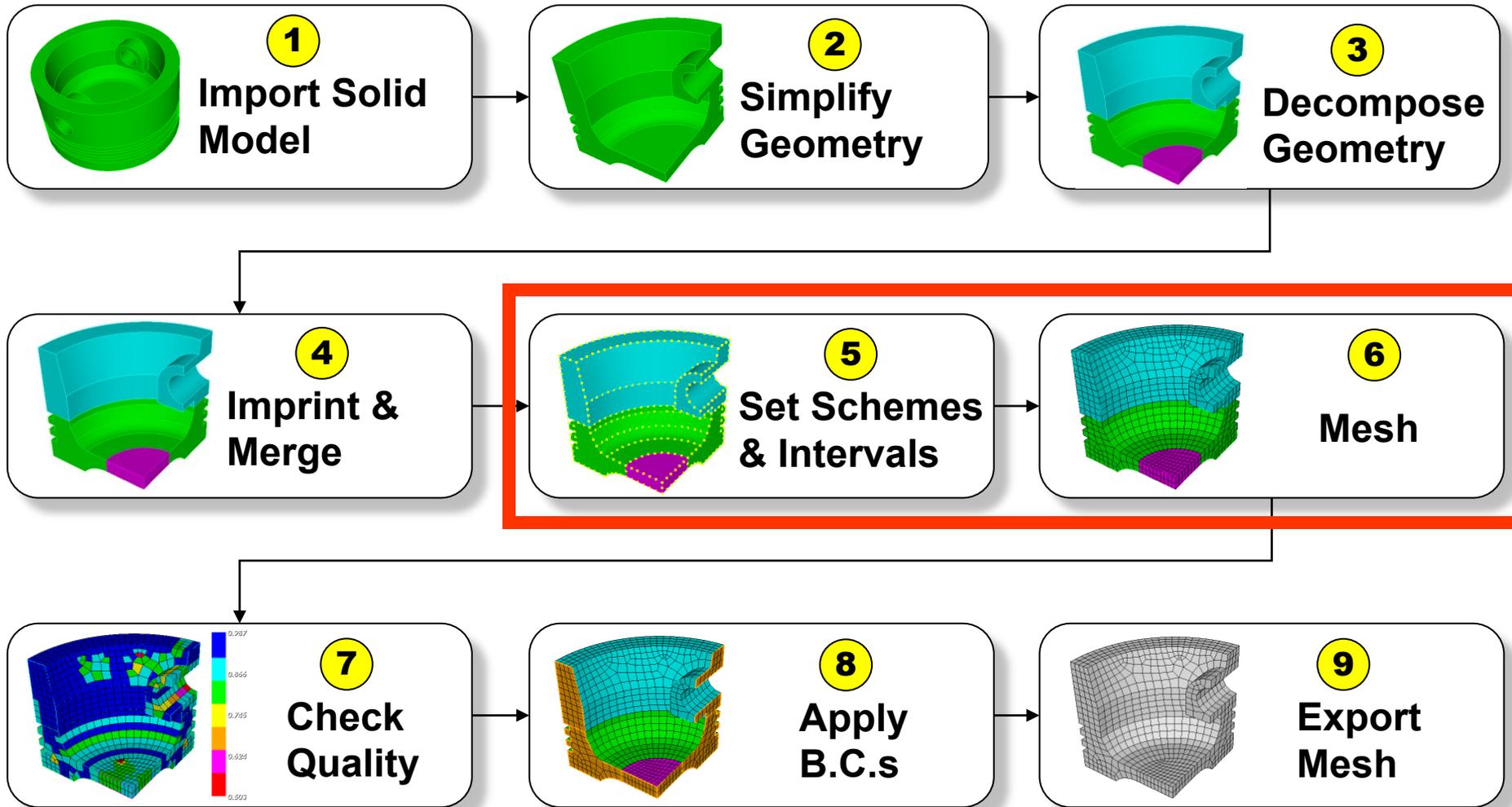


CUBIT Fast-Start Tutorial

9. Meshing Schemes

The Basic CUBIT Process

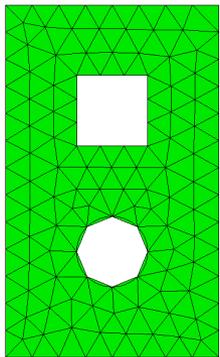
Simulation Modeling Sciences



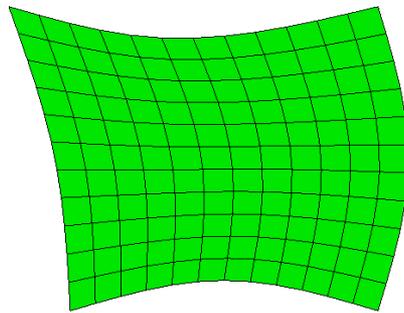
Surface Meshing Schemes

Simulation Modeling Sciences

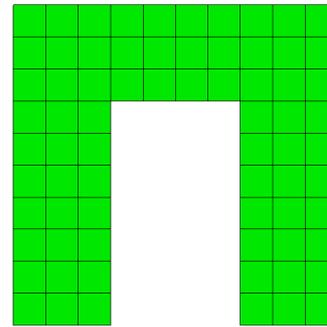
CUBIT Provides a number of different surface mesh schemes. Choosing the best scheme depends on the shape and number of curves in the surface. Your choice also depends on how you plan to mesh the volume.



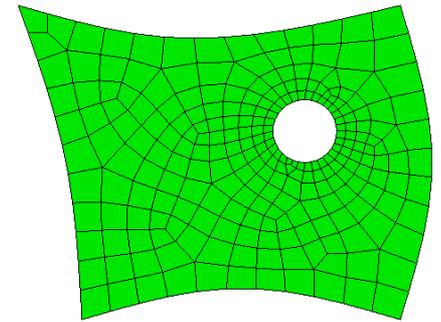
TriMesh



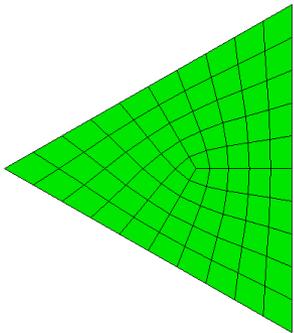
Map



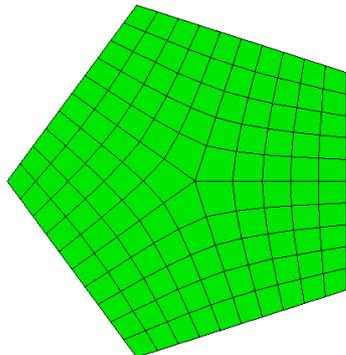
SubMap



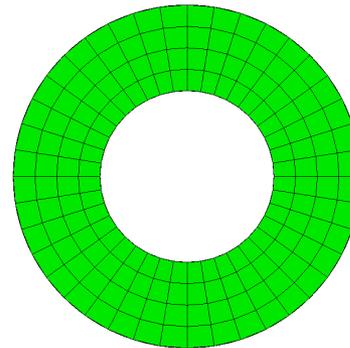
Pave



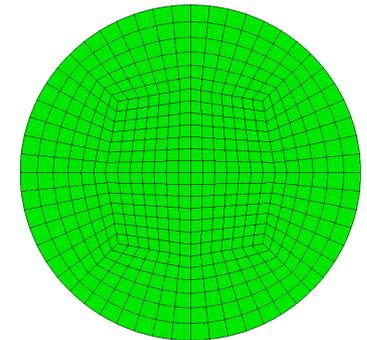
TriPrimitive



Polyhedron



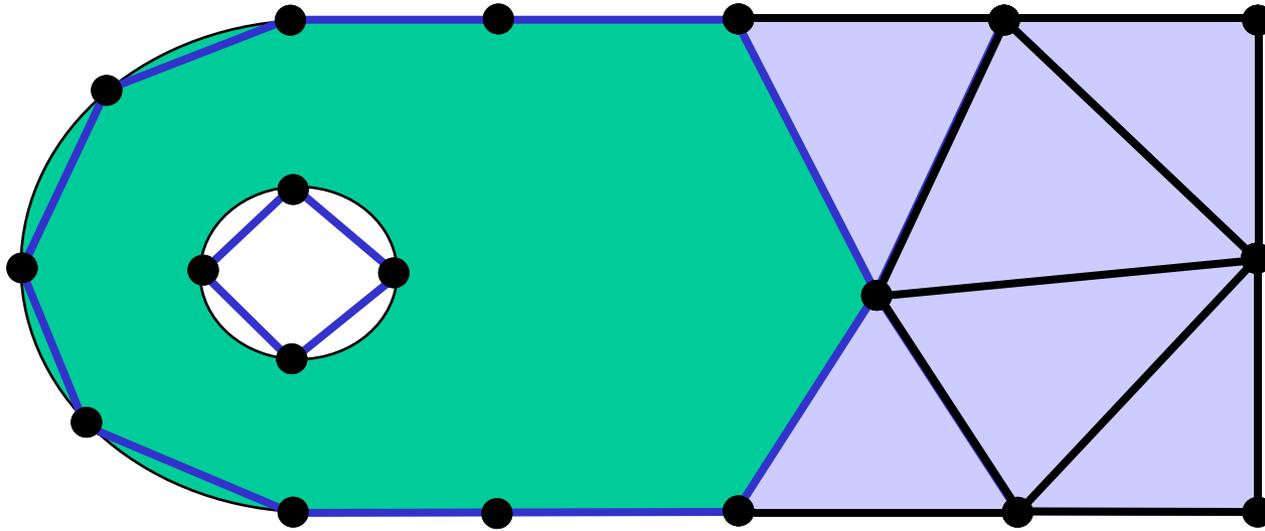
Hole



Circle

TriAdvance Scheme

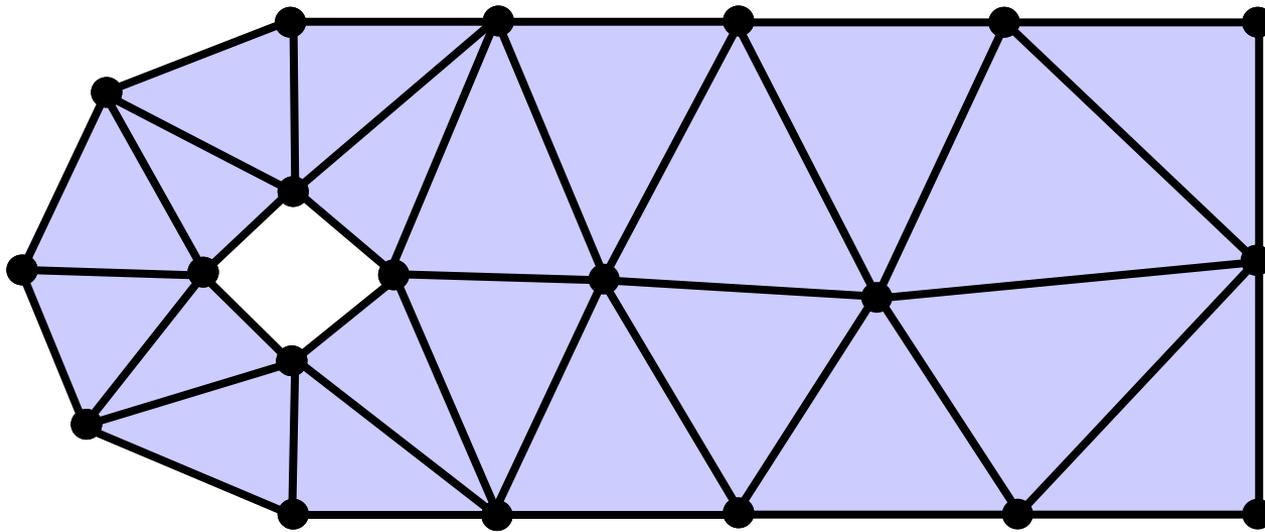
Simulation Modeling Sciences



Advancing Front: Starts from the boundaries, placing elements one at a time.

TriAdvance Scheme

Simulation Modeling Sciences

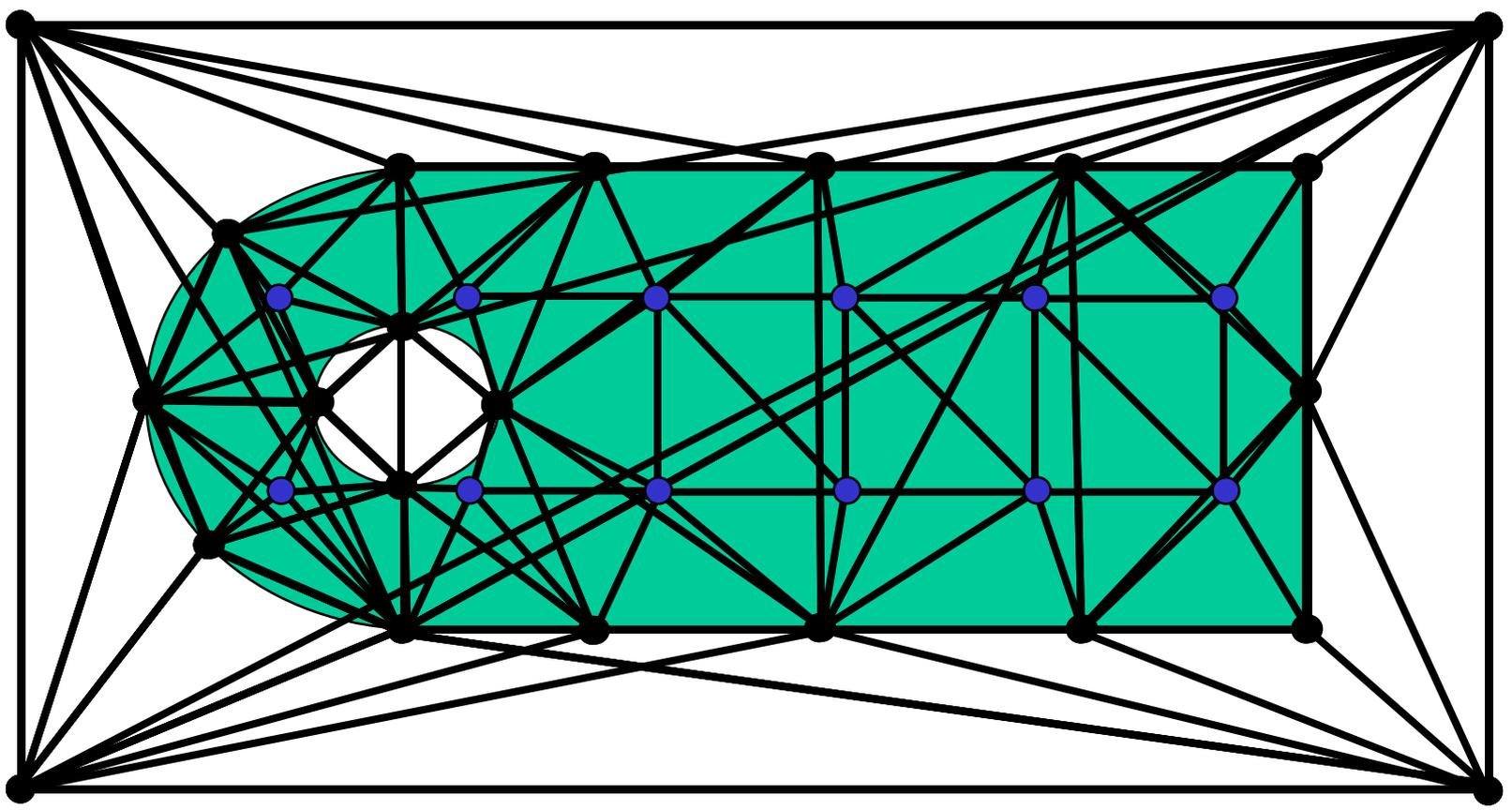


Advancing Front: Starts from the boundaries, placing elements one at a time.



