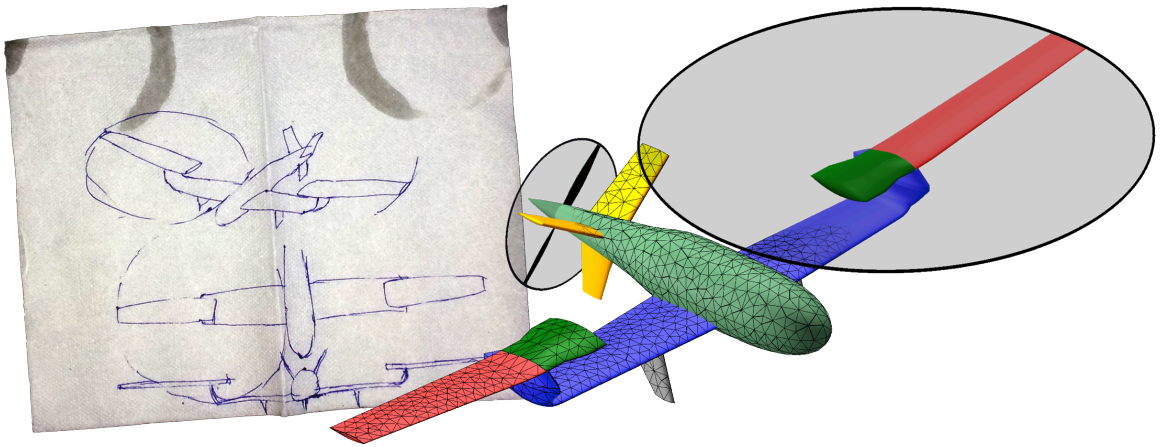
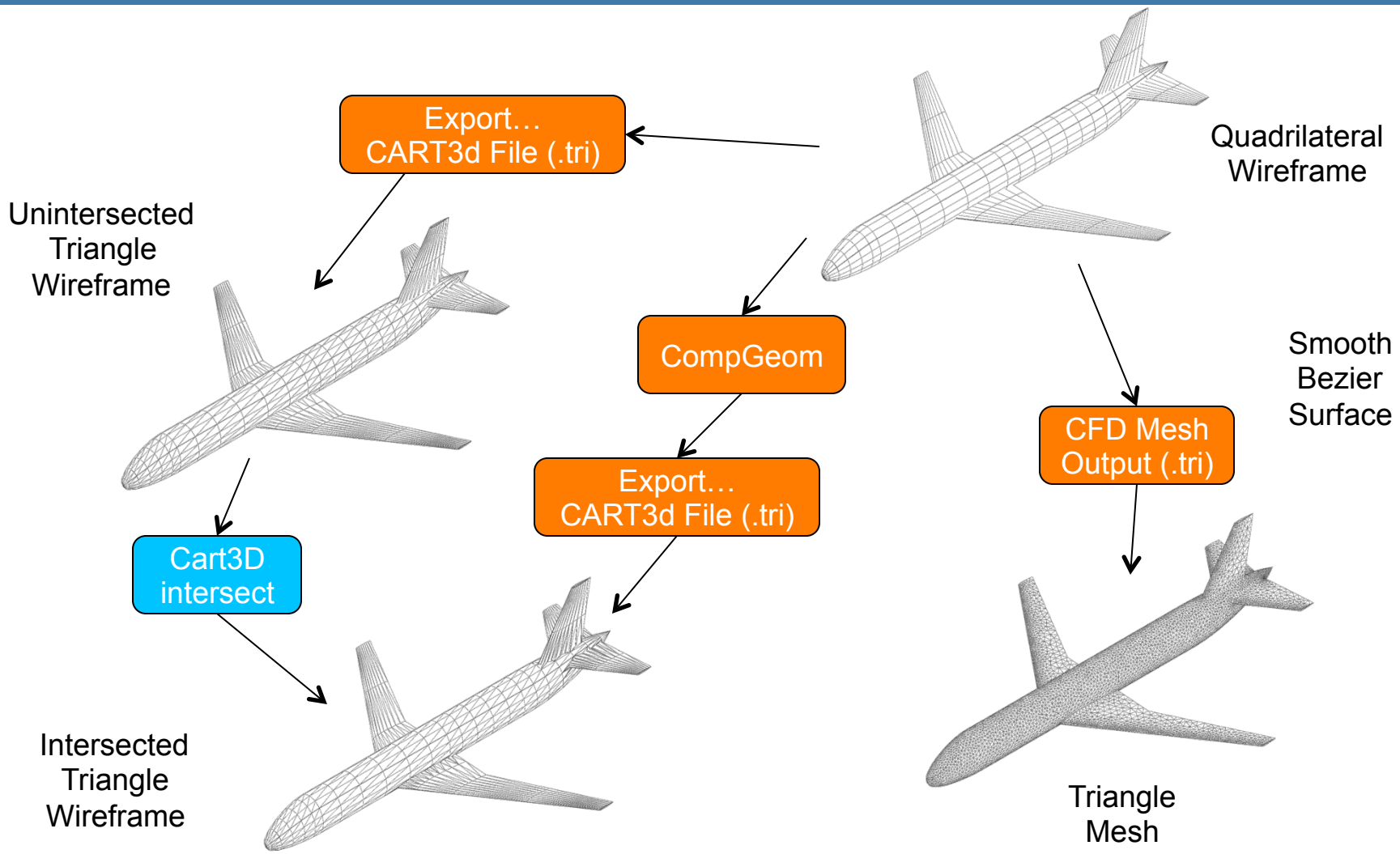


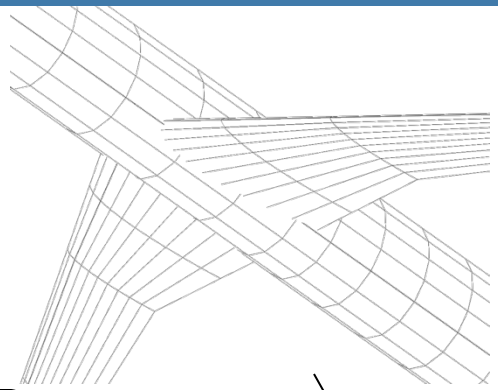
VSP Meshing

Rob McDonald

Paths to Cart3D

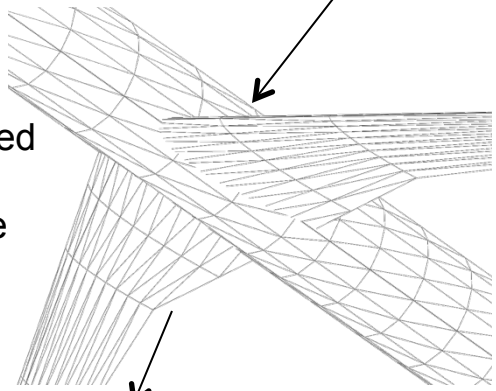


Paths to Cart3D



Quadrilateral Wireframe

Export…
CART3d File (.tri)



Unintersected Triangle Wireframe

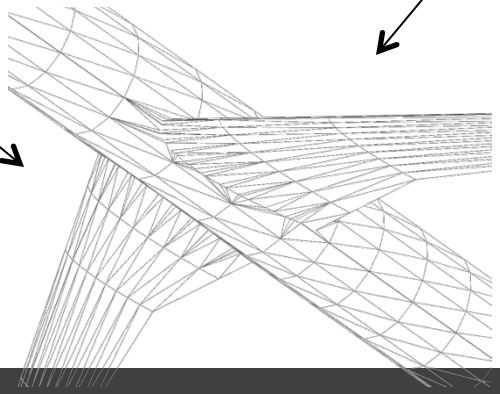
CompGeom

Smooth Bezier Surface

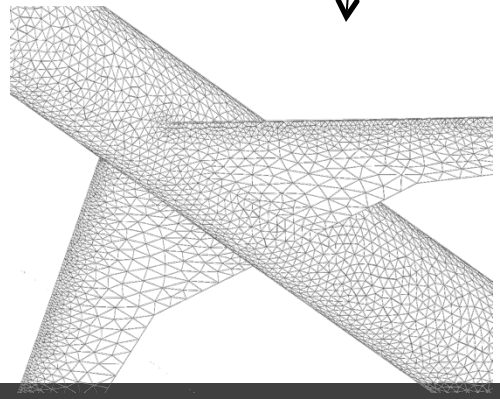
CFD Mesh Output (.tri)

Export…
CART3d File (.tri)

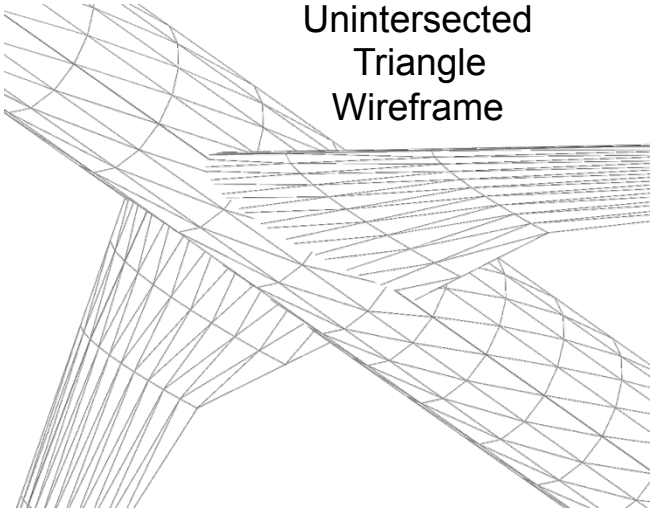
Cart3D intersect



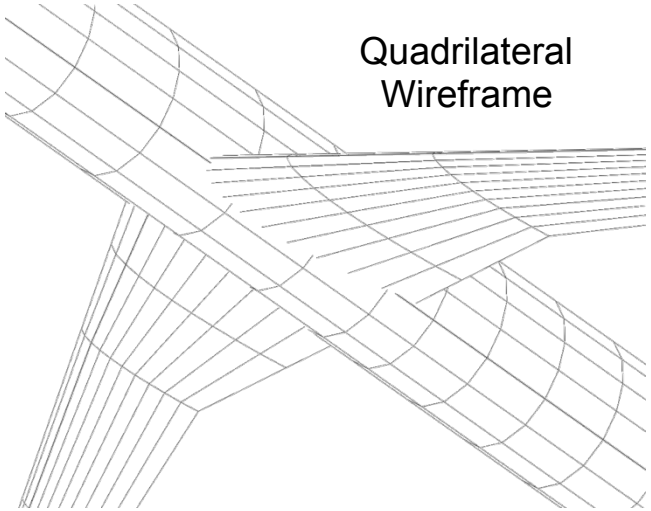
Intersected Triangle Wireframe



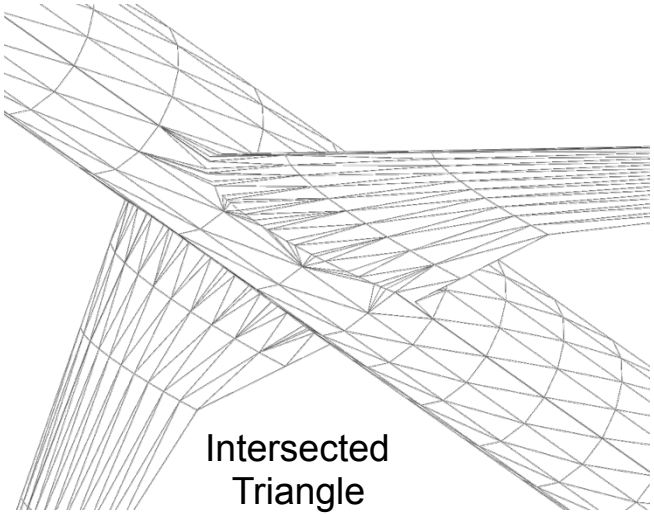
Triangle Mesh



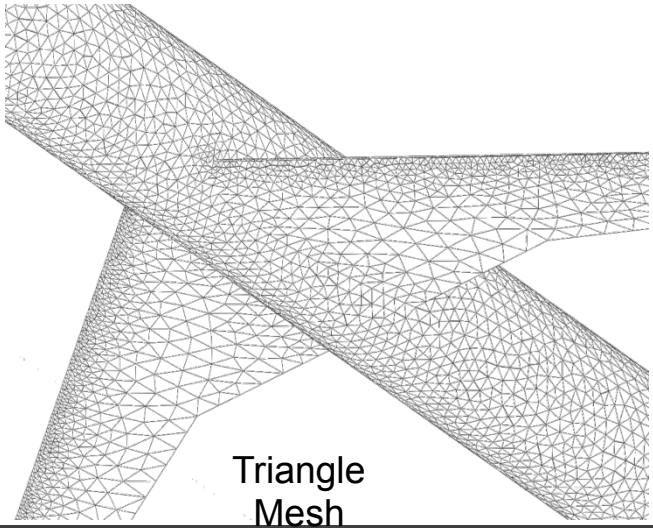
Unintersected
Triangle
Wireframe



Quadrilateral
Wireframe



Intersected
Triangle
Wireframe



Triangle
Mesh

Pros / Cons of Paths

Unintersected

- Pros
  - Speed
  - Robustness
  - Derivatives with design framework
- Cons
  - Robustness
    - Coincident faces
    - Nacelles
  - Extra step

