

Lecture 6

Local Mesh Controls

14.0 Release



Fluid Dynamics

Structural Mechanics

Electromagnetics

Systems and Multiphysics

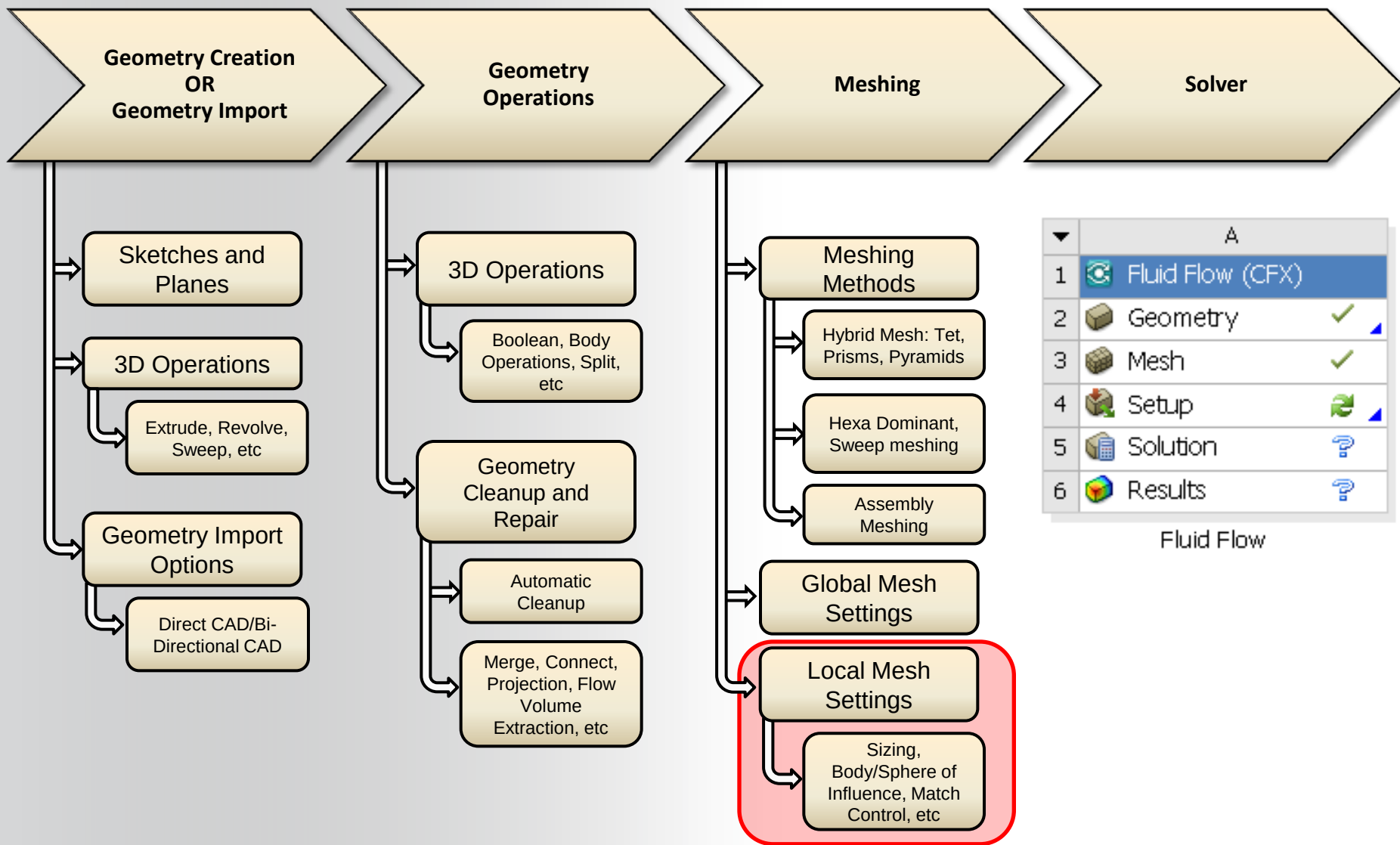
Introduction to ANSYS Meshing

Local Mesh Controls

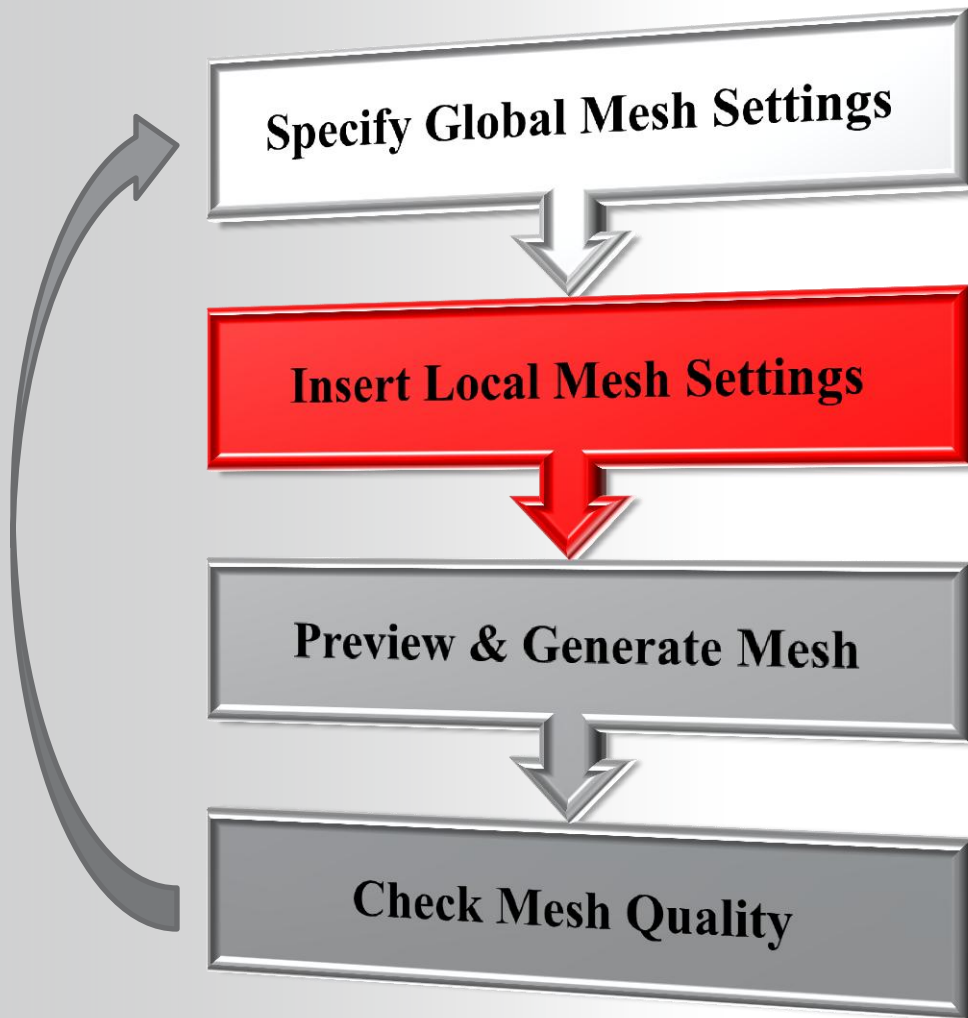
What you will learn from this presentation

- Local mesh controls (Mesh sizing, Refinement, Match control, Inflation, etc)
- How to apply local controls?
- Effect of local controls on mesh

Preprocessing Workflow



Meshing Process in ANSYS Meshing



Local Mesh Controls

Control the mesh locally

- Depends on the “Mesh Method” used

Local Mesh Controls are:

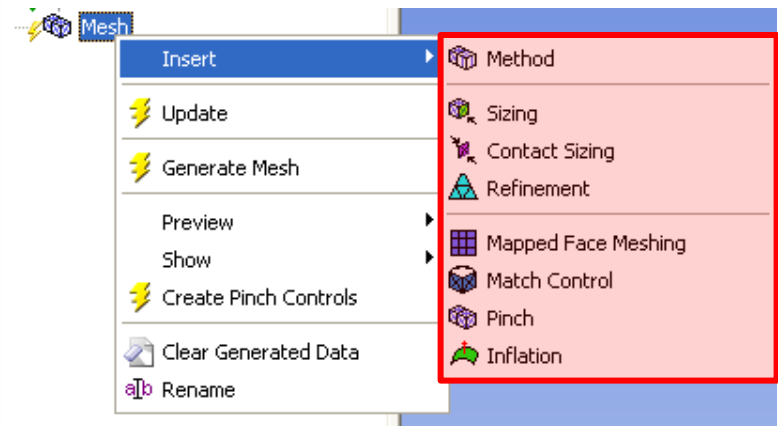
- Sizing
 - For Vertex, Edge, Face and Body
- Contact Sizing
 - For Edge and face
- Refinement
 - For Vertex, Edge and Face
- Mapped Face Meshing
 - For Face
- Match Control
- Pinch
- Inflation
 - For Edge and Face

Only Sizing and Inflation local controls are available for CutCell meshing

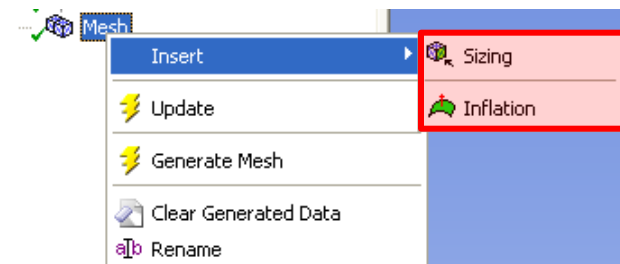


The latest control added on a particular entity overrides any prior controls

Non-CutCell meshing local controls



CutCell meshing local controls



Recommended for locally defining the mesh sizes

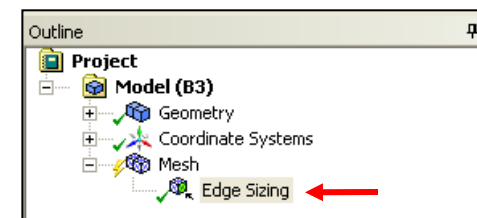
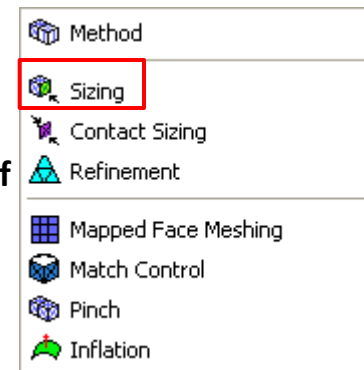
You can only scope sizing to one geometry entity type at a time

- For example: you can apply sizing to a number of edges or a number of faces, but not a mix of edges and faces.

