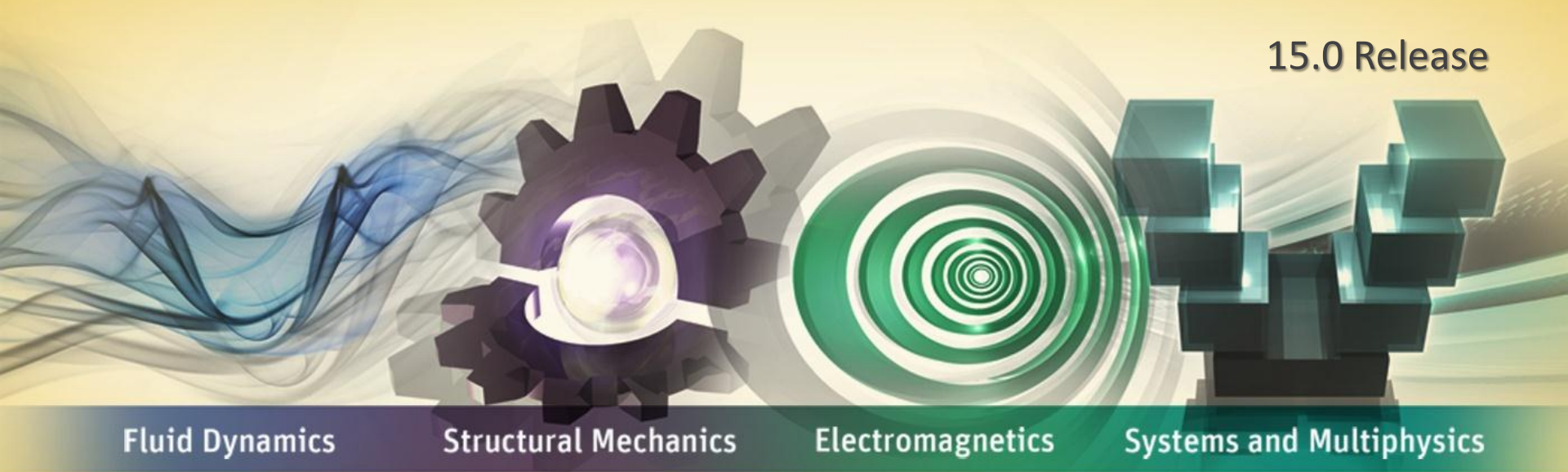


Workshop 3.2

Shell Meshing - Wingbody

15.0 Release

A horizontal banner with a yellow-to-orange gradient background. It features four distinct 3D visualizations: blue fluid flow streamlines on the left, a dark 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

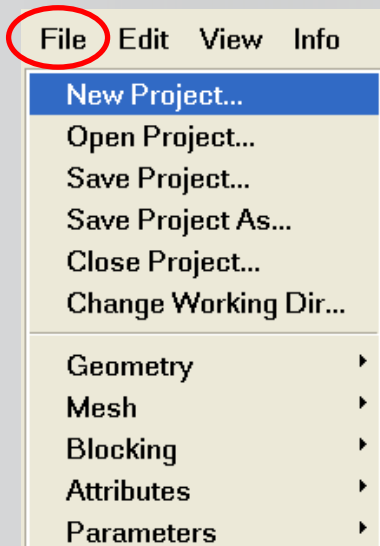
Electromagnetics

Systems and Multiphysics

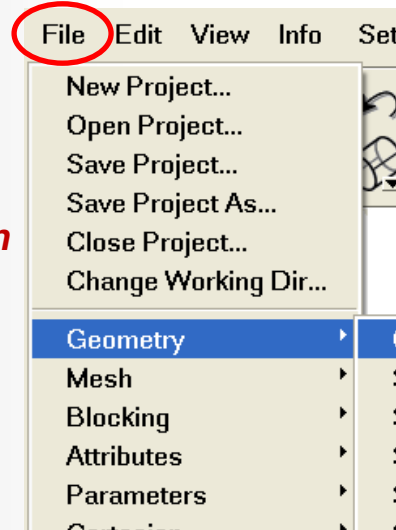
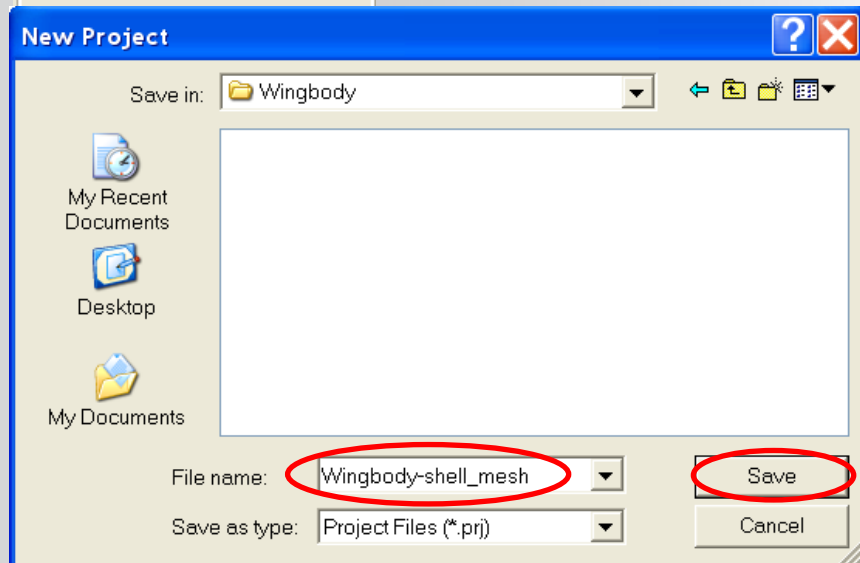
Introduction to ANSYS

ICEM CFD

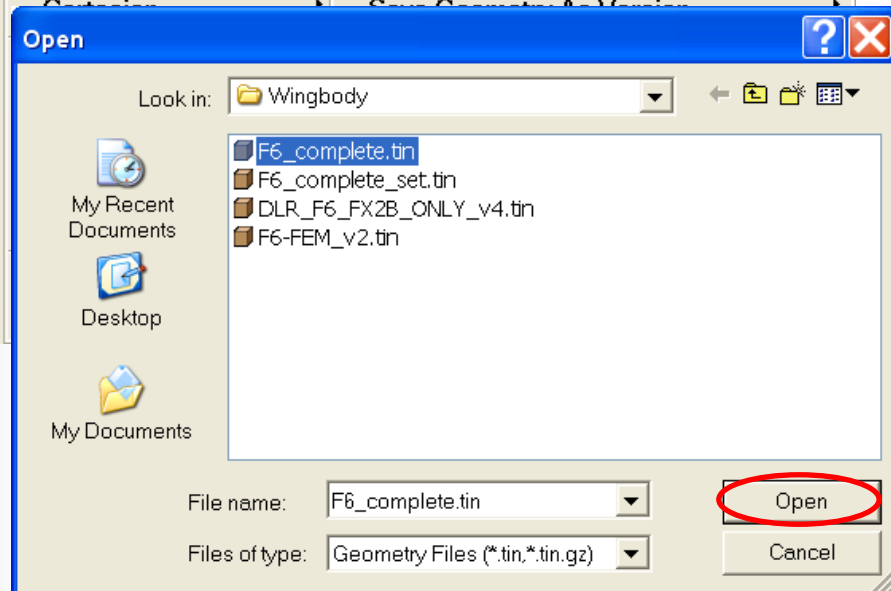
Create Project / Open Geometry



- **File > New Project**
 - Browse to the **Wingbody** folder
 - Type **Wingbody-shell_mesh**
 - **Save**



