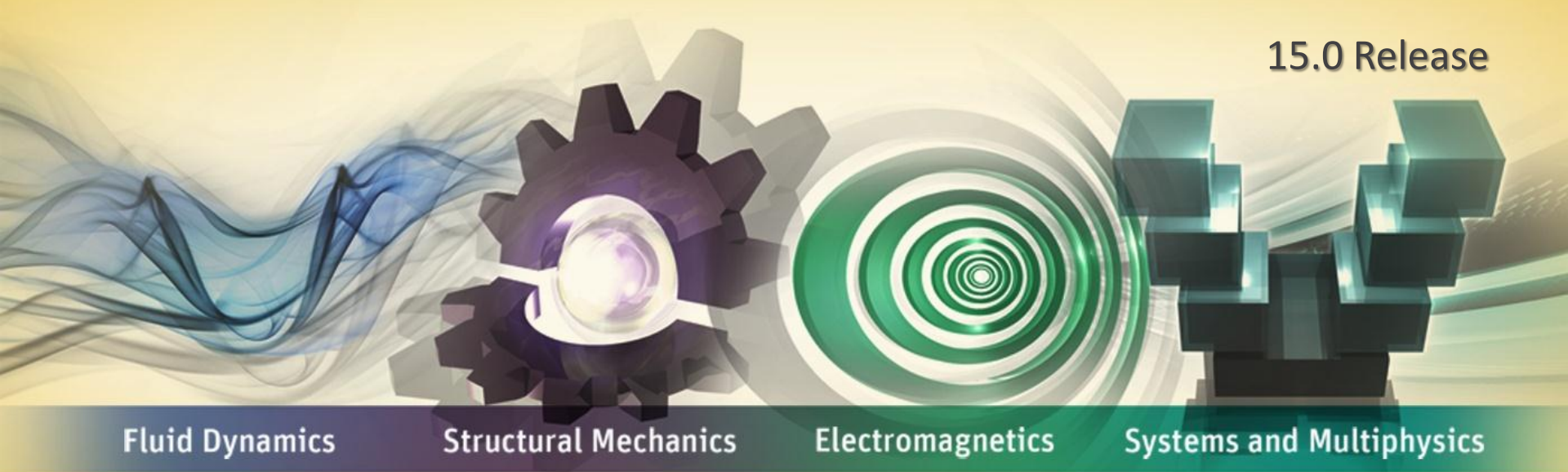


Workshop 5.2

Prism 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, a purple gear with a glowing center, a green concentric circle 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

