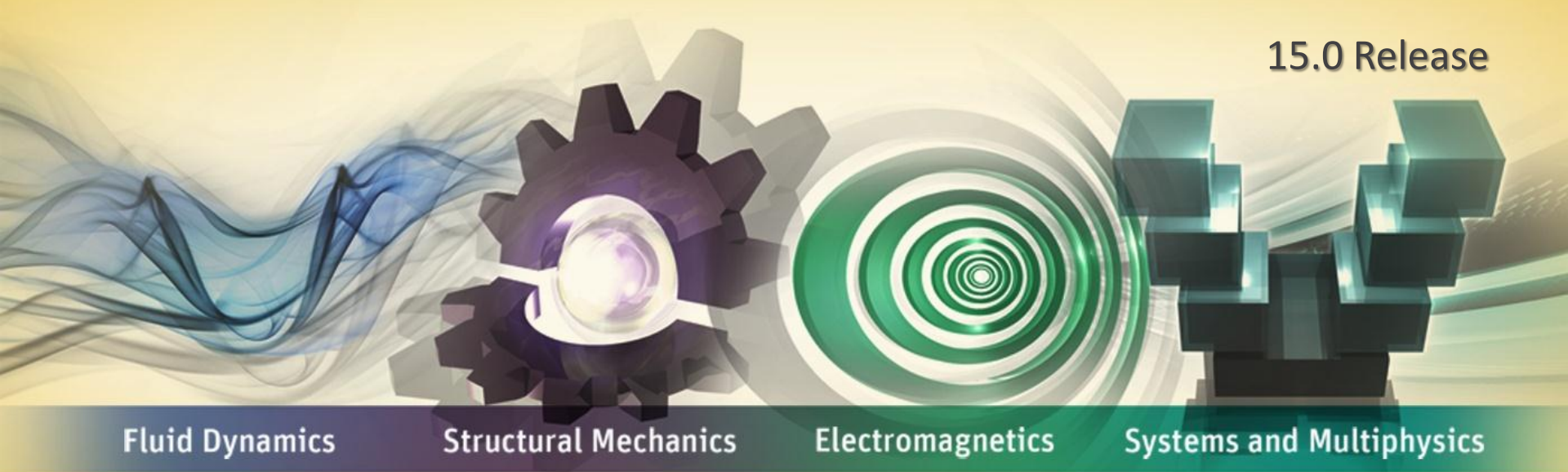


Workshop 8.2

3D Pipe Junction

15.0 Release

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

Fluid Dynamics

Structural Mechanics

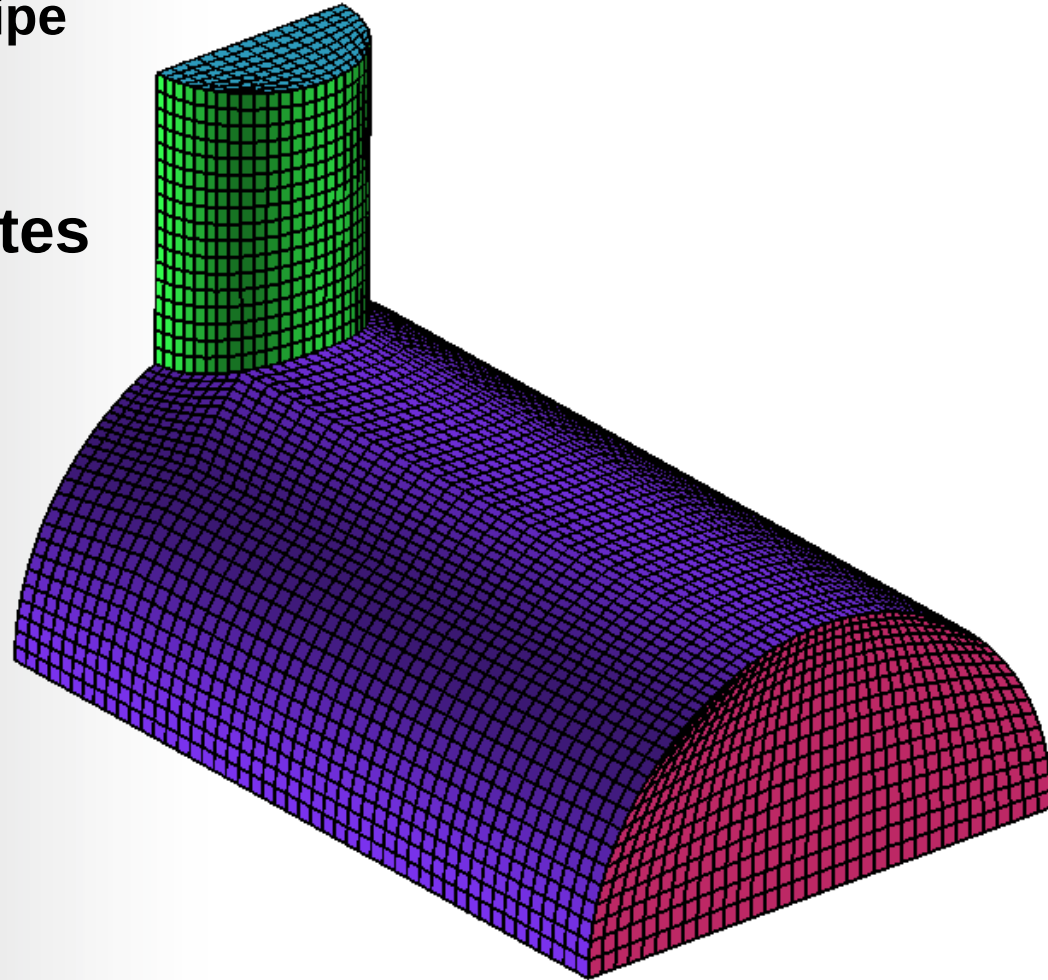
Electromagnetics

Systems and Multiphysics

Introduction to ANSYS

ICEM CFD

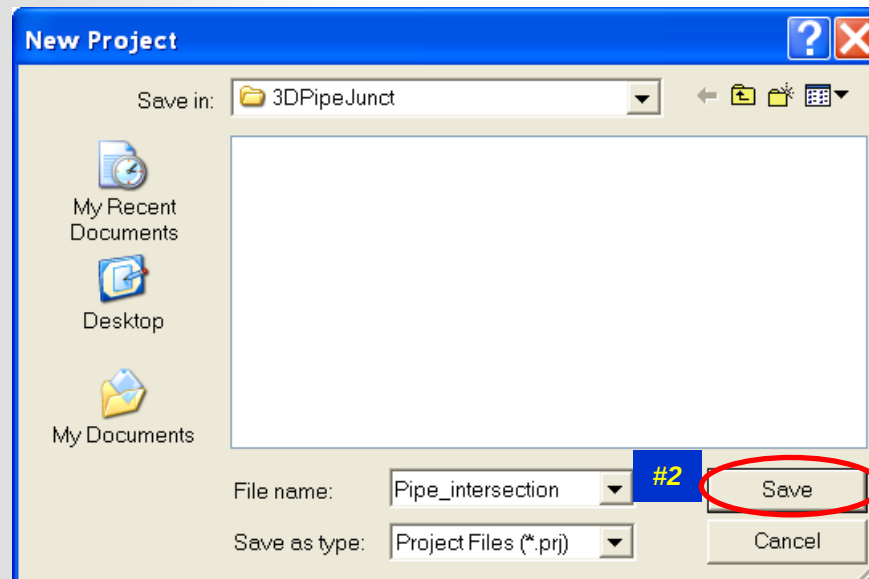
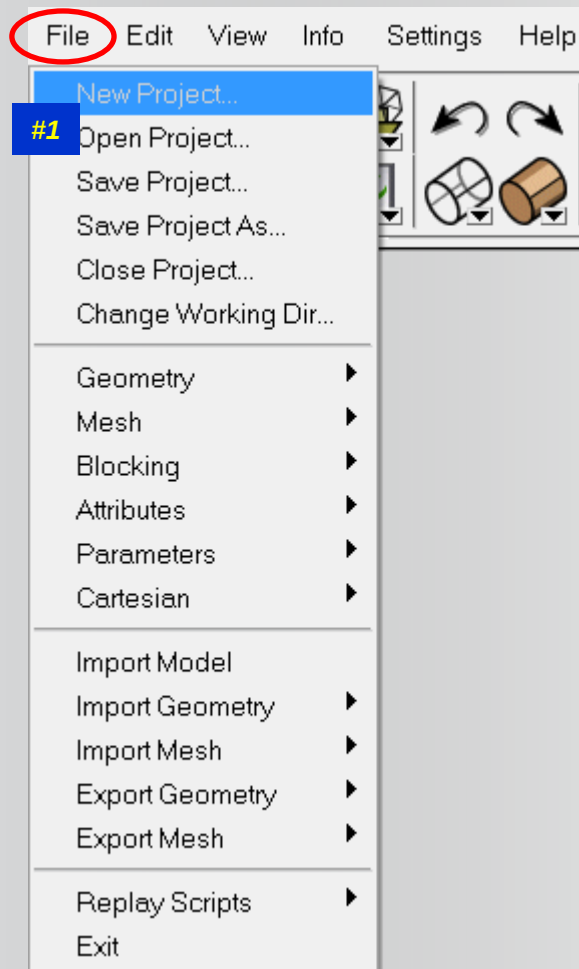
- **3D Pipe Junction**
 - This is a simple 4-way pipe intersection with two symmetry cuts
- **This tutorial demonstrates**
 - Parasolid import
 - Basic blocking process
 - Structuring blocking
 - Index control
 - Setting mesh sizes
 - Scaling mesh sizes



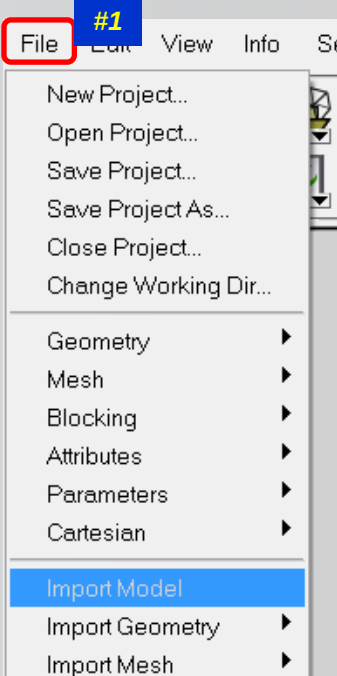
Create New Project

■ *File > New Project*

- Browse to the **3DPipeJunct** folder
- Type any new project name, **Save**
- Opening a project or setting a new project will also change the working directory
- No files are actually written until the project is saved

