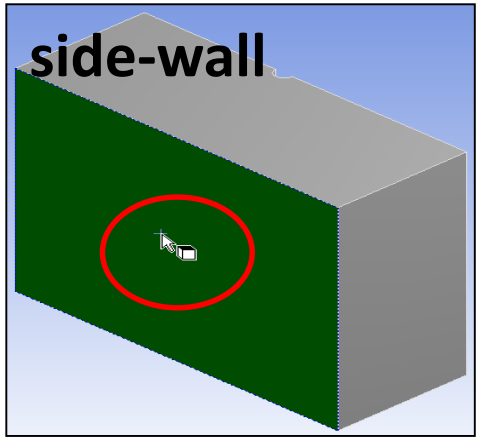








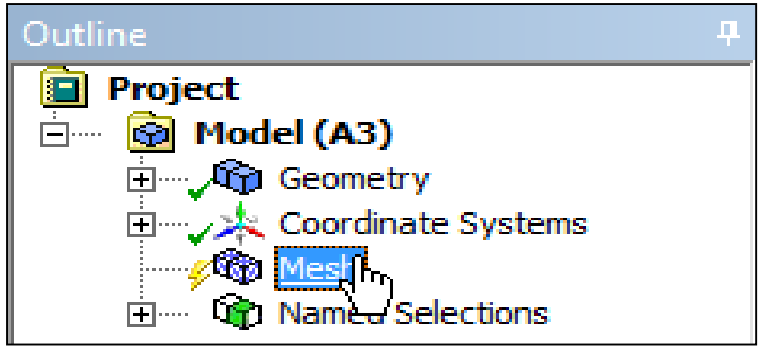




Global Mesh Settings

Mesh

- In the Outline, select the Mesh object to display Details of “Mesh”



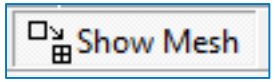
- In Details of “Mesh”, set the following under Defaults
  - Physics Preference: CFD
  - Solver Preference: FLUENT
- In Sizing
  - Set “Size Function” to Adaptive

Details of "Mesh"

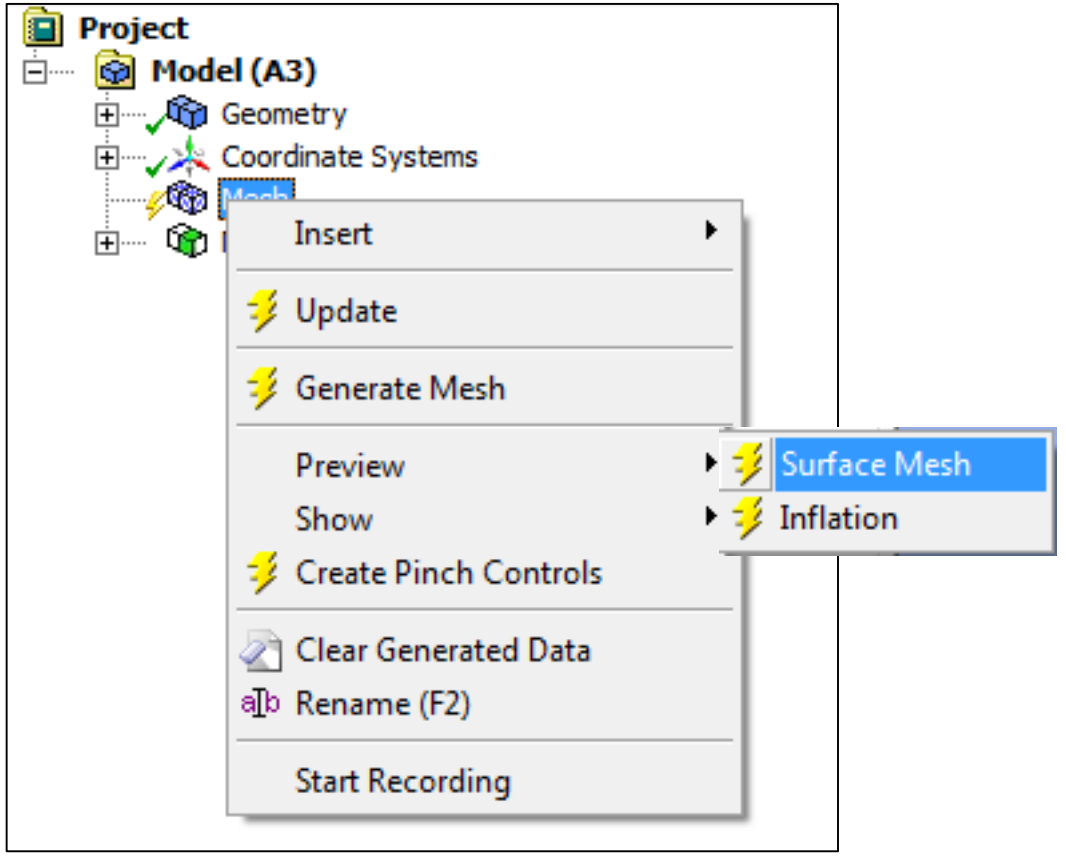
Display	
Display Style	Body Color
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
Relevance	0
Export Format	Standard
Shape Checking	CFD
Element Midside Nodes	Dropped
Sizing	
Size Function	Adaptive
Relevance Center	Coarse
Element Size	Default
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default
Minimum Edge Length	4.0905e-003 m
Inflation	
Assembly Meshing	
Advanced	
Statistics	

Preview

Preview Surface Mesh

- Before generating a volume mesh we should check that the surface mesh is satisfactory
- In the Outline, right click on the Mesh object and select Preview → Surface Mesh
- A mesh will be generated on all surfaces using the global settings applied so far
- Press 

