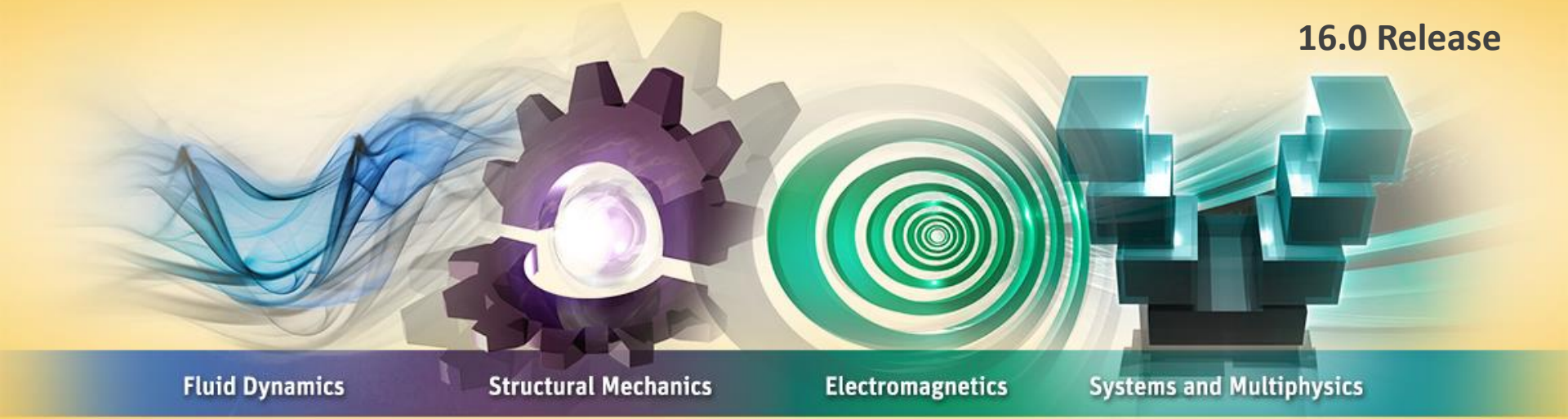
Lecture 6:
Local Mesh Controls

16.0 Release



Introduction to ANSYS Meshing

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Local Mesh Controls

In this lecture we will learn about:

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

Preprocessing Workflow

Import/ Geometry Creation

- Sketches and Planes
- 3D Operations
  - Extrude, Revolve, Sweep, etc
- Geometry Import Options
  - Bi-Directional CAD/ Neutral

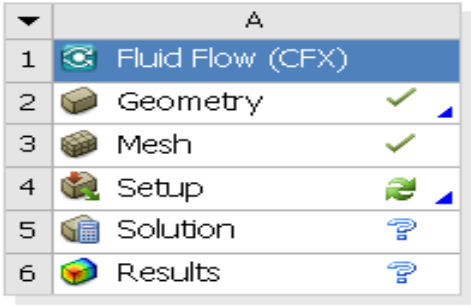
Geometry Modifications

- 3D Operations
  - Booleans, Decompose, etc.
- Geometry Cleanup and Repair
  - Automatic Cleanup
  - Simplification, Mid-surface, Fluid Extraction

Meshing

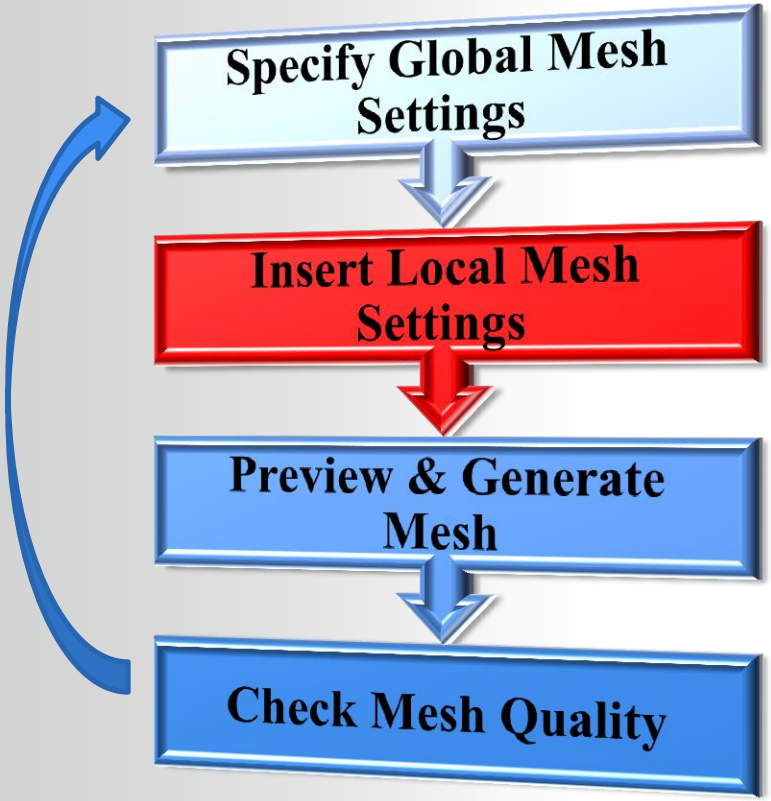
- Meshing Methods
  - Hybrid Mesh: Tet, Prisms, Pyramids
  - Hexa Dominant, Sweep meshing
  - Assembly Meshing
- Global Mesh Settings
- Local Mesh Settings
  - Sizing, Controls, etc.