CompGeom

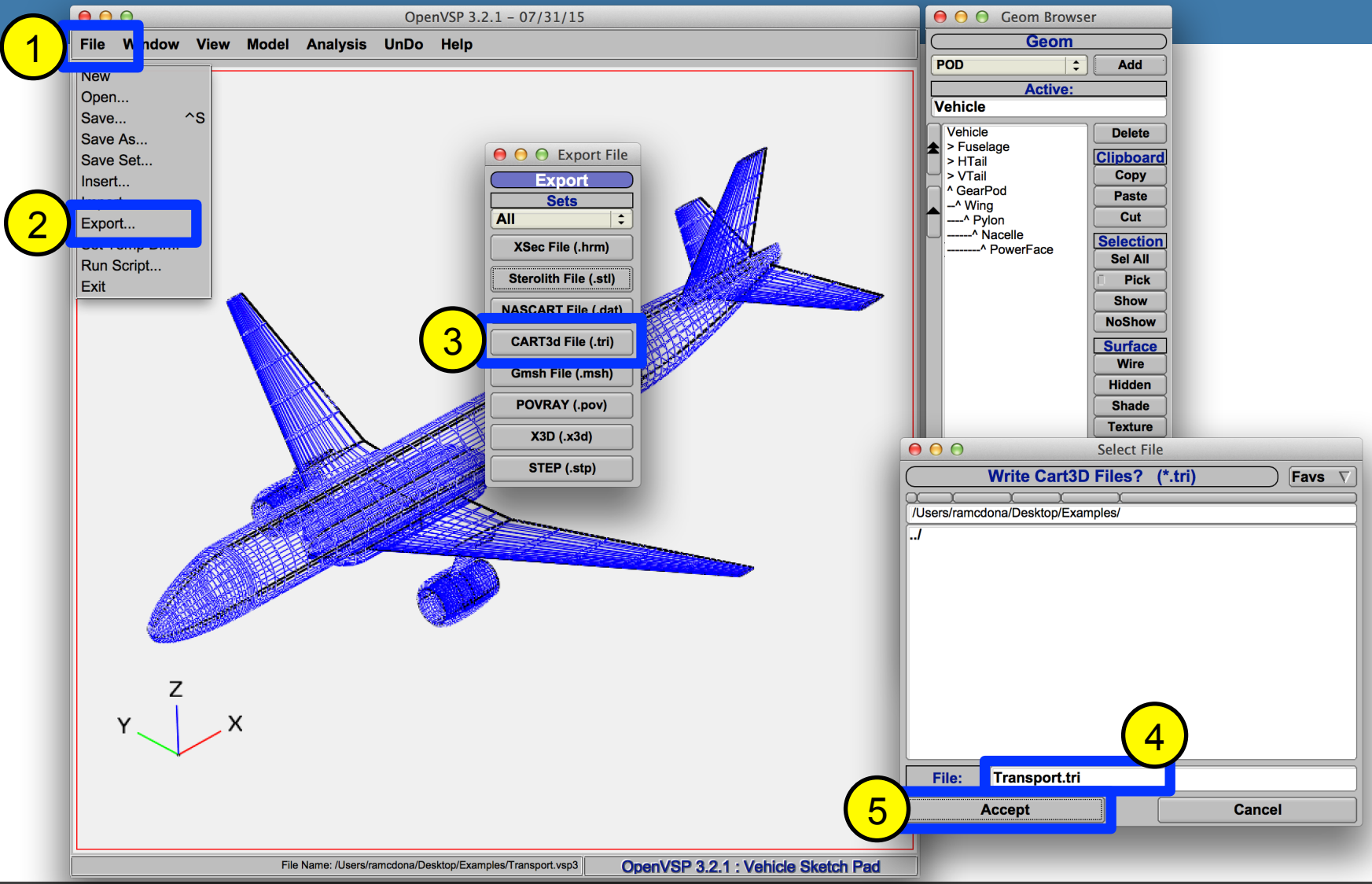
- Pros
  - Speed
  - Robustness
  - Special cases
  - Subsurfaces
- Cons
  - Robustness

Recommended for Cart3D Today

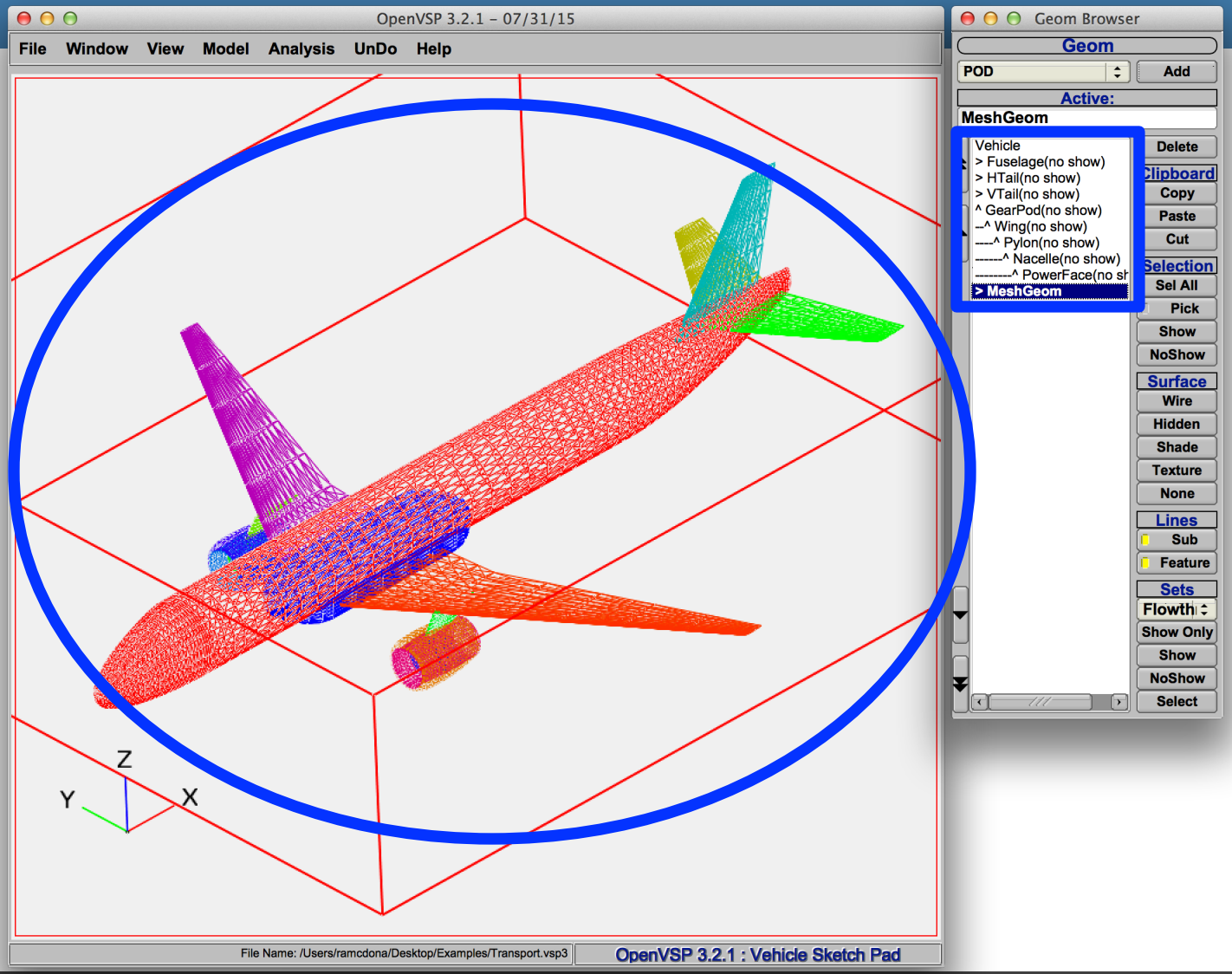
CFD Mesh

- Pros
  - Triangle Quality
  - Special cases
  - Subsurfaces
  - Negative Volume
  - Actuator Disk
- Cons
  - Robustness

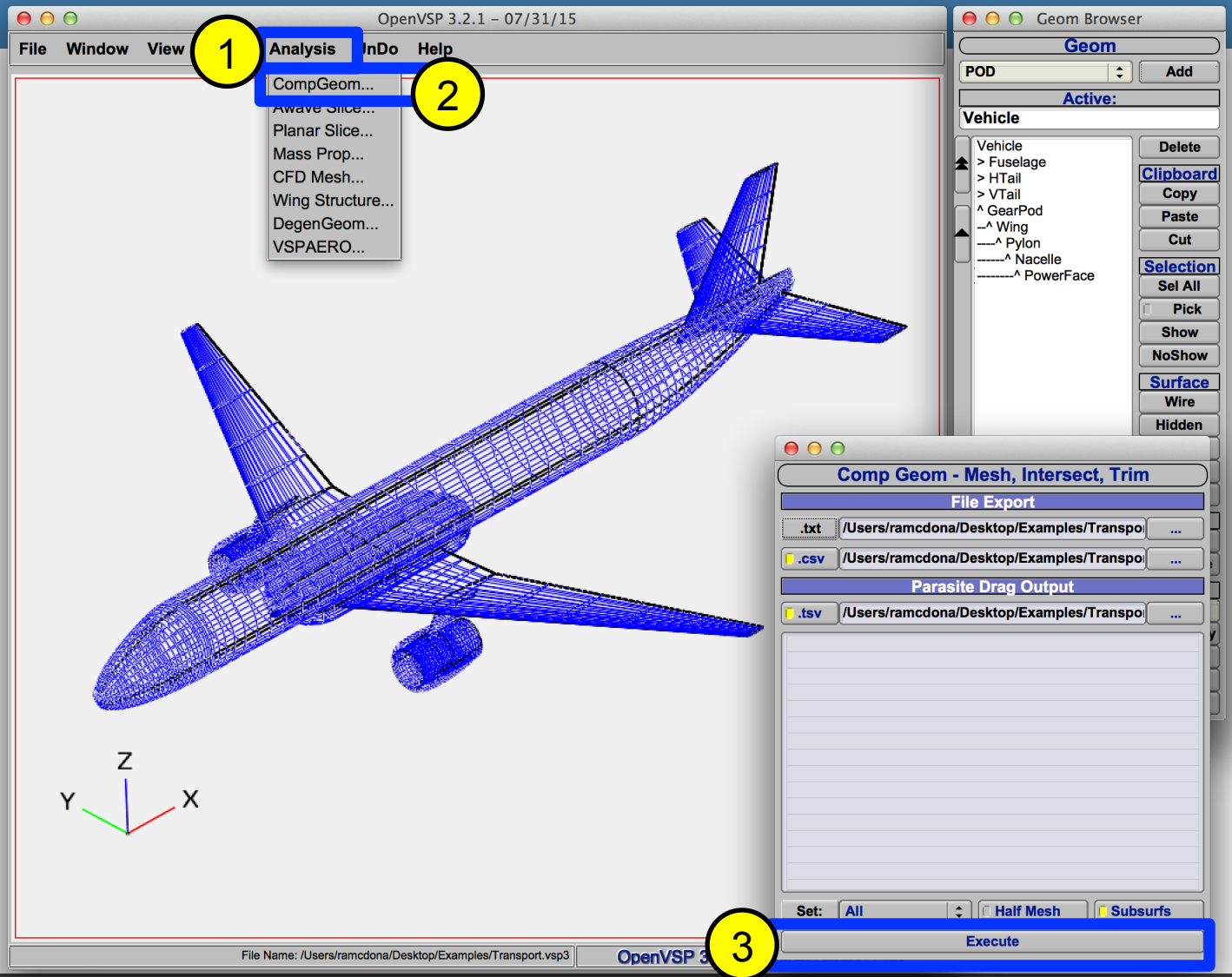
Export Unintersected (before)



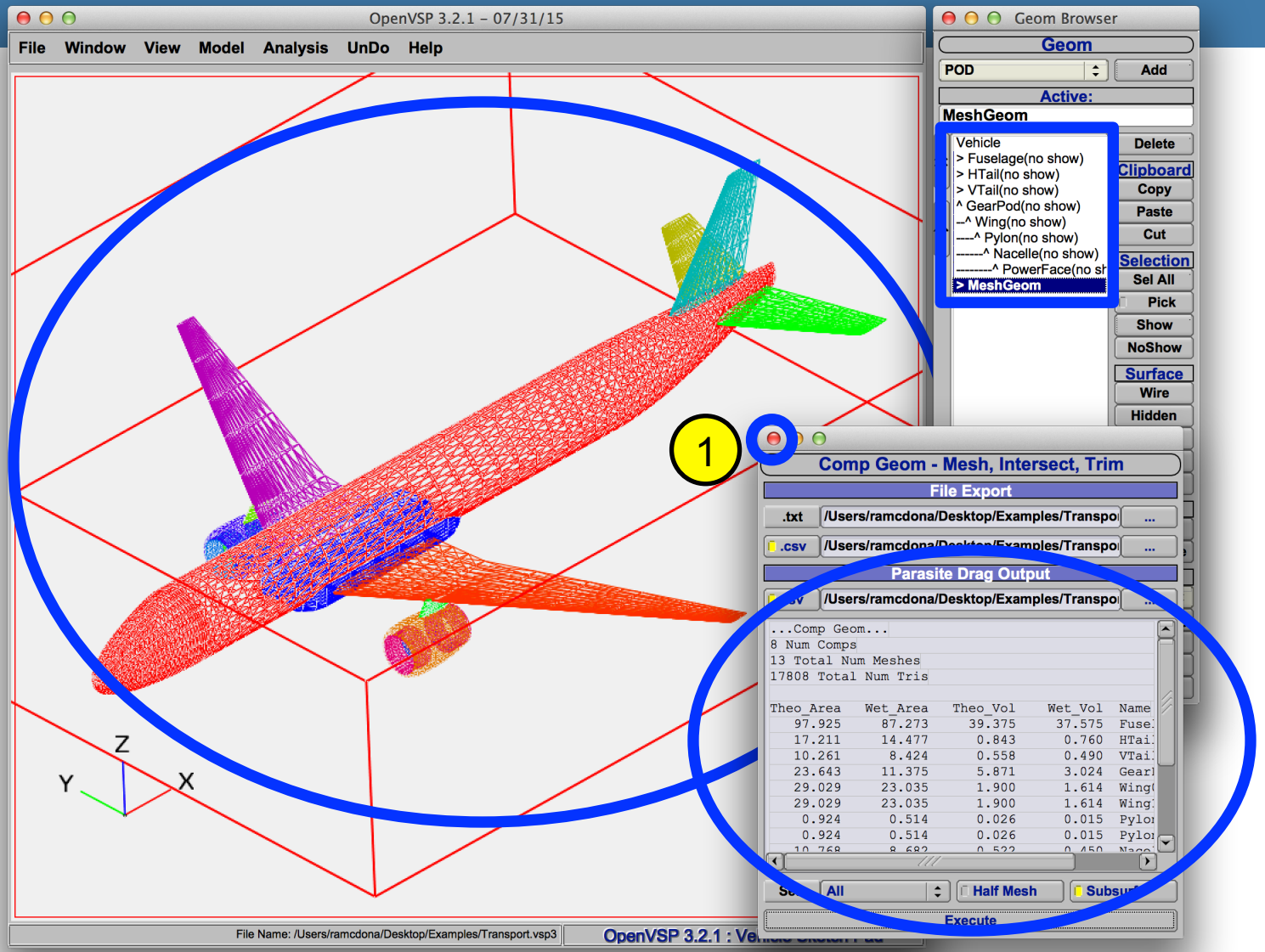
Export Unintersected (after)