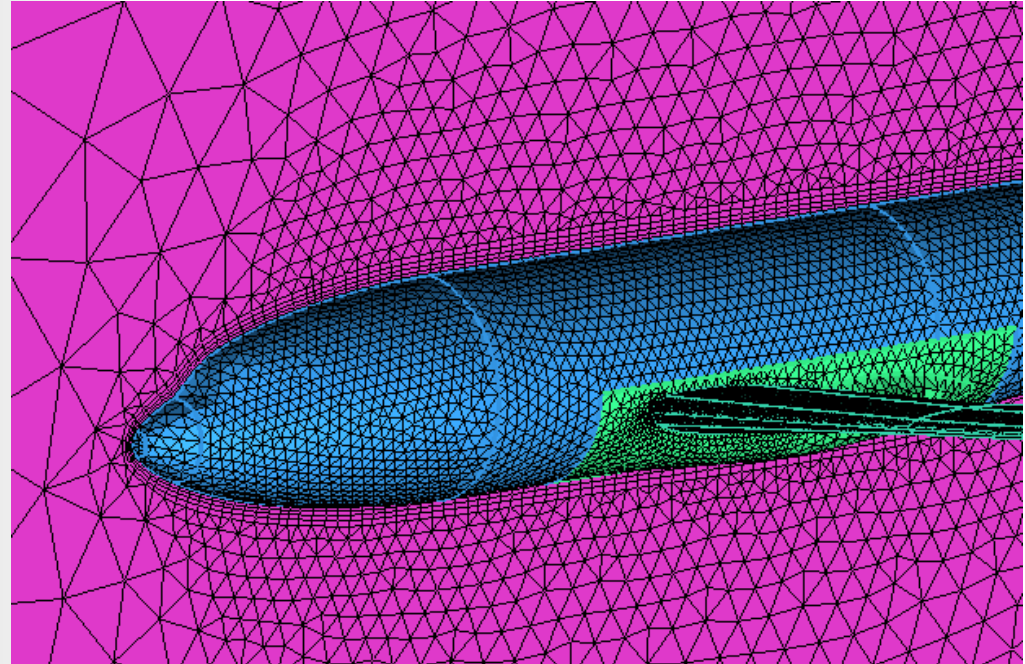
Systems and Multiphysics

Introduction to ANSYS

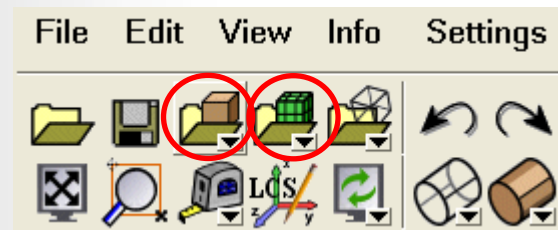
ICEM CFD

“Bottom up” Volume Meshing

- First, extrude prism mesh from standalone surface mesh
 - “Bottom up” approach
 - Could also extrude into existing volume mesh (traditional ICEM CFD method), “top down” approach
- Generate rest of grid
 - Farfield volume
 - Delauney
- Use density region
 - Define mesh size for refinement in area where no geometry exists
- Create Hexa core
 - For majority hex fill in far field
- Choose **File > Open Project**
 - To load previously saved surface mesh and geometry
 - Browse to **Wingbody** working directory
 - Load previous project
 - Loading project also sets directory



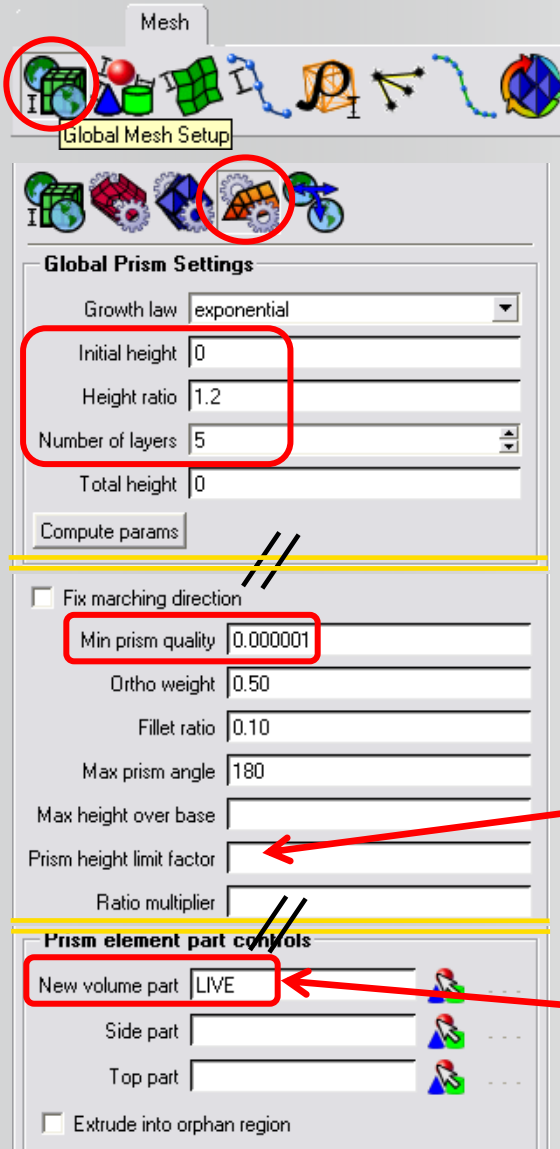
If previous project was not completed, or not done satisfactorily, set working directory to Wingbody, load the geometry, **F6_complete.tin** and the mesh **f6_surf.uns**



Global Prism Parameters

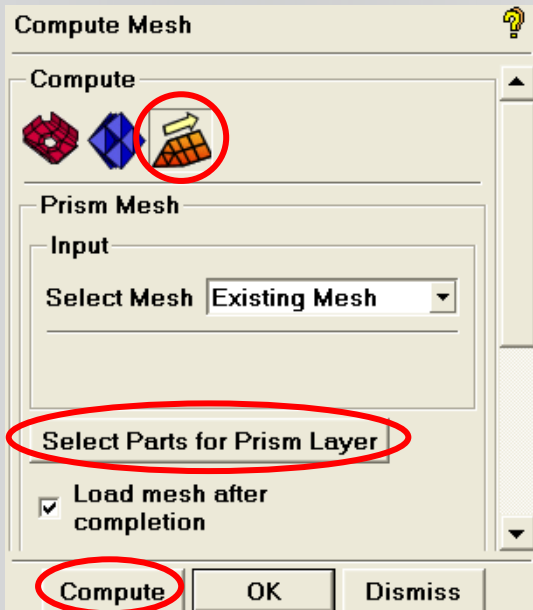
- Set global prism parameters

- **Mesh > Global Mesh Setup > Prism Meshing Parameters**
- Set **Growth law** to **exponential** (default)
- **Initial height** = 0 (total height must also be 0)
 - Height determined automatically so that last prism is of similar volume to adjacent tetra
 - Proportional to size of surface triangle
- **Height ratio** = 1.2
- **Number of layers** = 5
- **Min prism quality** = 0.000001
 - Min allowed is $1e10^{-6}$. A low quality encourages less pyramids to form.
- Clear out the **Prism height limit factor** from the previous project
- **New volume part** = **LIVE**
 - We will create prism from a surface-only mesh
 - The volume part is required when extruding from surface mesh only
- **Apply**



