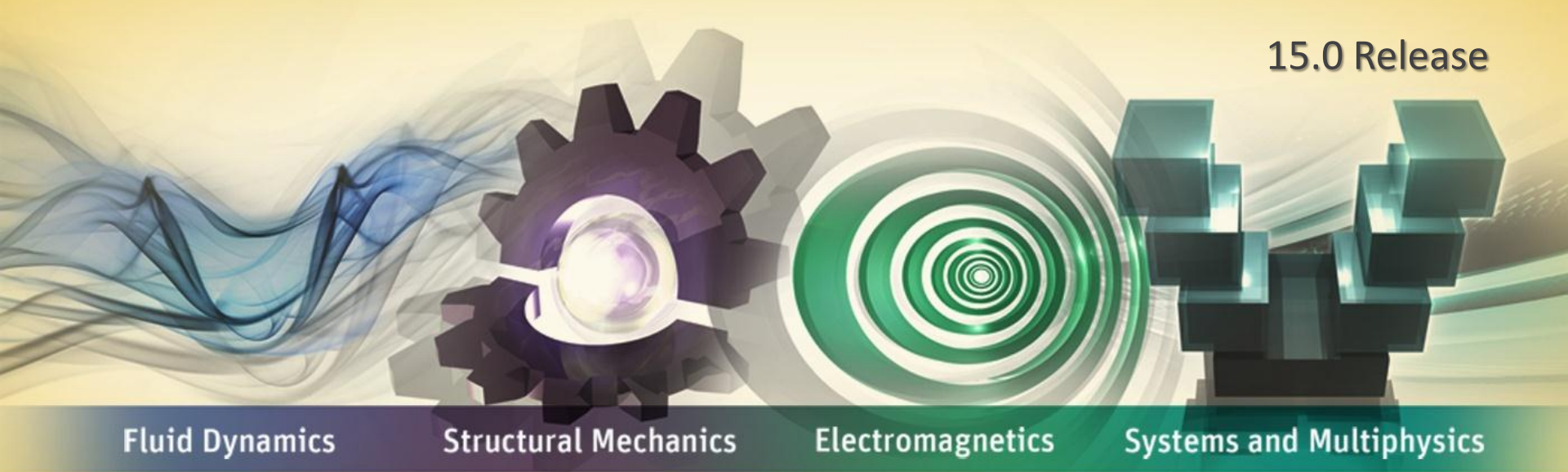


Workshop 3.1

Shell Meshing – Stamped Part

15.0 Release

A horizontal banner with a yellow background. It features four distinct 3D visualizations: blue fluid flow lines on the left, a purple gear with a glowing center, a green concentric circular 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 ICEM CFD

Create Project / Open Geometry

File Edit View Info

New Project...

Open Project...

Save Project...

Save Project As...

Close Project...

Change Working Dir...

Geometry ▶

Mesh ▶

Blocking ▶

Attributes ▶

• File > New Project

- Enter the **Stamping** folder
- Type **Stamped-mesh**
- **Save**

New Project

Save in: Stamping



My Recent Documents



Desktop



My Documents

File name: Stamped-mesh

Save

Save as type: Project Files (*.prj)

Cancel

File Edit View Info

New Project...

Open Project...

Save Project...

Save Project As...

Close Project...

Change Working Dir...

Geometry ▶

Mesh ▶

Blocking ▶

Attributes ▶

• File > Geometry > Open Geometry...

- Select **stamped_zero_thickness.tin**
- **Open**

Open Geometry...

Save Geometry...

Save Geometry As...

Save Visible Geometry As...

Open

Look in: Stamping



My Recent Documents



Desktop



My Documents

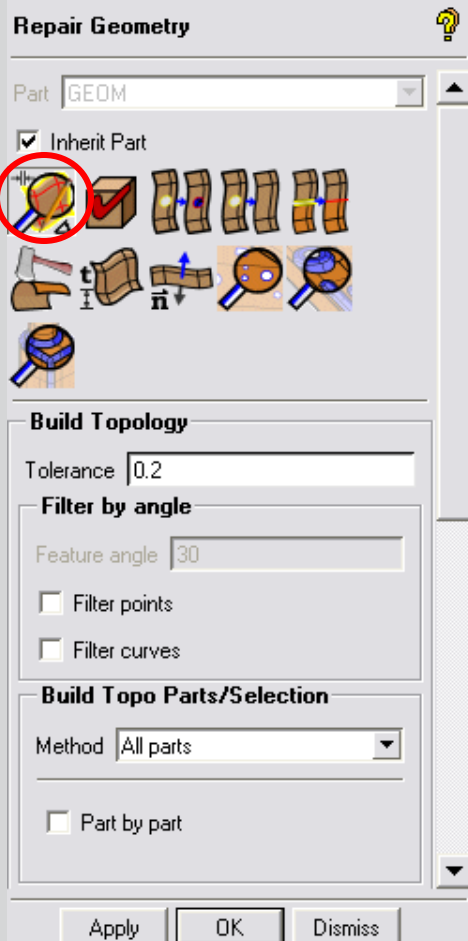
File name: stamped_zero_thickness.tin

Open

Files of type: Geometry Files (*.tin,*.tin.gz)

Cancel

Build Topology



Build Topology is absolutely necessary before running **patch based surface mesher**:

- Determines connectivity of surfaces so that mesh is connected across surfaces

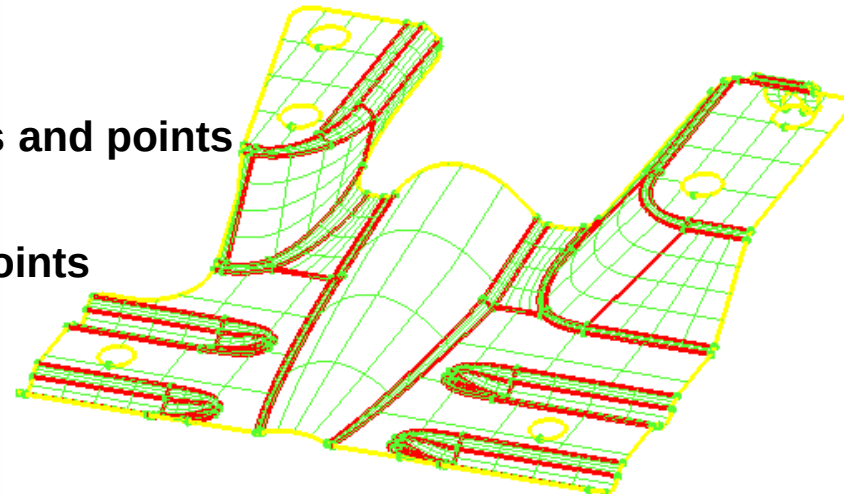
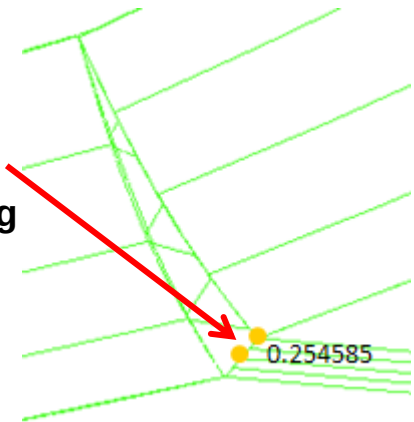
- **Geometry > Repair Geometry > Build Diagnostic Topology**

- It is always advisable to estimate the “allowable gap” (tolerance) by making a small distance measurement
 - Leave the default tolerance at 0.2. Could be slightly smaller
 - Leave **Filter points** and **Filter curves** off