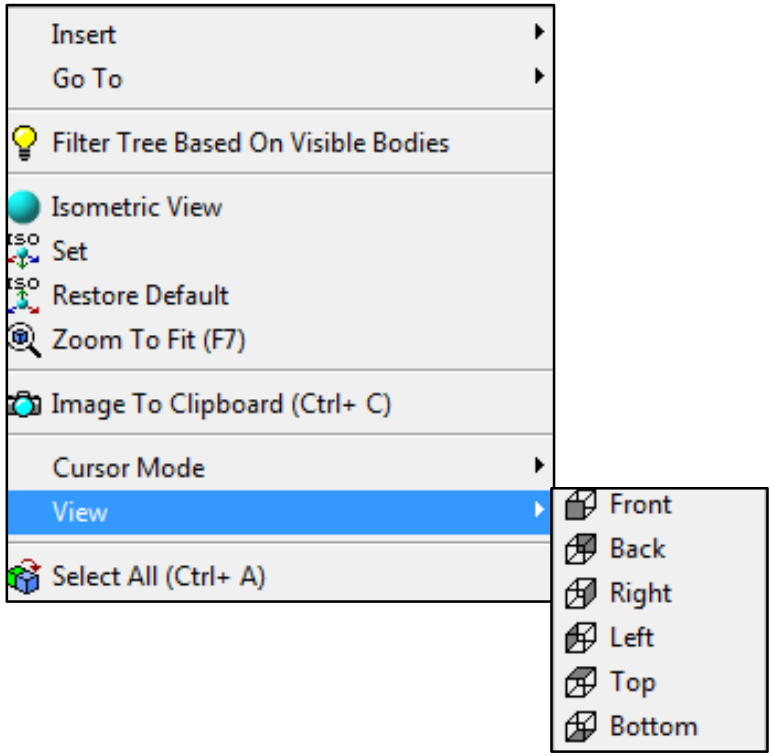
button to display mesh



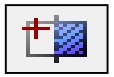
Section Plane

Preview Surface Mesh (Continued)

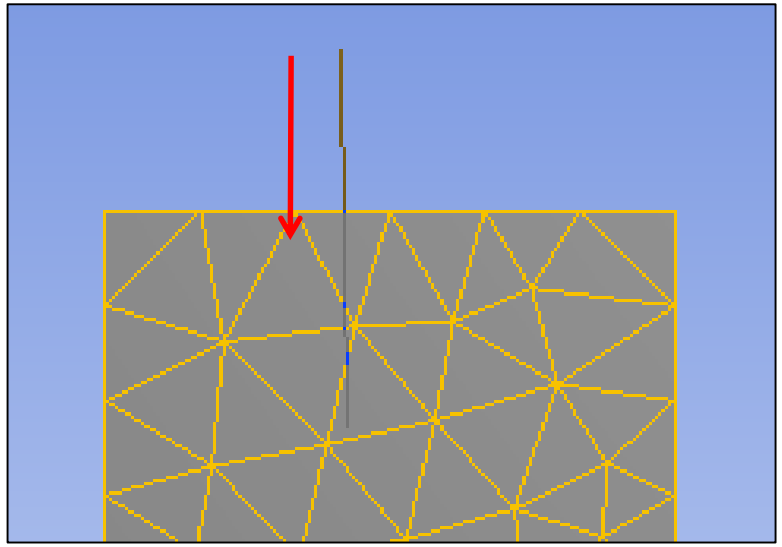
- Right click in the graphics window and select View → Left (corresponds to -X)



- Select the Section Plane Tool



- Create a Section Plane by clicking, dragging and releasing as shown vertically down through the mesh