Four Types of Sizing option

- Element Size specifies average element edge length on bodies, faces or edges
- Number of Divisions specifies number of elements on edge(s)
- Body of Influence specifies average element size within a body
- Sphere of Influence specifies average element size within the sphere

Sizing options vary depending on the entity type chosen



Entity/Option	Element Size	Number of Divisions	Body of Influence	Sphere of Influence
Vertices				X
Edges	X	X		X
Faces	X			X
Bodies	X		X	X

Requires a
Coordinate
system for
the sphere

Advanced Size
Function in Global
settings should be
disabled

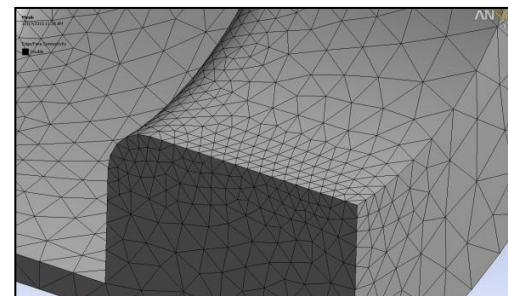
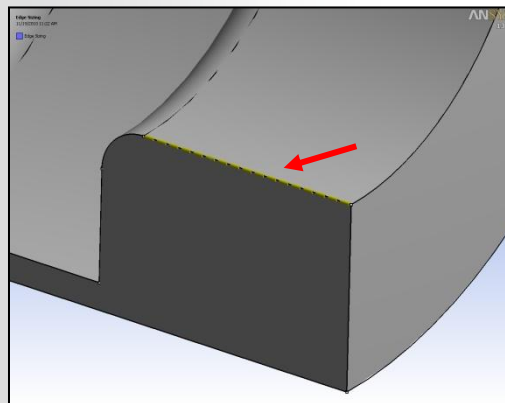


*Only Element Size type is available for
CutCell meshing*

Sizing : Edges

Sizing Type:
Element Size

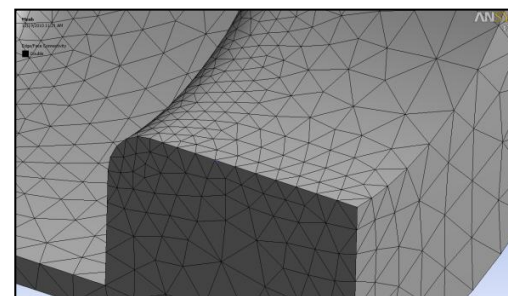
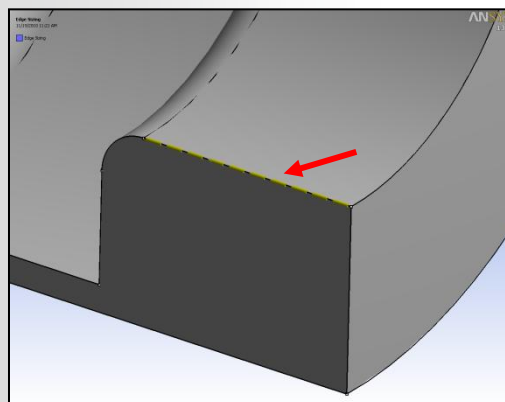
Details of "Edge Sizing" - Sizing	
Scope	
Scoping Method	Geometry Selection
Geometry	1 Edge
Definition	
Suppressed	No
Type	Element Size
☐ Element Size	60. mm
Behavior	Soft
☐ Curvature Normal Angle	Default
☐ Growth Rate	Default
Bias Type	No Bias



Edge meshed with constant element size of 60mm

Sizing Type:
Number of Divisions

Details of "Edge Sizing" - Sizing	
Scope	
Scoping Method	Geometry Selection
Geometry	1 Edge
Definition	
Suppressed	No
Type	Number of Divisions
☐ Number of Divisions	10
Behavior	Soft
☐ Curvature Normal Angle	Default
☐ Growth Rate	Default
Bias Type	No Bias



Edge meshed with 10 elements



The Curvature Normal Angle and/or the Growth Rate maybe not displayed depending on the ASF used

Sizing : Edges (Contd...)

Bias Type and Bias Factor

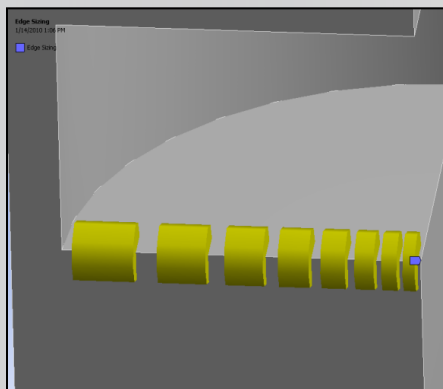
Specify the grading scheme and factor

- Bias Type:** grading of elements towards one end, both ends, or the center

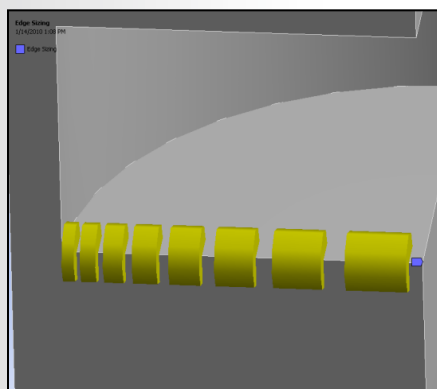
Edge Behavior	Soft
Bias Type	---
Bias Factor	---
No Bias	

Method
Sizing
Contact Sizing
Refinement
Mapped Face Meshing
Match Control
Pinch
Inflation

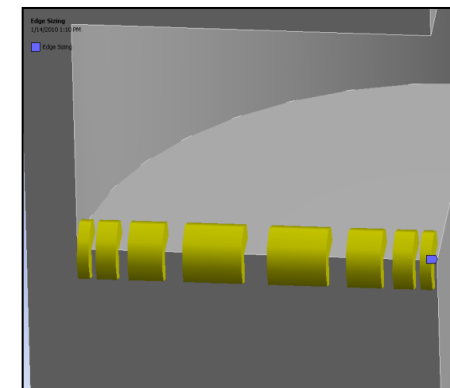
- Bias Factor:** is the ratio of the largest element to the smallest element



Definition	
Suppressed	No
Type	Number of Divisions
☐ Number of Divisions	8
Behavior	Soft
☐ Curvature Normal Angle	Default
☐ Growth Rate	Default
Bias Type	---
☐ Bias Factor	5.



Definition	
Suppressed	No
Type	Number of Divisions
☐ Number of Divisions	8
Behavior	Soft
☐ Curvature Normal Angle	Default
☐ Growth Rate	Default
Bias Type	---
☐ Bias Factor	5.



Definition	
Suppressed	No
Type	Number of Divisions
☐ Number of Divisions	8
Behavior	Soft
☐ Curvature Normal Angle	Default
☐ Growth Rate	Default
Bias Type	---
☐ Bias Factor	5.

Sizing : Edges (Contd...)

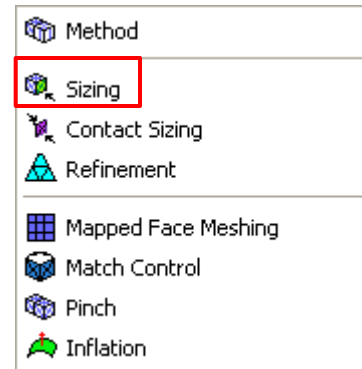
Behavior

Soft: Sizing will be influenced by global sizing functions such as those based on proximity and/or curvature as well as local mesh controls

Hard: Size control is strictly adhered to



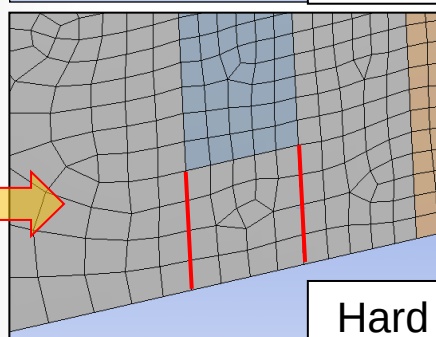
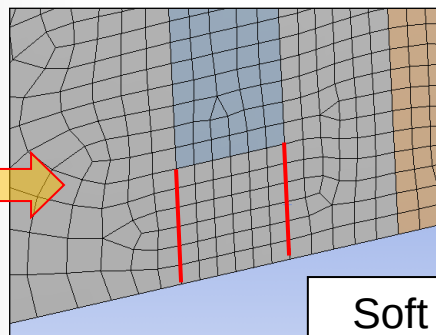
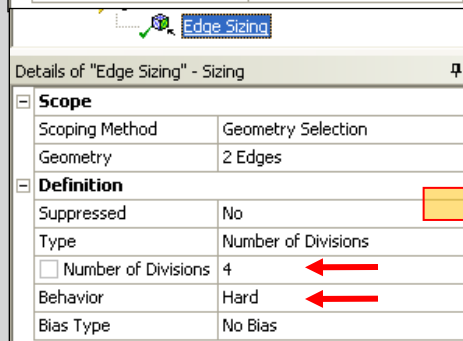
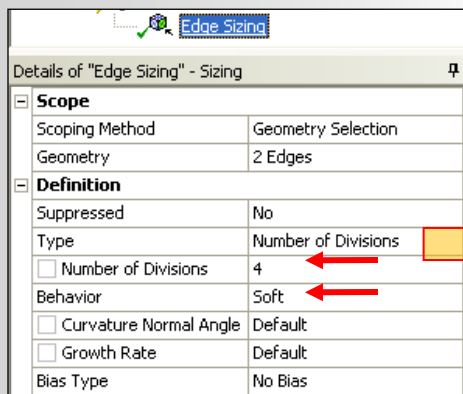
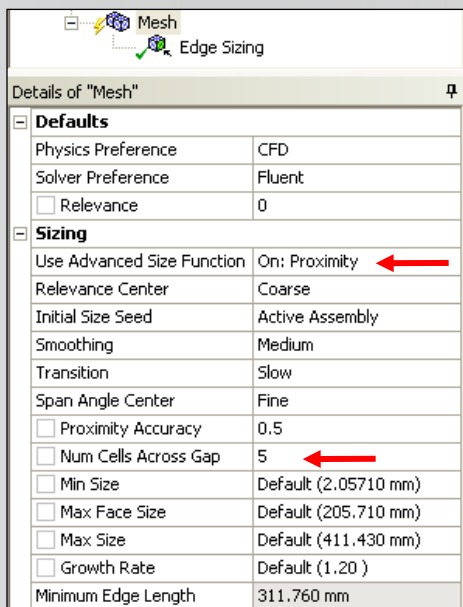
- Transition between hard edges (or any edge with bias) and adjacent edge and face meshes may be abrupt
- Hard edges or edges with bias will override Max Face Size and Max Size properties



Behavior	Soft
Bias Type	Soft
Bias Factor	Hard

Influenced by global Proximity advanced size function.

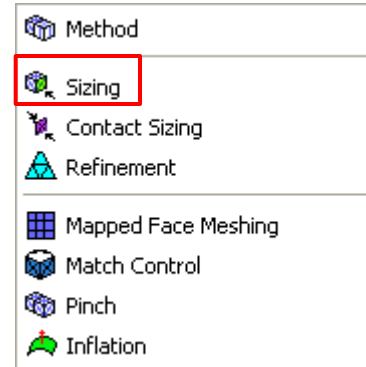
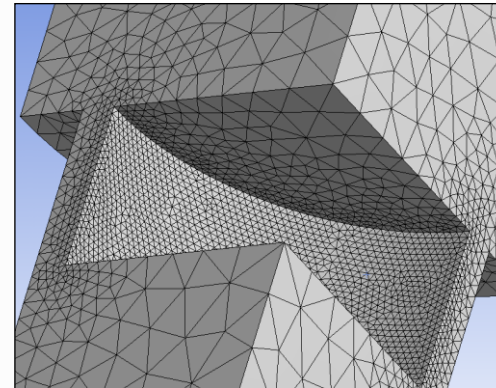
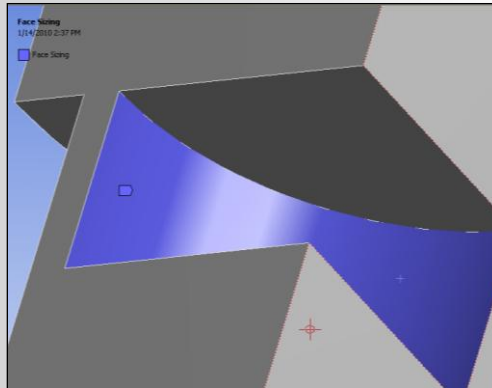
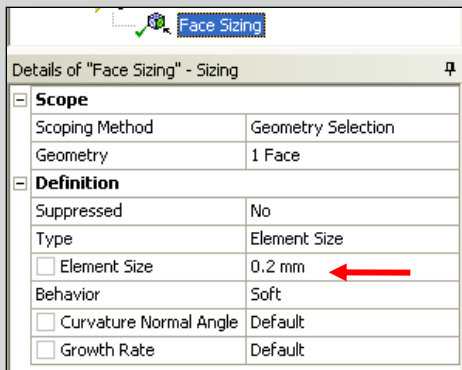
No influence from other global settings



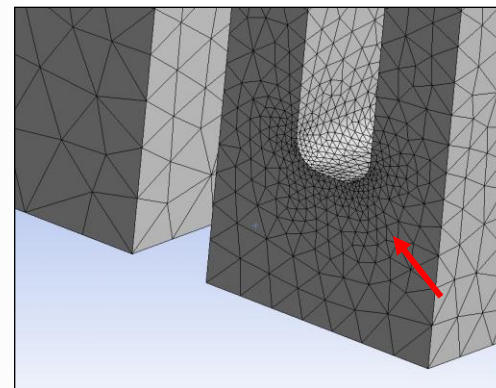
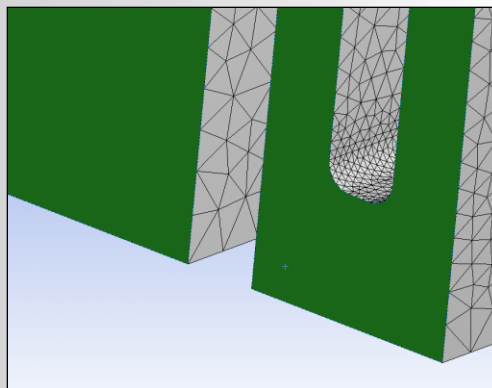
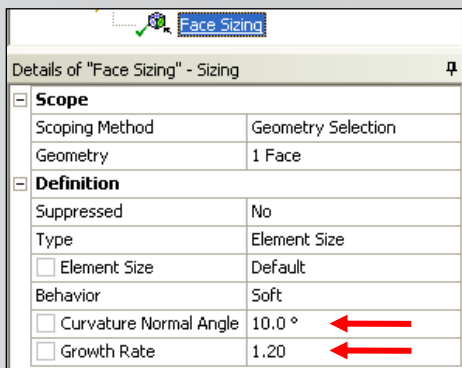
Sizing : Faces