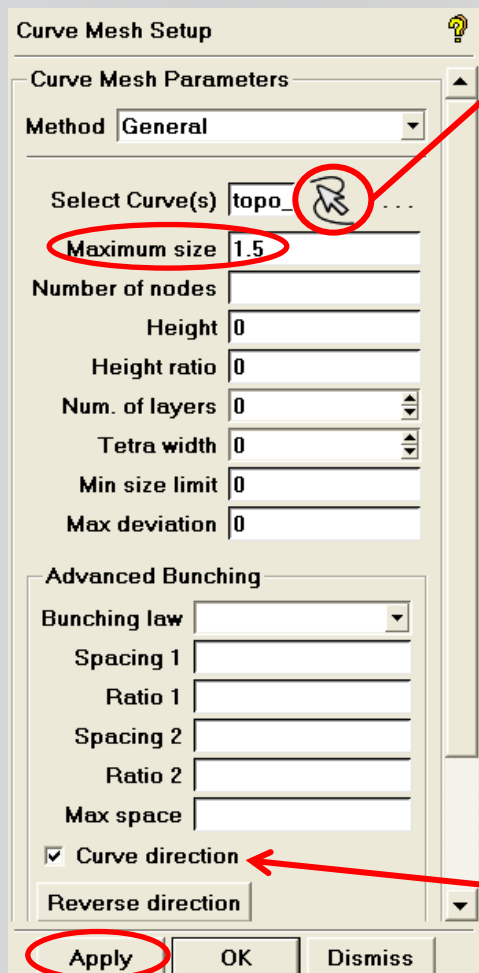
- **Apply**

- Also extracts curves and points

- Usually run without filtering curves or points for the **patch based surface mesher**



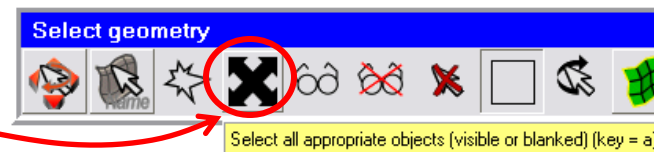
Set Curve Mesh Sizes



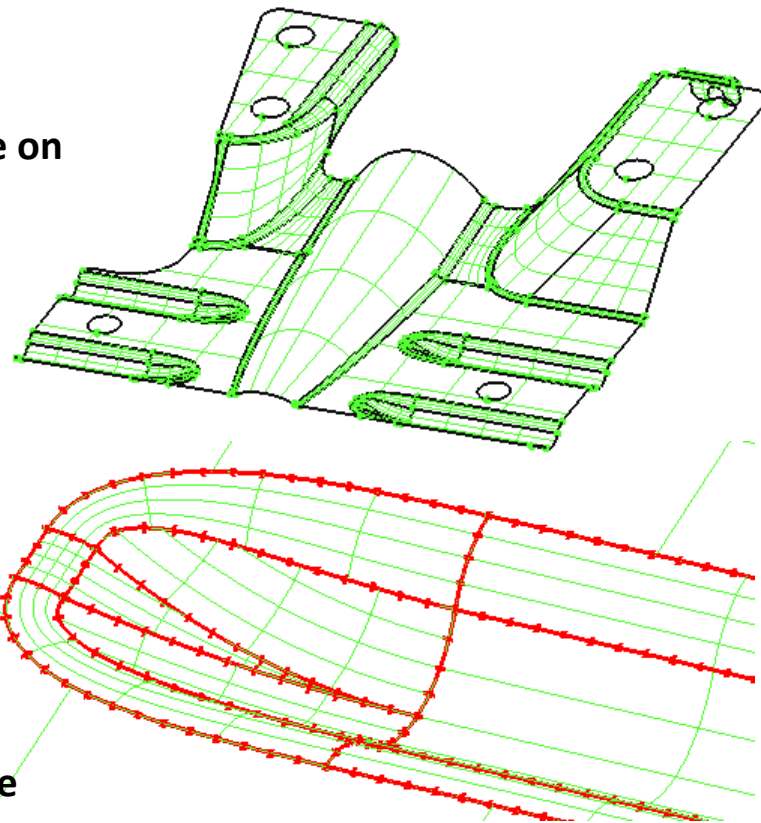
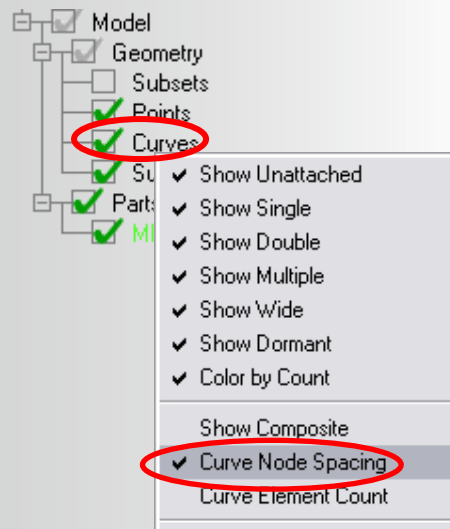
- The Patch based surface mesher uses curve sizes, not surface sizes (except for when *adapt mesh interior* is on) in global shell parameters

• *Mesh > Curve Mesh Setup*

- Select all curves
- *Maximum size* = 1.5
- *Apply*

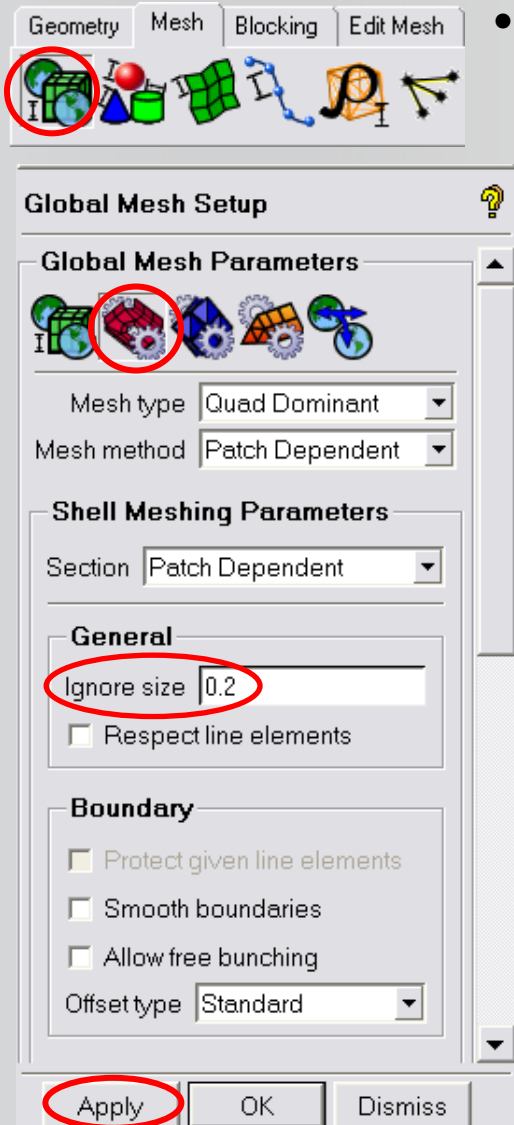


- To view node positions, right mouse click in the model tree on *Curves > Curve Node Spacing*



- Turn off *Curve direction* if the arrows are too large

Set Shell Meshing Parameters and Compute

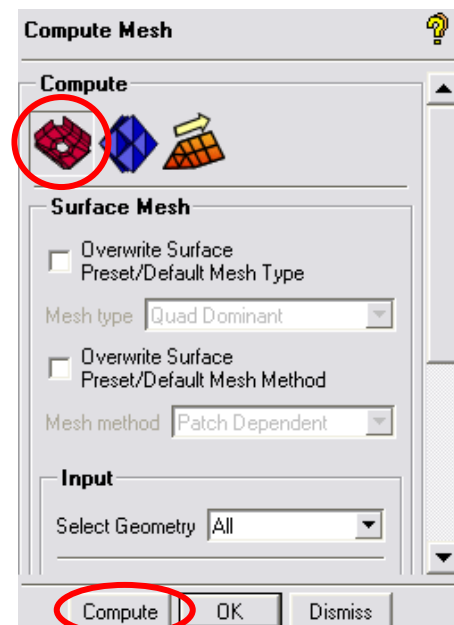


- Set the mesh default type and method to use

- *Mesh > Global Mesh Setup > Shell Meshing Parameters*
- *Mesh type = Quad Dominant* (most common for structural shell meshing)
- *Mesh method = Patch Dependent*
- Set *Section* to *Patch Dependent*
- *Ignore size = 0.2*
 - Nodes and thin loops will be merged across this distance
 - The default ignore size will be the same as the tolerance from *Build Diagnostic Topology*