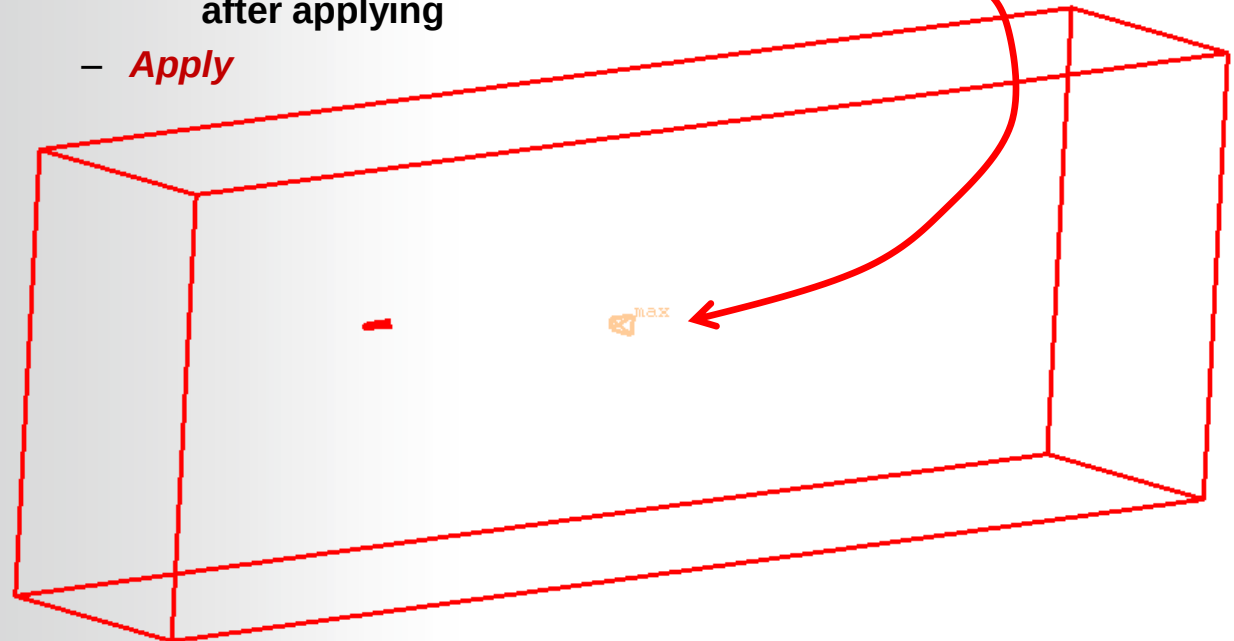
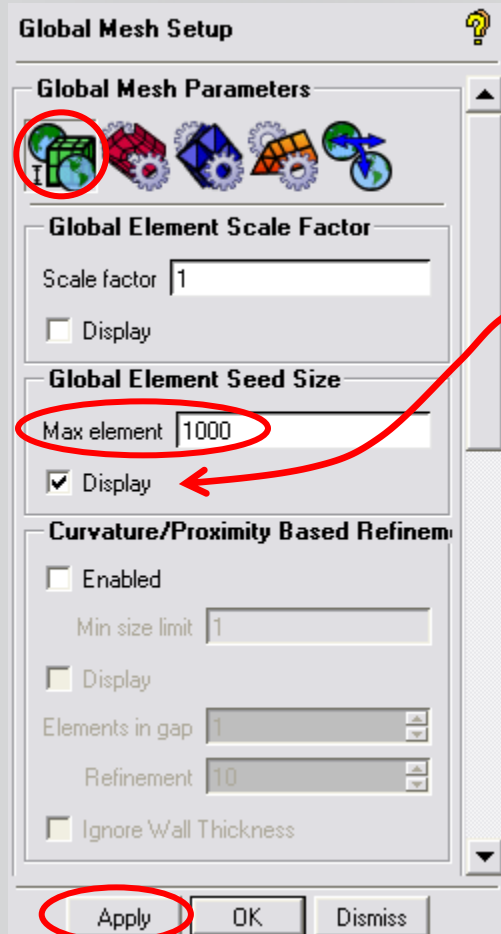
- **File > Geometry > Open Geometry...**
 - Select **F6_complete.tin**
 - **Open**





Need to set Mesh Methods, Types and Sizes:

- First set global settings
 - *Mesh > Global Mesh Setup > Global Mesh size*
 - Set *Max element* size to 1000
 - Maximum allowable mesh size in model
 - Click on *Display* to see an icon display after applying
 - *Apply*



Part Mesh Setup Spreadsheet

- Set **Max Size** by parts as shown in the table below

- **Mesh > Part Mesh Setup**
- **Apply** then **Dismiss**



Part Mesh Setup

part	prism	hexa-core	max size	height	height ratio	num layers	tetra size ratio	tetra width	min size limit	max deviation
FAIRING	☐		10	0	0	0	0	0	0	0
FARFIELD	☐		1000	0	0	0	0	0	0	0
FUSELAGE	☐		10	0	0	0	0	0	0	0
INLET	☐		1000	0	0	0	0	0	0	0
OUTLET	☐		1000	0	0	0	0	0	0	0
SYMM	☐		1000	0	0	0	0	0	0	0
WING	☐		5	0	0	0	0	0	0	0

☒ Show size params using scale factor

☐ Apply inflation parameters to curves

☐ Remove inflation parameters from curves

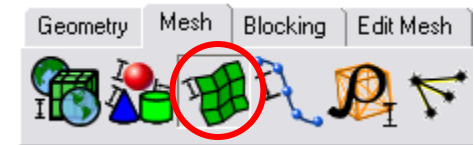
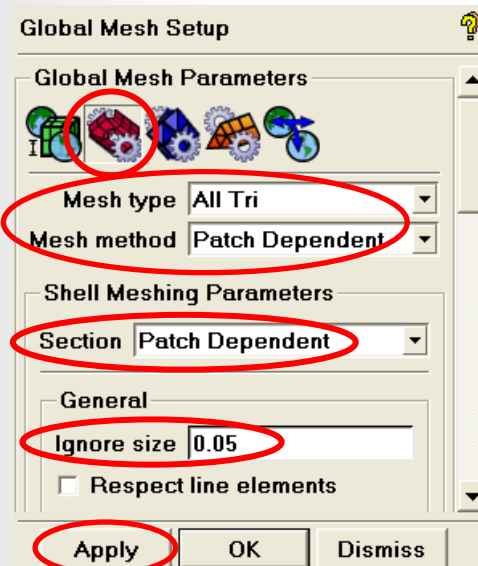
Highlighted parts have at least one blank field because not all entities in that part have identical parameters.

Apply **Dismiss**

- Sets sizes on all entities (surfaces and curves) within the part
- Inflation parameters are **height**, **height ratio**, and **num layers**, and will not be set on curves unless **Apply inflation parameters to curves** is toggled on

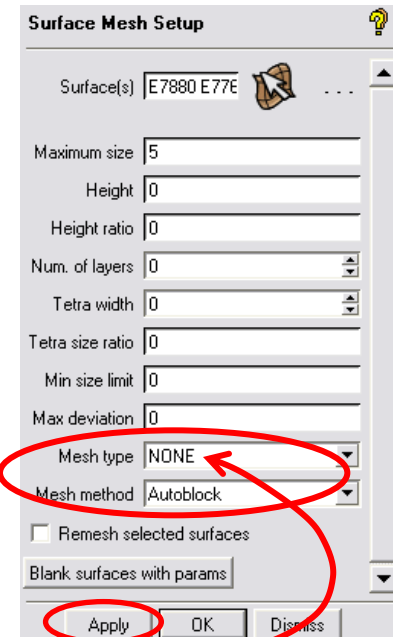
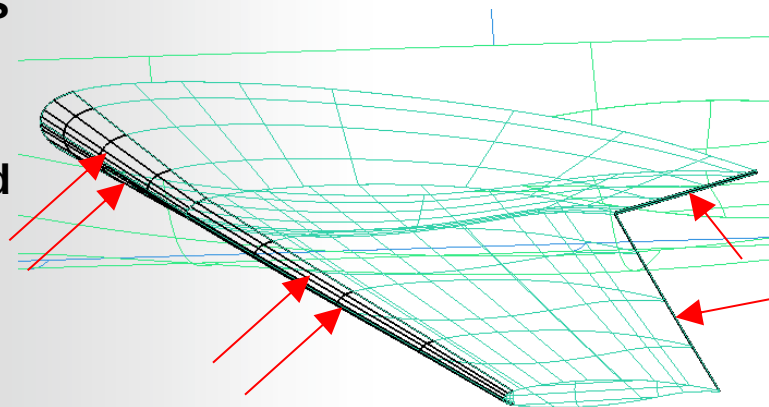
Surface Mesh Parameters

- **Mesh > Global Mesh Setup > Shell Mesh Parameters**
 - **Mesh type: All Tri**
 - **Mesh Method: Patch Dependent**
 - **Set Shell Meshing Parameters section to Patch Dependent**
 - **Set Ignore size = 0.05**
 - **Apply**



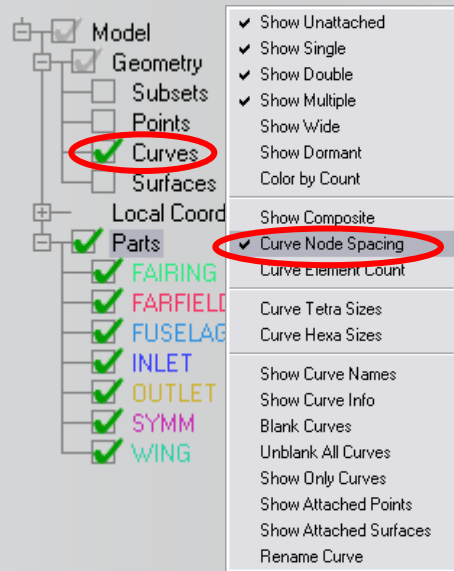
- **Force mapped mesh along wing leading/trailing edges**

- **Select Mesh > Surface Mesh Setup**
- **Select 4 leading edge, and 2 thin trailing edge surfaces as shown**
- **Change Mesh method to Autoblock**
- **Apply**



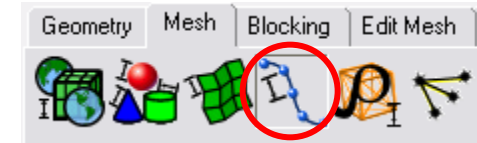
NONE means it will use the global setting
(All Tri)

Set Curve Parameters



- Set finer node distribution across leading edge
 - Turn on all **Parts**
 - Turn on **Curves** only (no surfaces or points)
 - Turn on **Curve Node Spacing** (right mouse select **Curves** > **Curve Node Spacing**)
 - Zoom toward front of **WING** where it meets the **FAIRING**