TriDelaunay Scheme

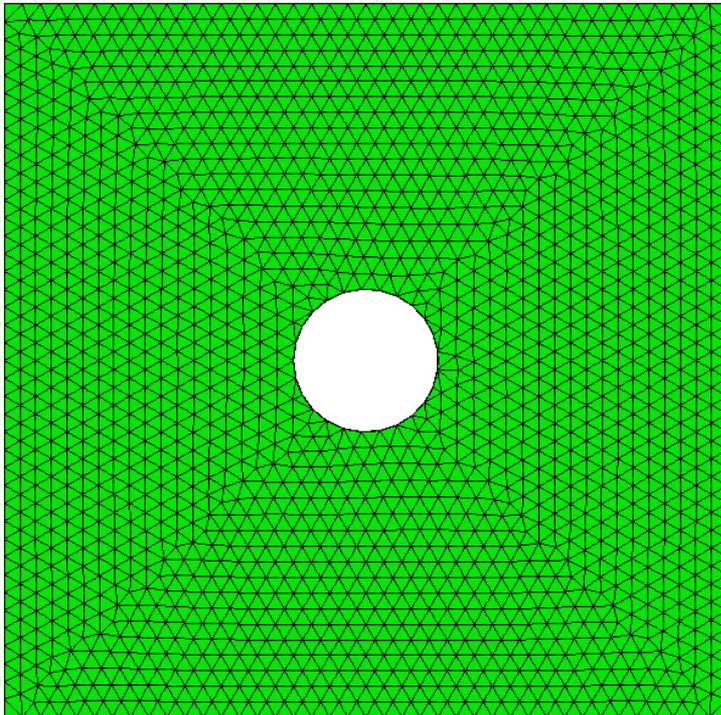
Simulation Modeling Sciences



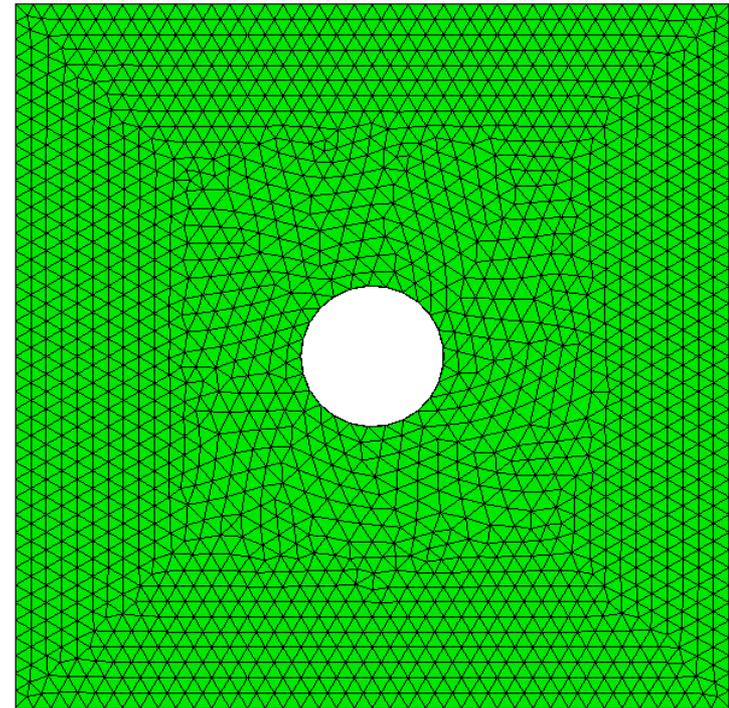
Delaunay: Inserts points into triangulation to satisfy *Delaunay Criteria*

TriMesh Scheme

Simulation Modeling Sciences



TriAdvance

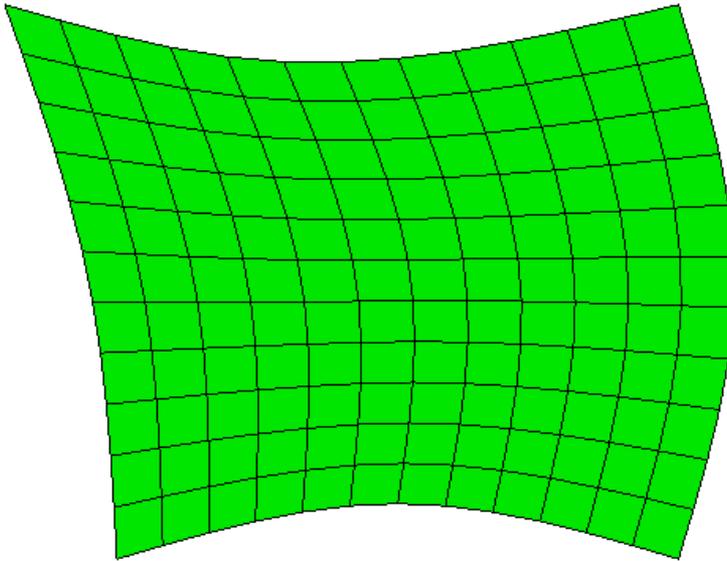


TriDelaunay

TriMesh Scheme = Defaults to TriAdvance. If fails will automatically use TriDelaunay

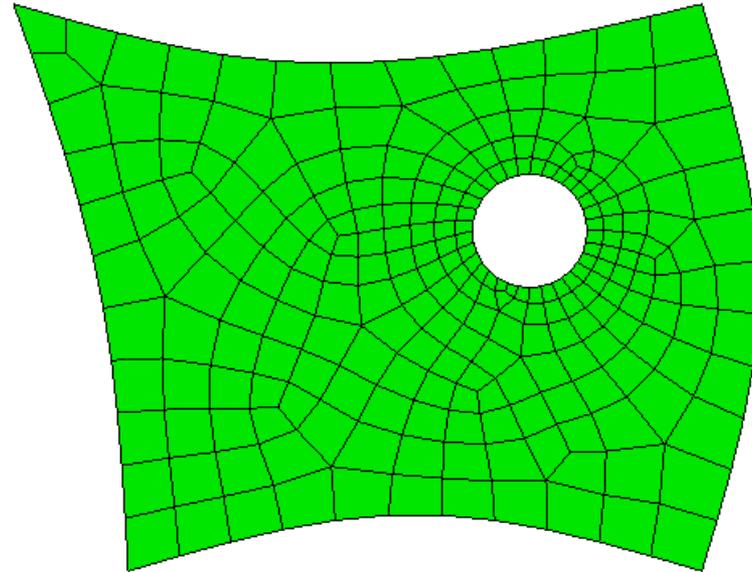
Quad Meshing Schemes

Simulation Modeling Sciences



Map

1. Interior node valence is constant.
ie. number of elements at each interior node=4
2. Meshing algorithm relies on specific topology constraints.
ie. number of sides=4



Pave

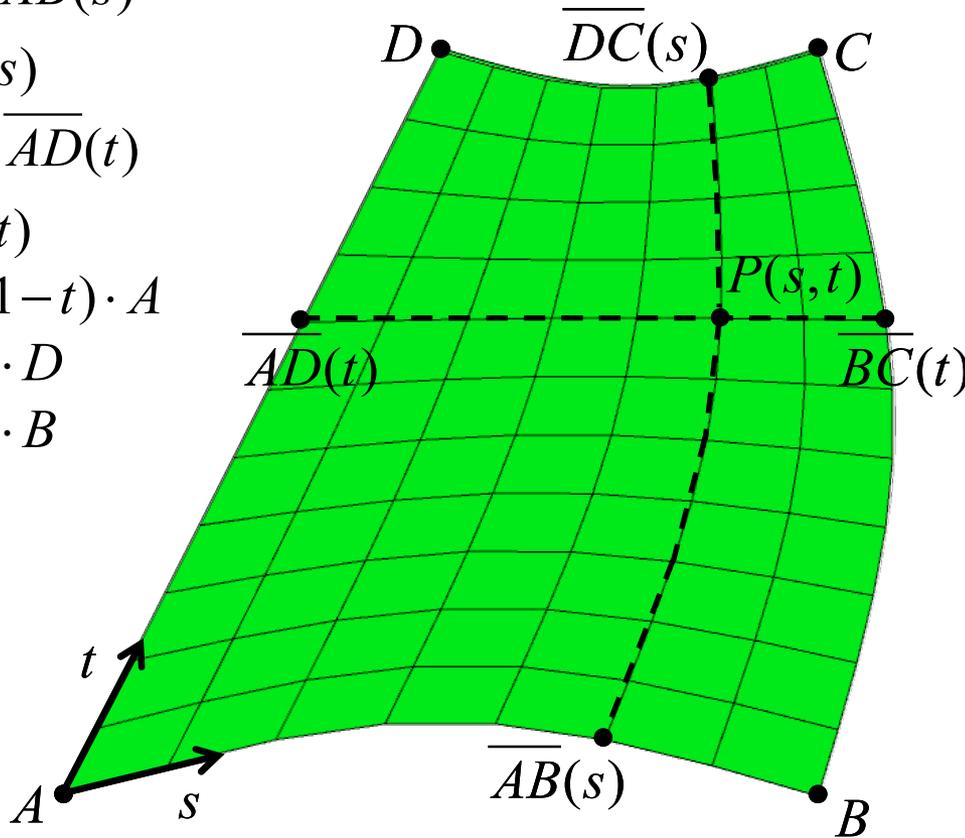
1. Interior node valence varies.
ie. number of elements at each node=3,4,5...
2. Meshing algorithm applies to arbitrary topology
ie. number of sides is arbitrary

Map Scheme

Simulation Modeling Sciences

$$\begin{aligned} P(s,t) = & (1-t) \cdot \overline{AB}(s) \\ & + t \cdot \overline{DC}(s) \\ & + (1-s) \cdot \overline{AD}(t) \\ & + s \cdot \overline{BC}(t) \\ & - (1-s)(1-t) \cdot A \\ & - (1-s)t \cdot D \\ & - s(1-t) \cdot B \\ & - st \cdot C \end{aligned}$$