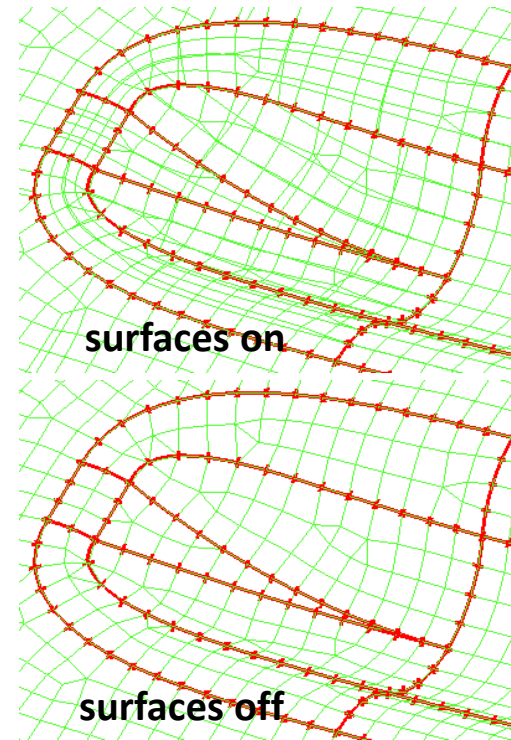
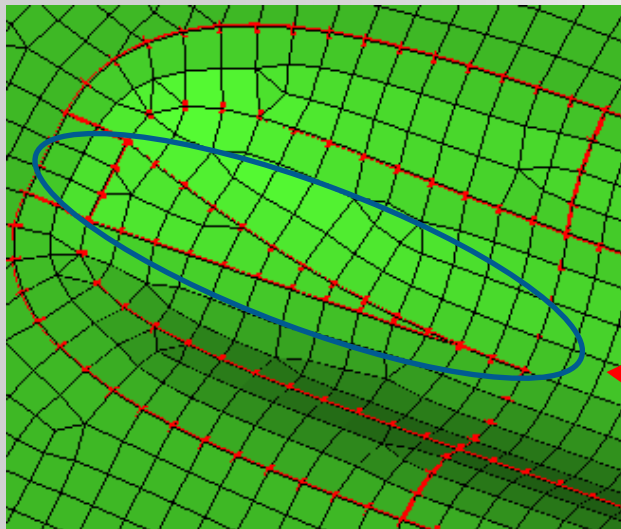
- Compute Mesh

- *Mesh > Compute Mesh > Surface Mesh Only*
- *Compute*

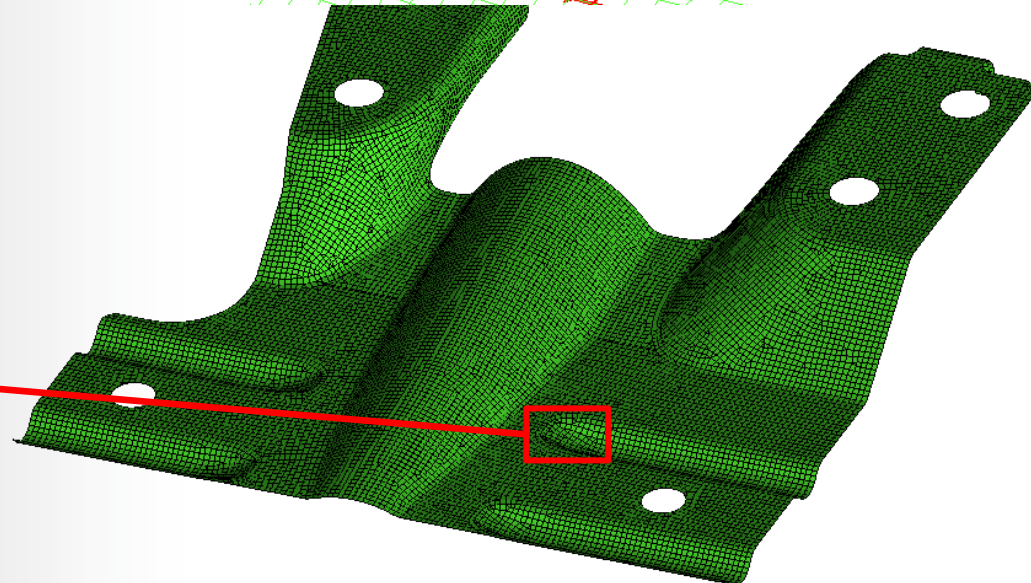


Inspect Sharp Angles

- Zoom in close on the red boxed section
 - You'll notice grid lines match the curves at the boundaries on this sharp-angled triangular surface
 - Curves can be deleted non-permanently, which will not destroy the connectivity between surfaces
 - The curves will be made dormant
 - Nodes will not be constrained here after the curve deletion



Turn
surfaces
off to see
clearer

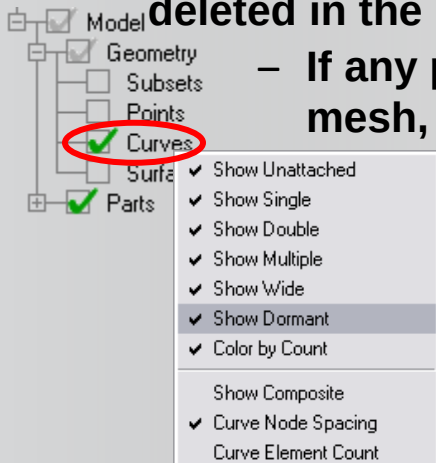
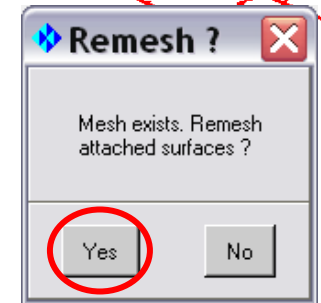
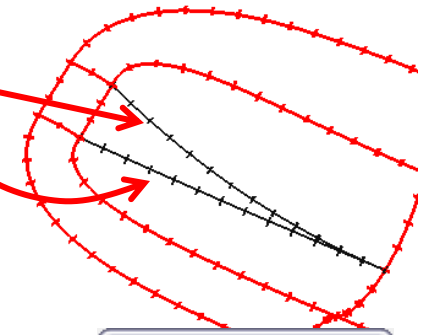
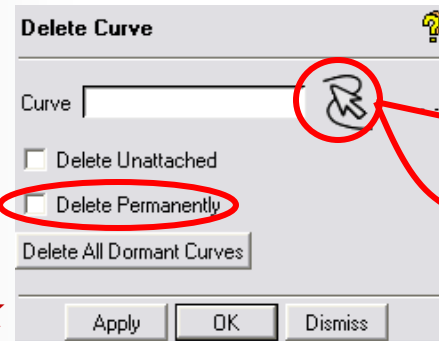