Solver



Fluid Flow

Meshing Process in ANSYS Meshing



Local Mesh Controls

Control the mesh locally

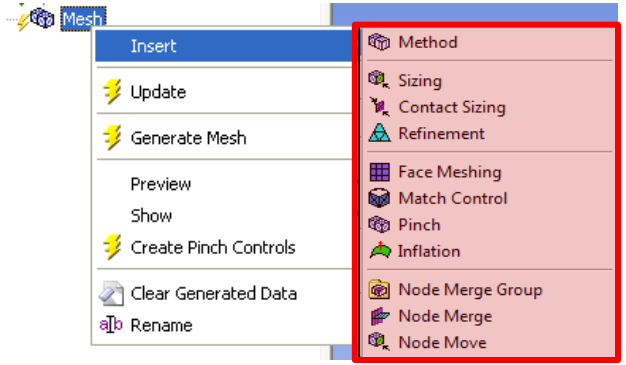
- **Depends on the “Mesh Method” used**

Local Mesh Controls are:

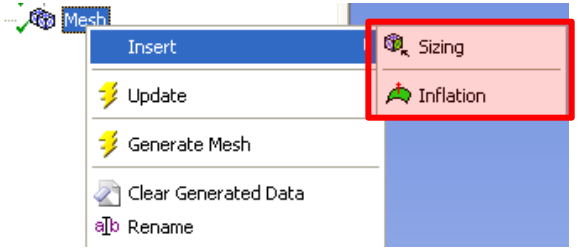
- **Sizing- For Vertex, Edge, Face and Body**
- **Contact Sizing - For Edge and face**
- **Refinement- For Vertex, Edge and Face**
- **Face Meshing - For Mapped or Pave Meshing**
- **Match Control - For Edge and Face**
- **Pinch - For Vertex and Edge**
- **Inflation - For Edge and Face**

Only Sizing and Inflation local controls are available for CutCell meshing

Non-CutCell meshing local controls



CutCell meshing local controls



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

Sizing

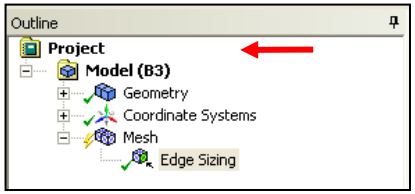
Recommended for locally defining the mesh sizes

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

Only Element Size type is available for CutCell meshing

Advanced Size Function in Global settings should be disabled

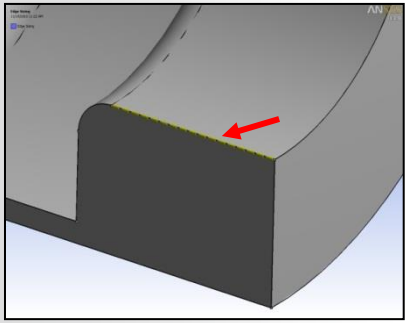
Sizing : Edges

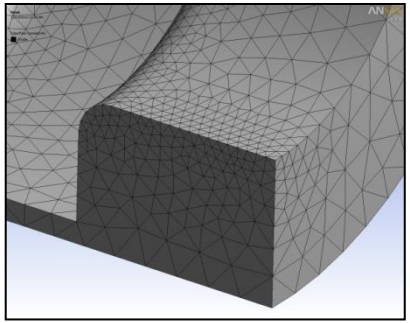
Sizing Type:
Element Size

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

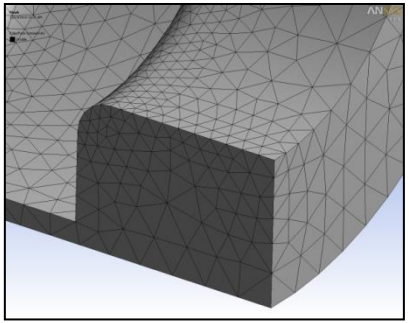
Sizing Type:
Number of Divisions

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 constant element size of 60mm