Transfinite
Interpolation

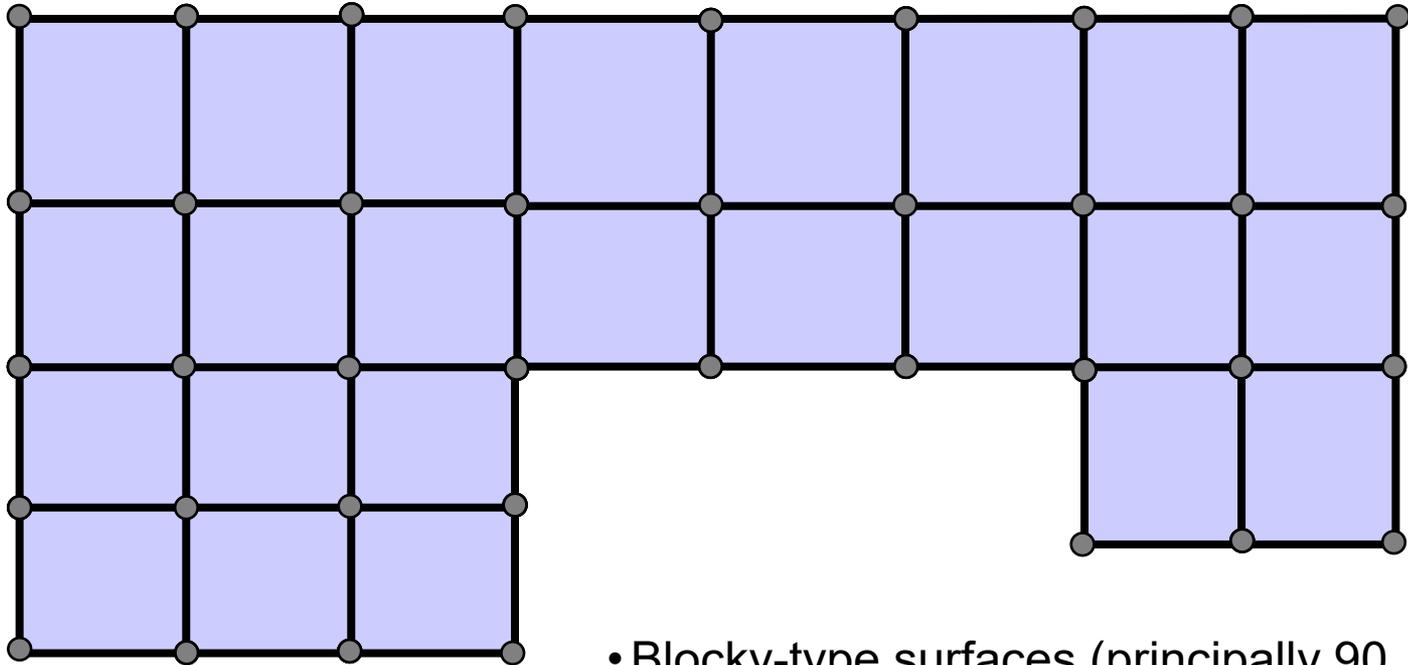


$$\overline{AD}(t) = A + t(D - A)$$

straight segment

Submap Scheme

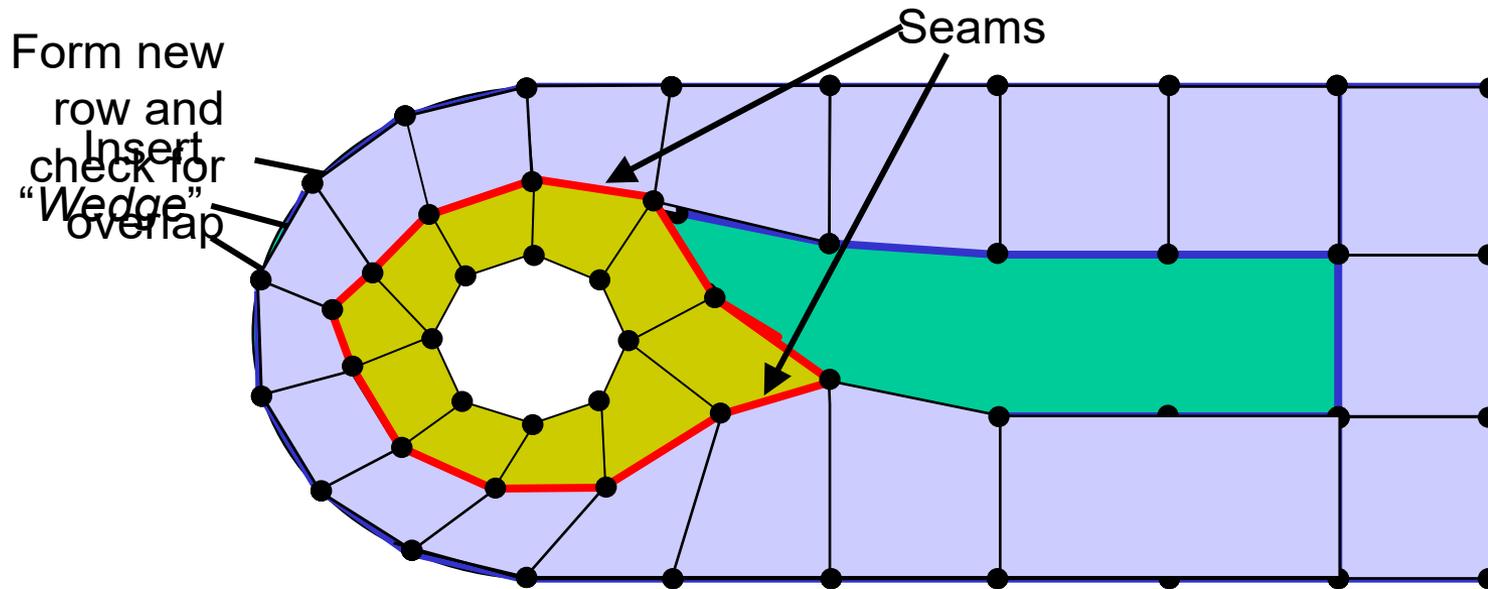
Simulation Modeling Sciences



- Blocky-type surfaces (principally 90 degree angles)
- Automatically decomposes surface into mappable regions based on assigned intervals

Paving Scheme

Simulation Modeling Sciences

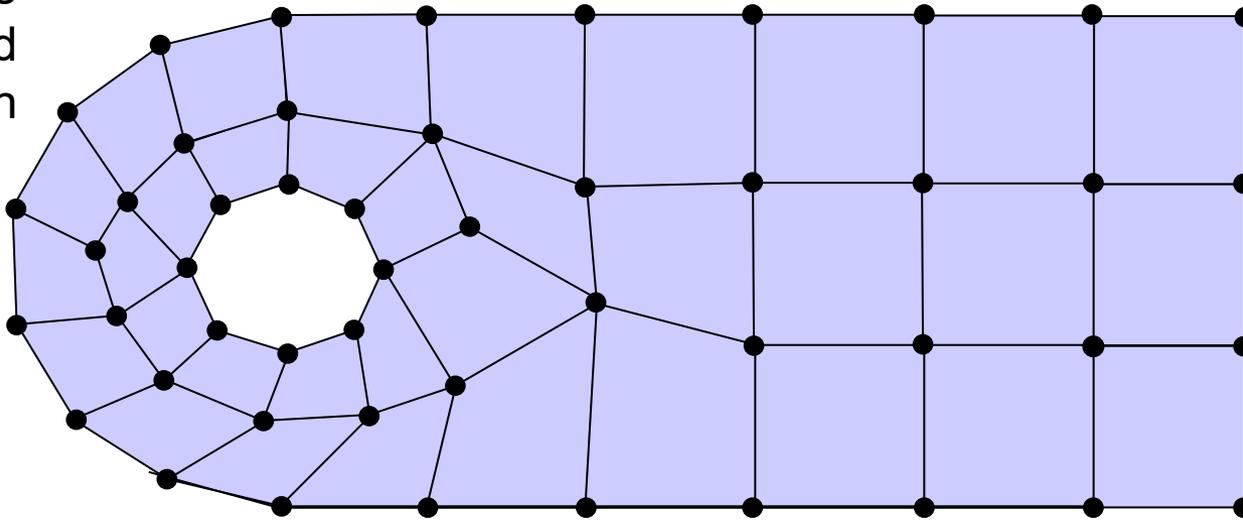


- Advancing Front: Begins with front at boundary
- Forms rows of elements based on front angles
- Must have even number of intervals for all-quad mesh

Paving

Simulation Modeling Sciences

Close
Loops and
smooth



- Advancing Front: Begins with front at boundary
- Forms rows of elements based on front angles
- Must have even number of intervals for all-quad mesh

Paving

Simulation Modeling Sciences

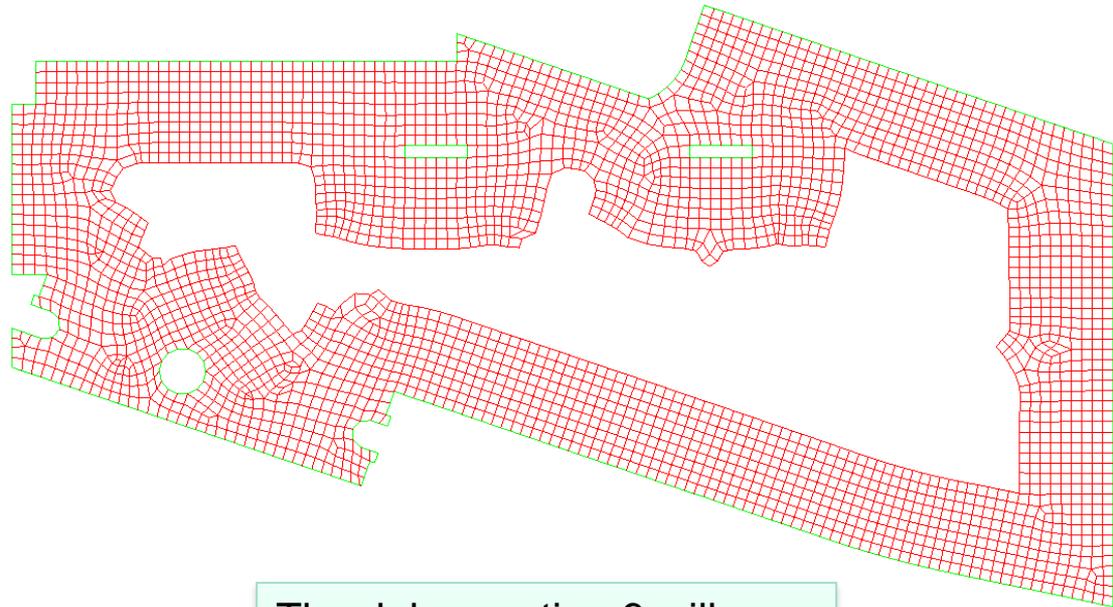
Example

Show the paving
algorithm in action

Import the Acis file
cad6.sat

Use the following
commands to display the
paver in action

```
draw surface 109  
vol all size 1  
set debug 9 ON  
mesh surf 109  
set debug 9 OFF
```

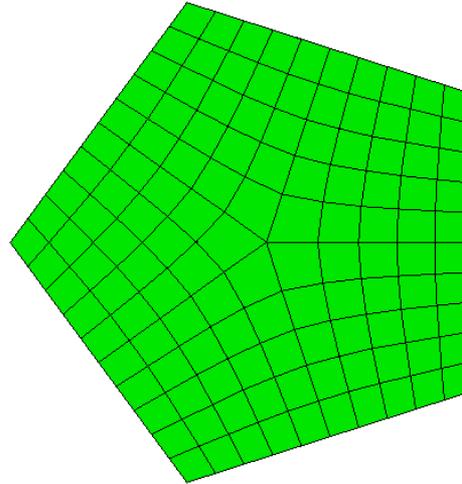
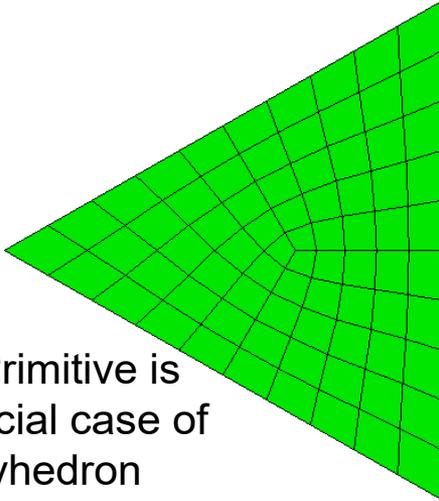


The debug option 9 will
display the paver's progress
as it meshes

Polyhedron Scheme

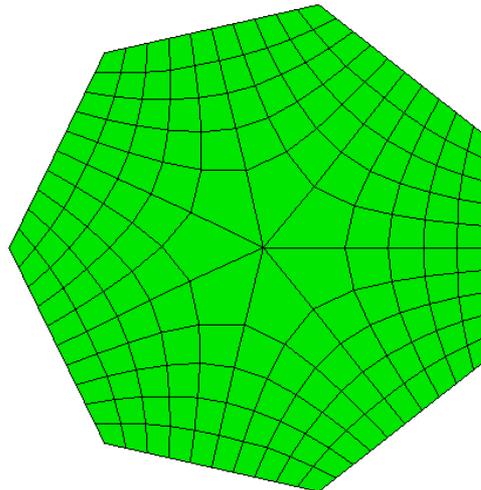
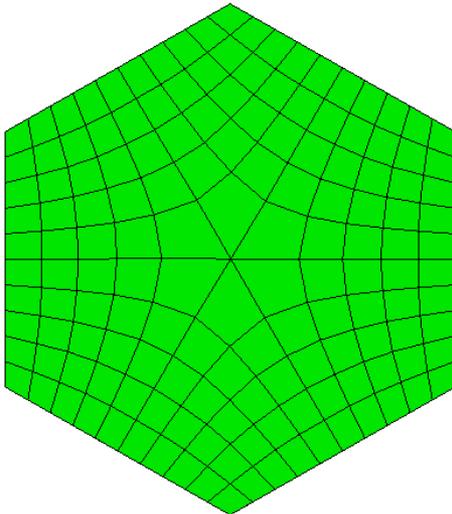
Simulation Modeling Sciences

TriPrimitive is
special case of
Polyhedron



Regular convex
polygons

Each side is
subdivided and one
node placed at the
interior to create
quadrilaterals

