Coreform Cubit Decomposition Tutorial

Creating Sweepable Volumes Through Webcutting

Most volumes require some measure of decomposition before they can be meshed with a hexahedral meshing scheme. The most common hexahedral meshing tool is the sweeping algorithm. Sweeping is the process of creating a hexahedral mesh by extruding a quadrilateral surface mesh from a source surface onto a topologically similar target surface by way of a linking surface. The surface mesh can be meshed with any surface meshing scheme (i.e. structured or unstructured mesh), but the most common surface meshing scheme for the sweeping algorithm is the pave scheme. In fact, the sweeping algorithm is sometimes called the "pave-sweep" algorithm. Most volumes aren't automatically sweepable, which is why geometry decomposition is so important to the meshing process. Decomposition usually involves a series of webcutting, boolean, and virtual geometry operations that break up a larger model into sweepable regions. Studies have shown that this step in the meshing process is the most time consuming for the analyst.

By completing this tutorial you will learn how to:

1. Recognize sweepable volumes
2. Recognize how to decompose a model into sweepable parts
3. Gain proficiency with webcutting and other decomposition techniques
4. Avoid common pitfalls with decomposition and sweeping

Why use sweeping?

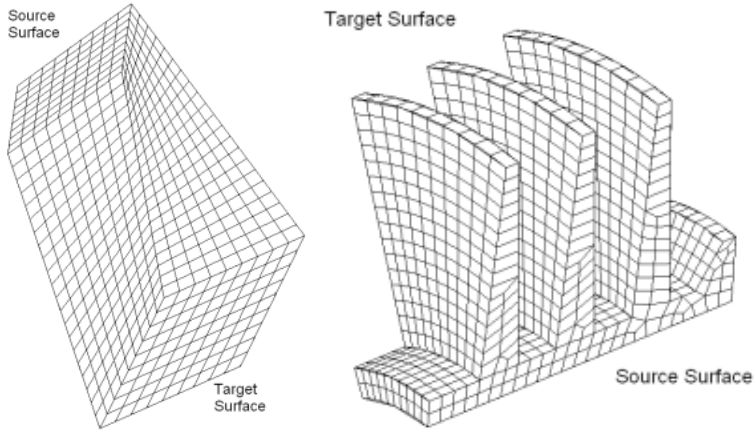
Of all the hexahedral meshing schemes in the Coreform Cubit toolkit, sweeping is considered the most reliable at producing high quality elements. Although decomposing a model into sweepable volumes can be time-consuming, and sometimes falls into the realm of trying to fit a square peg into a round hole, the pave-sweep algorithm has a high rate of success, and it sometimes the only way to get a hexahedral mesh on a model.

What makes a volume sweepable?

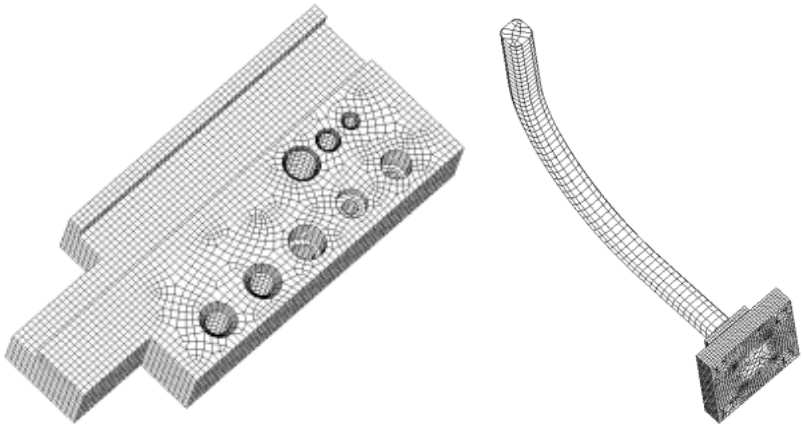
Recognizing sweepable topologies can be an art form. Sweepable volumes can be comprised of many different topologies. We typically classify sweeping problems into three groups, based on the number of source/target surfaces.

Basic Sweep Groups

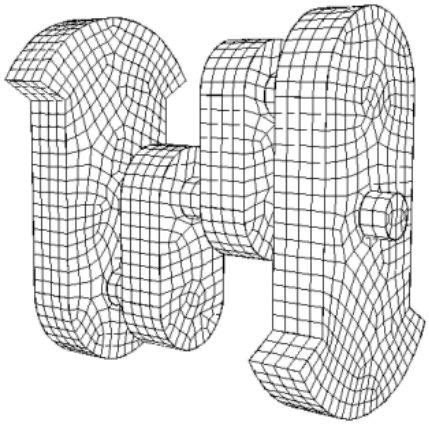
One-to-one: A volume with a one source surface and one target surface.



Many-to-one: A volume with multiple source surfaces and one target surface



Multisweep (or Many-to-Many): A volume with multiple target surfaces

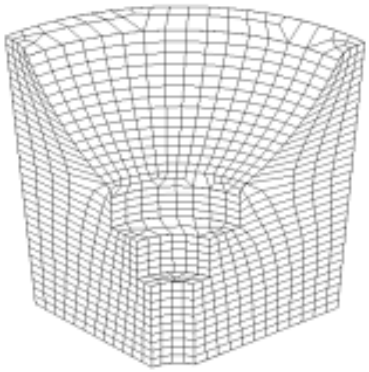


Points to consider when determining whether a volume is sweepable

- Swept surface meshes can be extruded through a volume which is rotated or translated. However, if the translation/rotation is severe then the quality of the resulting mesh may be poor.
- A volume with multiple target surfaces and a single source surface can sometimes be inverted and handled as a many-to-one sweepable volume. Otherwise, it is treated as a multisweep problem.
- Imprinting introduces new topology onto surfaces. Sweepable volumes may not be sweepable after imprinting and merging adjacent surfaces
- Multisweep is still under development, and has limitations, so if you are having difficulty with the multisweep algorithm, it is usually a good idea to decompose it into many-to-one or one-to-one sweepable regions.
- Coreform Cubit won't always automatically recognize your volume as a sweepable volume, even if it is. Sometimes, you have to give it a list of source/target surfaces explicitly.