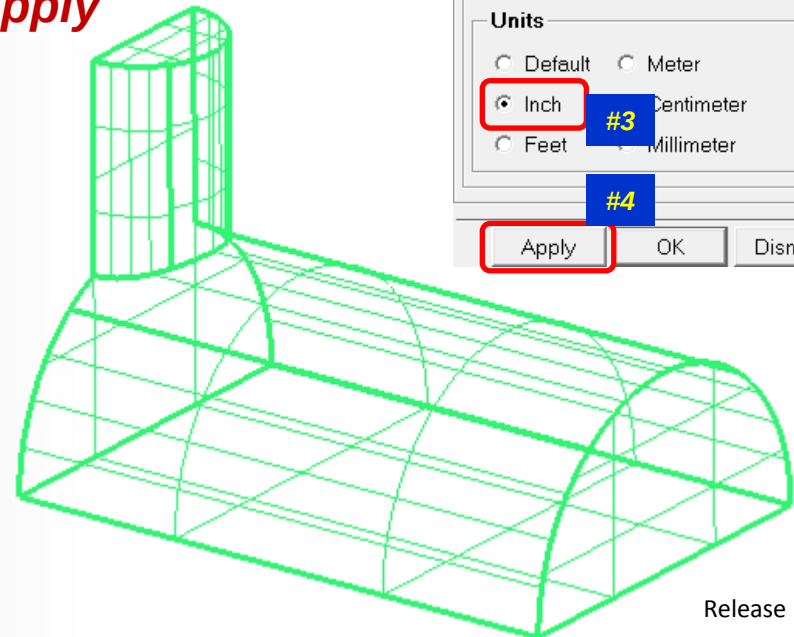
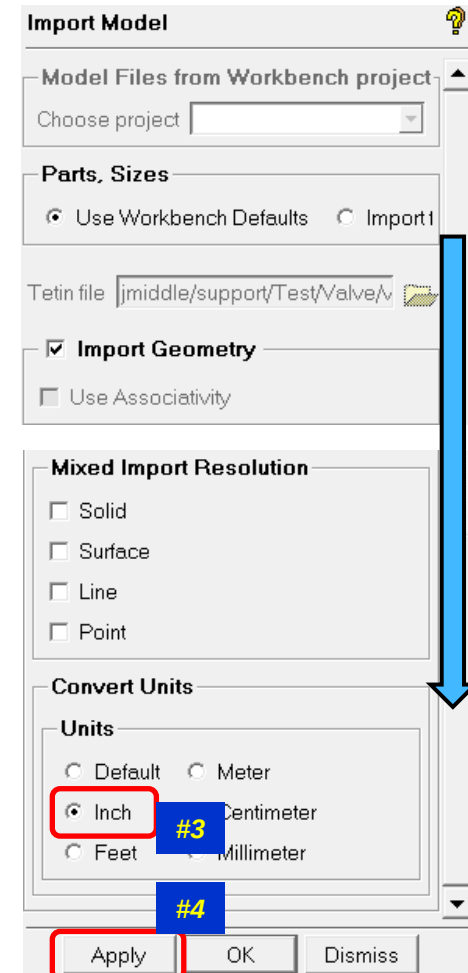
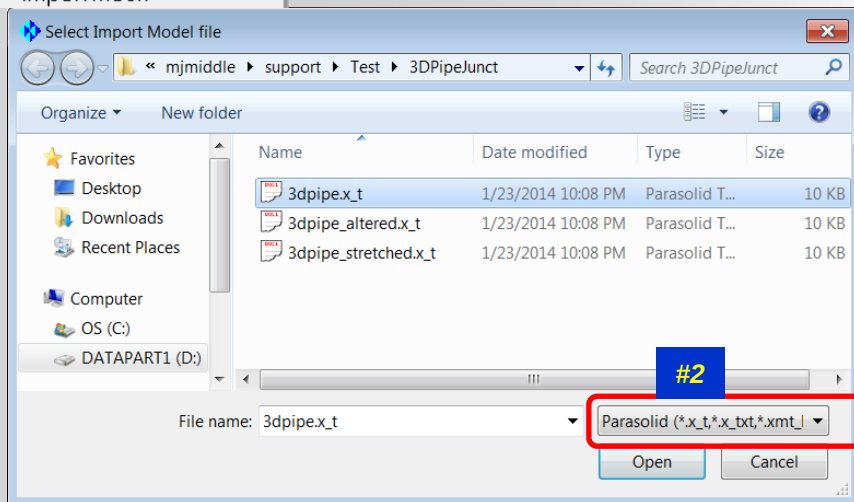


Open Geometry

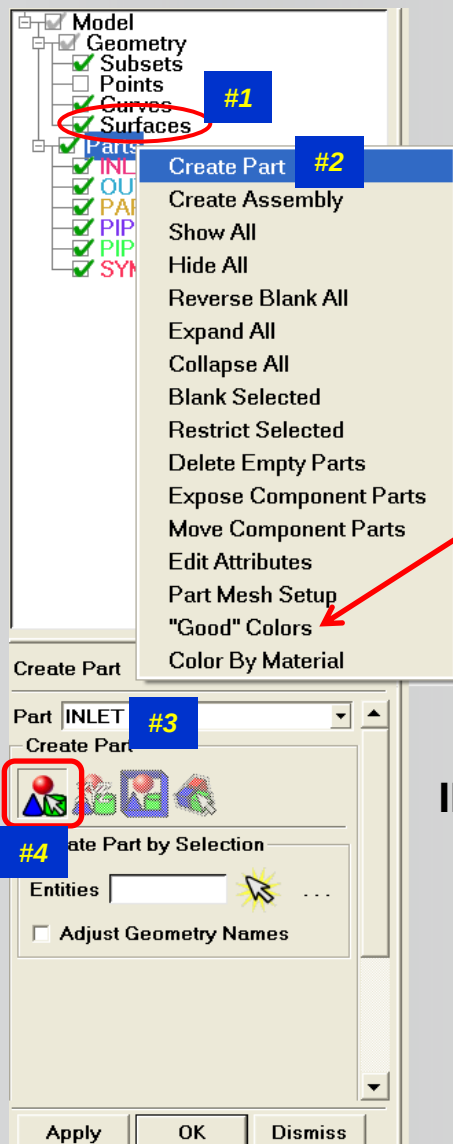


File > Import Model

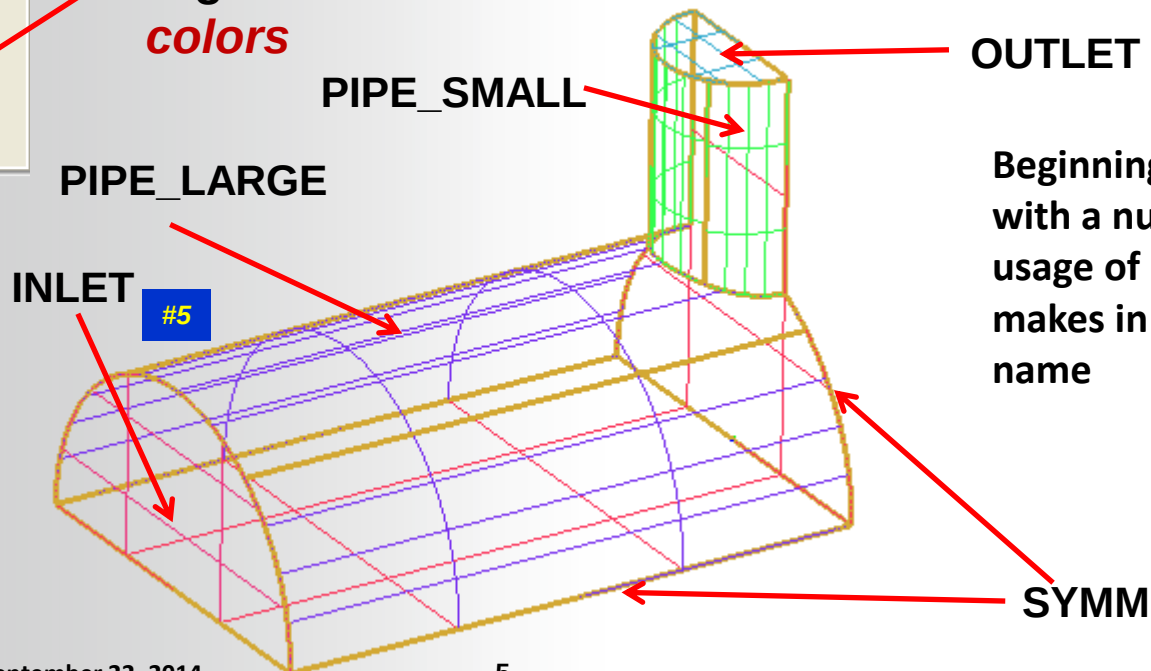
- Set the filter to **Parasolid** (*.x_t,*.x_txt,*.xmt_b,*.xmt_bin...)
- Select **3dpipe.x_t, Open**
- Although ICEM CFD has no units, parasolid files are always in meters, so the model dimensions need to be scaled back to the CAD units, or use transform  , scale  later
- Select **inch**, then **Apply**



Part Creation



- Turn on **Geometry > Surfaces** in the model tree
- Right-click on **Parts** in the tree and select **Create Part**
- Enter **INLET** as the **Part** name
- Select **Create Part by Selection** 
 - Select  the surface at the end of the large half-tube and middle click to accept
- Repeat for the other parts as shown
- Right-click on **Parts** in the tree and select **"Good" colors**



Beginning a part name with a number or the usage of most symbols makes an invalid part name



