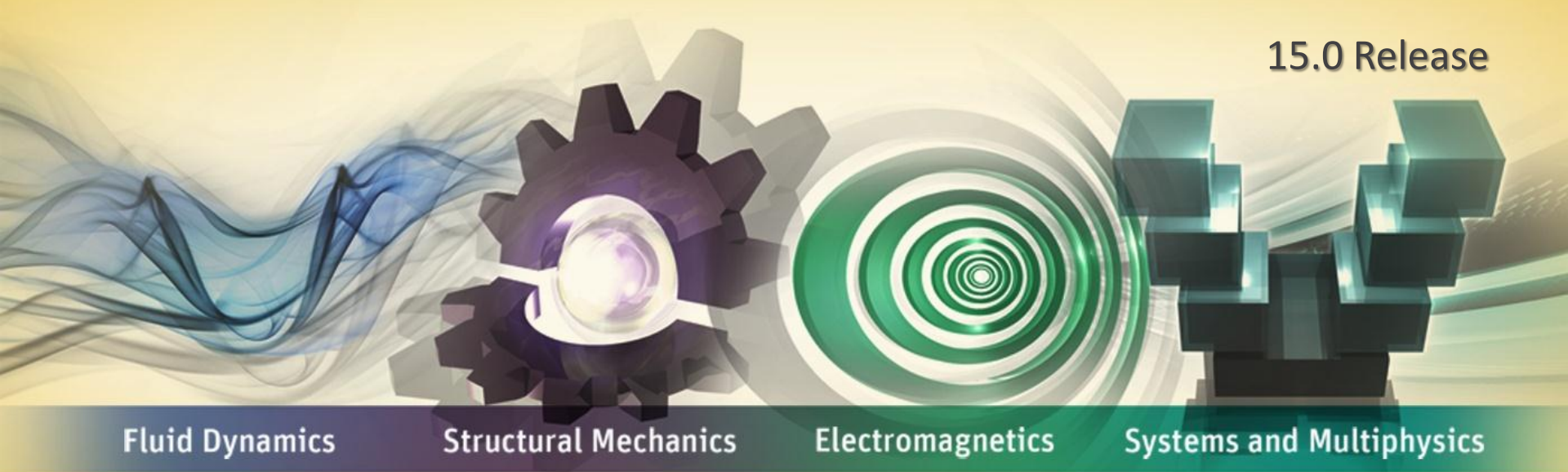


# Workshop 5.1

## Prism Meshing – Waterjacket Section

15.0 Release

A horizontal banner with a yellow-to-orange gradient background. It features four distinct 3D visualizations: blue fluid flow lines on the left, a purple gear with a glowing center, a green concentric circle 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

# Change Working Directory

File Edit View Info Settings Help

New Project...  
Open Project...  
Save Project...  
Save Project As...  
Close Project...  
Change Working Dir...

Geometry  
Mesh  
Blocking  
Attributes  
Parameters  
Cartesian

Import Model  
Import Geometry  
Import Mesh  
Export Geometry  
Export Mesh

Replay Scripts  
Exit

## Browse for Folder

New working directory

C:\users\matt\training\ANSYS-ICEM-CFD-Intro\_14.0\_1st\_edi

WaterJacketSection

Femur  
HVAC\_Hybrid  
Stamping  
Valve  
WaterJacketSection  
Wingbody  
workshops  
AnsysICEMCFDV12\_Trainingf  
APDL  
Autobave

OK

Cancel

- **File > Change Working Dir...**
  - Choose **WaterJacketSection**
  - **OK**
- **Use the quick icon to open geometry**
  - Choose **WaterJacketExtraction.tin**
  - **Open**

File Edit View Info Settings



## Open

Look in: WaterJacketSection

WaterJacketExtraction.tin

My Recent Documents

Desktop

My Documents

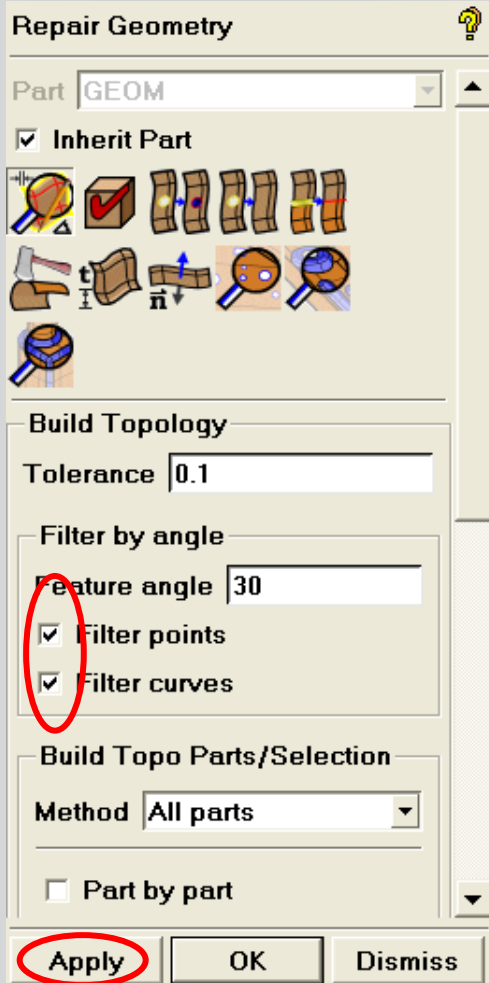
File name: WaterJacketExtraction.tin

Files of type: Geometry Files (\*.tin;\*.tin.gz)

Open

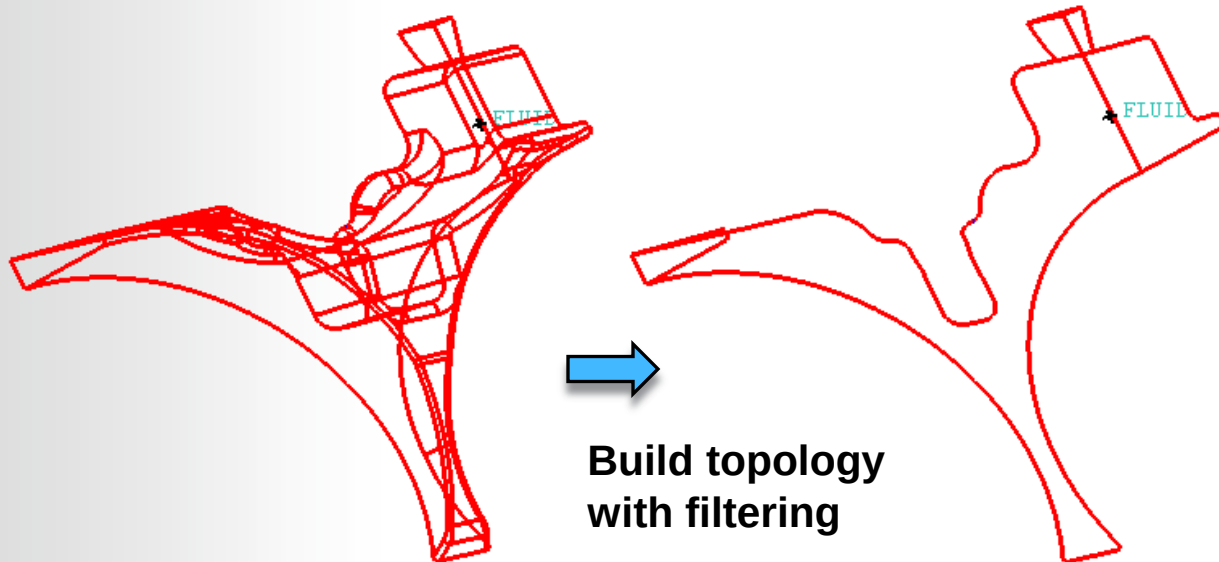
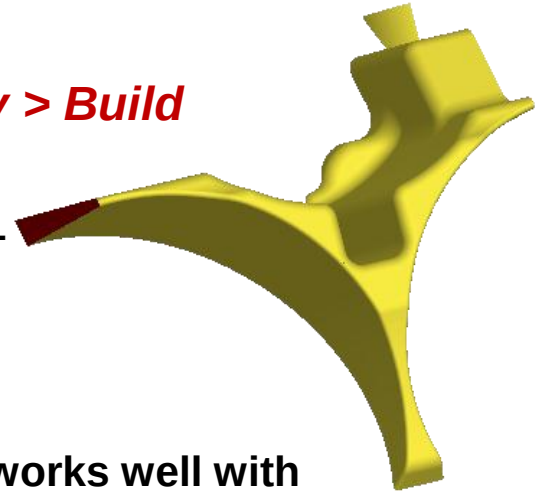
Cancel

