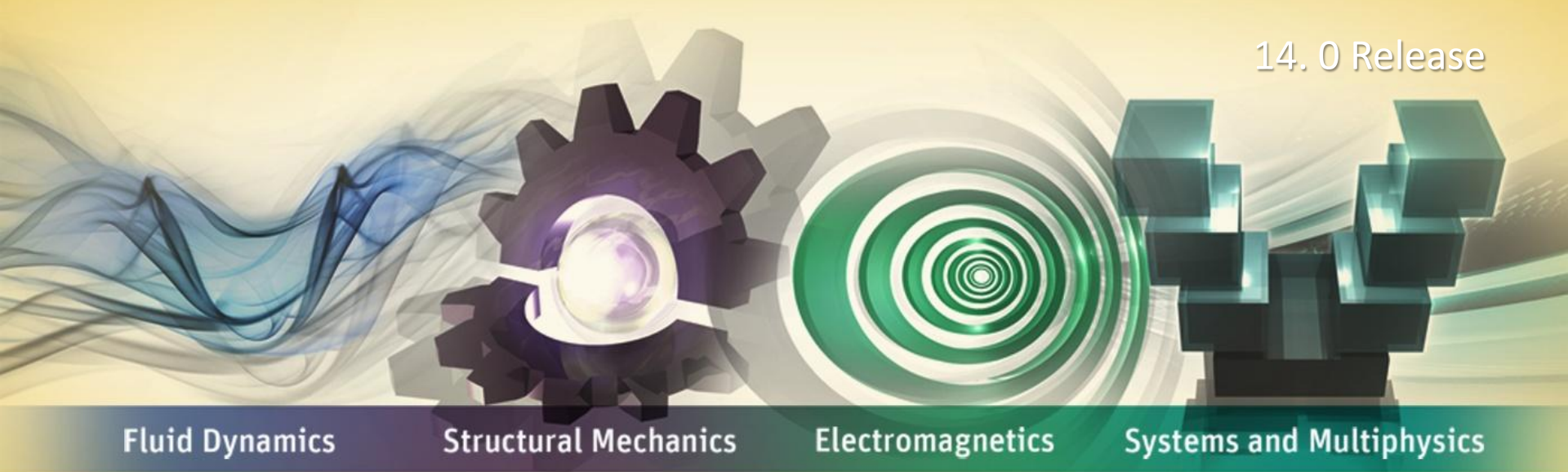


Lecture 5

Global Mesh Controls

14.0 Release

A horizontal banner with a yellow-to-orange gradient background. It features four distinct 3D visualizations: blue fluid flow lines on the left, a purple gear with a glowing center, a green concentric circle pattern, and a stack of teal cubes on the right. Below these images is a dark teal bar containing four white text labels.

Fluid Dynamics

Structural Mechanics

Electromagnetics

Systems and Multiphysics

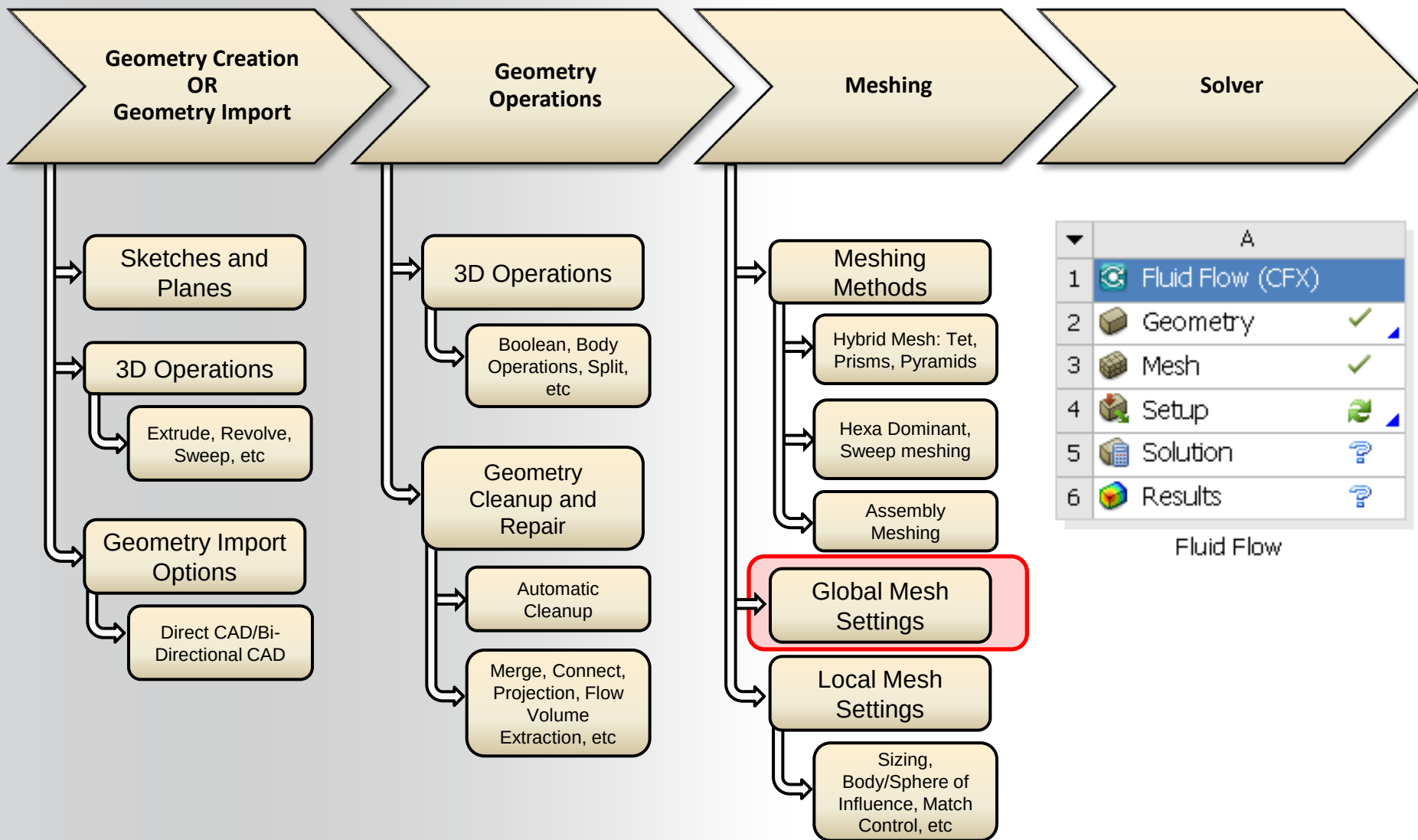
Introduction to ANSYS Meshing

Global Mesh Controls

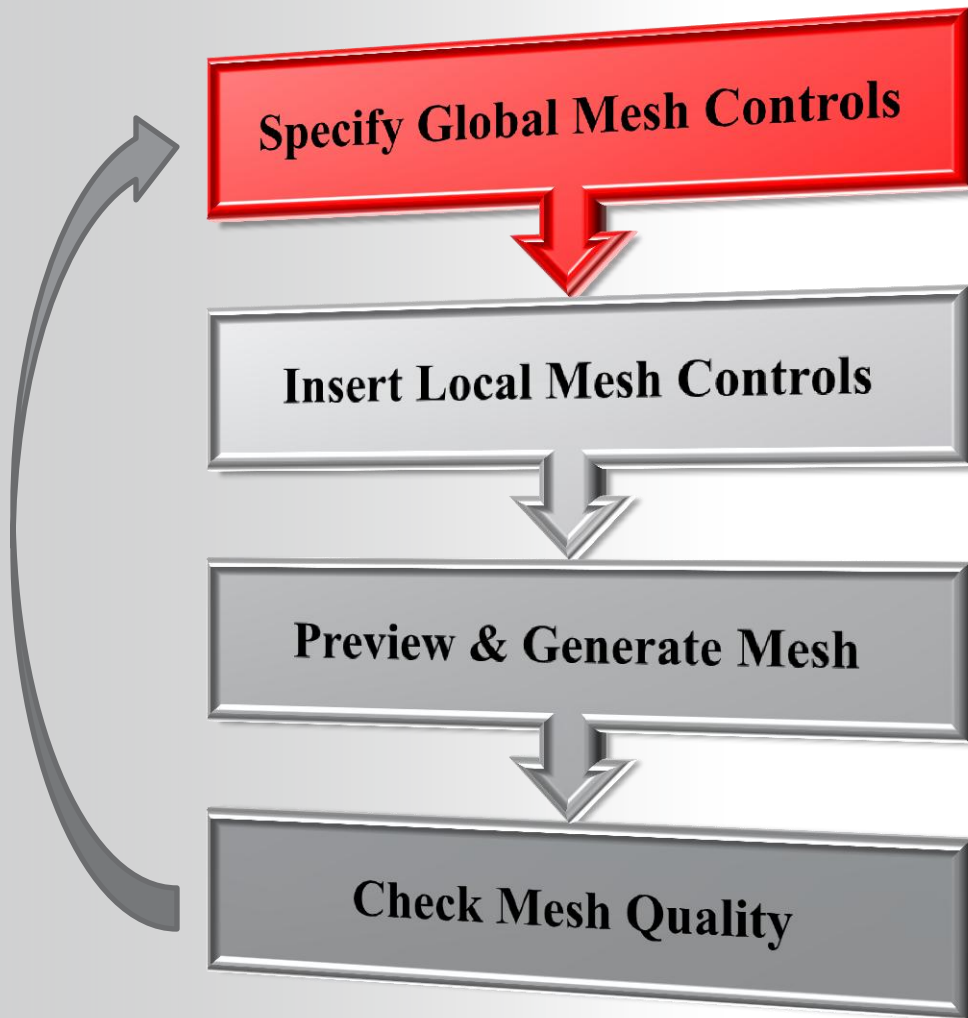
What you will learn from this presentation

- Introduction to Global Mesh Controls
- Defaults
- General Sizing Controls & Advanced Size Functions
- Global Inflation
- Assembly Meshing Controls
- Statistics

Preprocessing Workflow



Meshing Process in ANSYS Meshing



Global Mesh Controls (1)

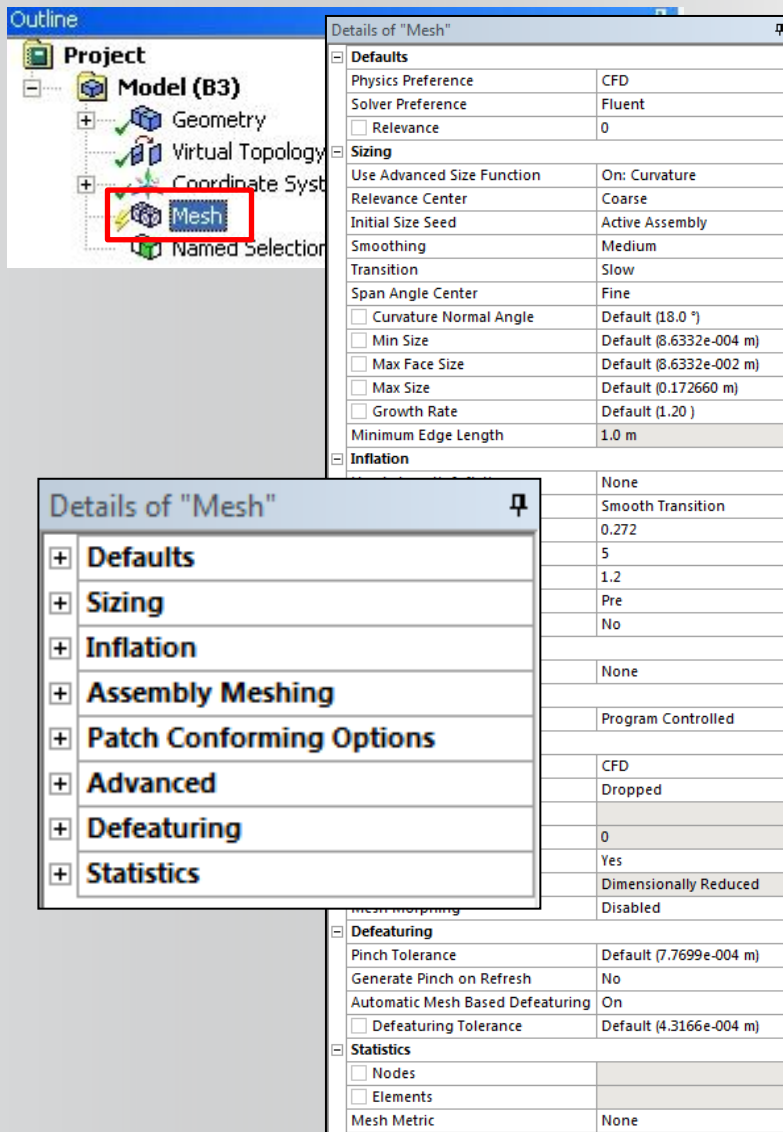
- Global mesh controls are used to make global adjustment in the meshing strategy, which includes sizing functions, inflation, smoothing, defeaturing, parameter inputs, assembly meshing inputs, etc.
- Minimal inputs
 - Automatically calculates global element sizes based on the smallest geometric entity
 - Smart defaults are chosen based on physics preference
- Makes global adjustments for required level of mesh refinement
- Advanced Size Functions for resolving regions with curvatures and proximity of surfaces

Smoothing	Medium	←
Transition	Slow	←
Span Angle Center	Fine	←
☐ Curvature Normal Angle	Default (18.0 °)	←
☐ Min Size	Default (8.6332e-004 m)	←
☐ Max Face Size	Default (8.6332e-002 m)	←
☐ Max Size	Default (0.172660 m)	←
☐ Growth Rate	Default (1.20)	←
Minimum Edge Length	1.0 m	
Inflation		
Use Automatic Inflation	None	
Inflation Option	Smooth Transition	←
☐ Transition Ratio	0.272	←
☐ Maximum Layers	5	
☐ Growth Rate	1.2	
Inflation Algorithm	Pre	
View Advanced Options	No	

Details of "Mesh"	
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Coarse
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
☐ Curvature Normal Angle	Default (18.0 °)
☐ Min Size	Default (8.6332e-004 m)
☐ Max Face Size	Default (8.6332e-002 m)
☐ Max Size	Default (0.172660 m)
☐ Growth Rate	Default (1.20)
Minimum Edge Length	1.0 m
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
☐ Transition Ratio	0.272
☐ Maximum Layers	5
☐ Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No
Assembly Meshing	
Method	None
Patch Conforming Options	
Triangle Surface Mesher	Program Controlled
Advanced	
Shape Checking	CFD
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Dimensionally Reduced
Mesh Morphing	Disabled
Defeaturing	
Pinch Tolerance	Default (7.7699e-004 m)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
☐ Defeaturing Tolerance	Default (4.3166e-004 m)
Statistics	
☐ Nodes	
☐ Elements	
Mesh Metric	None

Smart defaults !