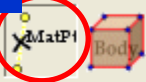
#1

Create Body

Part FLUID_MATL

#3

#2



#4

Centroid of 2 points

At specified point

2 screen locations

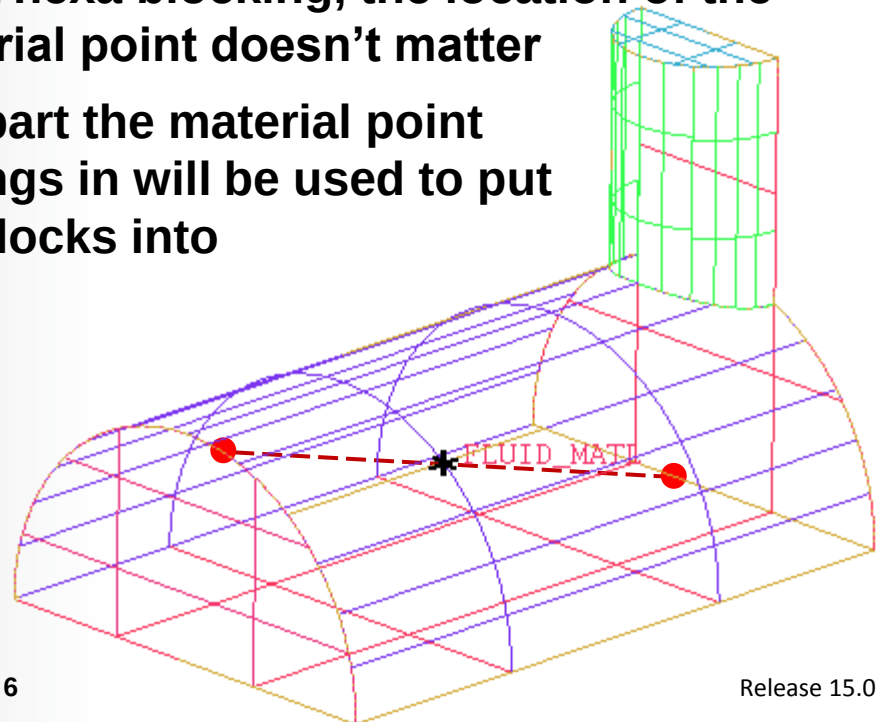
#5

Apply

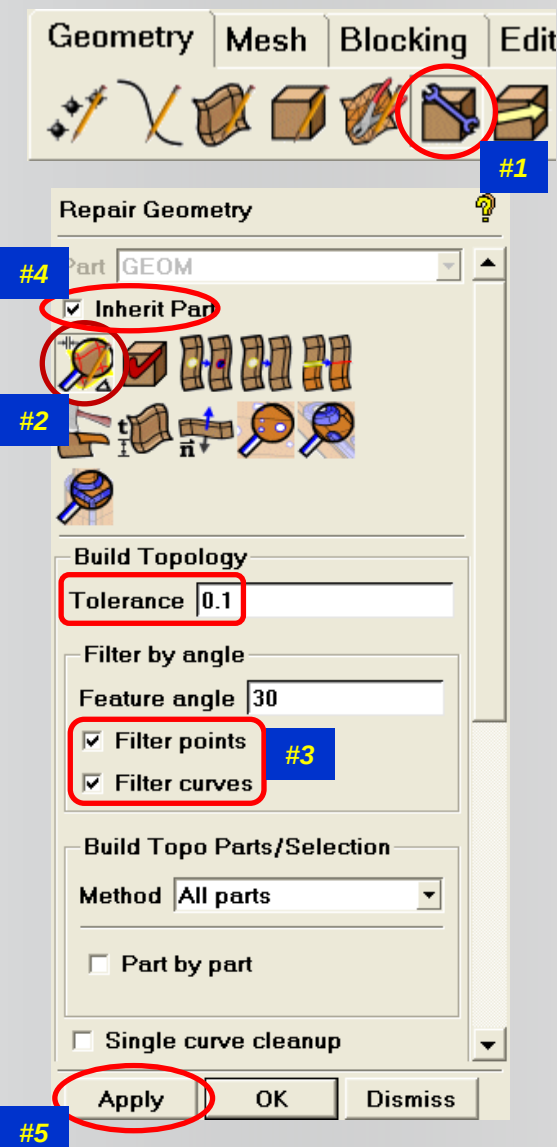
OK

Dismiss

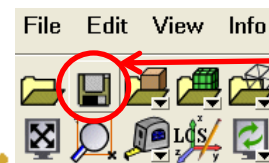
- **Geometry > Create Body > Material Point**
 - Type **FLUID_MATL** for the **Part**
 - **Location** should be **Centroid of 2 points**
 - Press the **Select Location(s)** button  and select two points so that the center of the two points will be inside the model, then middle mouse click once to apply, and another time to exit selection
- For a hexa blocking, the location of the material point doesn't matter
- The part the material point belongs in will be used to put the blocks into



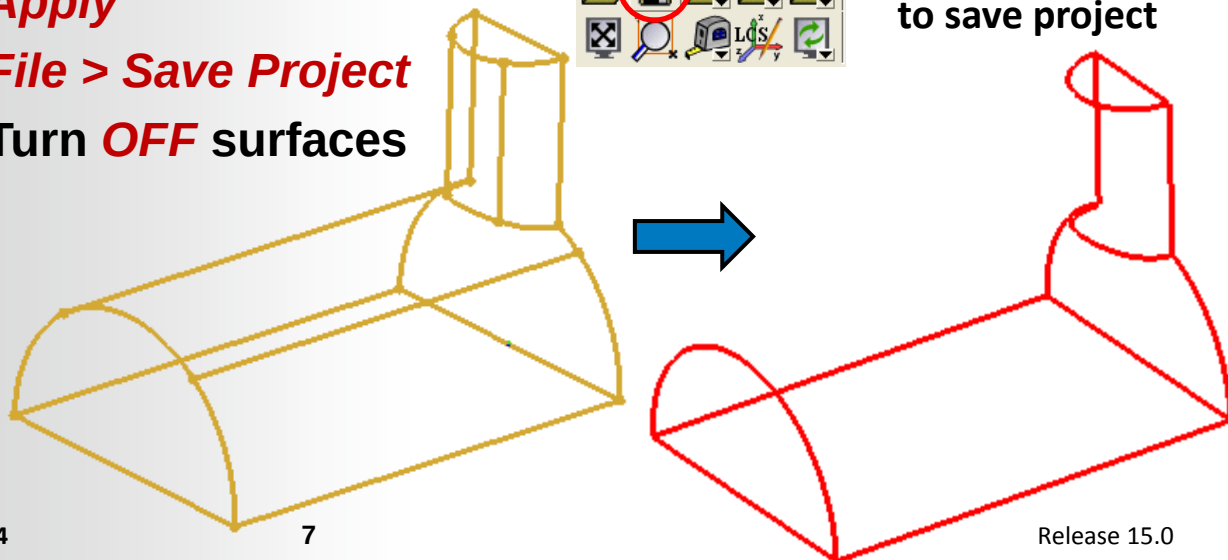
Build Topology



- **Geometry > Repair Geometry > Build Diagnostic Topology**
- Use the default tolerance of 0.1
 - Default tolerance = (diagonal of the bounding box) / 2500
 - Good for most models, but models with small features relative to the overall space of the model will need a lower tolerance
- Turn ON **Filter points** and **Filter curves**
 - Leaves only curves and points at sharper angles (> 30°)
- Turn ON **Inherit Part**
- **Apply**
- **File > Save Project**
- Turn OFF surfaces

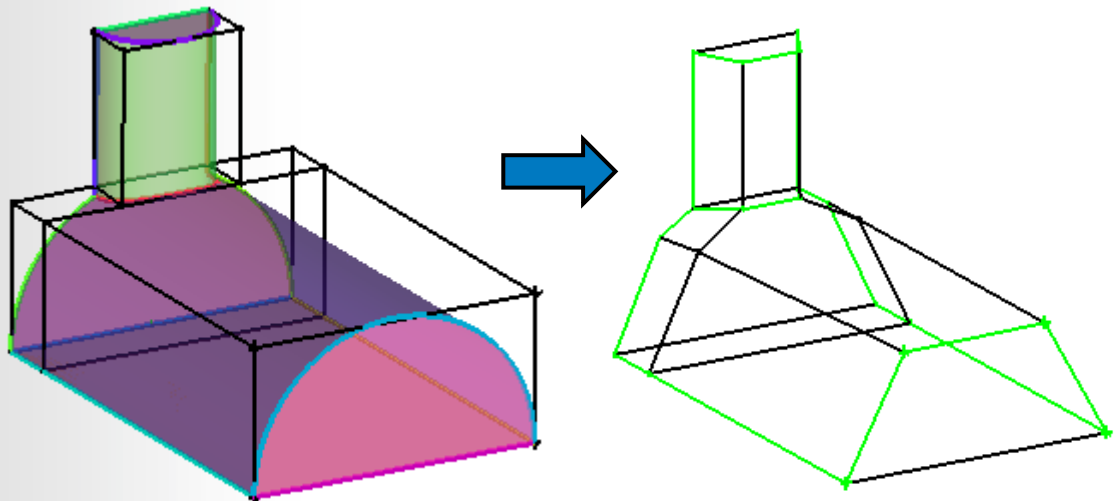
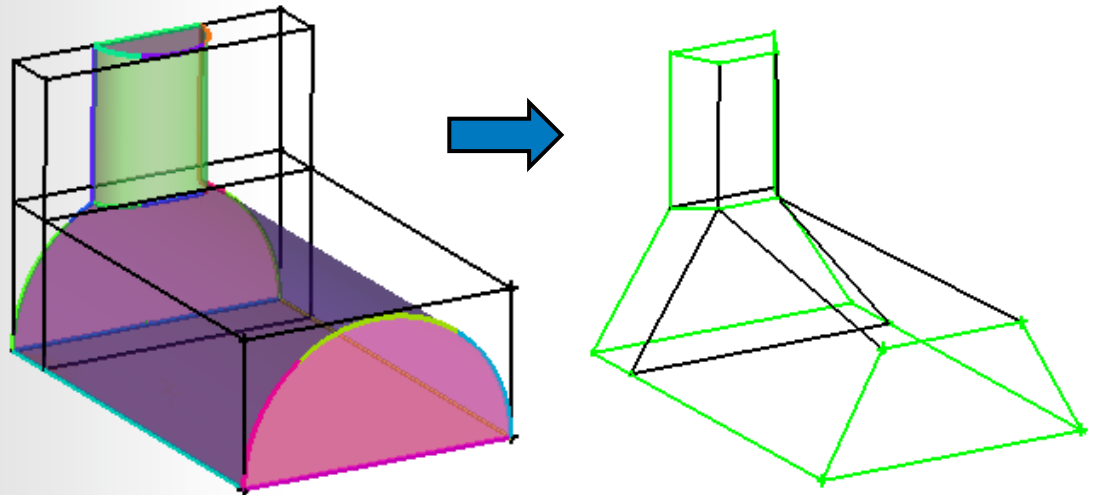