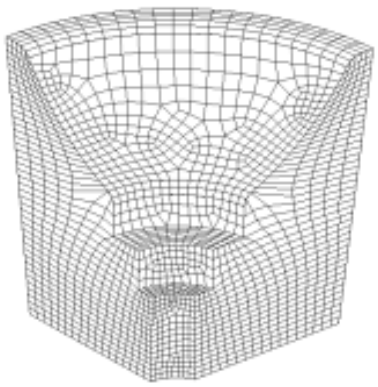
Basic Sweep Paths

In addition to the different topologies, sweepable volumes can be classified by the sweep direction. These include: top-to-bottom, inside-to-outside, and around (rotational). Be sure to consider all the possibilities for sweep directions when you begin decomposing a model. And keep in mind that sweep paths must be compatible with adjacent volumes. To be compatible, overlapping surfaces must have the same scheme (i.e. both must be a linking surface or a paved surface). The volume below is meshed three different times with the three different sweep directions. Notice the difference in element sizes and orientations between the meshes. See if you can pick out the different source and target surfaces in each example. As an exercise, try to mesh this model with each of the different sweep paths.



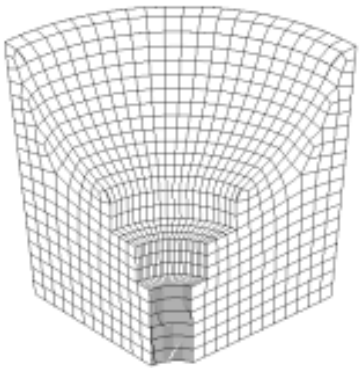
Top-to-Bottom

Many-to-one



Inside-to-Outside

Many-to-one



Around (Rotational)

One-to-one (this is the default sweep direction for this model)

What are some good strategies for decomposing my model?

Recognizing when a volume is sweepable is a difficult task, but being able to come up with viable webcutting, compositing, and boolean strategies to make a volume sweepable is even more difficult, and can only be achieved through practice.

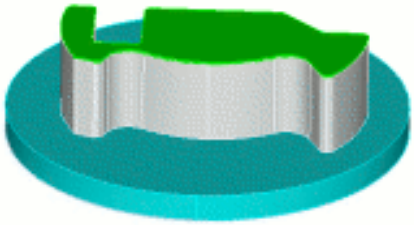
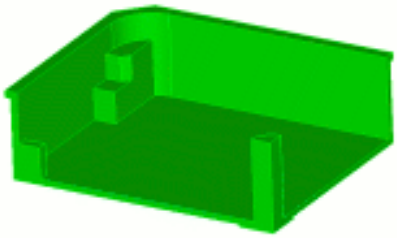
General Principles to follow when decomposing a mode

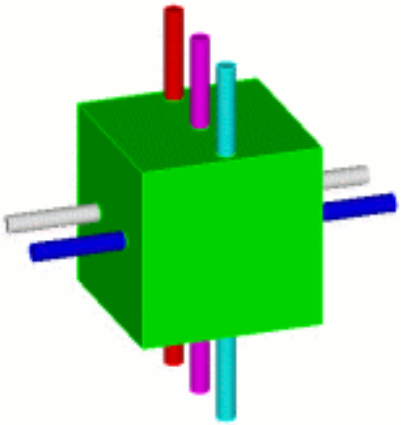
- Select your Sweeppath
- Use as few webcuts as possible
- Set your own source and target surfaces if Coreform Cubitdoes not pick them automatically
- If one of your volumes does not mesh, or has an undesirable mesh, try changing the order in which you mesh volumes. This will hard set the intervals on the volumes.
- The Reset Volume command will remove all schemes and interval settings from volumes.
- If changing the mesh order or resetting the volumes does not work and you continue to get “Matching Intervals Failed” errors, set explicit intervals on some or all curves.
- Make additional webcuts if necessary.
- Check for sliver surfaces or curves that may have been introduced during decomposition and remove these through tweaking, collapsing, or compositing.
- Change surface vertex types on mapped or submapped surfaces if you need to force a certain configuration
- Use partitioning to introduce virtual geometry constraints without affecting the underlying geometry.
- Composite surfaces to remove constraints without affecting the underlying geometry
- Save your work often. For a complex model, the meshing process can be very iterative. You may need to start over many times until you find an acceptable solution.

Decomposition Examples

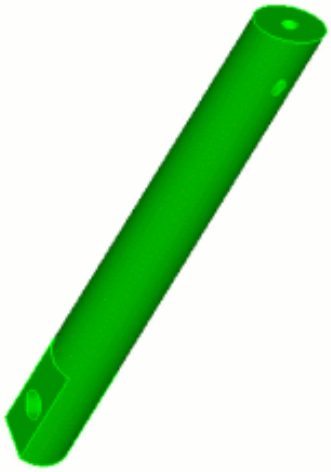
The following is a compilation of several different decomposition problems of varying difficulty. If you accessed this help from the Coreform Cubit Program (as opposed to the web documentation), you will need to browse for the geometry files.

Beginner Decomposition Examples

Example	Image	File
Sweeping through multiple adjacent volumes		example01.sat
Interlocking rings		example02.sat
Webcutting using the "sweep" option		example03.sat

Using the loft command		example04.sat
Multiple sweep directions		example05.sat

Advanced Decomposition Examples

Example	Image	File
Employing symmetry and controlling skew		example06.sat
Using virtual geometry		example07.sat
Sweeping volumes with narrow angles and surfaces		example08.sat

Beginner Decomposition Examples

Example 1. Sweeping multiple adjacent volumes

The following model has several interior volumes that share surfaces. This example may at first seem complex, but it actually requires very little decomposition. The key to this example is that each of the interior volumes is already sweepable, oriented along the same sweep axis, and that none of the linking surfaces have additional topology introduced through imprint/merge. In fact, there is only one required webcut to make this model automatically sweepable.