# Build Topology

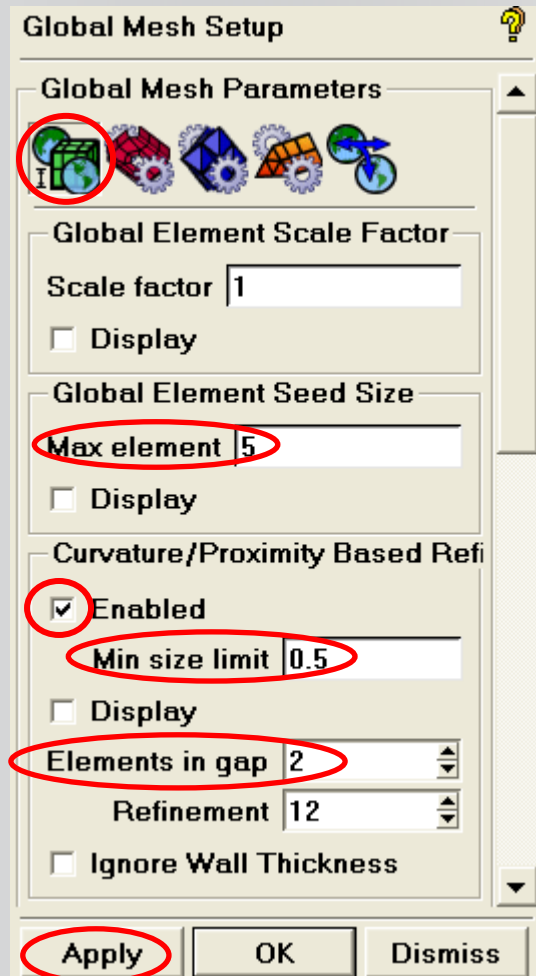


- **Geometry > Repair Geometry > Build Diagnostic Topology**

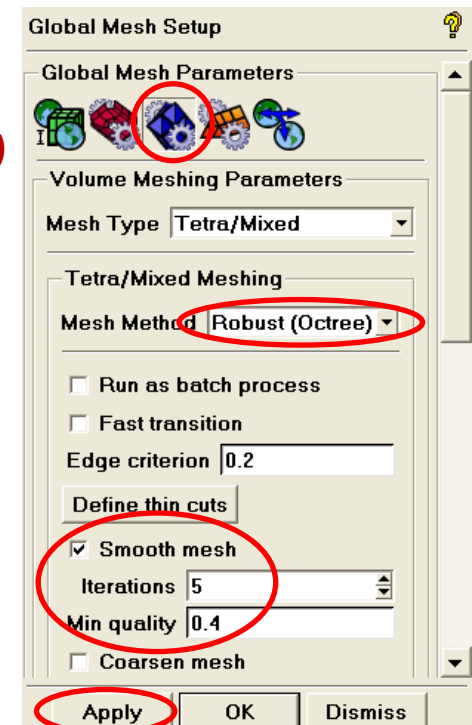
- Accept default **Tolerance** 0.1
- **Filter points** = on
- **Filter curves** = on
- **Feature angle** = 30 (default)
- Filtering curves and points works well with tetra octree to filter unnecessary constraints at low angles between surfaces
- Click **Apply**