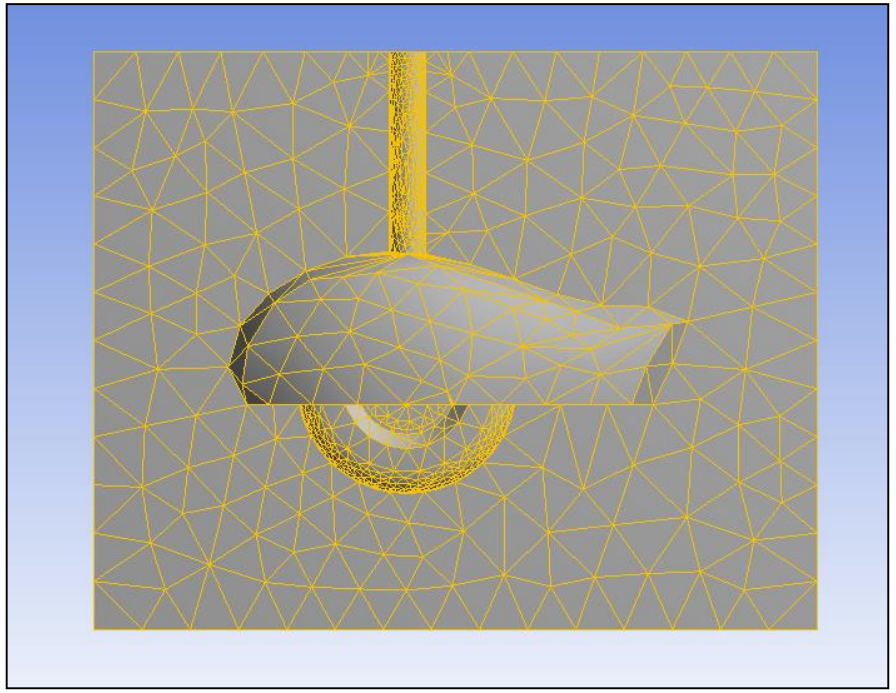


Size Function: Adaptive

Review the Surface Mesh

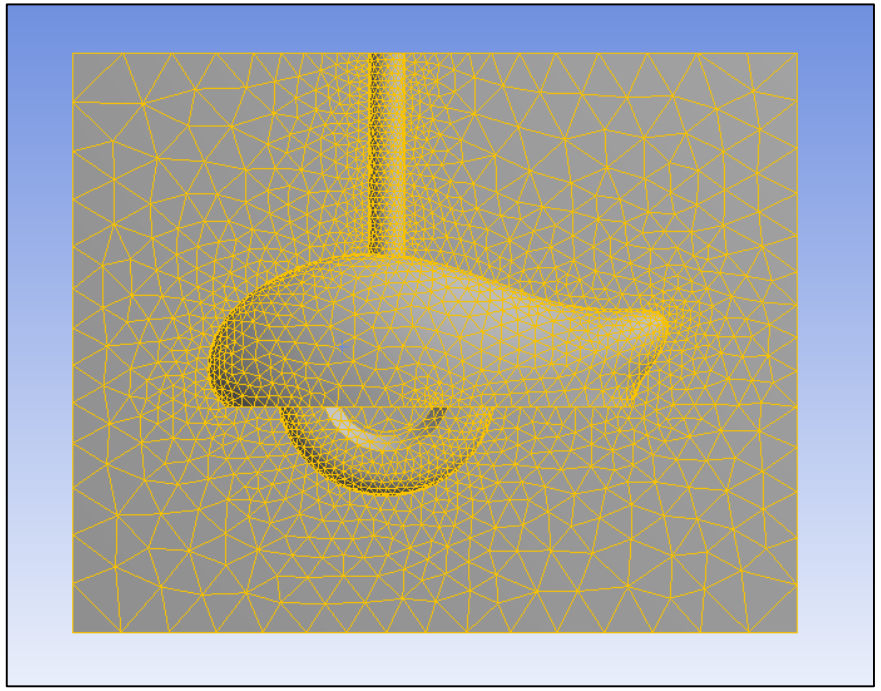
- Right click and select View → Front
- With the Size Function set to Adaptive the surface mesh is very low quality taking no account of surface curvature and containing rapid size changes

- In Details of “Mesh”, in Sizing set
  - Size Function: Curvature
  - Curvature Normal Angle: 24
- Preview the surface mesh again with the new settings



Sizing	
Size Function	Curvature
Relevance Center	Coarse
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
Curvature Normal Angle	24.0 °
Min Size	Default (6.6872e-004 m)
Max Face Size	Default (6.6872e-002 m)
Max Tet Size	Default (0.133740 m)
Growth Rate	Default (1.20)
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (3.3436e-004 m)
Minimum Edge Length	4.0905e-003 m

Size Function: Curvature (1)

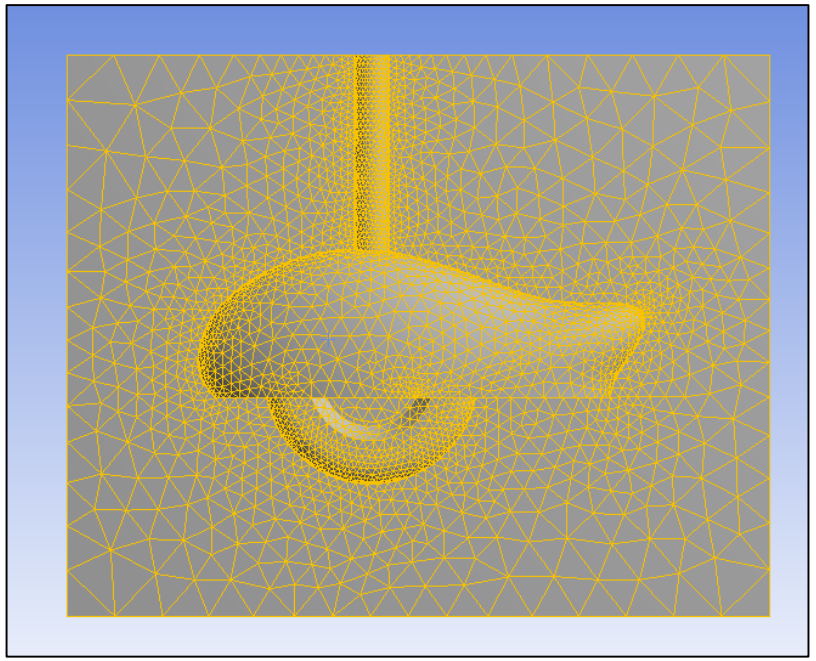


Review the Surface Mesh

- Much better! With the Advanced Size Function set to Curvature the surface mesh has automatically refined to the surface curvature
- The surface mesh also adheres to a specified growth rate
- We'll now look at controlling the curvature refinement
- In Details of "Mesh", in Sizing set
  - Curvature Normal Angle: 18
- Preview the surface mesh again with the new settings

Span Angle Center	Fine
Curvature Normal Angle	18.0 °
Min Size	Default (6.6872e-004 m)
Max Face Size	Default (6.6872e-002 m)
Max Size	Default (0.133740 m)
Growth Rate	Default (1.20)

Size Function: Curvature (2)



Review the Surface Mesh

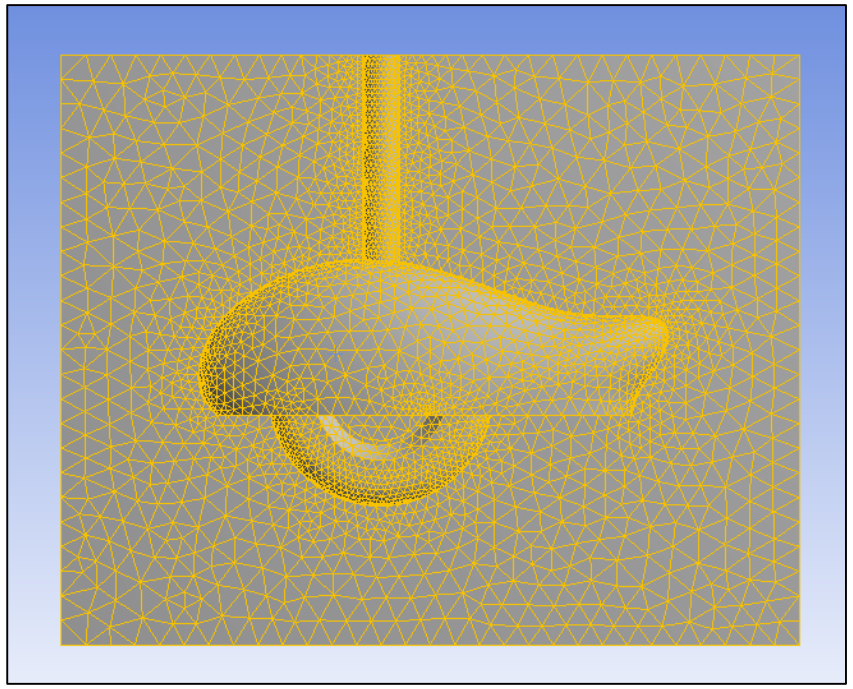
- By decreasing the Curvature Normal Angle the refinement to surface curvature increases
- We'll now look at controlling the overall limits for minimum and maximum sizes using the Relevance Center setting
- In Details of "Mesh", in Sizing set
  - Relevance Centre: Medium
  - Notice that the Min, Max Face and Max Size values have changed
- Preview the surface mesh again with the new settings