Edge meshed with 10 elements

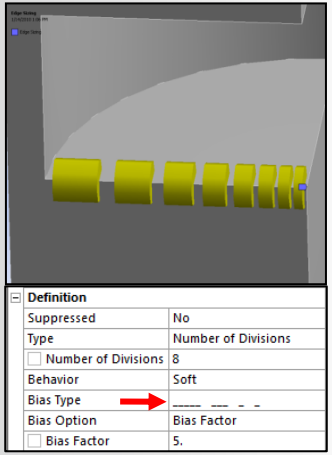
The Curvature Normal Angle and/or the Growth Rate maybe not displayed depending on the ASF used

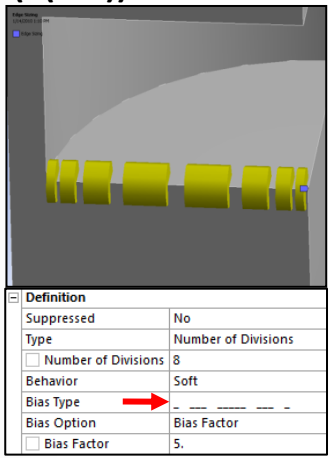
Sizing : Edges

Bias Type and Bias Factor

Specify the grading scheme and factor

- **Bias Type: grading of elements towards one end, both ends, or the center**
- **Bias Option:**
  - **Bias Factor: is the ratio of the largest element to the smallest element**
  - **Smooth Transition: defined by Growth Rate which is ratio of size of an element with size of previous element. (Growth Rate = Bias Factor^(1(n-1))**





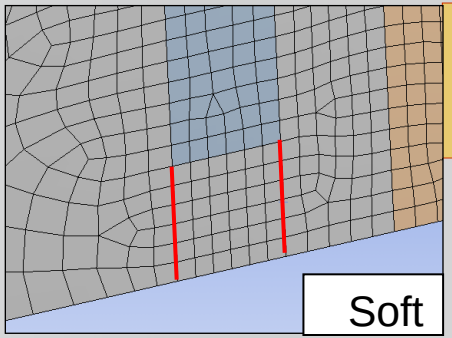
Sizing : Edges

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

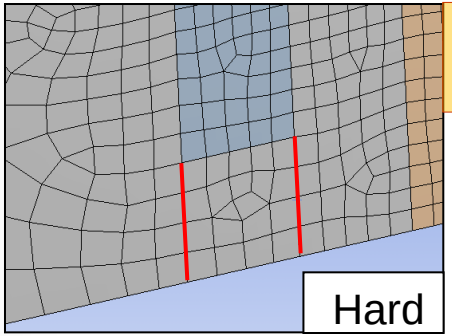
Hard: Size control is strictly adhered to

- *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*



Influenced by global Proximity advanced size function.

Number of Division = 4



No influence from other global settings

Number of Division = 4

Sizing : Faces & Body (volume)

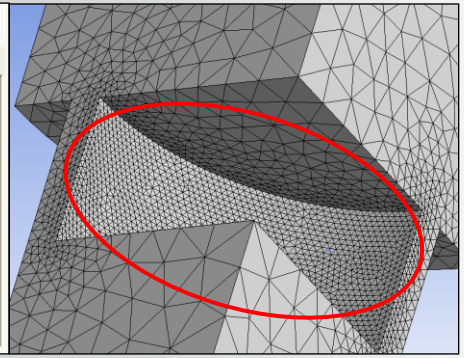
Element Size

Defines the maximum element size on the face

Face Sizing

Details of "Face Sizing" - Sizing

Scope	
Scoping Method	Geometry Selection
Geometry	1 Face
Definition	
Suppressed	No
Type	Element Size
Element Size	0.2 mm
Behavior	Soft
Curvature Normal Angle	Default
Growth Rate	Default



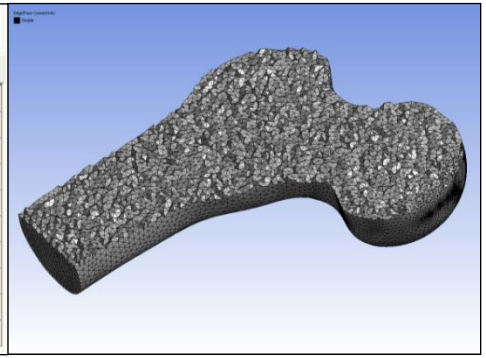
Element Size

Defines the maximum cell size on the Body

Body Sizing

Details of "Body Sizing" - Sizing

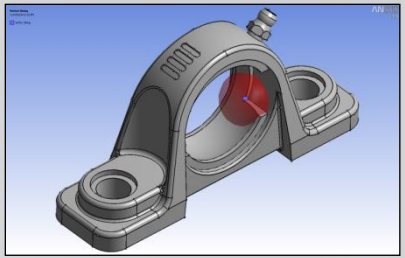
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Suppressed	No
Type	Element Size
Element Size	2. mm
Behavior	Soft
Curvature Normal Angle	Default
Growth Rate	Default