Element Size

Defines the maximum element size on the face



Face meshed with constant element size



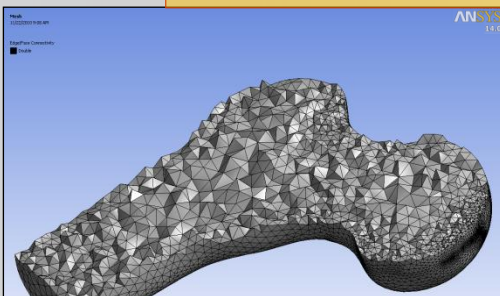
Edge curvature is resolved

Sizing : Body (volume)

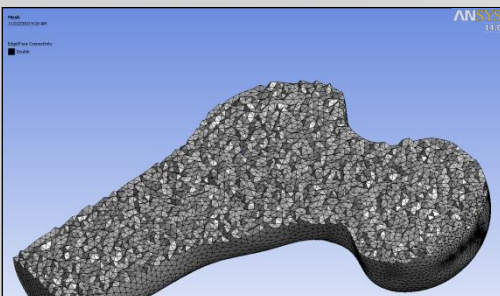
Element Size

Defines the maximum cell size on the Body

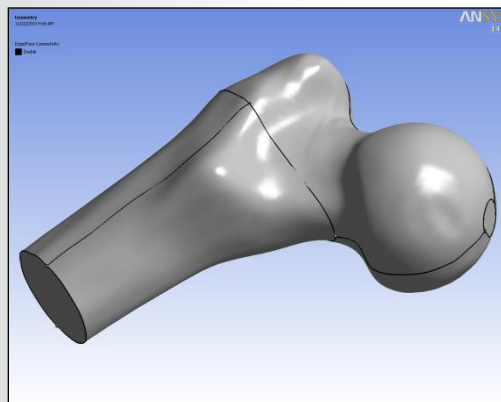
Tetrahedron patch
conforming mesh



Without
body sizing



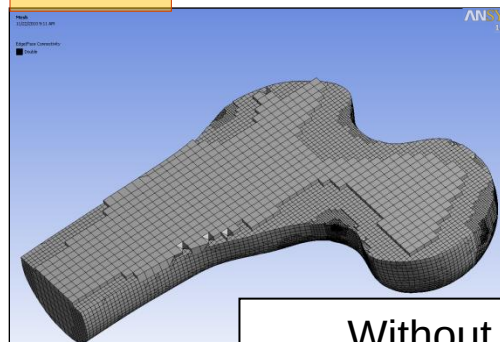
With body
sizing



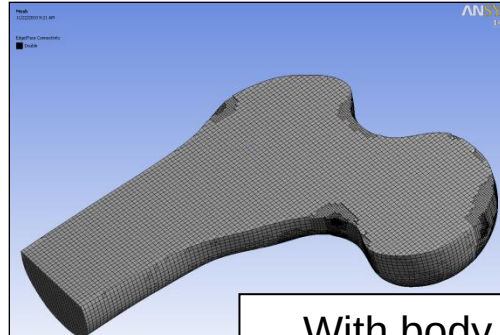
Details of "Body Sizing" - Sizing	
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Suppressed	No
Type	Element Size
☐ Element Size	2. mm
Behavior	Soft
☐ Curvature Normal Angle	Default
☐ Growth Rate	Default

Body meshed with max
cell size defined

CutCell
mesh



Without
body sizing



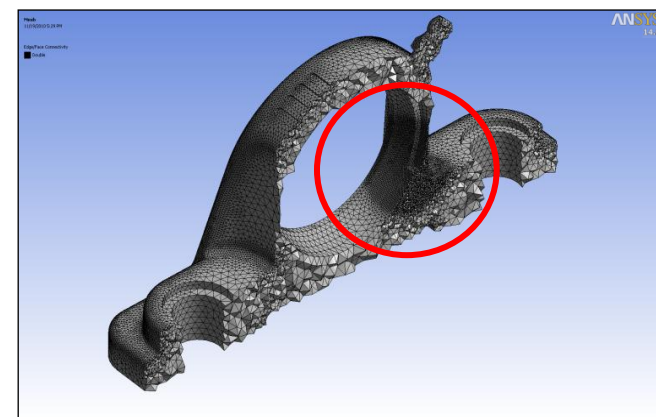
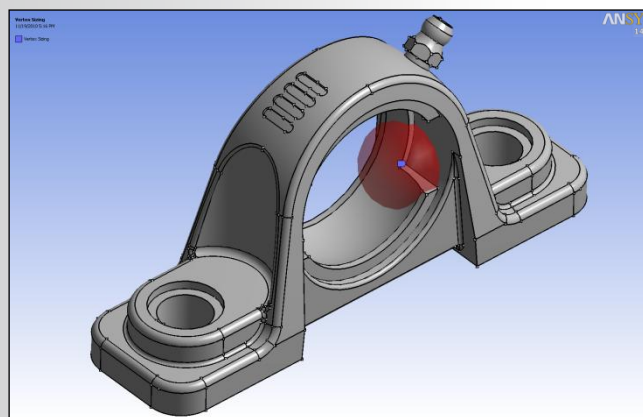
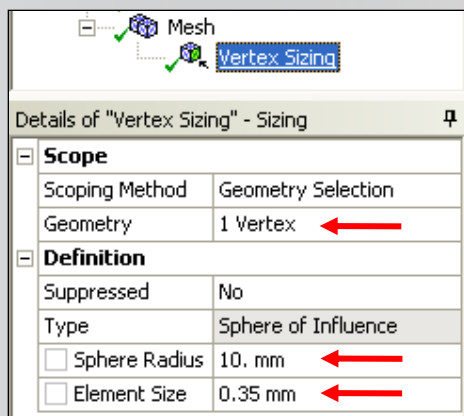
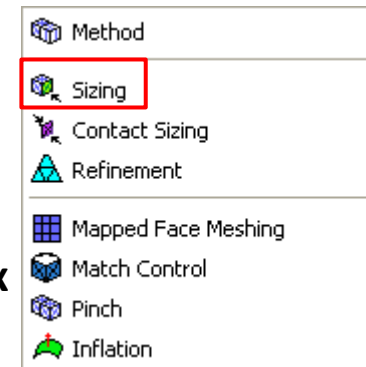
With body
sizing

Method
Sizing
Contact Sizing
Refinement
Mapped Face Meshing
Match Control
Pinch
Inflation

Sizing : Sphere of Influence

Sphere of Influence : on Vertex

- Available with or without Advanced Size Functions
- Sets the average element size around the selected vertex
- Inputs:
 - Sphere radius and Element size
 - Center of the sphere is defined by a model vertex

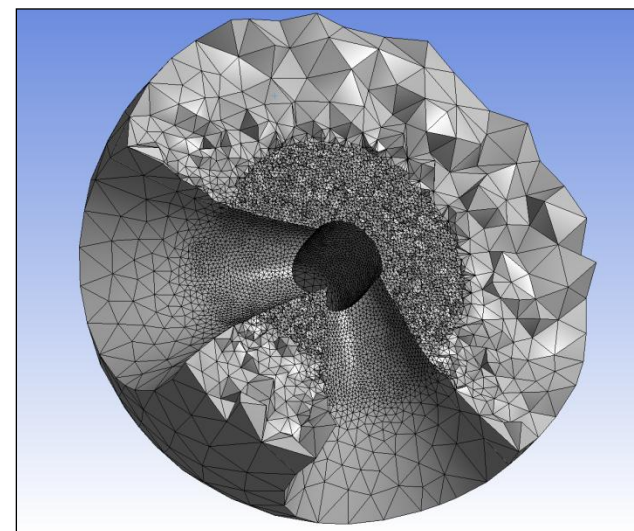
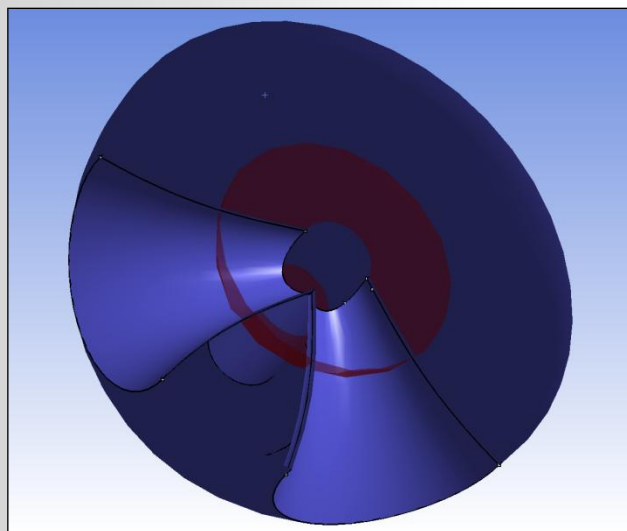
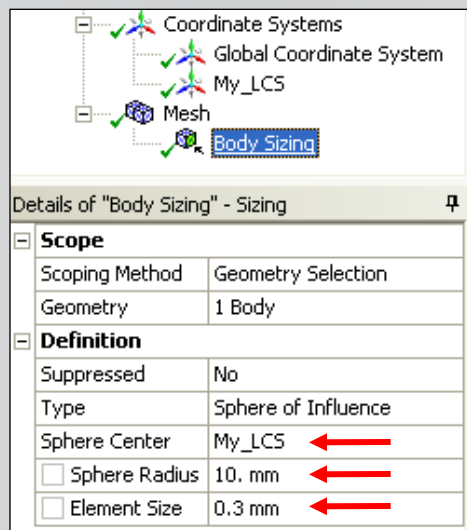
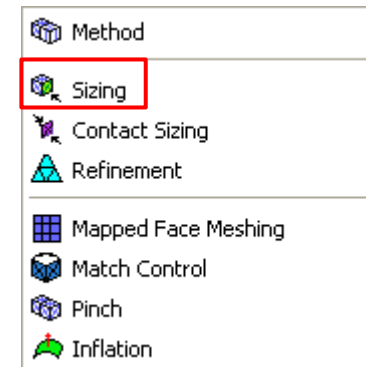


- Good resolution at the vertex
- The element size will be applied to all entities connected to the selected vertex

Sizing : Sphere of Influence

Sphere of Influence : on Bodies

- Available with or without Advanced Size Functions
- Constant element size is applied within the confines of a sphere
- Use coordinate system to define the center of the Sphere