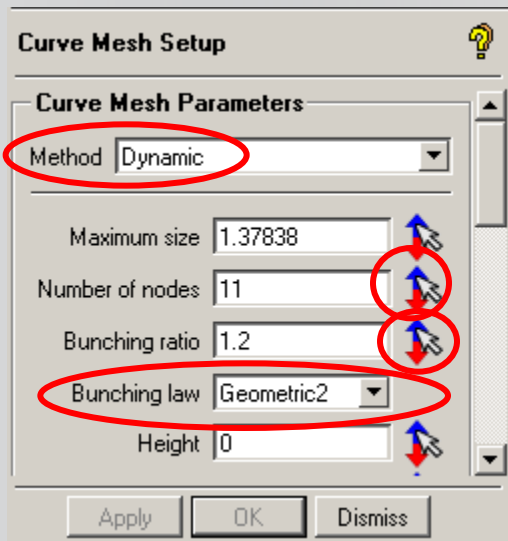
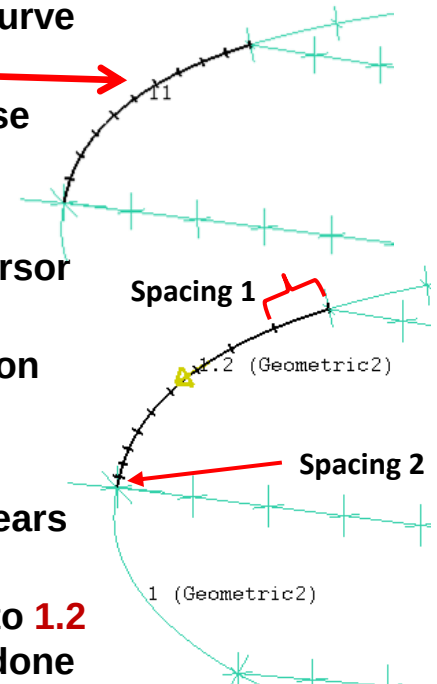
• Select **Mesh** > **Curve Mesh Setup**



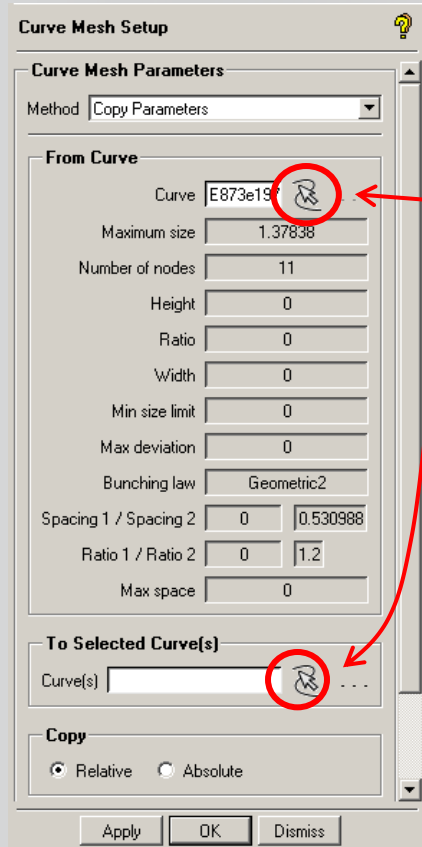
- Change **Method** to **Dynamic**
- Select **Number of nodes**
- Position cursor on node number next to curve shown
- Increment number of nodes with left mouse key to **11** nodes (right = decrement)
- Change **Bunching law** to **Geometric 1**
- Select **Bunching ratio** and position cursor over number near the same curve

- Note the arrow which defines direction from end spacing 1 to end spacing 2
- We want to bias towards side 2

- Right mouse select until **Geometric 2** appears (takes one click)
- Increment with left mouse (over number) to **1.2** (takes 2 clicks), and middle mouse when done



Set Curve Parameters



- Copy same distribution to opposing “parallel” edges

- Still under **Curve Mesh Setup**, change **Method** to **Copy Parameters**

- For **Curve** select same curve we just edited

- **To Selected Curve(s)**, select 5 curves shown across leading edge

- **Middle mouse**, then **Apply**

- Some curves have a reversed direction than the one we copied from

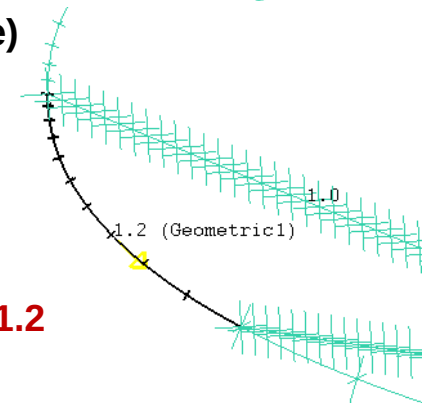
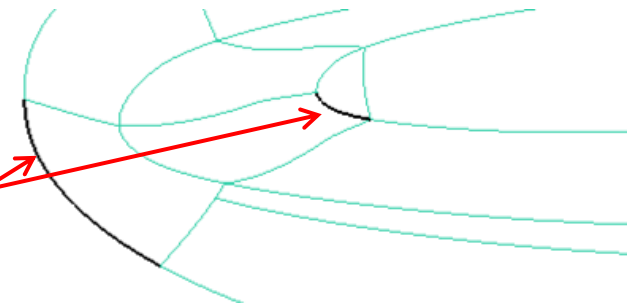
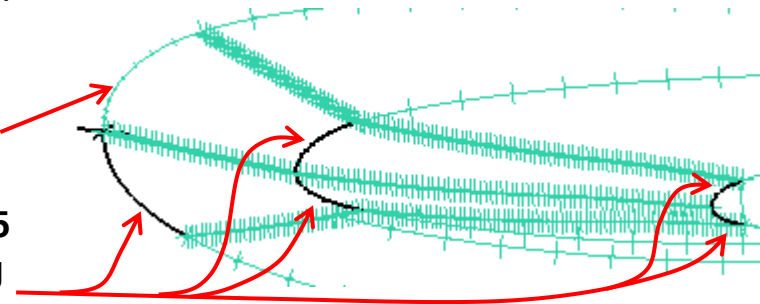
- In this case two bottom end curves as shown are opposite direction

- Go back to **Dynamic** method

- Reverse (right mouse on curve) to decrease **Bunching ratio** number to **1.0** (two clicks)

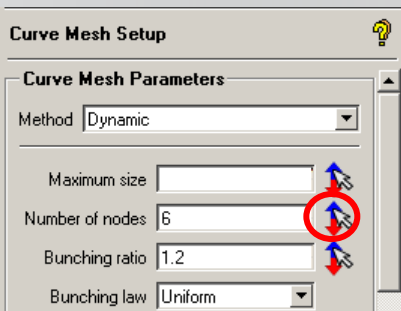
- Bunching law changes to **Geometric 1**, when the ratio reaches 1

- Left mouse key to increase to **1.2** (two clicks)



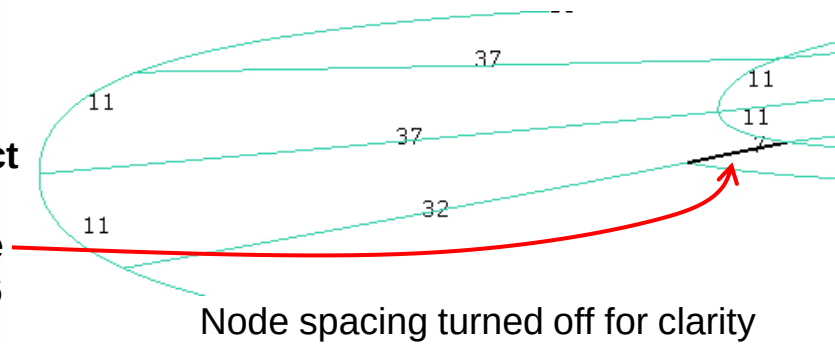
Remember F9 key allows you to move model during selection

Set Curve Parameters

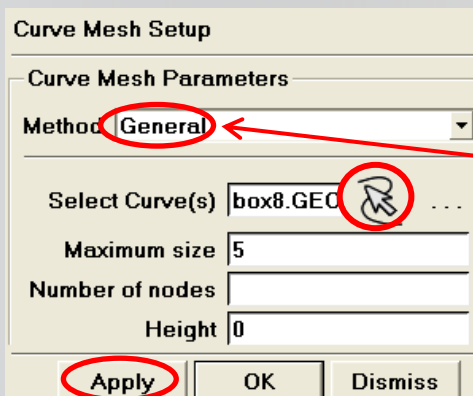
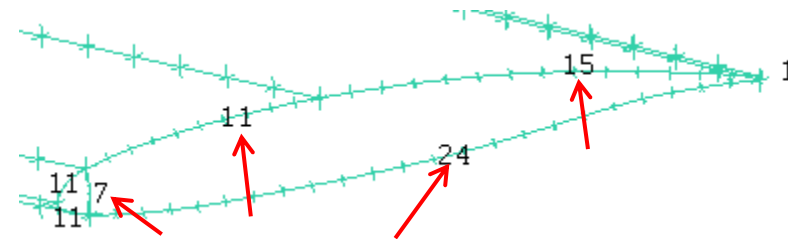


- Make number of nodes equal across parallel curves

- Still in **Dynamic** method select **Number of nodes** and change curve towards middle bottom of wing as shown to 6 (right mouse to decrease)
- **Middle mouse** to finish

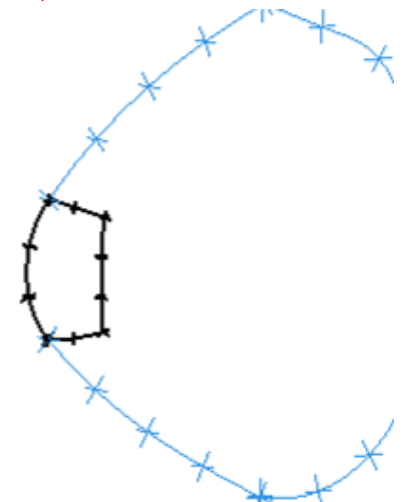


- This will give $32 + 6 - 1$ (shared node) = 37 nodes
- Same as parallel ones
- Needed to ensure a mapped mesh
- Also increase number of nodes along wing tip to more closely match those along leading edge