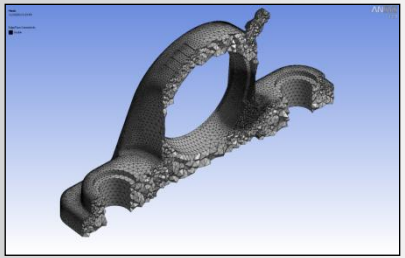


Sizing : Sphere of Influence

On Vertex

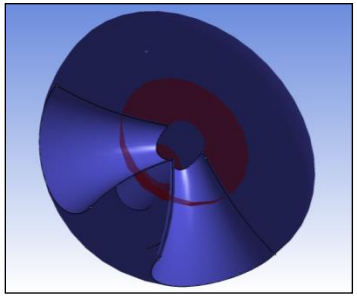
- Available with or without Advanced Size Functions
- Sets the average element size around the selected vertex
- Inputs:
  - Sphere radius and Element size
  - Center of the sphere is defined by a model vertex

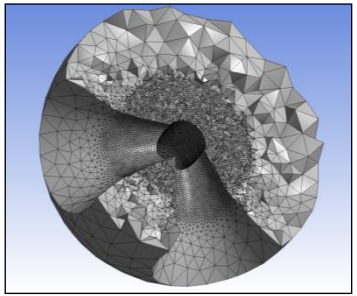




On Bodies

- 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

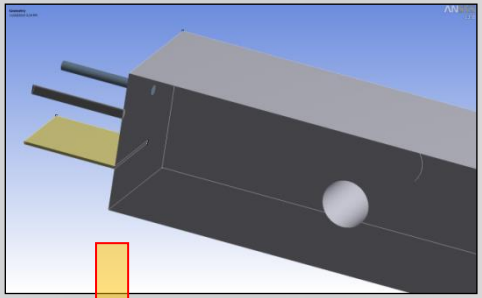


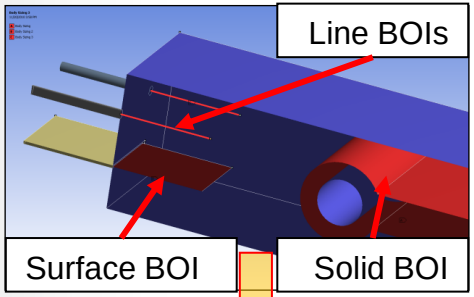


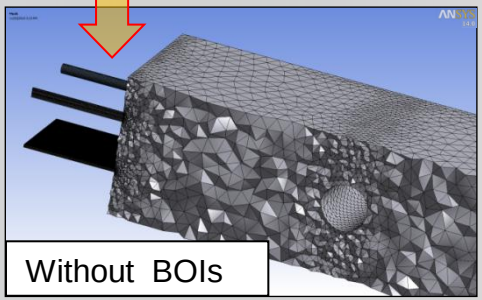
Sizing : Bodies of Influence

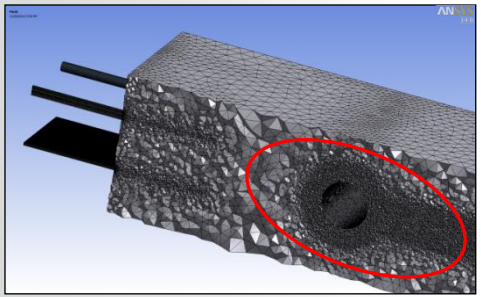
Bodies of influence (BOI)

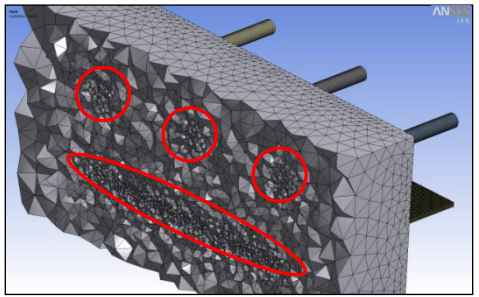
- **Lines, surfaces and solid bodies can be used to refine the mesh**
- **Accessible when ASF is On**
- **Not available for CutCell meshing**