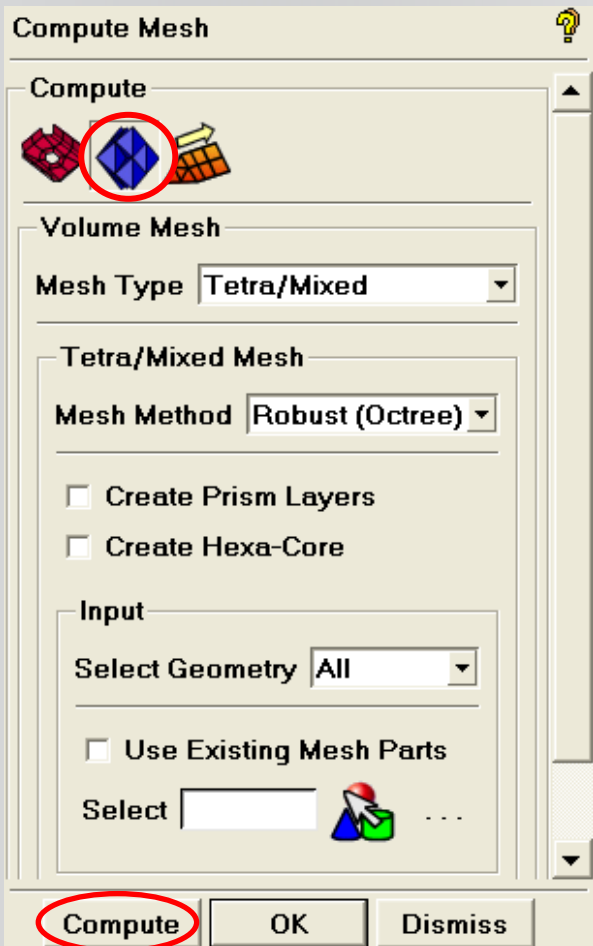


# Set Mesh Sizes for Tetra Meshing

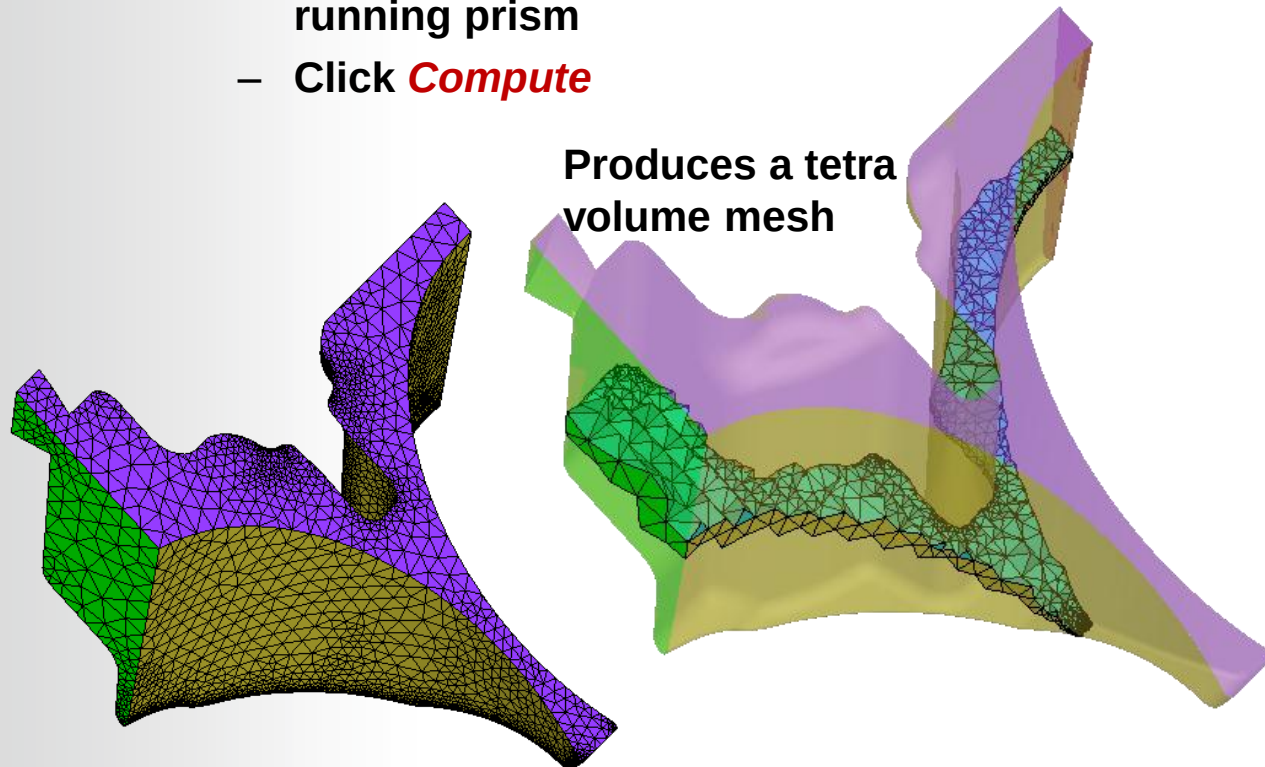


- **Mesh > Global Mesh Setup > Global Mesh Size**
  - **Max element** = 5
  - **Enable** Curvature/Proximity Based Refinement
  - **Min Size limit** = 0.5
  - **Elements in gap** = 2
  - **Apply**
- **Mesh > Global Mesh Setup > Volume Meshing Parameters**
  - **Mesh Type** = Tetra/Mixed
  - **Mesh Method** = Robust(Octree)
  - **Smooth mesh** = on
  - **Iterations** = 5
  - **Min quality** = 0.4
  - Click **Apply**
- Mesh sizes only set globally on this model – no part sizes, surface, or curve sizes set

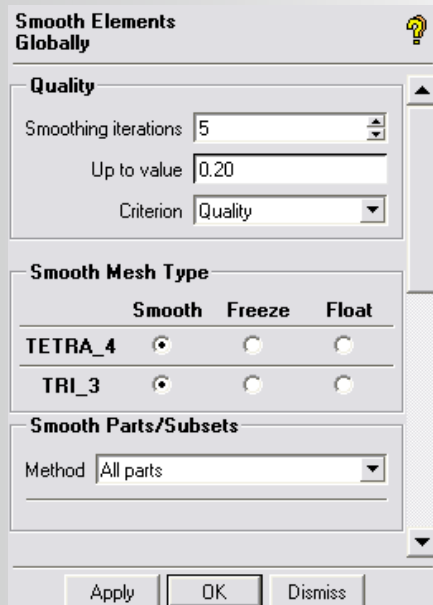
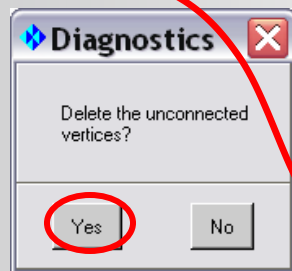
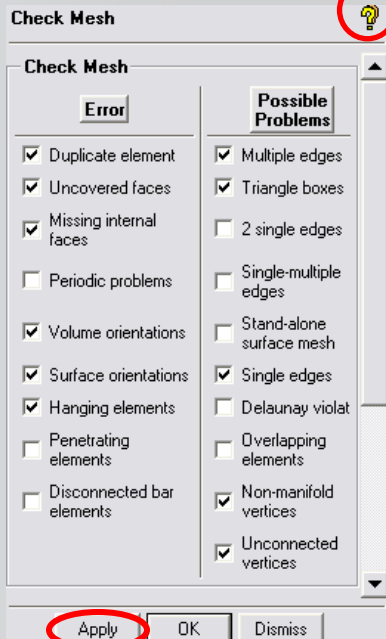




- **Mesh > Compute mesh > Volume Mesh**
  - Leave all the defaults
  - **Mesh Type = Tetra/Mixed**
  - **Mesh Method = Robust(Octree)**
  - **Create Prism Layers = off**
  - Better to run prism separately so you can check quality/errors in the input mesh before running prism
  - Click **Compute**



# Check Errors and Quality



- It is good practice to check errors and quality in the input mesh before running prism

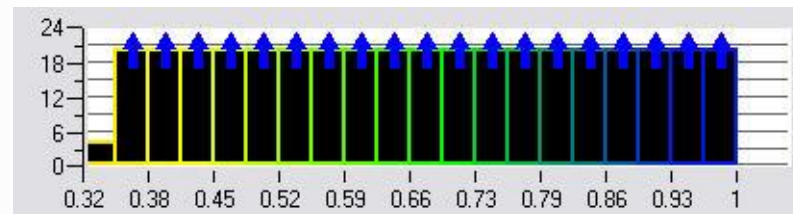
## **Edit Mesh > Check Mesh**

- Leave all the defaults, **Apply**
- If it finds **Unconnected vertices**, it is always safe to delete them
- The definitions of each check can be found in the Help inside ICEM CFD

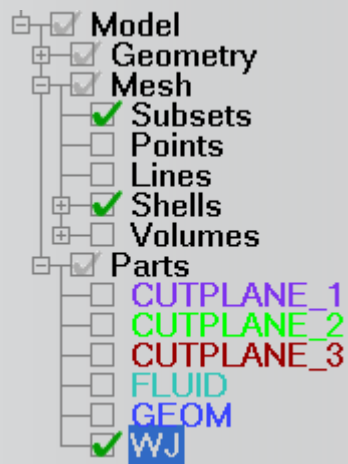
- Press “?” to take directly to help topic

## **Edit Mesh > Smooth Mesh Globally**

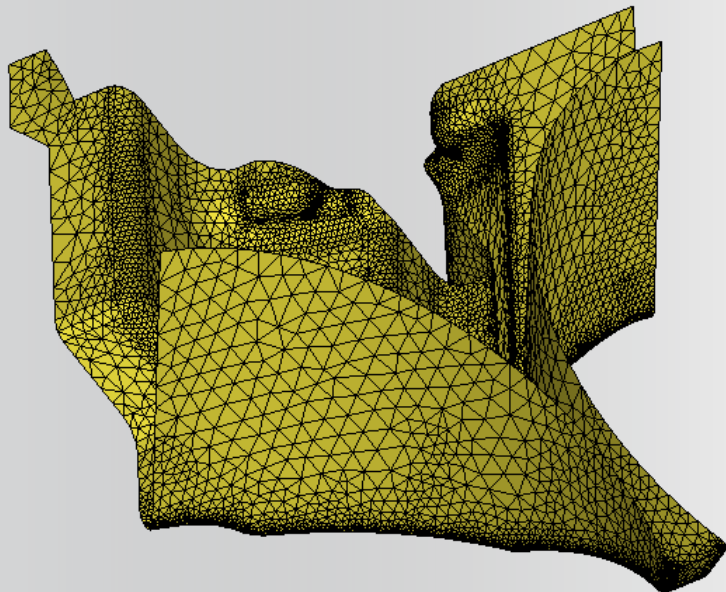
- This will show a histogram
- Target is all mesh above 0.2
- Smooth if necessary
- Mesh is already smoothed well and should be above 0.3