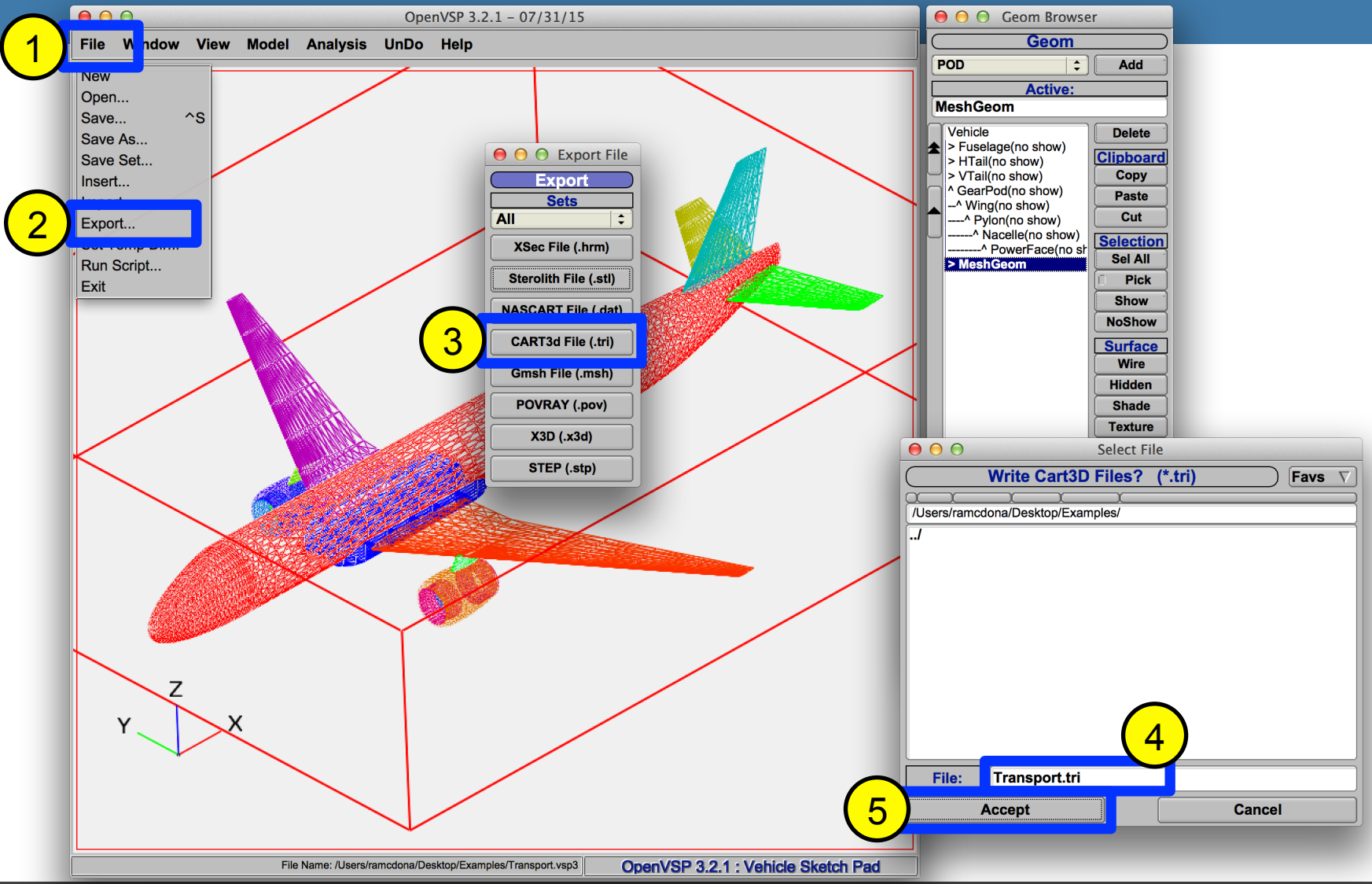
Execute CompGeom (before)



Execute CompGeom (after)



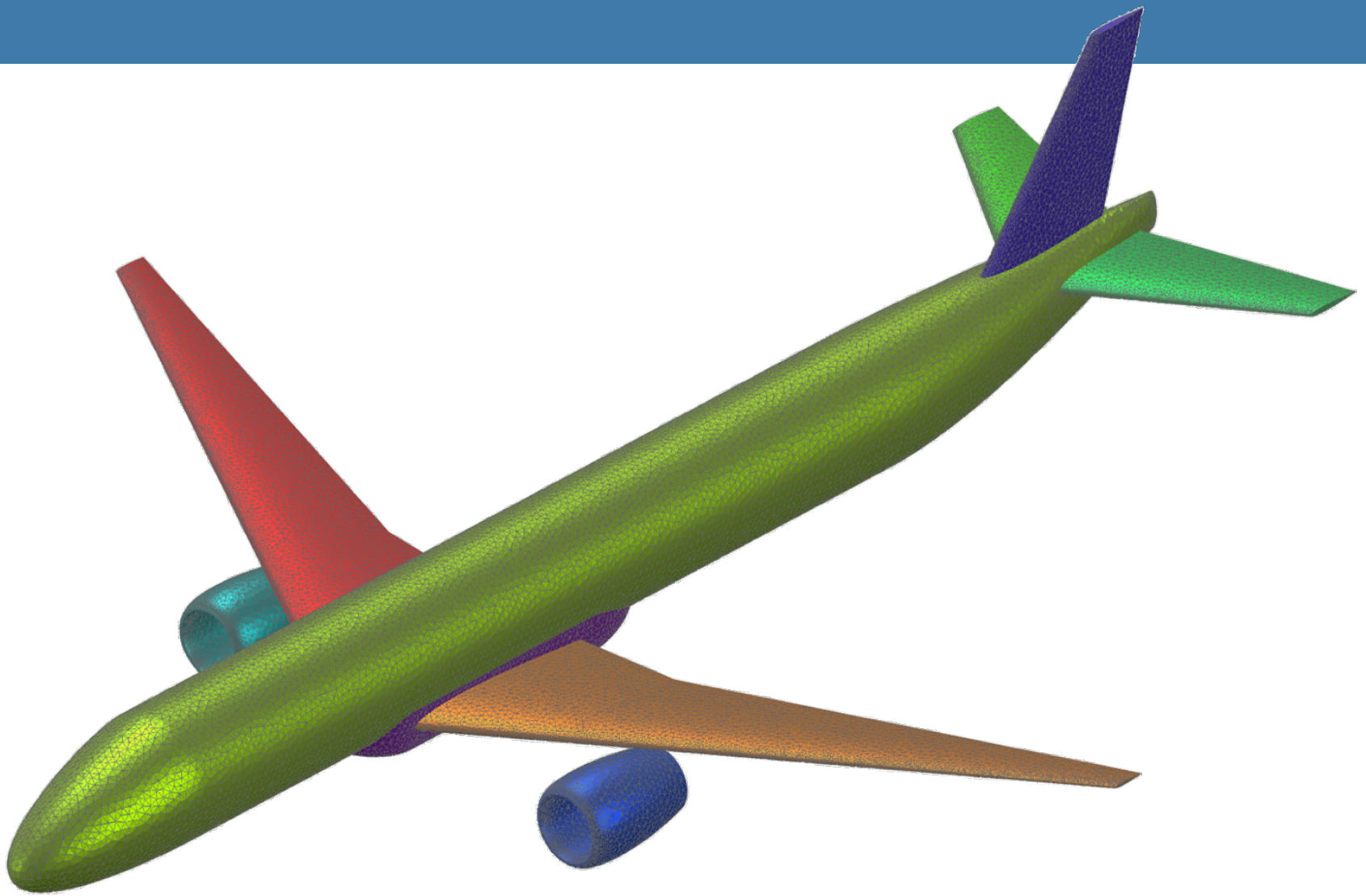
Export CompGeom



Practice Session

- Unintersected
- CompGeom
  - Save for Cart3D tutorial
- Resolution Effects (quads to triangles directly)
  - Num Pts
  - Num XSecs

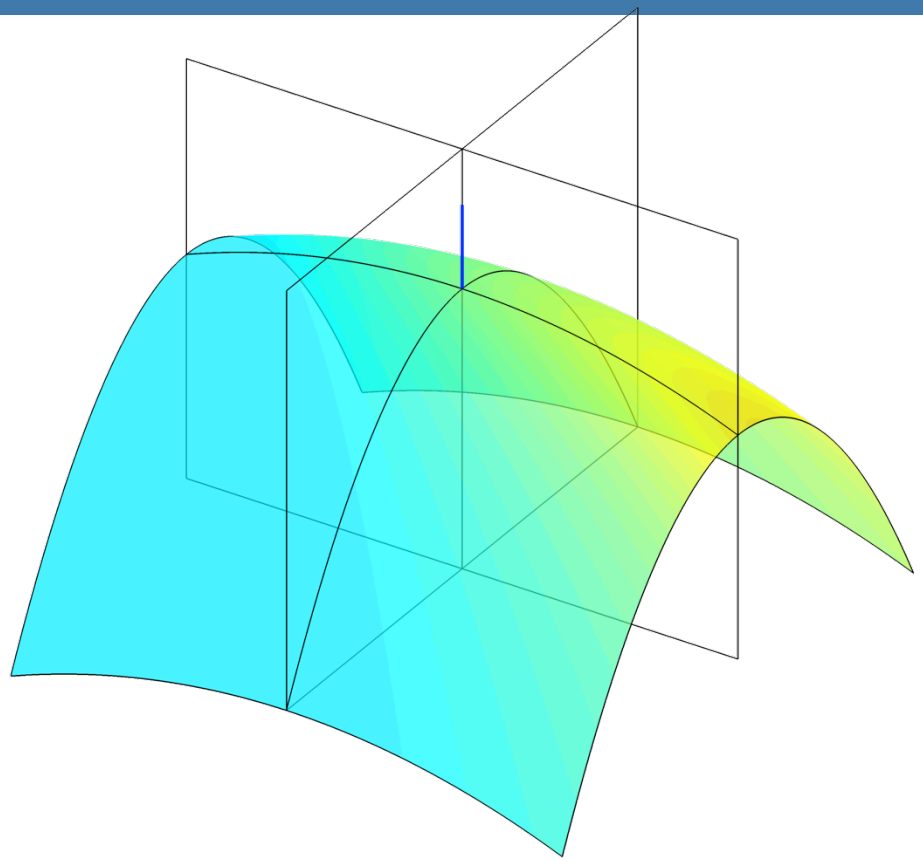
CFD Mesh Generator

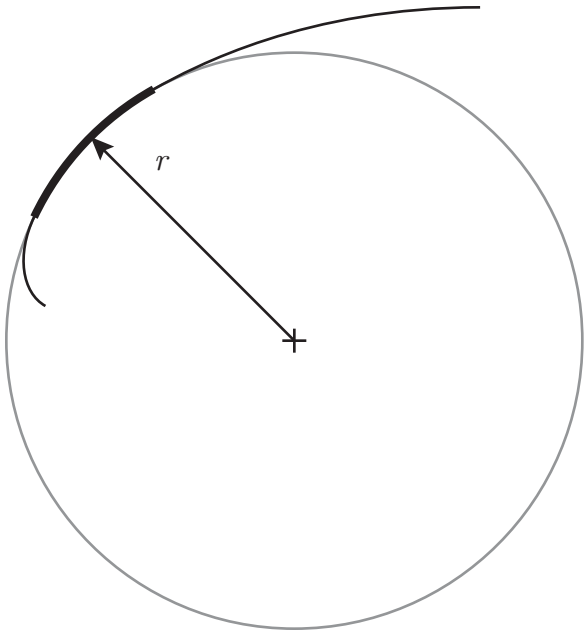


CFD Mesh

- Surface mesh generator
  - Isotropic triangles (no stretching)
  - Smooth Bezier surfaces
  - Bezier intersection curves
  - Subsurfaces
  - Negative volume
  - Actuator disk
  - Sourcing control
  - Curvature control
  - Optional wakes
  - Optional half-models
  - Optional domain modeling
- Preferred for most CFD tools
  - CBAero
  - Pointwise
  - AFLR3
  - Fun3D
  - FlightStream
  - TetGen
  - etc.

Local Radius of Curvature



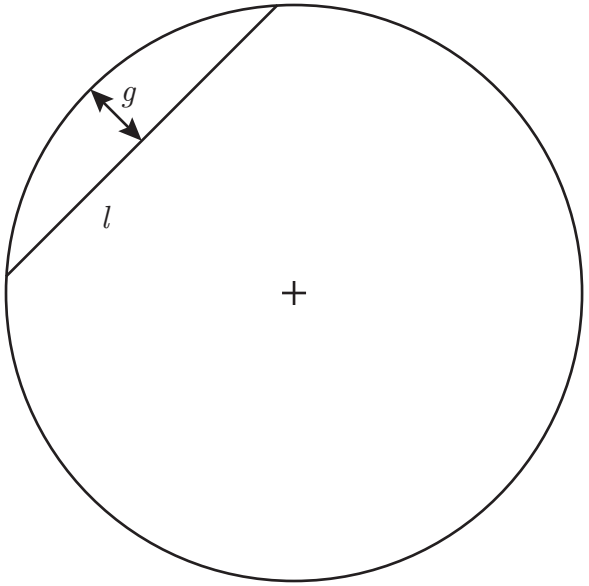


Greatest Principal Normal Curvature

$$r = 1/k$$

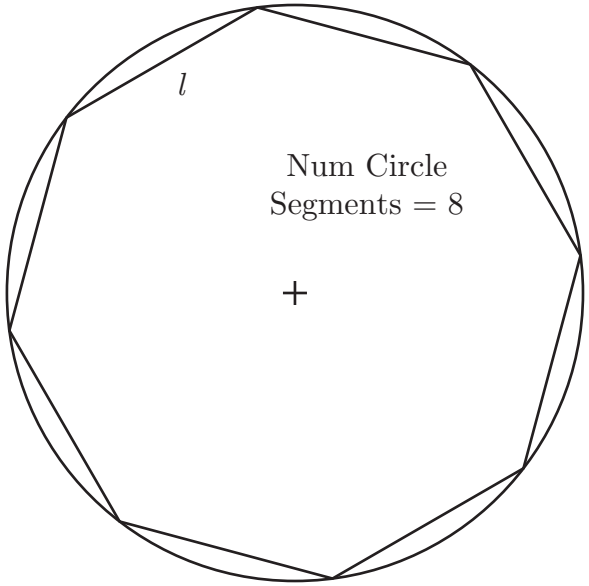
Curvature Meshing Criteria

Max Gap



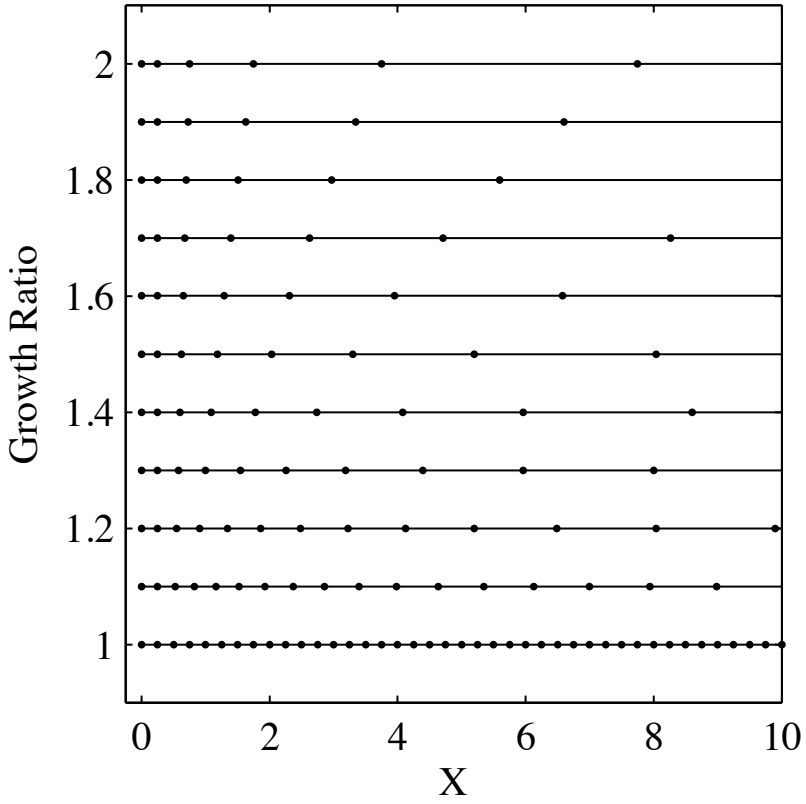
$$l = \begin{cases} r > g; & 2\sqrt{2 \cdot r \cdot g - g^2} \\ r \leq g; & 2 \cdot g \end{cases}$$