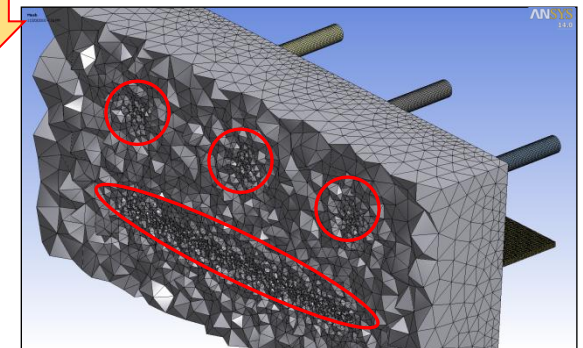
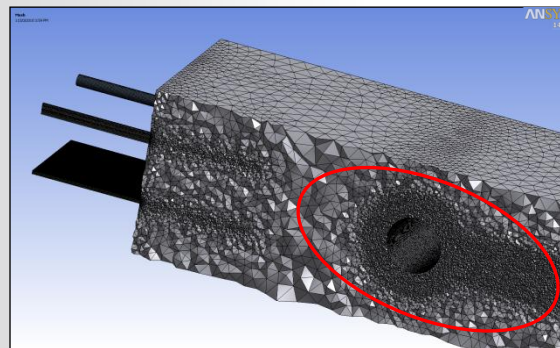
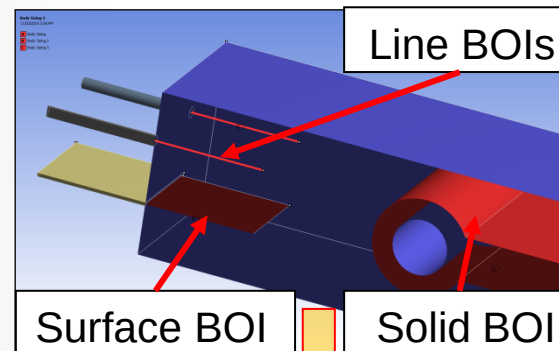
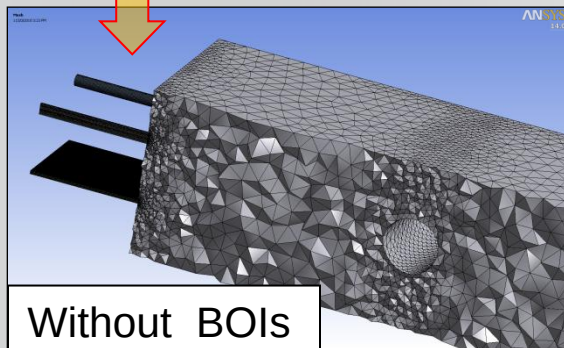
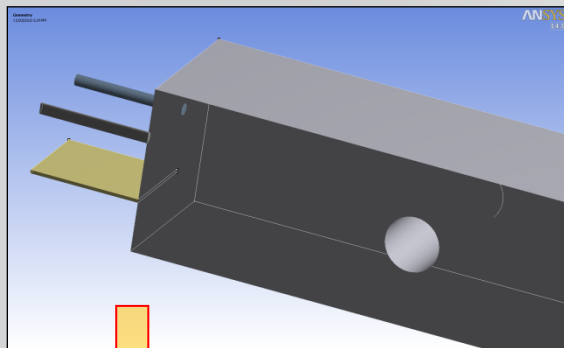


Sizing : Bodies of Influence

Bodies of influence (BOI)

- Lines, surfaces and solid bodies can be used to refine the mesh
- Accessible when ASF is On
- Not available for CutCell meshing

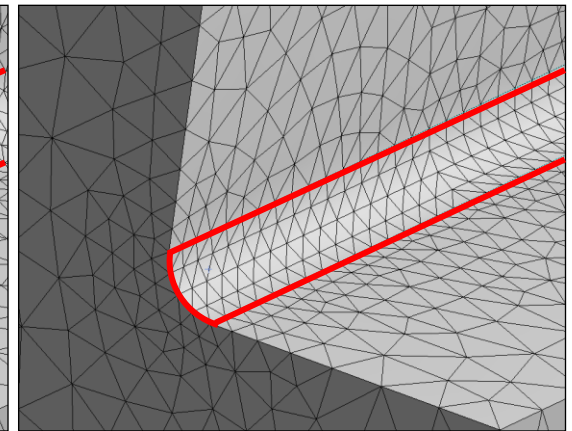
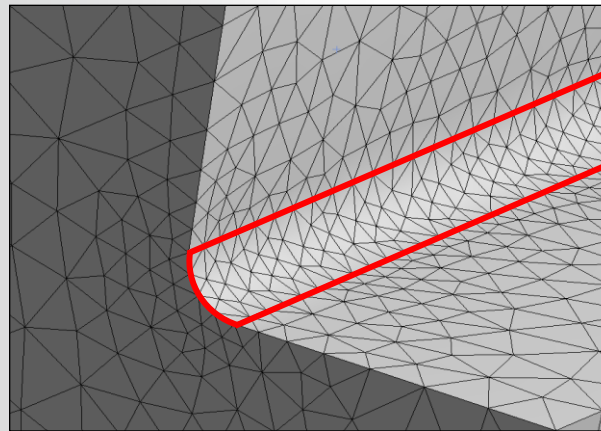
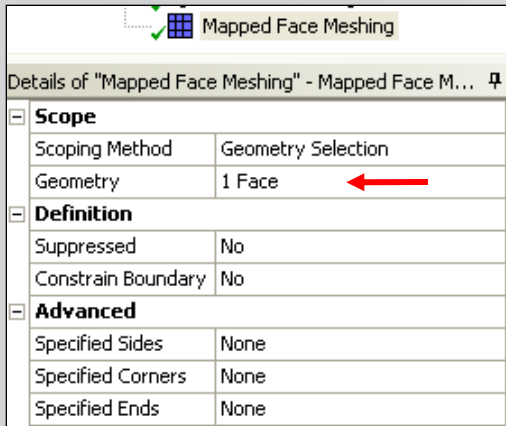
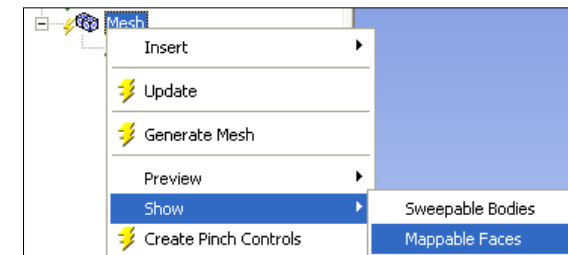
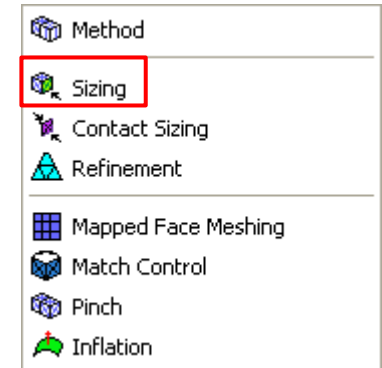
	Method
	Sizing
	Contact Sizing
	Refinement
	Mapped Face Meshing
	Match Control
	Pinch
	Inflation



The 'Body of Influence' itself will not be meshed

Mapped Face Meshing

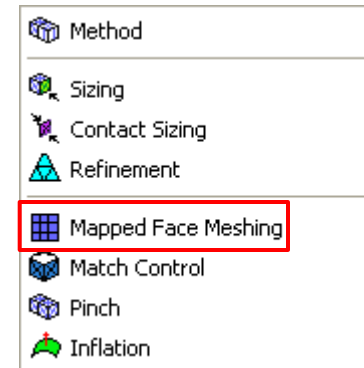
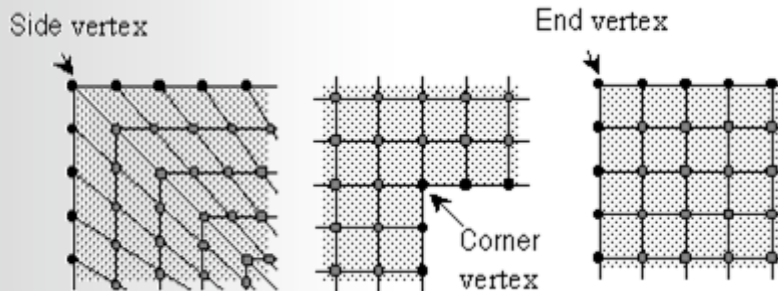
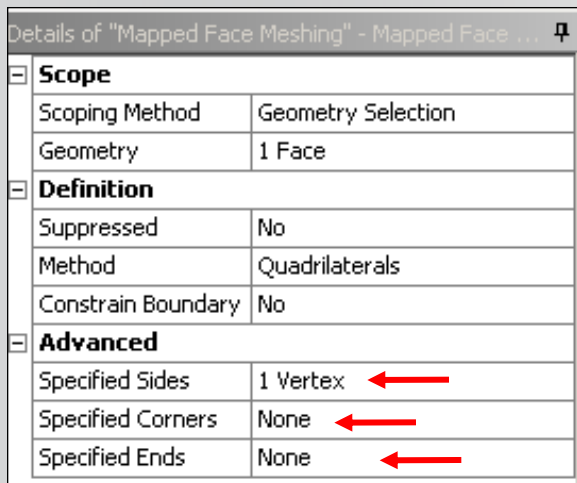
- Creates structured meshes on selected mappable surfaces
- Mapped Face Meshing with advanced control is supported for
 - Sweep, Patch Conforming, Hexa Dominant
 - Quad Dominant and Triangles
- Mapped Face Meshing with basic control is supported for
 - MultiZone
 - Uniform Quad/Tri and Uniform Quad
- RMB on Mesh and Show/Mappable Faces to display all mappable faces



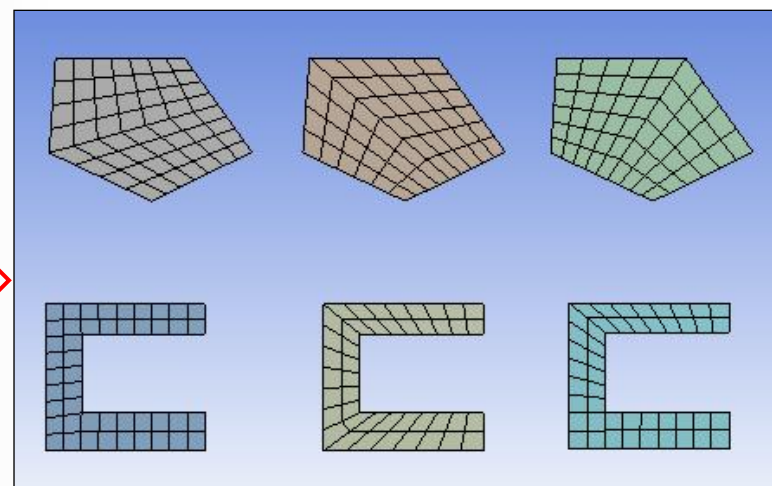
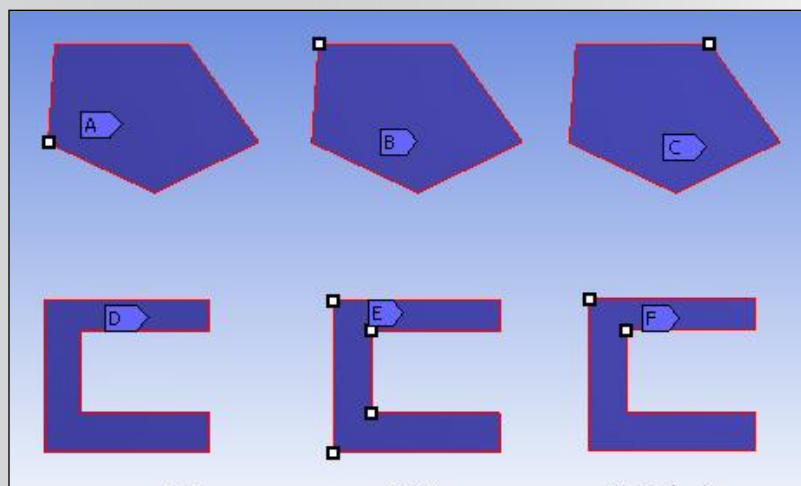
If Mapped Face Meshing fails,  icon appears adjacent to corresponding object in the Tree outline. The mesh will still be created but will ignore this control.