Global Mesh Controls (2)



Physics Based Settings

- Physics and Solver Preferences

Global Mesh Sizing Controls

- Relevance and Relevance Center
- Advanced Size Functions
- Smoothing and Transition
- Span Angle Center
- Curvature Normal Angle
- Proximity Accuracy and Cells Across Gap

Inflation

- Inflation Option, Inflation Algorithm
- Collision Avoidance
- Maximum Angle, Fillet Ratio, Smoothing

Assembly Meshing

- Activation of CutCell/Tetrahedrons Meshing

Patch Conforming Options

- Activation of Advancing Front Method

Advanced

- Shape Checking
- Element midside nodes

Defeaturing

- Pinch based
- Automatic Mesh Based

Statistics

- Mesh statistics, Quality criteria

Global Mesh Controls (3)

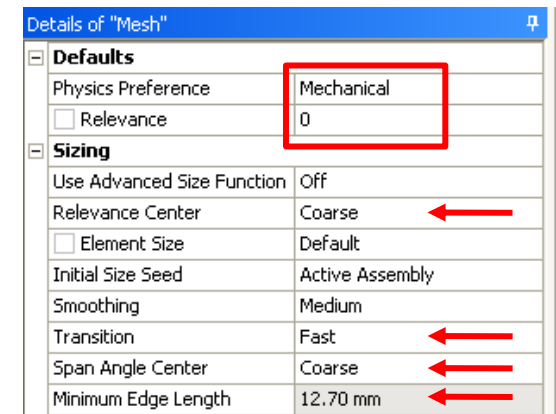
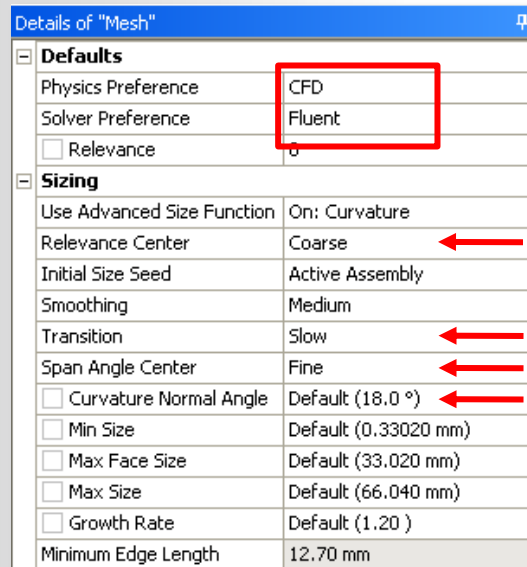
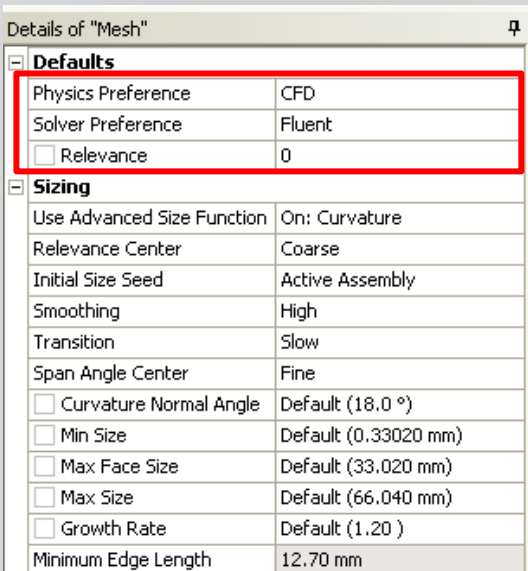
Details of "Mesh"	
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Coarse
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
☐ Curvature Normal Angle	Default (18.0 °)
☐ Min Size	Default (8.6332e-004 m)
☐ Max Face Size	Default (8.6332e-002 m)
☐ Max Size	Default (0.172660 m)
☐ Growth Rate	Default (1.20)
Minimum Edge Length	1.0 m
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
☐ Transition Ratio	0.272
☐ Maximum Layers	5
☐ Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No
Assembly Meshing	
Method	None
Patch Conforming Options	
Triangle Surface Mesher	Program Controlled
Advanced	
Shape Checking	CFD
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Dimensionally Reduced
Mesh Morphing	Disabled
Defeaturing	
Pinch Tolerance	Default (7.7699e-004 m)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
☐ Defeaturing Tolerance	Default (4.3166e-004 m)
Statistics	
☐ Nodes	
☐ Elements	
Mesh Metric	None

Details of "Mesh"	
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Coarse
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
☐ Curvature Normal Angle	Default (18.0 °)
☐ Min Size	Default (8.6332e-004 m)
☐ Max Face Size	Default (8.6332e-002 m)
☐ Max Size	Default (0.172660 m)
☐ Growth Rate	Default (1.20)
Minimum Edge Length	1.0 m

Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
☐ Transition Ratio	0.272
☐ Maximum Layers	5
☐ Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No
Assembly Meshing	
Method	None
Patch Conforming Options	
Triangle Surface Mesher	Program Controlled

Patch Conforming Options	
Triangle Surface Mesher	Program Controlled
Advanced	
Shape Checking	CFD
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Dimensionally Reduced
Mesh Morphing	Disabled
Defeaturing	
Pinch Tolerance	Default (7.7699e-004 m)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
☐ Defeaturing Tolerance	Default (4.3166e-004 m)
Statistics	
☐ Nodes	
☐ Elements	
Mesh Metric	None

- Four options under “Physics Preference”
 - CFD, Mechanical, Explicit and Electromagnetic
- Three options under “Solver Preference” when CFD is selected:
 - Fluent, CFX and POLYFLOW
- Mesh setting defaults are automatically adjusted to suit the “Physics Preference” and “Solver Preference”
- Assembly Meshing is active only when Physics Preference is CFD and Solver Preference is Fluent

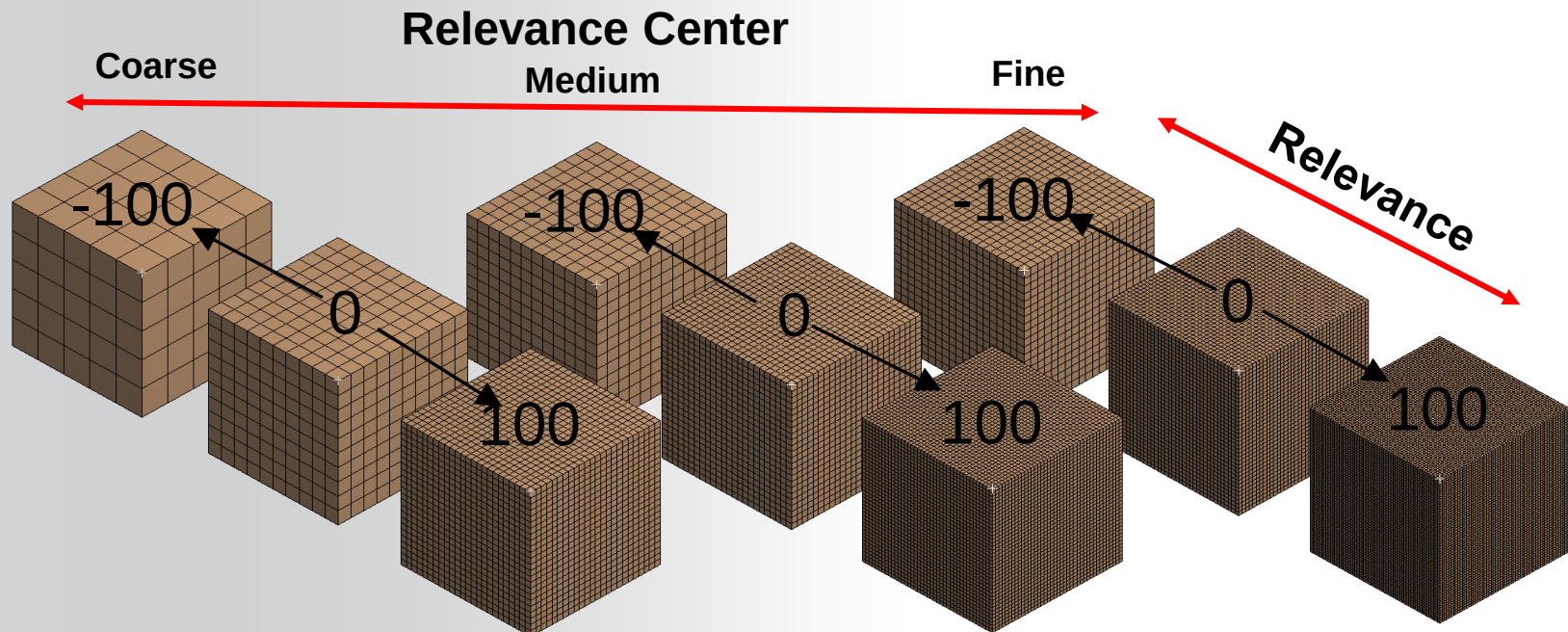


Defaults : Relevance

Details of "Mesh"	
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	10
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Coarse
Initial Size Seed	Coarse
Smoothing	Medium
	Fine

Relevance and Relevance Center

- Useful for automatic Global Refinement or Coarsening of the mesh



Sizing : Advanced Sizing Functions

Details of "Mesh"

Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	10
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Off
Initial Size Seed	On: Proximity and Curvature
Smoothing	On: Curvature
Transition	On: Proximity
Span Angle Center	On: Fixed
☐ Curvature Normal Angle	Fine
☐ Min Size	Default (16.860 °)
☐ Max Face Size	Default (0.313320 mm)
☐ Max Size	Default (31.3320 mm)
☐ Growth Rate	Default (62.6640 mm)
☐ Minimum Edge Length	Default (1.19450)
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
☐ Transition Ratio	0.272
☐ Maximum Layers	5
☐ Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No

- Controls the growth and distribution of mesh in important regions of high curvature or close proximity of surfaces

Five Options:

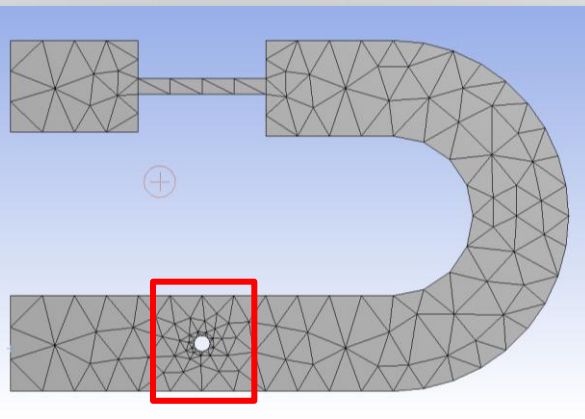
- Off. Unavailable for Assembly Meshing
- Proximity and Curvature
- Curvature
- Proximity
- Fixed

Details of "Mesh"

Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Use Advanced Size Function	On: Proximity
Relevance Center	Coarse
Smoothing	High
☐ Proximity Accuracy	0.5
☐ Num Cells Across Gap	Default (3)
Proximity Size Function Sources	Faces and Edges
☐ Min Size	Faces and Edges
☐ Max Size	Faces
☐ Growth Rate	Edges
☐ Minimum Edge Length	Default (1.20)
☐ Minimum Edge Length	0.46840 mm

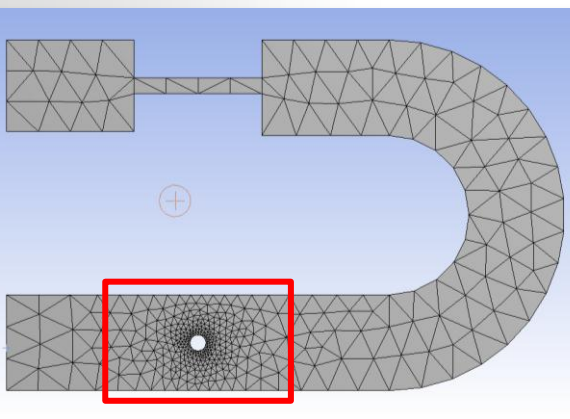
- When CutCellMeshing is active with 'Proximity' or 'Proximity and Curvature' ASF, Proximity Size Function Sources control is displayed to specify the regions of proximity between edges, faces or both in the computation of proximity SF

Sizing : Advanced Sizing Function Examples



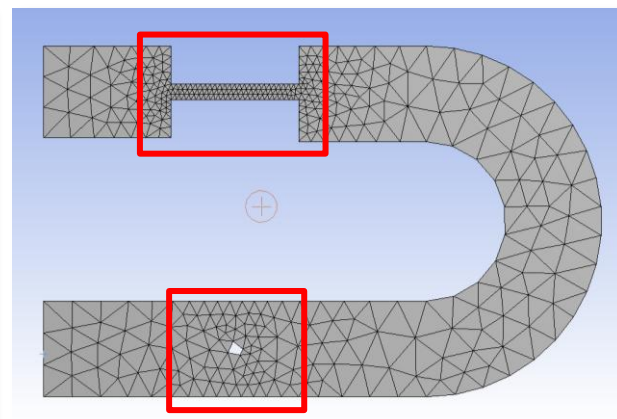
ASF: Off

- The edges are meshed with global **Element Size**
- Then the edges are refined for curvature and 2D proximity
- At the end, corresponding face and volume mesh is generated
- Transition of cell size is defined by **Transition**



ASF: Curvature

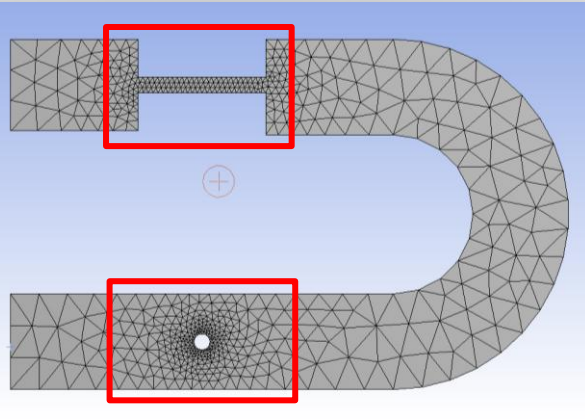
- Determines the Edge and Face sizes based on **Curvature Normal Angle**
- Finer Curvature Normal Angle creates finer surface mesh
- Transition of cell size is defined by **Growth Rate**



ASF: Proximity

- Controls the mesh resolution on proximity regions in the model
- Fits in specified number of elements in the narrow gaps
- Higher **Number of Cells Across Gap** creates more refined surface mesh
- Transition of cell size is defined by **Growth Rate**