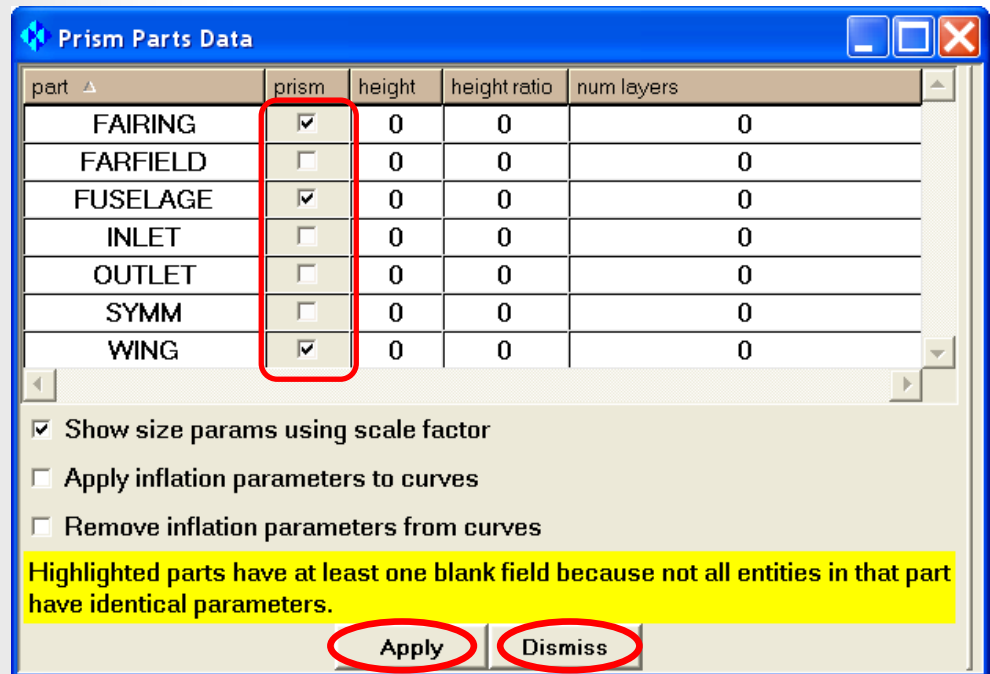
Pick Parts for Prism Mesh

Mesh

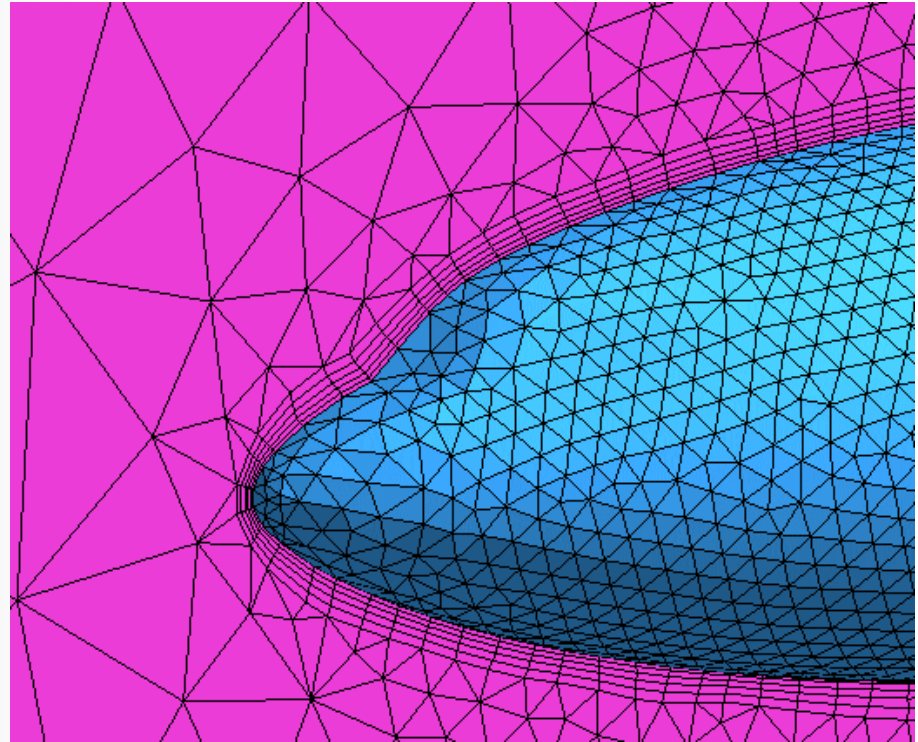
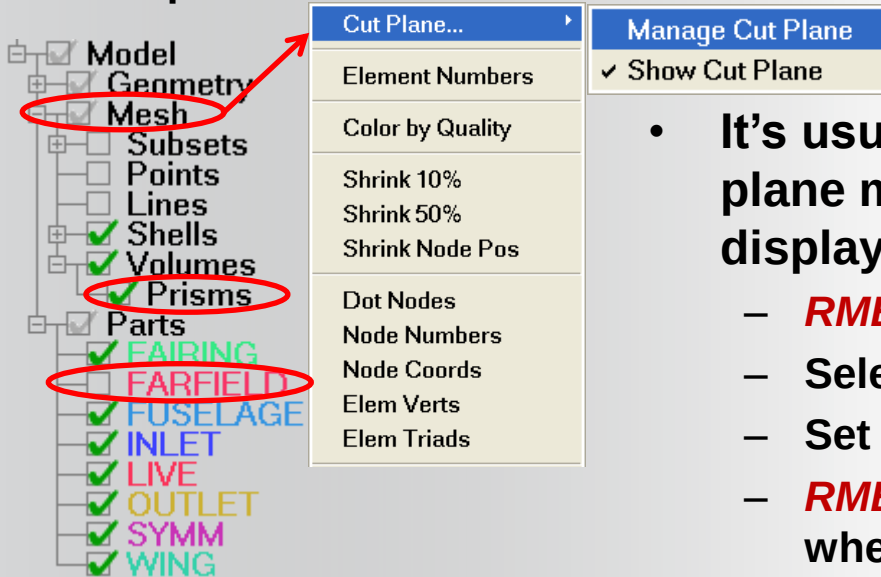