Mapped Face Meshing: Vertex Type

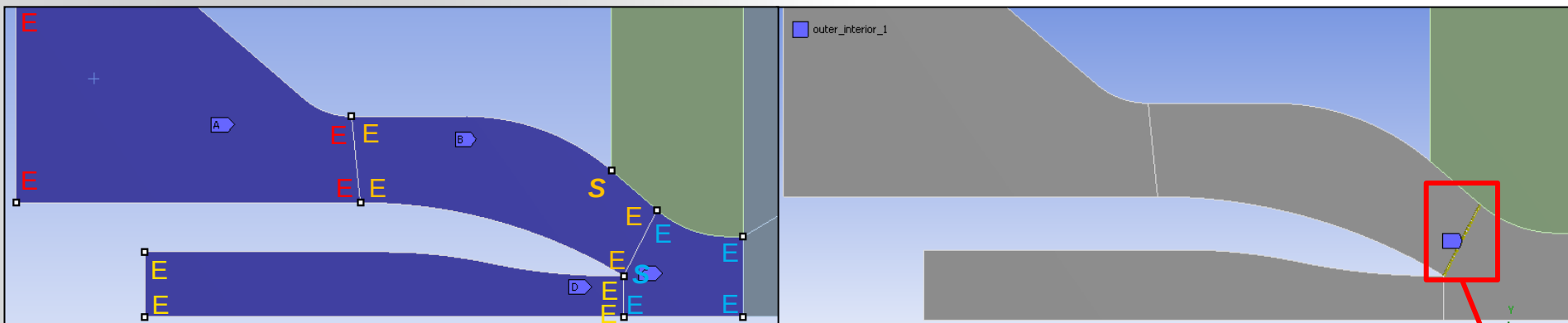
- 'Side', 'Corner' and 'End' controls for vertices, to define strategy for Mapping



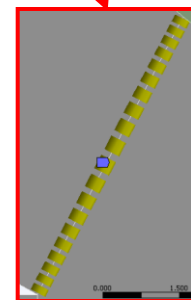
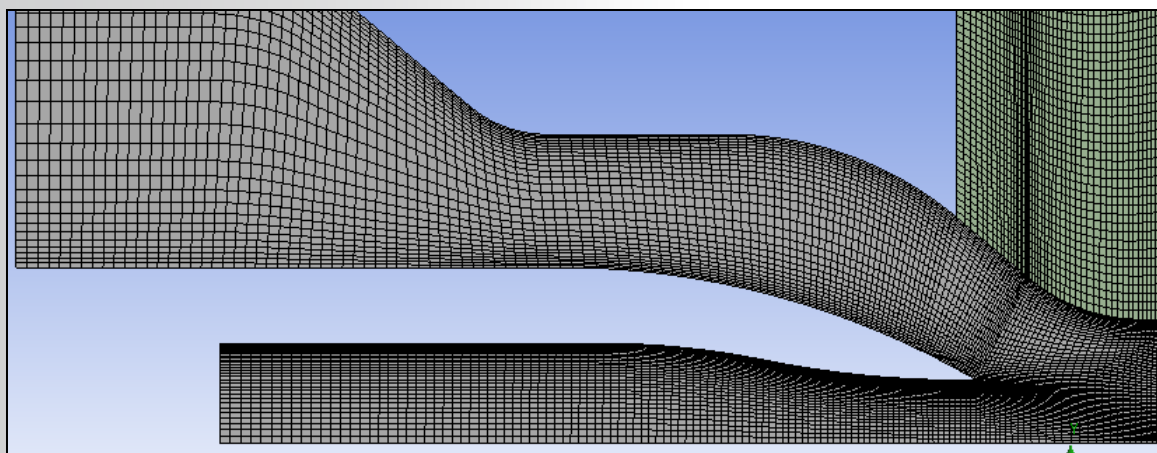
Vertex Type	Intersecting Grid Lines	Angle Between Edges
End	0	0° — 135°
Side	1	136° — 224°
Corner	2	225° — 314°



Mapped Face Meshing: Example

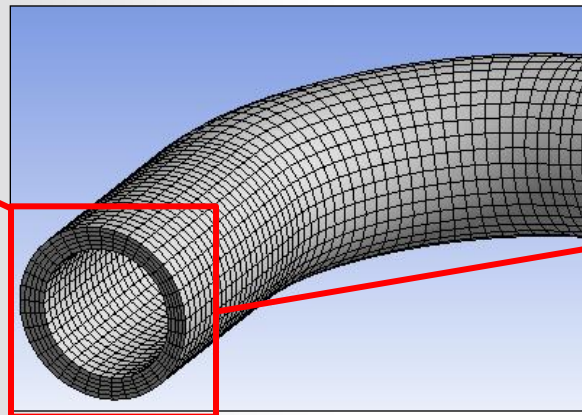
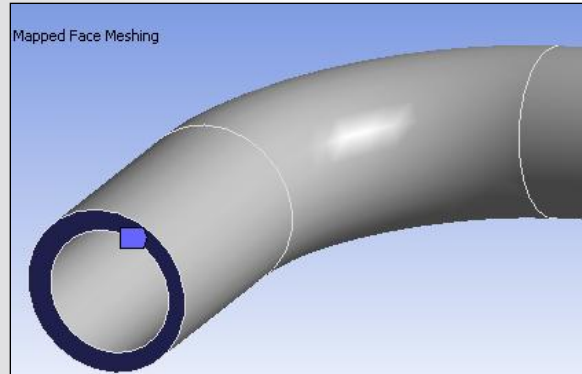
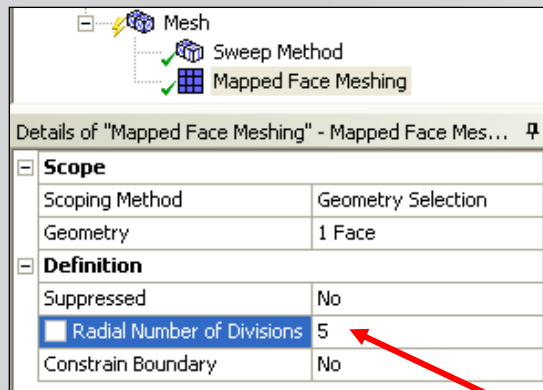
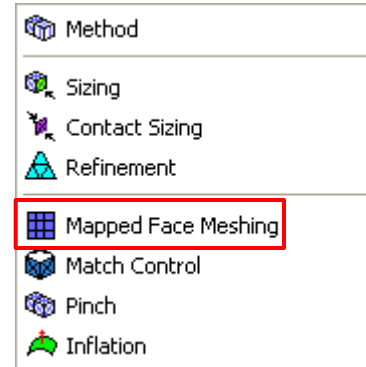


Vertex type is dependant to the attached face =>
the mesh can be individually controlled on all faces

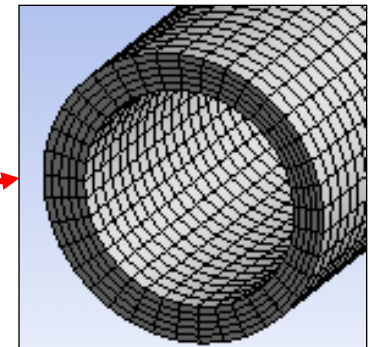


Mapped Face Meshing: Radial No. of Divisions

- If face is defined by two loops, then the “Radial Number of Divisions” field is activated
 - Specify the number of divisions across the annular region
 - Useful for creating number of layers across an annulus

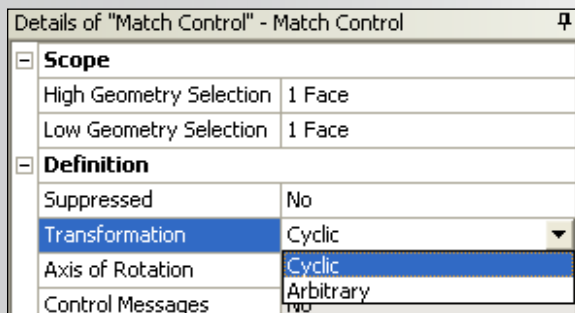
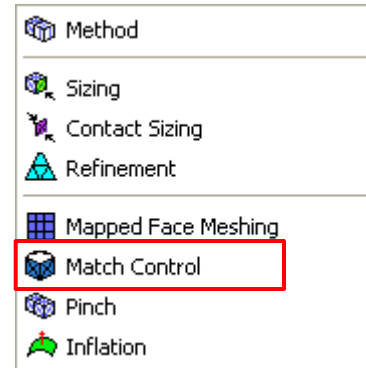


Mapped face is swept to create pure hex mesh

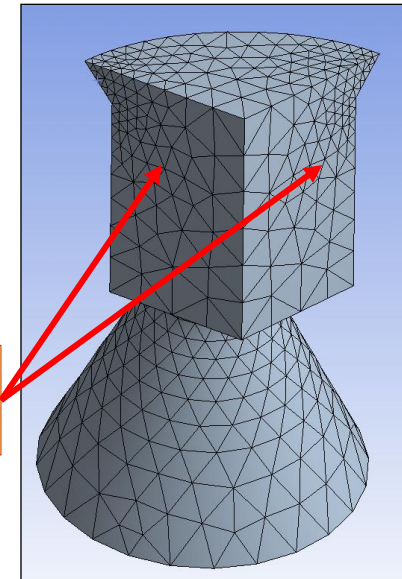


Match Control

- Define periodicity on faces (3D) or edges (2D)
 - The two faces or edges should be topologically and geometrically the same
 - A match control can only be assigned to one unique face/edge pair
 - Match controls are not supported with Post Inflation Algorithm
 - Match Control with Patch Independent tetrahedrons not supported yet
- Two types of match controls available:
 - Cyclic and
 - Arbitrary
- Not available for CutCell meshing



Matching face mesh

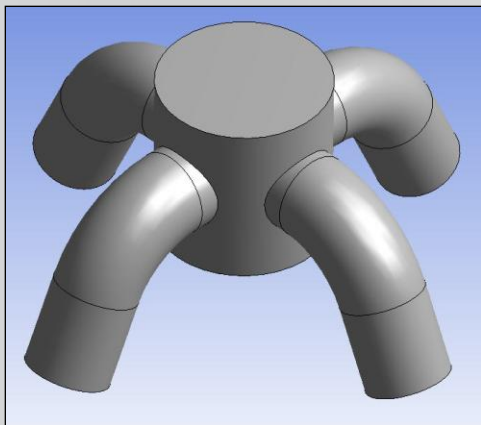


If 'Match Control' fails, (⚠) icon appears adjacent to corresponding object in the outline Tree, however the mesh is created ignoring it

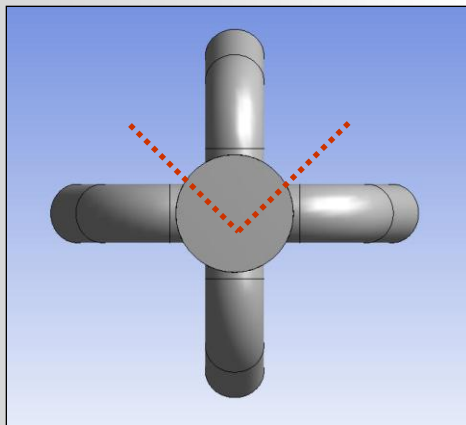
Match Control: Cyclic

- Define Rotational periodic

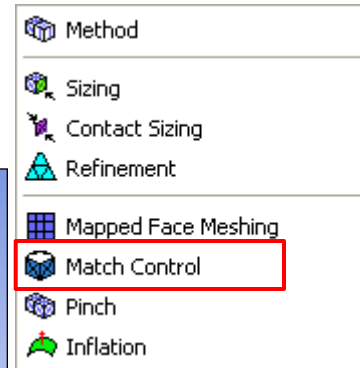
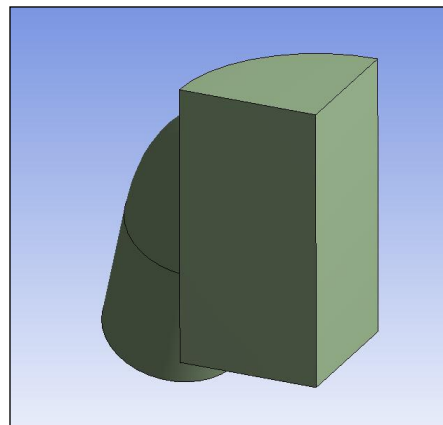
Full Model



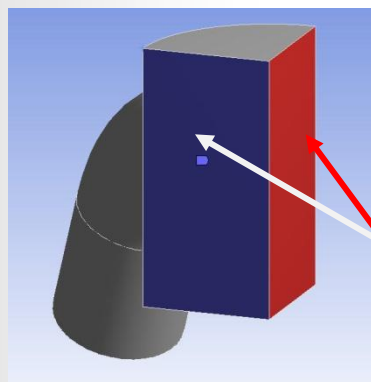
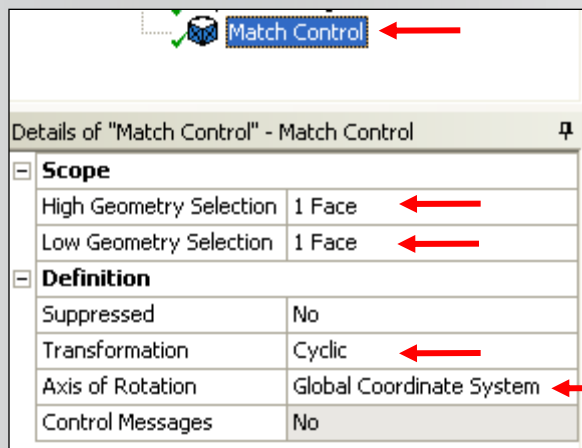
Cut Boundaries