Sizing : Advanced Sizing Function Examples

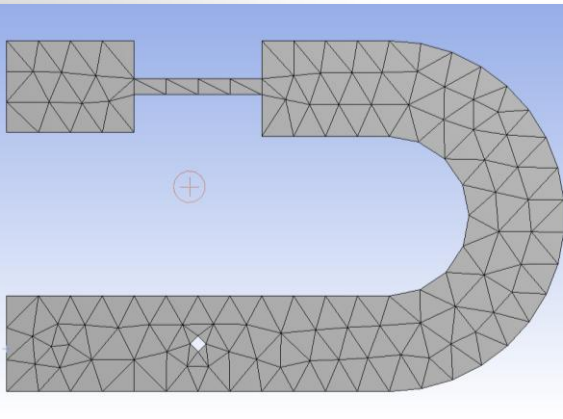


ASF: Proximity & Curvature

- Combines the effect of 'Proximity' and 'Curvature' size function

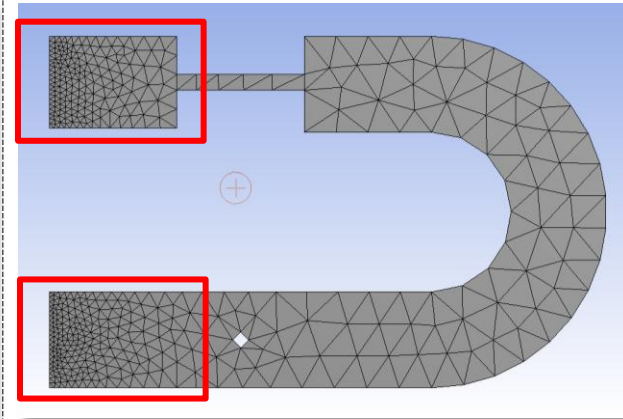


More computational time



ASF: Fixed

- Constant mesh size throughout
- No refinement due to curvature or proximity in the model
- Surface mesh is generated with specified **Max Face Size**
- Volume mesh is generated with specified **Max Size**



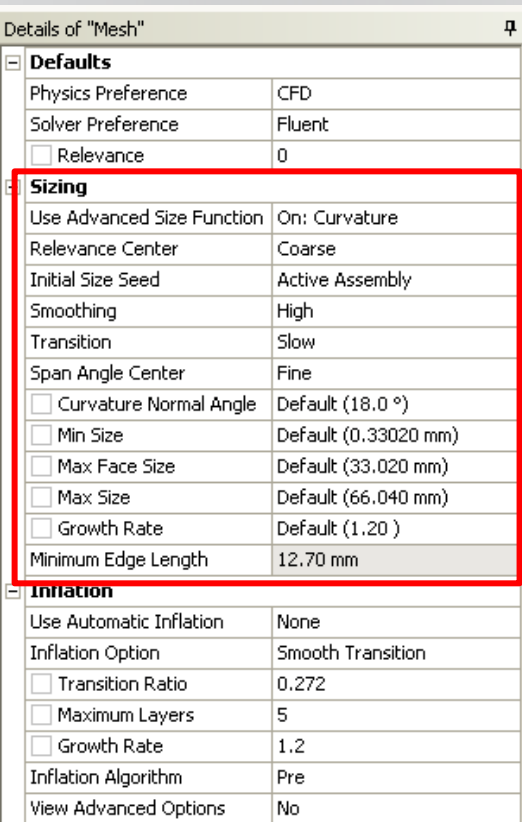
ASF: Fixed + Local Sizings

- Mesh is refined locally due to sizing (on 2 edges for that example)
- Elsewhere size is defined by **Max (Face) Size**
- Transition of cell size is defined by **Growth Rate**

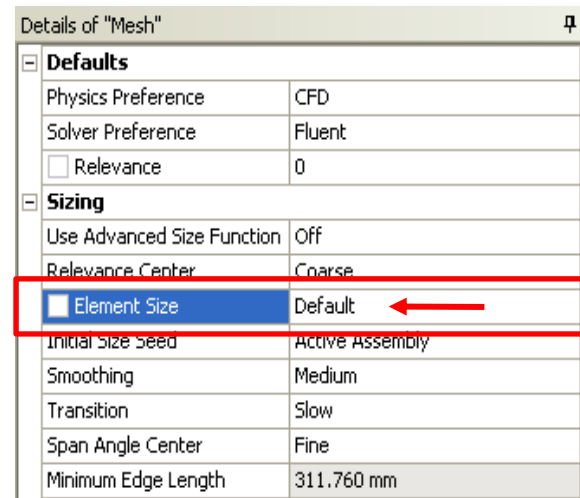
Sizing : Element Size

Element Size

- Element size used for the entire model
 - This size will be used for meshing all edges, faces and bodies
- Default value based on Relevance and Initial Size Seed
 - User can input required value as per geometry dimensions



Element size option available when Advanced Size Function is not used



Sizing : Min and Max Size

Min Size

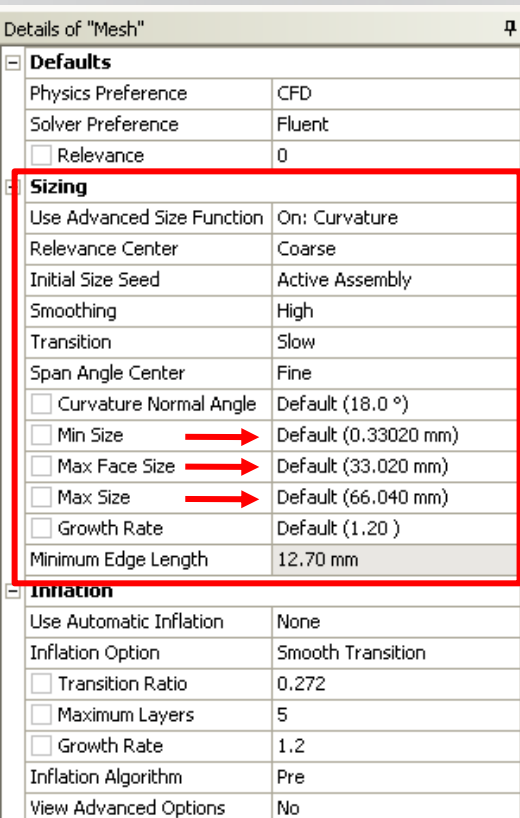
- Minimum element size that the size function will generate
- Some element sizes may be smaller than this size depending on the edge length

Max Face Size

- Maximum face size that the size function will generate
- Not supported by CutCell meshing

Max Size

- Maximum element size that can be grown in the interior of volume mesh

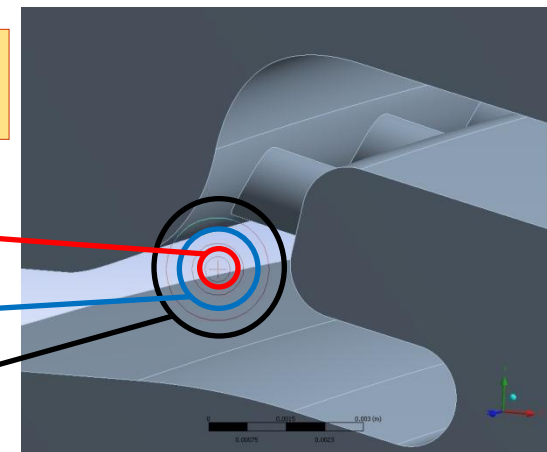


Mouse Pointer serves to estimate mesh sizes

Min Size

Max Face Size

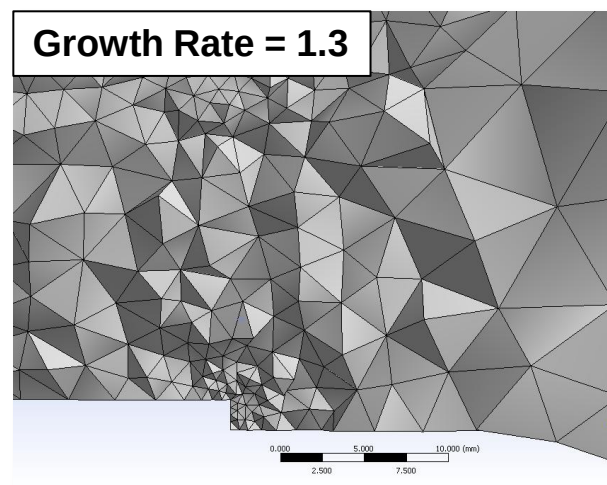
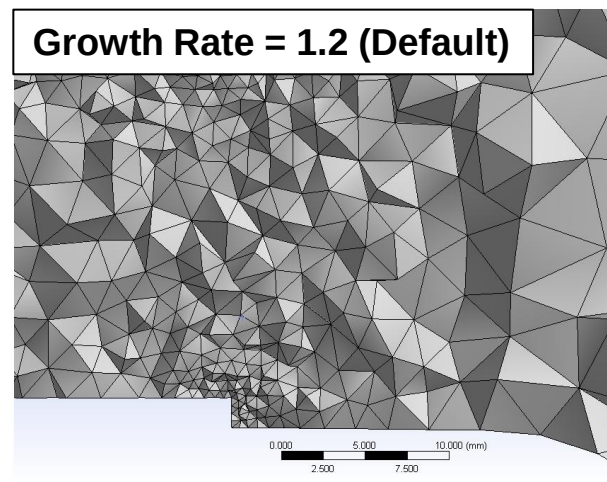
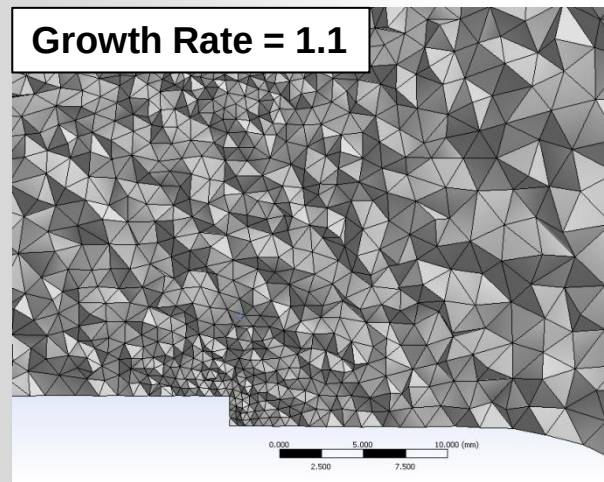
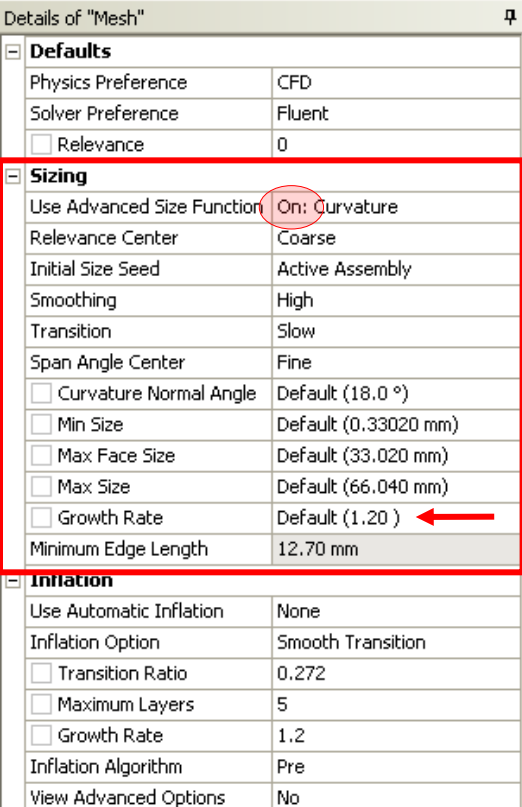
Max Size



$Min\ Size \leq Max\ Face\ Size \leq Max\ Size$

Sizing : Growth Rate

- Define the ratio between sizes of adjacent cells
 - On surfaces and inside the volumes



Mesh size:

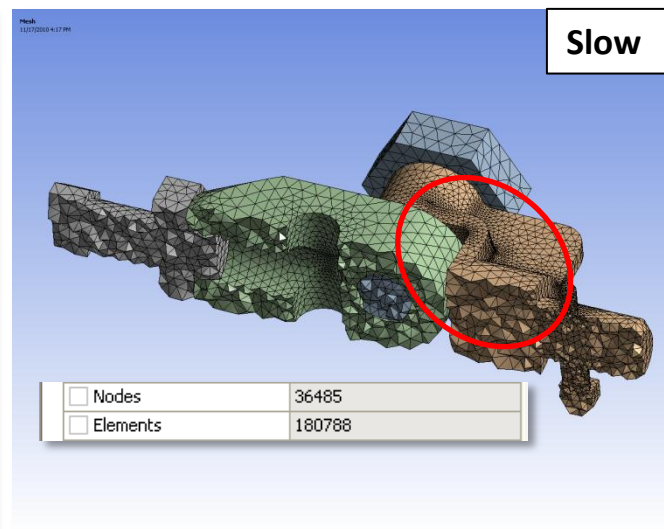
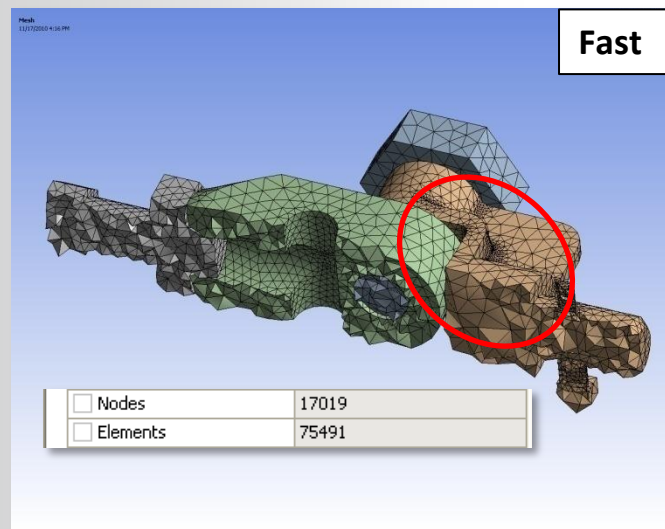
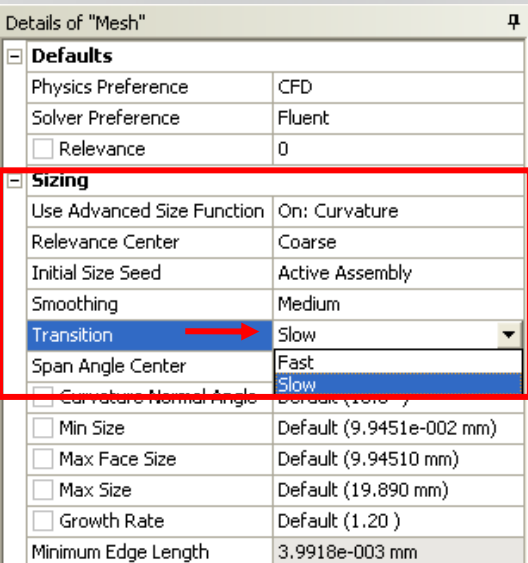
GR = 1.1 : 1,263,297 cells

GR = 1.2 : 587,026 cells

GR = 1.3 : 392,061 cells

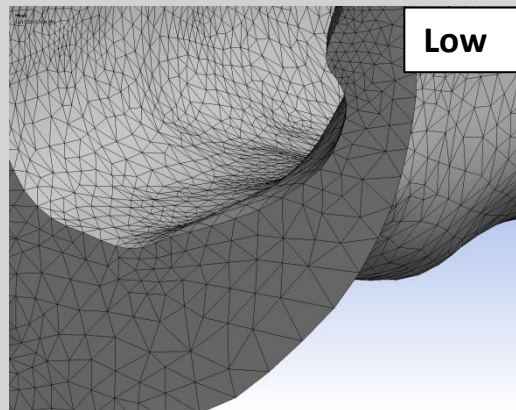
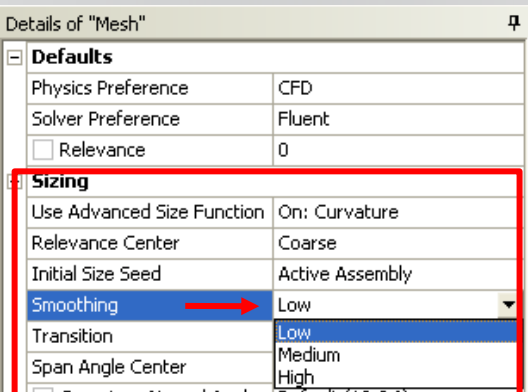
Sizing : Transition