Or use quick icon to save project

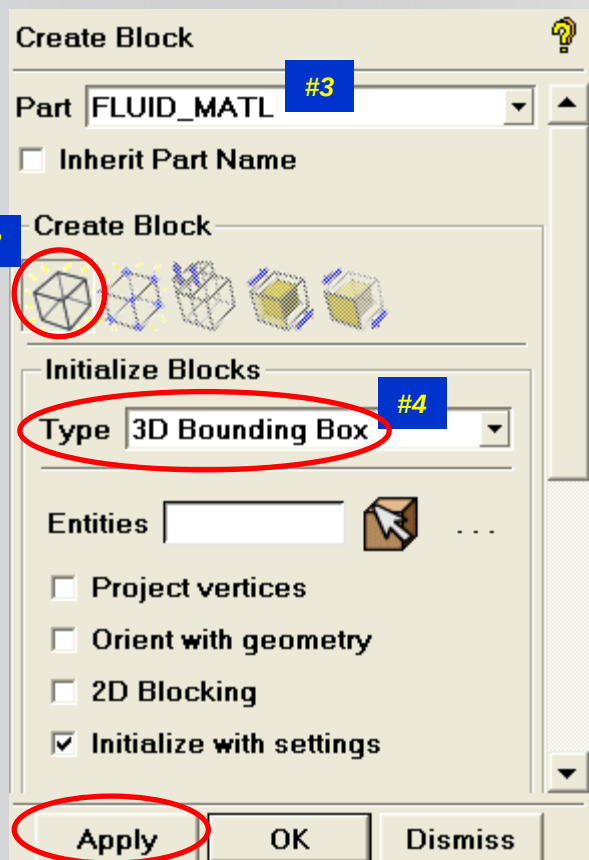
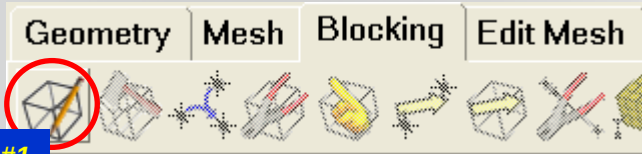


Decide on Topology

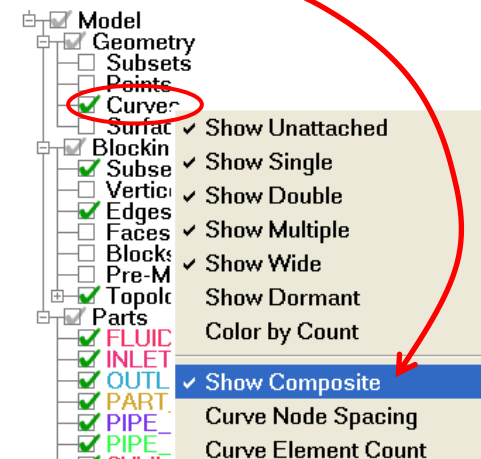
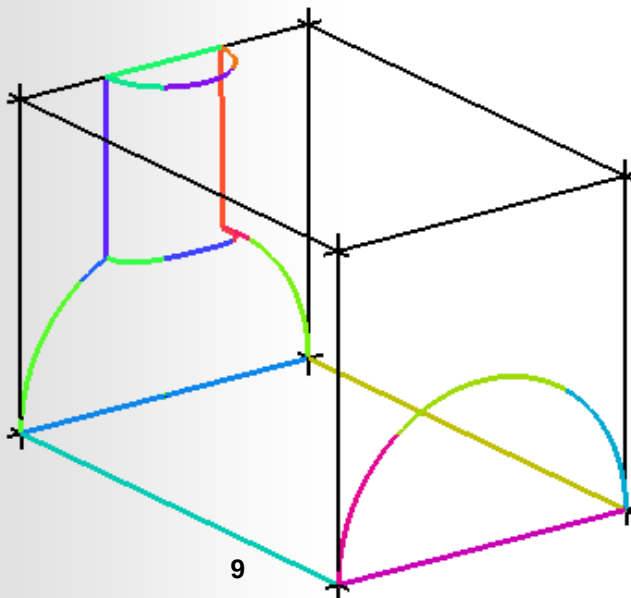
- A couple topologies will work well on this model
- Both are a basic “L” shape
- We’ll use the second one since mesh distributions are a little more uniform, and element angles are a little bit better



Initialize Blocking



- Select **Blocking > Create Block > Initialize Blocks**
- Select **FLUID_MATL** for the Part from the pulldown
- Set **Type** to **3D Bounding Box**
- **Apply**
 - With no geometry selected, the initial block will be around all geometry
 - Curves automatically change color to allow you to see where the ends of curves are
 - This curve color coding can be turned ON/OFF any time with **Curves > Show Composite** in the tree



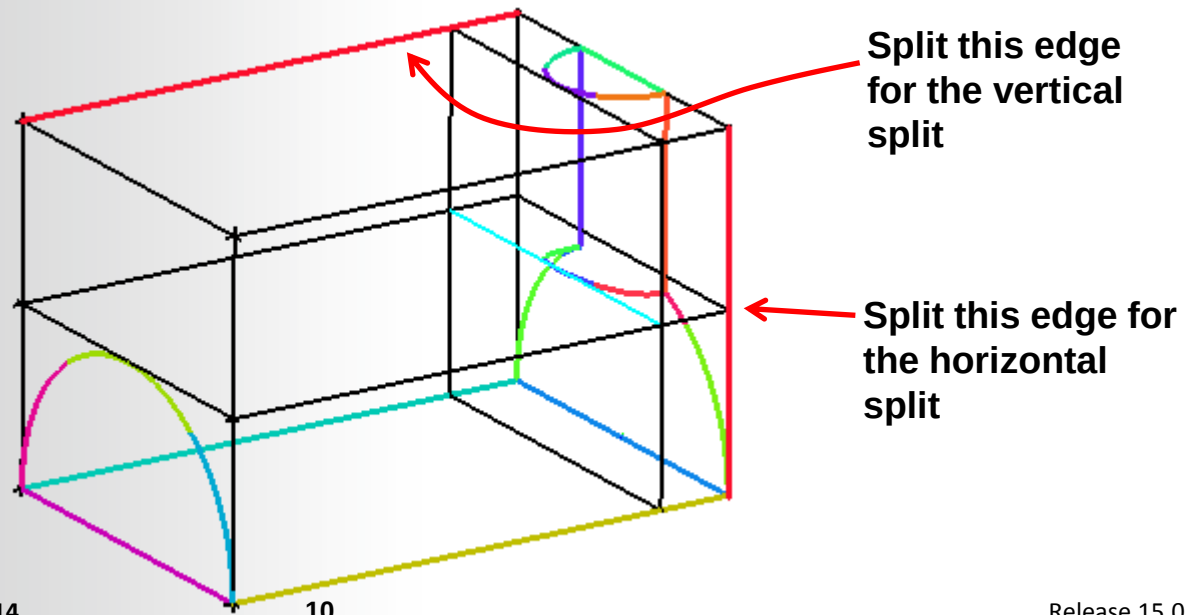
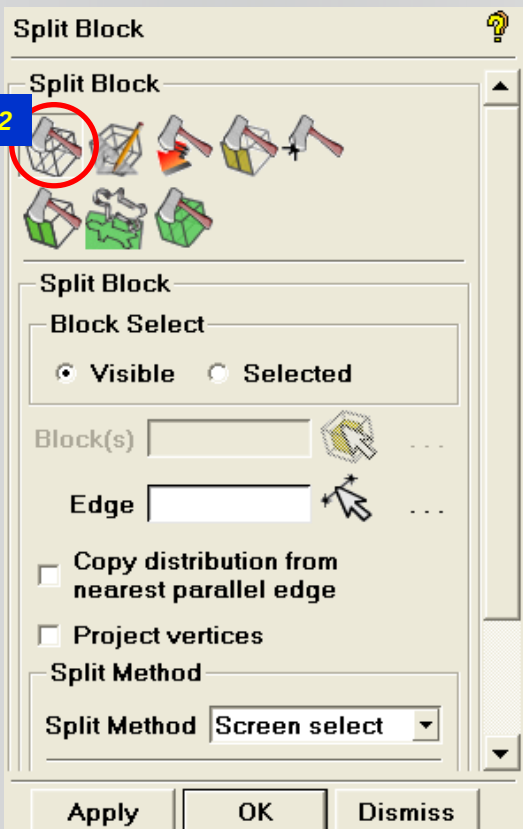
Split Blocks to Create Topology

- Select **Blocking > Split Block > Split Block**

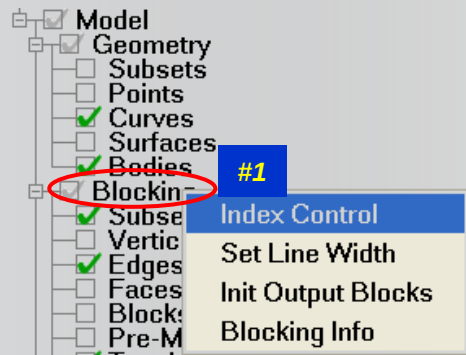
- Press the **Select edge(s)** button 
- Left click on the edge to split
- The new edge will be normal to the edge that you select
- Hold the left mouse button and drag the split to the desired location
- Middle mouse to complete or **Apply**
- Make one vertical split and one horizontal split as shown
- Middle click when done to exit selection



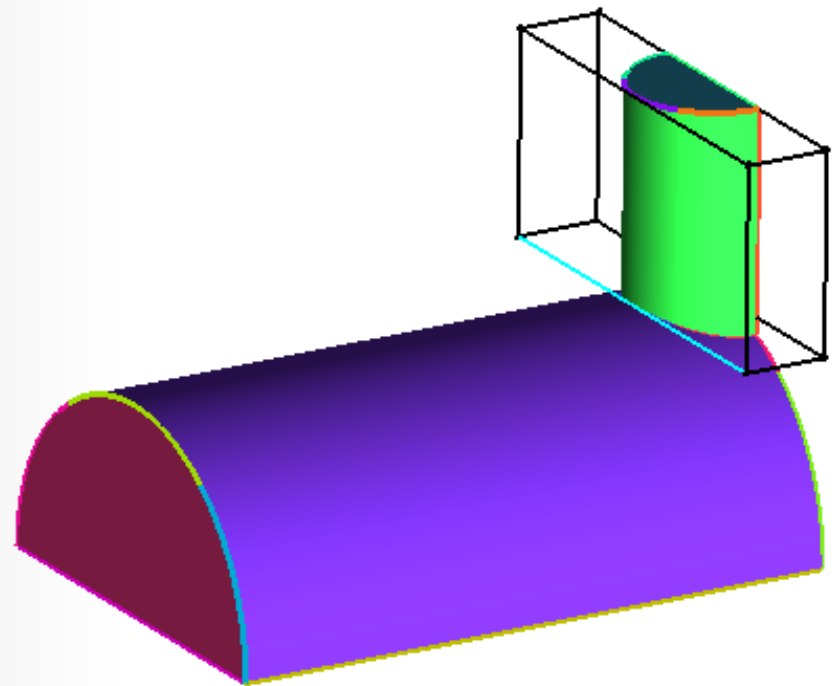
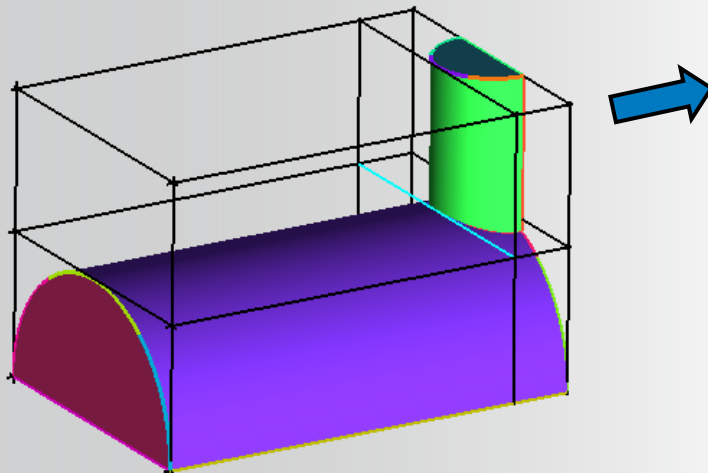
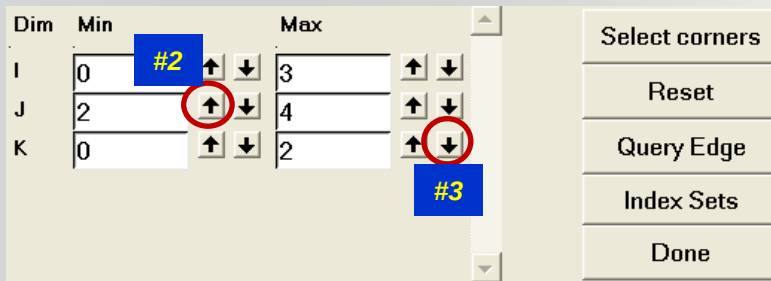
#1