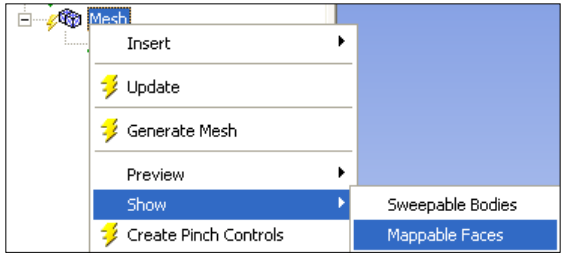




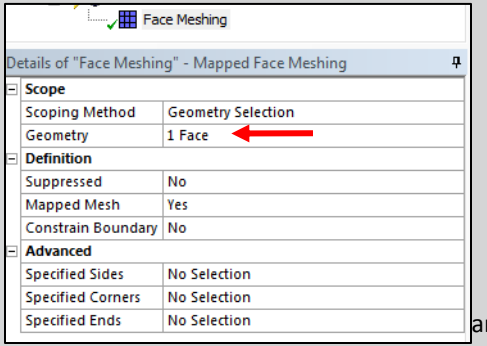
The 'Body of Influence' itself will not be meshed

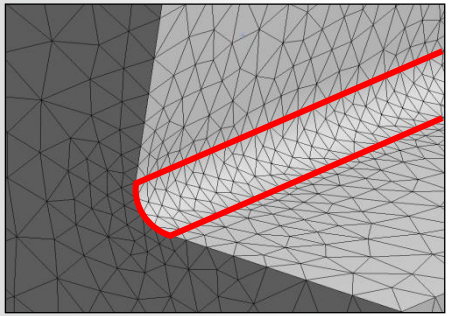
Face Meshing Control

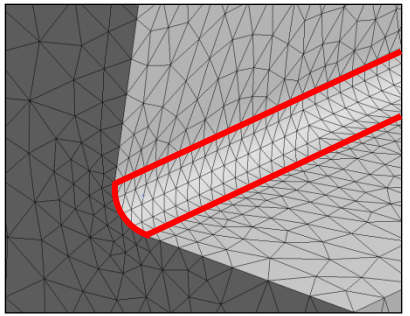
- **Forces Mapped/Pave meshes on selected mappable surfaces**
  - **Face Meshing with advanced control is supported for**
    - **Sweep, Patch Conforming, Hexa Dominant**
    - **Quad Dominant and Triangles**
    - **MultiZone**
    - **Uniform Quad/Tri and Uniform Quad**
  - **RMB on Mesh and Show/Mappable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



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

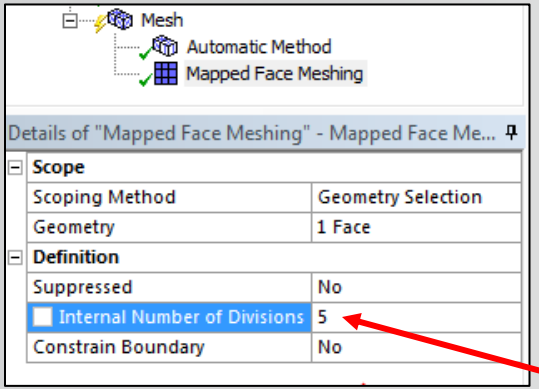


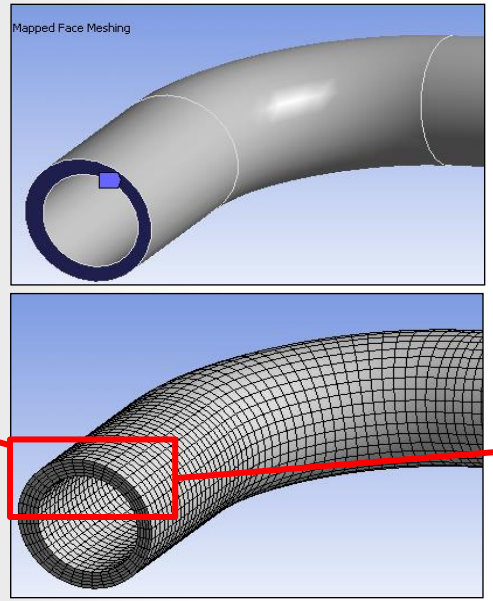




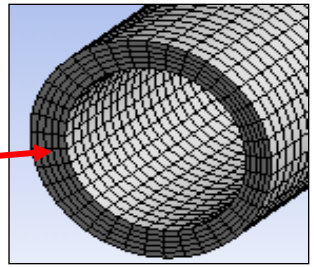
Face Meshing: Internal No. of Divisions

- If face is defined by two loops, then the “Internal Number of Divisions” field is activated
  - User can specify the number of divisions across the annular region
  - Also useful for defining number of divisions along sweeping direction for Multizone when there are no side edges