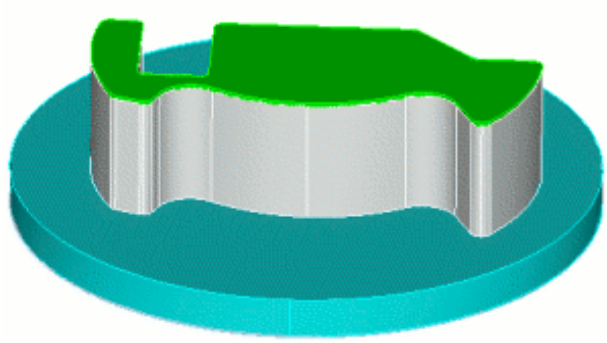


Figure 1. Exterior view

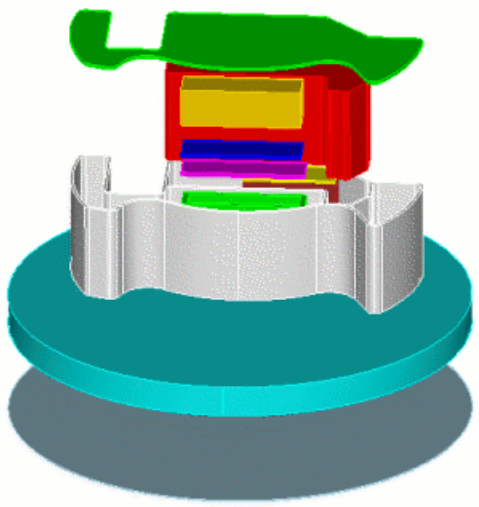
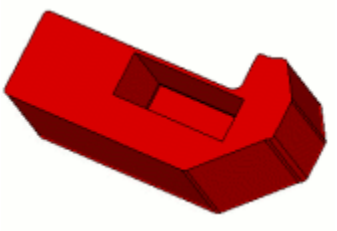
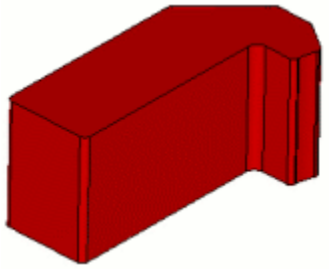
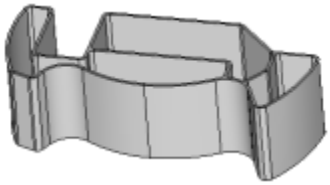
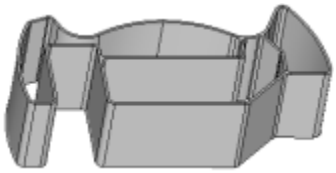
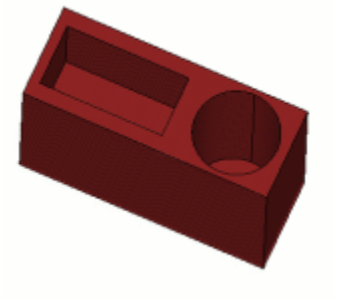
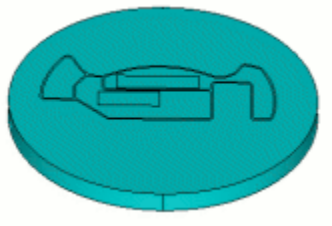
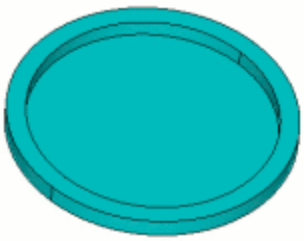


Figure 2. Interior view

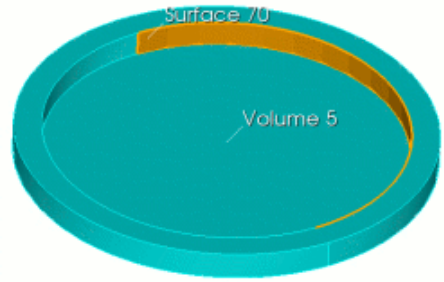
We examine several of the volumes below.

Source Surface(s)	Target Surface(s)	Sweep type
		**Many-to-one Sweepable** Imprinting and merging adjacent volumes creates additional partitions on the source surface, but the target surface does not contain imprints.
		**Many-to-one Sweepable** Multiple source surfaces due to interior void
		**One-to-One Sweepable** Source and target surfaces are single surfaces, and there are no imprints on the linking surfaces
		**Many-to-one Sweepable** Interior void causes multiple source surfaces.

		**Multisweep** Imprinting causes multiple source surfaces and interior void causes multiple target surfaces. This volume requires decomposition

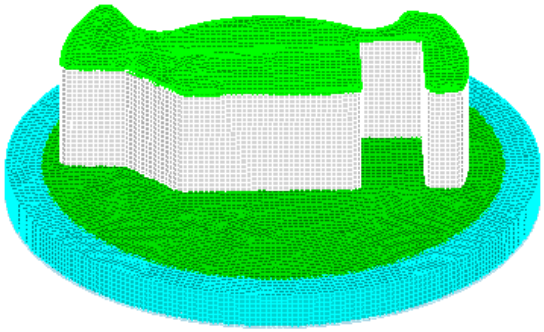
Suggested Webcuts

Begin by Webcutting the Volume



1. On the Command Panel, click on **Geometry** and then **Operation - Decompose Geometry.**.
2. Click on the **Volume Entity.**.
3. Select **Sheet Extended From Surface** from the drop-down bar.
4. With your cursor in the **Volume ID(s)** field, Click on Volume **5** in the Graphics Window.
5. Enter **70** in the **Surface ID** field.
6. Click **Preview** to preview the webcut.
7. Click **Apply** to cut the volume.