Num Circle Segments



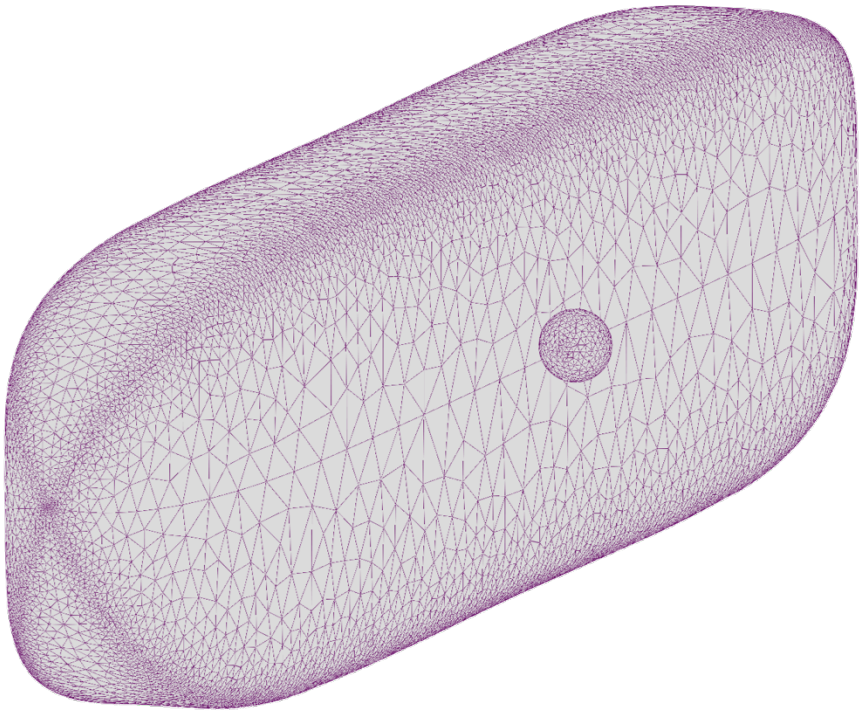
$$l = \begin{cases} N > 2; & r \cdot 2 \cdot \sin\left(\pi / N\right) \\ N \leq 2; & r \cdot 4 / N \end{cases}$$

Growth Ratio Limiter

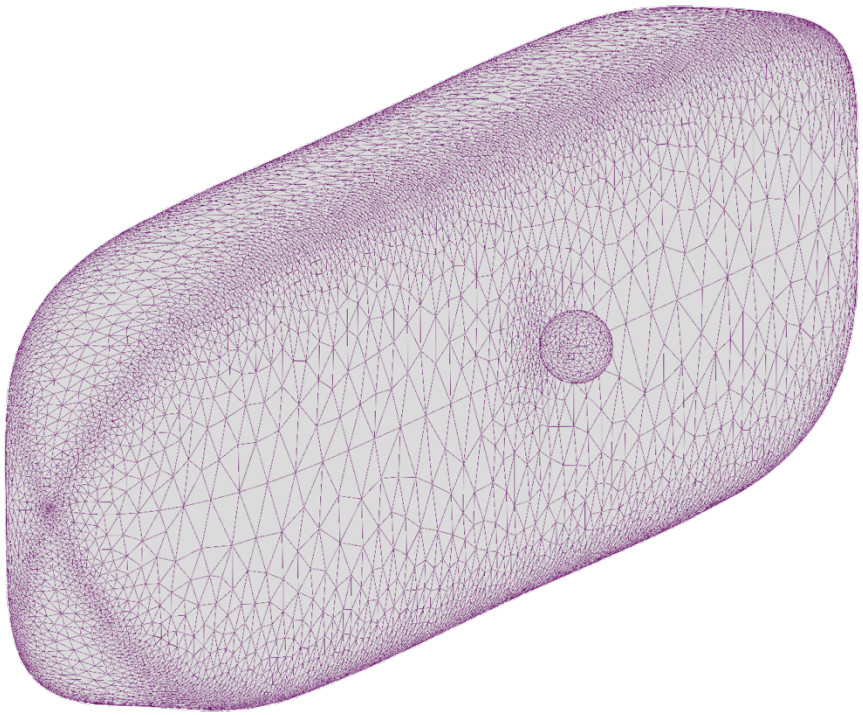


Limits length of next edge to ratio of current edge.

Rigorous 3D Growth Limiting



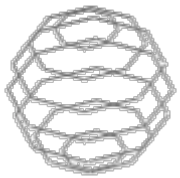
Off
(faster)



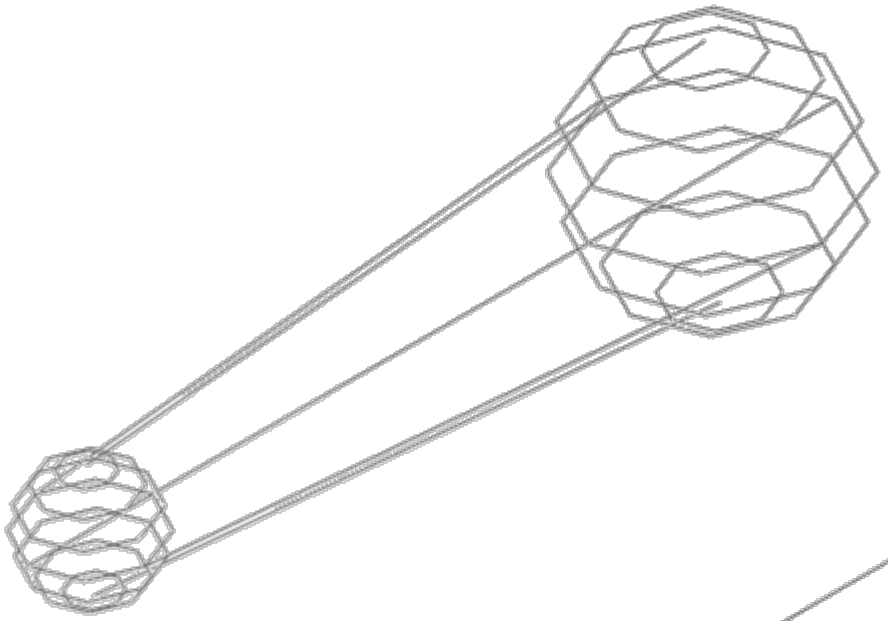
On
(slower)

Source Types

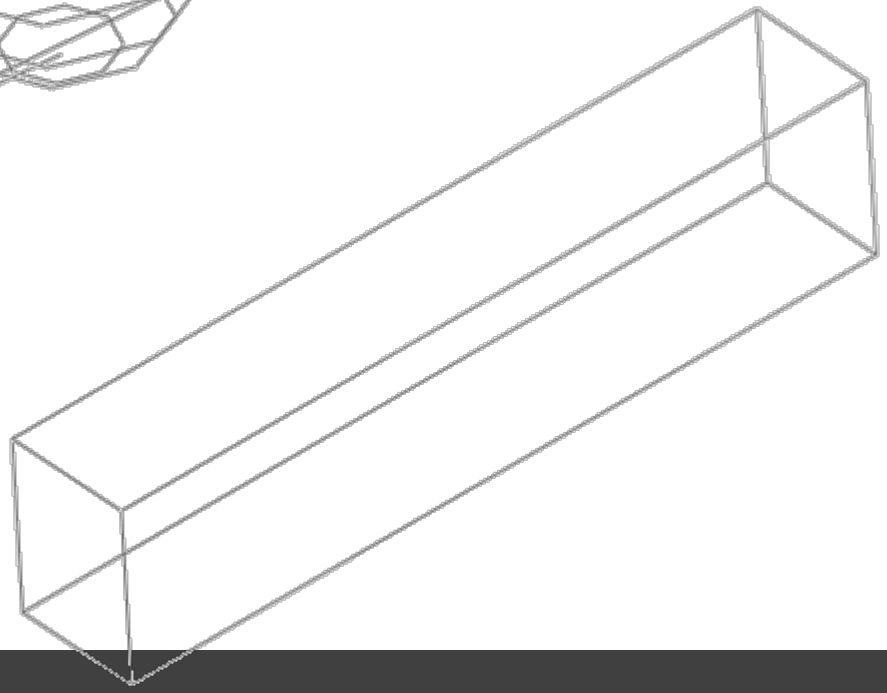
Point



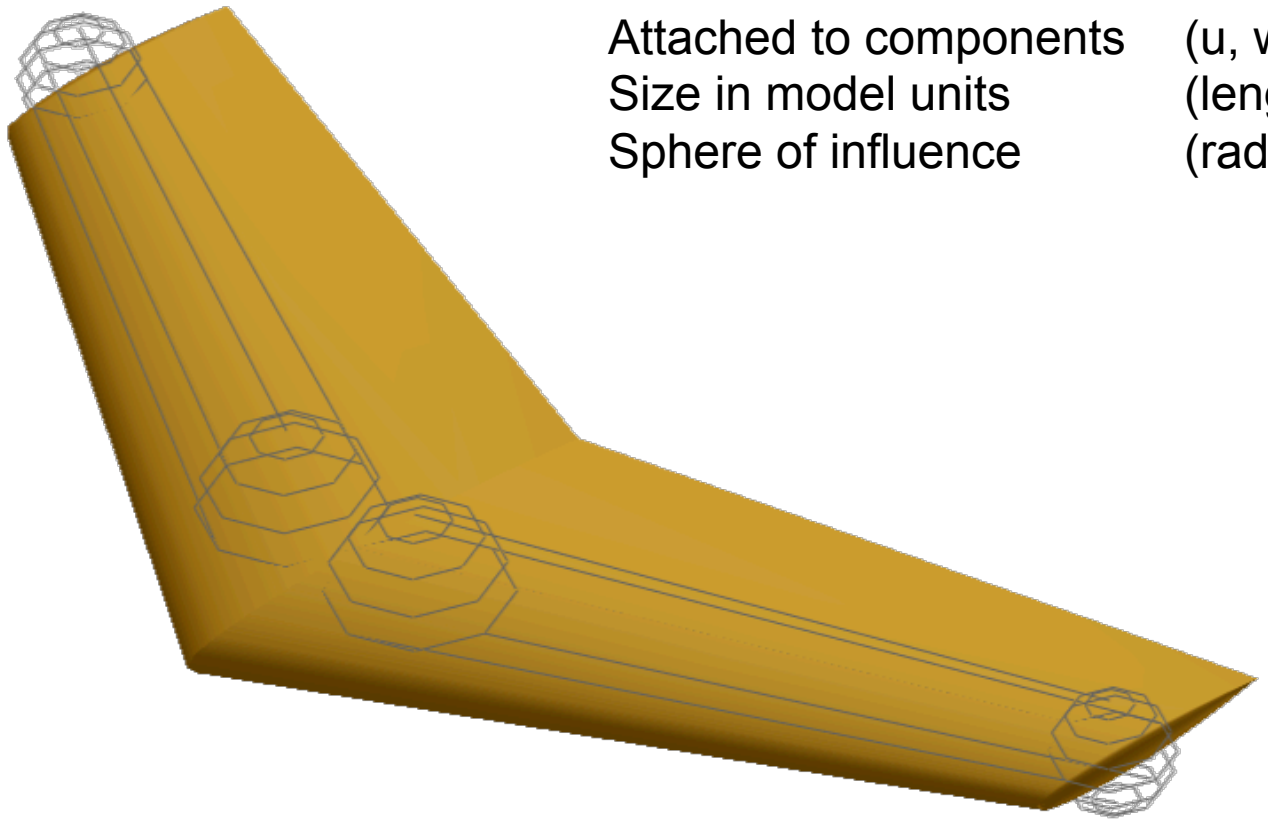
Line



Box

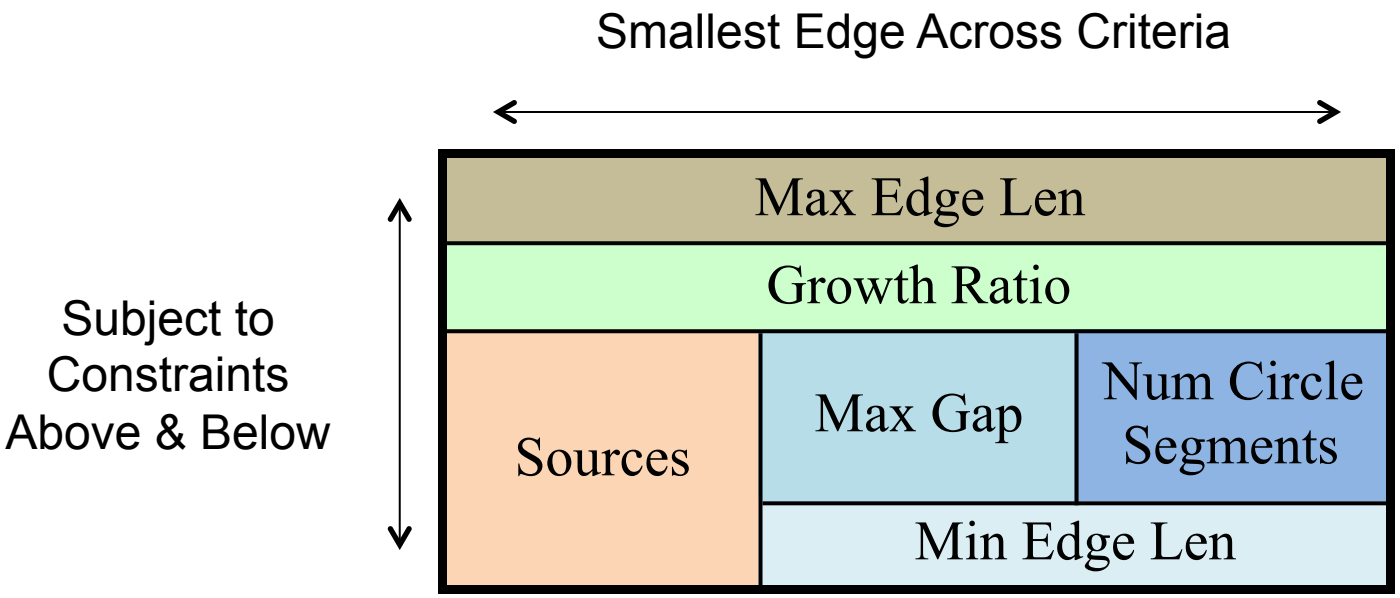


Sourcing



Attached to components	(u, w)
Size in model units	(length)
Sphere of influence	(radius)

Mesh Criteria Precedence

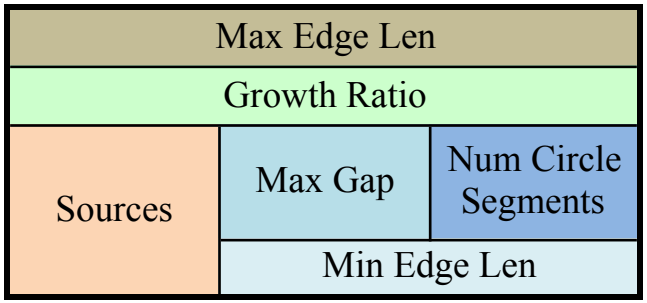


Turning Mesh Criteria ‘OFF’

Sometimes it is useful to turn a mesh criteria ‘OFF’.