- Controls the rate at which elements grow
- Two level control for transition
 - Slow (Default for CFD, Explicit), produces smooth transitions
 - Fast (Default for Mechanical and Electromagnetic), produces more abrupt transitions
- Not available for Cutcell meshing
- Hidden for sheet models, ignored for assemblies containing sheets, when ASF is On

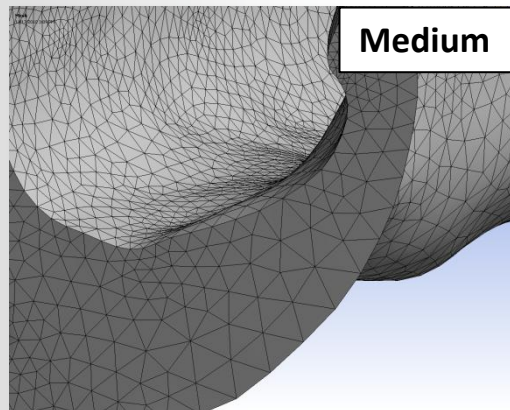


Sizing : Smoothing

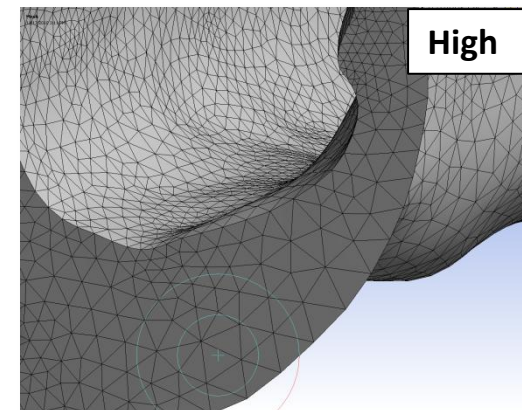
- Improves quality by moving locations of nodes with respect to surrounding nodes
- Three level control for smoothing iterations
 - High (Default for Explicit)
 - Medium (Default for Mechanical, Electromagnetic and CFD)
 - Low
- For Cutcell meshing, the Smoothing option controls the quality threshold at which it will start smoothing



Statistics	
☐ Nodes	35289
☐ Elements	178171
Mesh Metric	Orthogonal Quality
☐ Min	0.159433237759087
☐ Max	0.994295045184473
☐ Average	0.842949718413022
☐ Standard Deviation	9.29869563499239E-02

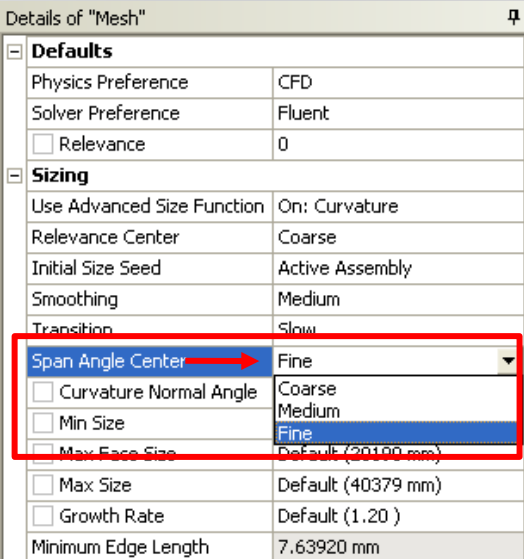


Statistics	
☐ Nodes	35880
☐ Elements	181504
Mesh Metric	Orthogonal Quality
☐ Min	0.219234540928443
☐ Max	0.997558407575095
☐ Average	0.849759914459716
☐ Standard Deviation	8.88455263724525E-02

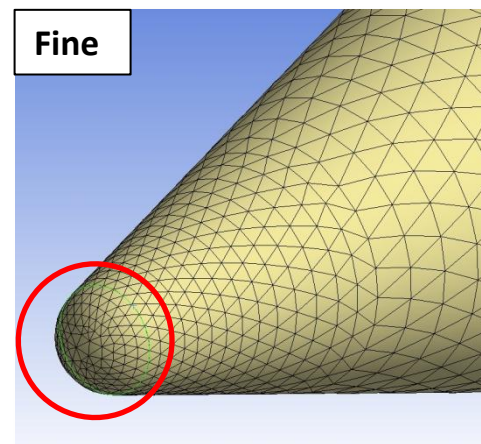
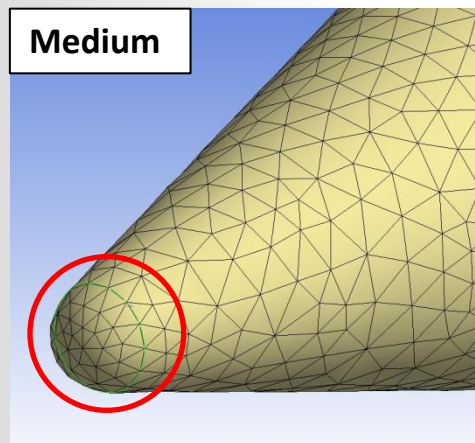
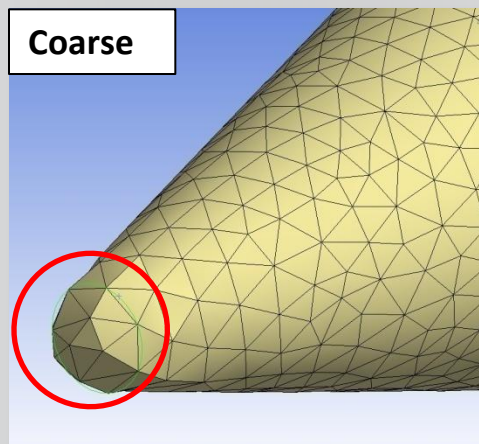


Statistics	
☐ Nodes	35716
☐ Elements	180536
Mesh Metric	Orthogonal Quality
☐ Min	0.267566660927052
☐ Max	0.995350440465592
☐ Average	0.850145343728712
☐ Standard Deviation	8.86677556985072E-02

Sizing : Span Angle Center



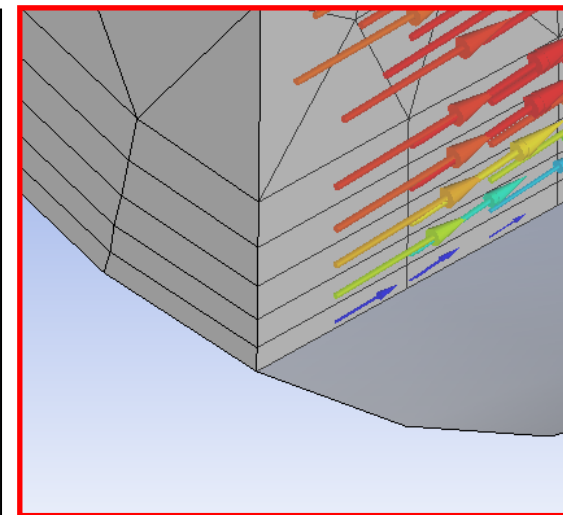
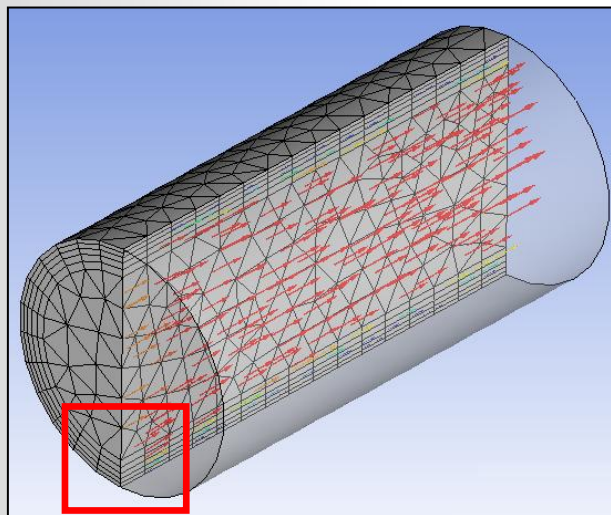
- Controls curvature based refinement for Edges
- Three options and corresponding span angle ranges are
 - Coarse: 91° to 60°
 - Medium: 75° to 24°
 - Fine: 36° to 12°
- Not available for Cutcell meshing



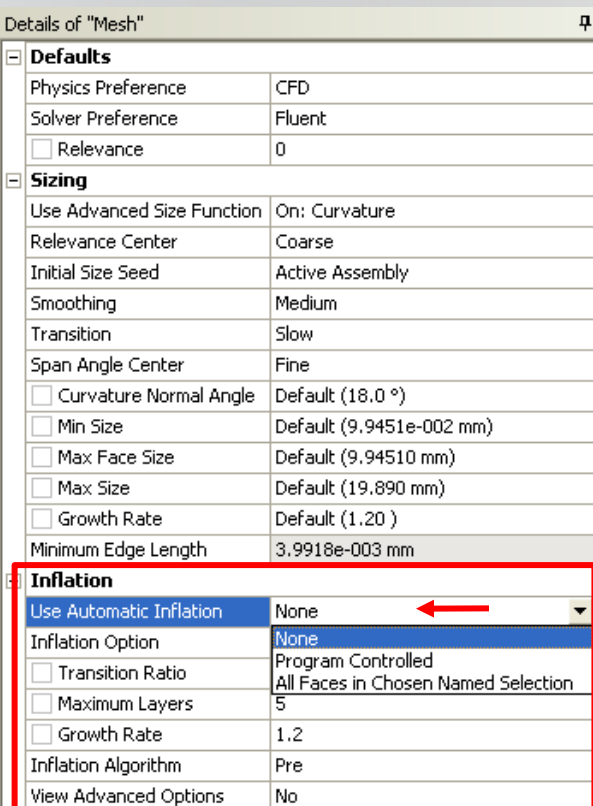
Details of "Mesh"	
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Coarse
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
☐ Curvature Normal Angle	Default (18.0 °)
☐ Min Size	Default (9.9451e-002 mm)
☐ Max Face Size	Default (9.94510 mm)
☐ Max Size	Default (19.890 mm)
☐ Growth Rate	Default (1.20)
Minimum Edge Length	3.9918e-003 mm
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
☐ Transition Ratio	0.272
☐ Maximum Layers	5
☐ Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No

Inflation

- Used to generate thin cells adjacent to boundaries
- Required for capture of wall adjacent boundary layers
 - Resolve viscous boundary layer in CFD
 - Resolve thin air gaps in Electromagnetic analysis
 - Resolve high stress concentration regions in Structures
- Cells are created by 'inflating' from the surface mesh into the volume (3d) or inflating from the boundary edge onto the face (2d)
- Options to control growth



Inflation : Automatic Inflation



• Three options

– None

- Select this for manual inflation settings using local mesh controls

– Program Controlled

- All the faces are selected for inflation except:
- Faces scoped to a Named Selection
- Faces with manual inflation defined
- Faces in contact regions
- Faces in symmetry
- Faces that belong to a part or body that has a mesh method defined that does not support 3D inflation, such as sweep or hex-dominant
- Faces in sheet bodies

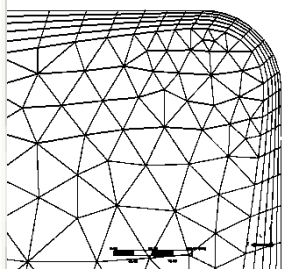
– All Faces in chosen Named Selection: can grow inflation layers from faces grouped in one named selection

Inflation : Inflation Options

Five options:

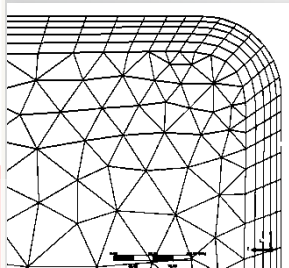
All available for PC tets and Assembly meshing

Details of "Mesh"	
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Coarse
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
☐ Curvature Normal Angle	Default (18.0 °)
☐ Min Size	1.60 mm
☐ Max Face Size	Default (238.760 mm)
☐ Max Size	Default (477.510 mm)
☐ Growth Rate	Default (1.20)
Minimum Edge Length	0.303010 mm
Inflation	
Use Automatic Inflation	Program Controlled
Inflation Option	Smooth Transition
☐ Transition Ratio	Total Thickness
☐ Maximum Layers	First Layer Thickness
☐ Growth Rate	Smooth Transition
Inflation Algorithm	First Aspect Ratio
	Last Aspect Ratio
View Advanced Options	No



Smooth Transition

Maintains smooth volumetric growth between each adjacent layer. Total thickness depends on the variation of base surface mesh sizes (Default)

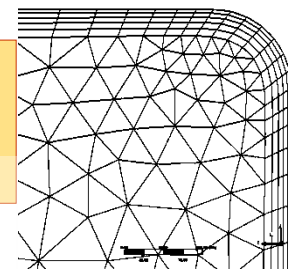


First Layer Thickness

Maintains constant first cell height throughout

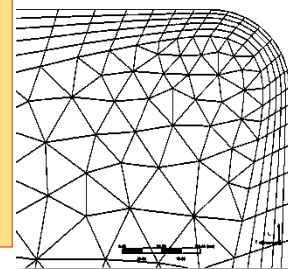
Total Thickness

Maintains constant total height of inflation layer throughout



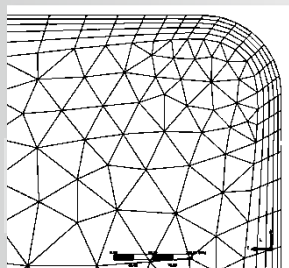
First Aspect Ratio

Controls the heights of the inflation layers by defining the aspect ratio of the inflations that are extruded from the inflation base



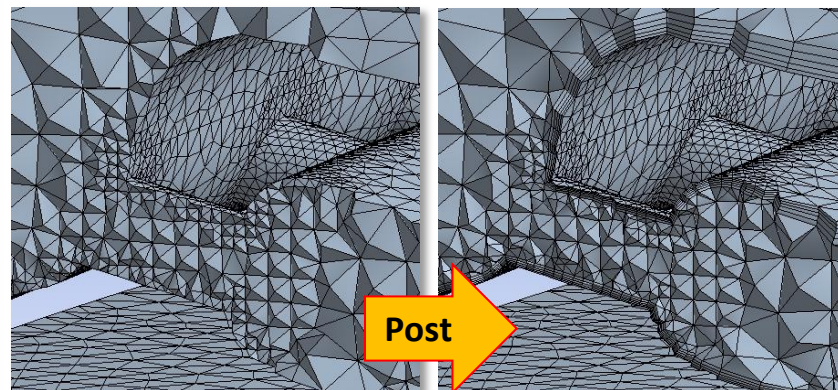
Last Aspect Ratio

Creates inflation layers using the values of the first layer height, maximum layers, and aspect ratio controls