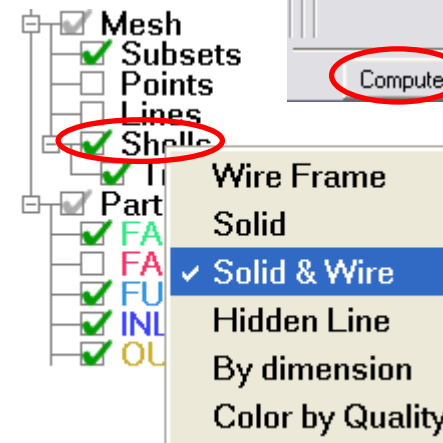
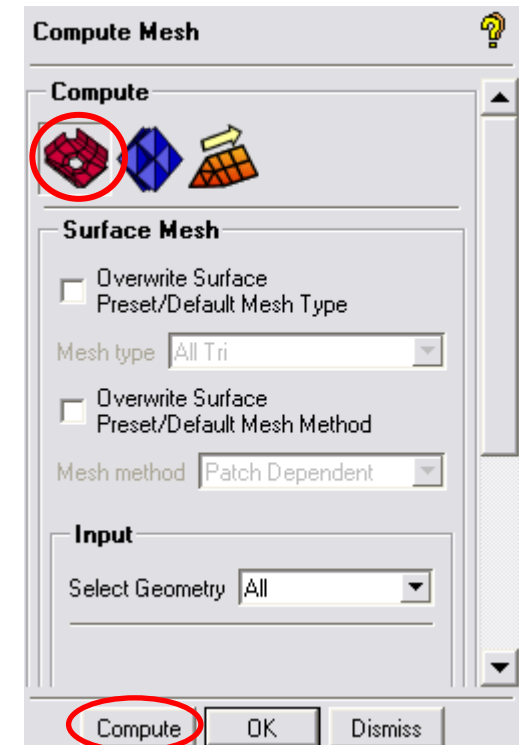
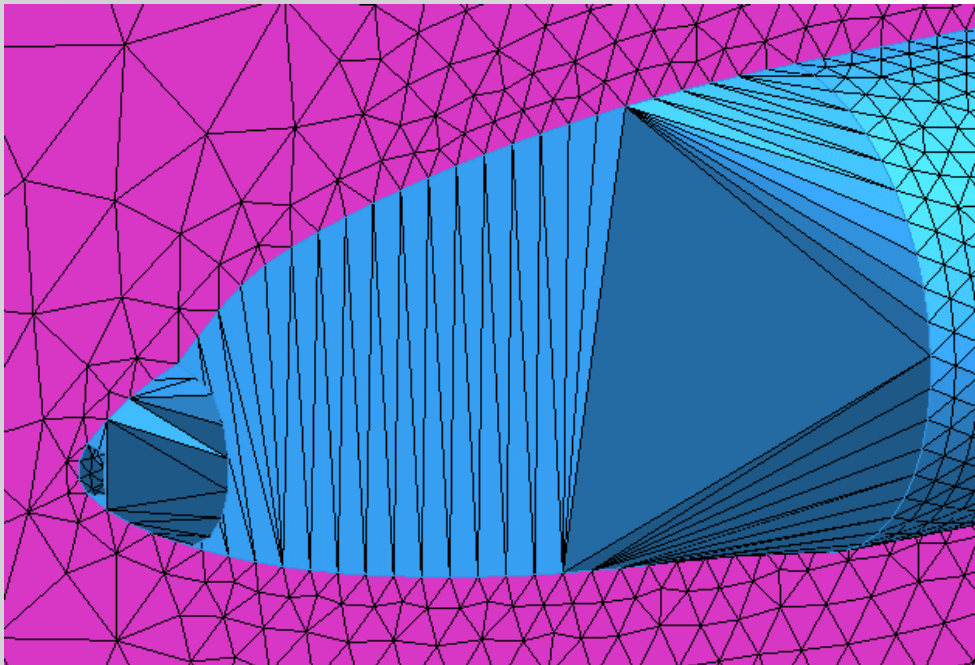
- Refine node distribution near the fuselage nose

- Change **Curve Mesh Setup Method** to **General**
- Select 4 front most curves along fuselage shown (nose of plane body)
- **Middle mouse** to accept selection
- Change **Maximum size** to 5
- **Apply**



Create Surface Mesh

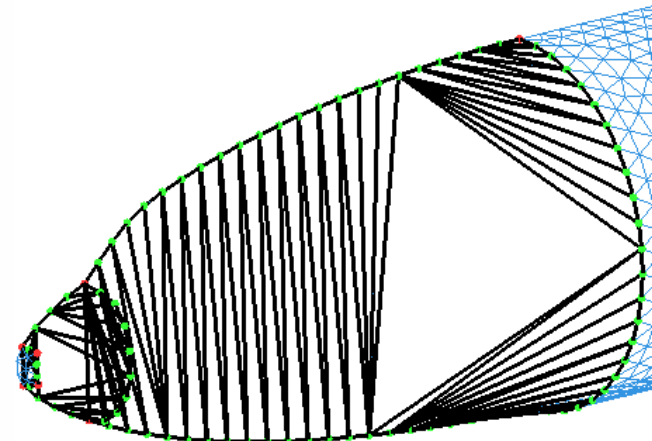
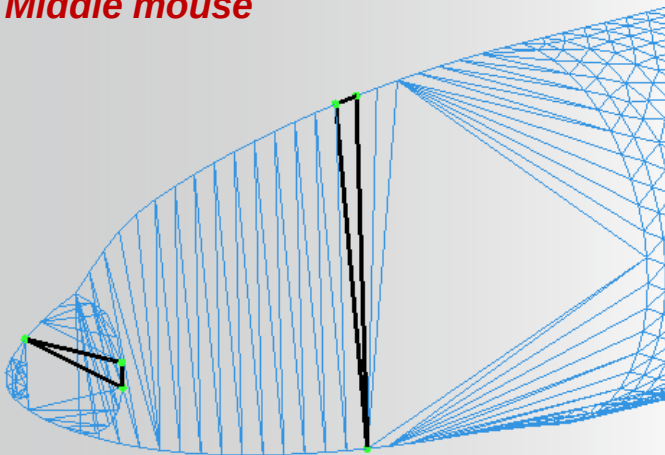
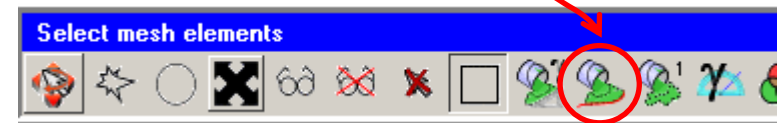
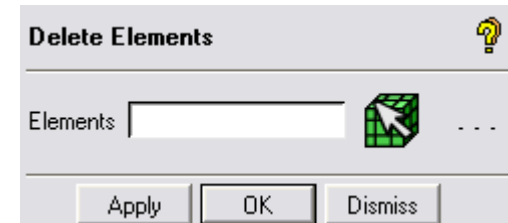
- **Mesh > Compute Mesh > Surface Mesh Only**
 - Select **Geometry > All**
 - **Compute**
- Note bad quality surface mesh in front of fuselage
 - Turn off **FARFIELD** part
 - Right click on **Mesh > Shells > Solid & Wire** in model tree



Delete Mesh



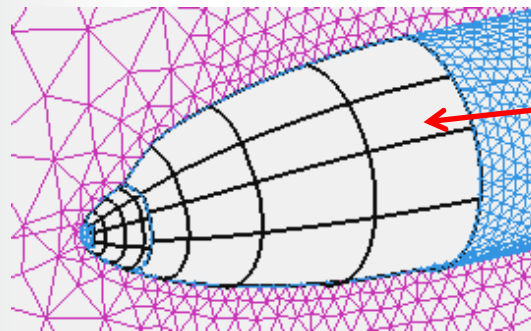
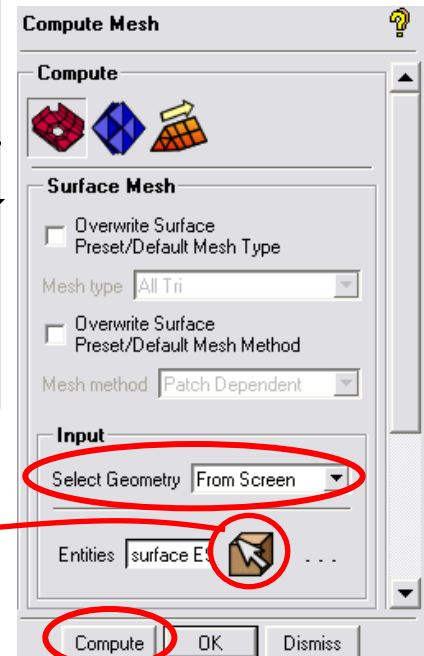
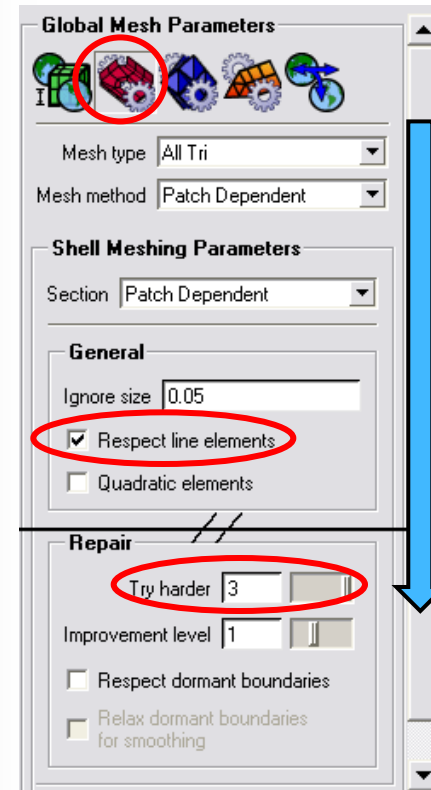
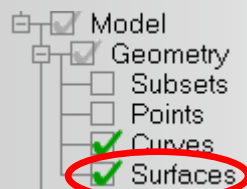
- Delete bad mesh
 - Turn off **FARFIELD**, **INLET**, **OUTLET**
 - To be able to select mesh behind them
 - Select **Edit Mesh > Delete Elements** and select one of the elements on each surface as shown
 - Press button for, **Select all items attached to current selection up to a curve** in **Select mesh elements** toolbar or “r” on the keyboard to flood-fill all other elements on those two surfaces
 - Flood fills to boundary curves making up loop
 - **Middle mouse**