Relevance Center	Medium
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
Curvature Normal Angle	18.0 °
Min Size	Default (3.3436e-004 m)
Max Face Size	Default (3.3436e-002 m)
Max Size	Default (6.6872e-002 m)
Growth Rate	Default (1.20)

Relevance Center

Review the Surface Mesh

- By increasing the Relevance Center from Coarse to Medium the Global limits on the mesh sizes have changed
- This change has forced smaller mesh sizes in the far field and allowed smaller sizes where required on the surfaces

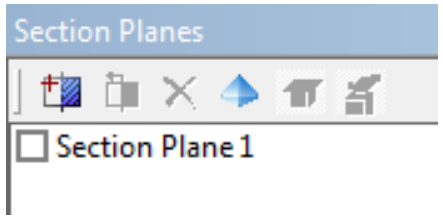


Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Medium
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
Curvature Normal Angle	18.0 °
Min Size	Default (3.3436e-004 m)
Max Face Size	Default (3.3436e-002 m)
Max Size	Default (6.6872e-002 m)
Growth Rate	Default (1.20)
Minimum Edge Length	4.0905e-003 m

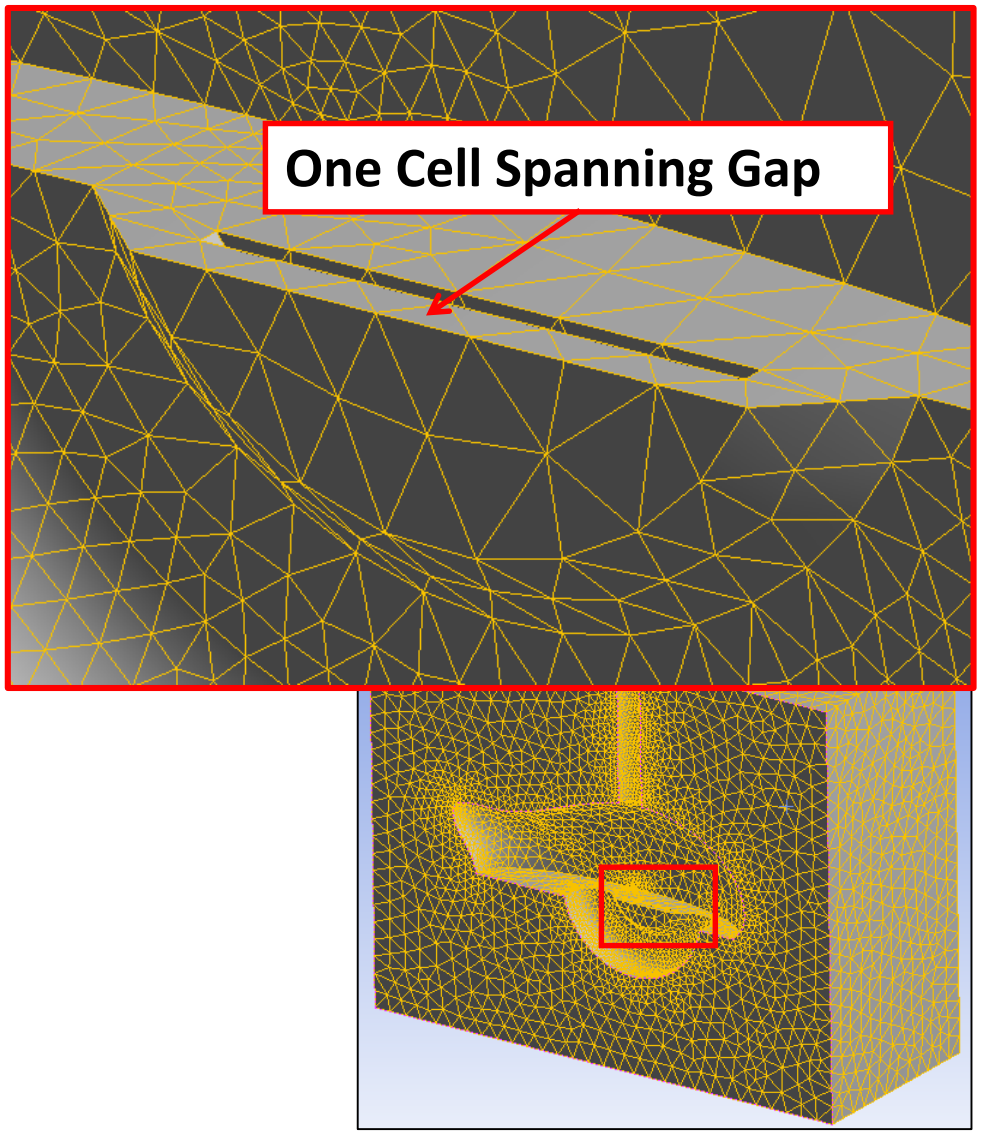
Size Function: Proximity (1)

Refine for Proximity

- Switch off the Section Plane by unchecking it in the Section Planes Panel



- Rotate the mesh such that the symmetry face is visible as shown (lower right)
- Zoom in to the region highlighted – this is the lower half of the disc brake
- There is a gap between the disc and the wheel rim
- To adequately resolve for flow through this gap we need to ensure a minimum number of cells span the gap. Just one, as in this case, is not sufficient



Size Function: Proximity (2)

Refine for Proximity (Continued)