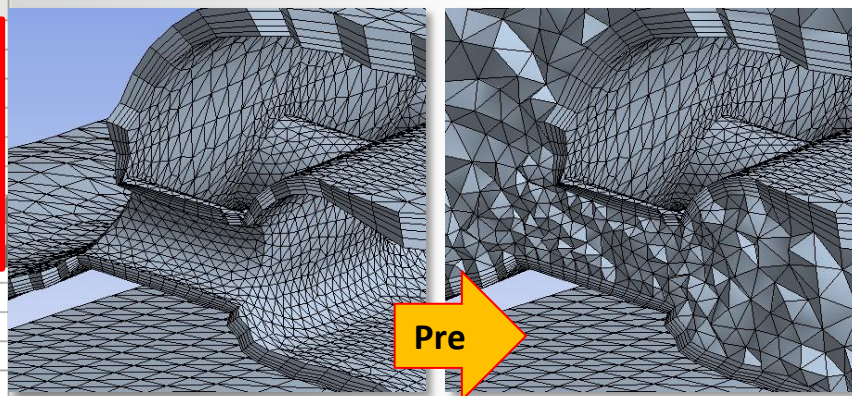
Inflation : Inflation Algorithms

- Two Algorithms
 - Post
 - Pre
- Patch independent meshes (including Assembly) use Post



- First Tet grows then Inflation process starts
- Tet mesh is undisturbed, if the inflation options are altered
- Default option for Patch Independent Tetrahedrons

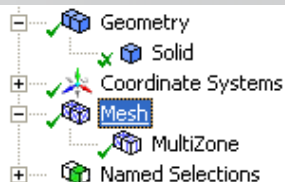
Details of "Mesh"	
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Coarse
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
☐ Curvature Normal Angle	Default (18.0 °)
☐ Min Size	Default (7.7699e-005 m)
☐ Max Face Size	Default (7.7699e-003 m)
☐ Max Size	Default (1.554e-002 m)
☐ Growth Rate	Default (1.20)
Minimum Edge Length	3.e-002 m
Inflation	
Use Automatic Inflation	Program Controlled
Inflation Option	Smooth Transition
☐ Transition Ratio	0.272
☐ Maximum Layers	5
☐ Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	Post
Assembly Meshing	Pre
Patch Conforming Options	
Advanced	
Defeaturing	
Statistics	



Preview Inflation is available only with Pre Algorithm

- Surface mesh is inflated first, then rest of the volume mesh grows
- Default method for Patch Conforming Tetrahedrons

Inflation: Automatic Inflation example



Details of "Mesh"

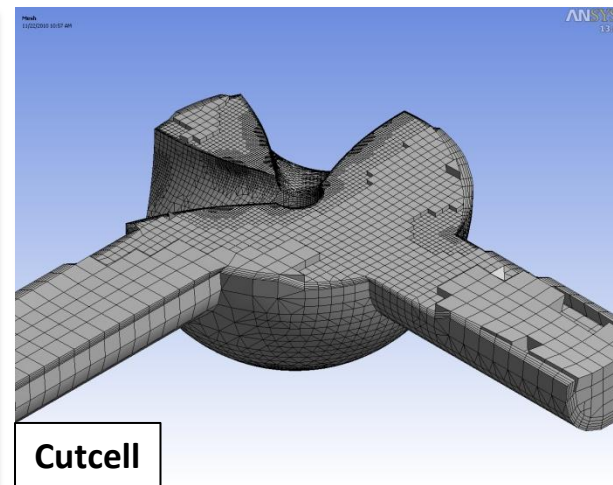
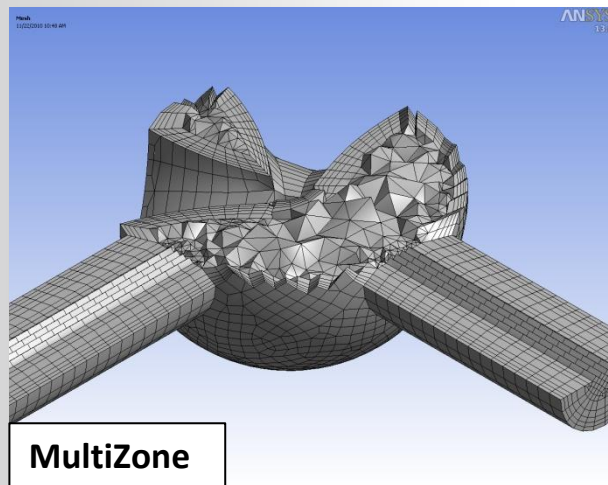
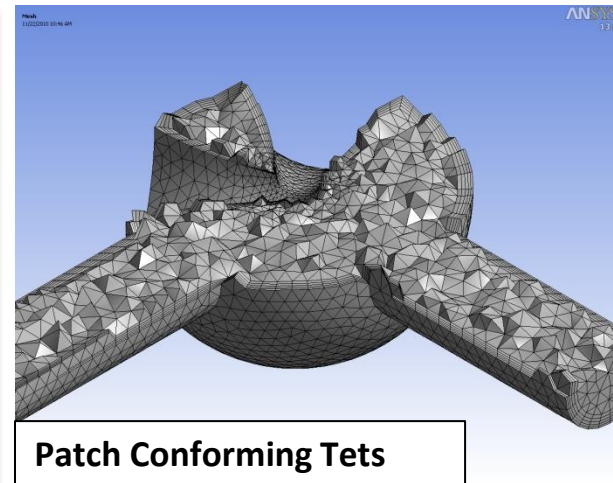
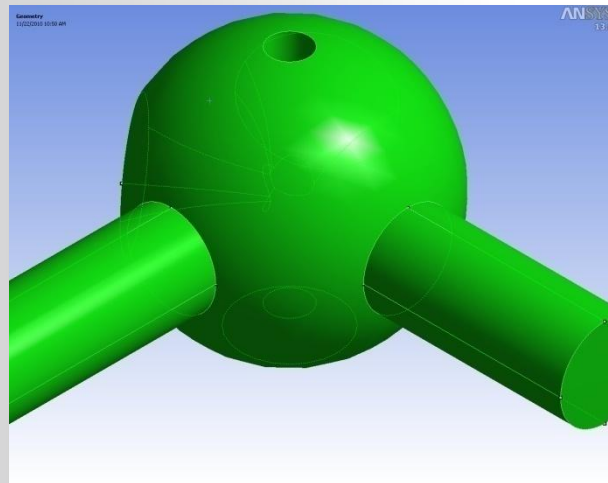
Defaults

Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0

Sizing

Inflation

Use Automatic Inflation	Program Controlled
Inflation Option	Smooth Transition
☐ Transition Ratio	0.272
☐ Maximum Layers	5
☐ Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No



Inflation : Advanced Options

Collision Avoidance: Control to detect proximity regions and adjust the cells in the inflation layer.

Details of "Mesh"	
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Coarse
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
☐ Curvature Normal Angle	Default (18.0 °)
☐ Min Size	Default (7.7699e-005 m)
☐ Max Face Size	Default (7.7699e-003 m)
☐ Max Size	Default (1.554e-002 m)
☐ Growth Rate	Default (1.20)
Minimum Edge Length	3.e-002 m
Inflation	
Use Automatic Inflation	Program Controlled
Inflation Option	Smooth Transition
☐ Transition Ratio	0.272
☐ Maximum Layers	5
☐ Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No
Assembly Meshing	No
Batch Conforming Options	Yes
Advanced	
Defeaturing	
Statistics	

- **None**
 - Does not check for proximity regions
- **Layer Compression (Default for Fluent)**
 - Compresses inflation layers in the proximity regions
 - Maintains the given number of layers in the proximity regions
 - May stair-step if needed (will give a warning)
- **Stair Stepping (Default for CFX)**
 - Inflation layers are stair stepped in the proximity regions
 - Removing layers locally in steps to avoid collisions as well as bad quality at sharp corners

When Cutcell meshing is used, both Layer Compression and Stair Steeping algorithms are used depending on the geometry complexity.

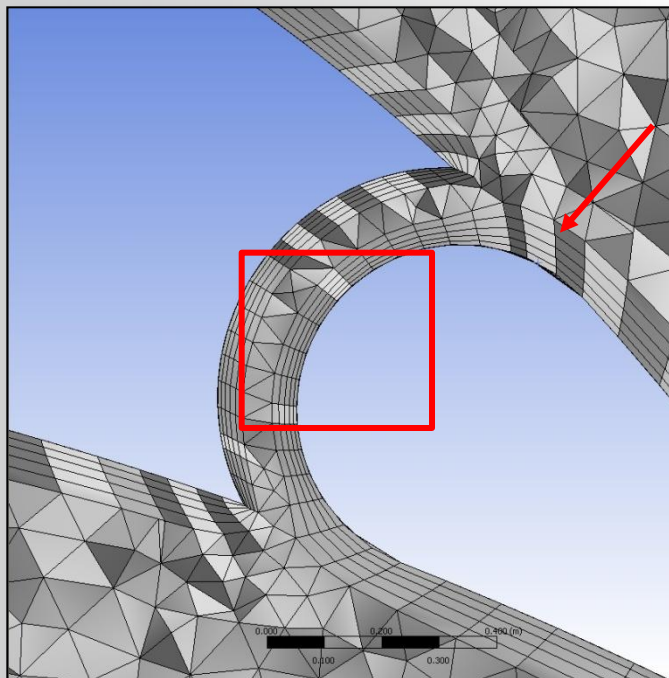
View Advanced Options	Yes
Collision Avoidance	Layer Compression
Fix First Layer	None
☐ Gap Factor	Layer Compression
☐ Maximum Height over Base	Stair Steeping
	1



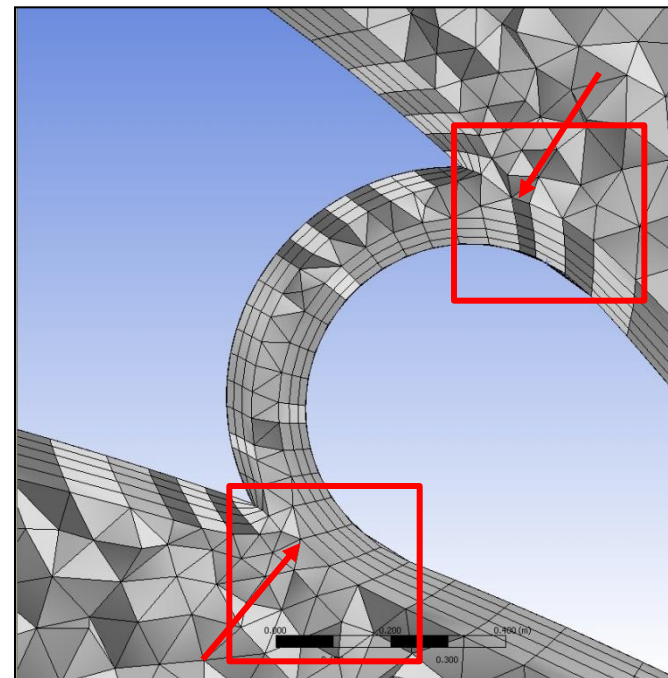
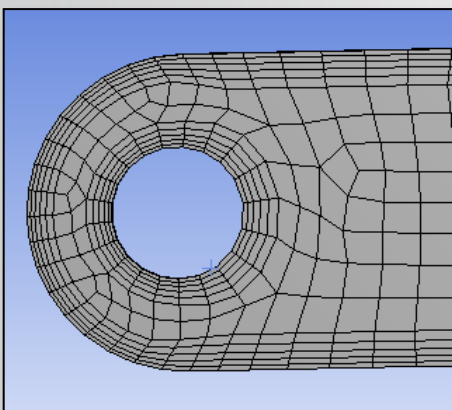
Generates combination of Pyramids and Tets to fill the stair step

Inflation : Collision Avoidance Example

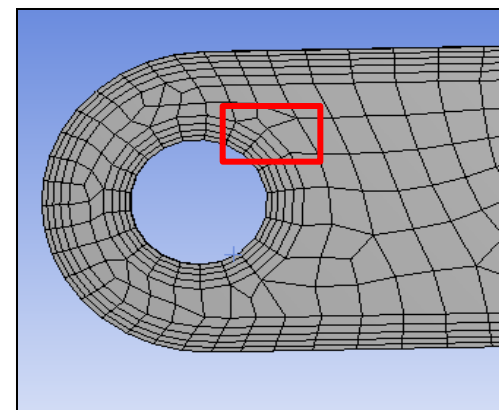
Example



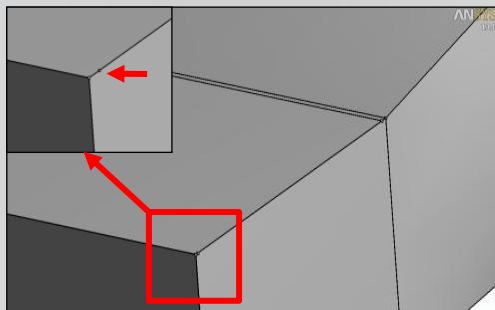
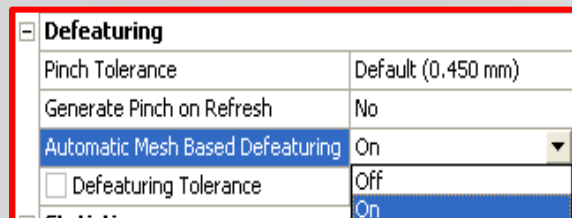
Layer Compression



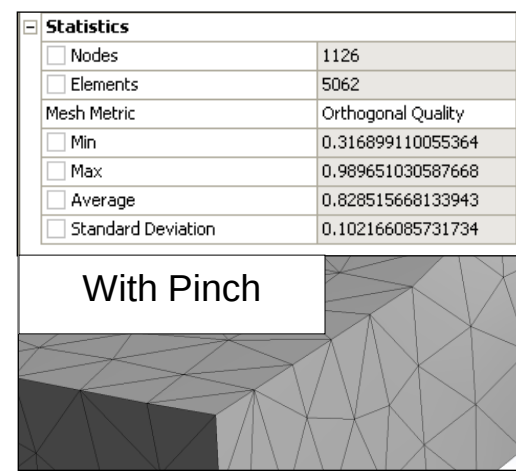
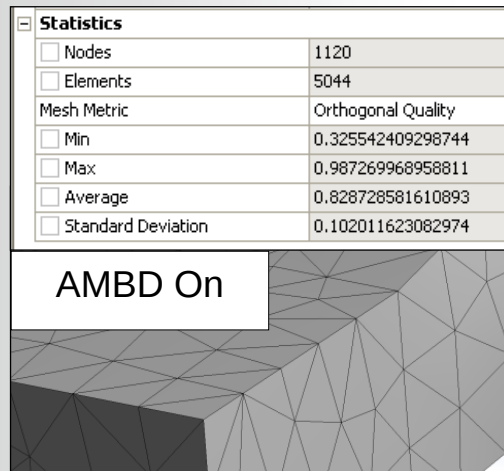
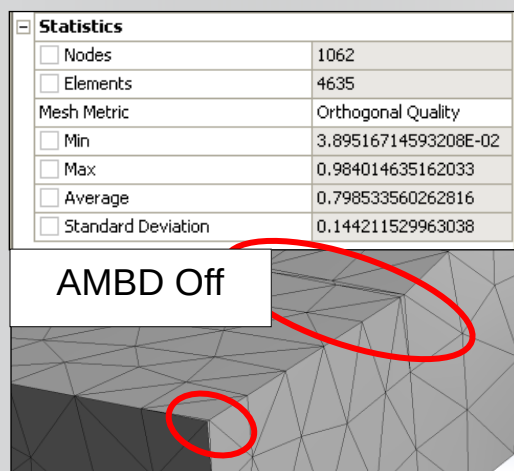
Stair Stepping