Periodic Model

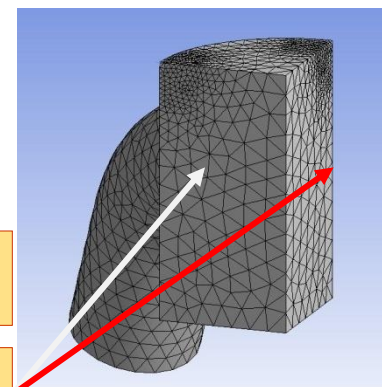


Model is symmetrical at 90° so slice the body along dotted lines in DesignModeler



Selected Faces for Match control

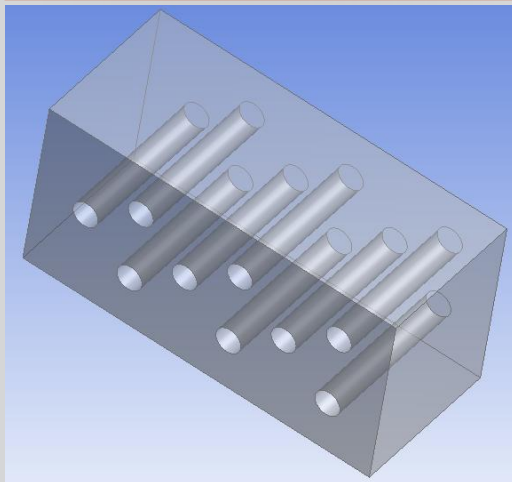
Matching face mesh



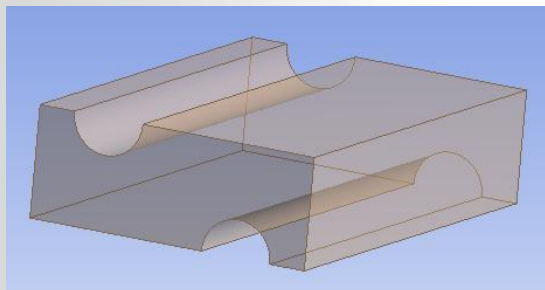
Match Control: Arbitrary

- Two faces or edges to be matched, can be arbitrarily located

Full Model : Tube Banks

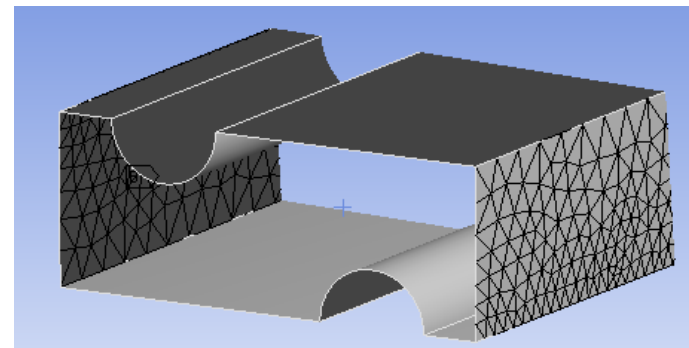


Symmetric + Periodic Model

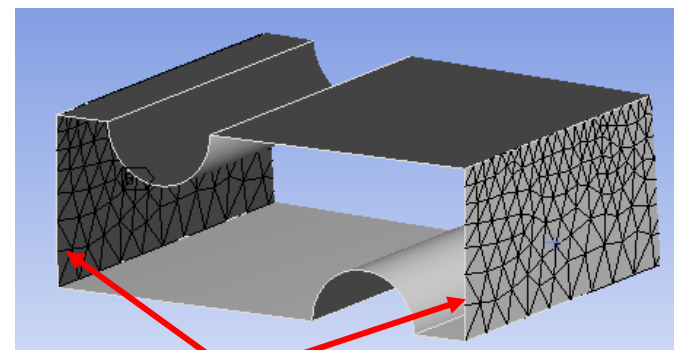


Model extracted through 'Slice' operation in DM

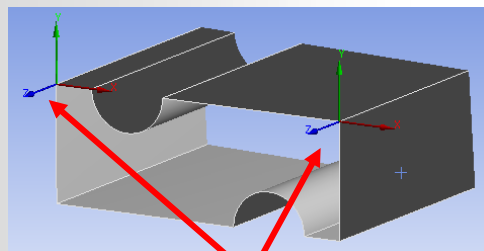
Face Mesh before 'Match Control'



Face Mesh after 'Match Control'



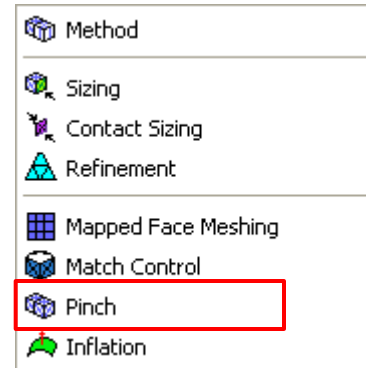
Matching face mesh



Coordinate systems need to be suitably defined at the faces to be matched

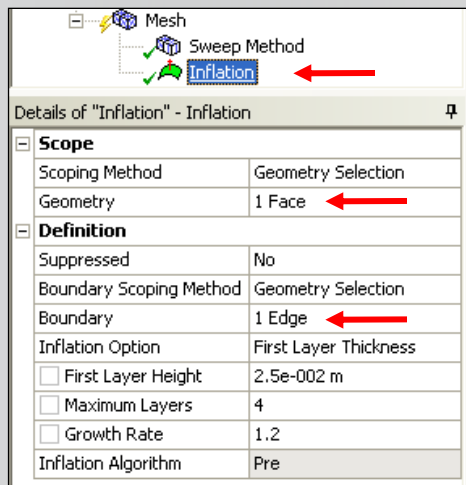
Details of "Match Control" - Match Control	
Scope	
High Geometry Selection	1 Face
Low Geometry Selection	1 Face
Definition	
Suppressed	No
Transformation	Arbitrary
High Coordinate System	Global Coordinate System
Low Coordinate System	Coordinate System
Control Messages	No

- To improve quality Pinch control removes small features (edges or narrow regions) at the mesh level
- The Pinch feature is supported for the following mesh methods:
 - Patch Conforming Tetrahedrons
 - Thin Solid Sweeps
 - Hex Dominant meshing
 - Quad Dominant Surface Meshing
 - Triangles Surface meshing
- Not supported for CutCell meshing
- More details in lecture 5 “mesh quality”

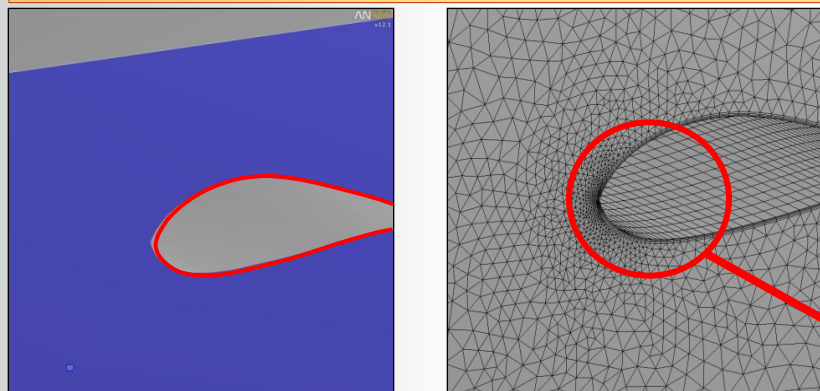


Used to generate prism layers (as explained in Global settings chapter)

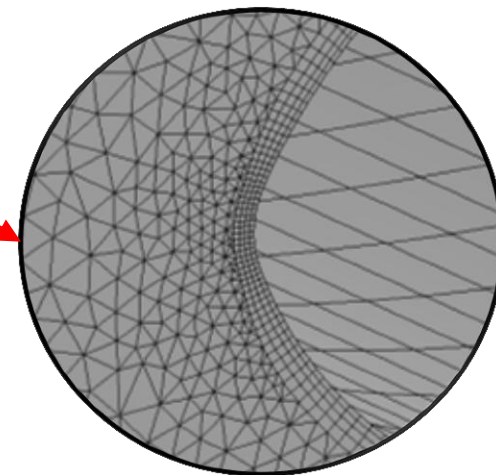
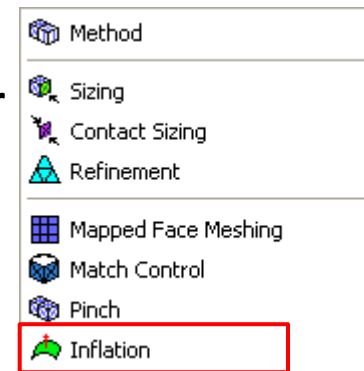
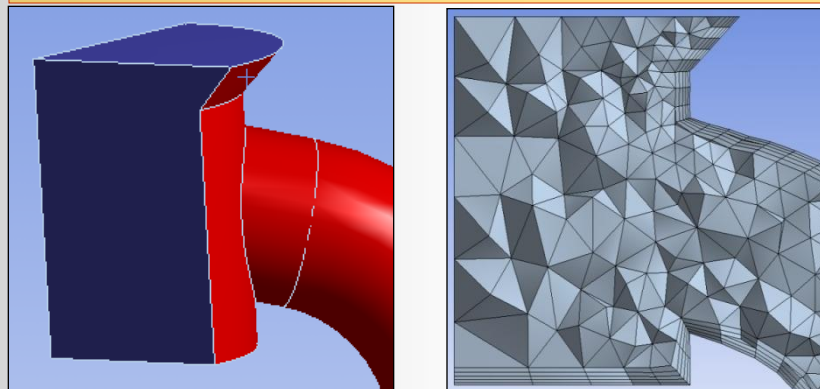
Inflation layer can be applied to faces or bodies using respectively edges or faces as the boundary



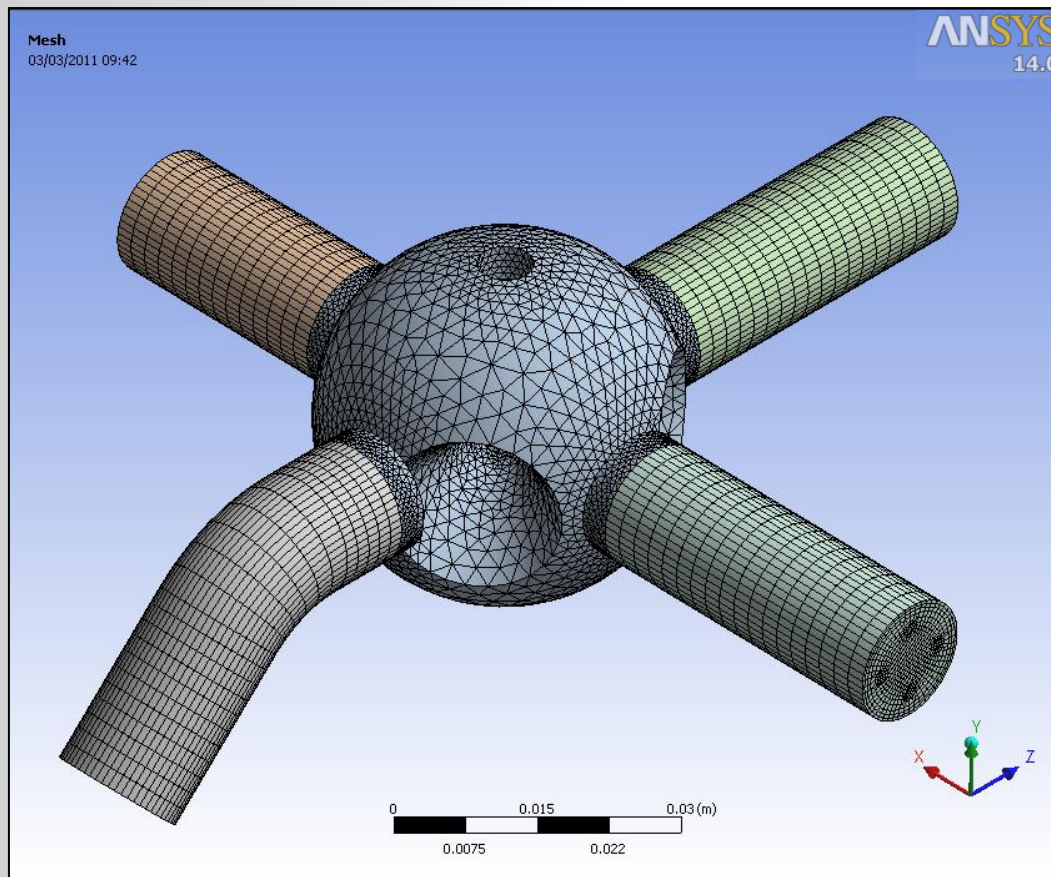
Inflation layer grown on edge boundary (red)



Inflation layer grown on face boundary (red)



Workshop 4 – Local Mesh Controls



Contents

- Edge, Face & Body Sizing Options
- Sizing: Sphere of Influence
- Contact Sizing
- Refinement
- Inflation

Edge, Face and Body Sizing Options

Curvature Normal Angle

Maximum allowable angle that one element edge is allowed to span

Available only when Use Advanced Size Function is set to either On: Proximity and Curvature or On: Curvature

You can specify a value from 0 to 180 degrees or accept the default. (A value of 0 resets the option to its default.)