Next Imprint and Merge



1. On the Command Panel, click on the **Geometry** button and then **Operation - Imprint and Merge..**
2. Click on the **Volume Entity.**.
3. Select **Imprint/Merge** from the drop-down bar.
4. Enter **all** in the **Volume ID(s)** field.
5. Click **Apply.**

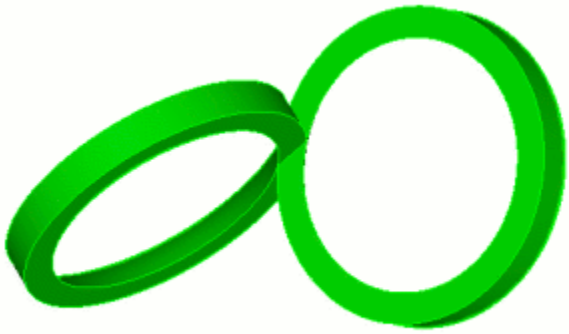
Finish by Meshing the Geometry

1. On the Command Panel, click on **Mesh** and then **Volumes.**
2. Click the **Intervals** action button.
3. Select **Approximate Size** from the drop-down menu and enter **0.15** in the **Approximate Size** field.
4. Enter **all** in the **Select Volumes** field.
5. Click **Apply Size**.
6. Click the **Mesh** action button.

Final mesh - The final mesh is created at a size of 0.15 for all volumes.

Example 2. Interlocking rings

The following example is composed of two rings of constant cross-section that can be swept along their axes. The problem here is that the rings overlap, forming a tetrahedral shape that cannot be swept. The key to solving this problem is separating out the region of overlap, explicitly setting the source and target surfaces, and using the tetprimitive scheme on the tetrahedral region.



Suggested webcuts

Begin by performing a series of Webcuts

1. On the Command Panel, click on the **Geometry** button and then **Operation - Decompose Geometry**.
2. Click the Entity - Volumes button.
3. Select **Plane From Surface,** from the drop-down bar.
4. Enter **1** in the **Volume ID(s)** field.
5. Enter **5** in the **Surface ID** field.
6. Click **Preview**
7. Click **Apply**

Second Webcut

1. With the same setting on the Command Panel, select **Sheet Extended From Surface** from the drop-down bar.
2. Enter **2** in the **Volume ID(s)** field.
3. Enter **4** in the **Surface ID** field.
4. Click **Preview.**
5. Click **Apply.**

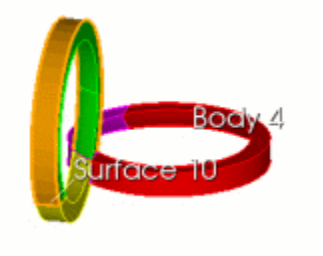
Third Webcut

1. With the same setting on the Command Panel, select **Plane From Surface** from the drop-down bar.
2. Enter **3** in the **Volume ID(s)** field.

3. Enter **12** in the **Surface ID** field.
4. Click **Preview.**
5. Click **Apply.**

Fourth Webcut

1. With the same setting on the Command Panel, select **Sheet Extended From Surface.**
2. Enter **4** in the **Volume ID(s)** field.
3. Enter **10** in the **Surface ID** field.
4. Click **Preview.**
5. Click **Apply.**



Next, you need to Imprint and Merge the Volumes

1. On the Command Panel, click on the **Geometry** button and then **Operation - Imprint and Merge**.
2. Click Entity - Volumes.
3. Select **Imprint/Merge** from the drop-down bar.
4. Enter **all** in the **Volume ID(s)** field.

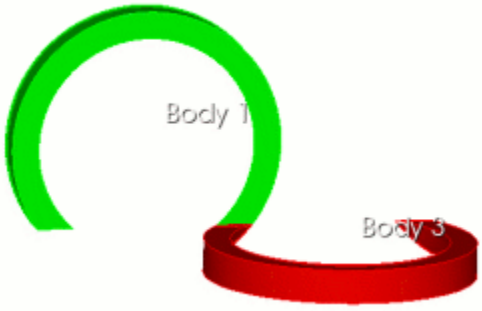
5. Click **Apply**.

Note: There are five volumes that result from the webcutting. Two of them are automatically sweepable. Two of them must have their schemes set explicitly, and one of them is meshed using the tetprimitive scheme.

Next set schemes and mesh the volumes

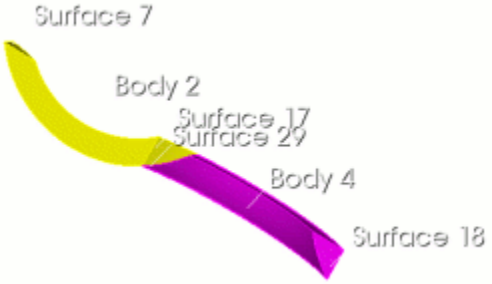
One-to-one Sweepable

1. From the Command Panel, select the **Mesh** button and then **Volume.**
2. Click on the **Mesh** action button.
3. Select **Automatically Calculate** from the drop-down bar.
4. Enter **Volume 1** and **3** in the **Select Volumes** field.
5. Click **Apply Scheme**



One-to-one Sweepable

1. With the same settings on the Command Panel, Select **Sweep** from the drop-down bar and enter **2** in the **Select Volumes** field.
2. Enter **17** in the **Source Surface ID(s)** field.
3. Enter **7** in the **Target Surface ID** field.
4. Click **Apply Scheme.**



Next, Specify the Meshing Schemes

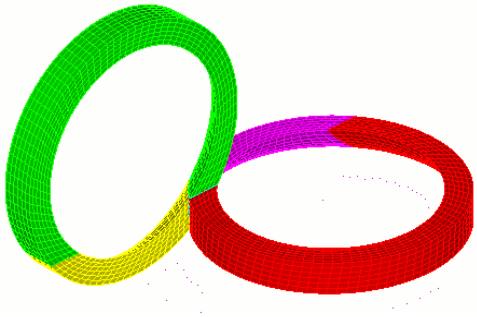
1. With the same setting on the Command Panel, enter Volume **4** in the **Select Volumes** field.
2. Enter **29** in the **Source Surface ID(s)** field.
3. Enter **18** in the **Target Surface** ID field.
4. Click **Apply Scheme**.