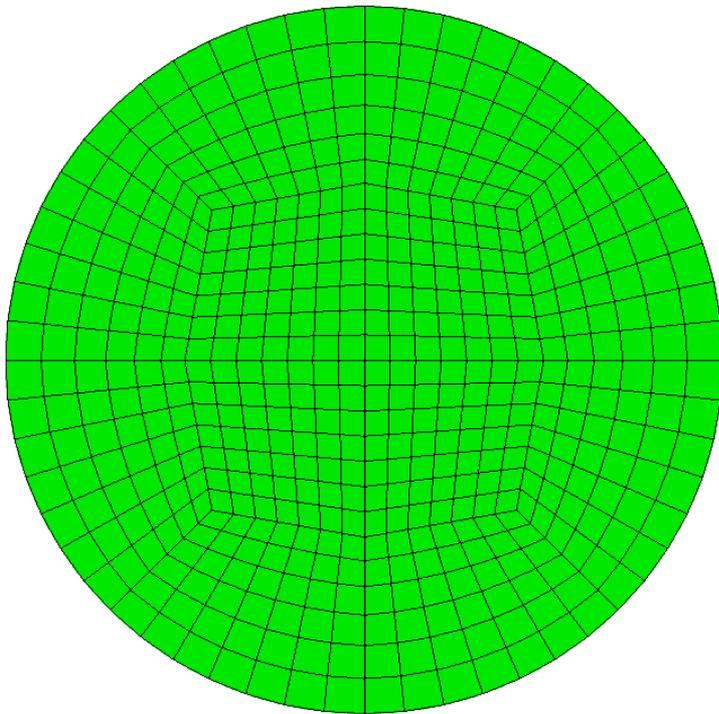


Each individual
quadrilateral is map
meshed

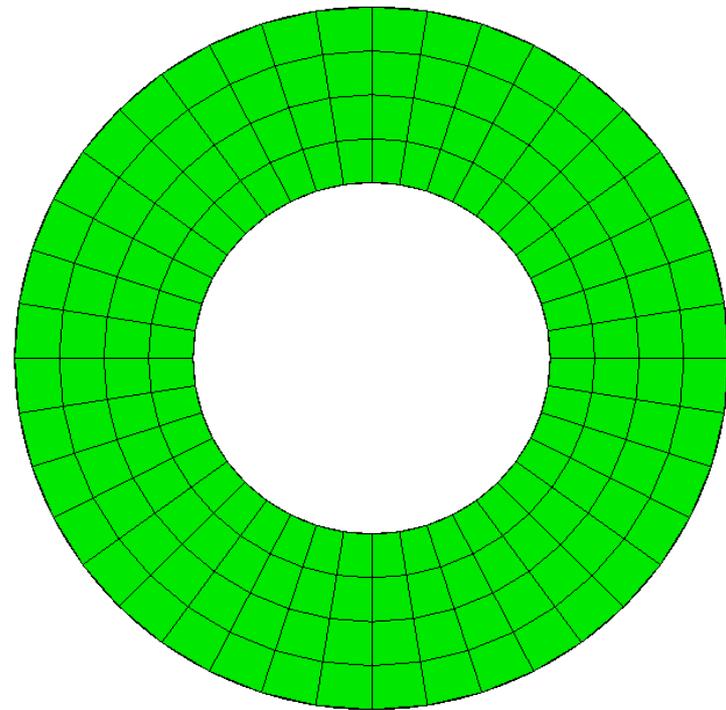
Each side must have
matching intervals

Circle and Hole Schemes

Simulation Modeling Sciences



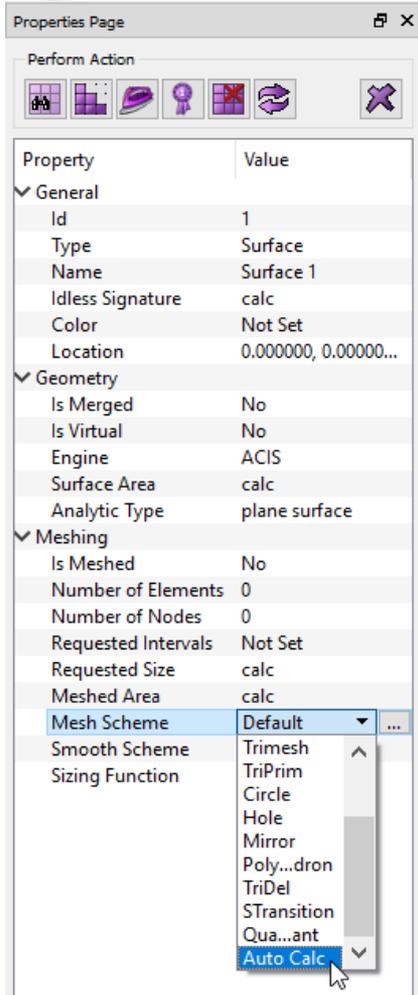
Circle Scheme
Uses four TriPrimitives



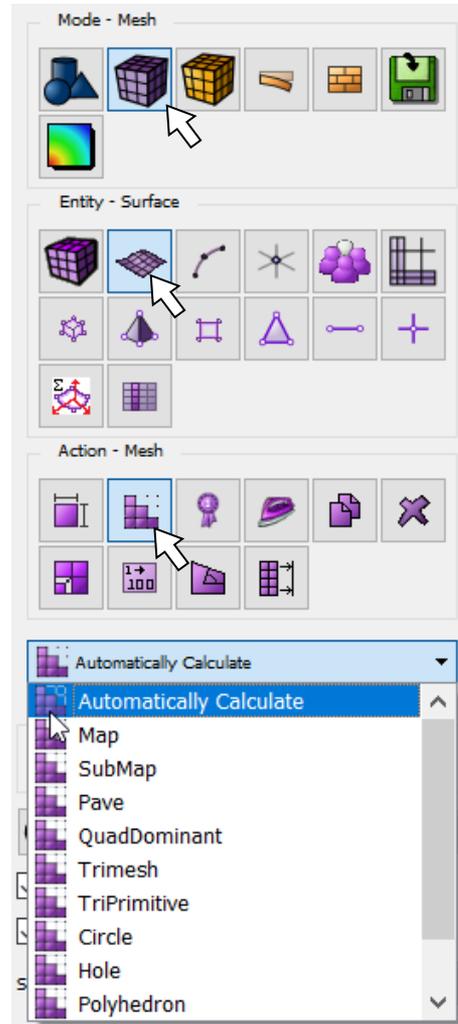
Hole Scheme
Uses Mapped Mesh

Surface Auto Scheme Selection

Simulation Modeling Sciences



CUBIT Property Page



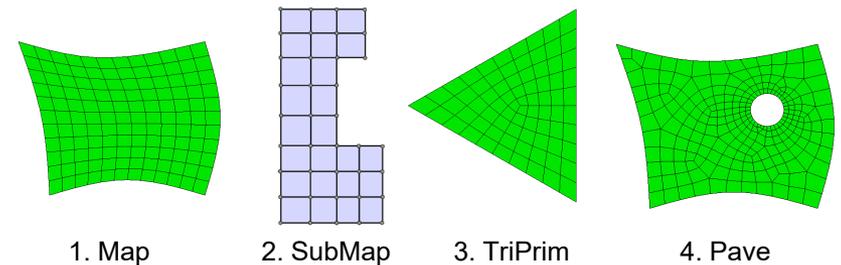
CUBIT Surface Meshing Command Panel

By default all volumes and surfaces are assigned the scheme **Auto**.

Schemes can be manually applied from the Property Page or from the CUBIT Surface Meshing Command Panel.

By choosing **Automatically Calculate**, Cubit will attempt to select the best mesh scheme for the surface

Scheme will be set based on characteristics of geometry.



1. Map

2. SubMap

3. TriPrim

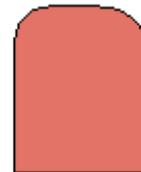
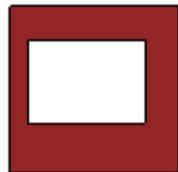
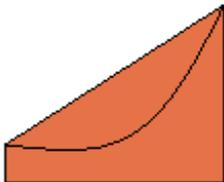
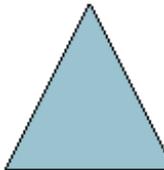
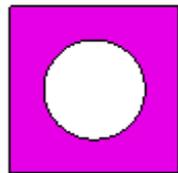
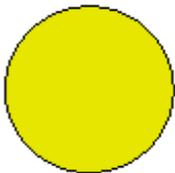
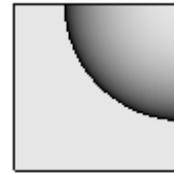
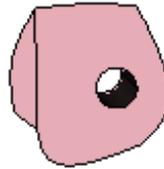
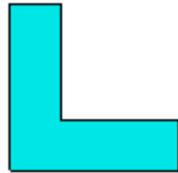
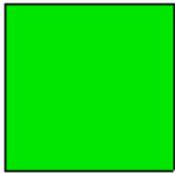
4. Pave

Priority of surface meshing schemes for auto

Surface Meshing Schemes

Simulation Modeling Sciences

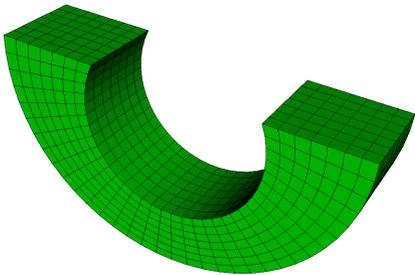
What surface meshing schemes would you select for each shape?



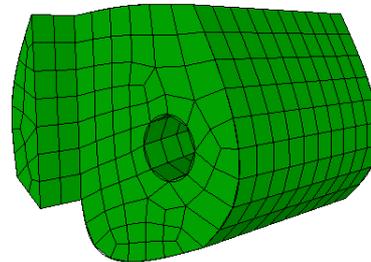
Volume Meshing Schemes

Simulation Modeling Sciences

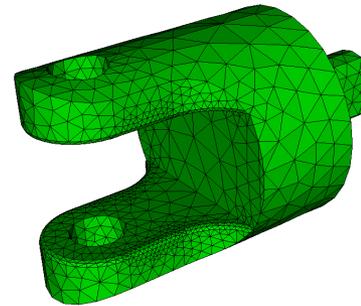
CUBIT Provides a number of different volume mesh schemes. Similar to Surface Scheme Selection, Volume Scheme Selection is based on the shape of the geometry and the requirements of the analysis code.



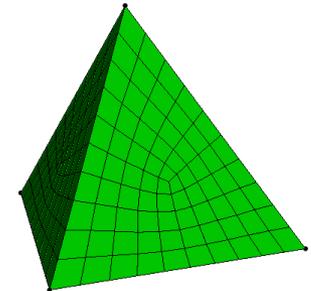
Map



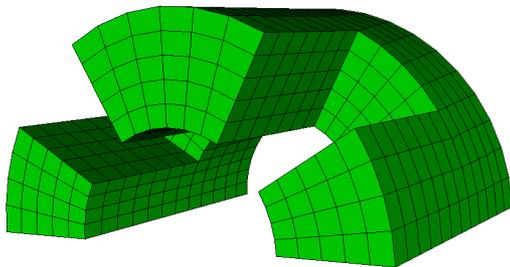
Sweep



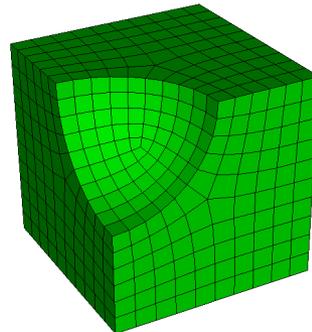
TetMesh



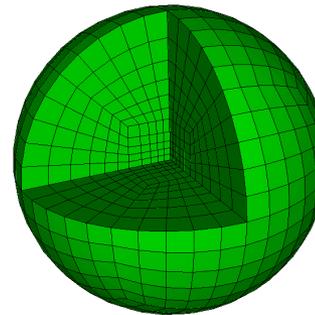
TetPrimitive



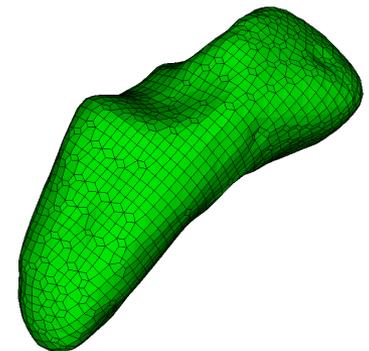
SubMap



Polyhedron



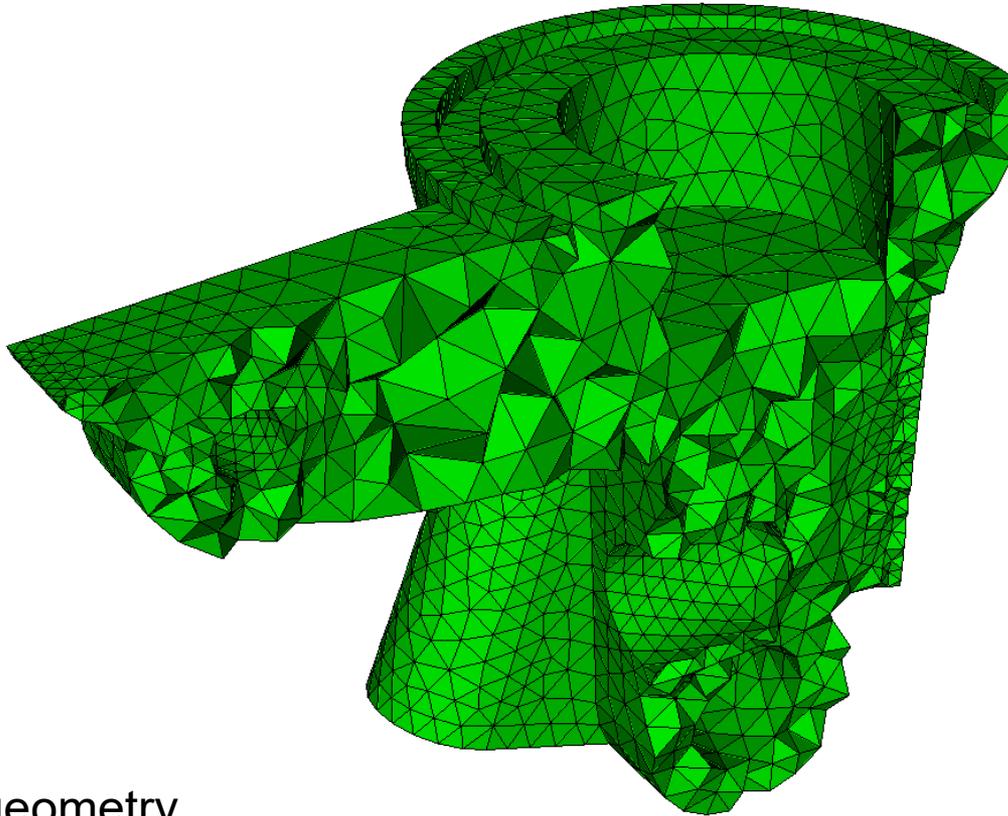
Sphere



Sculpt Parallel

TetMeshScheme

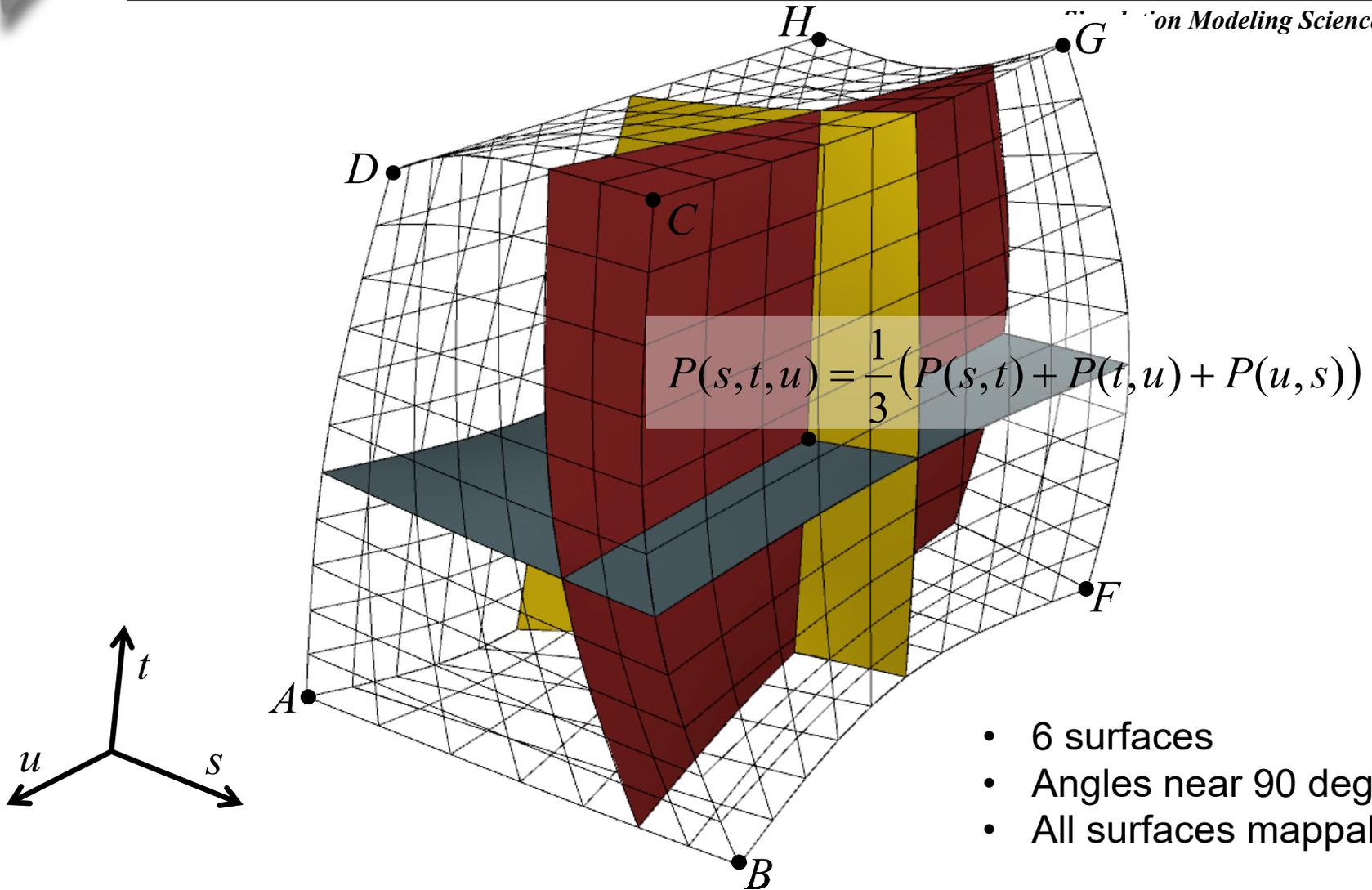
Simulation Modeling Sciences



- Arbitrary geometry
- Mostly push-button/automatic
- May still require geometry clean-up