Delete Some Curves

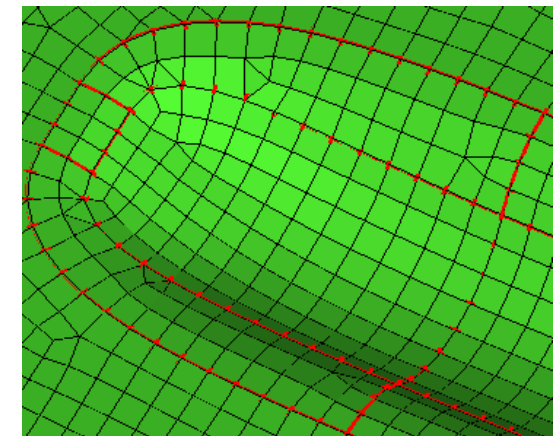


• Geometry > Delete Curve

- Ensure that **Delete permanently** is off
- Select the 2 curves shown, **middle click**
- Select **Yes**, when it says, **Mesh exists. Remesh attached surfaces?**
- Mesh is no longer constrained to the small angle
- There are 3 other similar locations in this model where curves can also be deleted in the same fashion
- If any patch fails meshing, close the mesh, and remesh the entire model

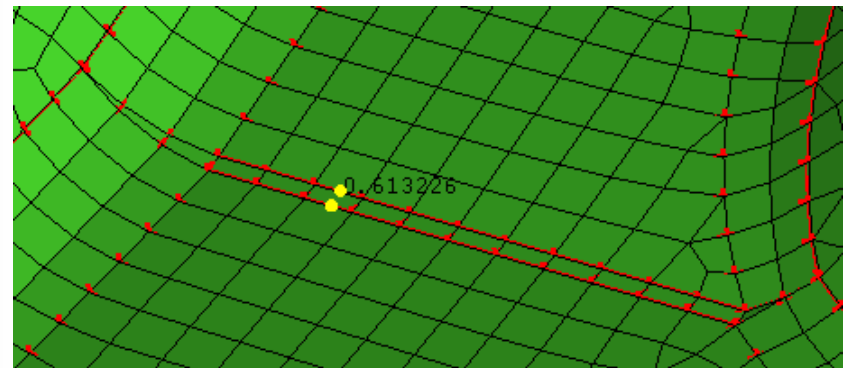
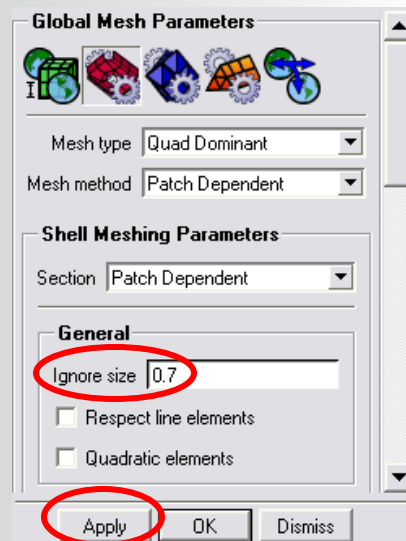
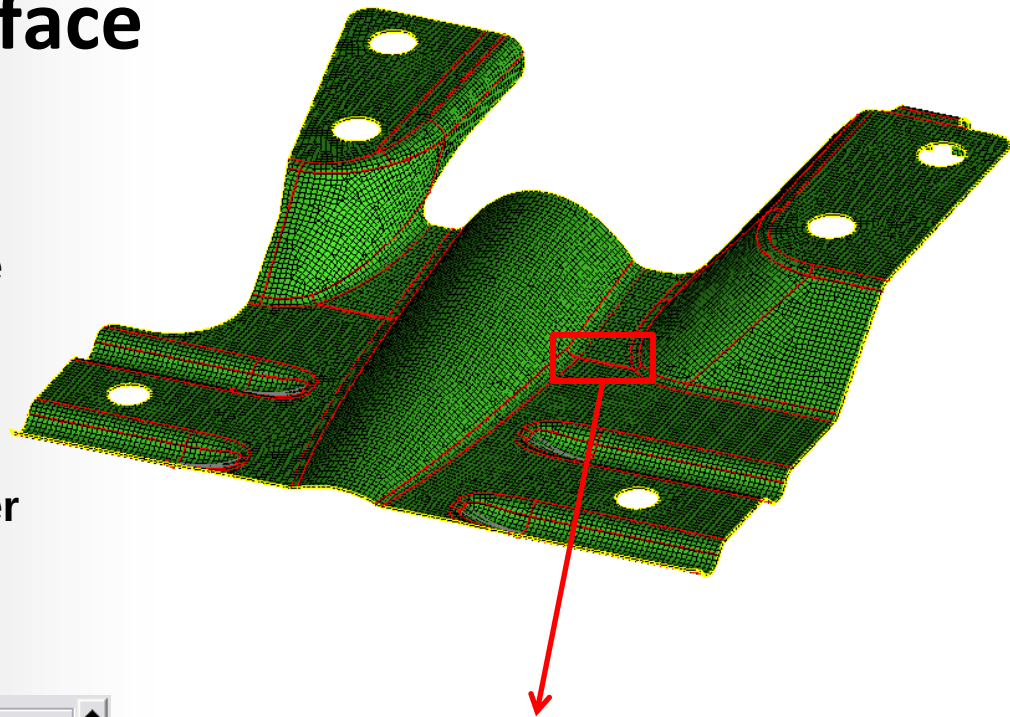


Dormant curves can be shown (in gray) by a right mouse click in the model tree on **Curves > Show Dormant**, then curves on



Inspect Sliver Surface

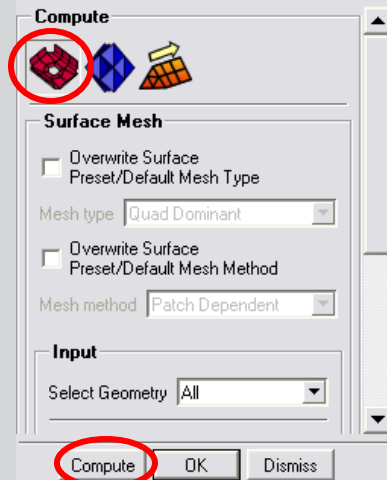
- Zoom in to the sliver surface in the red boxed area
 - Use the tape measure  to find the distance across (about 0.6)
- **Mesh > Global Mesh Setup > Shell Meshing Parameters**
 - Set the **ignore size** to slightly greater than this distance for the **Patch Dependent** section
 - **Ignore size** = 0.7
 - **Apply**



Recompute Mesh

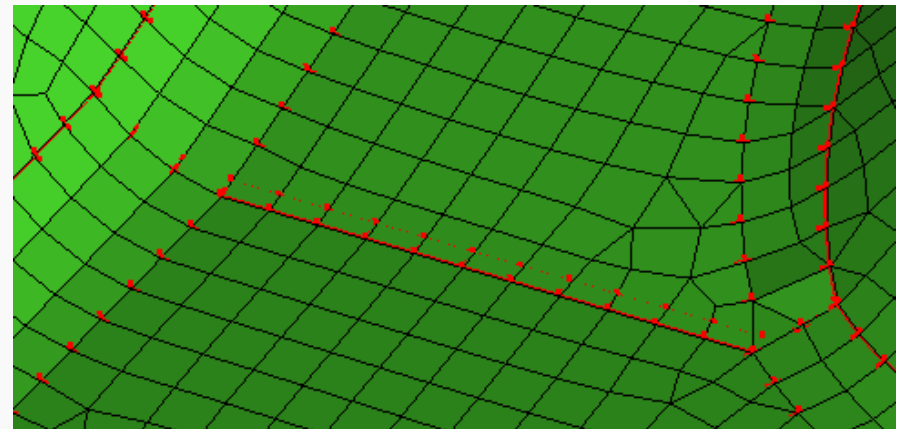
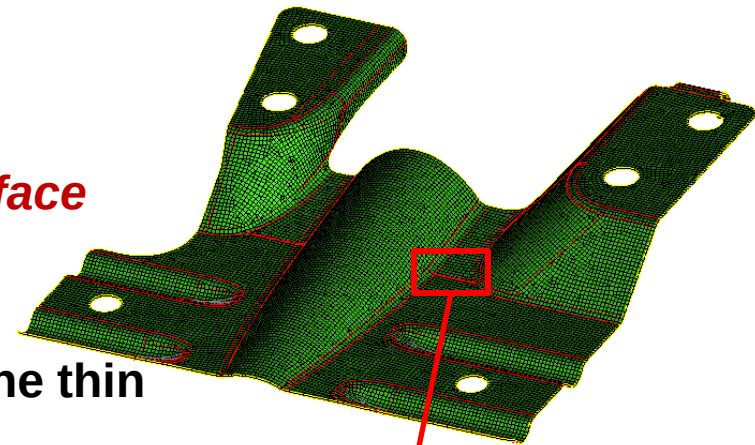


Compute Mesh



- **Mesh > Compute Mesh > Surface Mesh Only**
– **Compute**

- The ignore size merged out the thin loop
- This would have also taken care of the previous sharp angle problem if you did not choose to make curves dormant



May need to turn curves off to clearly see the mesh

Quad Rings



Curve Mesh Setup

Curve Mesh Parameters

Method: General

Select Curve(s): topo_ [icon] ...