Defeaturing

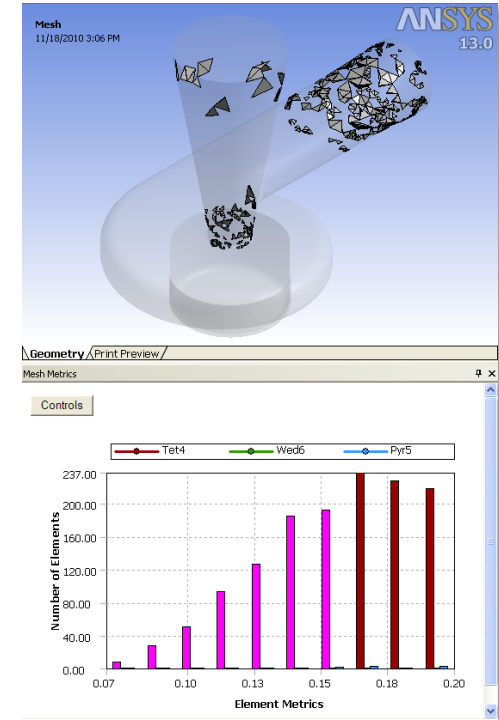
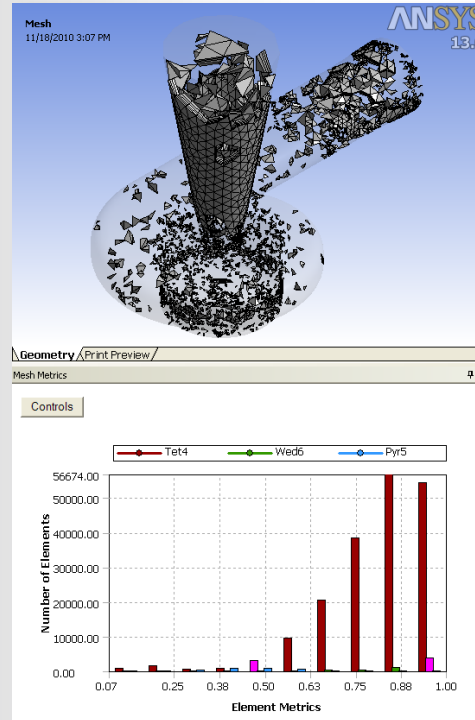
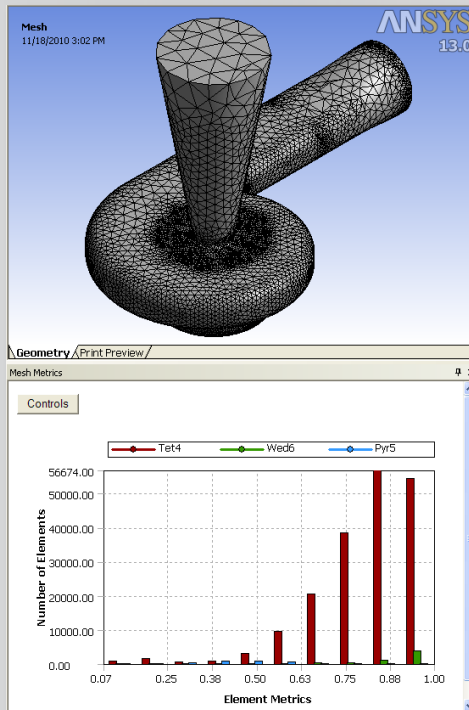


- Removes small geometry features meeting the tolerances using Pinch or/and Automatic Mesh Based Defeaturing controls in order to improve the mesh quality. Not all meshing methods can take advantage of these controls
- Pinch Tolerance control removes small features at the mesh level depending on the Pinch Tolerance value provided. ANSYS Meshing offers global and manual pinch controls
- Automatic Mesh Based Defeaturing (AMBD) when it is 'On', features smaller than or equal to the value of Defeaturing Tolerance are removed automatically

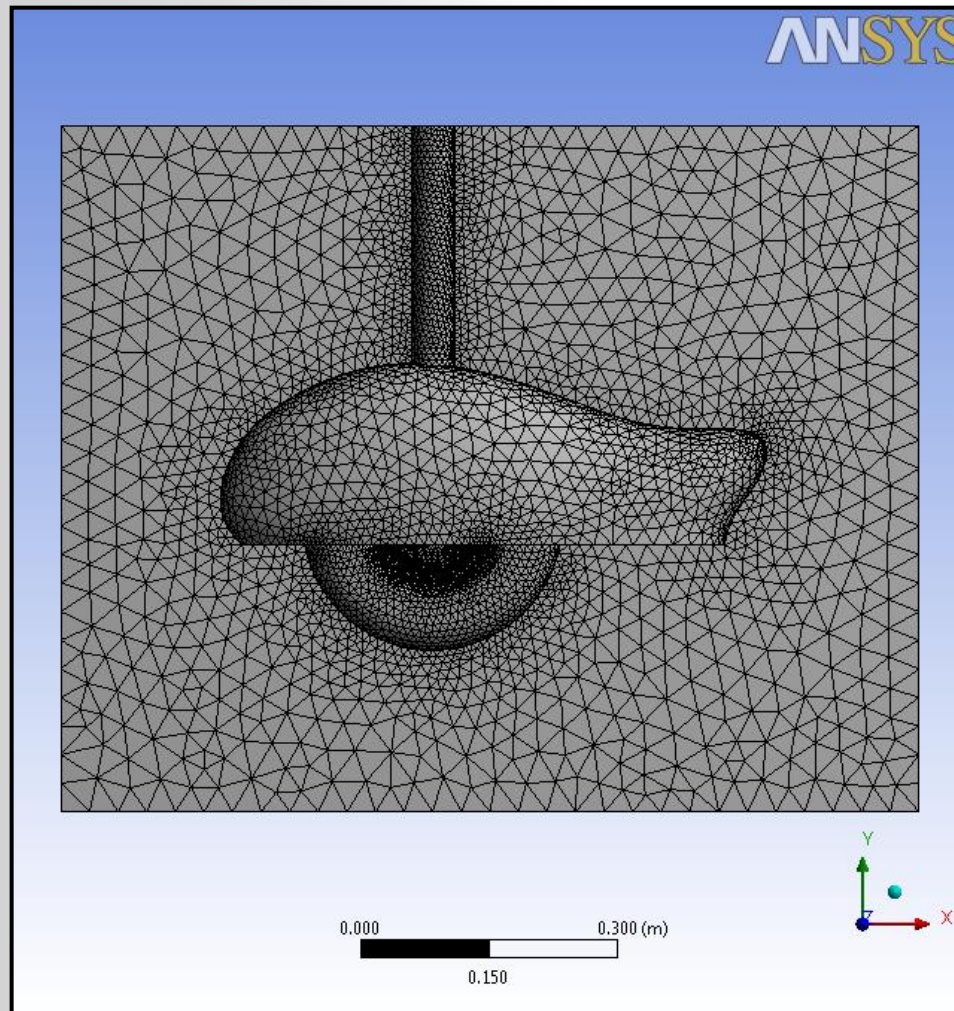


- Option to view the mesh quality metric
- Exhaustive list of quality metrics
- Orthogonal Quality mesh quality metrics
- Option to view the Mesh Metric chart
 - Intuitive controls available under Mesh Metric Chart
 - Various options to explore under the 'Controls'
- See lecture 5 for details

Statistics	
☐ Nodes	42344
☐ Elements	192686
☒ Mesh Metric	Orthogonal Quality
☐ Min	Jacobian Ratio
☐ Max	Warping Factor
☐ Average	Parallel Deviation
☐ Standard Deviation	Maximum Corner Angle
	Skewness
	Orthogonal Quality



Workshop 3 – Global Mesh Controls



Contents

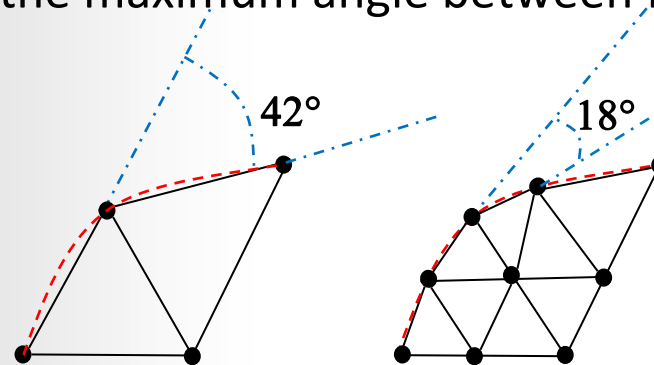
- **Sizing: ASF Controls**
- **Sizing: Initial Size Seed**
- **Sizing: ASF Examples**
- **Sizing: CutCell**
- **Inflation: Advanced Options**
- **Advanced Controls**

Sizing : ASF Controls (Curvature & Proximity)

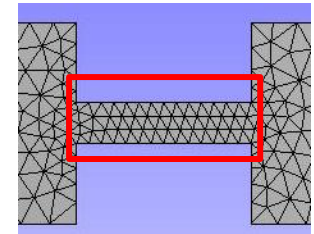
Curvature Normal Angle

- Defines the maximum angle between face normals

Geometry



- Smaller angles will produce smaller cells on curved faces capturing geometric curvature more accurately



Num Cells Across Gap

- Minimum number of cells spanning gaps
- Required to resolve flow gradients

Proximity Accuracy

- Range 0-1
- 0 faster, less accurate & 1 slower, more accurate
- Default value of 0.5 is a good compromise

Details of "Mesh"	
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Use Advanced Size Function	On: Proximity and Curvature
Relevance Center	Coarse
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
☐ Curvature Normal Angle	Default (18.0 °)
☐ Proximity Accuracy	0.5
☐ Num Cells Across Gap	Default (3)
☐ Min Size	Default (5.1799e-003 m)
☐ Max Face Size	Default (0.517990 m)
☐ Max Size	Default (1.0360 m)
☐ Growth Rate	Default (1.20)
Minimum Edge Length	6.28320 m
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
☐ Transition Ratio	0.272
☐ Maximum Layers	5
☐ Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No

Sizing : Initial Size Seed

- Controls how the initial sizes are assigned

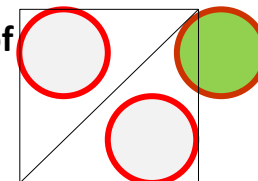
 Unsuppressed body

 Suppressed body

- Three options:

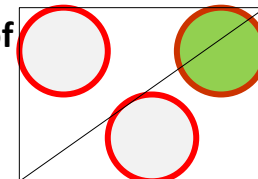
– Active Assembly:

- Assigned based on the diagonal of the bounding box of unsuppressed parts
- Mesh can change with varying bounding box sizes for various suppressed/unsuppressed parts



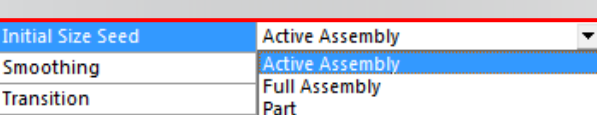
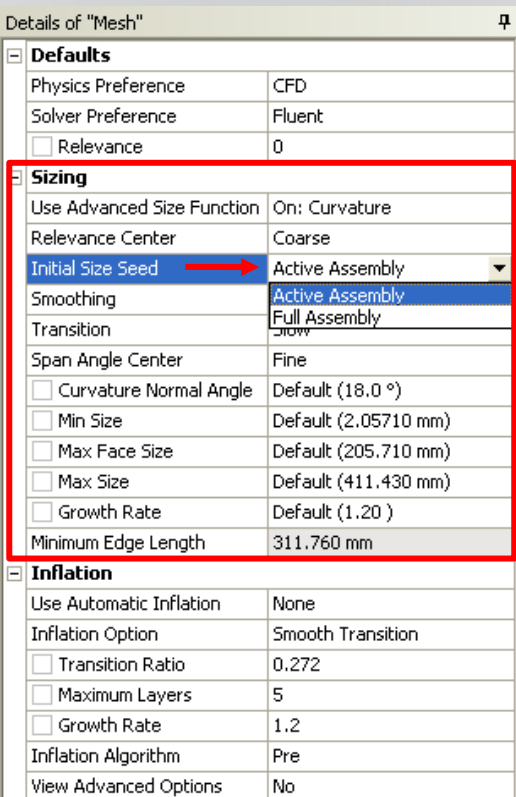
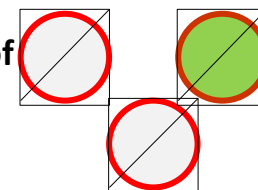
– Full Assembly:

- Assigned based on the diagonal of the bounding box of all assembly parts regardless of the number of suppressed parts
- Mesh never changes if parts are suppressed/unsuppressed



– Part:

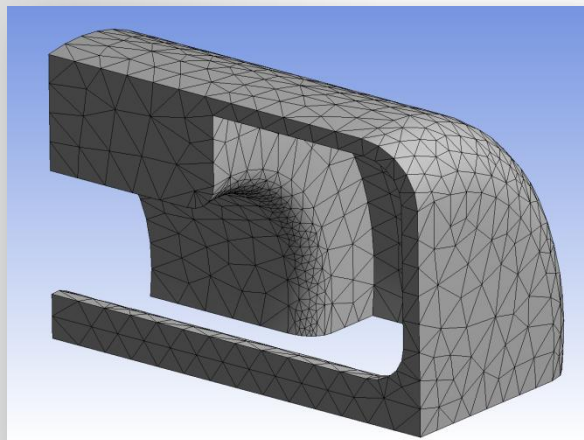
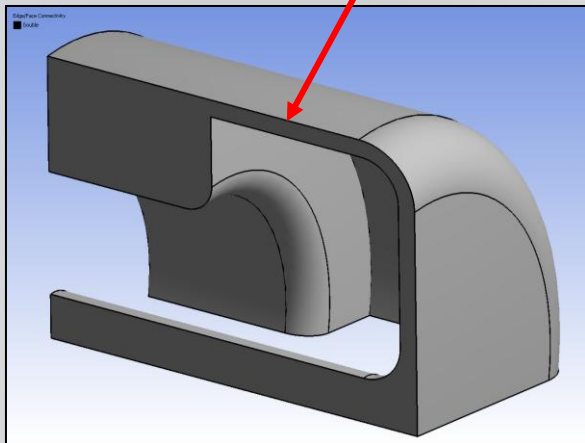
- This option is not available when ASF is On
- Assigned based on the diagonal of the bounding box of each particular individual part as it is meshed
- The mesh never changes due to part suppression
- Typically generates finer mesh