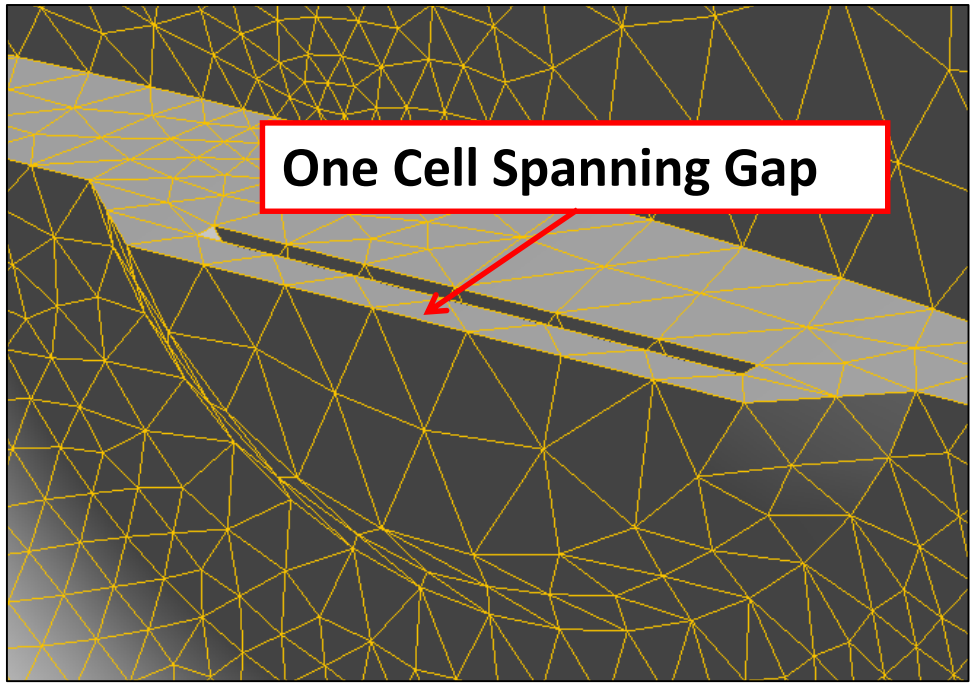
- In Details of “Mesh”, in Sizing set
  - Use Size Function: Proximity and Curvature
  - Num Cells Across Gap to 3
- Preview the surface mesh again with the new settings

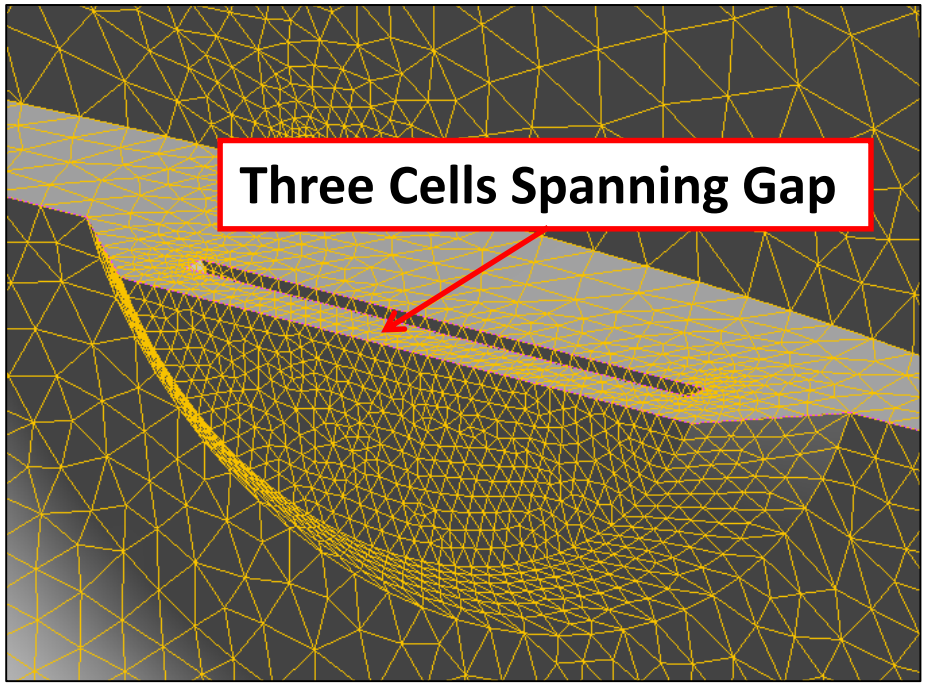
Sizing	
Size Function	Proximity and Curvature
Relevance Center	Medium
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
Num Cells Across Gap	Default (3)
Proximity Size Function Sources	Faces and Edges
Proximity Min Size	Default (3.3436e-004 m)
Max Face Size	Default (3.3436e-002 m)
Max Tet Size	Default (6.6872e-002 m)
Growth Rate	Default (1.20)
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (1.6718e-004 m)
Minimum Edge Length	4.0905e-003 m

Size Function: Proximity (3)

Refine for Proximity (Continued)

- Note the new surface mesh (right) now automatically refined for both Proximity and Curvature