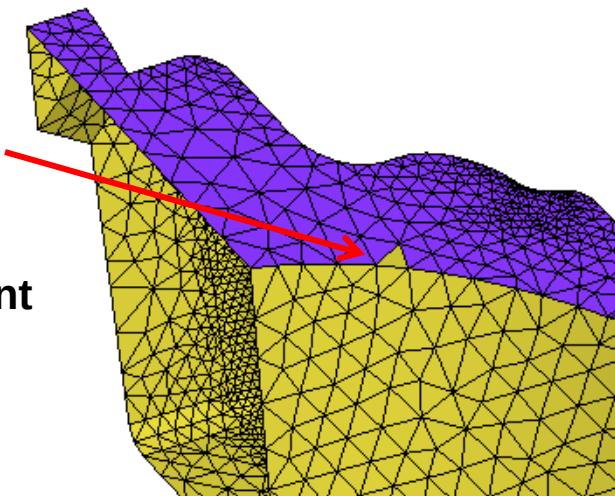
# Check Surface Mesh for Extrusion



- It is also good practice to inspect the surface mesh of the parts intended for prism
- Turn on only **shells** under **Mesh** and the part **WJ**
  - Only need to inspect parts selected for prism, which will be the **WJ** part
  - The boundary elements should be smoothly on the curves
  - Check for elements in the adjacent part and move to the correct part

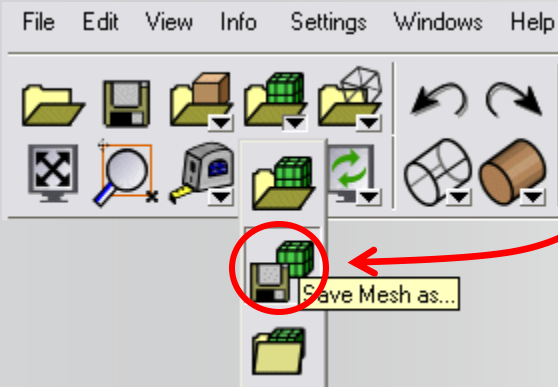


If you see this kind of thing, move the surface element to the correct part

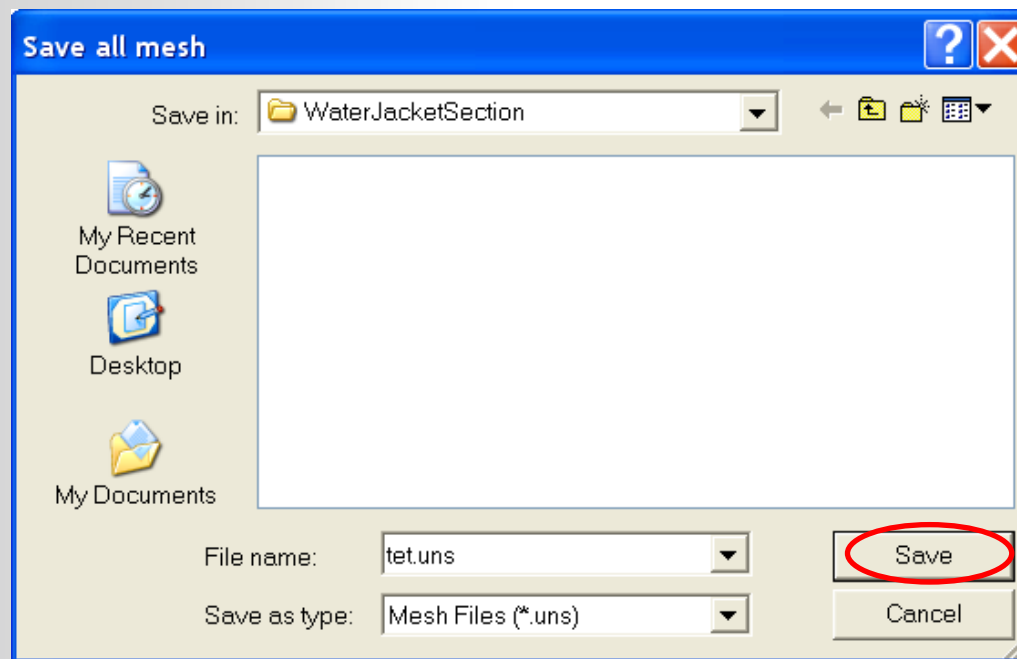


This mesh should not have any boundary problems, but it is good practice to check

# Save Input Mesh



- Save the input mesh
  - In case we want to run prism multiple times with different parameters
  - Use the quick **Save Mesh as...** button in the pulldown
  - Enter a new mesh name, **tet.uns**
  - Click **Save**



# Set Prism Global Parameters



- **Mesh > Global Mesh Setup > Prism Meshing Parameters**

- **Min prism quality** = 0.00001
- **Fillet ratio** = 0.2
- **Prism height limit factor** = 3
- **Number of surface smoothing steps** = 0
- Click **Apply**

**Global Mesh Setup**

**Global Mesh Parameters**

**Global Prism Settings**

Growth law: exponential

Initial height: 0

Height ratio: 1.2

Number of layers: 3

Total height: 0

Compute params

☐ Fix marching direction

Min prism quality: 0.00001

Ortho weight: 0.50

Fillet ratio: 0.2

Max prism angle: 180

Max height over base:

Prism height limit factor: 3

Ratio multiplier:

**Global Mesh Setup**

**Prism element part controls**

New volume part:

Side part:

Top part:

☐ Extrude into orphan region

**Smoothing Options**

Number of surface smoothing steps: 0

Triangle quality type:

Number of volume smoothing steps: 10

Max directional smoothing steps: 12

First layer smoothing steps: 1

**Advanced Prism Meshing Parameters**

Read a Prism Parameters File

- Clear out any **New volume part**
- It is usually best to set a low quality to limit the areas that may end the prism layers and cap with pyramids
- Smoothing results in better quality if pyramids are limited