- Unstructured mesh, *prism.uns* is saved automatically to the working directory when prism is run

- Select Parts and Compute prism mesh
 - Mesh > Compute Mesh > Prism Mesh*
 - Press *Select Parts for Prism Layer*
 - Select FAIRING, FUSELAGE, and WING in the prism column
 - Apply*, then *Dismiss*
 - Compute*
- Height, height ratio, and num layers were set globally



- Display Prism mesh
 - Make sure **Shells** are on
 - Turn off FARFIELD
 - Zoom in to view prism quad faces on symmetry plane
 - Turn on **Mesh > Volumes > Prisms** in **model tree**
 - There is no other volume mesh but prisms

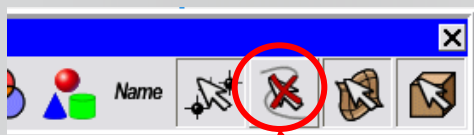
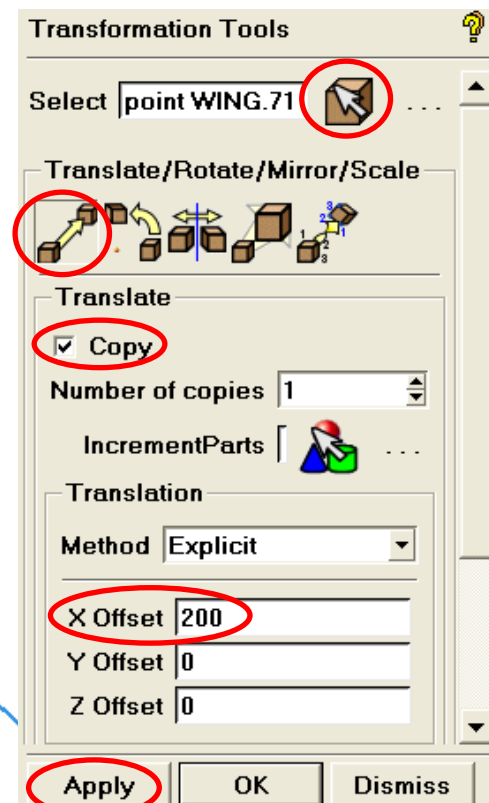


- It's usually best to view any volume mesh in cut plane mode, since there are a lot of elements to display
 - **RMB** on **Mesh > Cut Plane... > Manage Cut Plane**
 - Select **Method: Middle X Plane**
 - Set **D = 200** (actual X location), **Enter** on keyboard
 - **RMB** on **Mesh > Cut Plane... > Show Cut Plane** when done viewing to turn the cut plane off
 - Turn off **Prisms**