The default is calculated based on the values of the Relevance and Span Angle Center options

Growth Rate

Represents the increase in element edge length with each succeeding layer of elements. (For example, a growth rate of 1.2 results in a 20% increase in element edge length with each succeeding layer of elements.)

Available when Use Advanced Size Function is on

Specify a value from 1 to 5 or accept the default

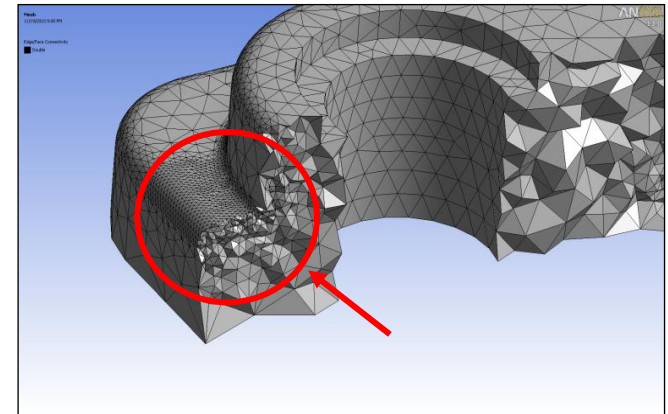
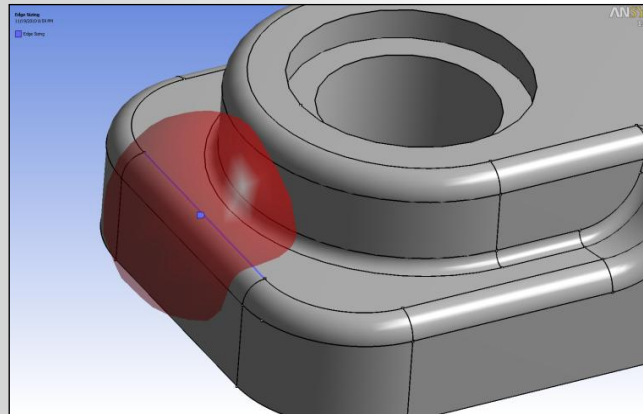
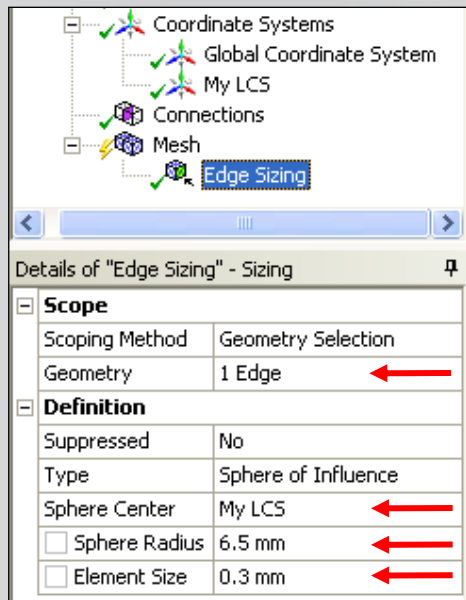
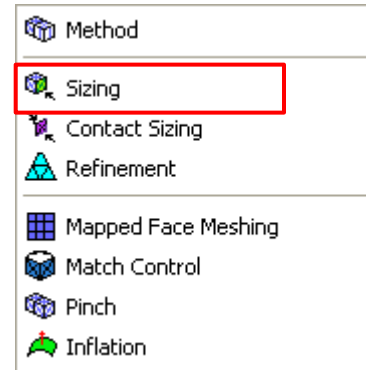
The default is calculated based on the values of the Relevance and Transition options

Must be always lower or equal the global growth rate

Sizing : Sphere of Influence

Sphere of Influence : on Edges

- Available only if Advanced Size Function is OFF
- Use coordinate system to define the center of the Sphere

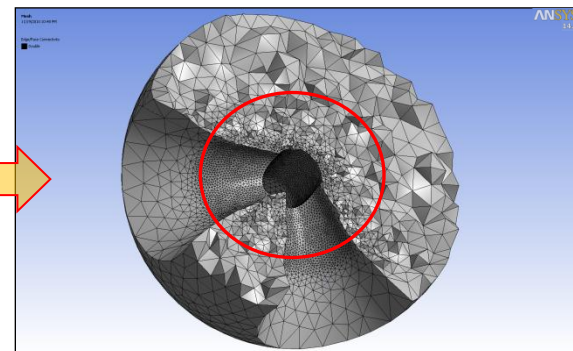
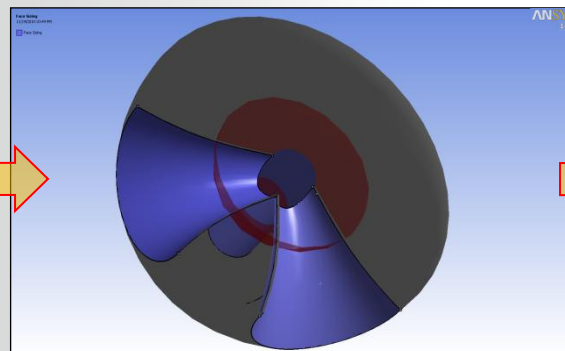
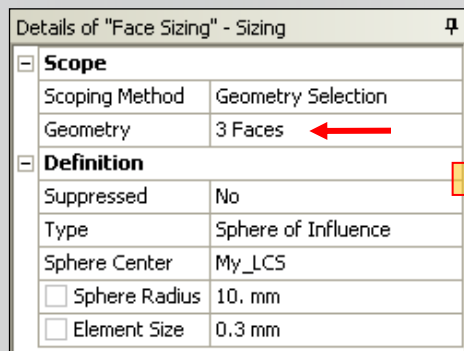
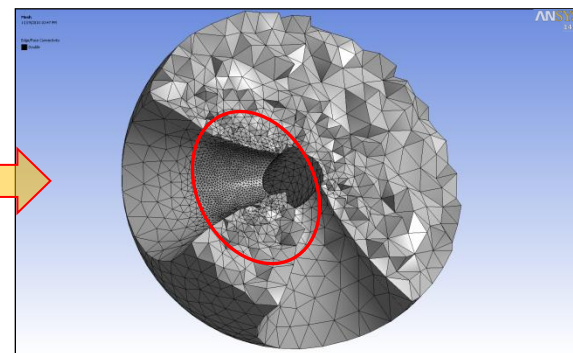
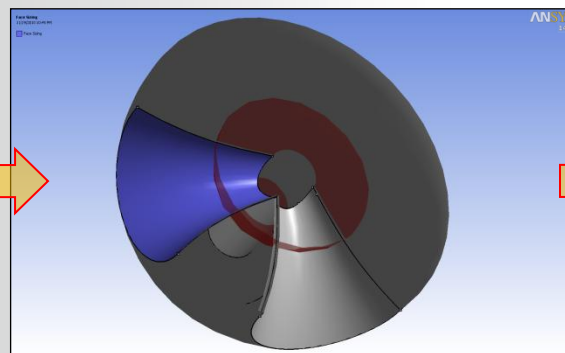
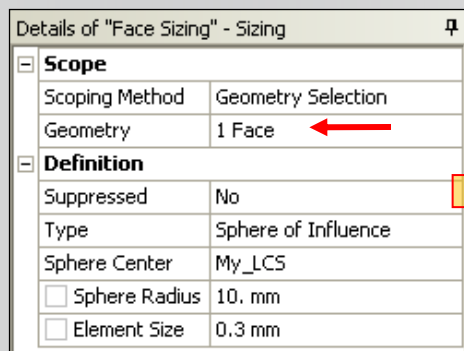
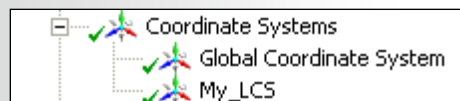
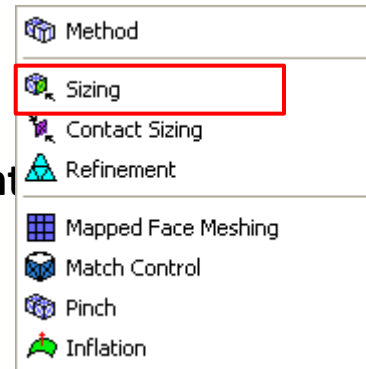


Mesh on the entity and other proximity entities that lies within the sphere of influence is affected

Sizing : Sphere of Influence

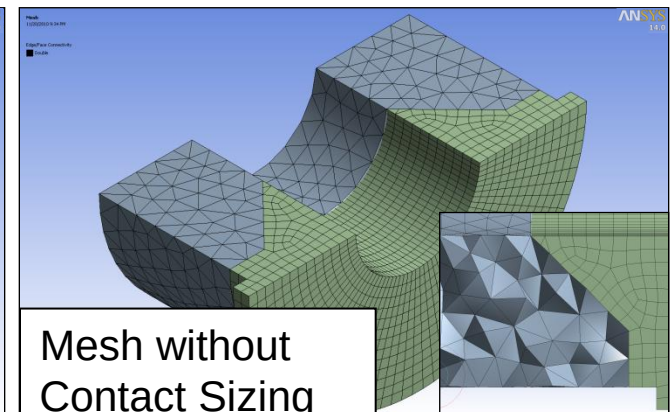
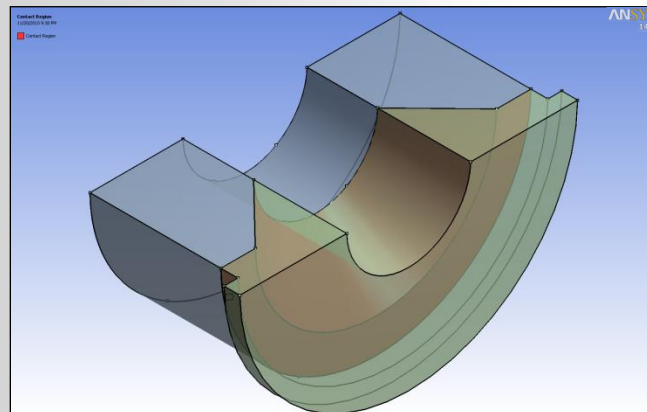
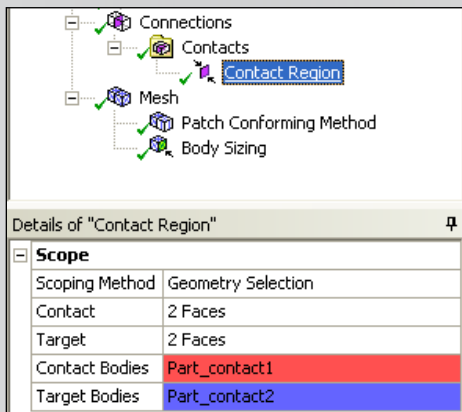
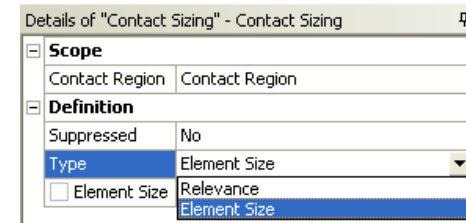
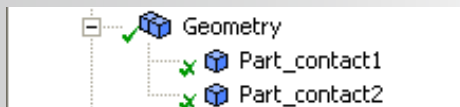
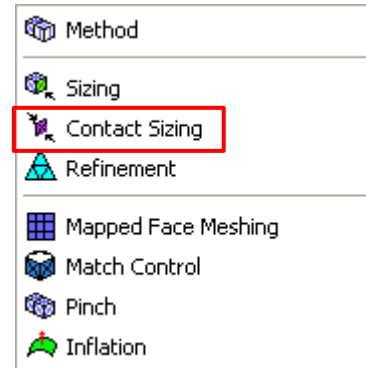
Sphere of Influence : on Faces