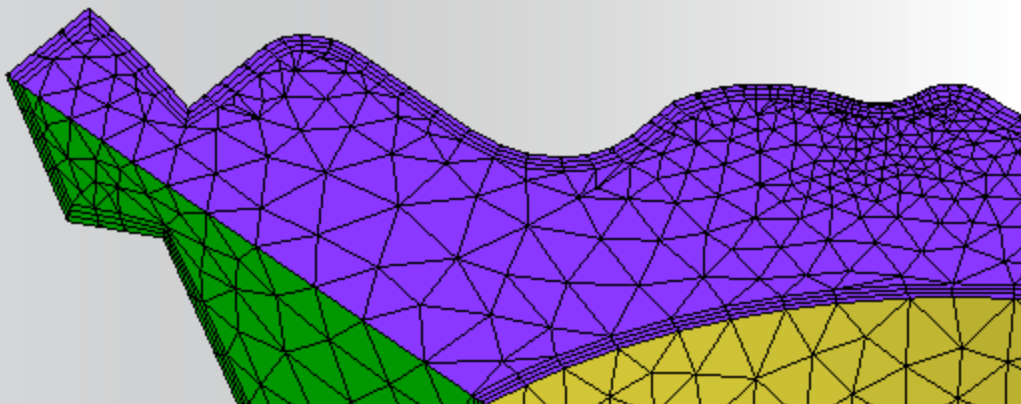
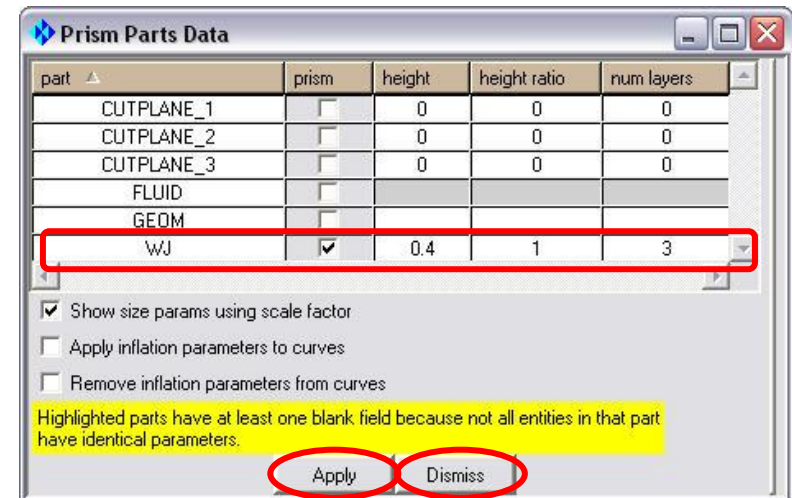
# Define Prism Parts and Compute



Prism parameters on parts can also be set with the *Part Mesh Setup* spreadsheet

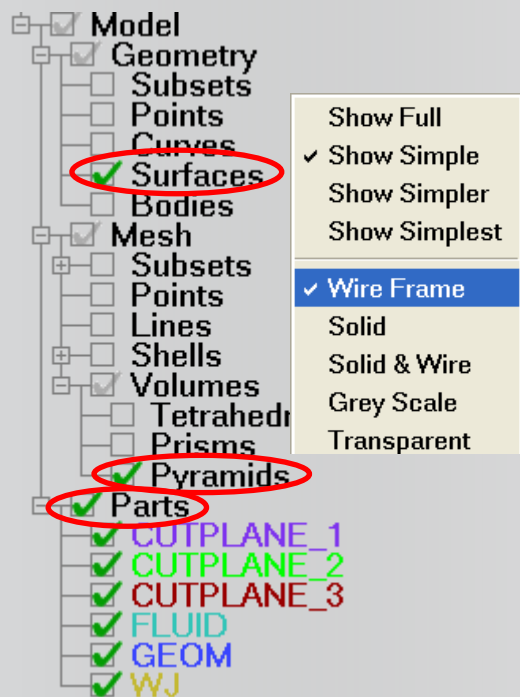


- **Mesh > Compute Mesh > Prism Mesh**
  - Press **Select Parts for Prism Layer**
  - Check **prism** for part **WJ**
  - **Height** = 0.4
  - **Height ratio** = 1
  - **Num layers** = 3
  - **Apply, Dismiss**
  - **Compute**

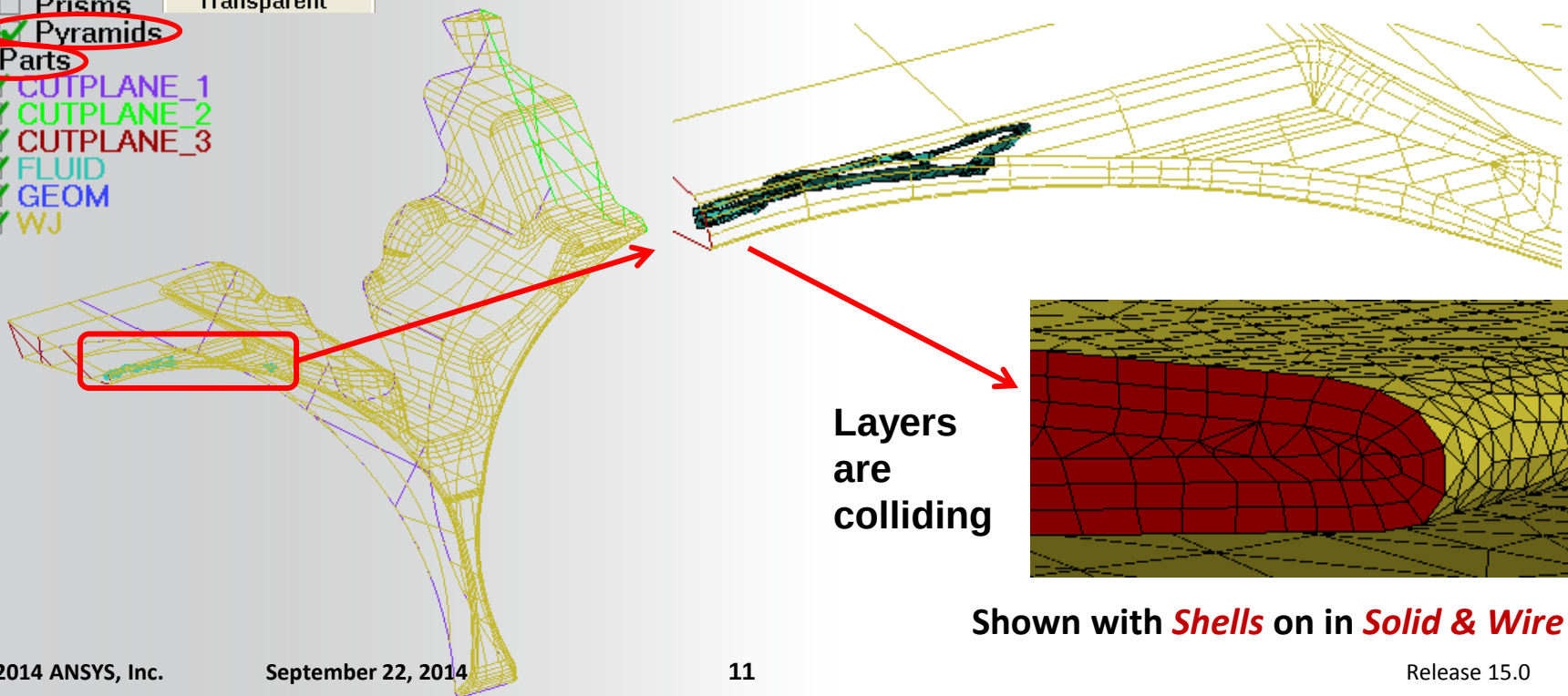


- We will extrude 3 fat layers and split into more layers, then redistribute
- This is less robust but faster than doing all layers at once

# Inspect Pyramids

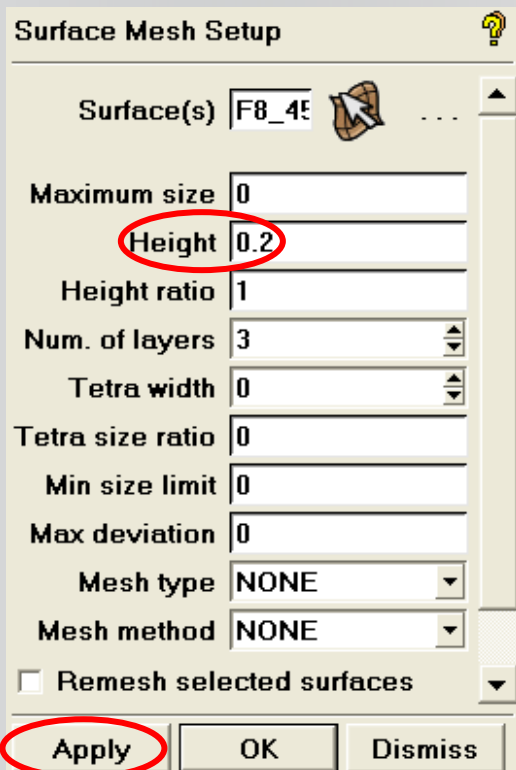


- The problem locations will have prism layers capped off with pyramids, so inspect where the pyramids form to find where there are problems
  - Turn on all **Parts**
  - Turn on only **Pyramids** in the **Mesh** section (Shells OFF)
  - Turn on only **Surfaces** in **wireframe** (in Geometry section) to have a reference for where these pyramids have formed