Non-sweepable

1. With the same setting on the Command Panel, click on the **Intervals** action button.
2. Select **Approximate Interval Count** from the drop-down bar.
3. Enter **5** in the **Select Volumes** field.
4. Enter **6** in the Interval field.
5. Click **Apply**
6. With the same setting on the Command Panel, select the **Mesh** action button.
7. Select **Tetprimitive** from the drop-down bar.
8. Enter **5** in the **Select Volumes** field.
9. Click **Apply Scheme**.

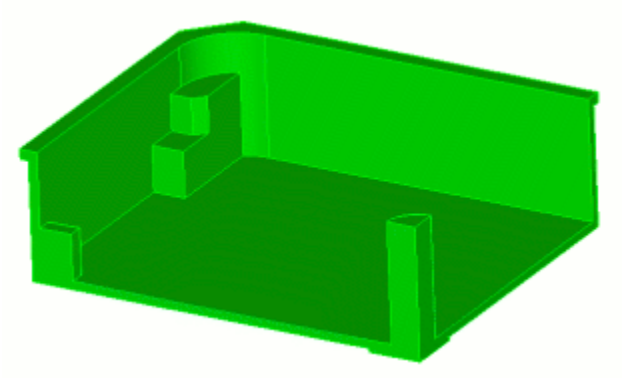
Finish by Meshing the Geometry

1. With the same setting on the Command Panel, select the **Intervals** action button.
2. Select **Approximate Size** from the drop-down bar.
3. Enter **all** in the **Select Volumes** field.
4. Enter **0.5** in the **Approximate Size** field. This sets the final mesh to be created at a size of 0.5 for all volumes
5. Click **Apply Size.**
6. Click **Mesh.**



Example 3. Webcutting using the sweep option

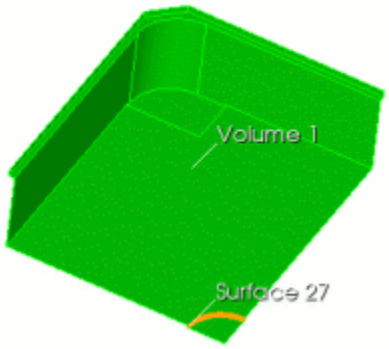
This example introduces additional webcutting options. This example would be a simple many-to-one sweep except for the overhanging lip and the protrusions on the bottom surface. To a beginner user, it may at first seem reasonable to use the bottom surface as a webcutting plane. However, this will not create a many-to-one sweepable volume. Instead, you need to use the protruding surfaces as cutting planes, and extend them through the entire volume.



Suggested webcuts

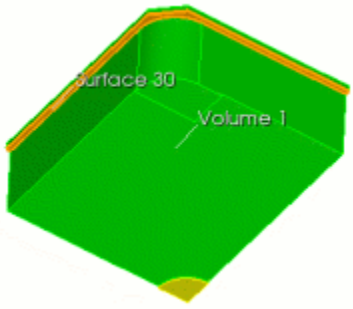
Begin by performing a series of Webcuts

1. On the Command Panel, click on the **Geometry** button and then **Operation - Decompose Geometry**.
2. Click Entity - Volumes.
3. Select **Sheet Extended From Surface** from the drop-down bar.
4. Enter **1** in the **Volume ID(s)** field.
5. Enter **23** in the **Surface ID** field.
6. Click **Preview.**
7. Click **Apply.**



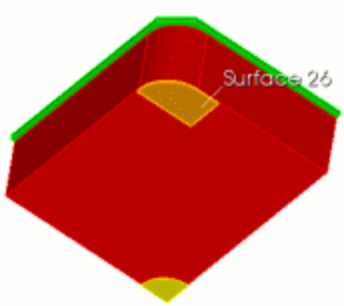
Next

1. With the same settings on the Command Panel, select **Plane From Surface** from the drop-down bar.
2. Enter **1** in the **Volume ID(s)** field.
3. Enter **30** in the **Surface ID** field.
4. Click **Preview.**
5. Click **Apply**



Next

1. With the same setting on the Command Panel, select **Sweep Surface** from the drop-down bar.
2. Enter **all** in the **Volume ID(s)** field.
3. Enter **28** in the **Sweep Surface ID** field.
4. Select **Vector** under the Sweep Direction menu.
5. Enter the **-1** for **X,** enter **0** for **Y** and enter **0** for **Z.**
6. Select **Through All.**
7. Click **Preview.**
8. Click **Apply.**

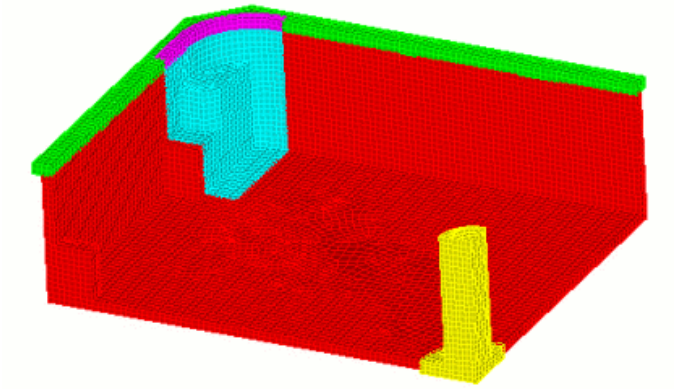


Next, you need to Imprint and Merge the Volumes.