Index Control



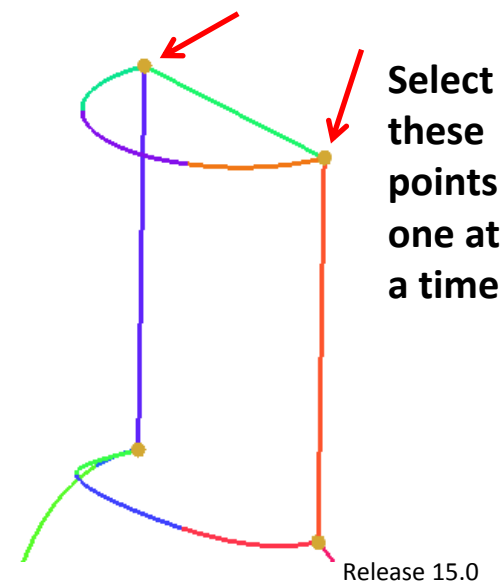
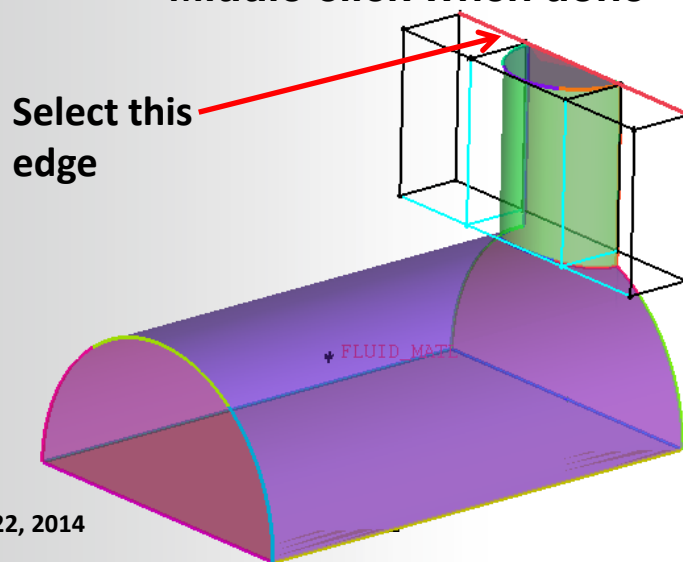
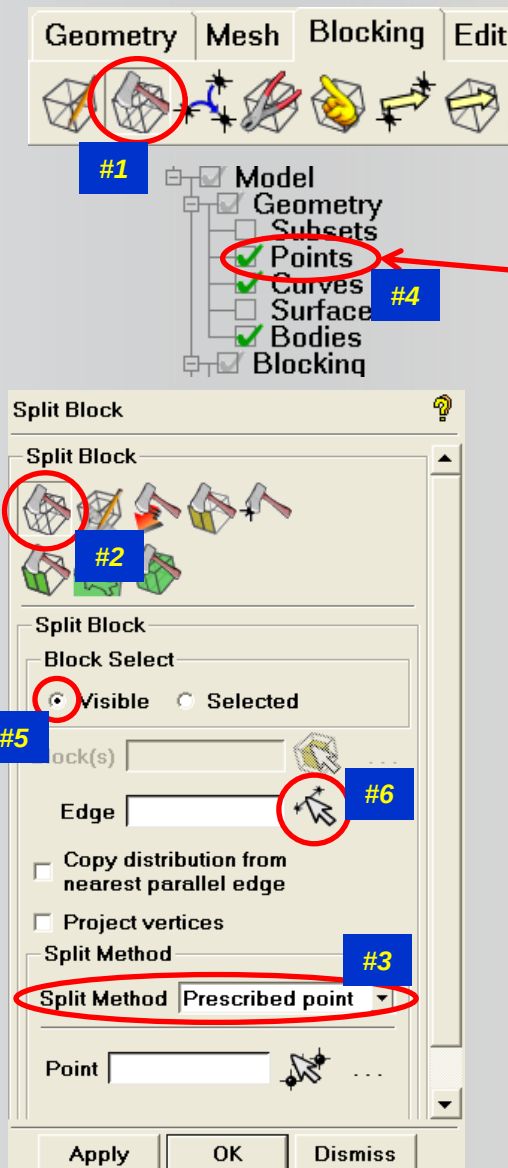
- Right click in model tree on **Blocking > Index Control**
 - Set **J** from 2 to 4 using the up arrow key ↑
 - Set **K** from 0 to 2 using the down arrow key ↓
- Some operations, like split block, can work on only the visible blocks



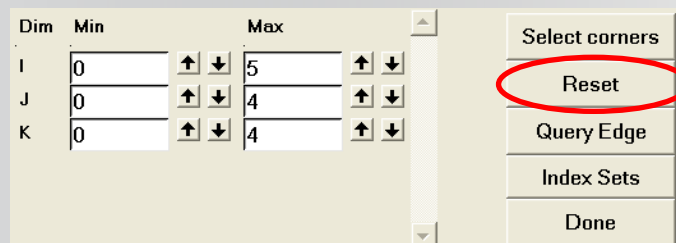
Split Visible Blocks

■ **Blocking > Split Block > Split Block**

- We'll split a little differently, just to give you experience with another feature
- Set the **Split Method** to **Prescribed point**
- Turn on **Points** in the model tree
- Set **Block Select** to **Visible** (default)
- Press the **Select edge(s)** button  and select the red edge shown below
- Then select one of the points shown below 
- Repeat with the other point for the second split
- Middle click when done



Delete Blocks



- First press **Reset** in the index control

- This resets indices to show the whole blocking
- Notice how the previous block splits do not go through the entire blocking

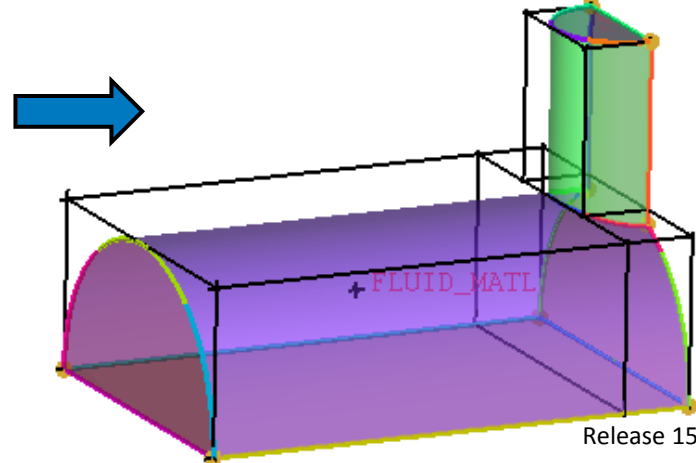
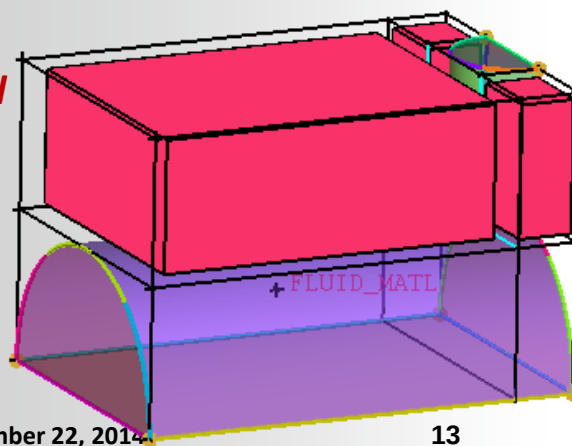
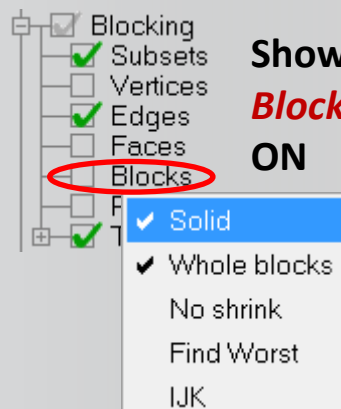


- Blocking > Delete Block**

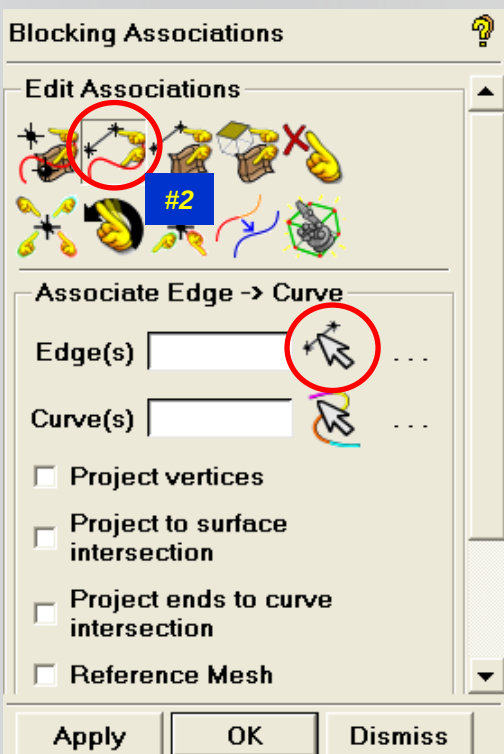
- Make sure **Delete permanently** is OFF
- With **Delete permanently** off, the block will be moved to the reserved part **VORFN**
- This is better for keeping a simple and stable index scheme, and allows the block to be moved out of **VORFN** at a later time
- Select the 3 blocks shown below, then middle click once to apply, and again to exit selection