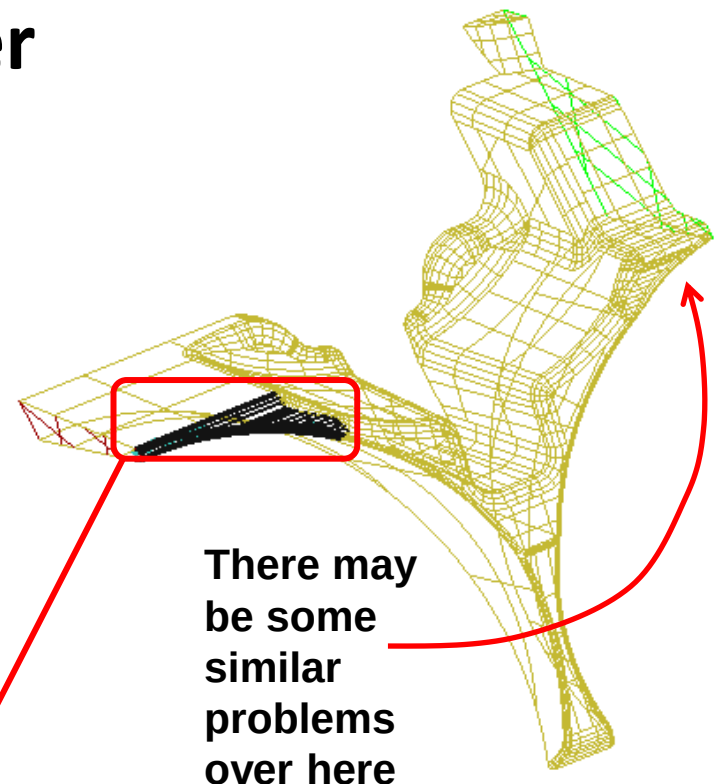
Shown with **Shells** on in **Solid & Wire**

# Set Local Heights Smaller

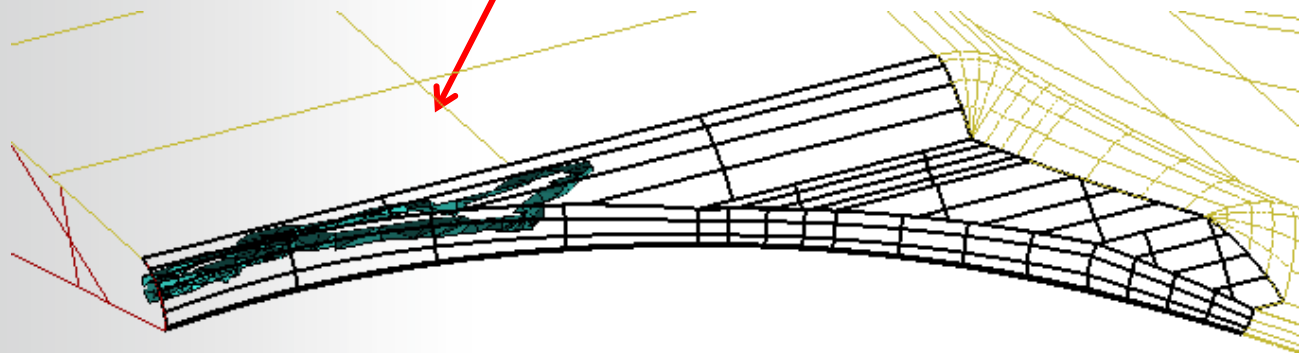


- **Mesh > Surface Mesh Setup**

- Select the surfaces around the collision region
- **Height** = 0.2 (half the previous height)
- **Apply**



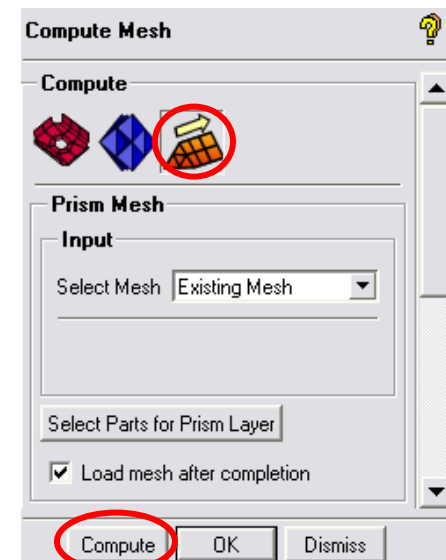
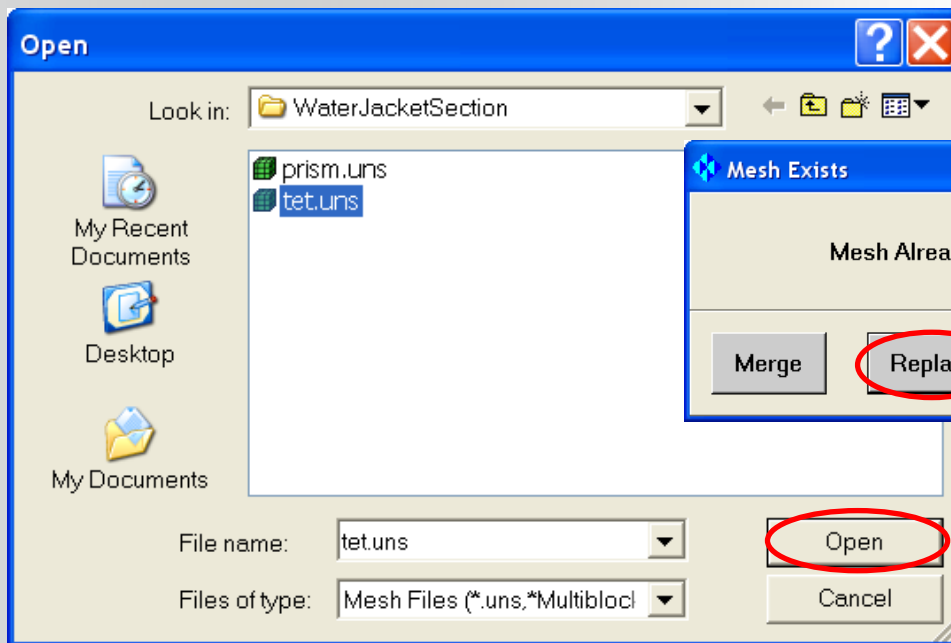
There may be some similar problems over here



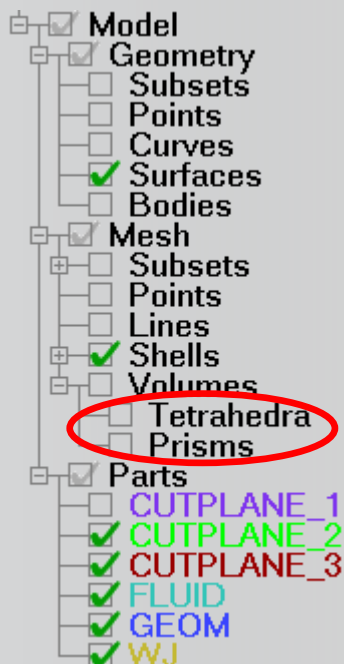
# Load Previous Input mesh and Run Prism