Maximum size: 1.5

Number of nodes:

Height: 0

Height ratio: 0

Num. of layers: 4

Tetra width: 0

Min size limit: 0

Max deviation: 0

Apply

OK

Dismiss



Compute

Surface Mesh

☐ Overwrite Surface
Preset/Default Mesh Type

Mesh type: Quad Dominant

☐ Overwrite Surface
Preset/Default Mesh Method

Mesh method: Patch Dependent

Compute

OK

Dismiss

- Create quad rings around the holes

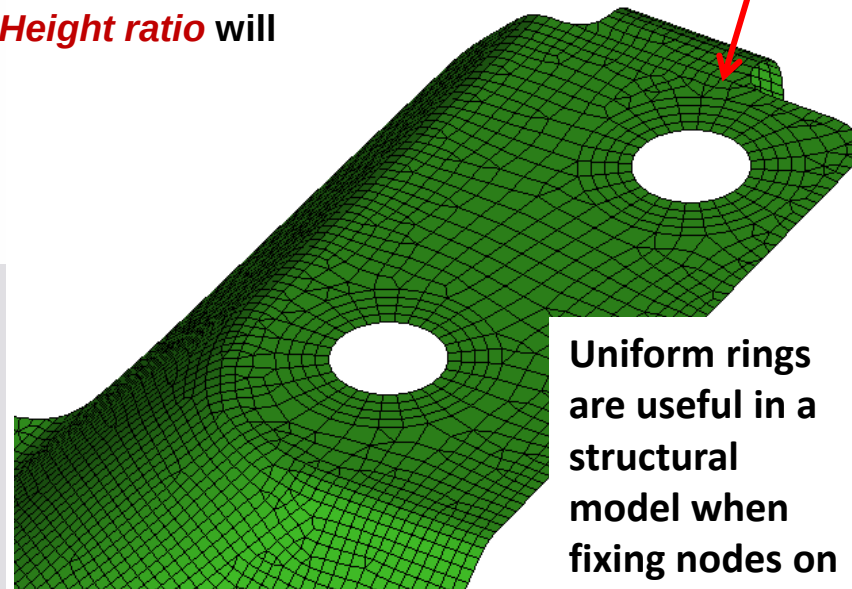
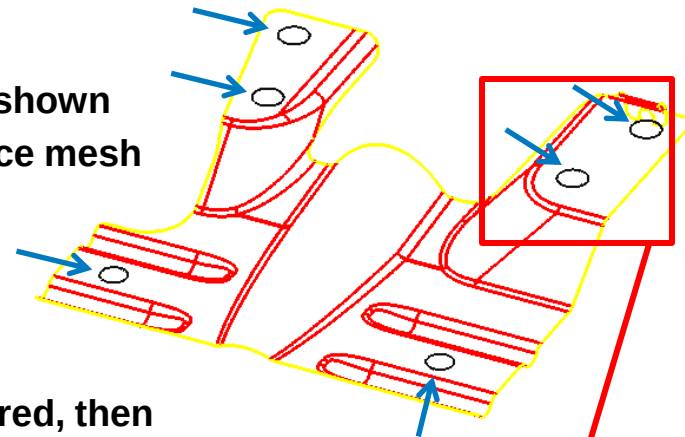
• **Mesh > Curve Mesh Setup**

- Select the curves of the 6 holes shown
- The 3 parameters used for surface mesh inflation are:

- **Height**
- **Height ratio**
- **Num. of layers**

- If only the **Num. of layers** is entered, then the **Height** will be the same as the **Maximum size** and the **Height ratio** will assumed to be 1

- Set **Num. of layers** = 4
- **Apply**
- **Recompute Mesh**



Uniform rings are useful in a structural model when fixing nodes on a washer

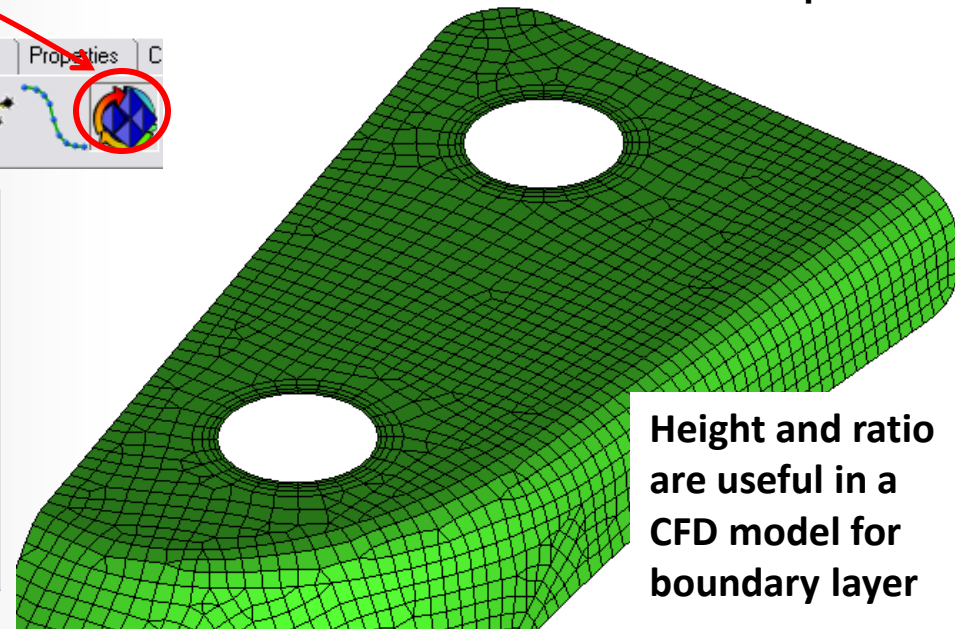
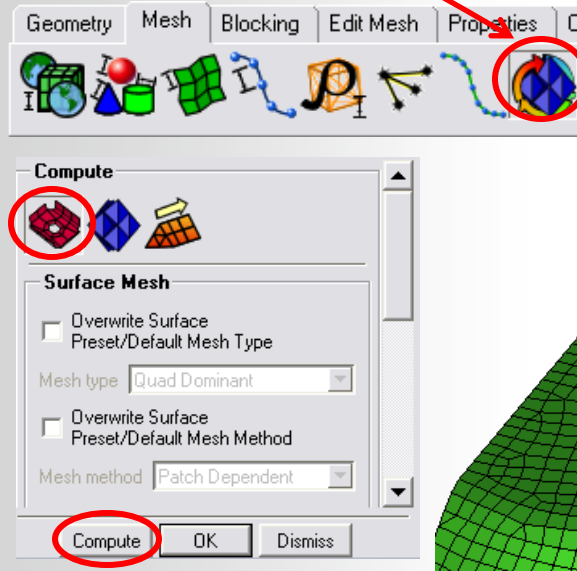
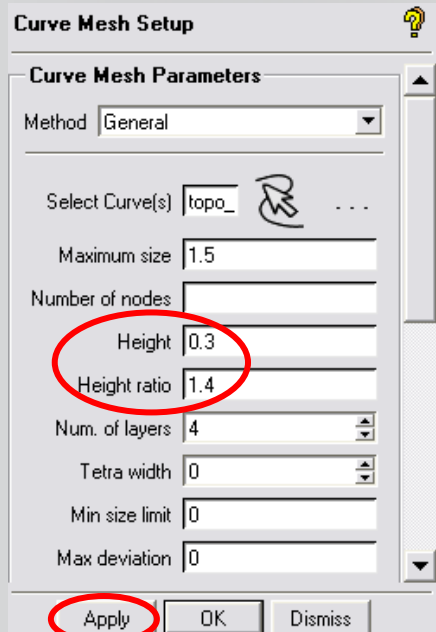
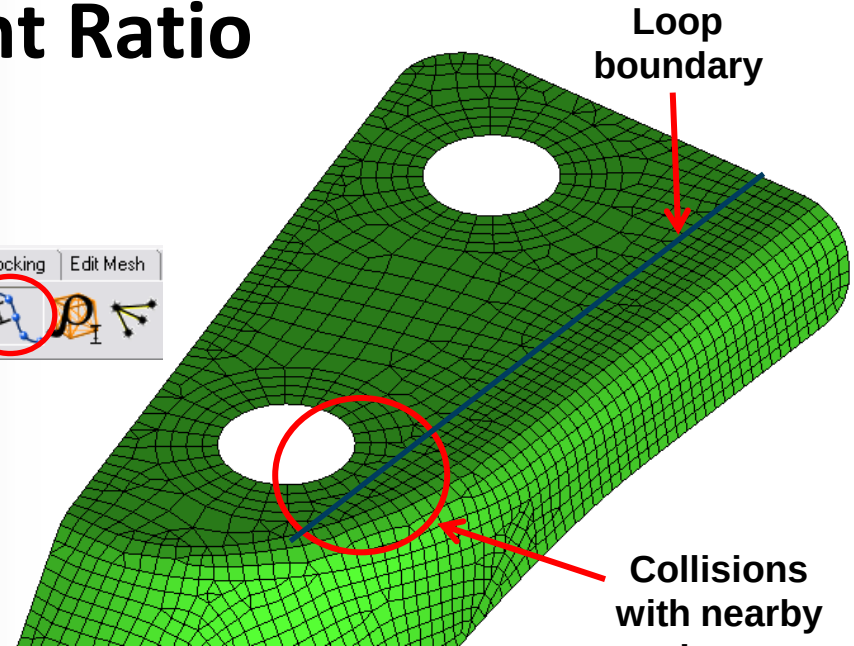
Set Height and Height Ratio