Shown with
Blocks > Solid
ON

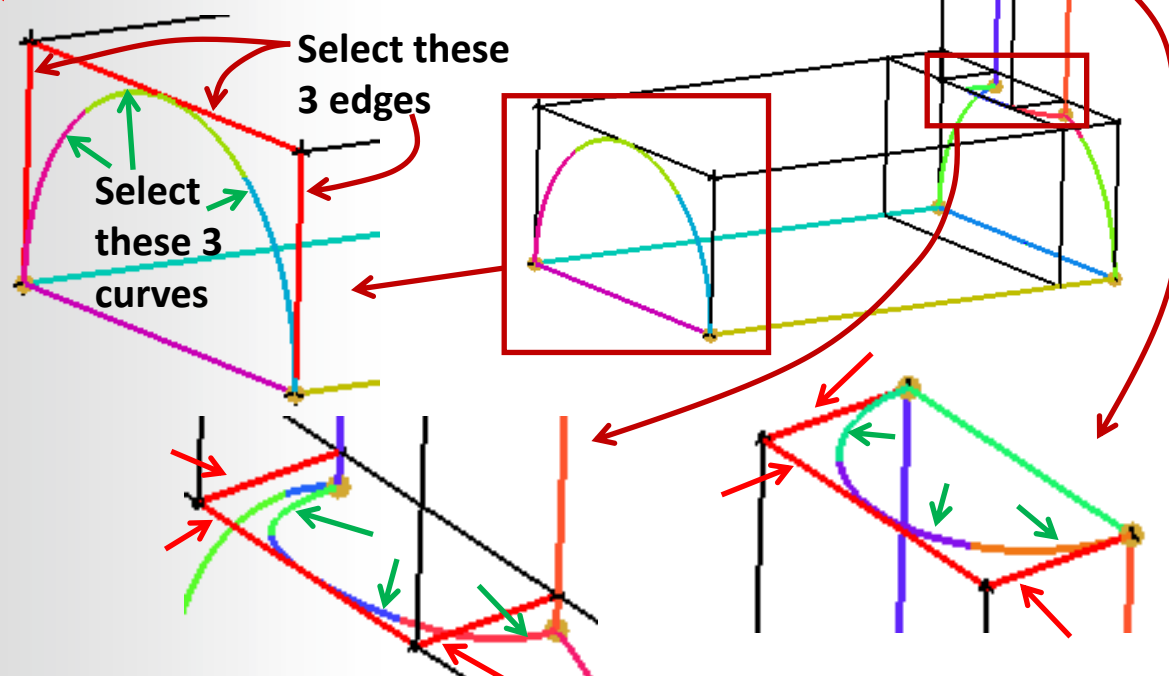


Associate Edges to Curves



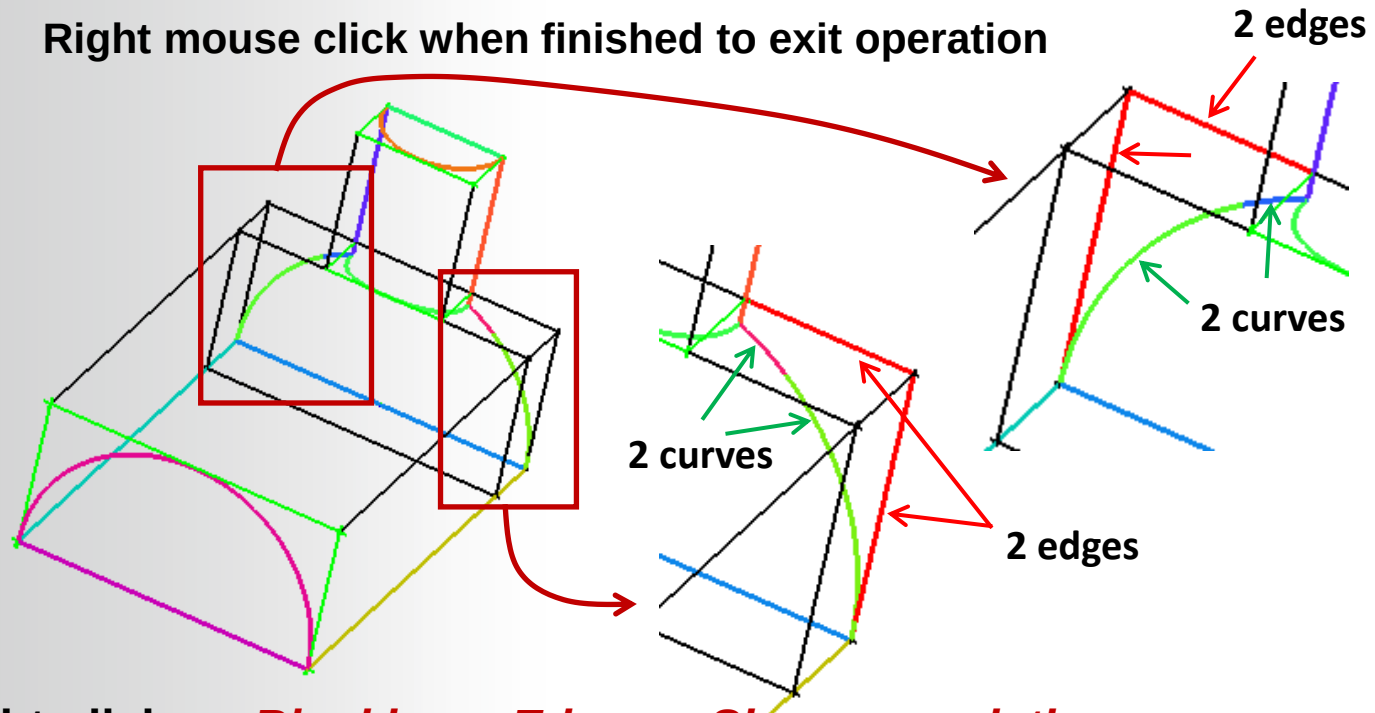
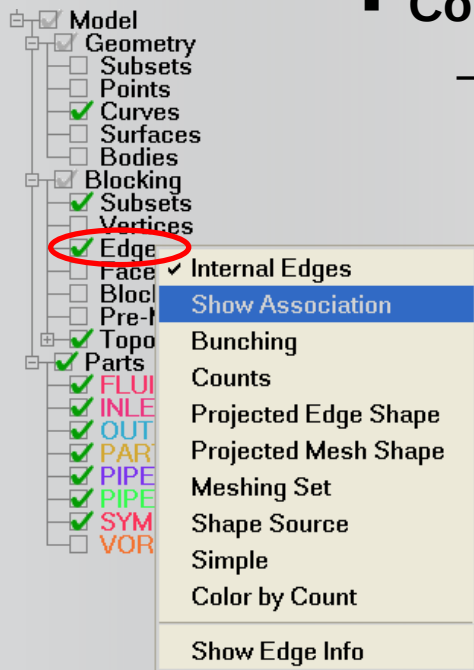
■ *Blocking > Associate > Associate Edge to Curve*

- Select the 3 edges shown, then middle mouse
- Then select the 3 curves shown (half circle), and middle mouse click. Right click will back up.
- The 3 curves will be grouped into one and the edges turn green to show they are constrained to a curve
- Repeat in two other locations shown

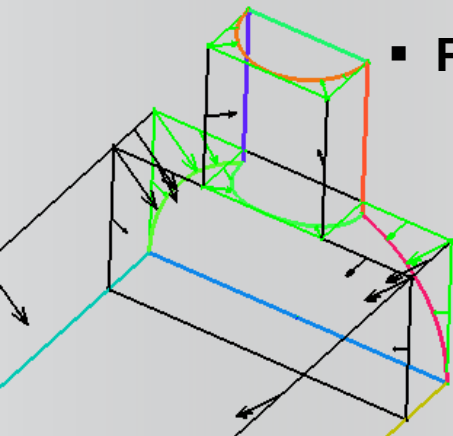


Associate Edges to Curves

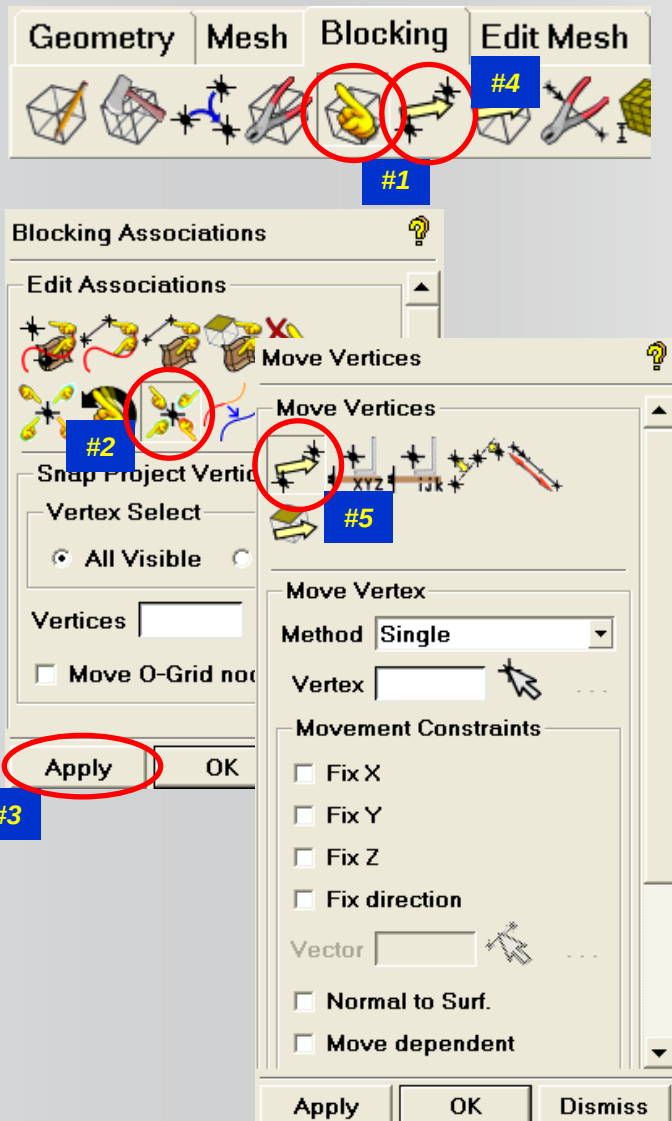
- Continue associating edges to curves as shown
 - Right mouse click when finished to exit operation



- Right-click on **Blocking > Edges > Show association**
 - This shows arrows from each edge and vertex going to the assigned geometry
 - Use to diagnose bad associations.
 - Correct any mis-associations by re-associating (no need to **Undo**)
 - Right click on **Blocking > Edges > Show association** again to turn off when done diagnosing