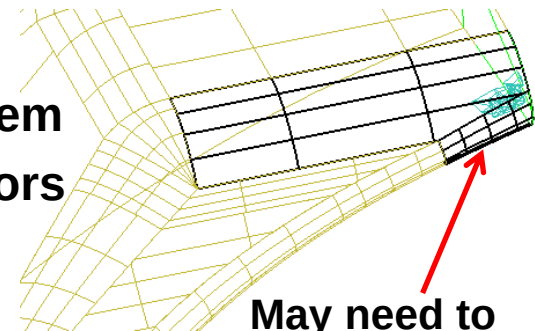
- Use the quick icon to load the previous tetra mesh (You don't want to run prism on the mesh that already has prism elements)
  - Choose *tet.uns*, *Open*
  - Choose *Replace* for *Mesh Already Exists*
- Compute the prism mesh again
  - *Mesh > Compute Mesh > Prism Mesh*
  - *Compute*



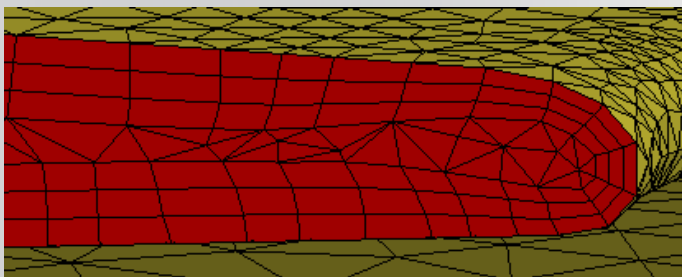
# Inspect the Mesh



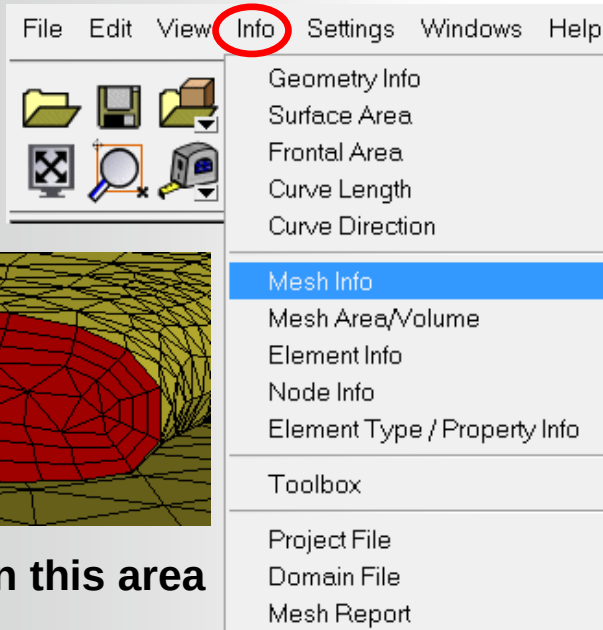
- The model tree no longer shows pyramids present
- It is not always possible to get rid of all pyramids but these are the low quality regions and you should try to reduce them
- Pyramids also show up where mesh errors occur
- **Info > mesh Info**
  - This will also print out mesh information



May need to reduce heights on the other side also to eliminate all the pyramids

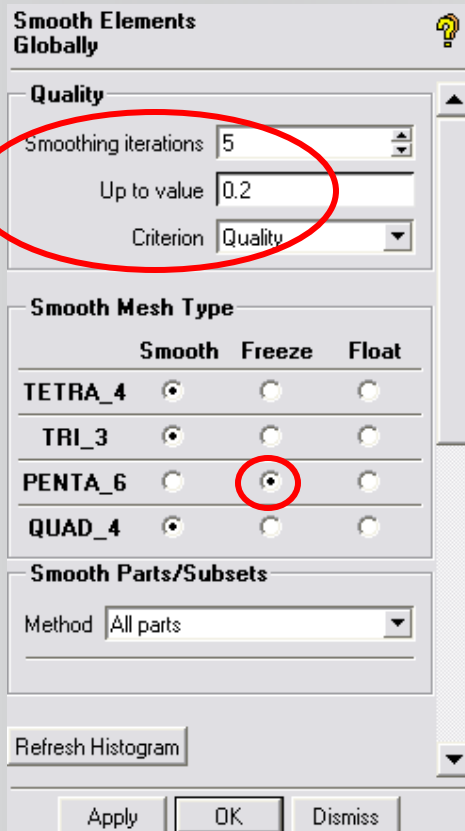


No more collisions in this area



— Mesh Info —  
 Element types :  
 NODE : 10  
 LINE\_2 : 368  
 TETRA\_4 : 71612  
 TRI\_3 : 20852  
 PENTA\_6 : 58674  
 QUAD\_4 : 1002  
 Element parts :  
 CUTPLANE\_1 : 1613  
 CUTPLANE\_2 : 359  
 CUTPLANE\_3 : 324  
 FLUID : 130286  
 GEOM : 378  
 WJ : 19558  
 Total elements : 152518  
 Total nodes : 47375  
 Min : 69.2091 105.155 67.3311  
 Max : 184.124 240.074 116.322

No  
 PYRA\_5  
 listed



0.2 -> 0.25 : 3353 (2.190%)  
 0.15 -> 0.2 : 1492 (0.974%)  
 0.1 -> 0.15 : 244 (0.159%)  
 0.05 -> 0.1 : 153 (0.100%)  
 0.0 -> 0.05 : 58 (0.038%)



0.2 -> 0.25 : 3270 (3.477%)  
 0.15 -> 0.2 : 1178 (1.252%)  
 0.1 -> 0.15 : 238 (0.253%)  
 0.05 -> 0.1 : 150 (0.159%)  
 0.0 -> 0.05 : 55 (0.058%)