- The quad rings are very big, and you will notice 3 rings that collide with the patch boundary, interrupting some layers

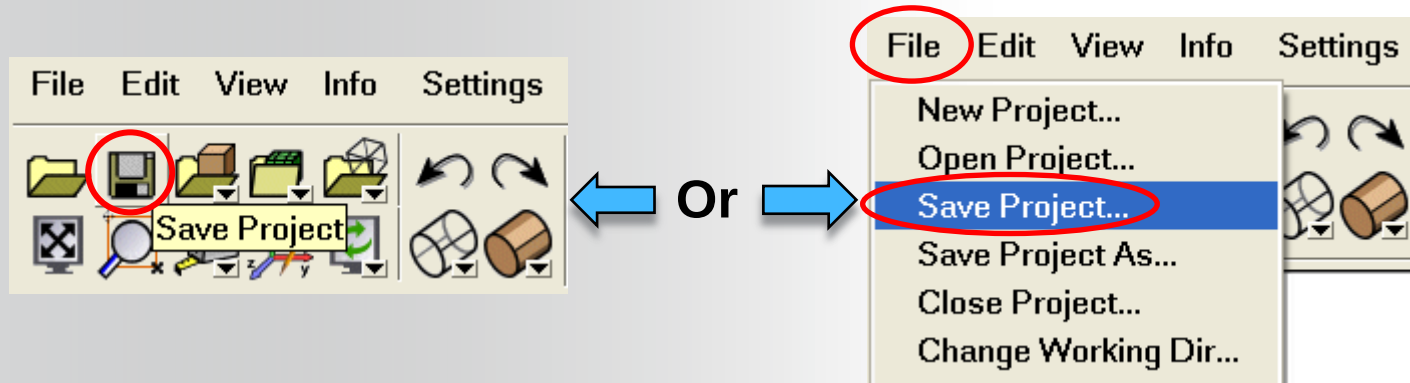
- Mesh > Curve Mesh Setup**

- Select the curves of the 6 holes again
- Height** = 0.3 (first layer height)
- Height ratio** = 1.4 (1.0 to 1.5 are typical)
- Apply**

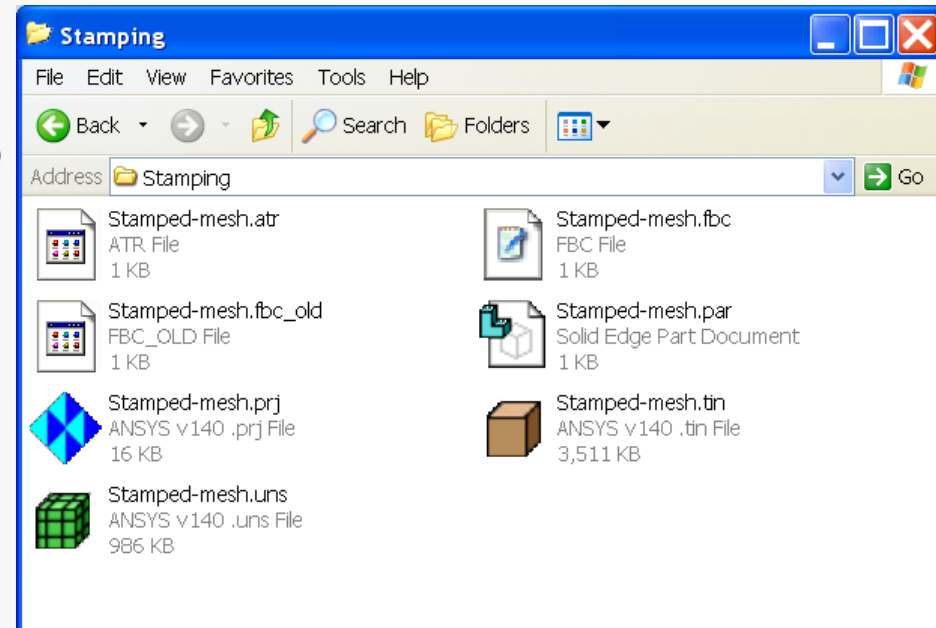
- Recompute Mesh**



Save Project

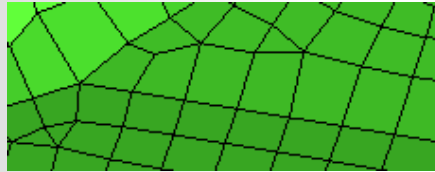
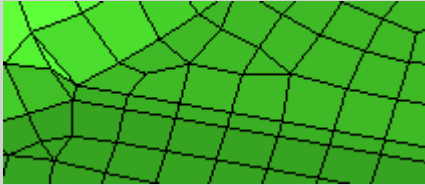


- **Save Project**
- Saves geometry (.tin), mesh (.uns), and settings file (.prj)
 - Mesh sizes and methods are saved to the geometry file (.tin)
 - The unstructured mesh file (.uns) is what will get written to the solver
 - When loading the project, select the settings file (.prj) and all these files will get loaded with it