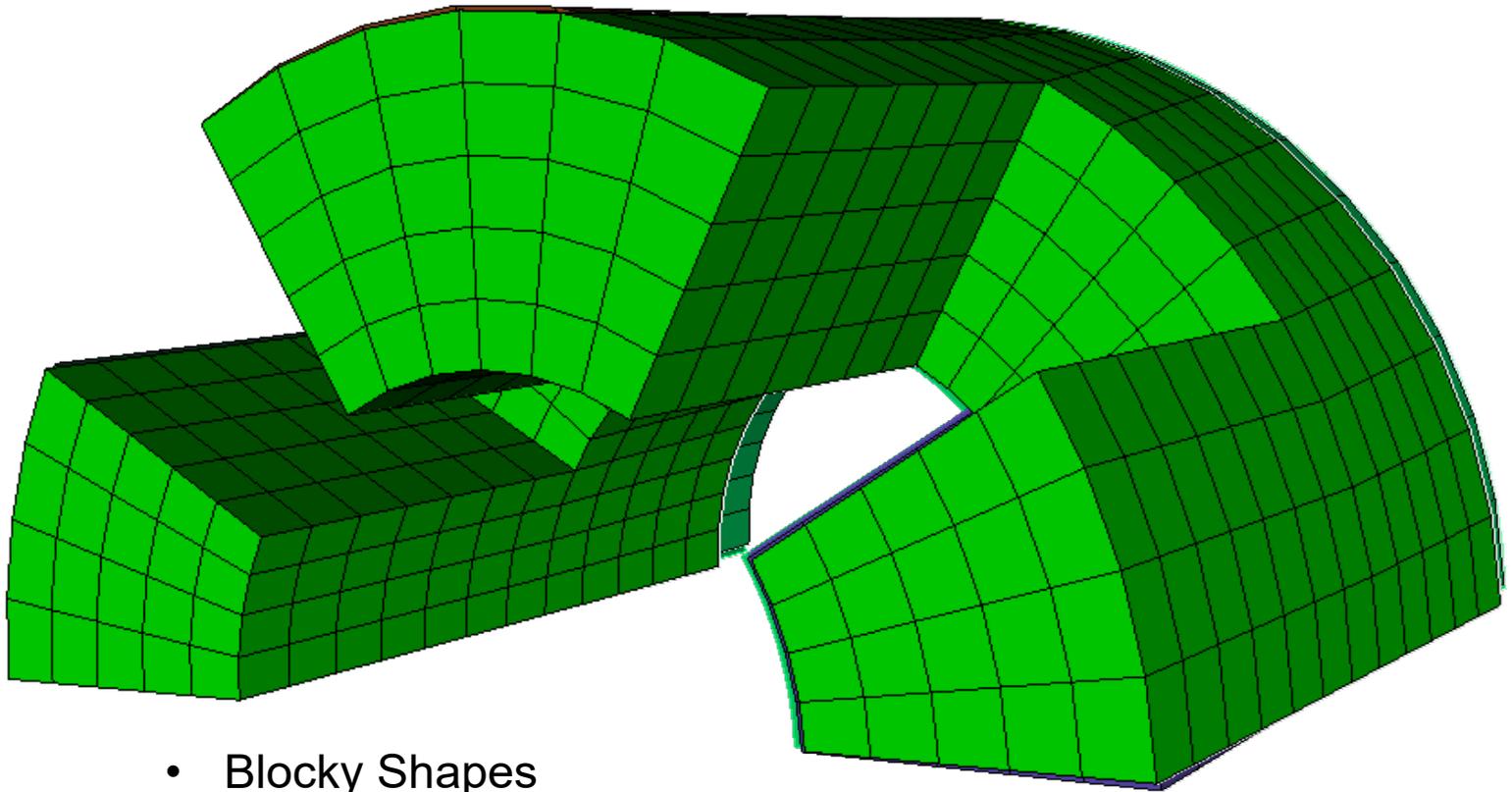
Map Scheme

on Modeling Sciences



SubMap Scheme

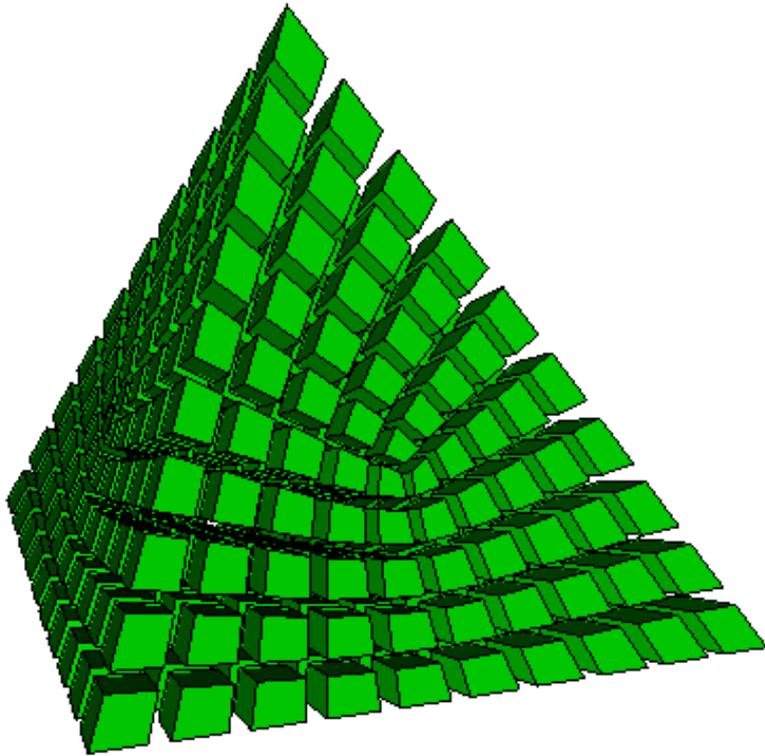
Simulation Modeling Sciences



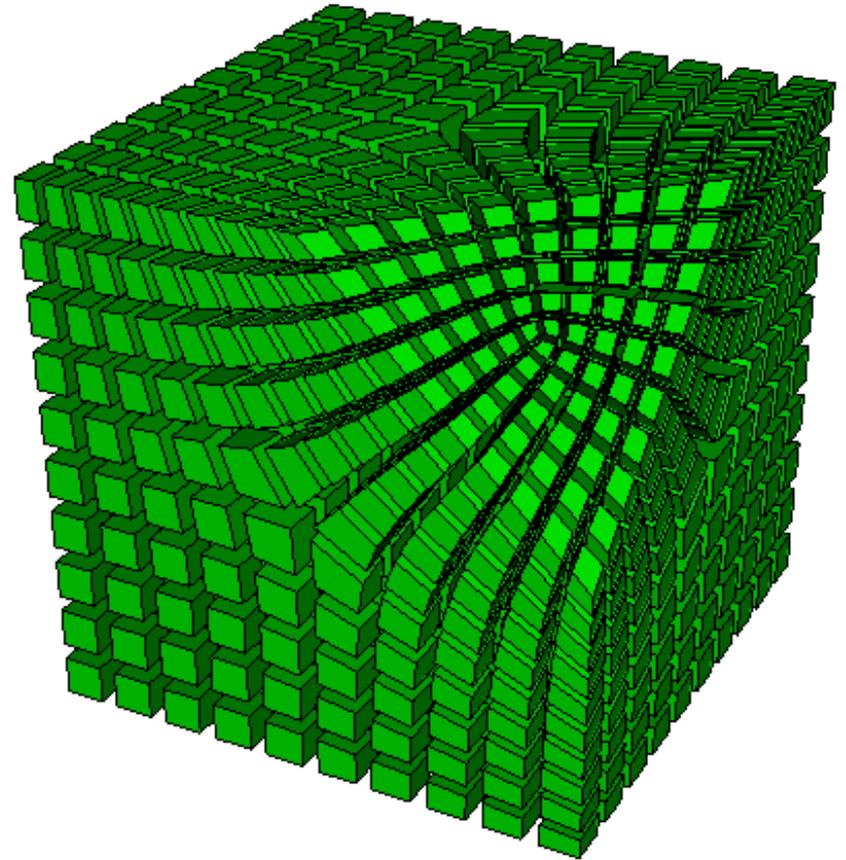
- Blocky Shapes
- Angles near 90 degrees
- All surfaces mappable



Polyhedron Scheme



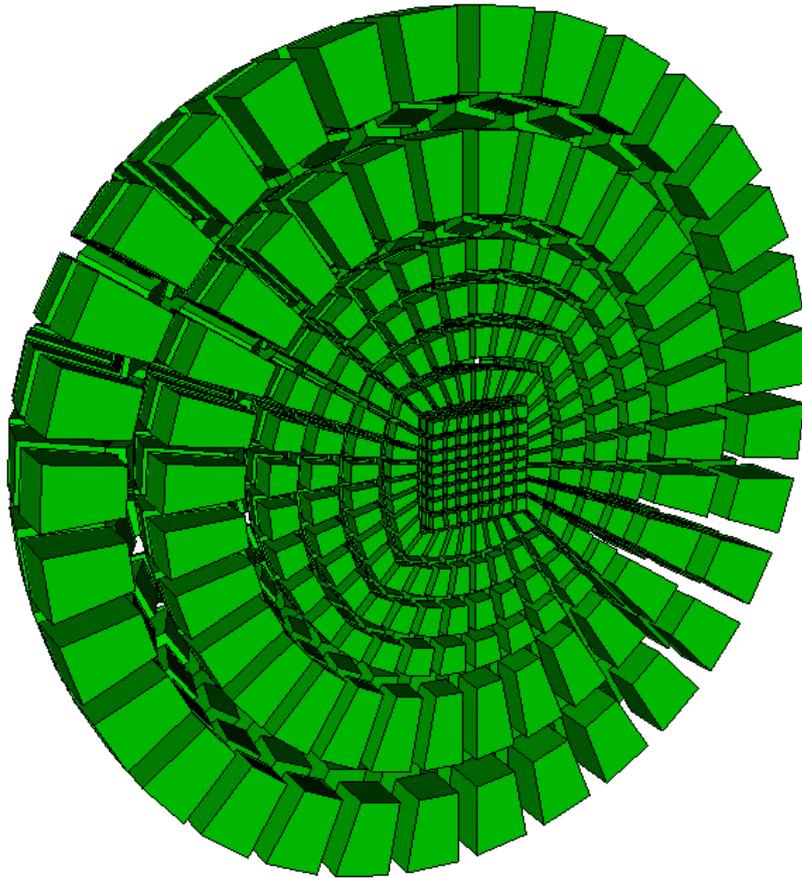
TetPrimitive: Special case of Polyhedron



- Requires 3-valent vertices and convex polyhedron
- Breaks volume into mappable regions