Re-Mesh Two Surfaces

- Remesh fuselage surfaces

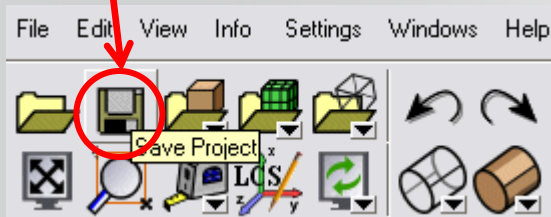
- Go back to **Mesh > Global Mesh Setup > Shell Meshing Parameters**
- Turn on **Respect Line Elements**
 - To ensure new mesh is conformal with mesh on adjacent surfaces
- Change **Repair > Try harder** level to **3**
 - Runs robust octree (patch independent) method on that surface if a surface fails
 - Further down menu
 - **Apply**
- Select **Mesh > Compute Mesh > Surface Mesh Only**
 - Change **Input** to **From Screen**
 - For **Entities**, select the two surfaces, then **middle mouse** click
 - Make sure to have surfaces turned on in Model tree
- **Compute**



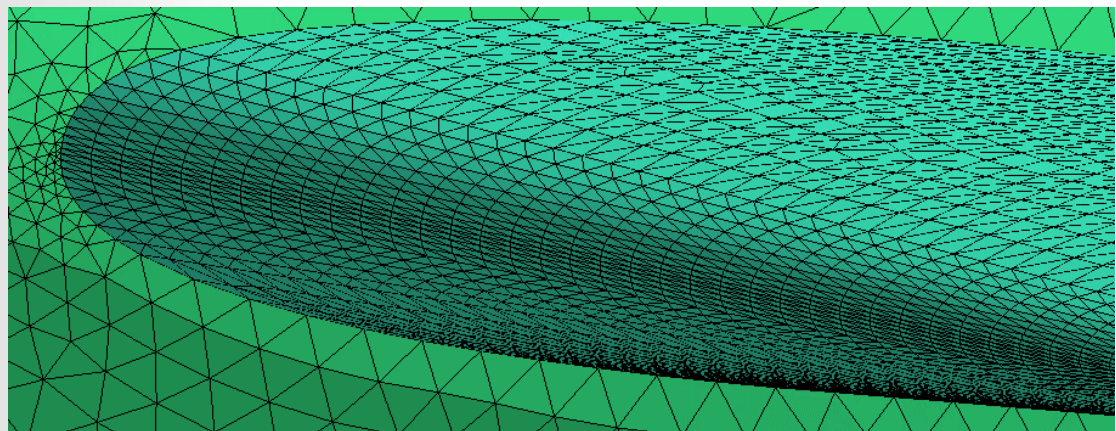
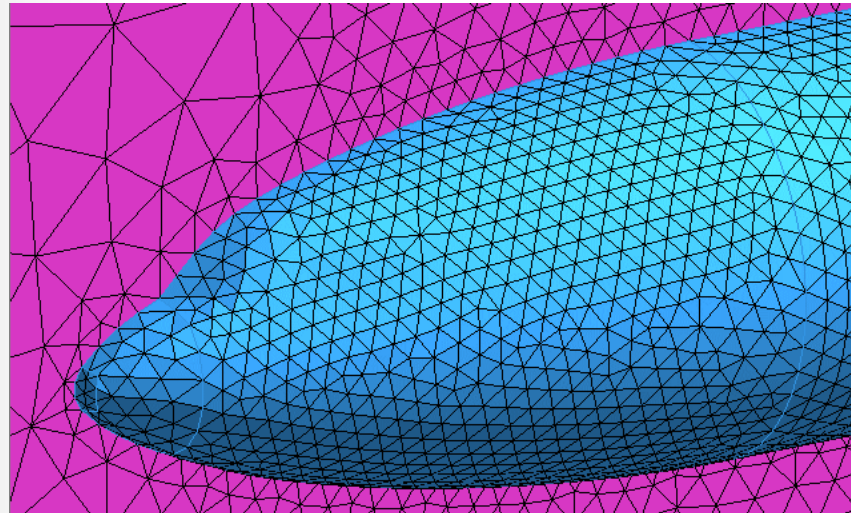
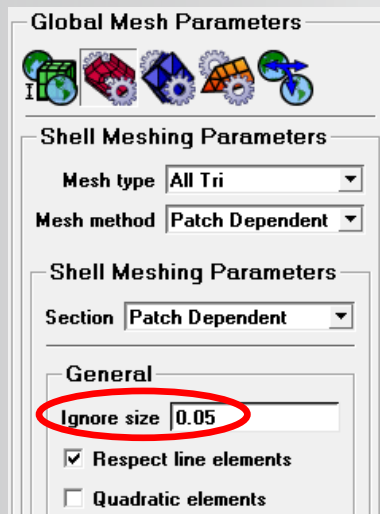
Final Mesh

- Observe revised surface mesh
- Note mapped (aligned) mesh along leading edge (front of wing)

Save Project!