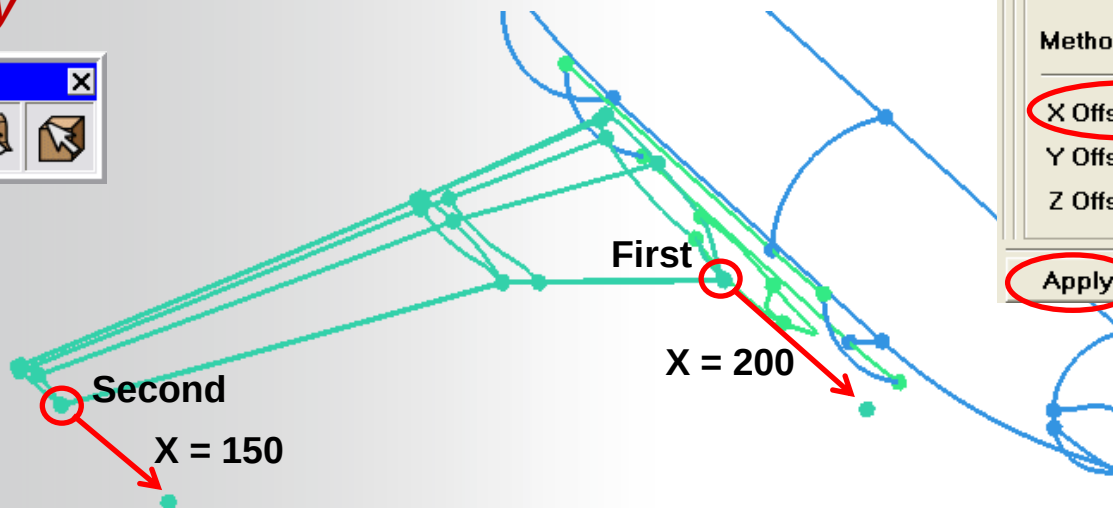
Prepare for Density Region

- Create density region to define more refined mesh behind wing
 - Turn off **Mesh**, turn on **Geometry > Points** and **Curves**
 - First create points behind wing
 - Select **Geometry > Transform Geometry**
 - Select first method: **Translate Geometry**
 - **Copy** = on
 - **Method** = **Explicit**, **X Offset** = 200
 - **Select**  the first point shown below, and **Apply**
 - **Select**  the second point, change **X Offset** to 150
 - **Apply**