Criteria	Direction	Value	Scaled?
Max Edge Len	large	100.0	(scaled)
Growth Ratio	large	10.0	
Sources		none	
Max Gap	large	10.0	(scaled)
Num Circle Segments	small	0.00001	
Min Edge Len	small	0.000001	(scaled)

Max = Min
will turn ‘OFF’
Max Gap &
Num Circle Segments



Meshing Strategy

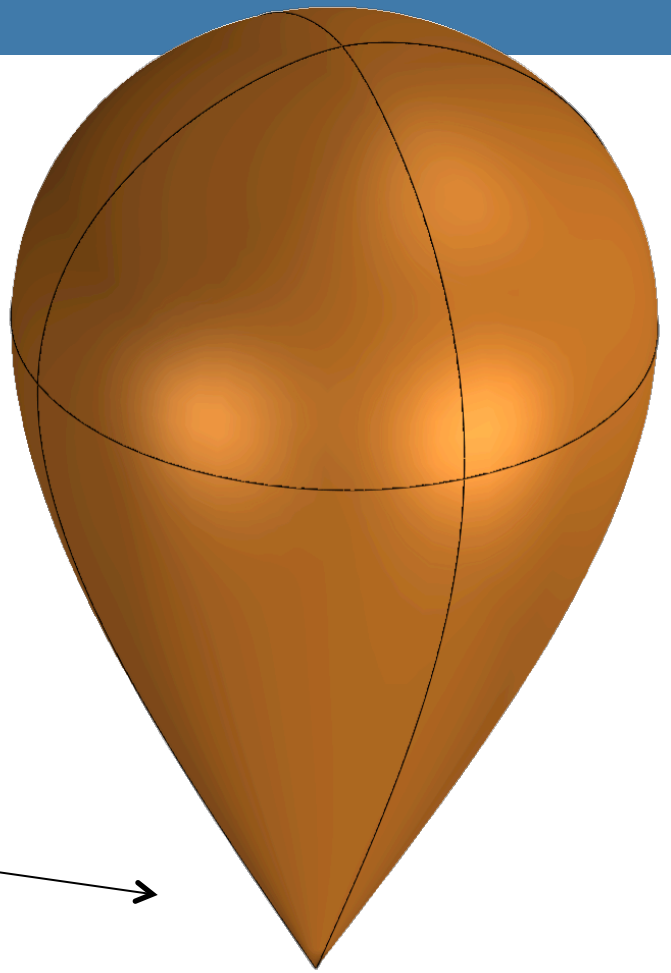
1. Set Max based on model dimensions
   - Set Min = Max (turning off MG and NCS)
   - No Sources
   - Adjust Max & Min until satisfied (uniform coarsest)
2. Set Min to smaller value
   - Say Min = Max/20
3. Choose MG or NCS as preferred curvature parameter (CP)
   - Set other curvature parameter (OCP) ‘OFF’
   - Adjust CP until satisfied
   - Adjust Min as required (are smallest edges small enough?)
4. Adjust OCP (optional)
5. Add mesh sources as required
   - Resolve flow features

‘Top’ Model

Constant curvature
(constant radius)

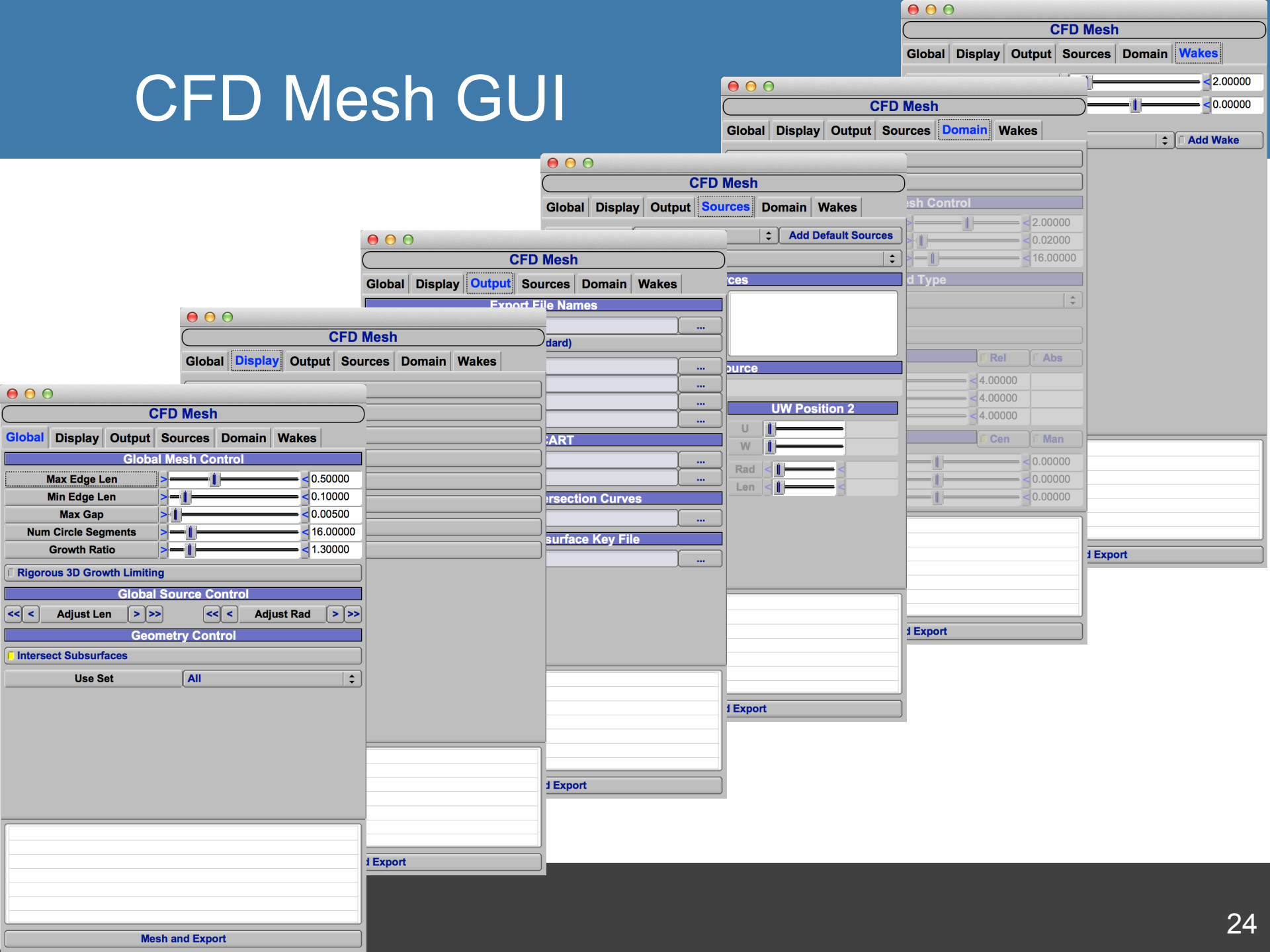
Increasing curvature
(decreasing radius)

Extreme curvature
(vanishing radius)



File on the wiki.

CFD Mesh GUI


CFD Mesh
Global
Display
Output
Sources
Domain
Wakes
Global Mesh Control
Max Edge Len
0.50000
Min Edge Len
0.10000
Max Gap
0.00500
Num Circle Segments
16.00000
Growth Ratio
1.30000
Rigorous 3D Growth Limiting
Global Source Control
Adjust Len
Adjust Rad
Geometry Control
Intersect Subsurfaces
Use Set
All
Mesh and Export
Export File Names
Add Default Sources
UW Position 2
U
W
Rad
Len
Add Wake
2.00000
0.00000
0.02000
16.00000
4.00000
0.00000