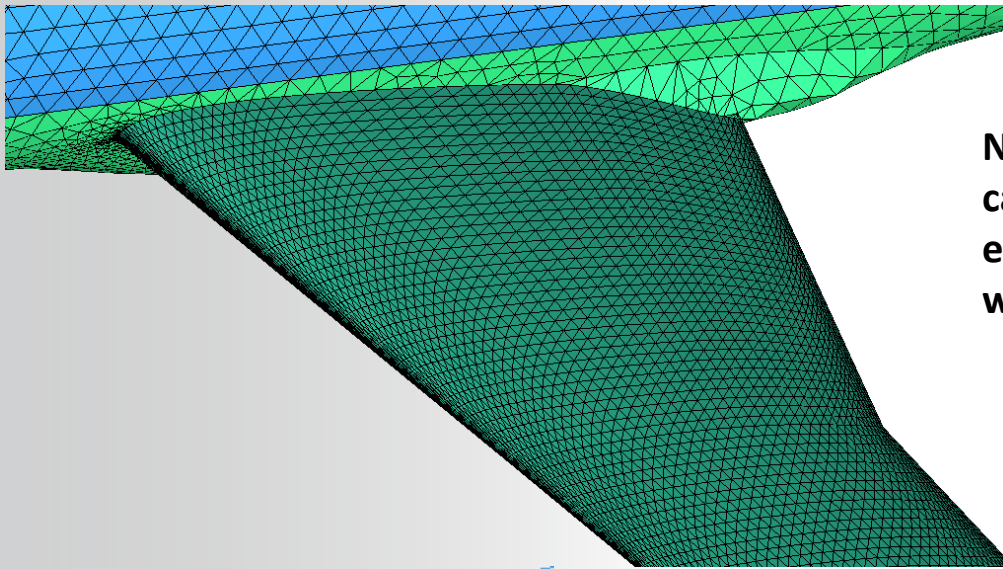


- Mapped mesh will not work if ignore size is not small enough



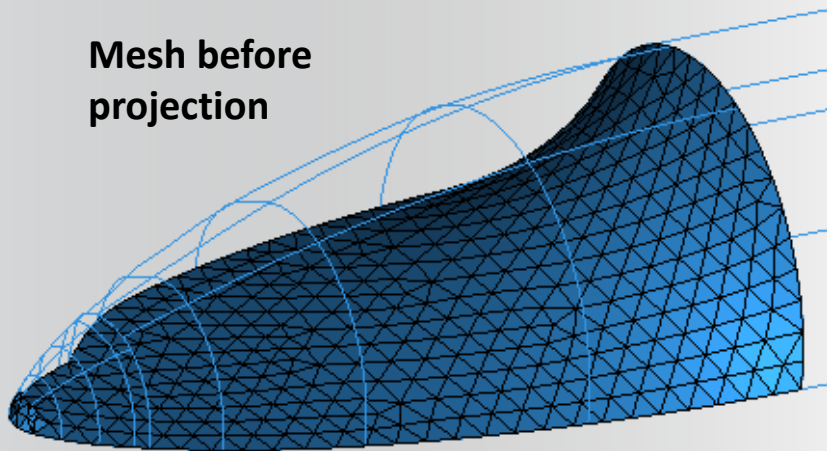
Further Investigation

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

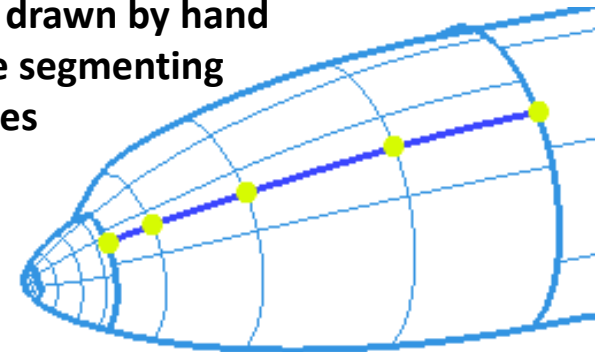


Node distributions
carefully set along
entire wing along
with mapping

Mesh before
projection

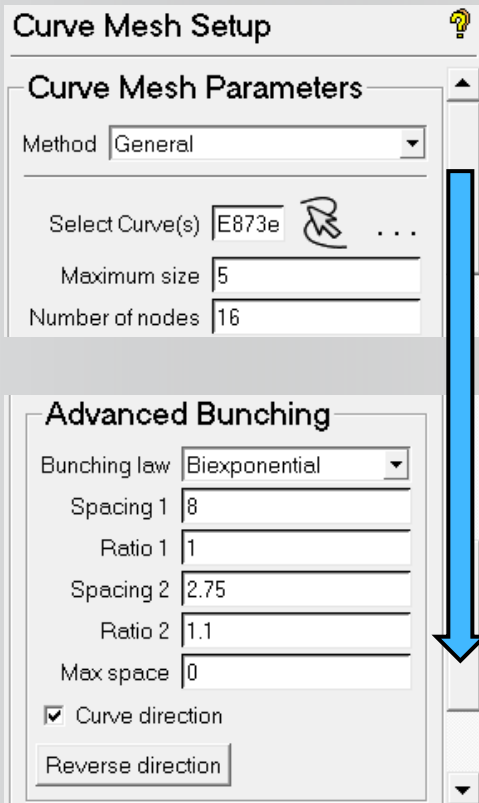


Curve drawn by hand
before segmenting
surfaces



Curve Distribution

- Use the Advanced Bunching of the **General** method (instead of the **Dynamic** method) for **Curve Mesh Setup** to set the distribution on the curve shown at the base of the WING
 - The parameters will read the current settings when you select the curve

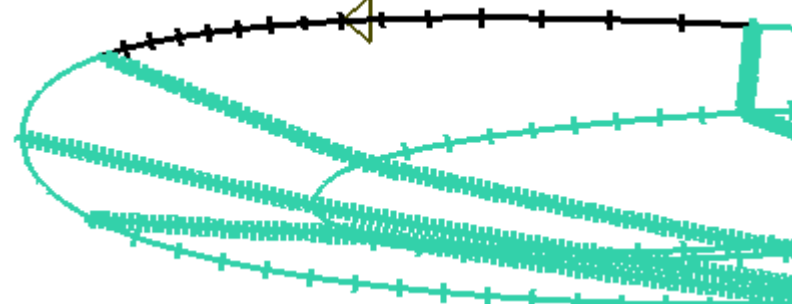
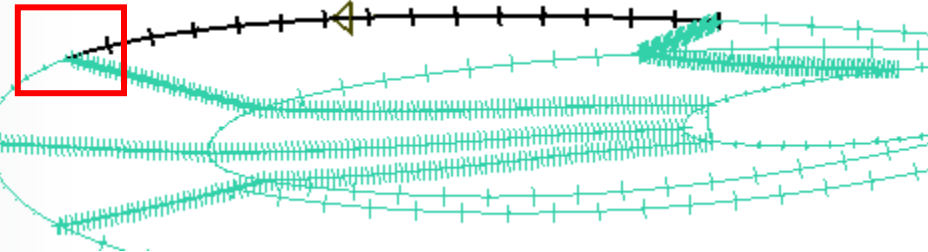


- Turn on **Curve direction** to indicate side 1 and side 2

- Quick jumps in element size are bad for most CFD analysis
- Measure the first node distance on the adjacent curve to match sizes on side 2. Set **Spacing 2** to this same size (2.75)
- Set the **Bunching law** to **Biexponential**, which is the most accommodating law (“**Bi**” means growth from both sides)
- Increase the distance at the middle of the wing (set **Spacing 1** = 8) and set a more reasonable growth of 1.1 for **Ratio 2**. Set **Ratio 1** to 1.

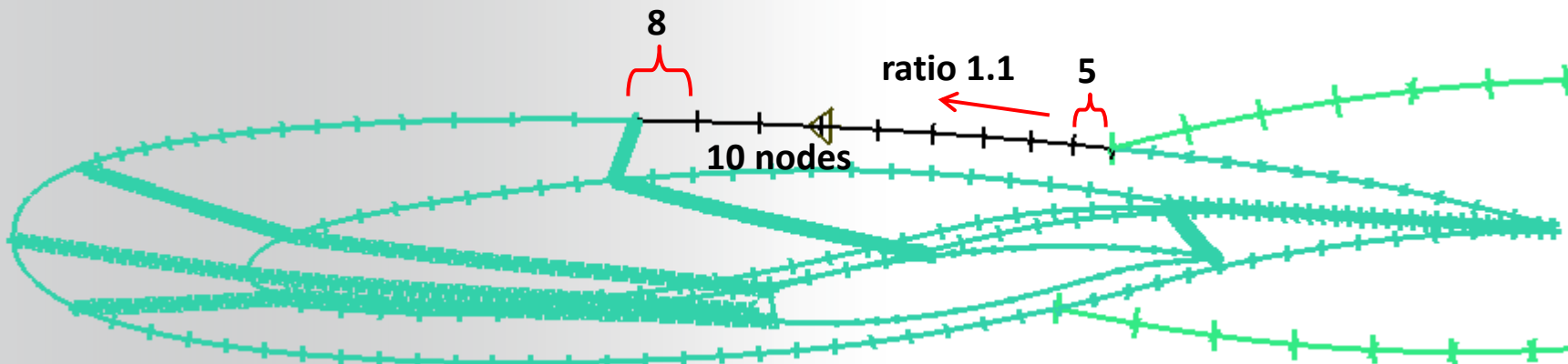


2.75



Curve Distribution

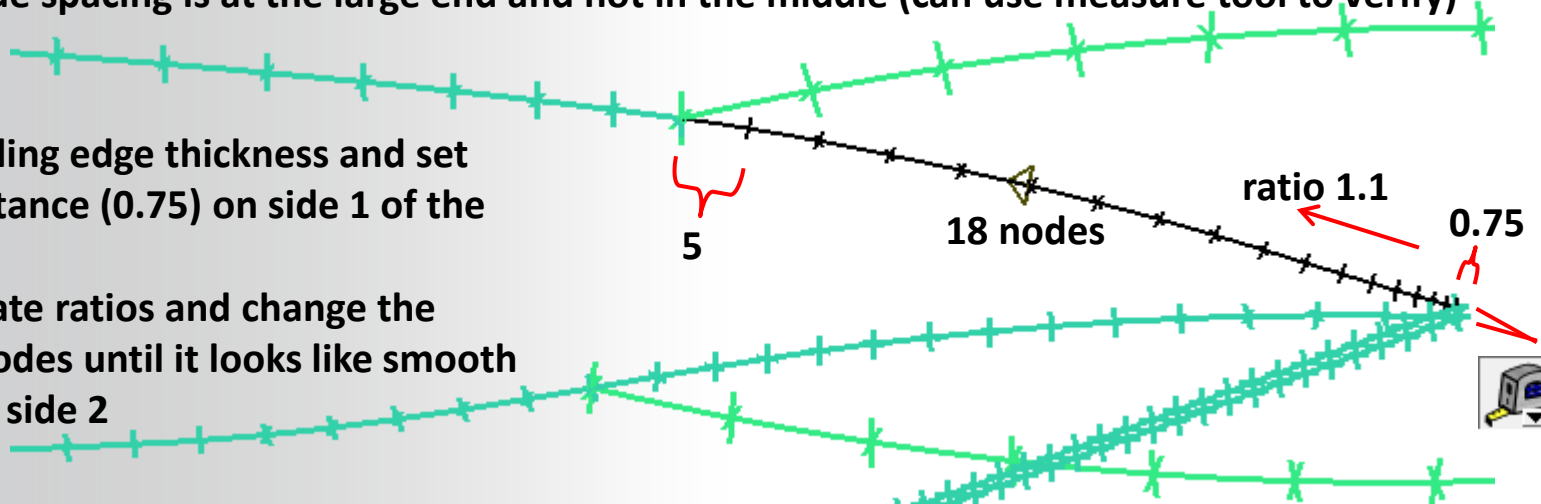
- You can repeat a similar procedure at the WING base curve at the middle and nearer to the trailing edge to get matching sizes at the trailing edge and a larger size at the wing center with a smooth growth along the curve



Set the spacings and ratios, then increase or decrease the number of nodes until it looks like the largest node spacing is at the large end and not in the middle (can use measure tool to verify)