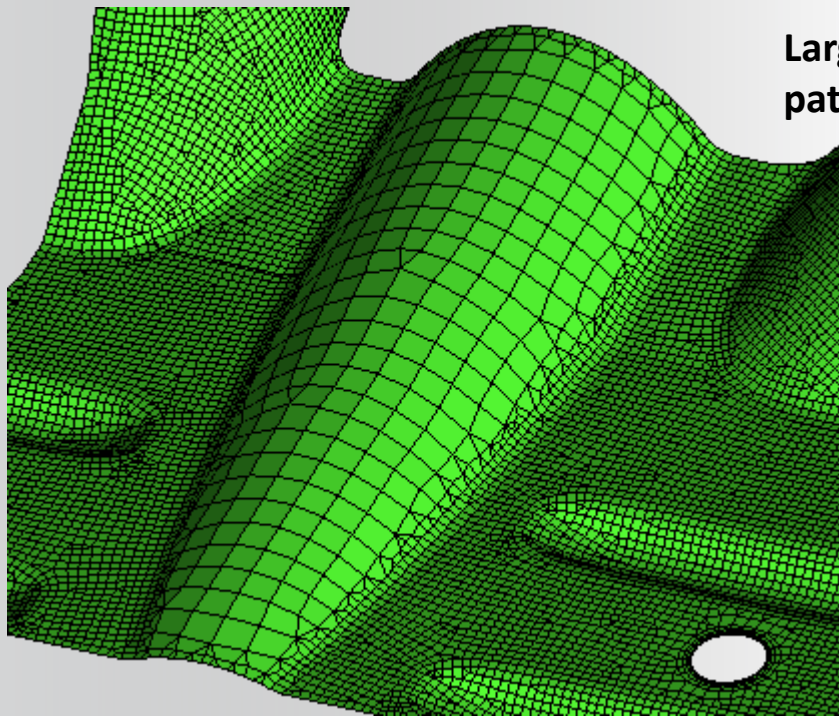


Further Investigation

- For those that have the time, the following pages introduce additional concepts

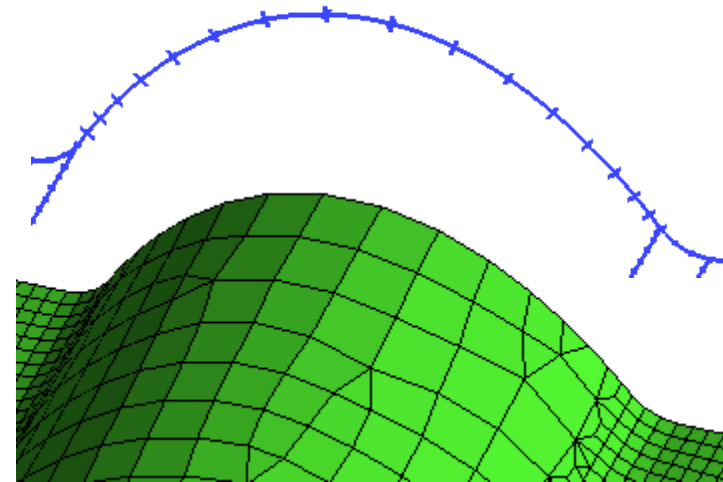


Merge nodes



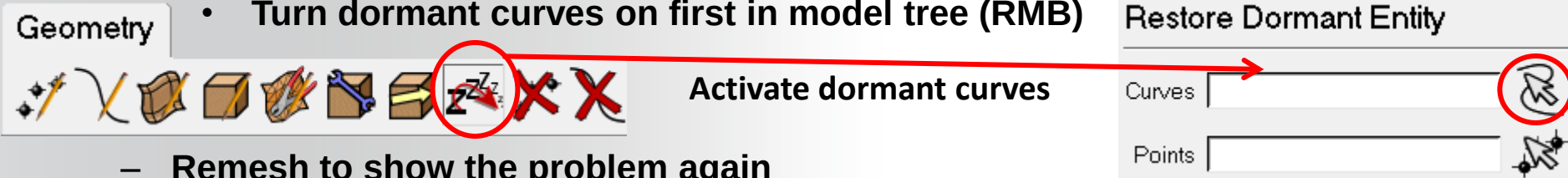
Larger internal
patch sizes

Curve distribution

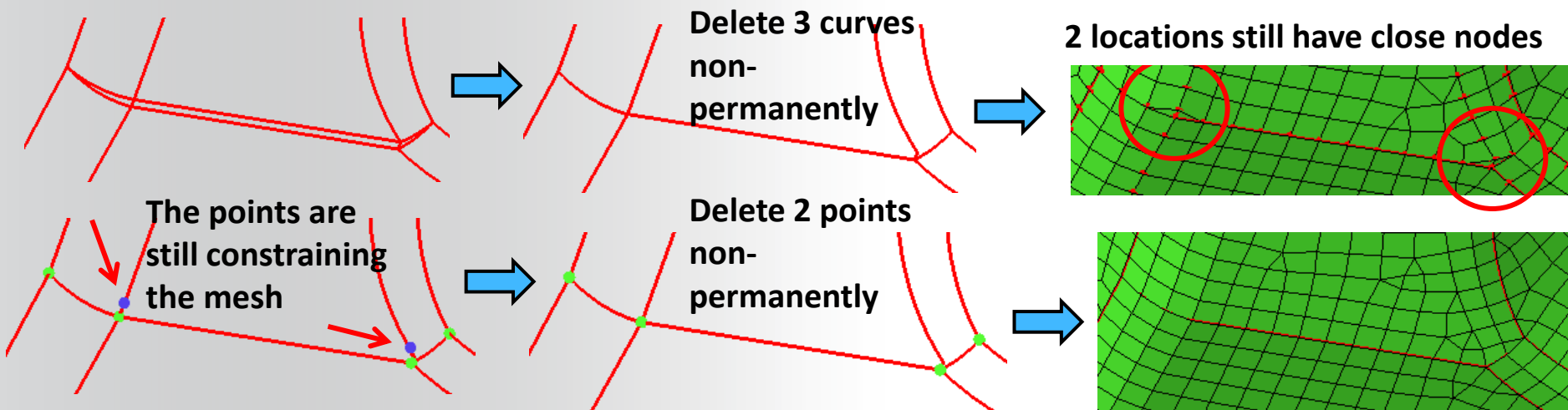


Deleting Constraints

- Experiment with ways to merge out small features for the patch dependent surface mesher or otherwise get the mesher to ignore small features
- First bring the thin element and small angle problem back
 - Set the ignore size back to the default (0.2) for the patch based surface mesher
 - Bring back the dormant curves to active either by building topology again or manually activating the dormant curves:
 - Turn dormant curves on first in model tree (RMB)



- Remesh to show the problem again
- Fix the thin region by deleting the curves on one side (non-permanently)



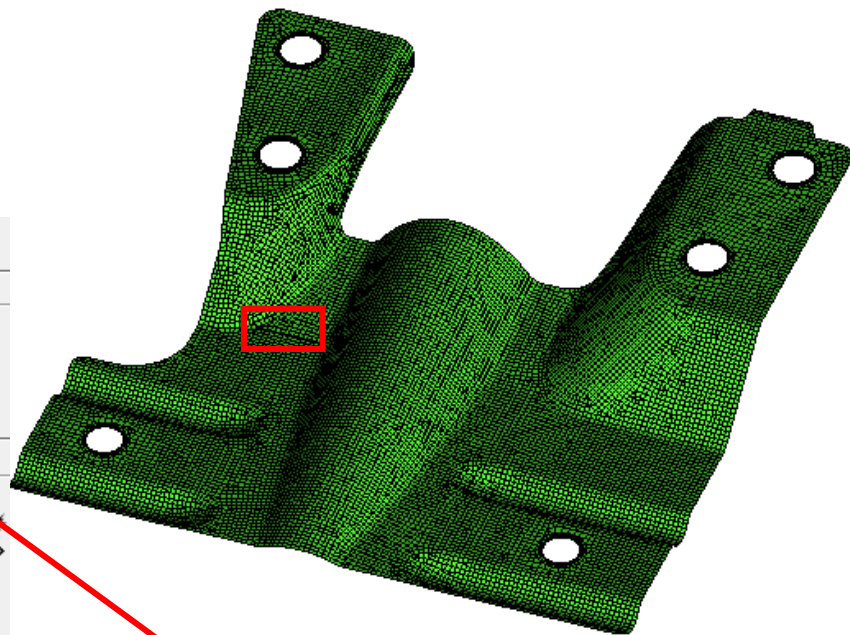
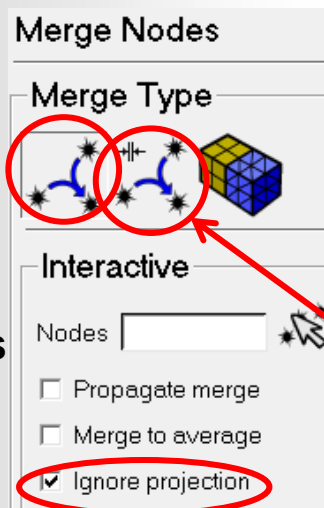
Merging Nodes