Global

Global & Curvature Meshing Criteria

Rigorous Limiting Switch

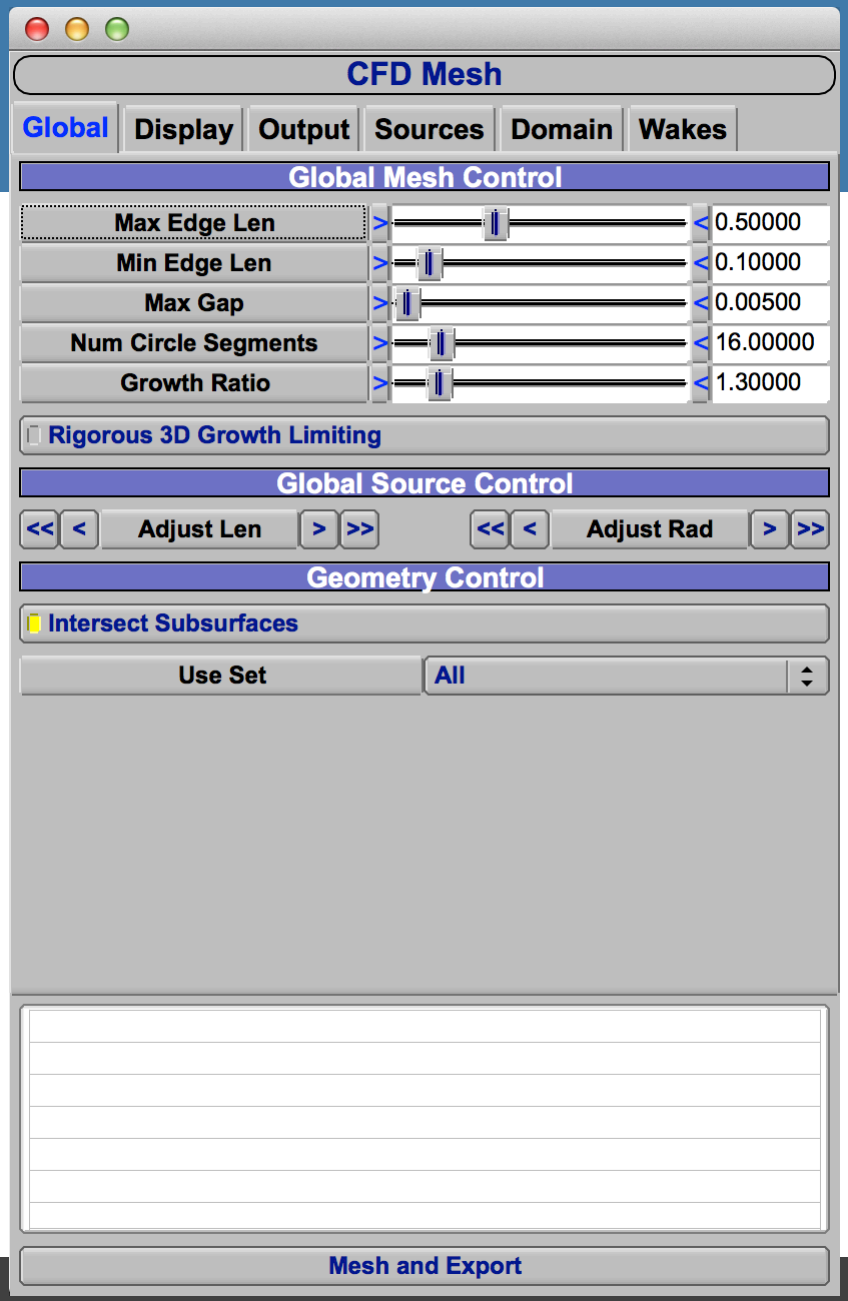
Global Source Adjustment

Intersect Subsurfaces

Choose Set

Mesh Output

'Go' Button

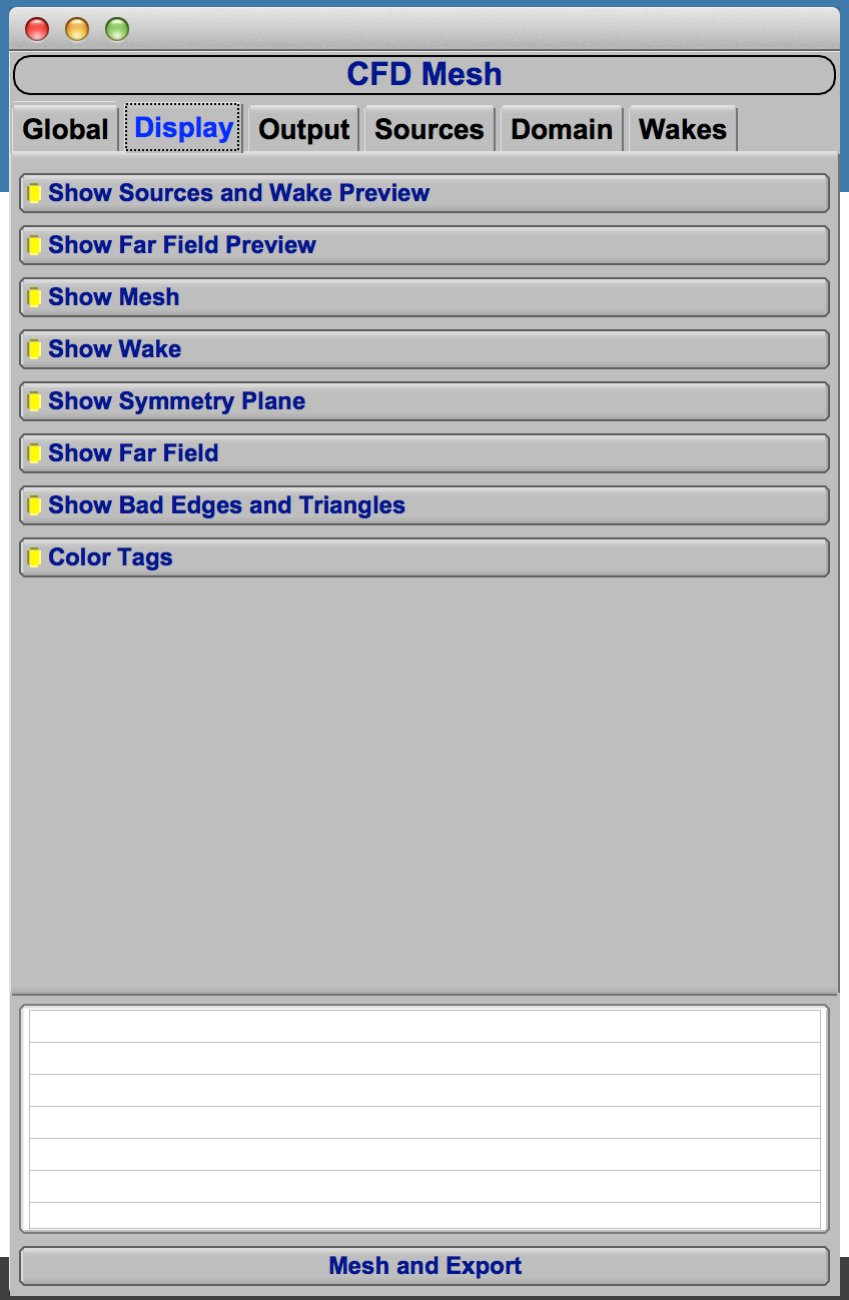


Display

Display Switches

Mesh Output

‘Go’ Button



Output

Multi-Solid STL Switch

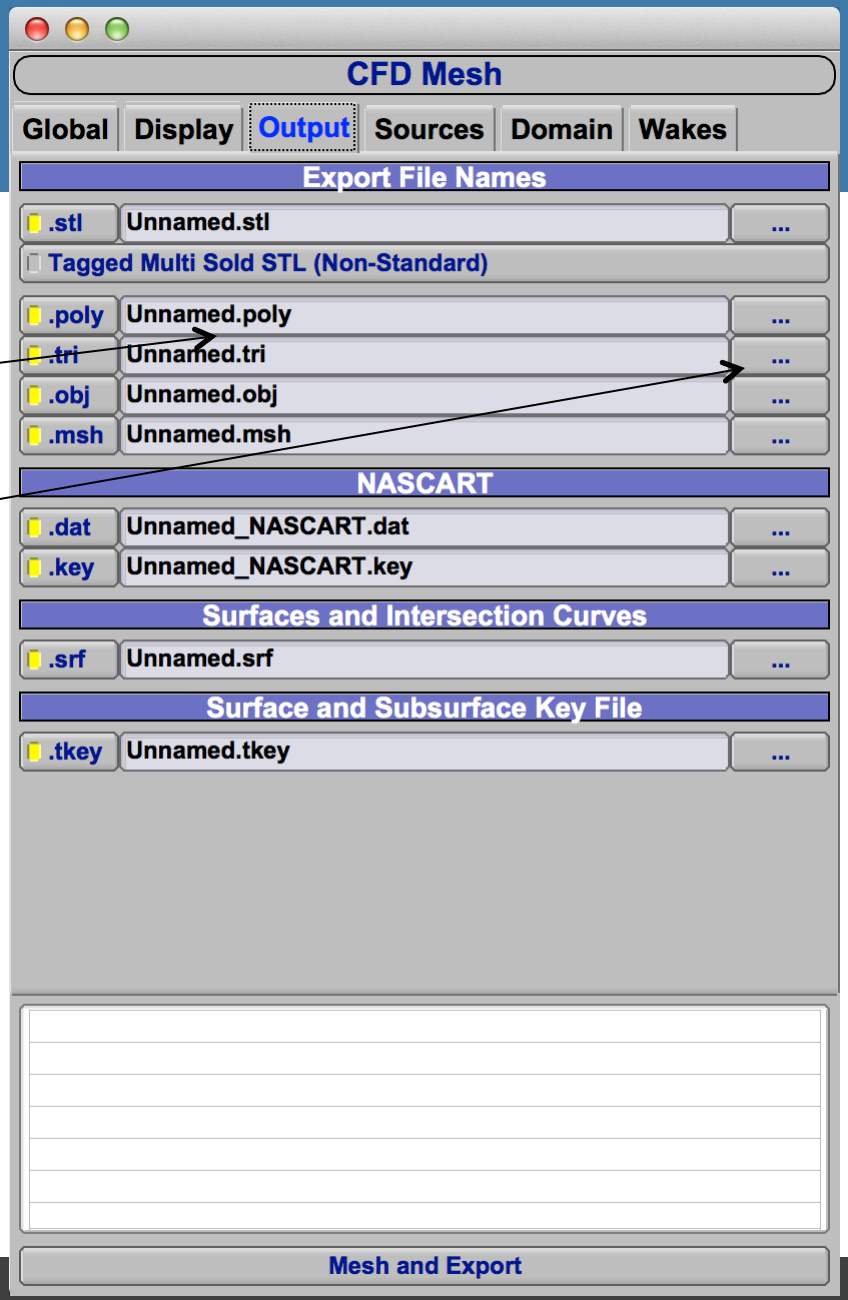
File Output Switches

File Paths

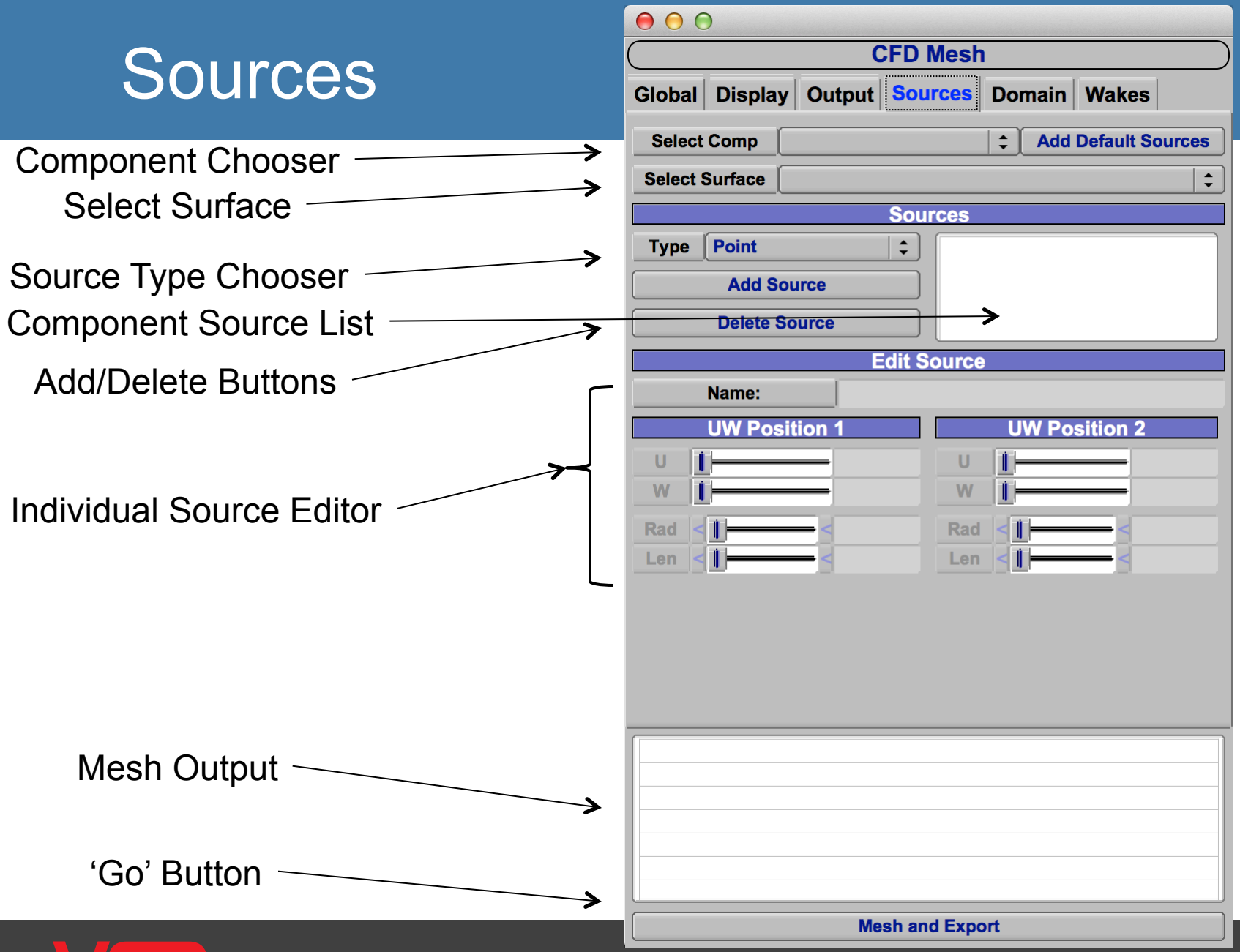
File Browser Button

Mesh Output

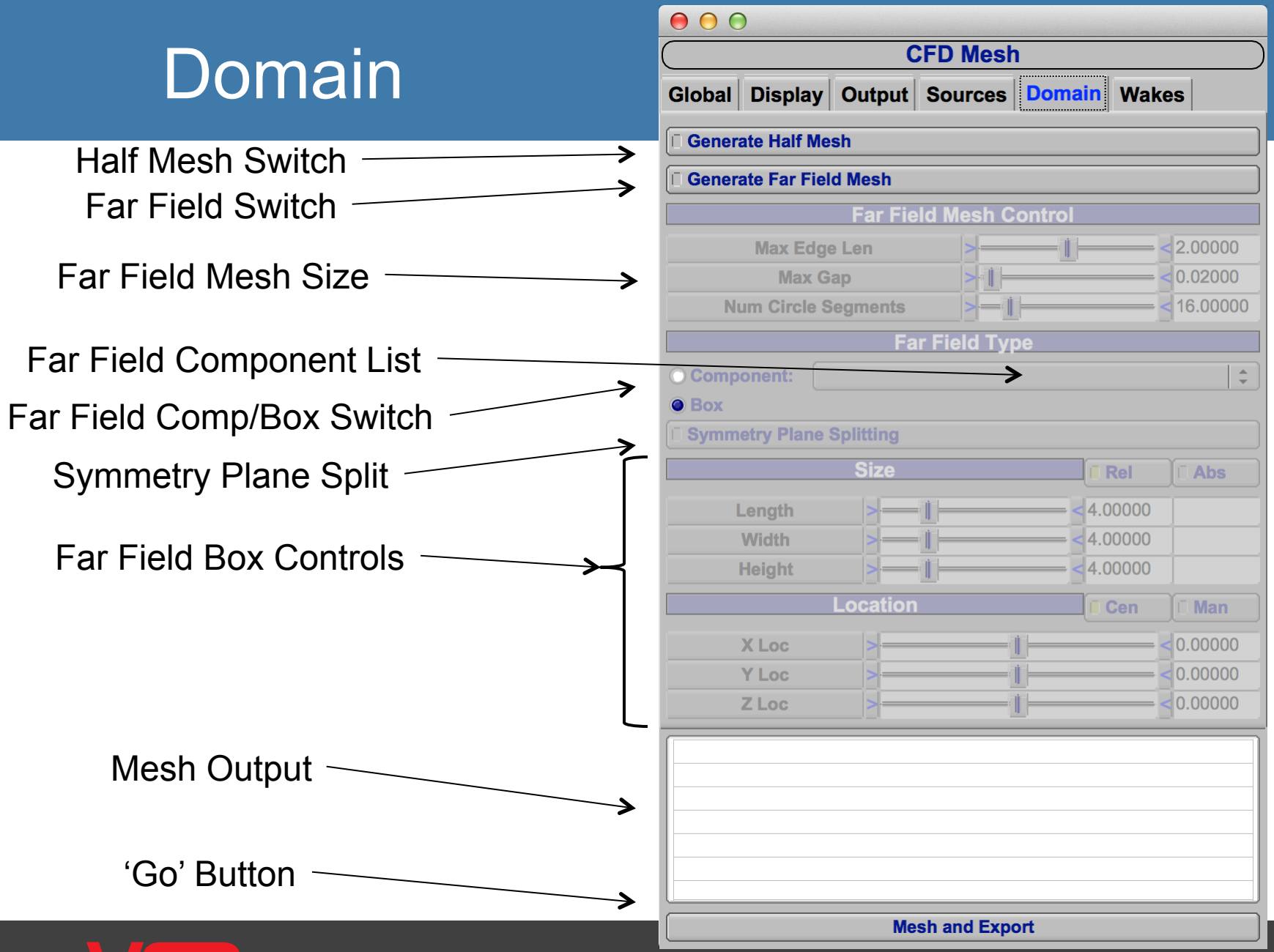
‘Go’ Button



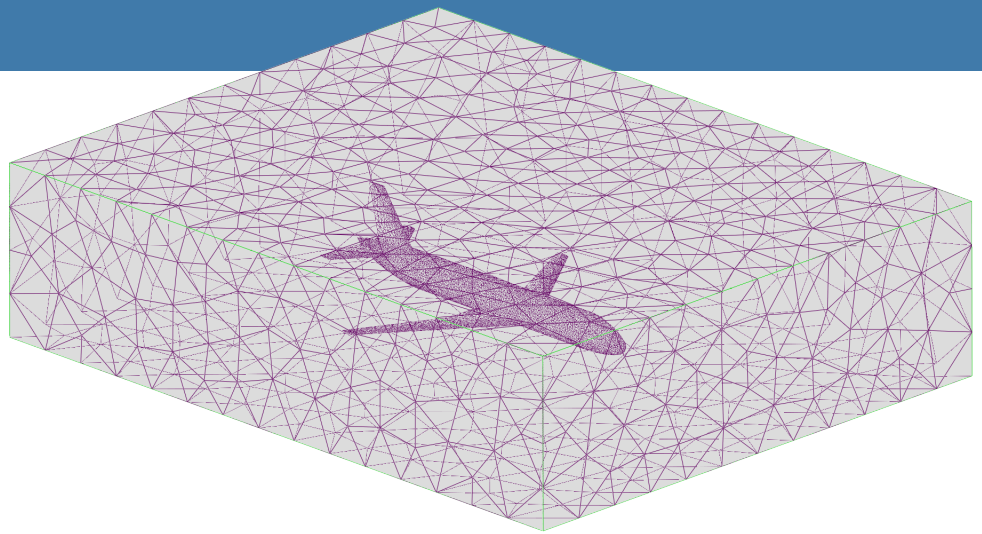
Sources

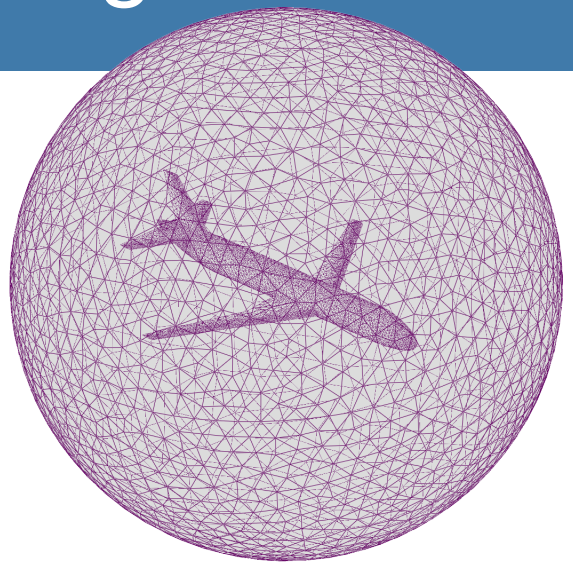

Component Chooser
Select Surface
Source Type Chooser
Component Source List
Add/Delete Buttons
Individual Source Editor
Mesh Output
'Go' Button
CFD Mesh
Global
Display
Output
Sources
Domain
Wakes
Select Comp
Add Default Sources
Select Surface
Sources
Type
Point
Add Source
Delete Source
Edit Source
Name:
UW Position 1
UW Position 2
U
W
Rad
Len
U
W
Rad
Len
Mesh and Export