Geometry

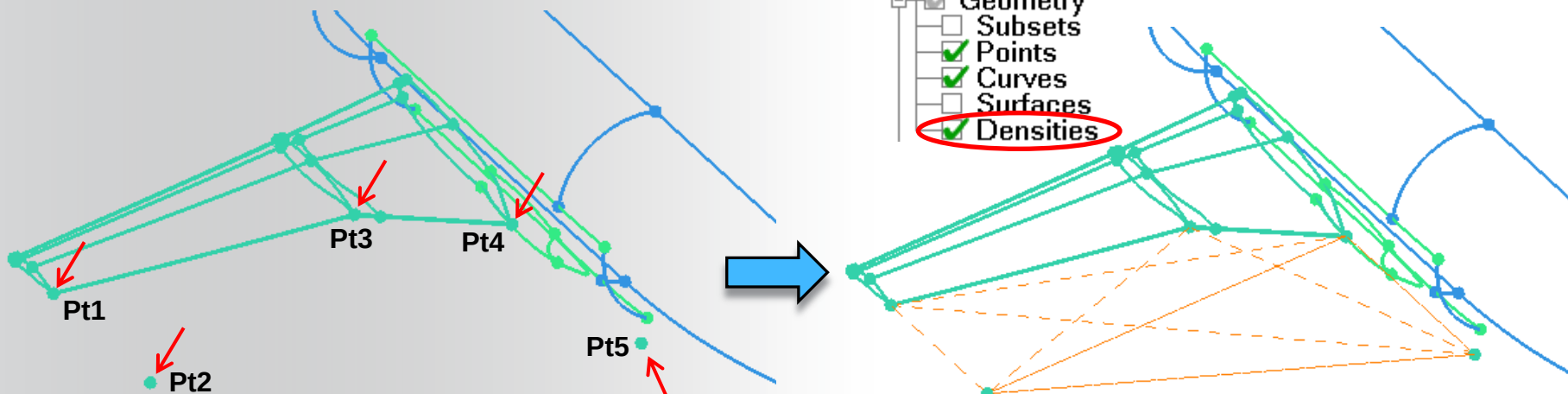


If you have trouble selecting points, turn off curve selection



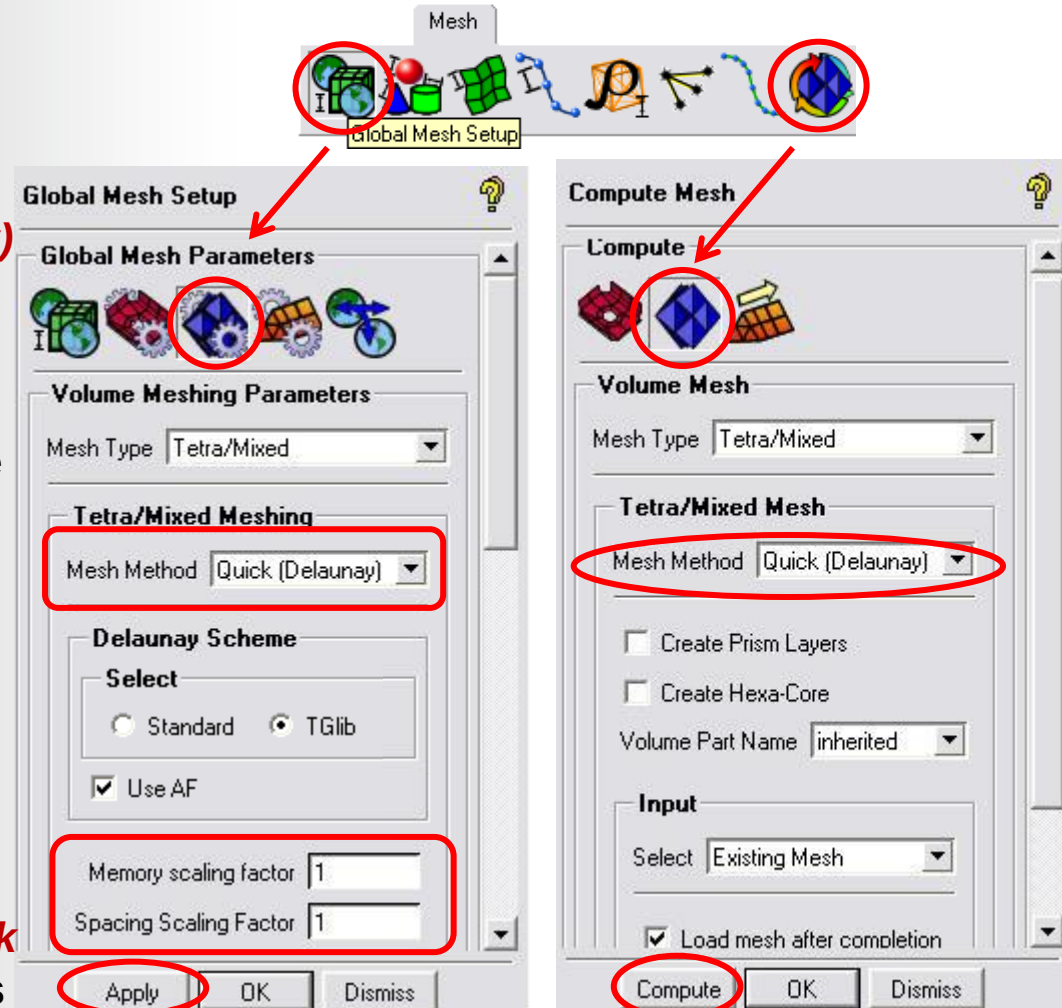
Create Density Region

- Select **Mesh > Create Mesh Density**
 - Set **Size = 5**
 - **Ratio = 1.2**
 - **Width = 5**
 - Element size of 5 within density region, 5 layers (width) of size 5 outside of density region, expansion ratio of 1.2 away after 5 layers
 - In this case, the density region is planar, so the virtual “region” is defined by the width and size
- Select **Density Location > From: Points** and select the 5 points as shown (any order)
 - Three along wing, two created behind wing
- **Apply**
- Turn on all parts and **Geometry>Densities** to see it

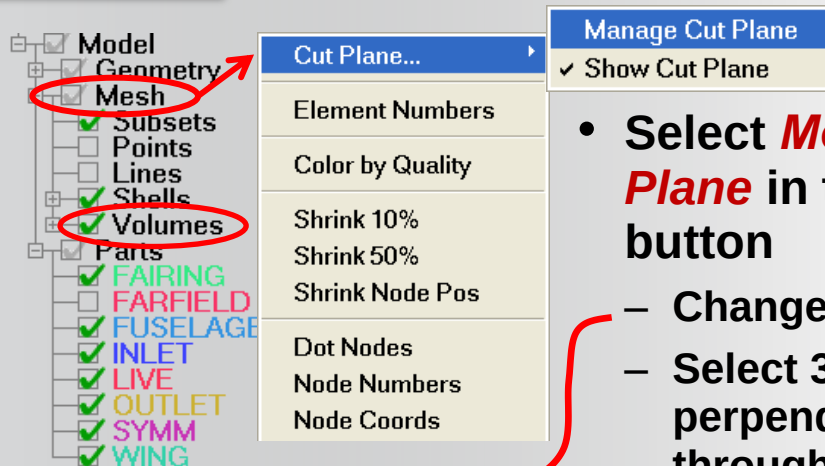


Compute Mesh

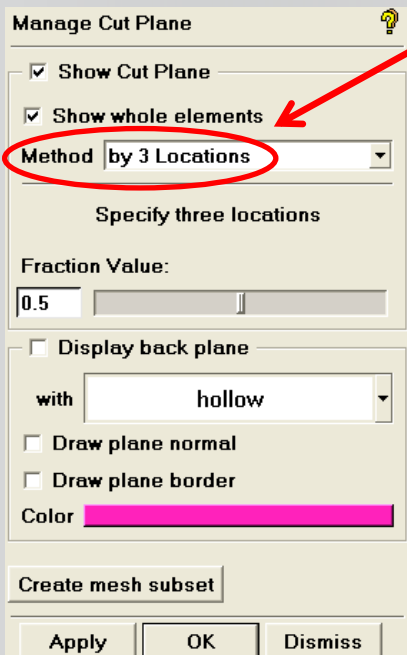
- Check Delaunay settings first
 - *Mesh > Global Mesh Setup > Volume Meshing Parameters*
 - *Mesh Method = Quick (Delaunay)*
 - *Memory scaling factor = 1*
 - *Spacing scaling factor = 1*
 - This is the growth rate from surface/curve sizes into volume (default 1 actually does 1.2)
 - *Apply*
- We now need to fill the volume between the prisms and the farfield surface mesh
 - *Select Mesh > Compute Mesh > Volume Mesh*
 - *Mesh Method* will be set to *Quick (Delaunay)* since the default was changed in the global parameters
 - *Compute* (prism elements will be kept and tetras filled between them and farfield)