- Available only if Advanced Size Function is OFF
- Elements within the sphere will have given average element
- Use coordinate system to define the center of the sphere



Contact Sizing

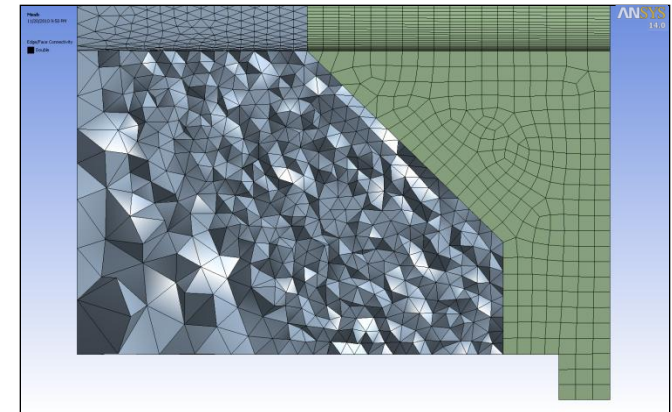
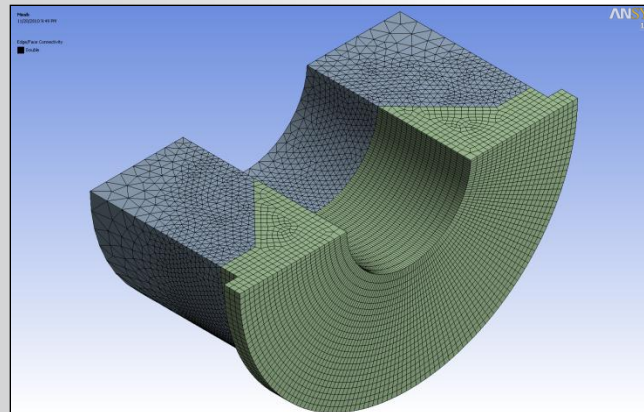
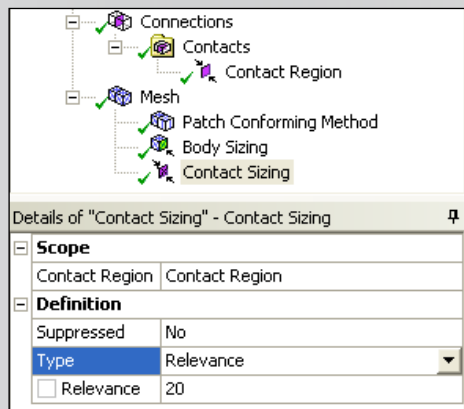
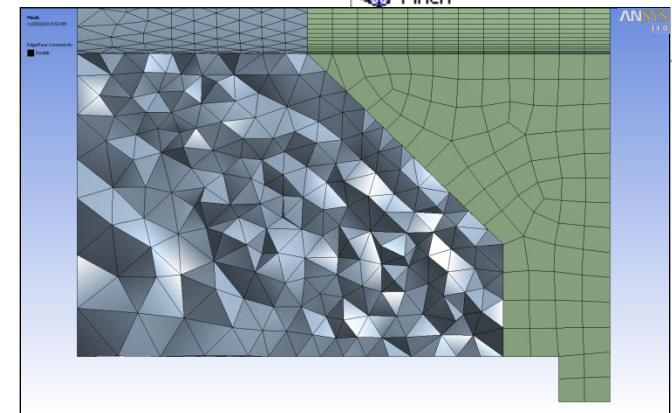
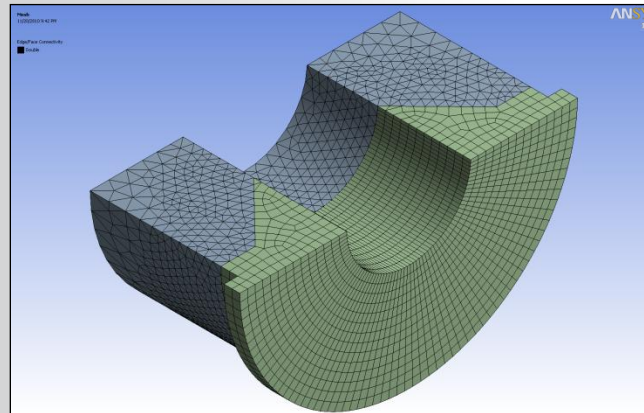
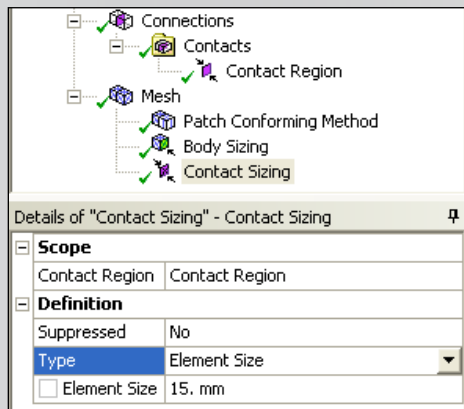
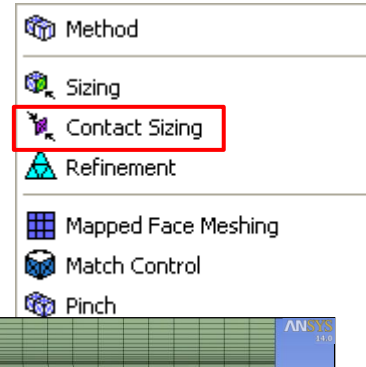
- Generates similar-sized elements on contact faces between parts
- Two options
 - Element Size.** The size of the elements on contact faces respects the value of Element Size specified
 - Relevance.** The size of the elements on contact faces are determined internally by spheres of influence with automatic determination of radius and size depending on the value of specified Relevance
- Not available for CutCell Meshing



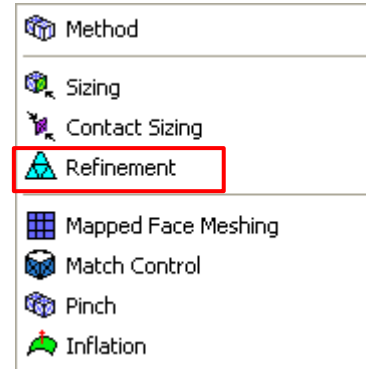
Contact Sizing



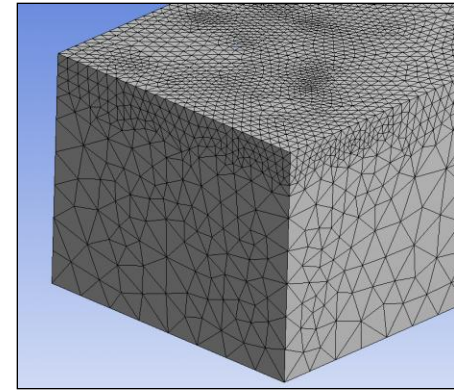
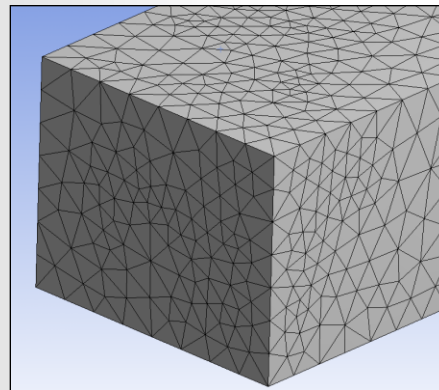
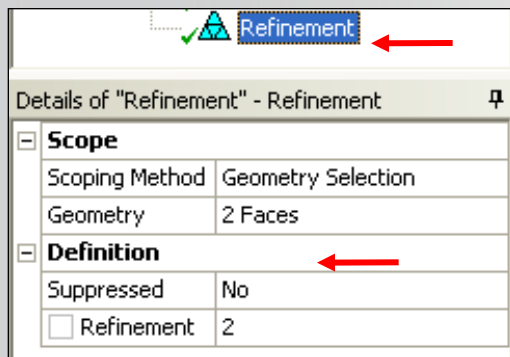
- Note that the mesh is still non-conformal across the contact region
- To insert a Contact Sizing in the Mesh tree select the contact region from Contacts list and drag it to Mesh object, or use RMB on the Mesh



- Valid for only for faces or edges
 - Not available for Patch Independent Tetrahedrons, CutCell, Uniform Uniform Quad meshing methods
- Refinement is applied after the creation of mesh with rest of the settings
- Refinement level can vary from 1 (minimal) to 3 (maximum)
 - A refinement level of “1” breaks up the edges of the elements into half
- The Refinement control may be automatically suppressed when use inflation depending on how the inflation/refinement is used. See the user’s Guide for details



Resultant mesh may be of poor quality



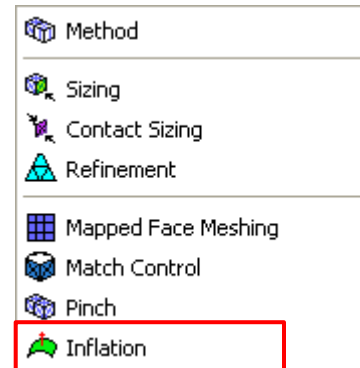
Only the selected face is affected and rest is almost unchanged

Inflation

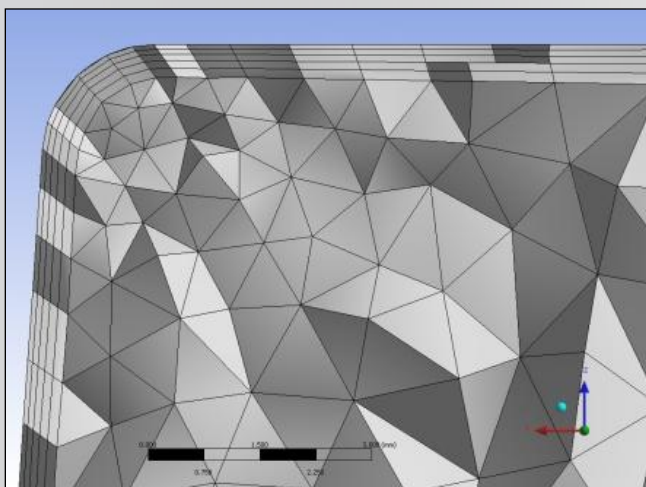
Details of "Inflation" - Inflation	
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Suppressed	No
Boundary Scoping Method	Geometry Selection
Boundary	5 Faces
Inflation Option	Smooth Transition
☐ Transition Ratio	Default (0.272) ←
☐ Maximum Layers	5
☐ Growth Rate	1.2 ←
Inflation Algorithm	Pre

Transition Ratio: Attempts to match the size of last prism layer with that of next Tet cell

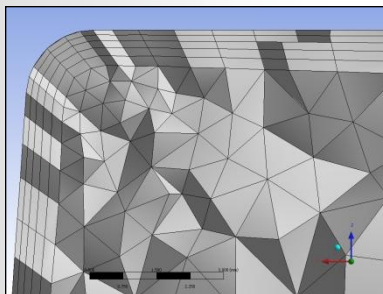
Growth Rate: It determines the relative thickness of adjacent inflation layers



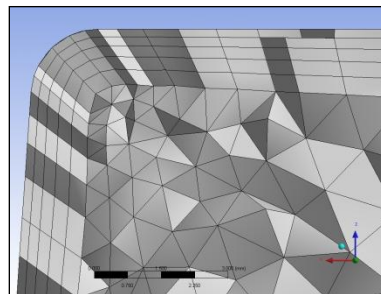
Defaults: Transition Ratio: 0.272
Growth Rate: 1.2



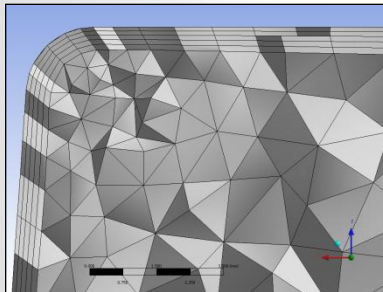
Transition Ratio: 0.5
Growth Rate: 1.2



Transition Ratio: 0.8
Growth Rate: 1.2



Transition Ratio: 0.27
Growth Rate: 1.1



Transition Ratio: 0.27
Growth Rate: 1.4