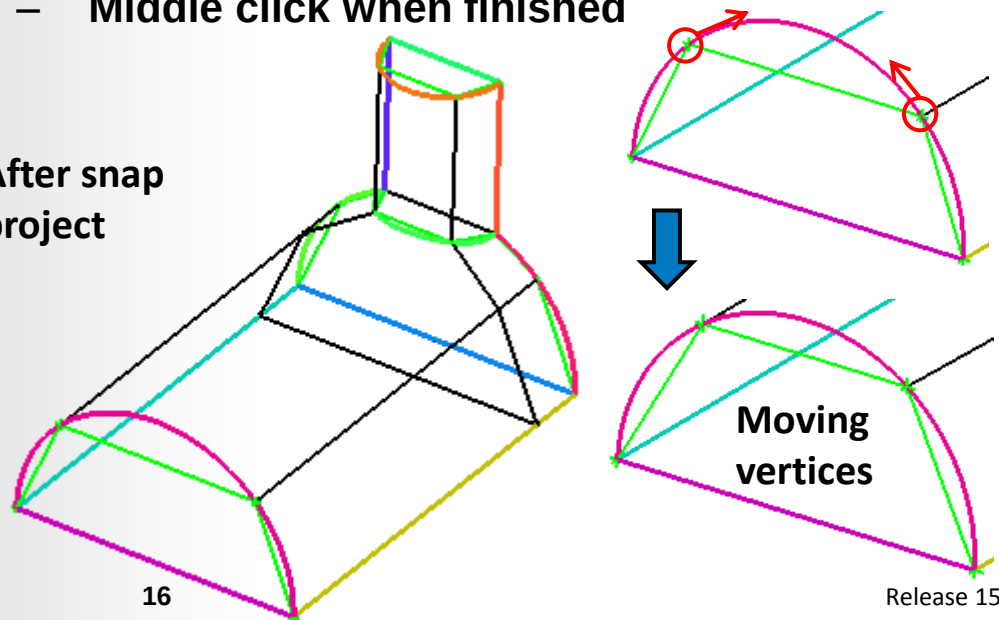


Move Vertices onto Geometry

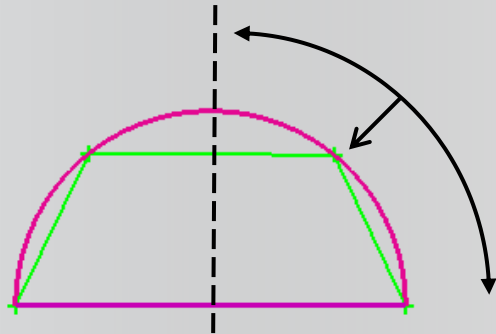


- **Blocking > Associate > Snap Project Vertices**
 - Automatically snaps associated vertices to nearest position on geometry
 - **Apply**
 - The nearest position is not necessarily the best position so adjust by moving vertices manually
- **Blocking > Move Vertex > Move Vertex**
 - Make sure to move corner vertices to curve ends
 - Right mouse will undo last movement
 - Middle click when finished

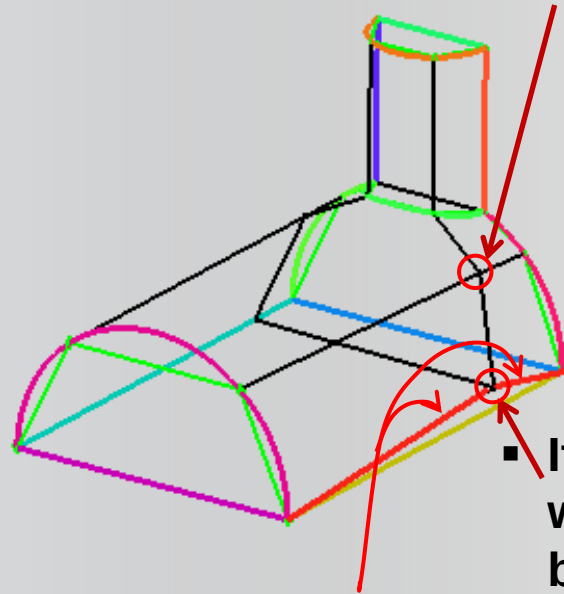
After snap project



Vertex Moving Guidelines



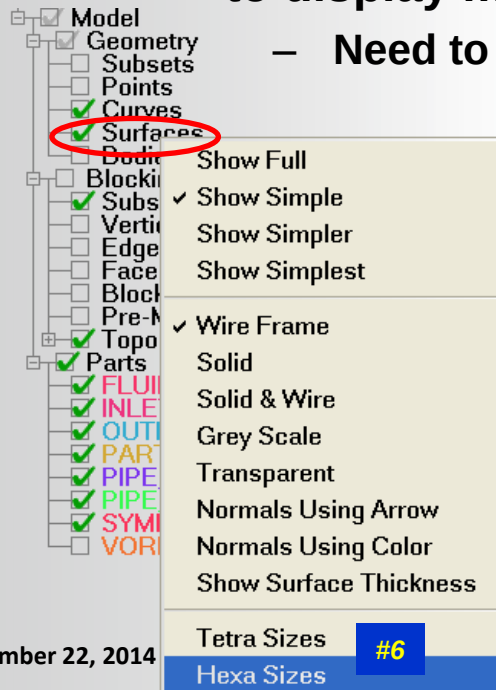
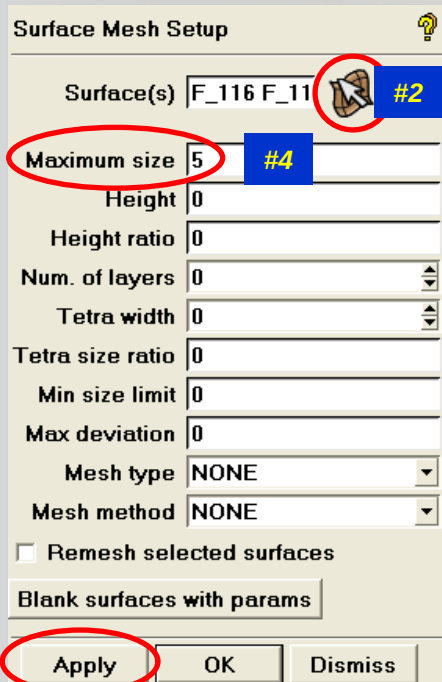
- It's usually best to have a block corner (vertex) at the center of every approximate 90° of curvature (curve or surface curvature)
- White vertices (when dark background) or black vertices (when light background) slide on the **NEAREST ACTIVE surface**



Associate these 2 edges to the underlying curve

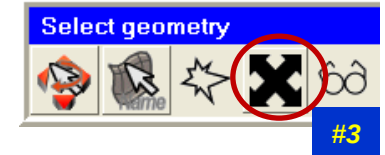
- These can be tricky to move correctly until you get some practice at it
- Keep moving the model as you move these vertices, so that the vertex is sliding on the front surface in the display and approximately in the screen plane
- Never move these vertices so that they are sliding along a part of the surface that runs normal to the screen plane
- If you move this vertex, it will move off the curve, so you will want to use the edge-to-curve association on 2 of the bounding edges to constrain its movement to the curve
 - Don't worry if the edge is on top of the curve. The edge-to-curve association knows to select edges for the first selection, and then curves for the second selection. The highlight color may not show well though

Set Mesh Sizes

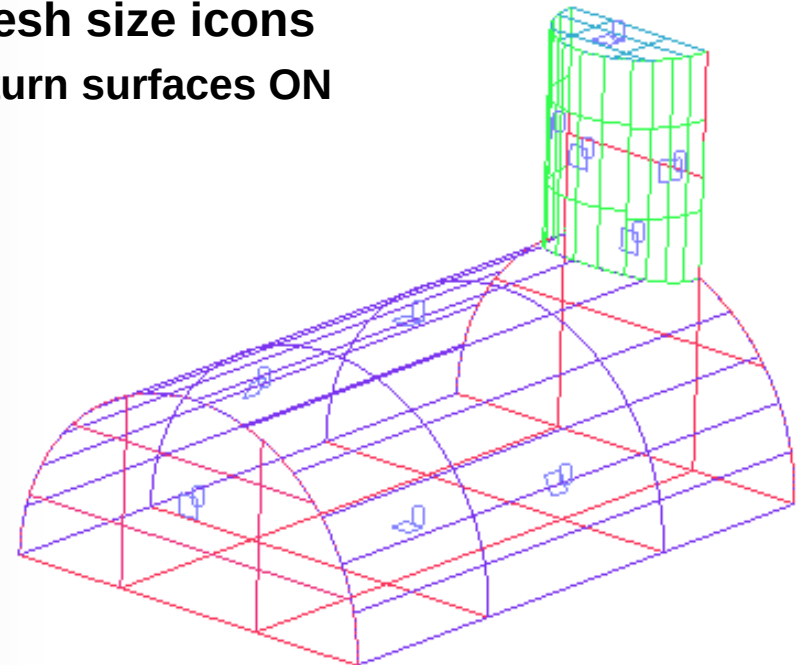


Set mesh sizes on surfaces

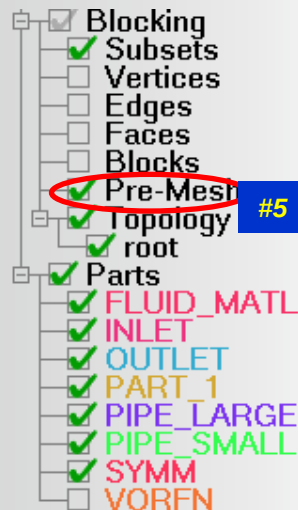
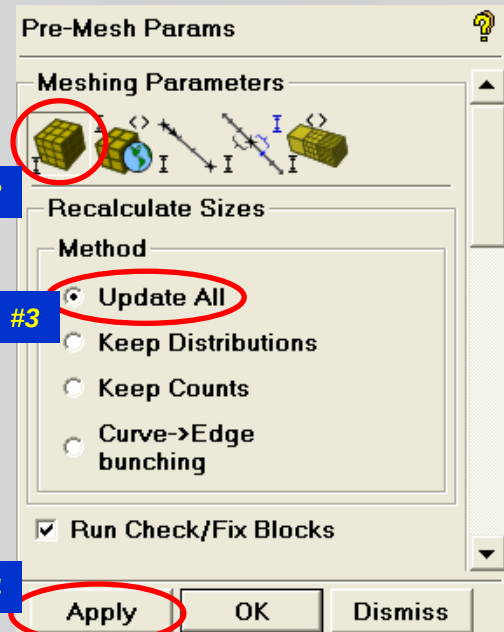
- **Mesh > Surface Mesh Setup**
- Press the **Select surface(s)** button  and then press key '**a**' (with pointer in model window) or the  **select all appropriate objects** button
- Set the **Maximum size** to 5
- **Apply**