1. With the same setting on the Command Panel, click Operation - Imprint and Merge.
2. Click Entity - Volumes
3. Select **Imprint/Merge** from the drop-down bar.
4. Enter **all** in the **Volume ID(s)** field.
5. Click **Apply.**

Finish by Meshing the Geometry

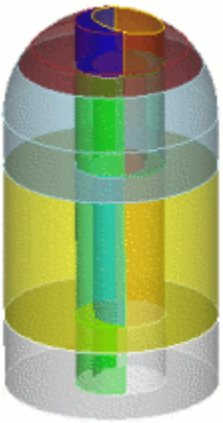
1. From the Command Panel, select the **Mesh** button and then **Volume.**
2. Click on the **Intervals** action button.
3. Select **Approximate Size** from the drop-down bar.
4. Enter **all** in the **Select Volumes** field.
5. Enter **0.05** in the **Approximate Size** field. This sets the final mesh to be created at a size of 0.05 for all volumes.
6. Click **Apply Size.**
7. Click **Mesh.**



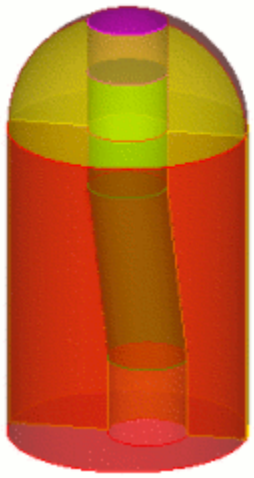
Example 4. Using the Loft command

In the next example, the loft command significantly decreases the number of required webcuts. This model also demonstrates using 2 separate sweep paths (top-to-bottom and rotational) on adjacent volumes.

Original Volume



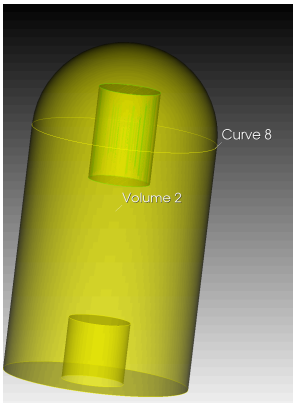
Webcuts created from sweeping surfaces (not recommended)



Webcuts using loft command (recommended)

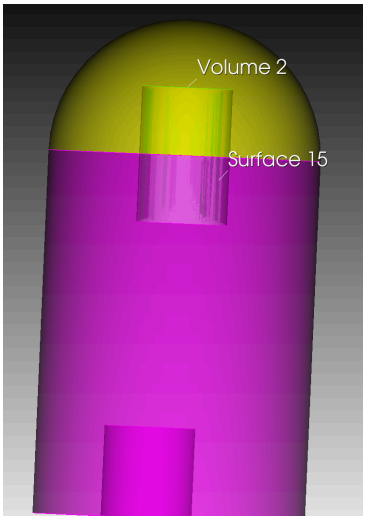
Suggested webcuts

Begin by performing a series of Webcuts



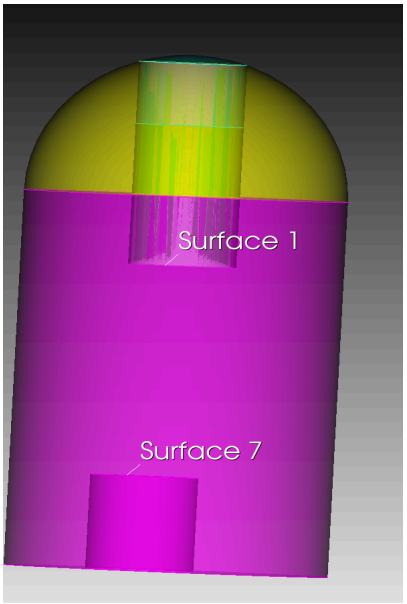
1. On the Command Panel, click on the **Geometry** button and then **Operation - Decompose Geometry.**
2. Click on the **Entity - Volume** button.
3. Select **Loop** from the drop-down bar.
4. With your cursor in the **Volume ID(s)** field, click on **Volume 2** in the graphics window.
5. With your cursor in the **With Curve ID(s)** field, click on **Curve 8** in the graphics window. Click **Preview.**
6. Click **Apply.**

Note: Once an ID is selected in the graphics window, you can press the **tab button** to select other identities from that same ID.



1. With the same settings on the Command Panel, select **Sheet Extended from Surface** from the drop-down bar.
2. With your cursor in the **Volume ID(s)** field, click on **Volume 2** in the graphics window.
3. With your cursor in the **Surface ID(s)** field, click on **Surface 15** in the graphics window.
4. Click **Preview.**
5. Click **Apply.**

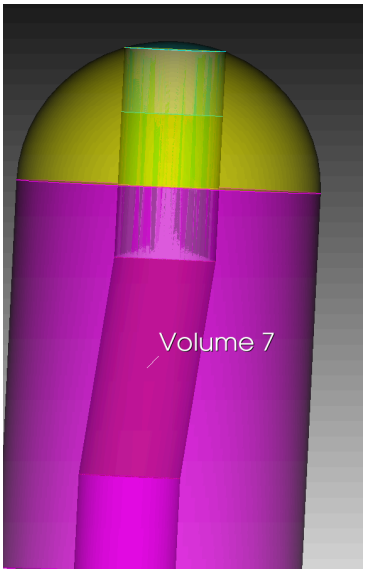
Next, you will create surfaces that, in the next step, will help create a volume



1. On the Command panel, click on **Geometry** and then **Operation - Create Geometry**.
2. Click the **Entity - Surfaces** button.
3. Select **Copy and Transform** from the drop-down menu.
4. With your cursor in the **Surface ID(s)** field, click on Surface **1** and **7** in the graphics window.
5. Uncheck the **Transform Copied Surfaces** box.
6. Click **Apply**.

Next, create a lofted volume to connect the two surfaces just created

1. Now select Entity - Volume and select **Lofted Volume** from the drop-down bar.
2.
3. With your cursor in the **Surface ID(s)** field, click on **Surface 19** and **Surface 20.** These are the two surfaces that will be connected by a volume.