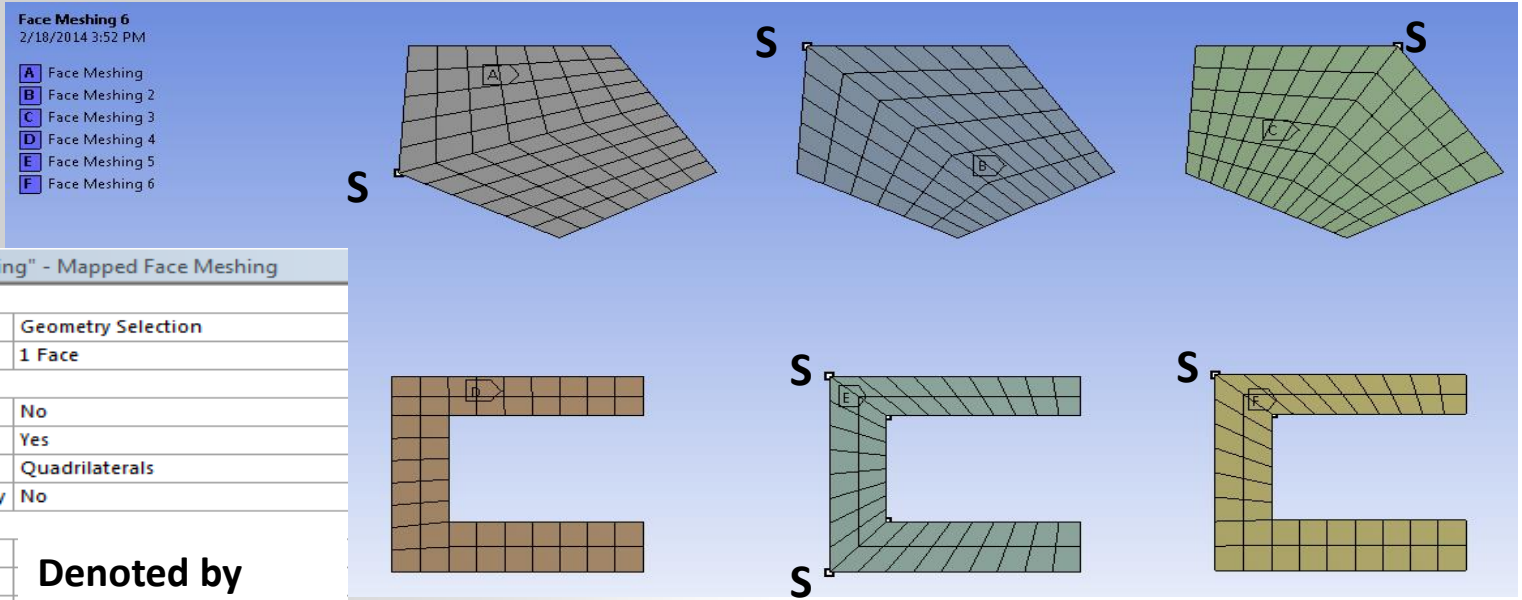


Mapped face is swept to create pure hex mesh



Face Mesh Control: Advanced Vertex options

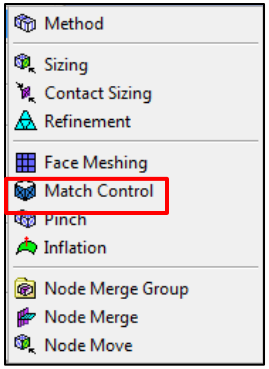
- **Sweep/MultiZone (2D and 3D) support for Advanced Vertex options on Face meshing**



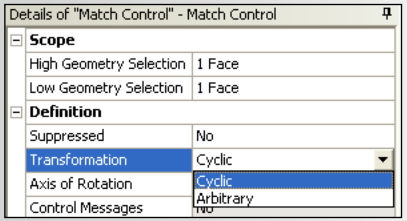
Details of "Face Meshing" - Mapped Face Meshing	
Scope	
Scoping	Geometry Selection
Geometry	1 Face
Definition	
Suppressed	No
Mapped Mesh	Yes
Method	Quadrilaterals
Constrain Boundary	No
Advanced	
Specified Sides	
Specified Corners	
Specified Ends	