Not available for Assembly (CutCell/Tetrahedrons) Meshing

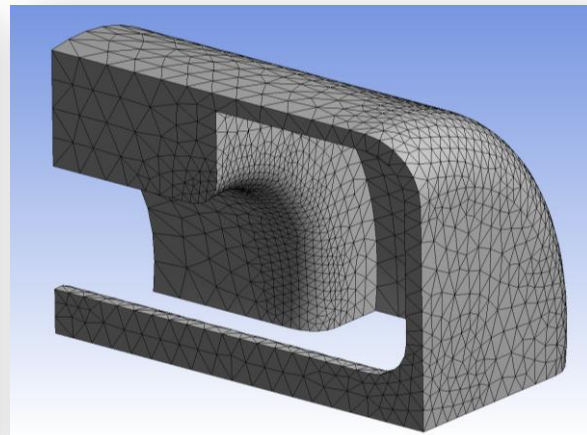
Sizing : Advanced Sizing Functions

Fluid gap



ASF : Off

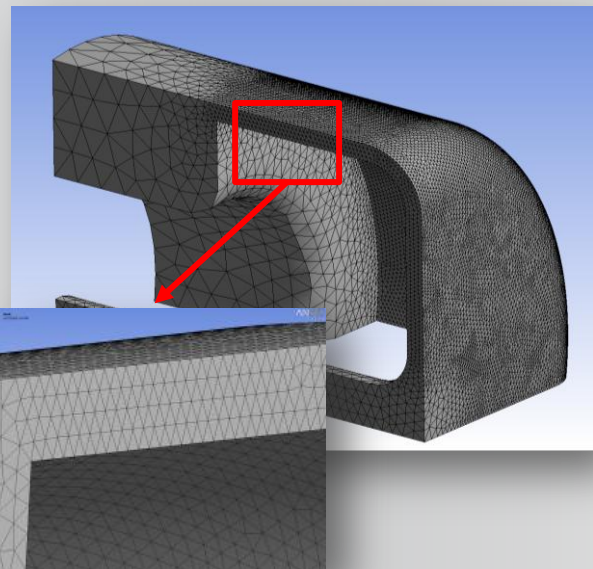
- The edges are meshed with global element size computed by the mesher
- Then the edges are refined for curvature and 2D proximity
- At the end, corresponding face and volume mesh is generated



ASF : Curvature

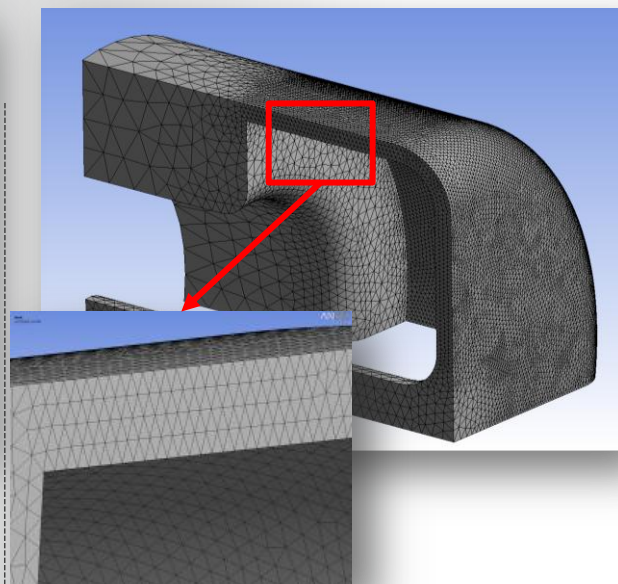
- Determines the Edge and Face sizes based on 'Curvature Normal Angle'
- 'Curvature Normal Angle' is the max angle b/w adjacent Face normals
- Finer Curvature Normal Angle creates finer surface mesh

Sizing : Advanced Sizing Functions



ASF : Proximity

- Controls the mesh resolution on proximity regions in the model
- Fits in specified number of elements in the narrow gaps
- Higher Number of Cells Across Gap creates more refined surface mesh

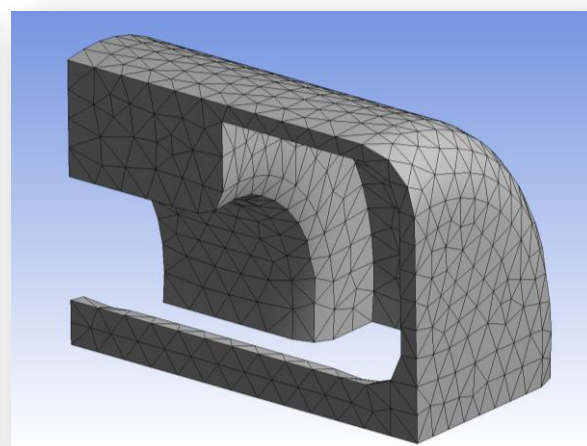


ASF : Proximity & Curvature

- Combines the effect of 'Proximity' and 'Curvature' size function



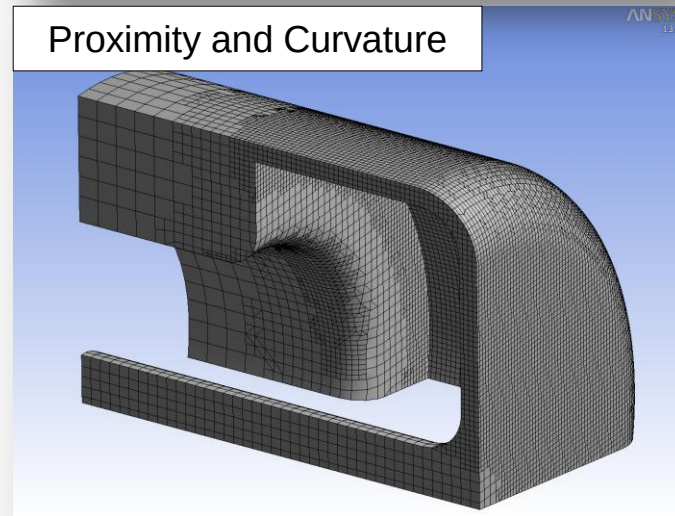
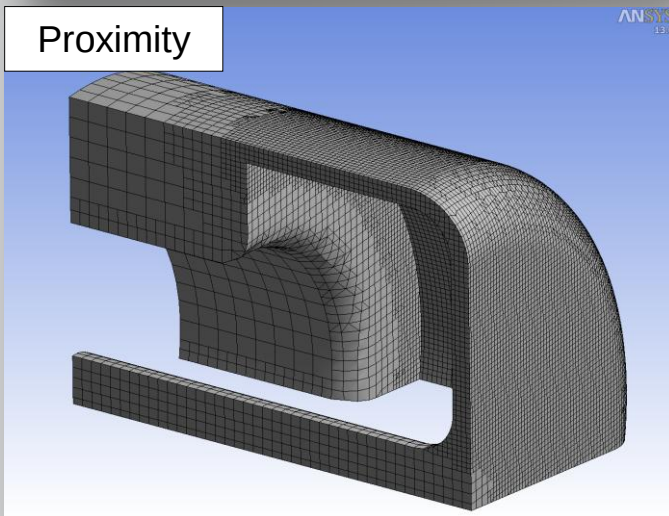
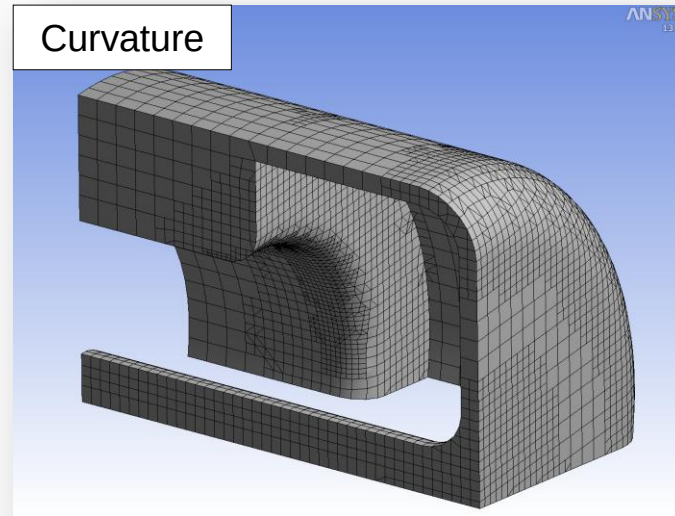
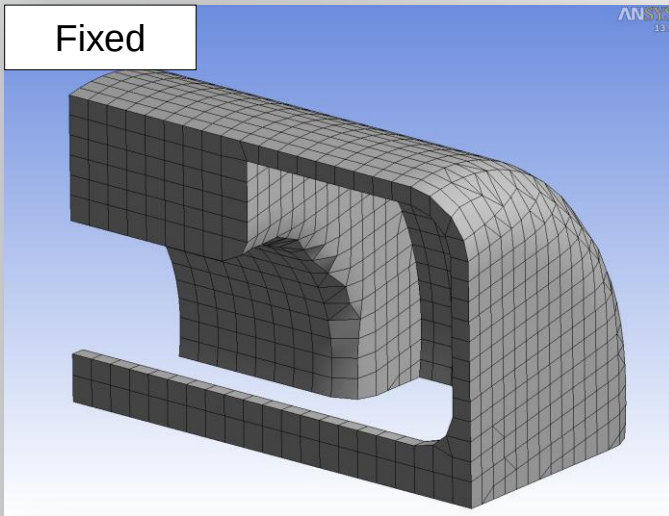
*More computational time
due to combined effect of
Curvature and Proximity*



ASF : Fixed

- Constant mesh size through out
- No refinement due to curvature or proximity in the model
- Surface mesh is generated with specified Max Face Size
- Volume mesh is generated with specified Max Size

Sizing : Advanced Sizing Functions with Cutcell



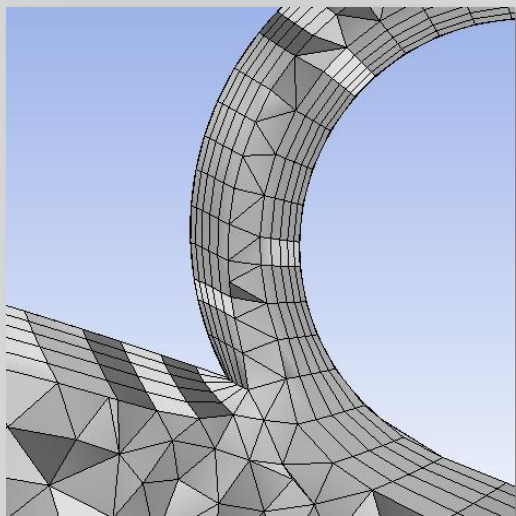
Cutcell meshes generated with default settings

Inflation : Advanced Options

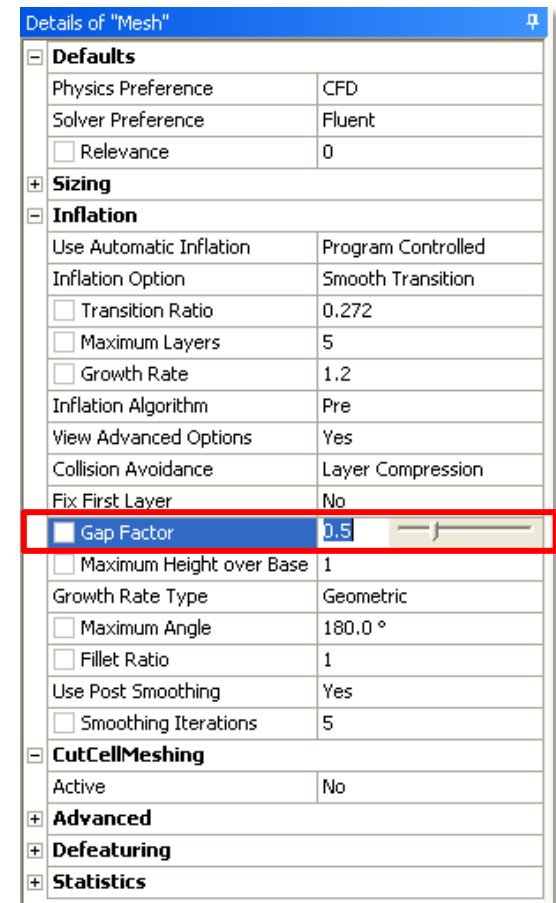
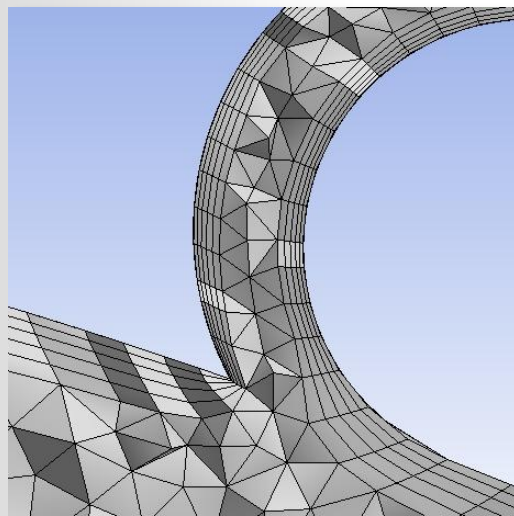
Gap Factor

- Controls the size of Tet element to be filled in the gap after inflation layers are generated
- For Gap Factor of 1, gap is controlled such that a tetra element with height matching the base element size can fit in the gap
- Applicable only when the Collision Avoidance is Layer Compression or Stair stepping

Gap Factor = 0.5 (Default)



Gap Factor = 1

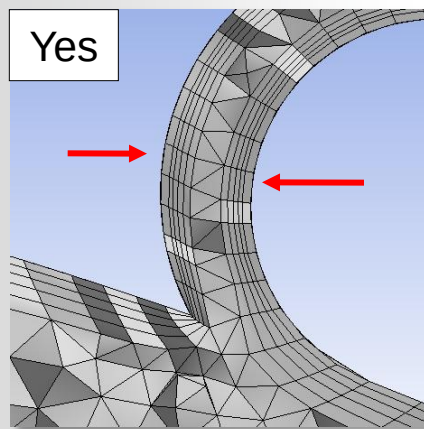
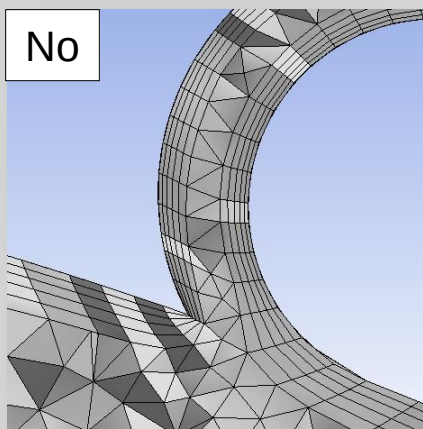