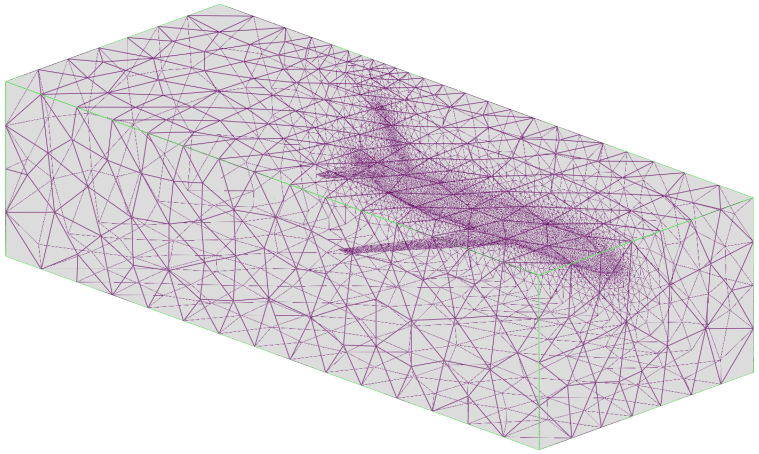
Domain

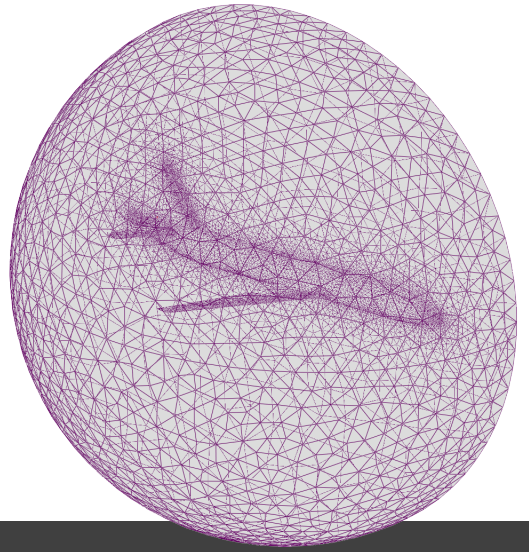

Half Mesh Switch
Far Field Switch
Far Field Mesh Size
Far Field Component List
Far Field Comp/Box Switch
Symmetry Plane Split
Far Field Box Controls
Mesh Output
'Go' Button
CFD Mesh
Global
Display
Output
Sources
Domain
Wakes
Generate Half Mesh
Generate Far Field Mesh
Far Field Mesh Control
Max Edge Len
2.00000
Max Gap
0.02000
Num Circle Segments
16.00000
Far Field Type
Component:
Box
Symmetry Plane Splitting
Size
Rel
Abs
Length
4.00000
Width
4.00000
Height
4.00000
Location
Cen
Man
X Loc
0.00000
Y Loc
0.00000
Z Loc
0.00000
Mesh and Export

Domain Modeling

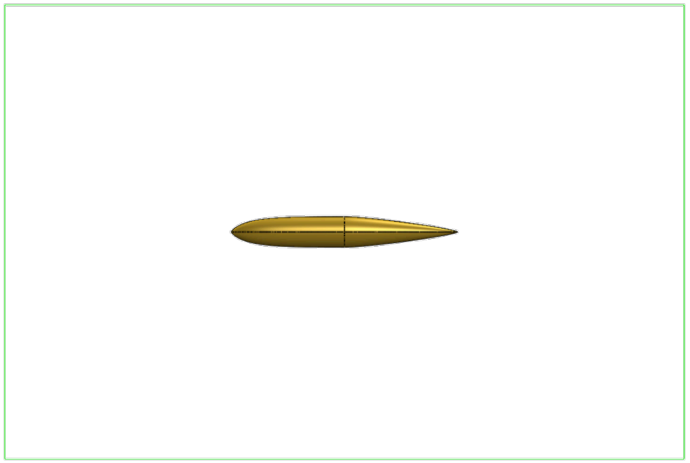


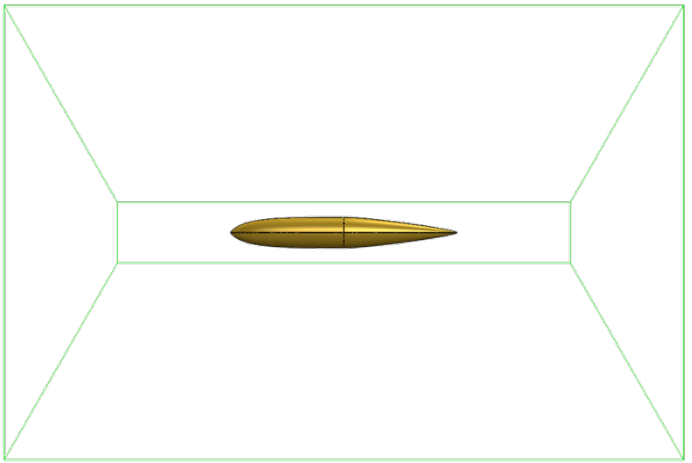


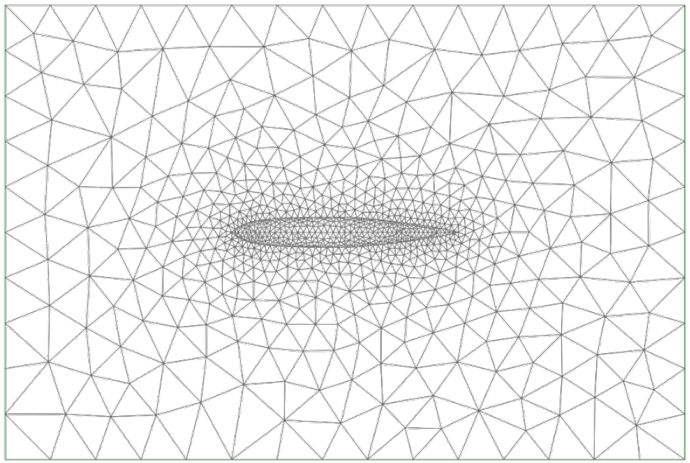


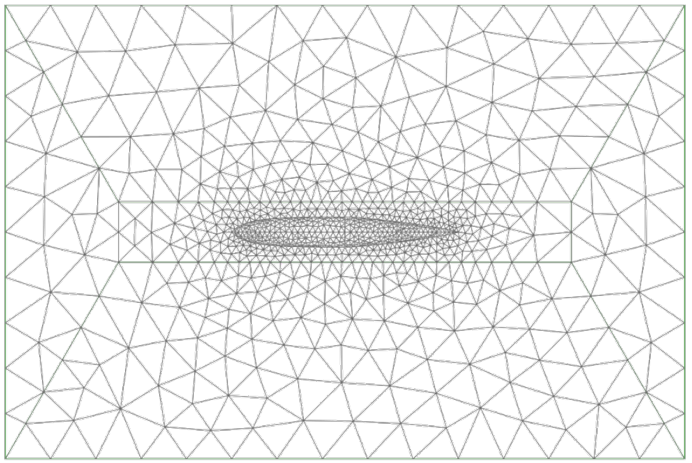


Symmetry Plane Splitting

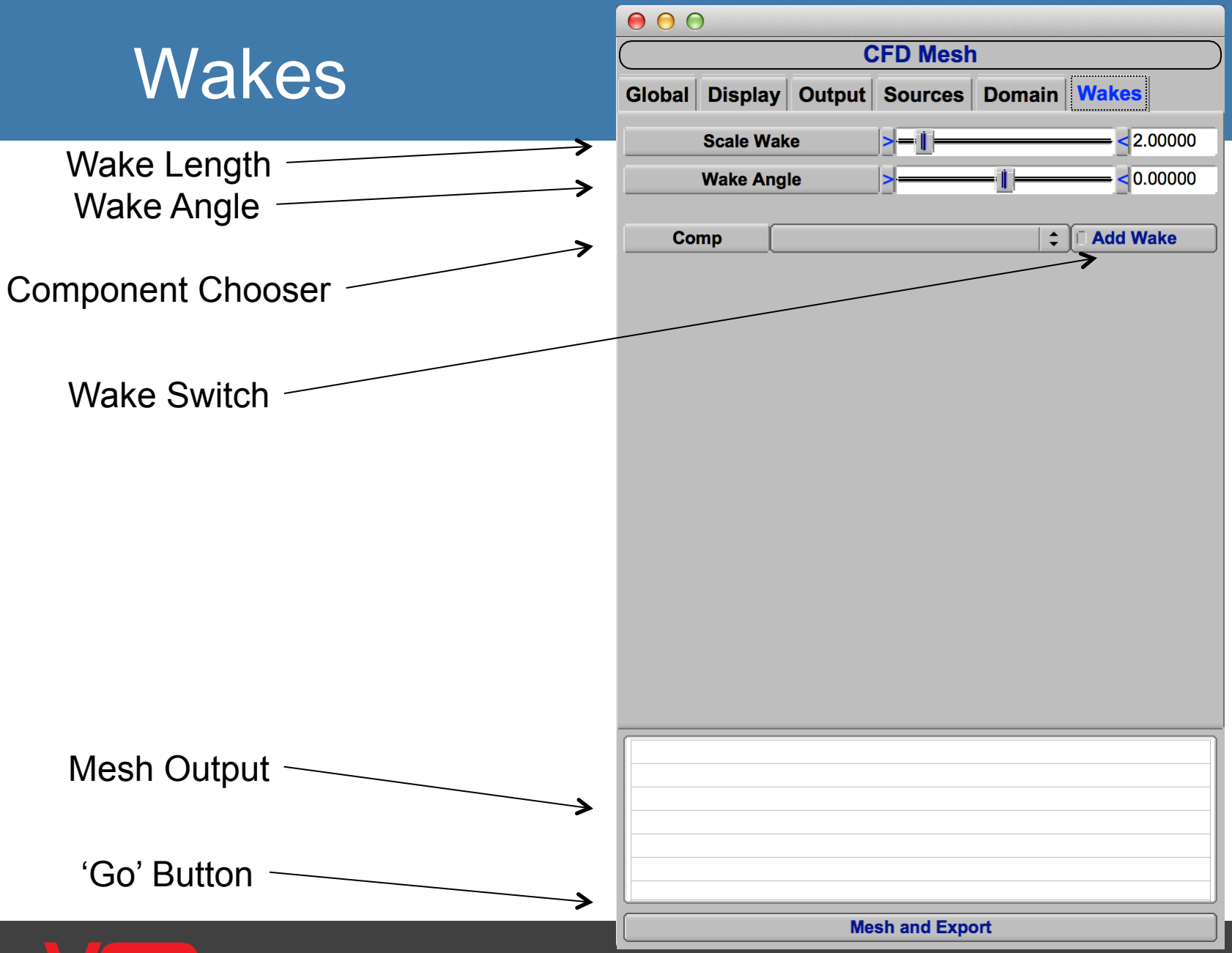








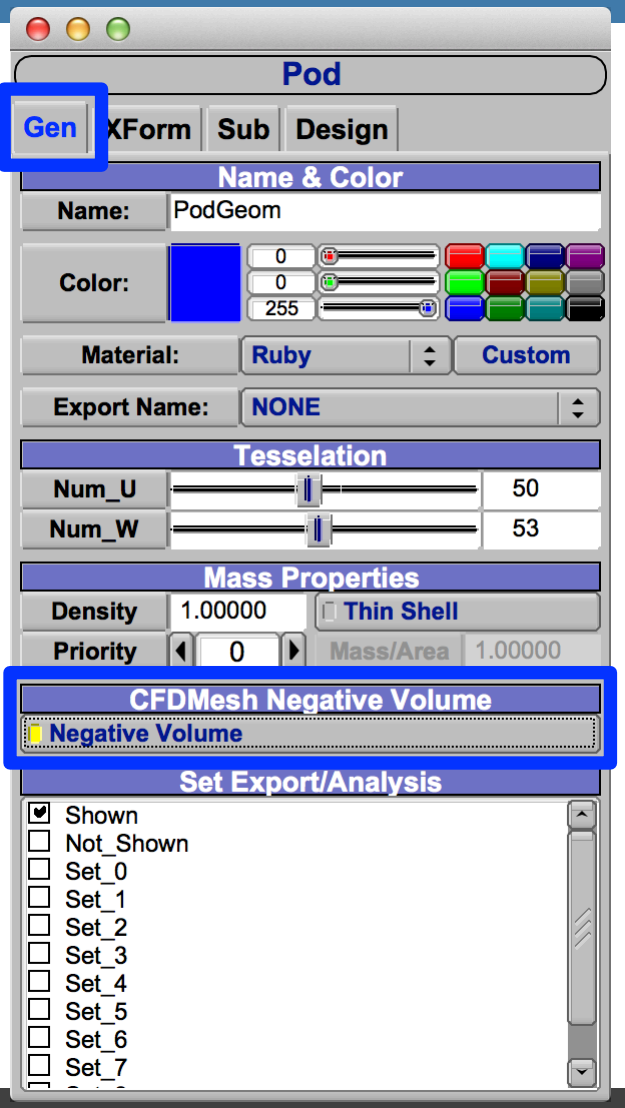
Wakes


Wake Length
Wake Angle
Component Chooser
Wake Switch
Mesh Output
‘Go’ Button
CFD Mesh
Global
Display
Output
Sources
Domain
Wakes
Scale Wake
2.00000
Wake Angle
0.00000
Comp
Add Wake
Mesh and Export