Denoted by S, C or E

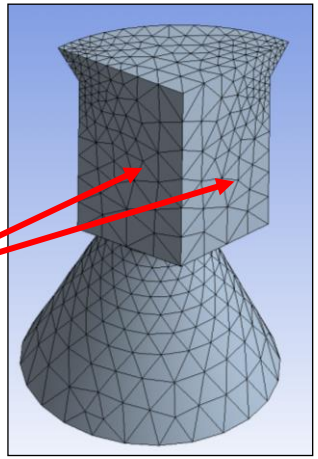
Match Control



- **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

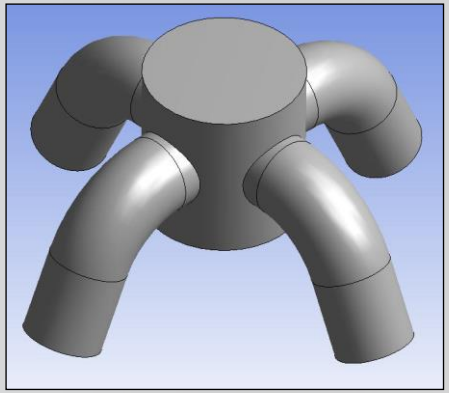


If 'Match Control' fails, (⛔) icon appears adjacent to corresponding object in the outline Tree, however the mesh is created ignoring it