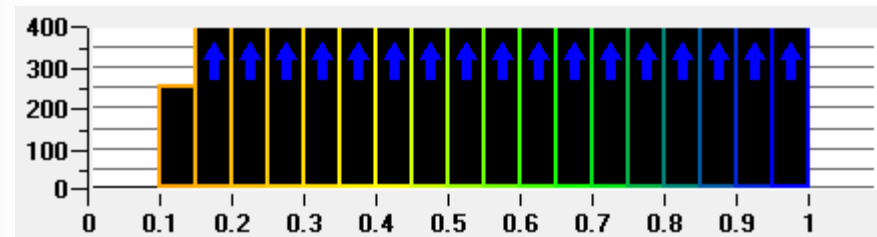
Should take 3 times

## • Edit mesh > Smooth Mesh Globally

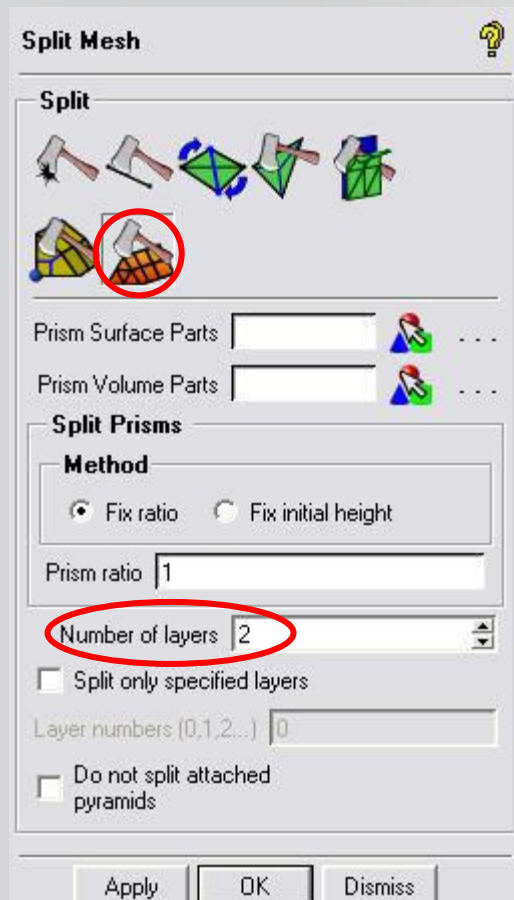
- **Smoothing iterations** = 5
- **Up to value** = 0.2
- **Criterion** = **Quality**
- **PENTA\_6** = **Freeze**
- If any PYRA\_5 are present, Freeze these also
  - Prisms already smoothed during prism generation
  - Adjacent tetras have been compromised
- Press Apply until no more improvement

## • Now smooth everything

- **PENTA\_6** = **Smooth**
- Lower **Up to value** to 0.1
- Press **Apply** twice (2 times of 5 iterations)



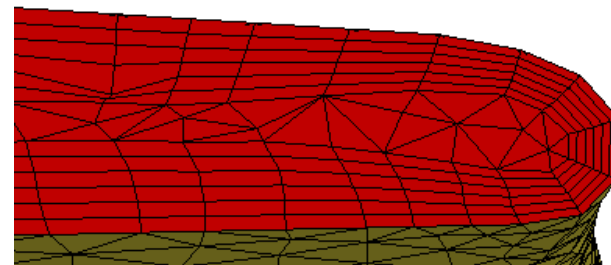
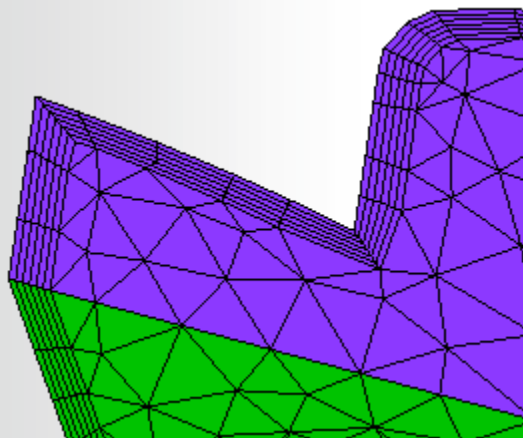
# Split Prisms



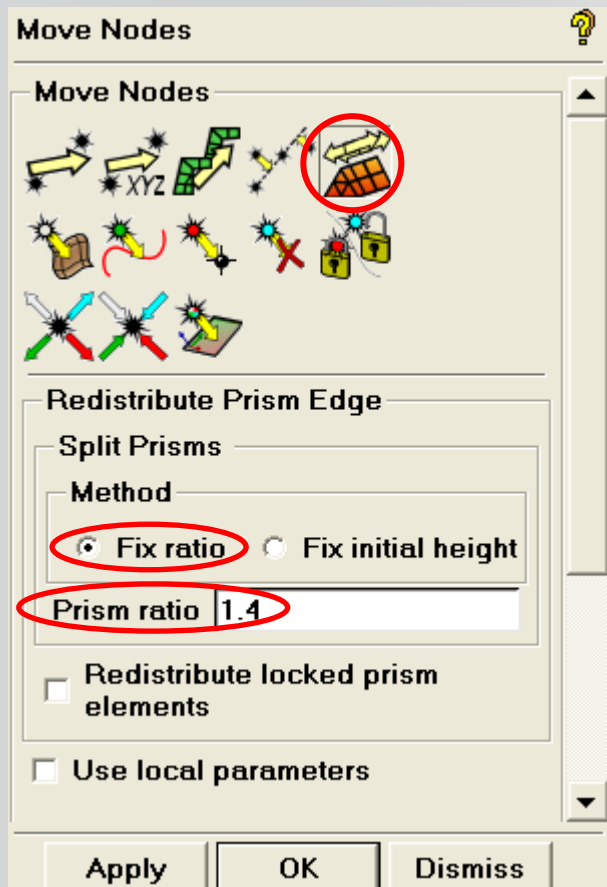
- *Edit mesh > Split Mesh > Split Prisms*

- *Method = Fix ratio*
- *Prism ratio = 1*
- *Number of layers = 2*
- Click *Apply*

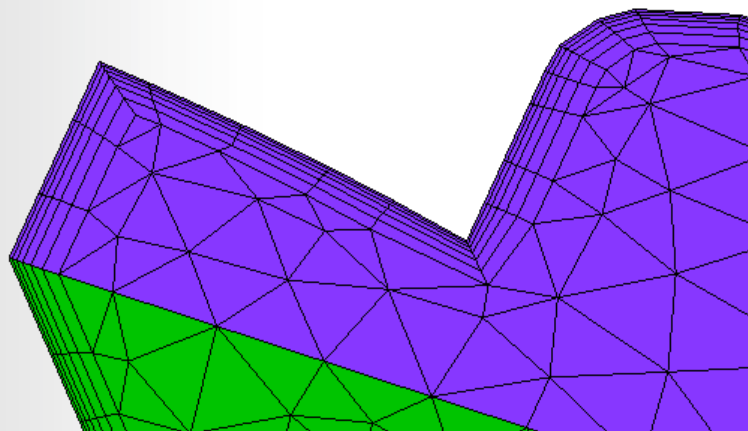
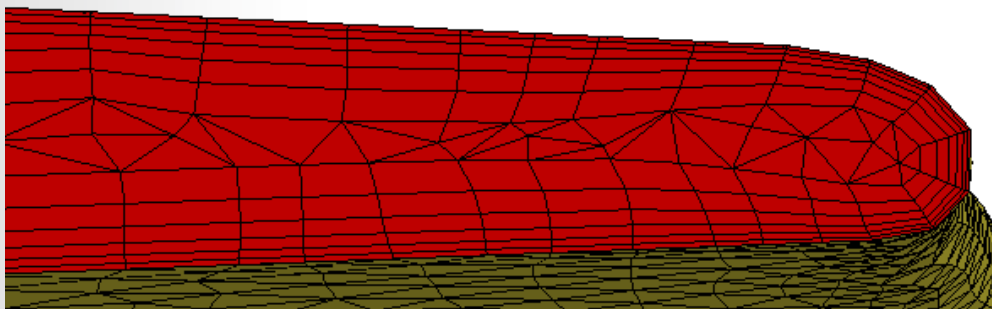
- Splits all prisms if no *Prism Volume Parts* selected
- Total height remains fixed. Number of layers is being set. That leaves only ratio or initial height as variables. One of them is specified.
- Specifying a prism ratio or initial height is only practical if there is 1 fat layer to split
  - No point in distributing each split layer independently
  - We will redistribute afterward anyway



# Redistribute Prism Nodes



- **Edit mesh > Move Nodes > Redistribute Prism Edge**
  - **Method = Fix ratio**
  - **Prism ratio = 1.4**
  - Click **Apply**



# Save Mesh and Geometry

- **Save mesh and geometry using the quick icons**
  - Mesh size parameters are saved to the geometry
  - All the mesh setup parameters for prism are saved to a .prism\_params file within the working directory at the time prism is run