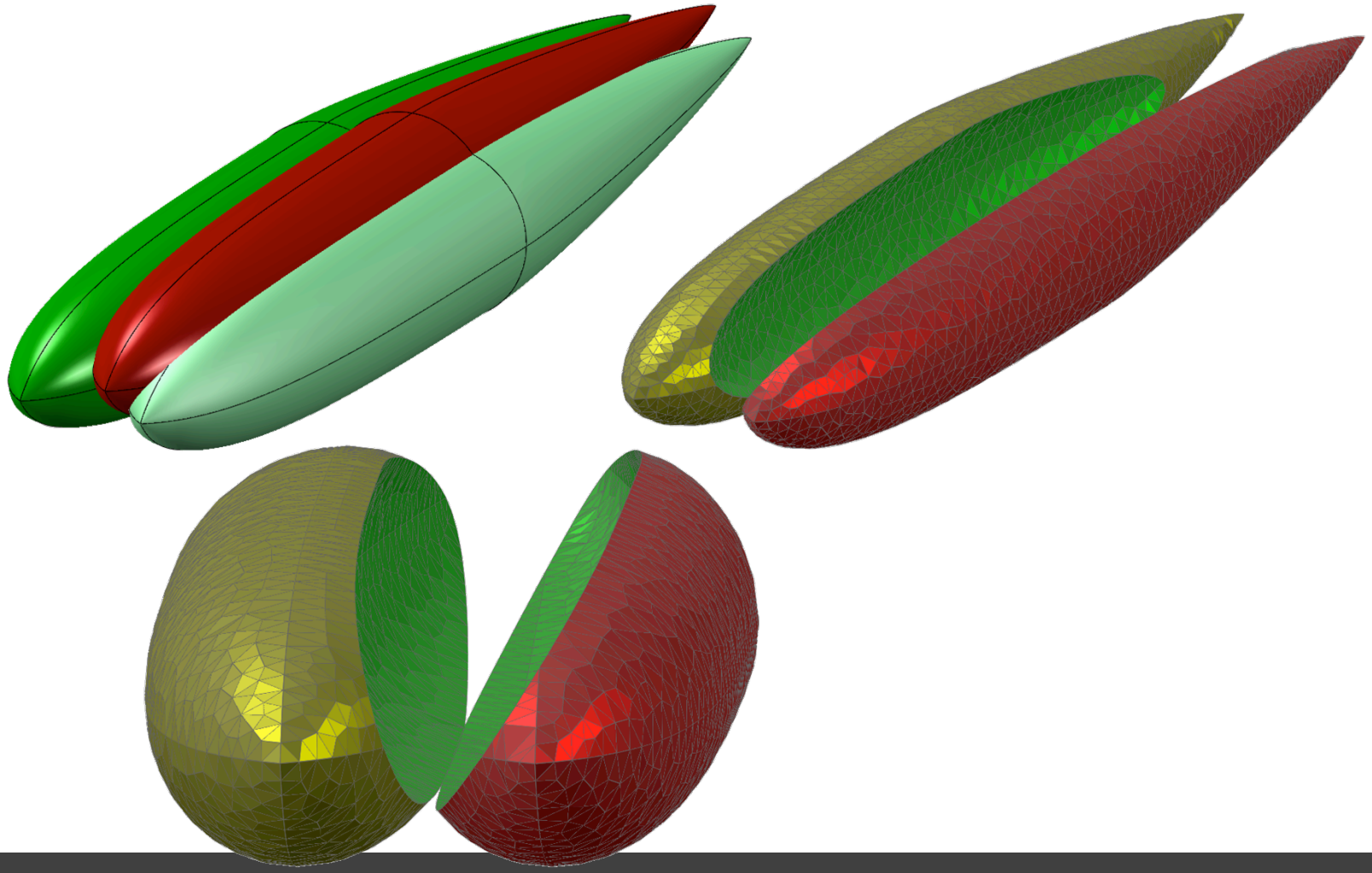
‘Negative’ Components

Gen Tab

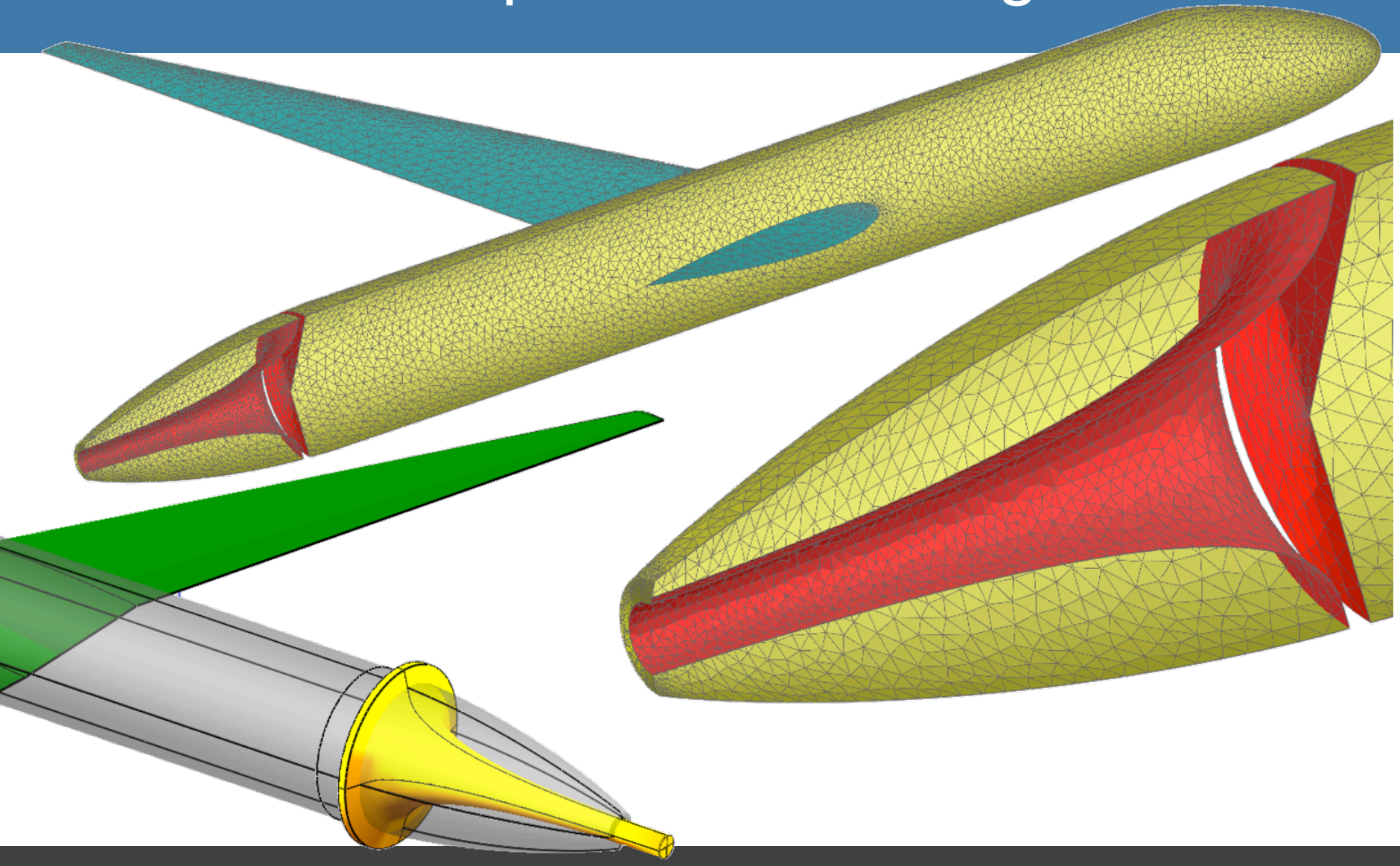
Negative Volume



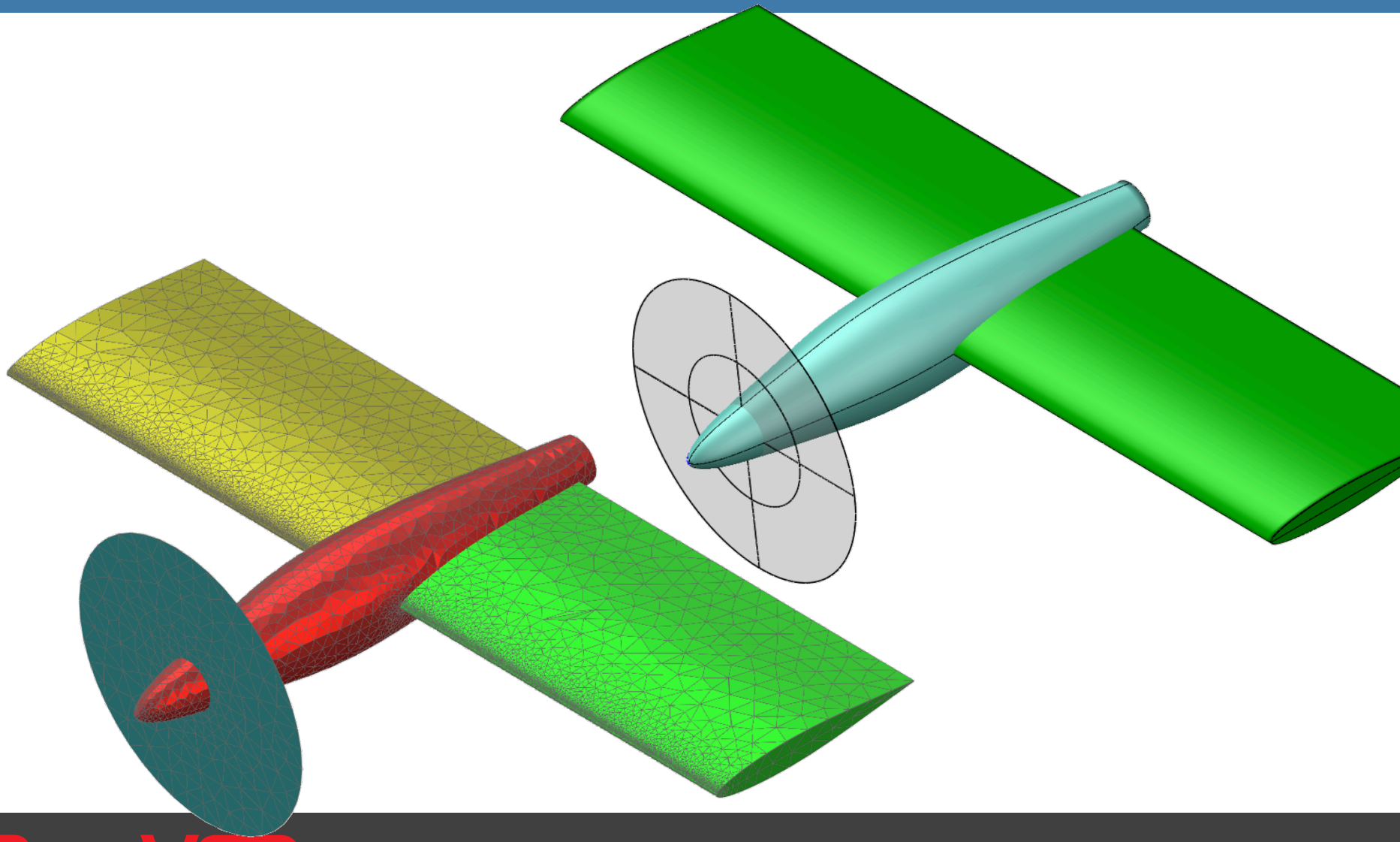
Negative Pod



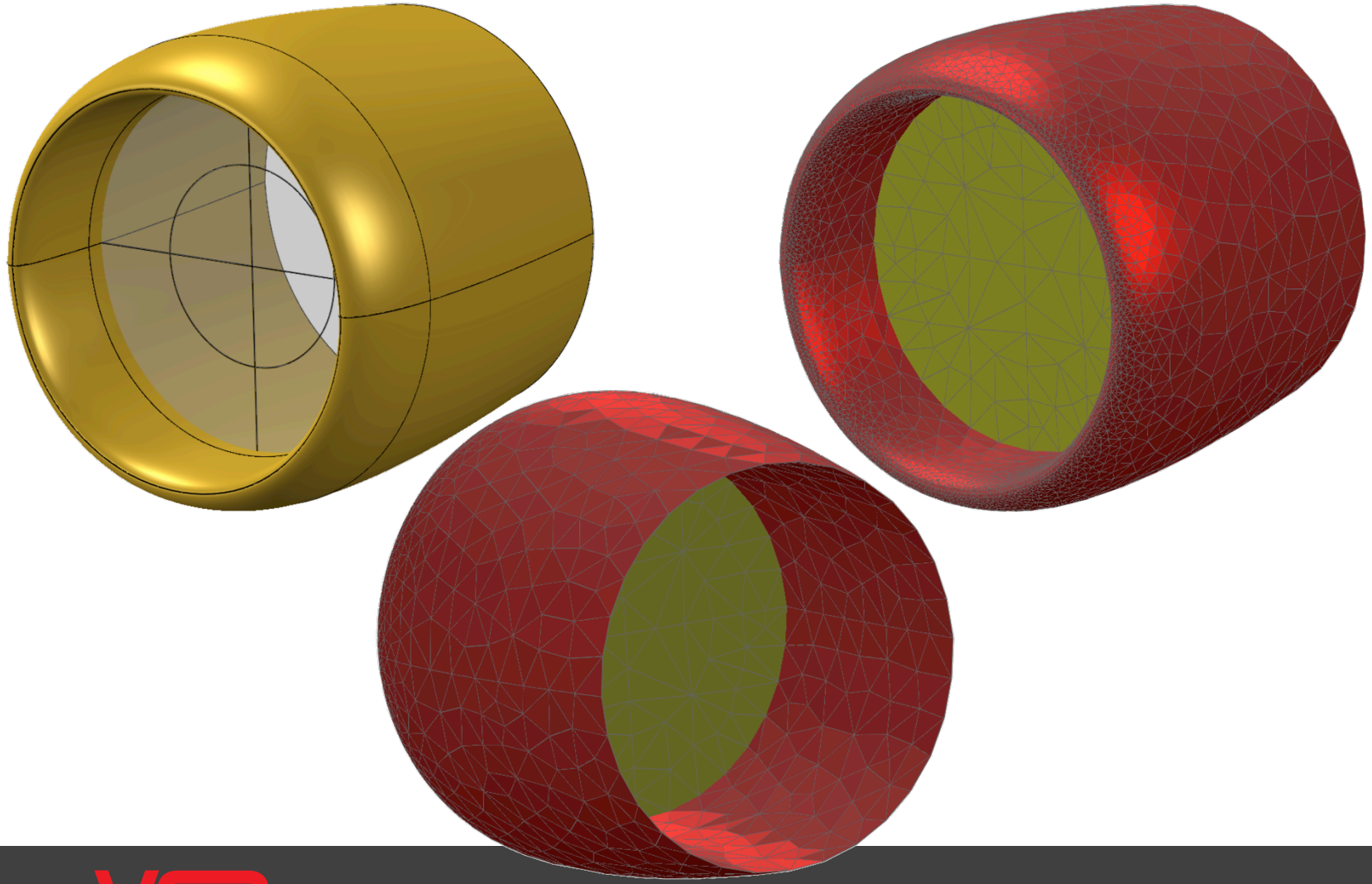
Propulsion Modeling



Actuator Disk



Actuator Disk in Duct



Practice Session

- CFD Mesh
  - ‘Top’ model
  - Experiment with meshing parameters
  - Turn all criteria off – ‘play’ with one at a time
  - Follow meshing strategy

- CFD Mesh
  - ‘Your’ model
  - Follow meshing strategy

Command Line / API

```
vsp airplane.vsp3 -script myscript.vspscript

# -des airplane.des    # Apply design file
# vspscript            # Batch only executable
```

```
// Script to export Unintersected Cart3D tri file
void main()
{
    ExportFile( “output.tri”, 0, EXPORT_CART3D );
}
```

```
// Script to execute CompGeom and export Cart3D tri file
void main()
{
    ComputeCompGeom( 0, false, NO_FILE_TYPE );
    ExportFile( “output.tri”, 0, EXPORT_CART3D );
}
```

```
// Script to execute CFDMesh and export Cart3D tri file
void main()
{
    ComputeCFDMesh( 0, EXPORT_CART3D );
}
```