- Right click in the tree on **Surfaces > Hexa Sizes** to display mesh size icons
- Need to turn surfaces ON

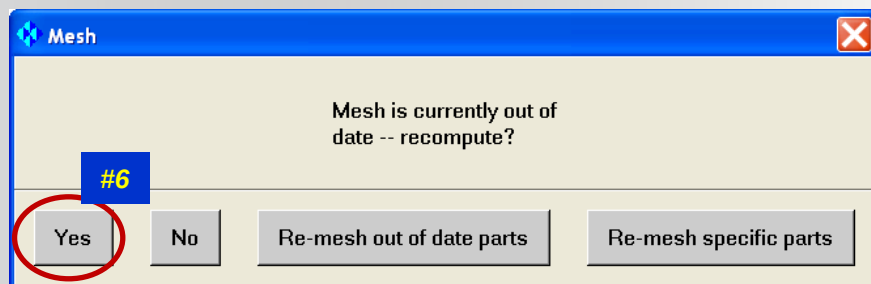


Compute Pre-mesh

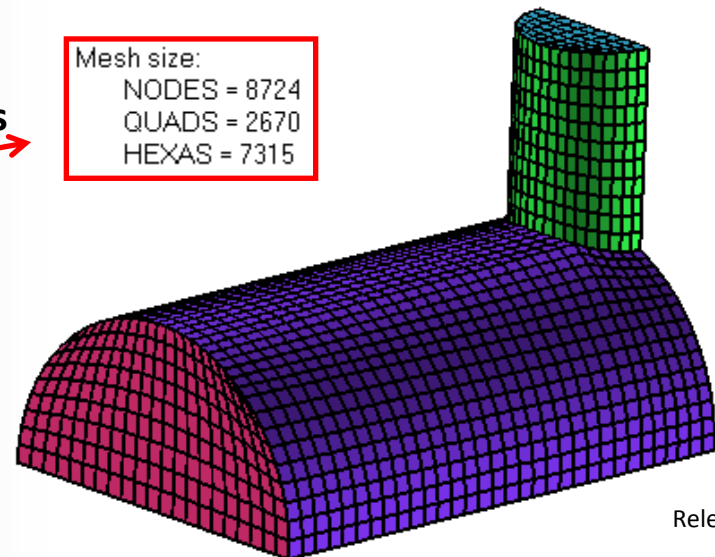


Message window prints element counts

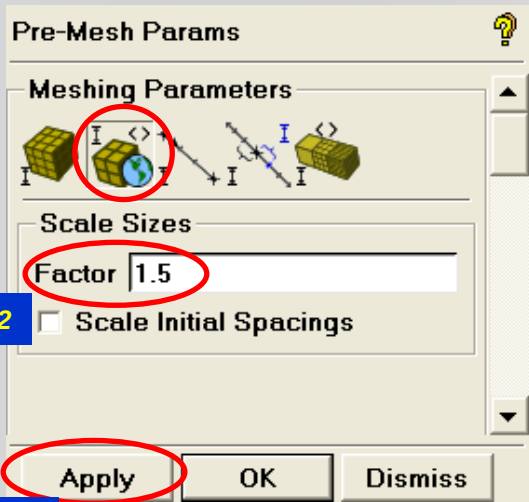
Mesh size:
NODES = 8724
QUADS = 2670
HEXAS = 7315



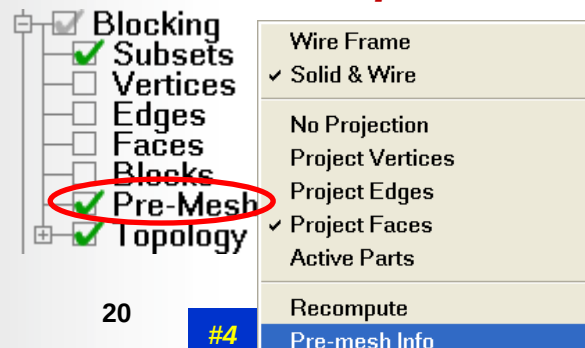
- First transfer all surface and curve sizes to the blocking edges
 - *Blocking > Pre-Mesh Params > Update Sizes*
 - *Method* set to *Update All*
 - *Apply*
- Then compute the Pre-mesh
 - In the model tree, turn on *Pre-mesh*
 - Press *Yes* for *Mesh is currently out of date – recompute?*
- *Pre-mesh > Solid & Wire* in model tree



Scale Mesh Globally



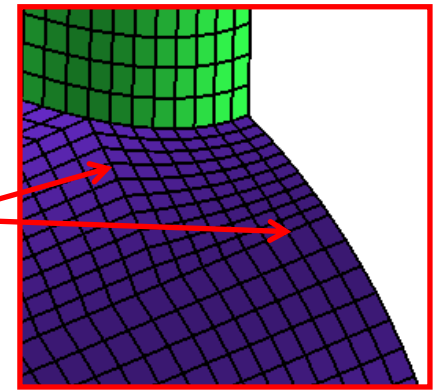
- The entire pre-mesh can be scaled
 - **Blocking > Pre-Mesh Params > Scale Sizes**
 - Enter a **Factor** of **1.5**, then **Apply**
 - Press **Yes** when asked to recompute
 - This increases the node counts on every edge by 1.5 times as many nodes as previously
- Use **Pre-mesh > pre-mesh Info** in the model tree to get an element count
- You can return to the original sizes by reapplying the surface and curve sizes to the edges with **Blocking > Pre-Mesh Params > Update Sizes**



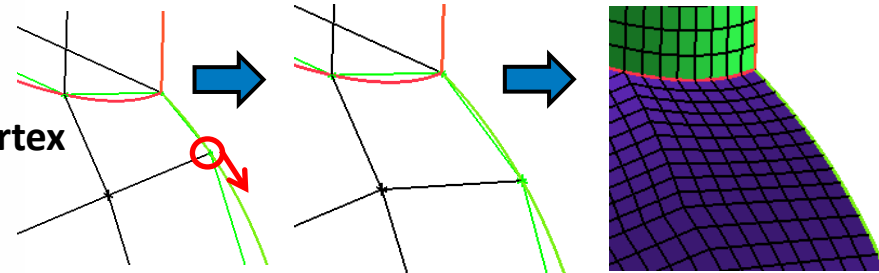
Mesh size:
 NODES = 31401
 QUADS = 6540
 HEXAS = 28016

Adjust Mesh Distributions

- Quick jumps in element size are bad for accuracy and convergence
- One way to spread out this region is to move vertex



- *Blocking > Move Vertex > Move Vertex*
- Slide vertex as shown



- Use *Edge Params* to finely tune distributions on edges

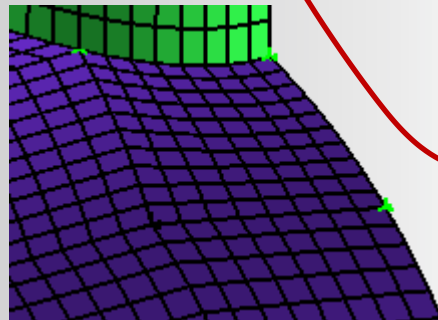
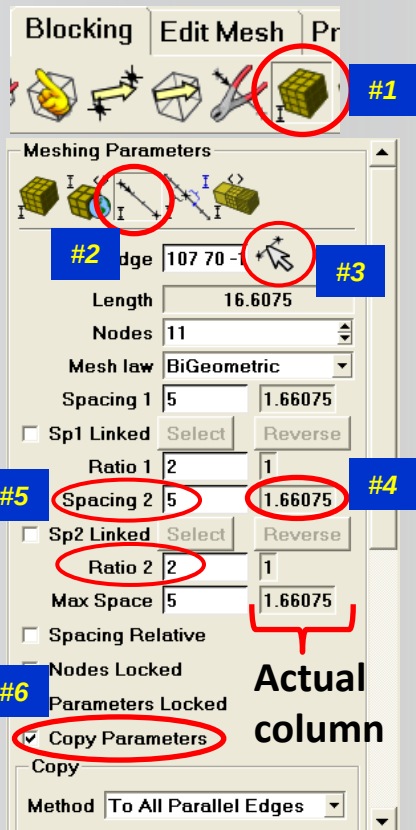
- *Blocking > Pre-Mesh Params > Edge Params*

- Select  edge shown and take note of the arrow indicating side 1 and side 2

- Look at the actual column for *spacing 2*, and take note of the number, about **1.66**

- Select  the edge below it and enter **1.66** for *spacing 2*, and **1.1** for *ratio 2*

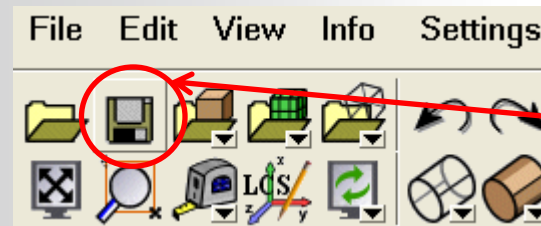
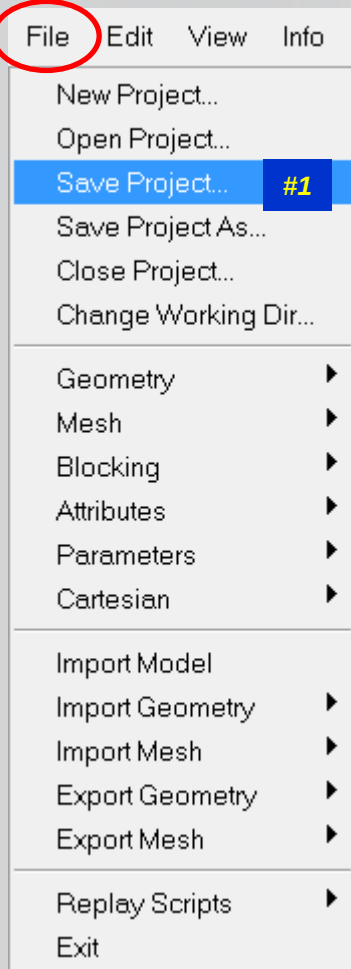
- Click on *Copy Parameters*, then *Apply*
– *Pre-Mesh > Recompute* in tree



Save Project

- **File > Save Project...**

- Saves project to the name specified at the beginning when a new project was entered
- Saving the project saves all files that were currently loaded: geometry (.tin), blocking (.blk), mesh (.uns), boundary condition file (.fbc), etc...
- Saving the project also saves a settings file (.prj) containing the file associations to load next time as well as some entries in the **settings** menu



Can also use the utility icon to save project

- **Close project when done**

- **File > Close Project**
- Closes all open files, even if a project was not opened or a new project was not specified