Sphere Scheme

Simulation Modeling Sciences



Spheres: treat as 8
TetPrimitives

Subdivide each
triangle face into
quadrilaterals

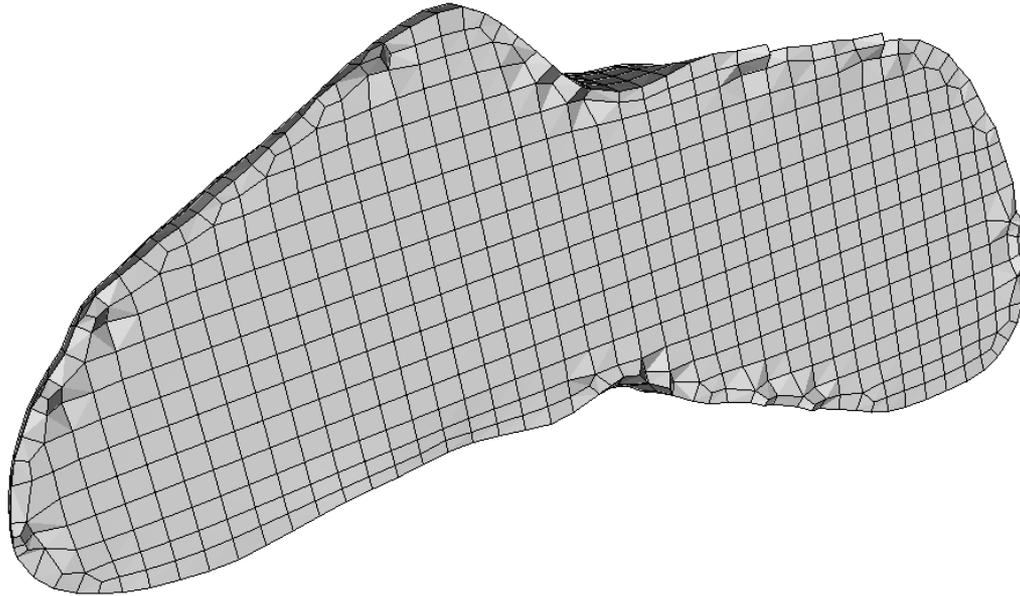
Insert an interior node

Generate tetrahedron
subdivision in each
octant

Generate mapped
mesh in each
hexahedron region

Sculpt Parallel

Simulation Modeling Sciences

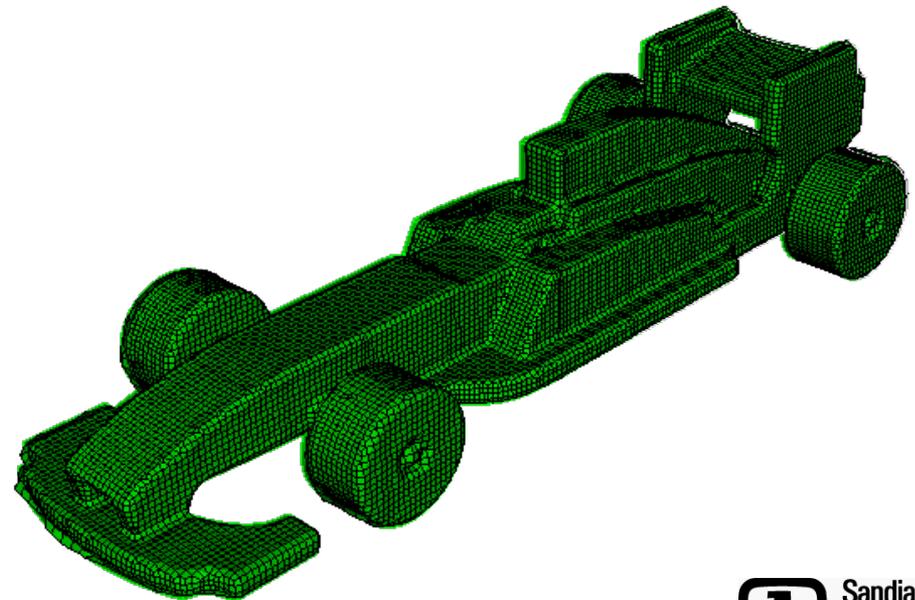


Ideal for non-mechanical/
organic shapes

But can be used for any
geometry

Overlay Grid Method

- Uses Cartesian Grid as Base Mesh
- Adjusts nodes to geometry
- Inserts Layer of Hexes



Sculpt Parallel

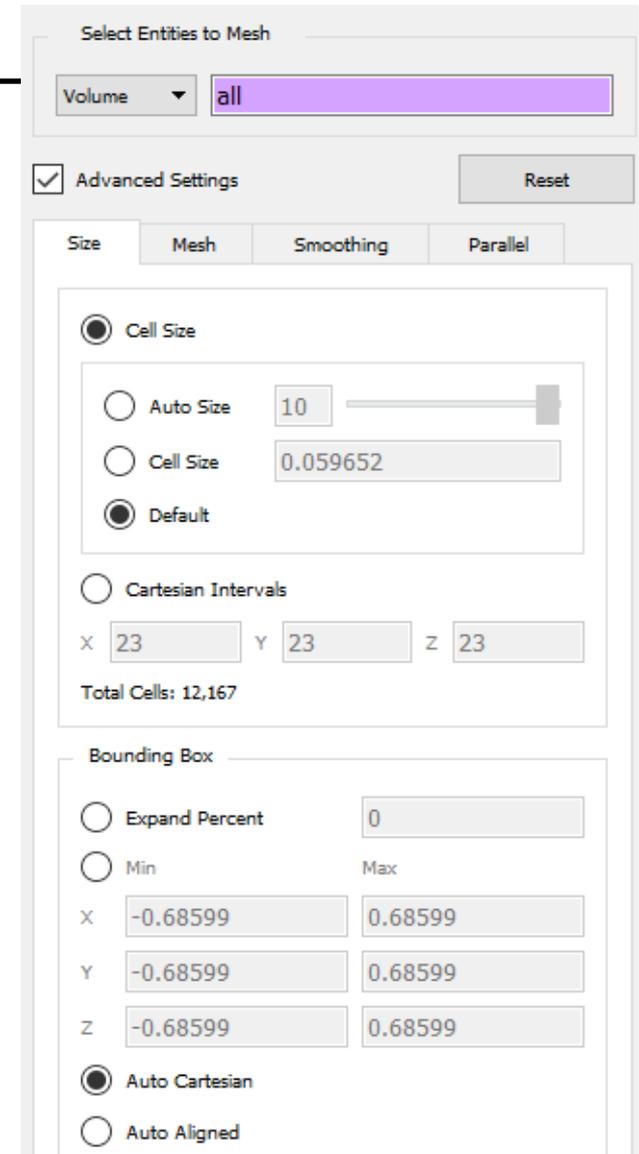
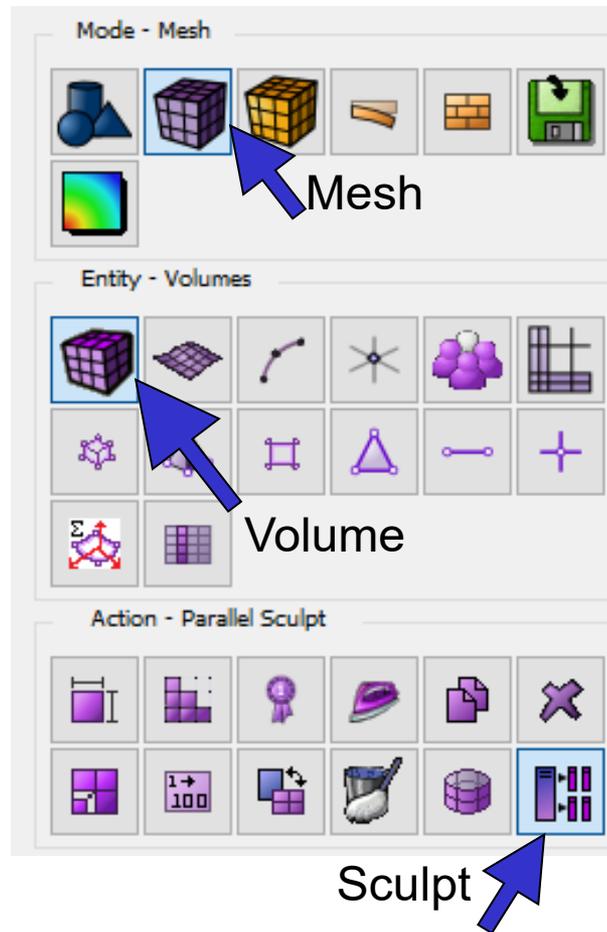
Sculpt is a separate companion application to Cubit.

Does not use *Scheme*, instead uses *Sculpt Parallel* command.

Can be run from Cubit GUI or in batch from OS command line

Parallel application uses MPI to run on multiple cores/processors

See Lecture 21 for more details/exercises

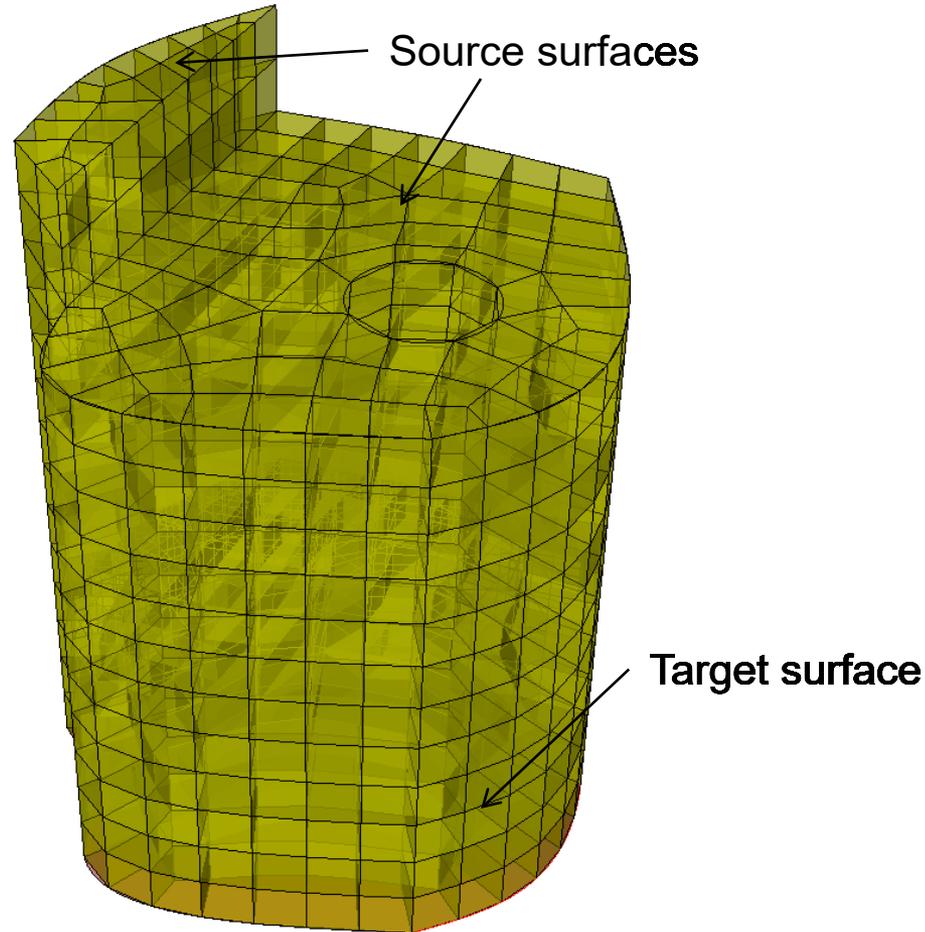


Sweep Scheme

Simulation Modeling Sciences

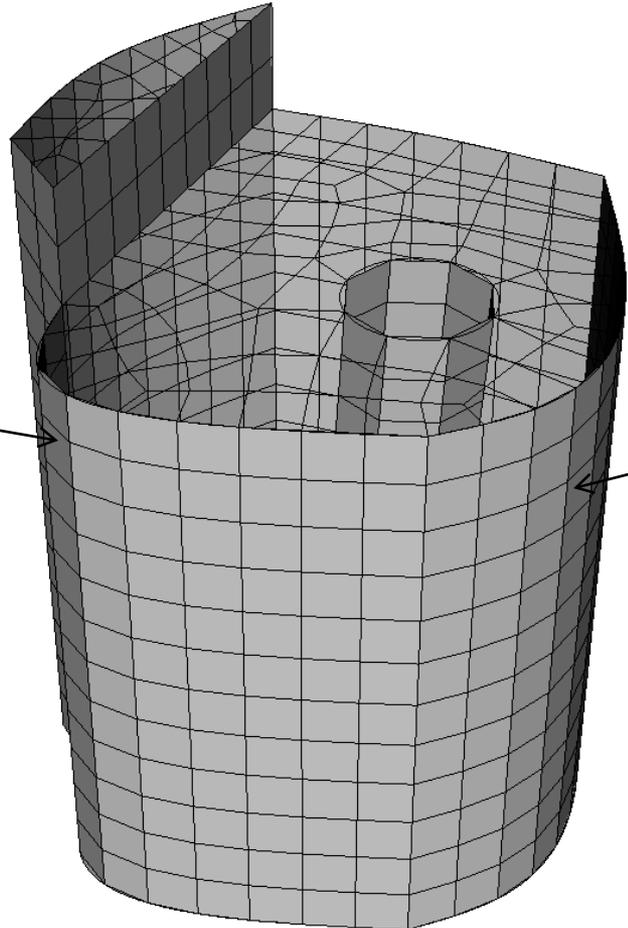
Source Surfaces

- One or more surfaces
- Can be meshed with any Quad Scheme (Pave, Map)



Target Surface

- Must be a single surface
- Must be unmeshed
- Matches topology of source surfaces



Linking surfaces

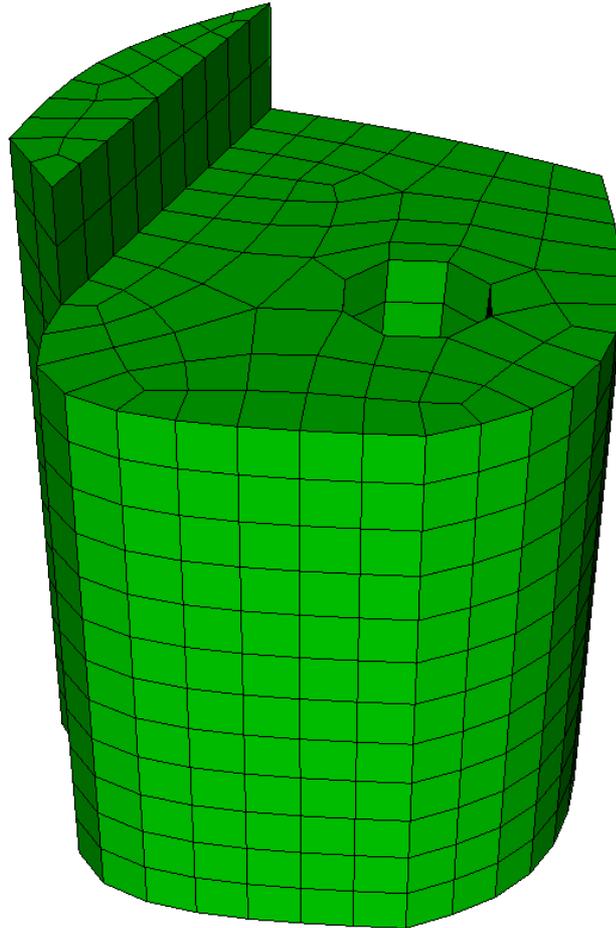
Linking surfaces

Linking Surfaces

- Must be “Mappable”
- Connect Sources with Target

Sweep Scheme

Simulation Modeling Sciences



- Most frequently used meshing scheme
- Normally requires geometry to be decomposed to apply sweeping (webcutting)