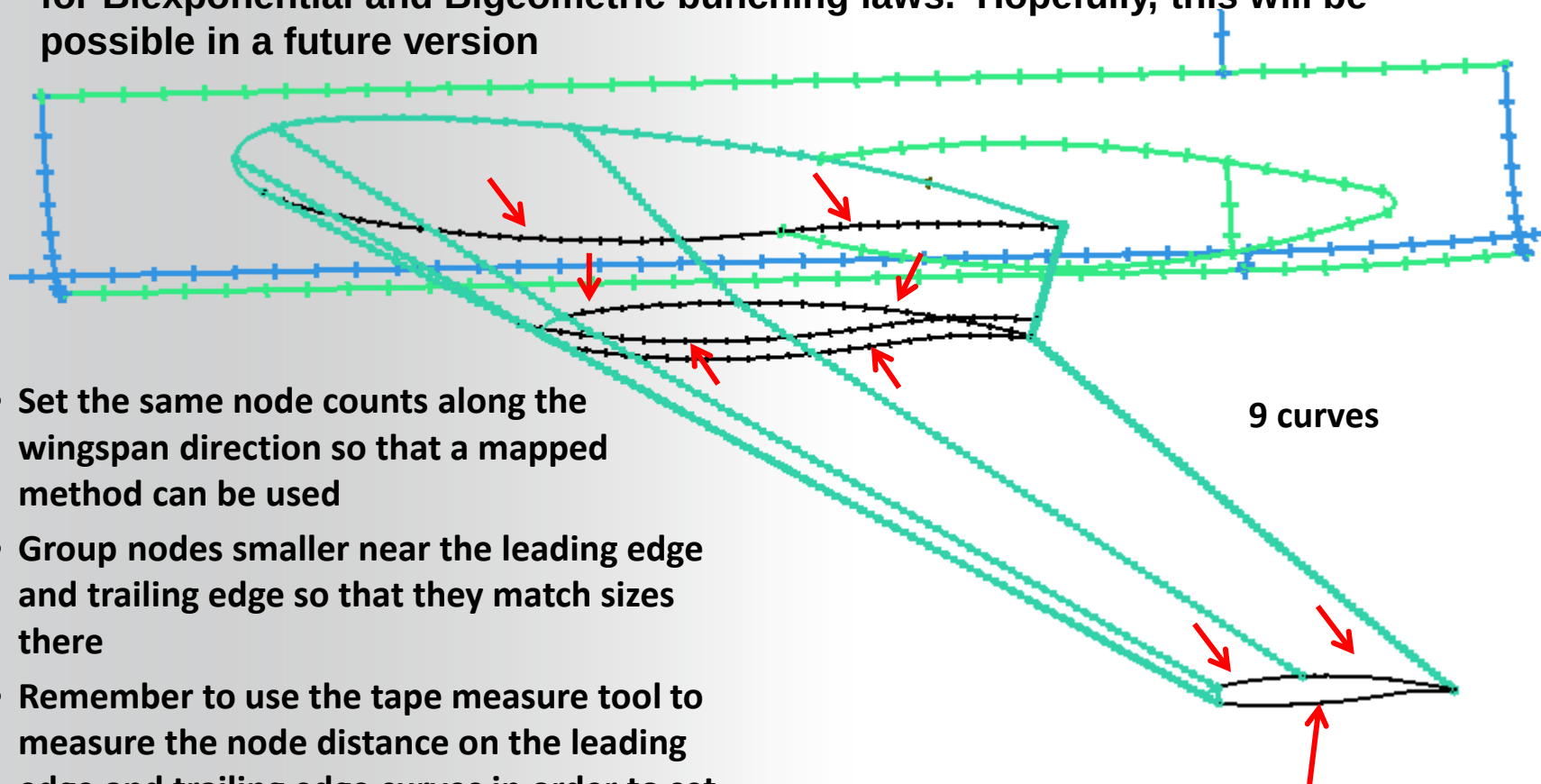
Measure trailing edge thickness and set the same distance (0.75) on side 1 of the curve

Set appropriate ratios and change the number of nodes until it looks like smooth grow toward side 2



Curve Distribution

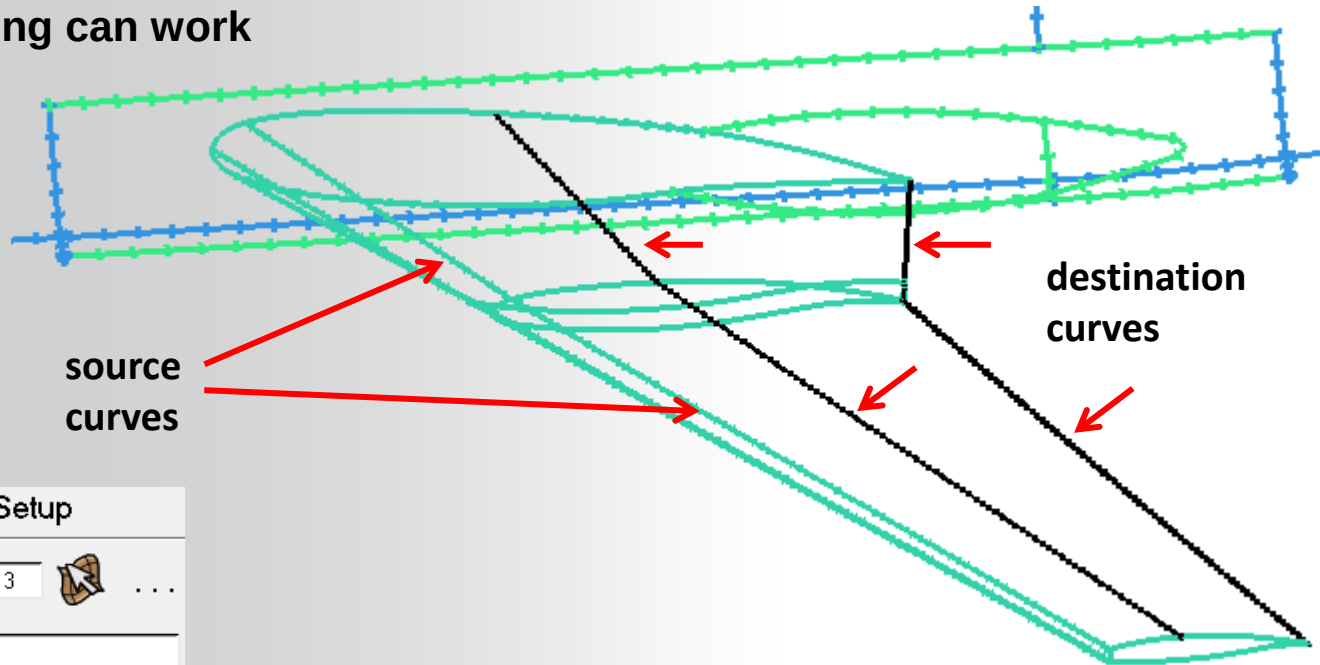
- Set similar distributions on the rest of the chord-length curves on the top and bottom of the wing
- This must be done manually, since *Copy parameters* for curves does not work for Biexponential and Bigeometric bunching laws. Hopefully, this will be possible in a future version



- Set the same node counts along the wingspan direction so that a mapped method can be used
- Group nodes smaller near the leading edge and trailing edge so that they match sizes there
- Remember to use the tape measure tool to measure the node distance on the leading edge and trailing edge curves in order to set spacing 1 or spacing 2

Copy Parameters

- Copy curve parameters from the leading edge curves to the middle and trailing edge curves running spanwise so that the node counts match and the mapped meshing can work



Surface Mesh Setup

Surface(s)  ...

Maximum size

Height

Height ratio

Num. of layers

Tetra width

Tetra size ratio

Min size limit

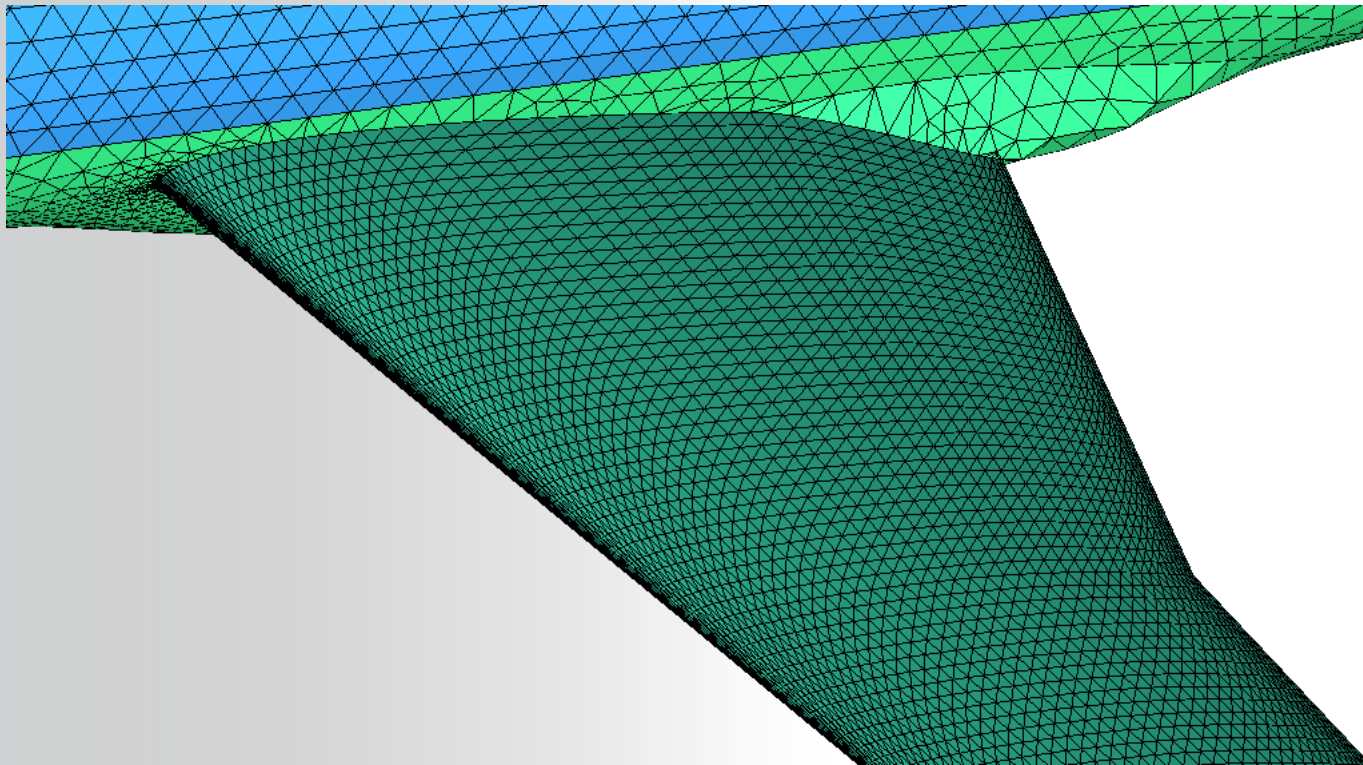
Max deviation

Mesh type

Mesh method

- Then set the mapped method (autoblock) on all the wing surfaces except the wing tip surfaces

- Generate the surface mesh again
- If you remesh with **Respect line elements** ON, you will not see a change, since shell mesh on surface patches begin node seeding at the boundaries where the line elements exist, and these are kept from the previous mesh
 - Either close the current mesh before remeshing or,
 - Turn **Respect line elements** OFF before remeshing



Nose Mesh

- In order to show different methods to fix the nose mesh, you must first bring the problem back
 - In the **Global Mesh Setup > Shell Meshing Parameters**, lower the **Try harder** back to the default of 1 instead of 3 where the tutorial set it earlier
 - Close the current mesh
 - Remesh to see the problem again
- Manually set the 2 surfaces to patch independent using the **Surface Mesh Setup**

Surface Mesh Setup

Surface(s) ...