Note: You can press the Control Key to select more than one ID in the graphics window.

4. Click **Preview**. The preview will show a blue line in the path that connects the two surfaces.
5. Click **Apply.**

Next

1. With the same settings on the command panel, click the **Operation - Decompose Geometry** button.
2. Select **Tool** from the drop-down menu.
3. Enter **3** in the **Volume ID(s)** field.

4. Enter **7** in the **Tool** - **Body ID** field. Volume **7** is the new body that was created in the last step.
5. Click **Preview.**
6. Click **Apply.**

Next

1. With the same settings on the Command panel, click the Operation - **Delete Geometry - Entity Volumes** button.
2. Enter **5 6 7** in the **Volume ID(s)** field.
3. Click **Apply.**

Next

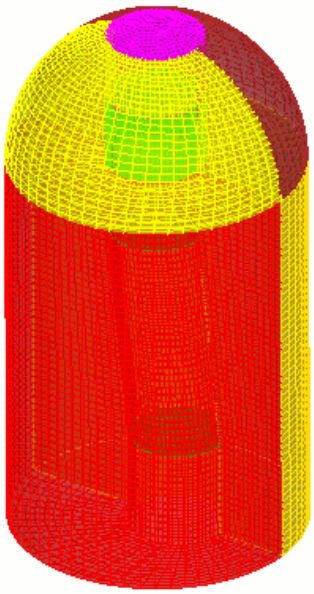
1. With the same settings on the Command panel, click the **Operation** - **Delete Geometry** button, click the **Operation - Decompose Geometry** button.
2. Select **General Plane** from the drop-down menu.
3. With your cursor in the **Volume ID(s)** field. Click on **Volume 2** and **3** in the graphics window.
4. Select **YZ**
5. Click **Preview.**
6. Click **Apply.**

Next, you need to Imprint and Merge the volumes

1. With the same setting on the Command Panel, click on the **Operation - Imprint and Merge** button.
2. Select **Imprint/ Merge** from the drop-down menu.
3. Enter **all** in the **Volume ID(s)** field.
4. Click **Apply.**

Finish by Meshing the Geometry

1. On the Command Panel, click on **Mesh** and then **Volume.**
2. Click on the **Intervals** action button.
3. Select **Approximate Size** from the drop-down menu.
4. Enter **all** in the **Select Volumes** field.
5.
6. Enter **0.15** in the **Approximate Size** field.
7. Click **Apply.**
8. Click **Mesh.**

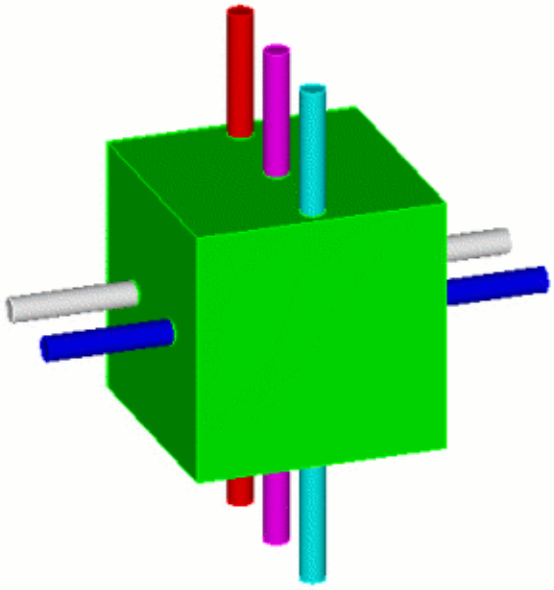


Final mesh

The final webcut model consists of a central shaft that can be swept top to bottom, and a surrounding casing that can be swept around. This is possible because the shared surface is a linking surface for both types of sweeps. The final mesh is created with a size of 0.15

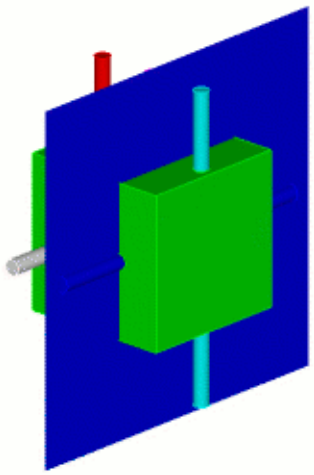
Example 5. Multiple sweep directions

The next example gives another example of using different sweep directions on the same model. The following model shows a brick that is perforated by several cylindrical shafts. The shafts do not intersect each other.



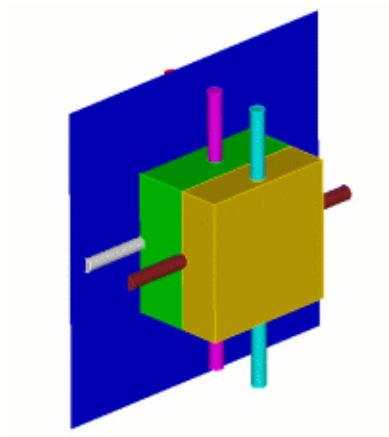
Suggested webcuts

Begin by performing a series of Webcuts



1. On the Command Panel, click on the **Geometry** button and then **Operation - Decompose Geometry.**
2. Click on the **Entity - Volume** button.
3. Select **Coordinate Plane** from the drop-down menu.
4. Enter **all** in the **Volume ID(s)** field.
5. Click on **ZX**
6. Enter **20** in the **Offset Value** field.
7. Click **Preview.**
8. Click **Apply.**

1. With **Coordinate Plane** still selected from the drop-down menu enter **all** in the **Volume ID(s)** field.
2. Click on **ZX**
3. Enter **-20** in the **Offset Value** field.
4. Click **Preview.**
5. Click **Apply.**