- So far, the fixes have been on the geometry level (deleting curves/points, using ignore size) which requires a remesh
- Fixes can also be done at the mesh level
- **Edit mesh > Merge nodes > Merge Interactive**

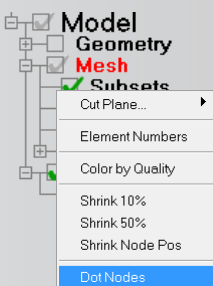


- Turn ON **Ignore projection**

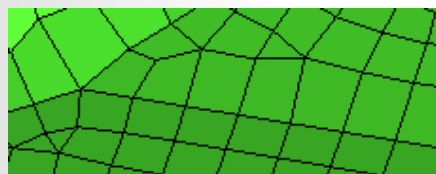
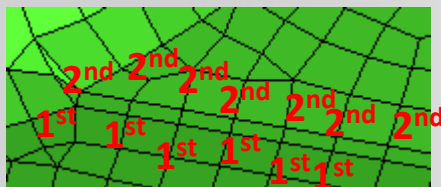
- **Ignore projection** off doesn't allow 2 curve-nodes or 2 point-nodes to merge
- 2nd node merges to 1st node
- Select pairs of nodes at a time



- You can also merge all or selected nodes within a tolerance
 - You can try the same as the **ignore size** earlier (0.70)
 - Experiment with larger tolerances
 - Select all or box select nodes

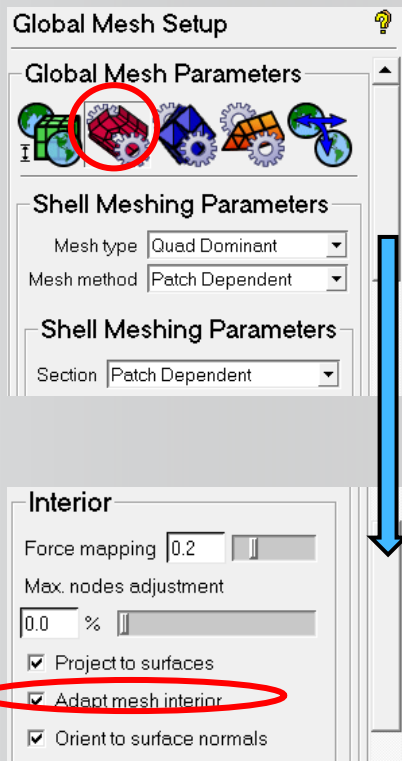
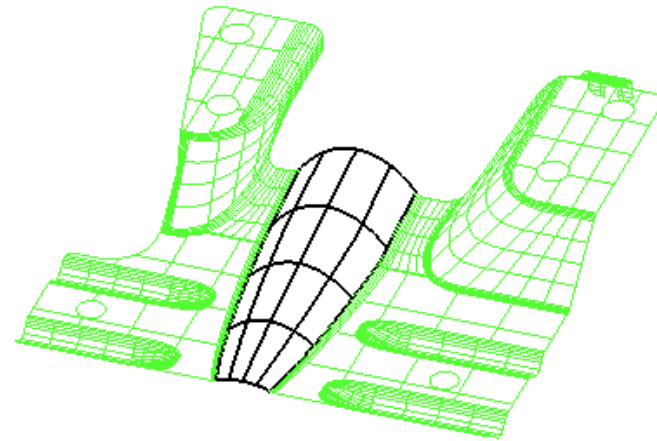


Mesh > Dot nodes shows node type

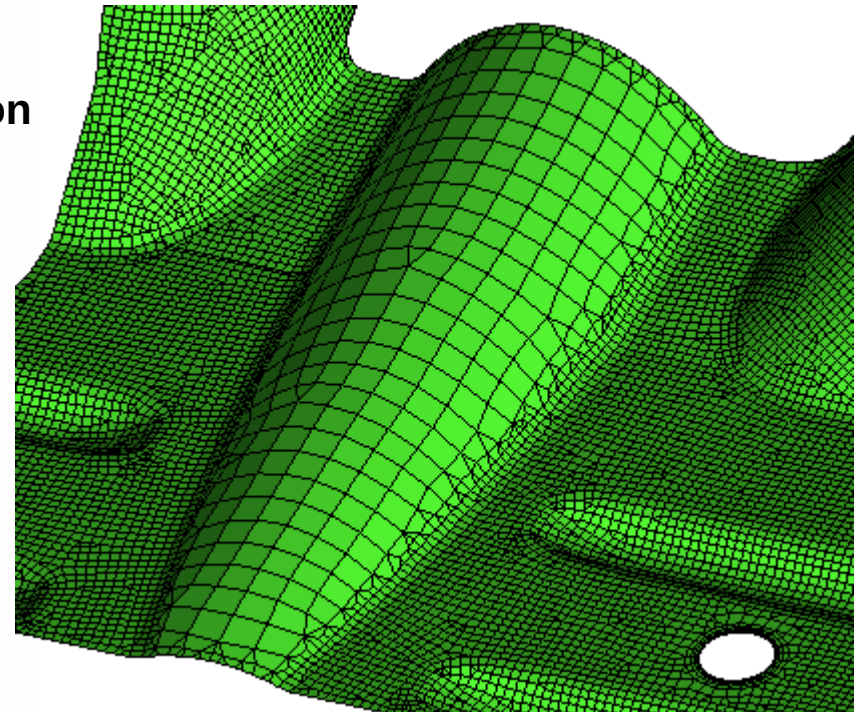


Larger Internal Patch Sizes

- In the global setup for **Shell Meshing Parameters** turn on **Adapt mesh interior**
 - This will require the max size to be set on a surface for it to work
 - The mesh will transition quickly to the size set on the surface



- **Mesh > Surface mesh setup**
 - Set a max size of 5 on one of the surfaces and remesh
- Transitions are better handled with tri mesh rather than quad mesh
- Could experiment with setting the mesh type to **All Tri**



Curve Distribution

- Use **Mesh > Curve Mesh Setup** to set a distribution on one of the boundary curves of the surface you previously selected and remesh

Curve Mesh Parameters

Method: General

Select Curve(s): topo.  ...

Maximum size: 3.65146

Number of nodes: 18

Height: 0

Height ratio: 0

Num. of layers: 0

Tetra width: 0

Min size limit: 0

Max deviation: 0

Advanced Bunching

Bunching law: BiGeometric

Spacing 1: 1.5

Ratio 1: 1.2

Spacing 2: 1.5

Ratio 2: 1.2

Max space: 0

☐ Curve direction

Reverse direction

- Use the **General** method
- Set the **Bunching law** to **BiGeometric** or **Biexponential**
 - The “**Bi**” means growth from both sides
- Set the **Spacing 1** and **Spacing 2** to the same size (1.5 set earlier) as the surrounding curves so sizes match at the ends
- Set **Ratio 1** and **Ratio 2** to a more reasonable 1.2 or 1.1
- Decrease the **Number of nodes** (pressing **Apply**) until you can measure the same size (5) between nodes at the middle as the size set on the surface