View Mesh Cut Plane

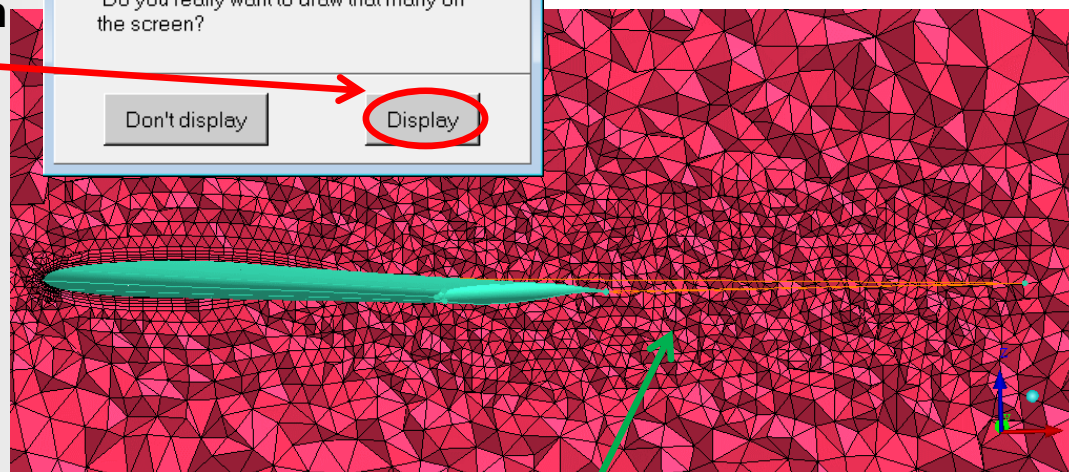
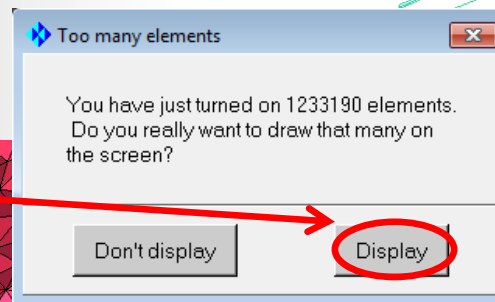


- Select **Mesh > Cut Plane... > Manage Cut Plane** in the Model Tree with right mouse button
 - Change **Method** to **by 3 Locations**
 - Select 3 locations defining a plane perpendicular to the wing, through the wing. Middle click.



Turn on **Volumes**

- Click **Display** in popup
- Rotate to side view
- Note refined mesh behind wing
- Prisms immediately around wing



Notice refined mesh due to density region



Smooth Elements Globally

Quality

Smoothing iterations: 5

Up to value: 0.20

Criterion: Quality

Smooth Mesh Type

	Smooth	Freeze	Float
TETRA_4	☒	☐	☐
TRI_3	☒	☐	☐
PENTA_6	☒	☐	☐
QUAD_4	☒	☐	☐

Smooth Parts/Subsets

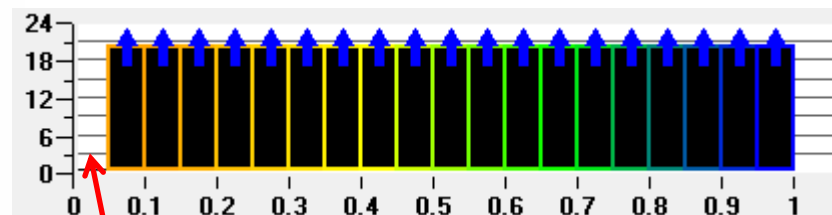
Method: All parts

Apply OK Dismiss

- Improve overall mesh quality
- Select **Edit Mesh > Smooth Mesh Globally**
 - Note histogram in lower right hand corner
 - It is not necessary to freeze the prism elements first in this case since prisms were not extruded into a volume mesh that already exists, which compromised the tetras in the previous tutorial
 - Use default for **Smoothing iterations (5)**, **Up to Value (0.2)** and **Criterion (Quality)**
 - **Apply**
 - Not much change in quality since prisms were smoothed during generation and the Delaunay algorithm places nodes in a way that produces decent tetras

Watch the message printout of the number of elements in the lowest ranges for any changes