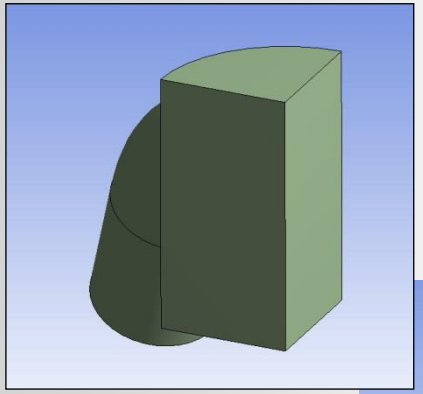
Match Control: Cyclic

- **Define Rotational periodic**

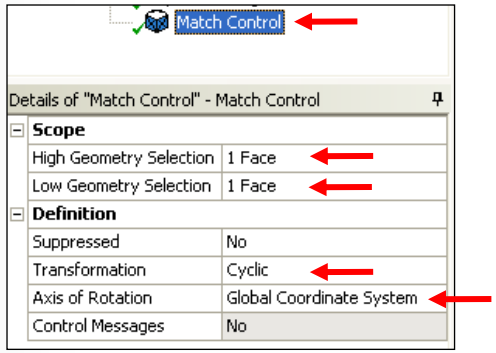
Full Model

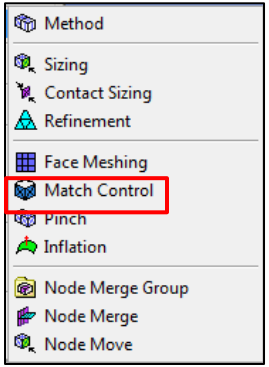


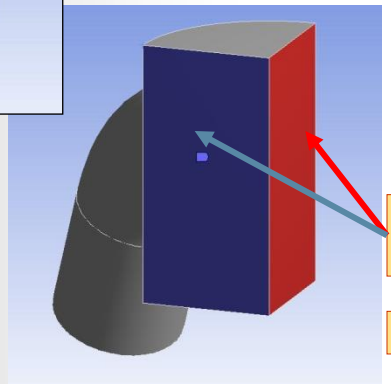
Periodic Model



Model is symmetrical at 90°

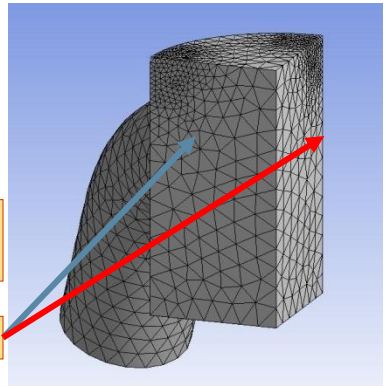






Selected Faces for Match control

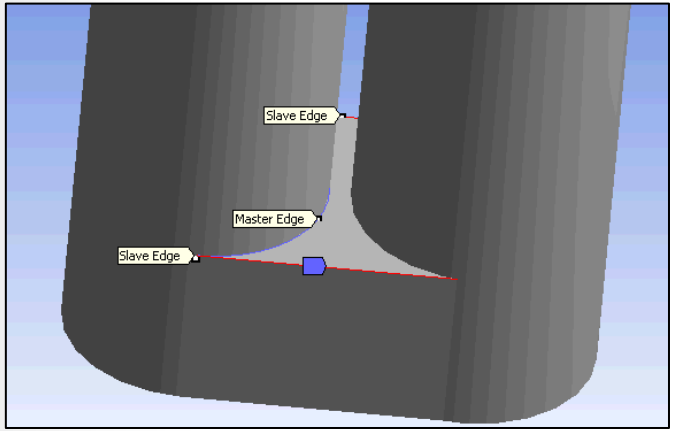
Matching face mesh

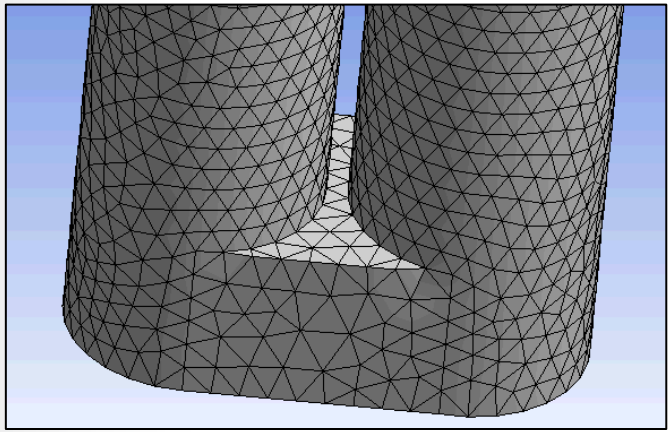


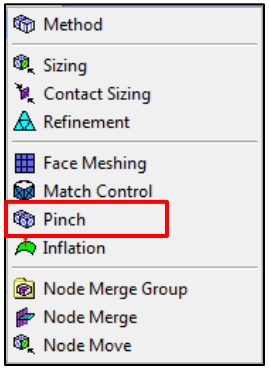
Pinch

- 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



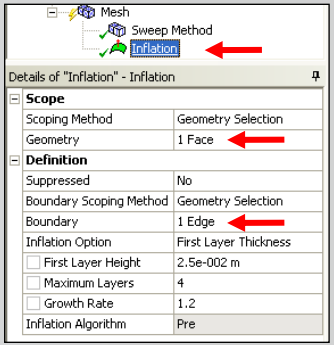


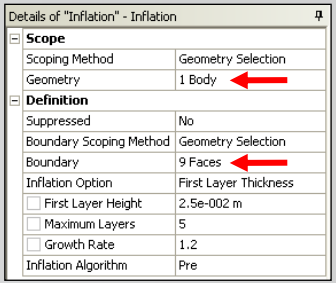


Inflation

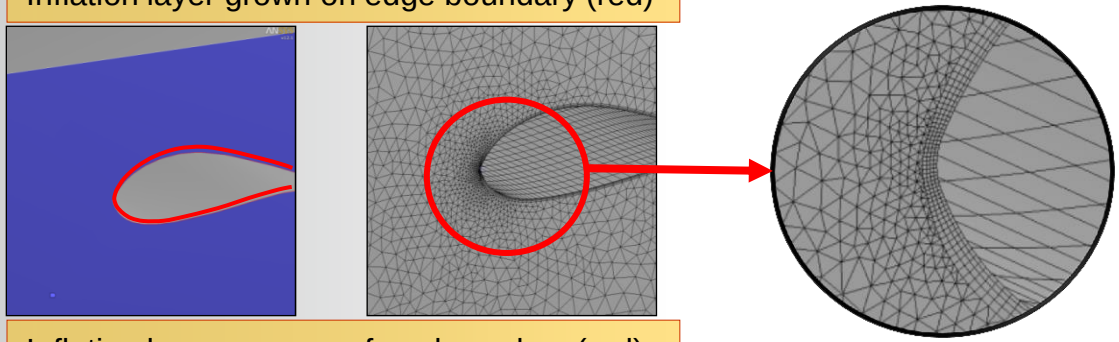
Used to generate prism layers (as explained in Global settings chapter)

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

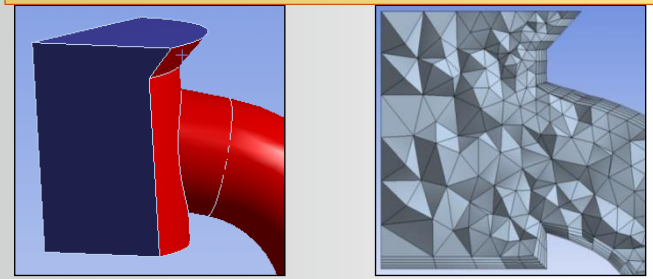


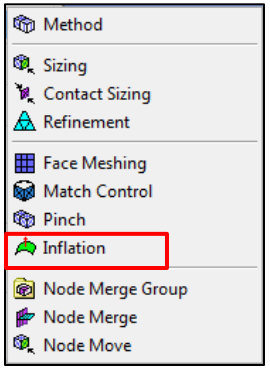


Inflation layer grown on edge boundary (red)



Inflation layer grown on face boundary (red)





Summary

What have we learnt in this session:

- How local mesh controls allow more control over meshes
- Different types of Sizing Controls
- Mapped Meshing Controls
- Periodic Meshes Matching
- Local Prism Controls

Workshop 6.1 – Local Mesh Controls