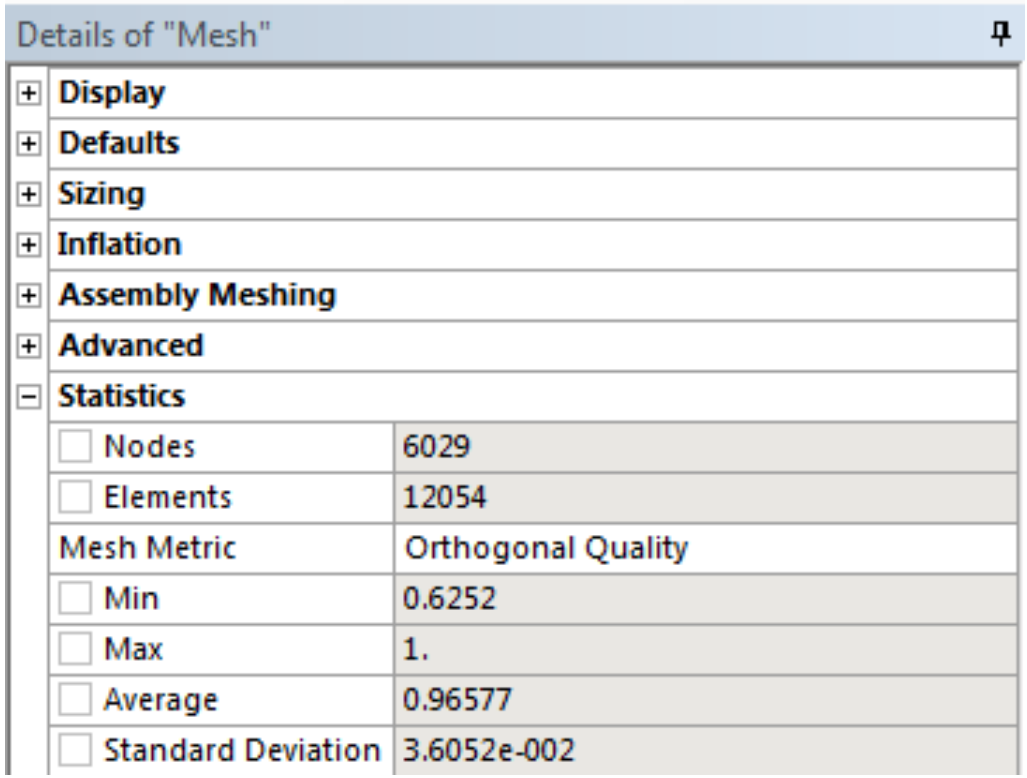




Quality

Check Surface Quality

- Before moving onto setup inflation it is prudent to check the quality of the surface mesh
  - There is little point attempting to generate inflation and a volume mesh on a poor quality surface mesh
- In Details of “Mesh”, in Statistics set
  - Mesh Metric: Orthogonal Quality
- For good quality volume mesh, the min value for Orthogonal Quality should be greater than 0.4-0.5 for surface mesh
- It is, so we can proceed
  - You may have slightly different figures than shown here



Inflation (1)

Add Inflation

- Right click and select View → Back
- In Details of “Mesh”, as shown, under Inflation set
  - Use Automatic Inflation: All Faces in Chosen Named Selection
  - Named Selection: wall-gear
  - Inflation Option: Total Thickness
  - Maximum Thickness: 0.012m*
- In the Outline, right click on the Mesh object and this time select Preview → Inflation

Details of "Mesh"	
⊞ Display	
⊞ Defaults	
⊞ Sizing	
⊟ Inflation	
Use Automatic Inflation	All Faces in Chosen Named Selection
Named Selection	wall-gear
Inflation Option	Total Thickness
Number of Layers	5
Growth Rate	1.2
Maximum Thickness	1.2e-002 m
Inflation Algorithm	Pre
View Advanced Options	No

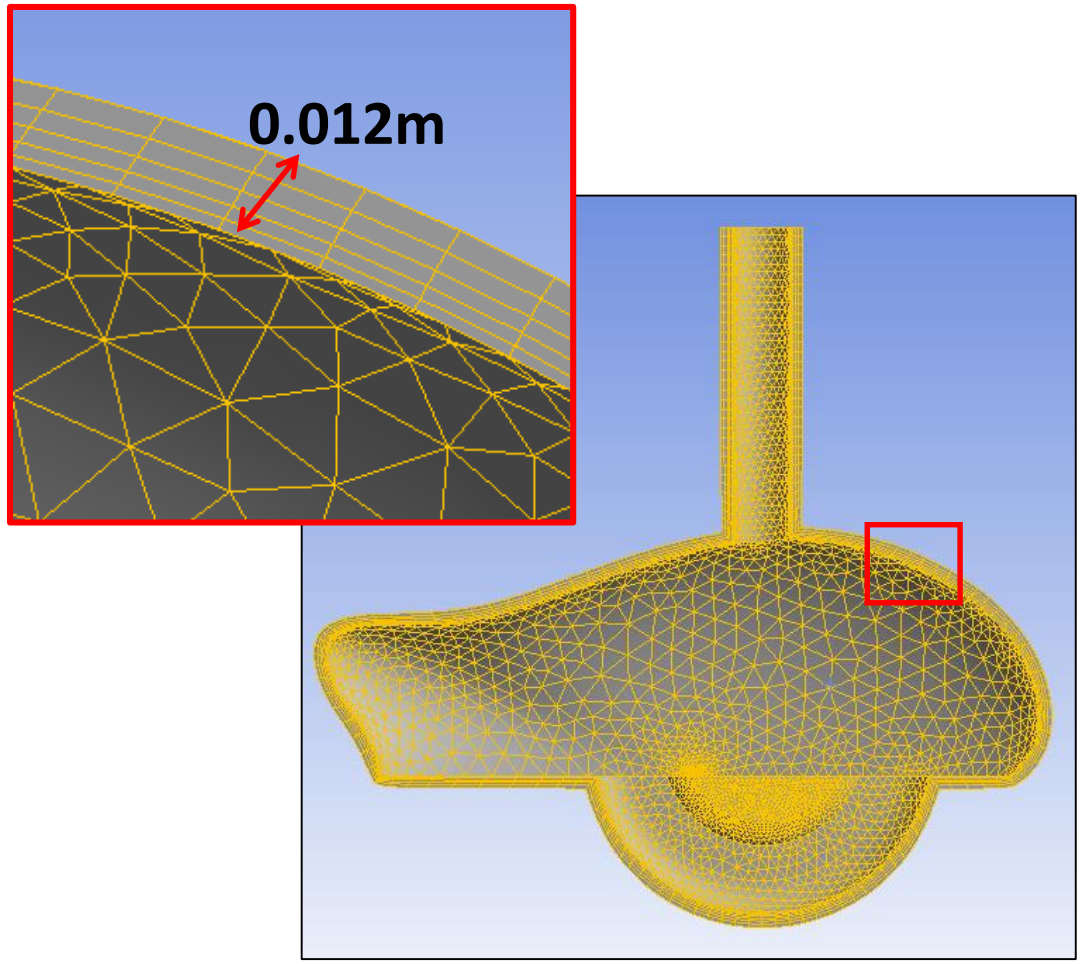
*Note: Inflation layer thickness should be defined to capture the boundary layer. This depends upon the flow characteristics and will need to be evaluated on a case by case basis, the value here is an example