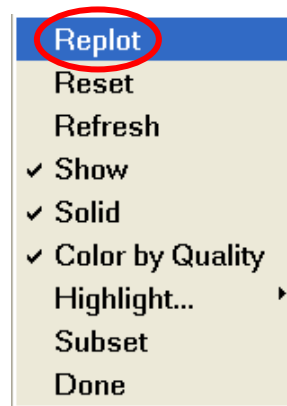
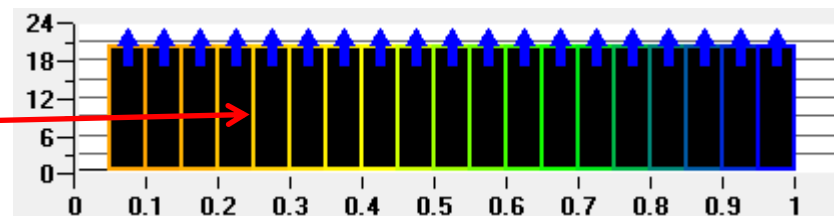
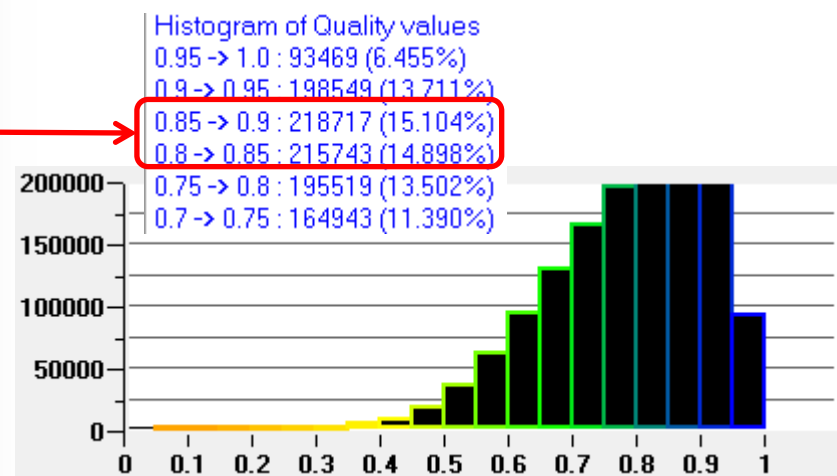
0.2 -> 0.25 : 982 (0.068%)
 0.15 -> 0.2 : 39 (0.003%)
 0.1 -> 0.15 : 111 (0.008%)
 0.05 -> 0.1 : 69 (0.005%)
 0.0 -> 0.05 : 0 (0.000%)



No elements below 0.05

Replot Histogram

- Replot histogram
 - Right mouse select anywhere in histogram window
 - Select **Replot**
 - Change values in **Replot** pop up window
 - **Min X = 0.0**
 - **Max X = 1.0**
 - **Max Y height = 200,000**
 - The default max height is set to 20 by default so you can easily see bars with smaller number of cells
 - Solvers have a minimum value they will accept, so it is first important to achieve greater than this
 - The number 200,000 was chosen because it is close to the max number of elements in the individual ranges
 - You can easily see now that the majority of elements are above 0.4

Hexa Core

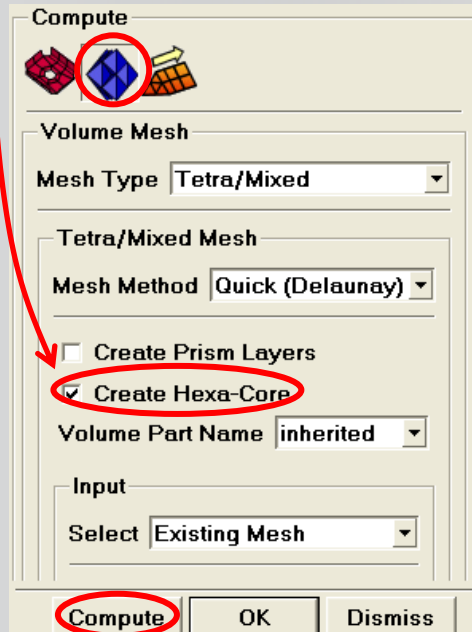
- Refill the volume with a hexa-core mesh
 - Turn on **Hexa-Core** for LIVE in **Mesh > Part Mesh Setup**
 - Set **max size** = **340** for LIVE (max hexa size within region)
 - **Apply** and **Dismiss**
- Recompute mesh
 - With **Create Hexa-Core** toggled on
 - Will replace tetras while keeping the prisms and grow hexa elements within selected volume part(s)
 - **Hexa-Core** ignores density region



Part Mesh Setup

part	prism	hexa-core	max size
FAIRING	☒	☐	0
FARFIELD	☐	☐	0
FUSELAGE	☒	☐	0
INLET	☐	☐	0
LIVE	☐	☒	340
OUTLET	☐	☐	0
SYMM	☐	☐	0
WING	☒	☐	0

☒ Show size params using scale factor
☐ Apply inflation parameters to curves



Viewing cut plane