Maximum size

Height

Height ratio

Num. of layers

Tetra width

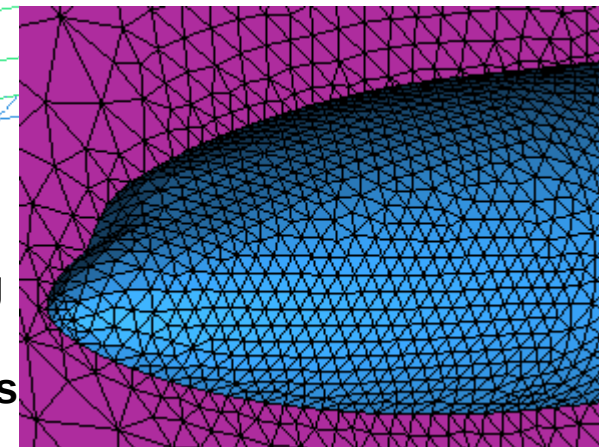
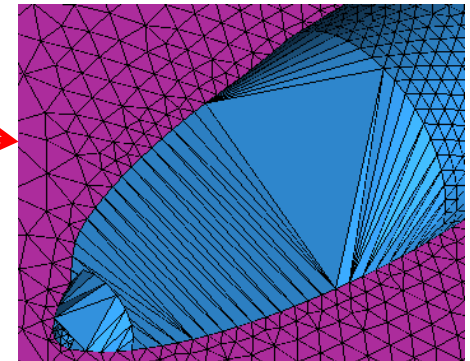
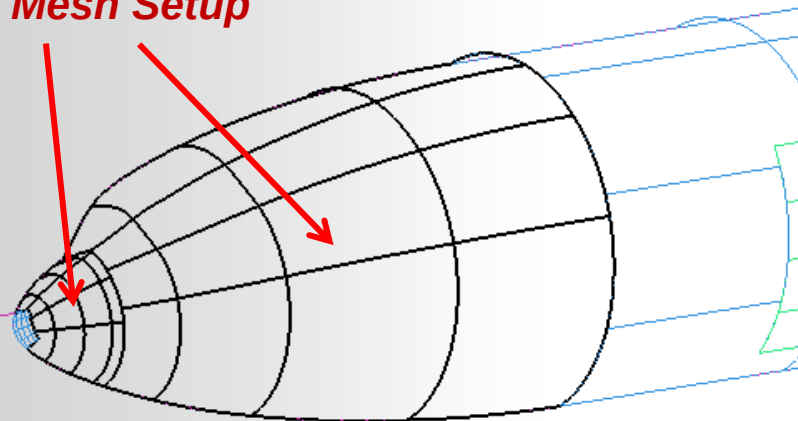
Tetra size ratio

Min size limit

Max deviation

Mesh type

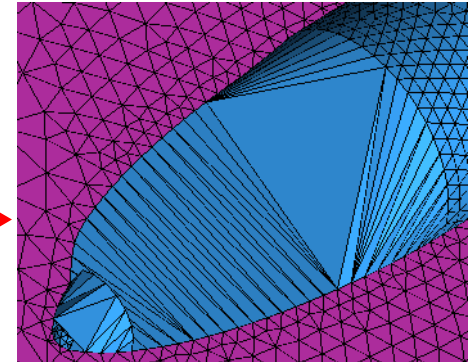
Mesh method



- Either close the mesh and remesh
- Or delete the 2 mesh patches using **“attached to current selection”** and remesh only the 2 selected surfaces with **“respect line elements”** ON

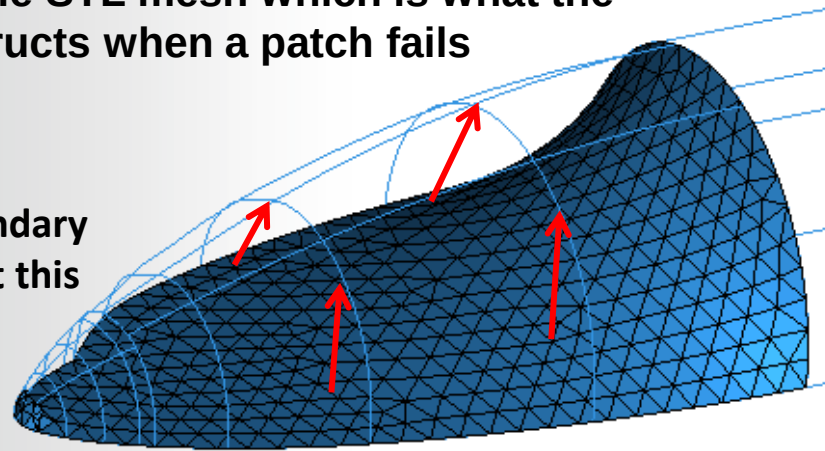
Nose Mesh

- Set the **mesh method** back to **NONE** on the 2 surfaces and remesh in order to see the problem again →
- The reason this is a problem is because the mesh begins at the boundary node positions and paves inward, then projects nodes to the surface, but the distance to project is too far, so it does a simple STL mesh which is what the **Try harder** setting of 1 instructs when a patch fails

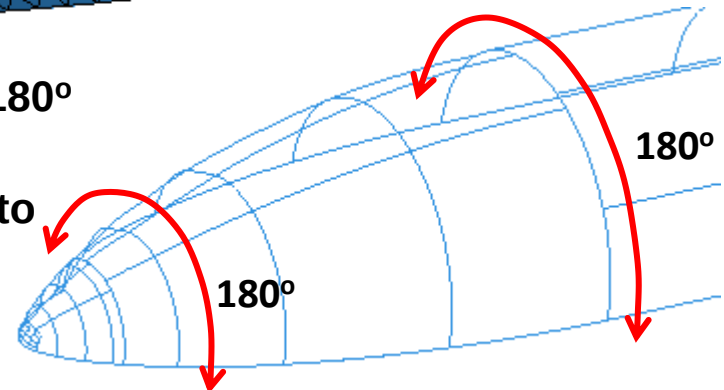


Simple STL mesh

Mesh generates from boundary and projects to surface but this is too far to project



- This problem occurs when the surface spans 180° or more of curvature
- So another solution is to segment the surface to break it up into less than 180° curvature



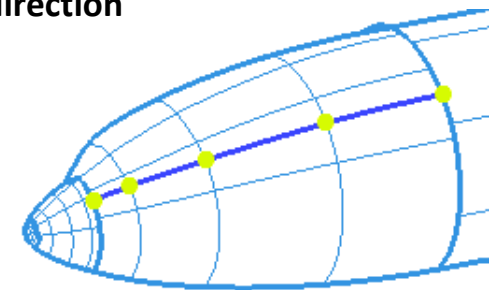
Segment Surfaces

- First create the curve
 - Could do this as an Iso-curve
 - Or draw a spline on the surface and project to surface
 - Or could create an intersection plane surface and create the curve by intersection
- Then segment the surface either manually or using **Build Diagnostic Topology**
 - You must run **Build Topology** anyway to compute the connectivity on the new surfaces before using the patch dependent surface mesher

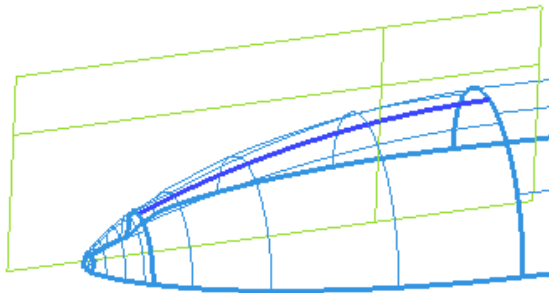
Geometry



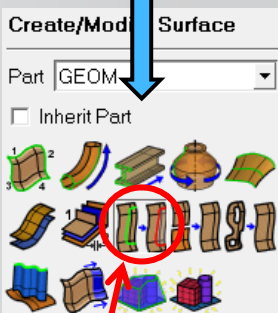
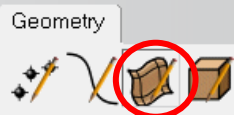
Surface parameter (iso-curve) – choose **U** or **V** and delete (or **undo**) the curve in the wrong direction



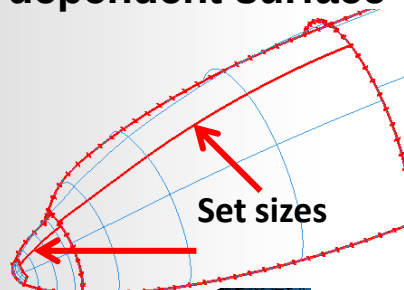
From points (spline) – select locations on surface
Project to surface if necessary



Create a plane and then create the curve by intersection



- The new curves will need mesh sizes set on them
- Finally mesh the geometry



Segment/Trim Surface manually