Higher Gap Factor means more layer compression

Inflation : Advanced Options

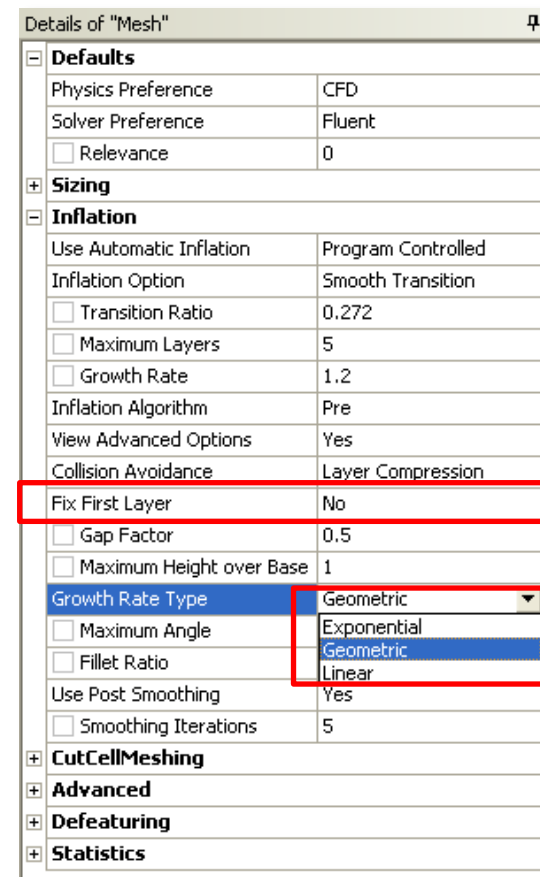
Fix First Layer

- Control for fixing the first layer height throughout the model



Growth Rate Type

- Three types available
 - Exponential, Geometric, Linear
- Controls the inflation layer height with selected “growth rate type”



Inflation : Advanced Options

Growth Rate Type

- Exponential

$$h_n = h_1 \times e^{(n-1)p}$$

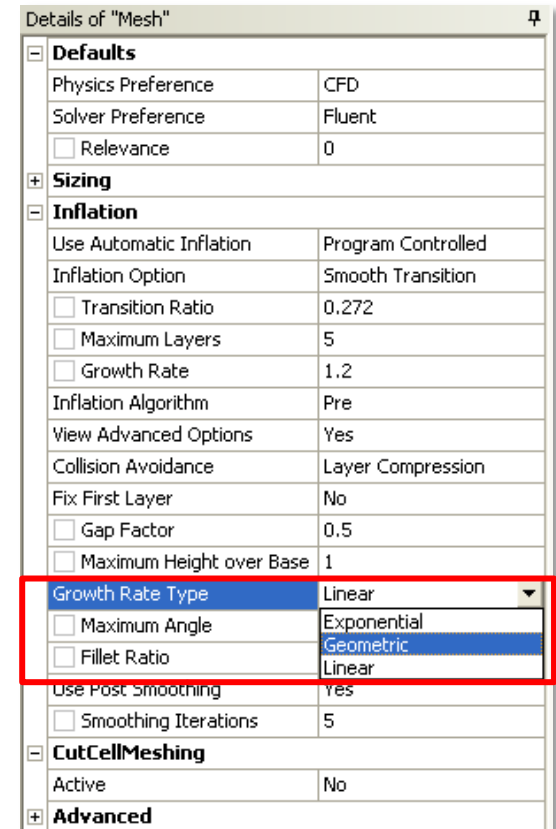
- Geometric (Default)

$$h_n = h_1 \times r^{(n-1)} \quad H_n = h_1 \frac{(1-r^n)}{1-r}$$

- Linear

$$h_n = h_1 \times [1 + (n-1)(r-1)]$$

$$H_n = nh_1 \times \frac{(n-1)(r-1) + 2}{2}$$



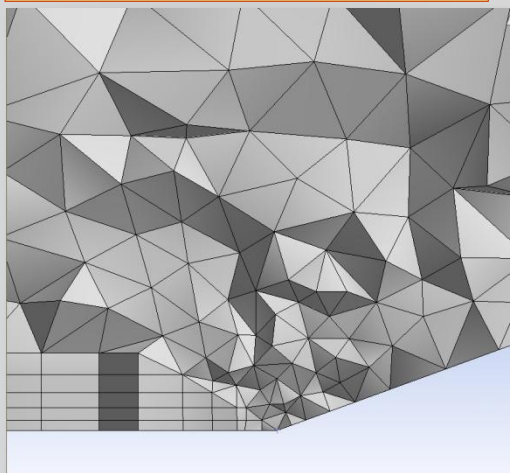
Where h_1 is the initial layer height, h_n is the height of layer n , r is the growth rate, p an exponent, and H_n is the total height at layer n

Inflation : Advanced Options

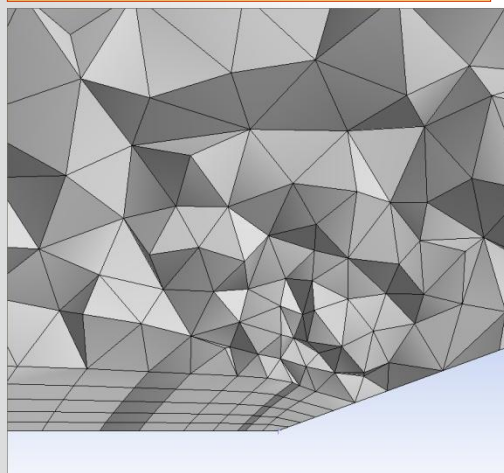
Maximum Angle

- Controls the projection/imprinting of the inflation layers on the adjacent faces

Maximum Angle = 140°



Maximum Angle = 180°



Adjacent Face Angle = 160°

Details of "Mesh"	
[-] Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
[+] Sizing	
[-] Inflation	
Use Automatic Inflation	Program Controlled
Inflation Option	Smooth Transition
☐ Transition Ratio	0.272
☐ Maximum Layers	5
☐ Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	Yes
Collision Avoidance	Layer Compression
Fix First Layer	No
☐ Gap Factor	0.5
☐ Maximum Height over Base	1
Growth Rate Type	Geometric
☒ Maximum Angle	140.0 °
☐ Fillet Ratio	1
Use Post Smoothing	Yes
☐ Smoothing Iterations	5
[+] CutCellMeshing	
[+] Advanced	
[+] Defeaturing	
[+] Statistics	



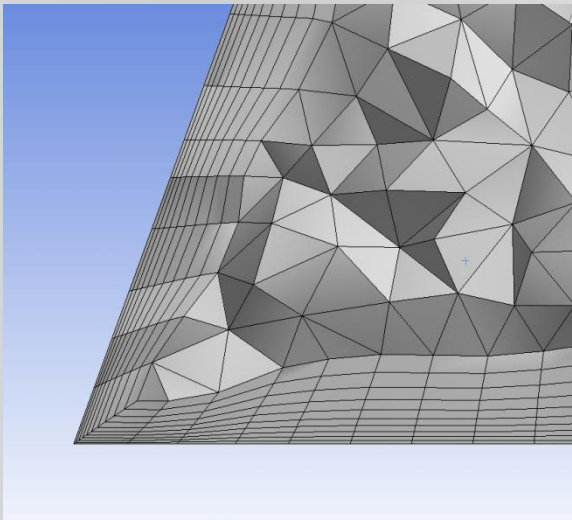
Higher Maximum Angle means more chances of layer projection on adjacent faces

Inflation : Advanced Options

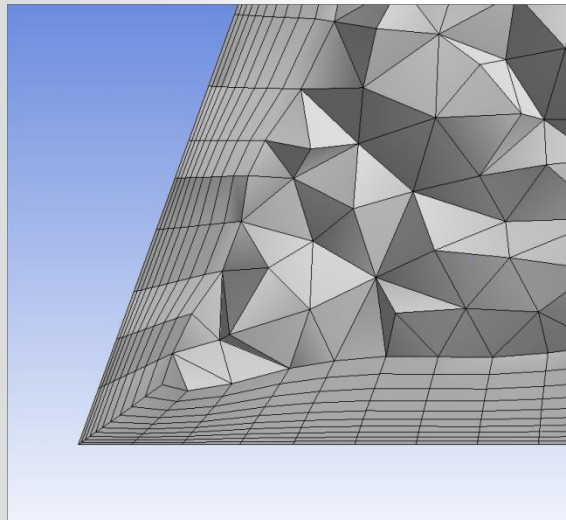
Fillet Ratio

- Generates the inflation layers at corner with fillet like smoothing, proportional to inflation height
- Controls smoothing of corner nodes of inflation layers for better quality

Fillet Ratio = 0



Fillet Ratio = 1



Details of "Mesh"	
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Inflation	
Use Automatic Inflation	Program Controlled
Inflation Option	Smooth Transition
☐ Transition Ratio	0.272
☐ Maximum Layers	5
☐ Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	Yes
Collision Avoidance	Layer Compression
Fix First Layer	No
☐ Gap Factor	0.5
☐ Maximum Height over Base	1
Growth Rate Type	Geometric
☐ Maximum Angle	140.0 °
☒ Fillet Ratio	1
Use Post Smoothing	Yes
☐ Smoothing Iterations	10
CutCellMeshing	
Advanced	
Defeaturing	
Statistics	



Higher Fillet Ratio means more smoothing for corner nodes

Inflation : Advanced Options

Post Smoothing

- Checks whether to perform smoothing on inflation layers after generation
- If set to Yes, it moves node locations with respect to adjacent nodes to improve quality
- Smoothing iterations control the number of smoothing cycles to be performed after inflation layer generation

Without Post Smoothing

Statistics	
☐ Nodes	75482
☐ Elements	219096
Mesh Metric	
Orthogonal Quality	
☐ Min	7.83784753144795E-02
☐ Max	0.999007761070449
☐ Average	0.859478655338394
☐ Standard Deviation	0.102424084268833

With Post Smoothing

Statistics	
☐ Nodes	75499
☐ Elements	219224
Mesh Metric	
Orthogonal Quality	
☐ Min	0.152419064639509
☐ Max	0.999007737386726
☐ Average	0.858953274656384
☐ Standard Deviation	0.102779723158533

Details of "Mesh"

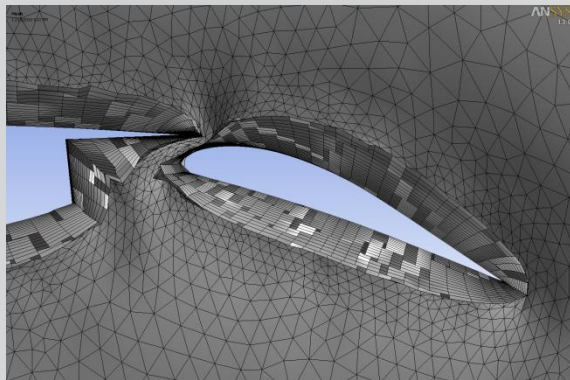
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Inflation	
Use Automatic Inflation	Program Controlled
Inflation Option	Smooth Transition
☐ Transition Ratio	0.272
☐ Maximum Layers	5
☐ Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	Yes
Collision Avoidance	Layer Compression
Fix First Layer	No
☐ Gap Factor	0.5
☐ Maximum Height over Base	1
Growth Rate Type	Geometric
☐ Maximum Angle	140.0 °
☐ Fillet Ratio	1
Use Post Smoothing	Yes
☐ Smoothing Iterations	5
CutCellMeshing	
Advanced	
Defeaturing	
Statistics	

Inflation : Advanced Options

Maximum Height over Base

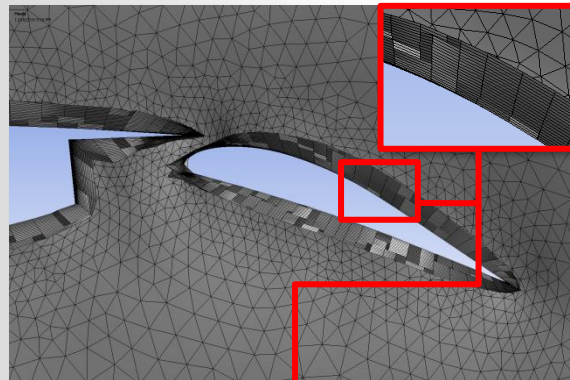
- Controls the allowable ratio of last inflation layer height over the base element size
- Once this allowable value is reached, inflation layers are grown but the cell height remains constant
- Valid values are from 0.1 to 5. The default is 1.0

Max Height over Base = 1



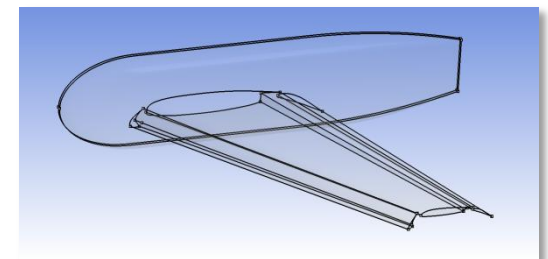
Higher Max Height over Base means thicker inflation height

Max Height over Base = 0.1



The value has been reached, the prism growing continues with constant height

Details of "Mesh"	
Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Inflation	
Use Automatic Inflation	Program Controlled
Inflation Option	Last Aspect Ratio
☐ First Layer Height	1. mm
☐ Maximum Layers	20
☐ Aspect Ratio (Base/Height)	3.
View Advanced Options	Yes
Collision Avoidance	Layer Compression
Fix First Layer	No
☐ Gap Factor	0.5
☒ Maximum Height over Base	1
Growth Rate Type	Geometric
☐ Maximum Angle	180.0 °
☐ Fillet Ratio	1
Use Post Smoothing	Yes
☐ Smoothing Iterations	5
CutCellMeshing	
Active	No
Advanced	



Details of "Mesh"

Defaults	
Physics Preference	CFD
Solver Preference	Fluent
☐ Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Coarse
Initial Size Seed	Active Assembly
Smoothing	High
Transition	Slow
Span Angle Center	Fine
☐ Curvature Normal Angle	25.0 °
☐ Min Size	Default (4.9004e-002 mm)
☐ Max Face Size	Default (4.90040 mm)
☐ Max Size	Default (9.80080 mm)
☐ Growth Rate	Default (1.20)
Minimum Edge Length	8.1579e-004 mm
Inflation	
CutCellMeshing	
Active	No
Advanced	
Shape Checking	CFD
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Dimensionally Reduced
Mesh Morphing	Disabled
Defeating	
Statistics	

Advanced group is not accessible for Cutcell meshing

Shape Checking

- The quality criterion varies with the type of physics
 - For CFD uses a shape checking criterion based on the element volume for any Non-Cutcell meshing, and on the orthogonal quality for Cutcell meshing
- Mesh check fails if the above criteria is not met

Element Midside Nodes

- Control for creating element with (quadratic element) or without (linear element) midside node
 - Higher-order solution for Mechanical Analysis
- Not required for CFD
 - Default option "Dropped"

See the User's Guide for more details

Shape Checking	CFD
Element Midside Nodes	Standard Mechanical
Straight Sided Elements	Aggressive Mechanical
Number of Retries	Electromagnetics
Extra Retries For Assembly	CFD
	Explicit
	None

Element Midside Nodes	Dropped
Straight Sided Elements	Program Controlled
Number of Retries	Dropped
	Kept