Inflation (2)

Add Inflation (Continued)

- The surface mesh has been inflated on all surfaces within the Named Selection “wall-gear” to a maximum total thickness of 0.012m
- Now try a different option, under Inflation set Inflation Option to Smooth Transition and preview inflation again

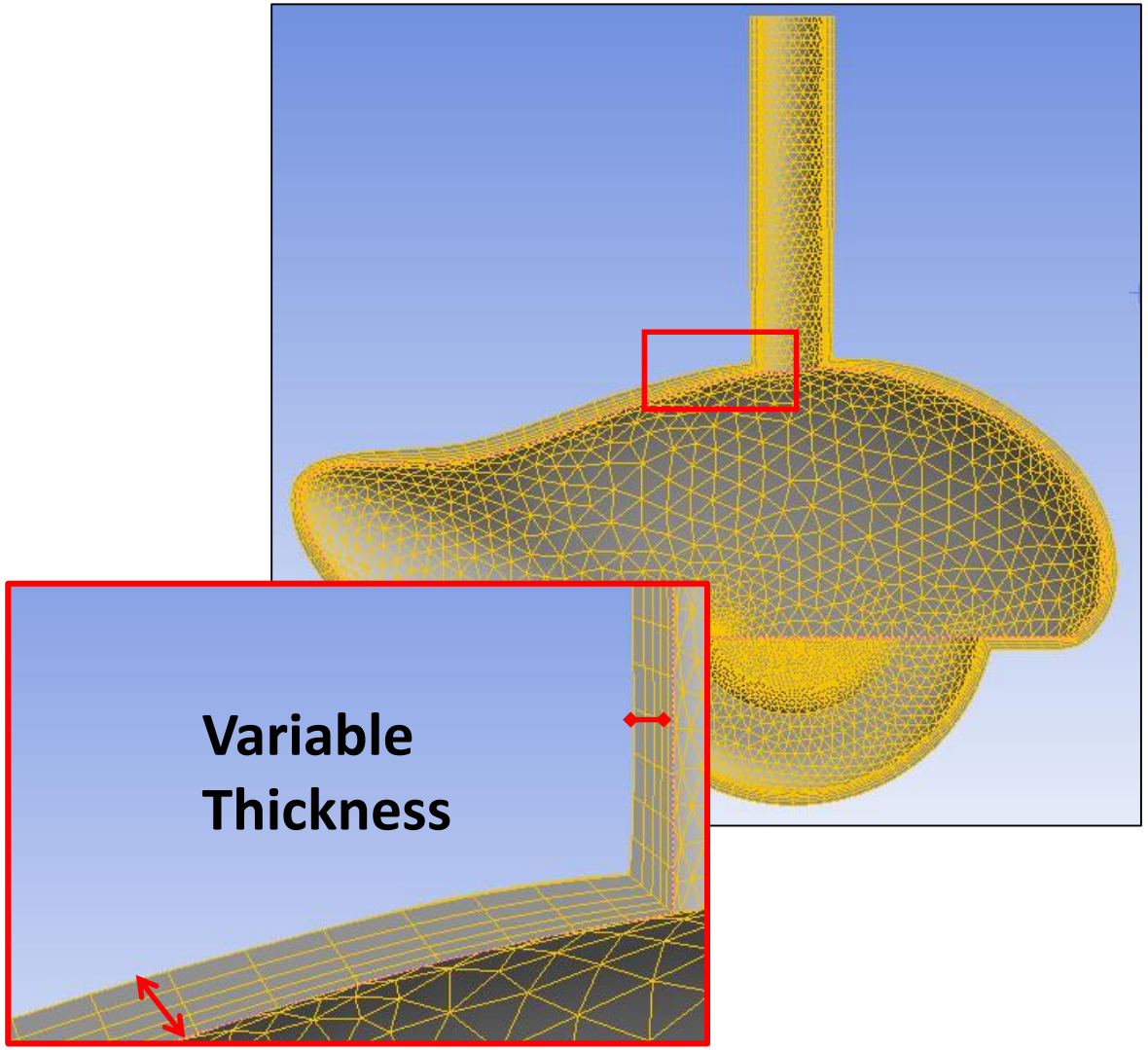
Inflation	
Use Automatic Inflation	All Faces in Chosen Named Selecti...
Named Selection	wall-gear
Inflation Option	Smooth Transition
Transition Ratio	0.272
Maximum Layers	5
Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No



Inflation (3)

Add Inflation (Continued)

- The new inflation has a thickness defined automatically as a function of the surface mesh size
  - Smooth Transition ensures a constant rate of volume change between inflation cells and the tetrahedron cells. It is useful in cases such as these where the surface mesh size varies extensively



Quality

Check Inflation Quality

- Again, before moving on to the complete volume mesh it is prudent to check the quality of the inflation mesh
- Quality should be above 0.15
- The quality is acceptable so we can proceed

Statistics	
Nodes	25878
Elements	42145
Mesh Metric	Orthogonal Quality
Min	0.30536
Max	0.99781
Average	0.79391
Standard Deviation	0.12107