Sweep Scheme

Setting Source and target Surfaces

- 1 Navigate to Scheme Selection Command Panel
- 2 Choose Sweep Scheme
- 3 Pick Sources and Targets
- 4 Apply Scheme

Entity - Volumes

Action - Mesh

Sweep

Select Volumes

1

Specify Source and Target

Auto Select Source and Target

Source Surface ID(s) 7 11

Target Surface ID 6

Default Extrude Advanced

Apply Scheme

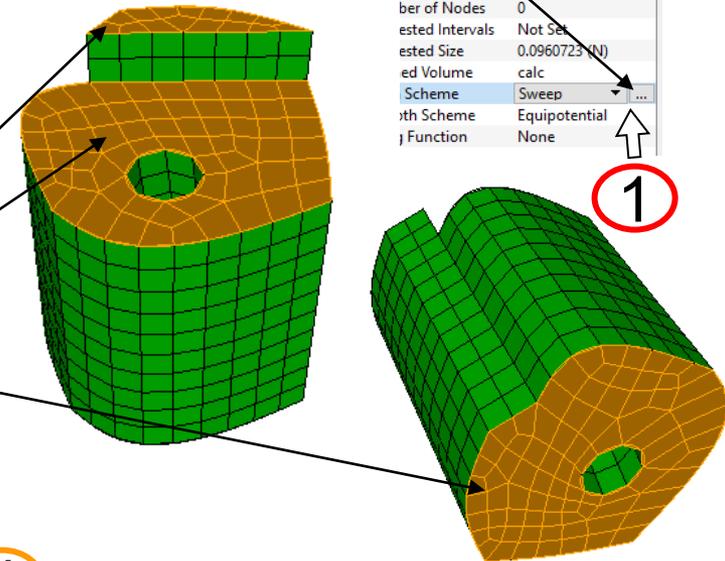
Check For Overlapping Surfaces

Apply Scheme Before Meshing

Scheme: Mesh

Shortcut from property panel to scheme selection

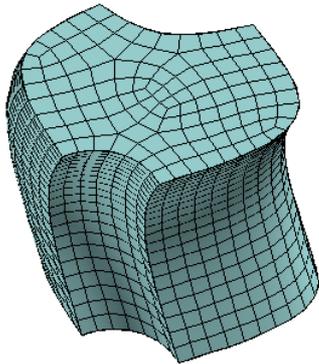
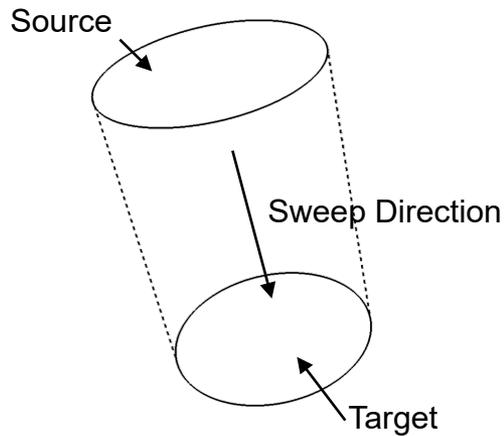
Property	Value
Id	1
Type	Volume
Name	Volume 1
Idless Signature	calc
Color	Not Set
Location	0.000000, 0.000000, 0.000000...
Engine	ACIS
Volume	calc
Is Meshed	No
ber of Elements	0
ber of Nodes	0
ested Intervals	Not Set
ested Size	0.0960723 (N)
ed Volume	calc
Scheme	Sweep
yth Scheme	Equipotential
y Function	None



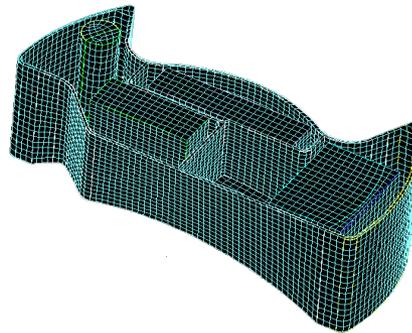
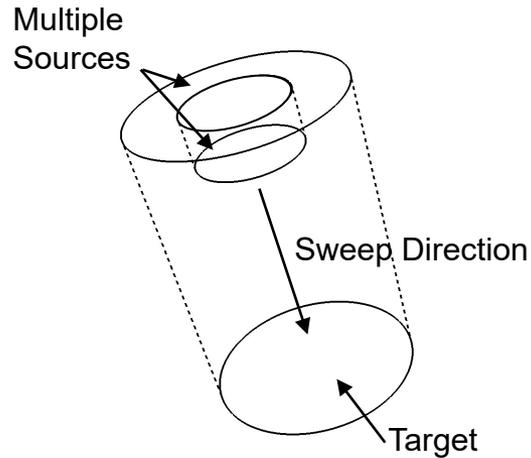
Sweep Scheme

Simulation Modeling Sciences

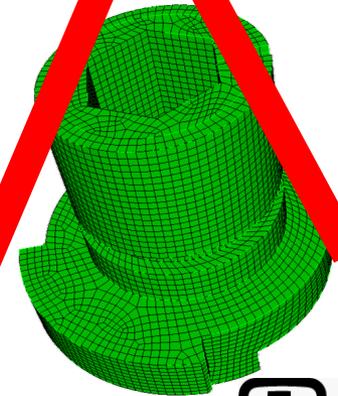
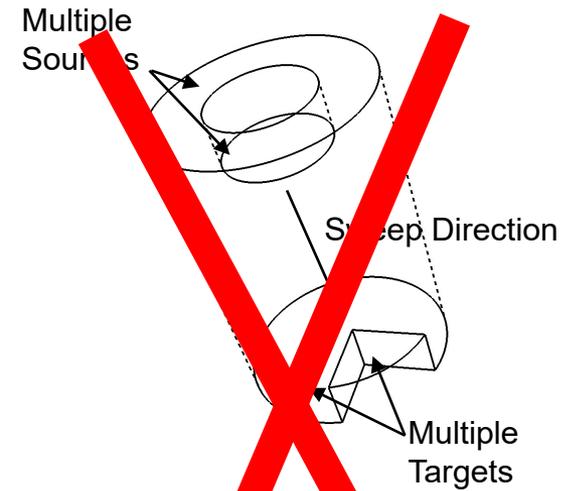
One-to-one



Many-to-one



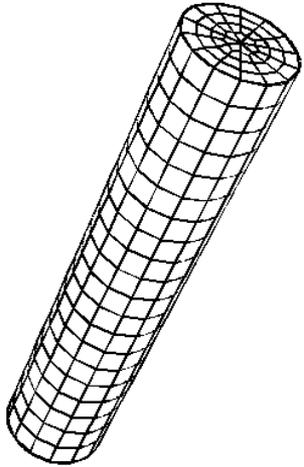
Many-to-many



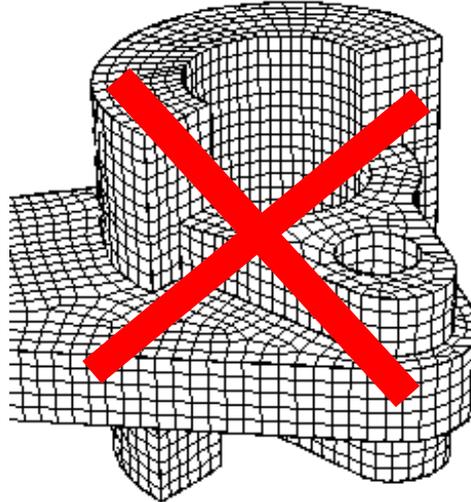
Sweep Schemes

Simulation Modeling Sciences

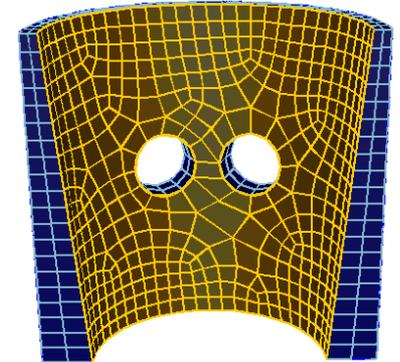
What type of sweep scheme is used on each of these meshes?



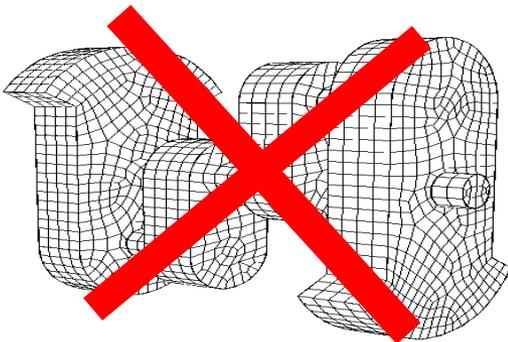
One-to-one



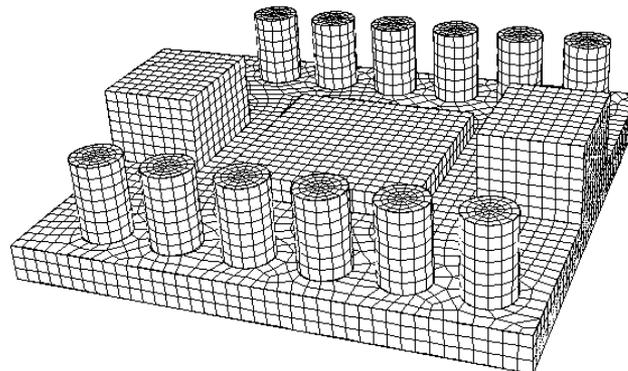
Many-to-many



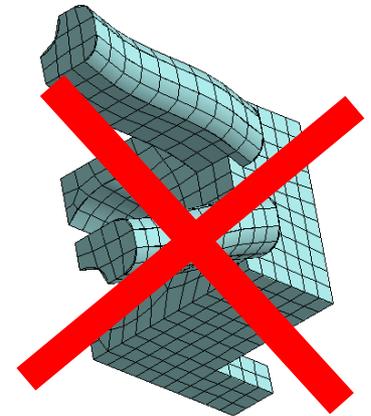
One-to-one



Many-to-many



Many-to-one



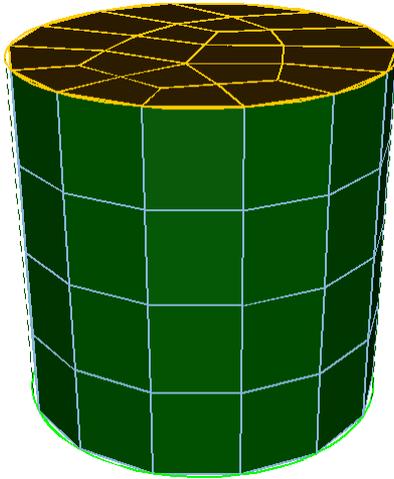
Many-to-many

Sweep Scheme

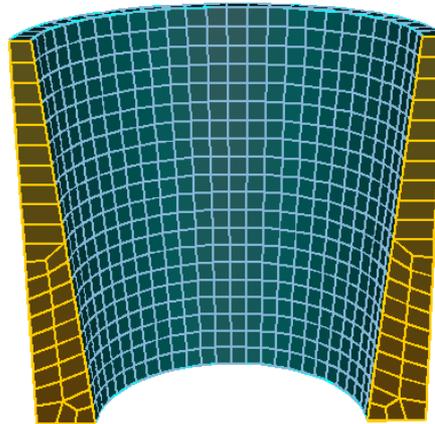
Simulation Modeling Sciences

Typical one-to-one sweeps

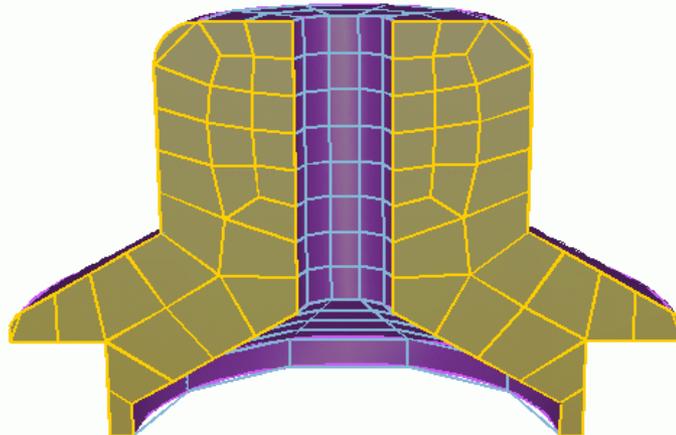
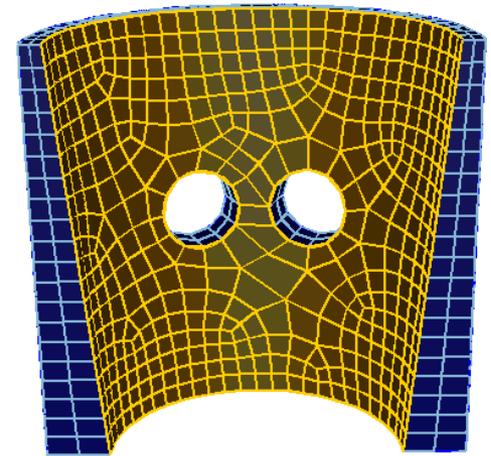
translation



rotation



inside-out



Sweep Scheme

Simulation Modeling Sciences

Volume Sweep questions to ask:

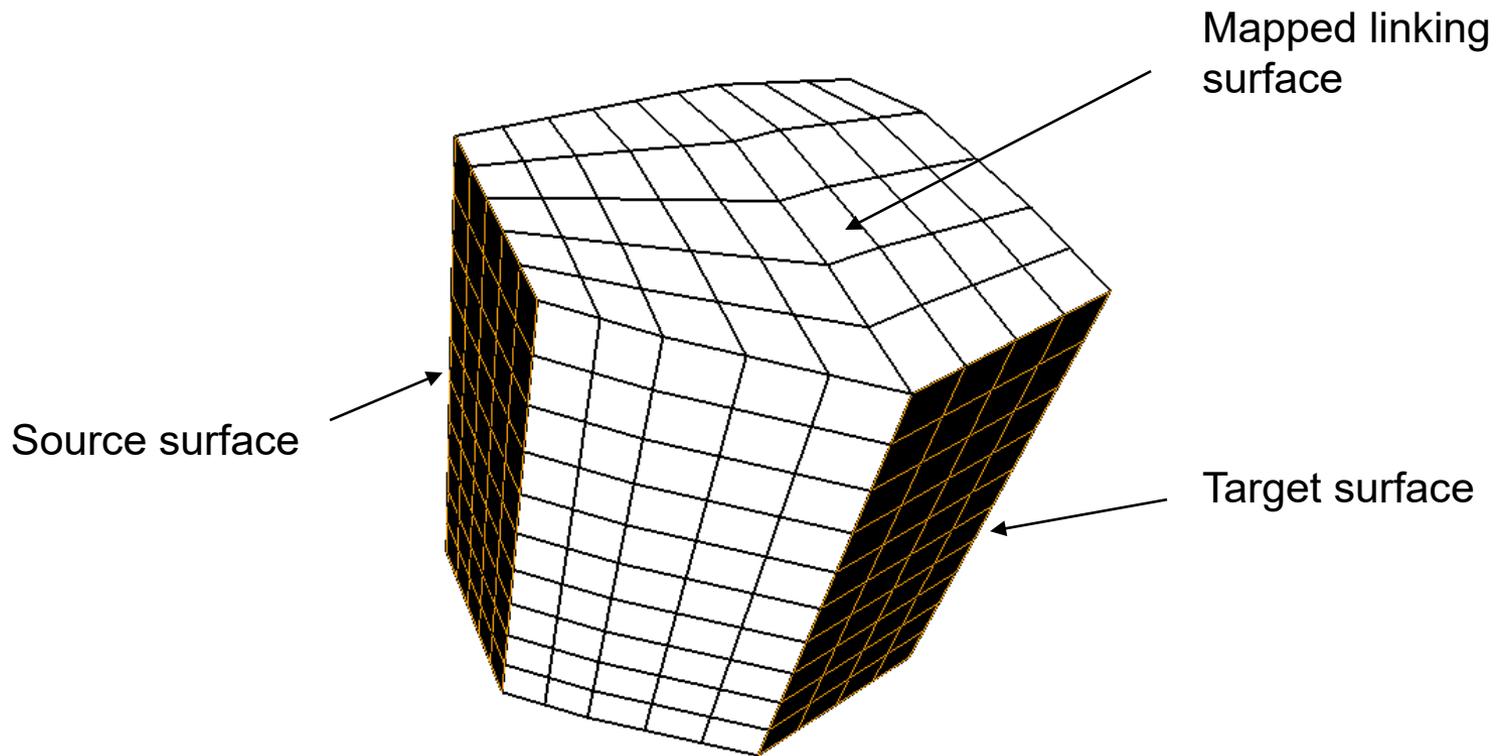
1. Do I have a single target surface?
2. Can all the linking surfaces be mapped or Submapped?
3. Do I see a path through the volume in which a layer by layer set of Hexes could reasonably be generated?



Sweep Scheme

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Can this volume be swept as shown?

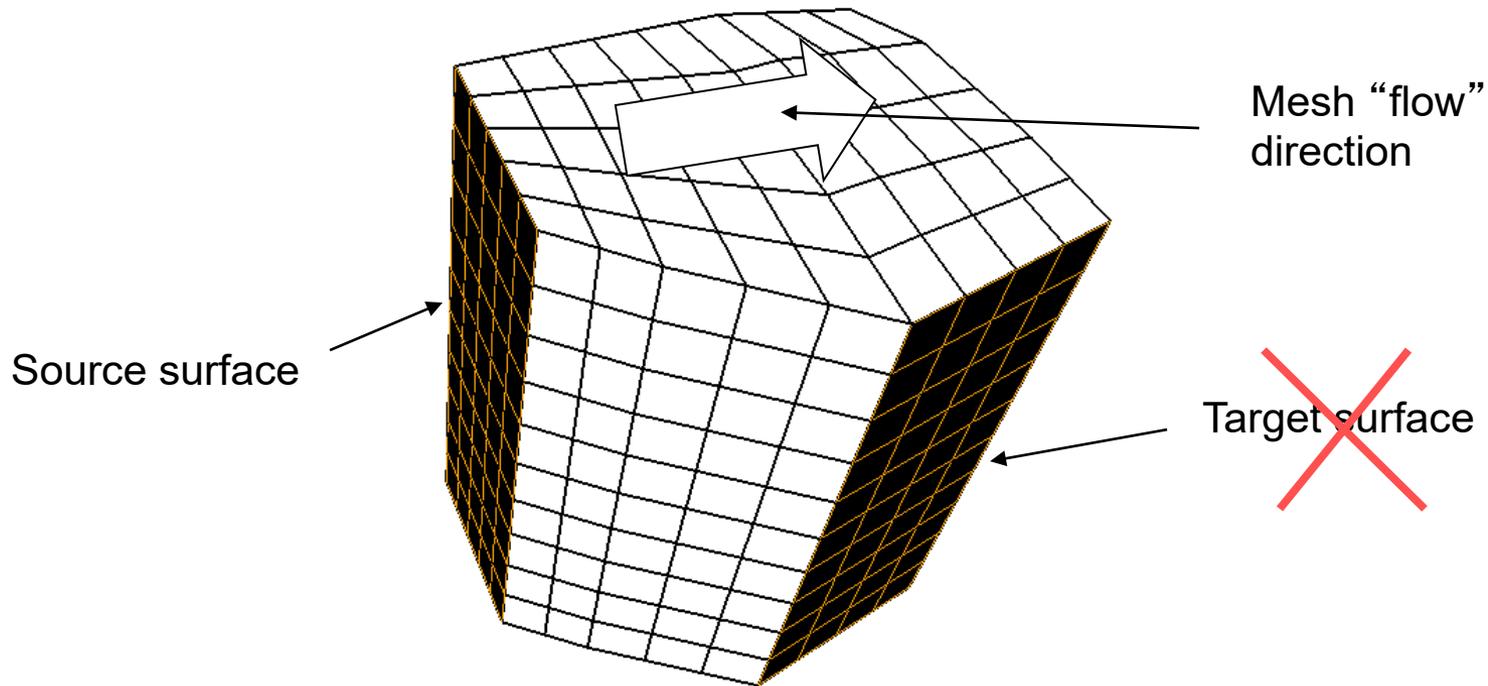


Sweep Scheme

Simulation Modeling Sciences

Can this volume be swept as shown? **No**

The mesh needs to “flow” in the direction of the target surface

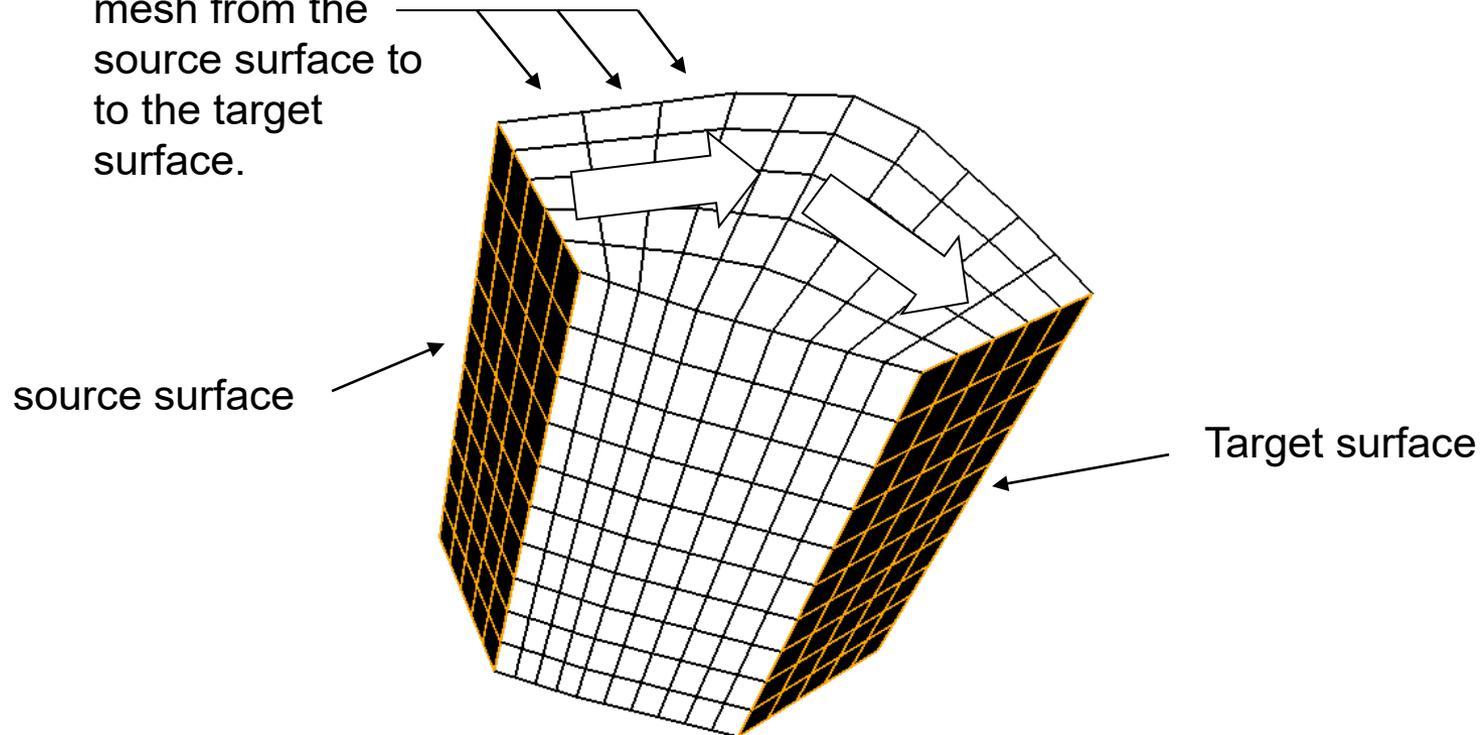


Sweep Scheme

Simulation Modeling Sciences

Try to visualize a layer by layer creation of the mesh from the source surface to the target surface.

Sweepable source-link-target set



Volume Auto Scheme Selection

Simulation Modeling Sciences

Perform Action

Property	Value
Id	1
Type	Volume
Name	Volume 1
Idless Signature	calc
Color	Not Set
Location	0.000000, 0.00000...
Engine	ACIS
Volume	calc
Is Meshed	No
Number of Elements	0
Number of Nodes	0
Requested Intervals	Not Set
Requested Size	0.0960723 (N)
Meshed Volume	calc
Mesh Scheme	SubMap
Smooth Scheme	Default
Sizing Function	Map

CUBIT Property Page

Mode - Mesh

Entity - Volumes

Action - Mesh

Automatically Calculate

Select Volumes

1

Apply Scheme

Check For Overlapping Surfaces

Apply Scheme Before Meshing

Scheme: submap

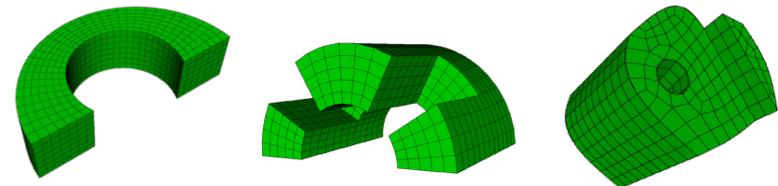
Mesh

CUBIT Volume Meshing Command Panel

Volume Schemes can be manually applied from the Property Page or from the CUBIT Surface Meshing Command Panel.

By choosing **Automatically Calculate**, Cubit will attempt to select the best mesh scheme for the surface

Scheme will be set based on characteristics of geometry.



1. Map

2. SubMap

3. Sweep

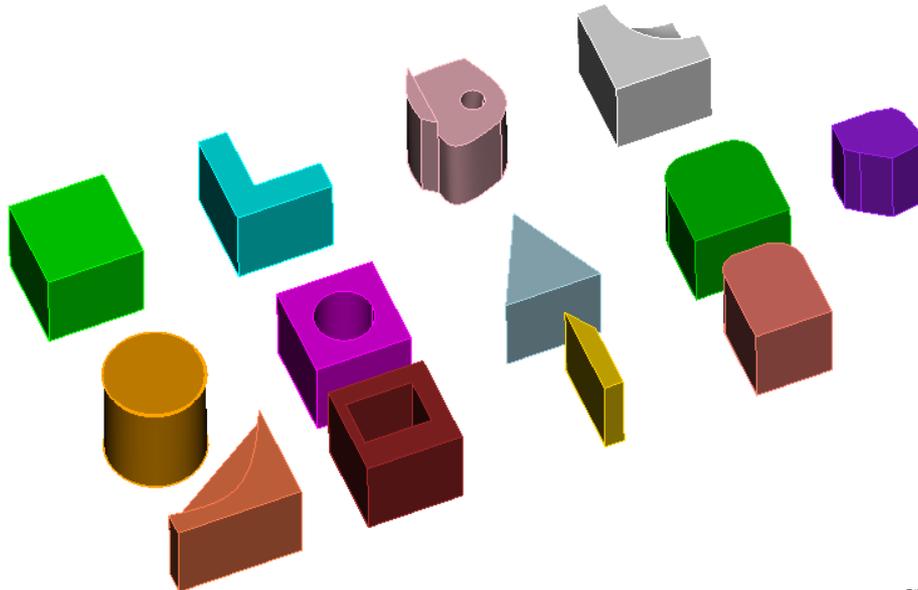
Priority of surface meshing schemes for **auto**

Auto scheme may need some help. May need to select sources/target manually

Volume Meshing Schemes Exercise

Simulation Modeling Sciences

- 1 Reset and reimport **schemes.sat**
- 2 Before meshing, inspect the volumes and try to determine what volume schemes should be used.
- 3 Using the Property Page set requested interval size to 1.00 before attempting to mesh.
- 4 Using the Property Page Reset each volume, set size and choose an appropriate Mesh Scheme and mesh
- 5 Using the Property Page Reset each volume and choose **Auto Calc** to allow Cubit to select the mesh scheme.



Perform Action

Property	Value
✓ General	
Id	1
Type	Volume
Name	Volume 1
Idless Signature	calc
Color	Not Set
Location	0.000000, 0.000000...
✓ Geometry	
Engine	ACIS
Volume	calc
✓ Meshing	
Is Meshed	No
Number of Elements	0
Number of Nodes	0
Requested Intervals	Not Set
Requested Size	0.0960723 (N)
Meshed Volume	calc
Mesh Scheme	SubMap
Smooth Scheme	Default
Sizing Function	Map

Auto Calc