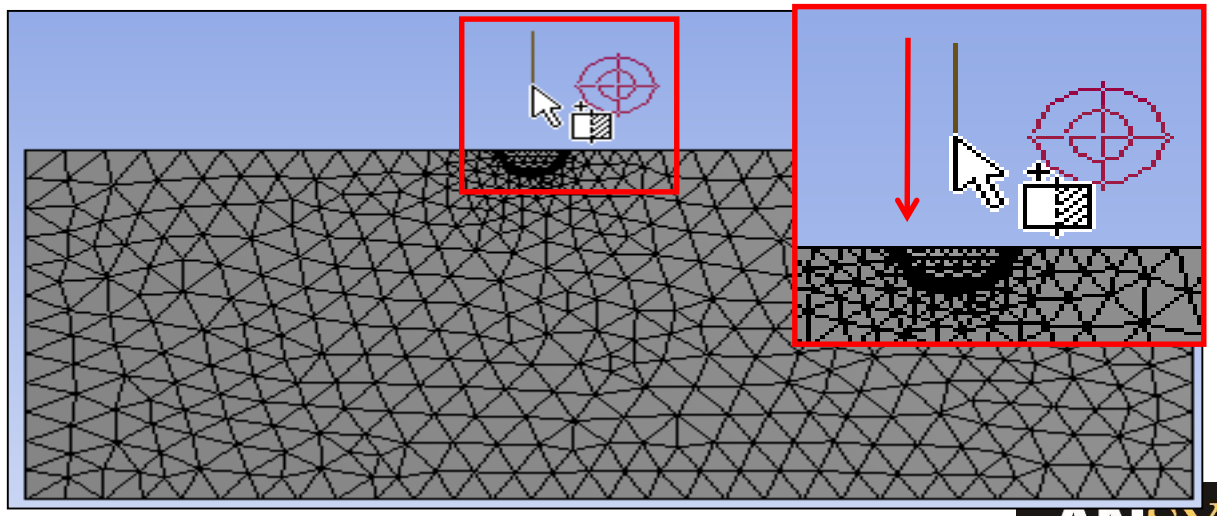
Generate Mesh

Generate the Complete Mesh

- With appropriate global settings and having checked the quality in the previewed inflation mesh we can now generate the complete mesh
- In the Outline, right click on the Mesh object and select Generate Mesh or click the Mesh Update button in the Toolbar

- When the mesh is generated check quality
- Right click in the Graphics Window and select View → Top
- Create a Section Plane through the middle of the mesh as shown

Statistics	
Nodes	48747
Elements	181529
Mesh Metric	Orthogonal Quality
Min	0.23031
Max	0.99781
Average	0.84085
Standard Deviation	9.7954e-002

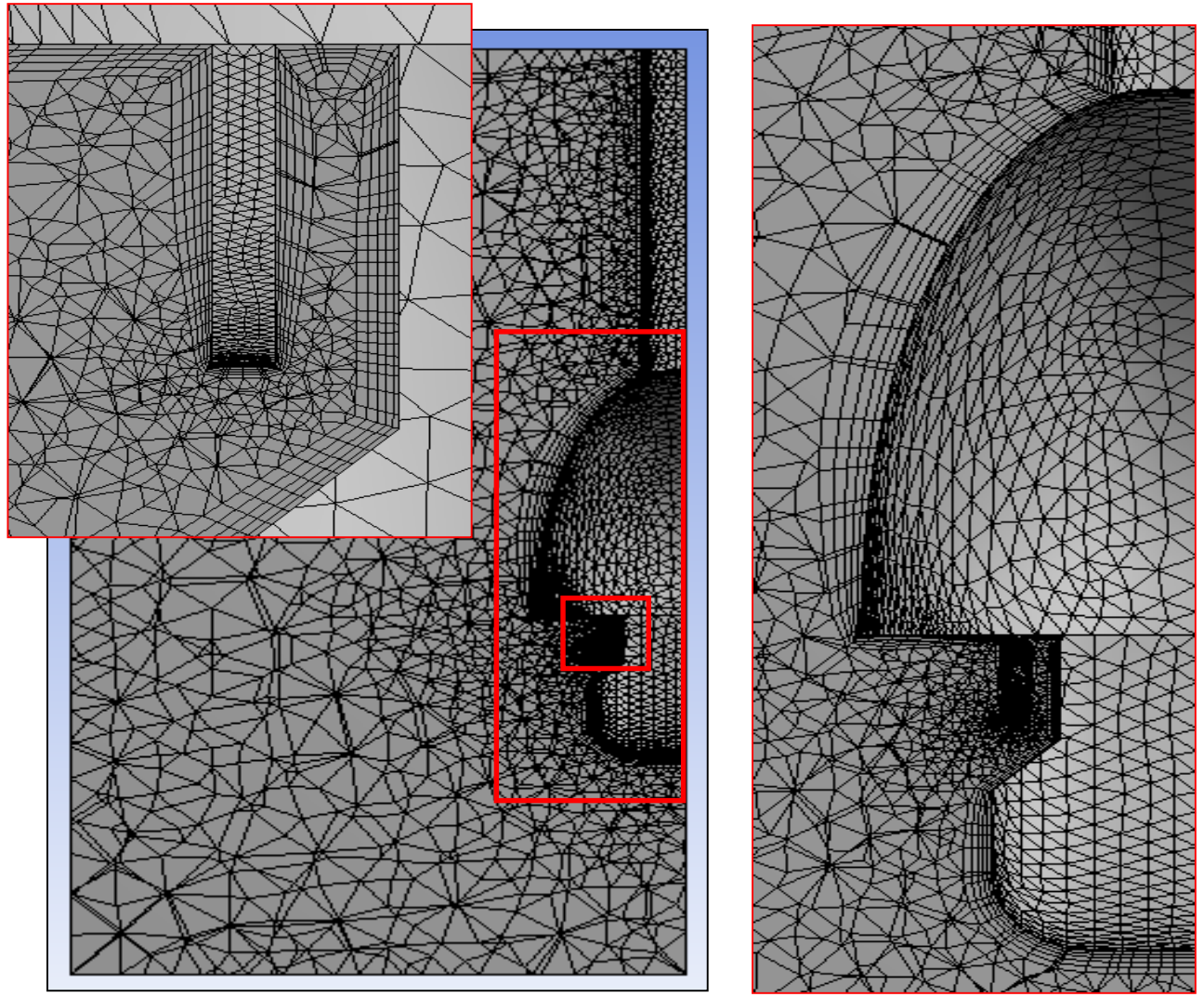


View Mesh

View Mesh Interior

- **The mesh is now ready to be transferred to the solver**
- **This completes the workshop**

Note: that for training purposes the bounding box for this geometry is relatively small. In reality, particularly for aerodynamic simulations, the boundaries (inlet, outlet & side-walls) would be further away as dictated, for example, by wind tunnel dimensions



Save the project

- This completes the workshop
- From the main menu select File → Close Meshing
  - Workbench will save any application data

- From the Workbench Project Page use the file menu and save the project as “AMWS3.1.cfd.wbpj” to your working folder