Next, Imprint and Merge the Volumes

1. With the same settings on the Command Panel, click on the **Operation** - **Imprint and Merge** button.
2. Select **Imprint/ Merge** from the drop-down menu.
3. Enter **all** in the **Volume ID(s)** field.
4. Click **Apply.**

Note: All of the volumes in this model are now one-to-one sweepable. However, the source and target surfaces for the main block portions must be set explicitly

Next, set the Meshing Schemes to prepare the geometry to be meshed

1. On the Command Panel, click on **Mesh** and then **Volume.**
2. Click on the **Mesh** action button.
3. Select **Sweep** from the drop-down menu.
4. With your cursor in the **Select Volumes** field, click on **Volume 8** in the graphics window.
5.
6. Click on **Specify Source and Target**
7. With your cursor in the **Source Surface ID(s)** field, click on **Surface 94** in the graphics window.
8. With your cursor in the **Target Surface ID** field, click on **Surface 90** in the graphics window.
9. Click **Apply Scheme.**

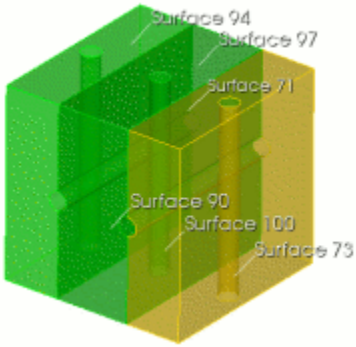
Next

1. Enter **10** in the **Select Volumes** field.
2. Click on **Specify Source and Target.**
3. With your cursor in the **Source Surface ID(s)** field, click on **Surface 71** in the graphics window.
4. With your cursor in the **Target Surface ID** field, select **Surface 73** in the graphics window.
5. Click **Apply Scheme.**

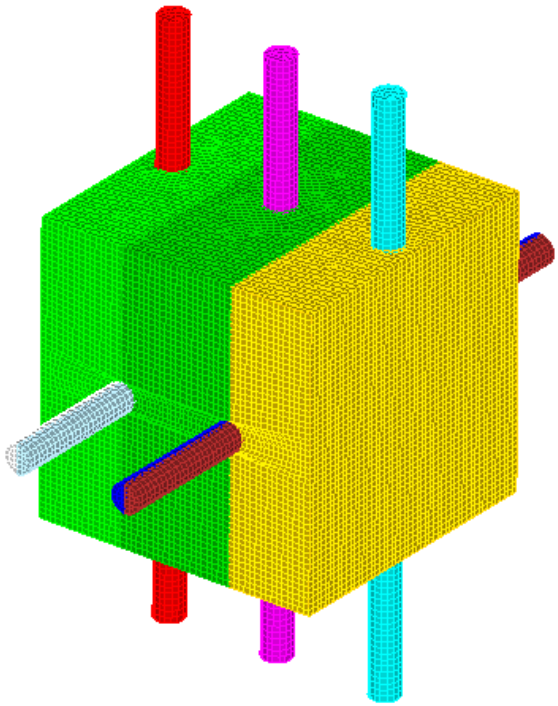
Next

1. Enter **12** in the **Select Entities to Mesh** field.
2.
3. Click on **Specify Source and Target.**
4. With your cursor in the **Source Surface ID(s)** field, click on **Surface 97** in the graphics window.
5. With your cursor in the **Target Surface ID** field, select **Surface 100** in the graphics window.
6. Click **Apply Scheme.**

Finish by Meshing the Geometry



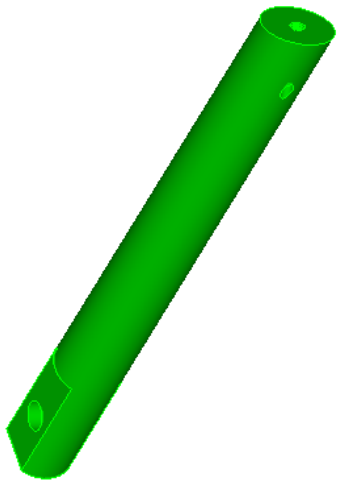
1. On the Command Panel, click on **Mesh** and then **Volume.**
2. Click on the **Intervals** action button.
3. Select **Approximate Size** from the drop-down menu.
4. Enter **all** in the **Select Volumes** field.
5.
6. Enter **2** in the **Approximate Size** field.
7. Click **Apply.**
8. Click **Mesh.**



Advanced Decomposition Examples

Example 6. Employing Symmetry

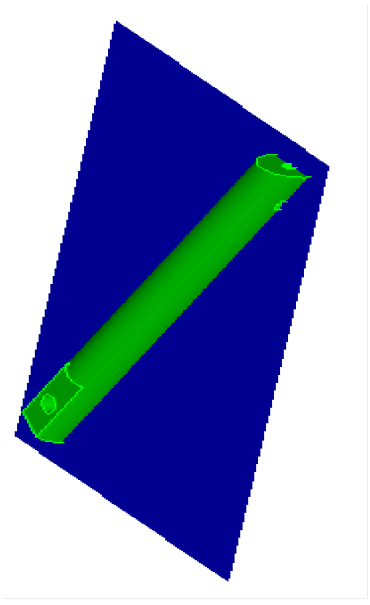
One technique for creating a symmetric mesh on a symmetric model is to mesh only half of the volume, then copy the mesh onto the other half. The following example employs this technique. This model at first appears quite simple, but it actually requires a good deal of webcutting to get a reasonable mesh that is not highly skewed.



Suggested webcuts

Begin by performing a series of Webcuts

1. On the Command Panel, click on the **Geometry** button and then **Operation - Decompose Geometry.**
2. Click on the **Entity - Volume** button.
3. Select **General Plane** from the drop-down menu.
4. With your cursor in the **Volume ID(s)** field, select the entity in the graphics window. **1** should appear.
5. Enter **YZ** in the **With Plane** field
6.
7. Click **Preview**.
8. Click **Apply**.



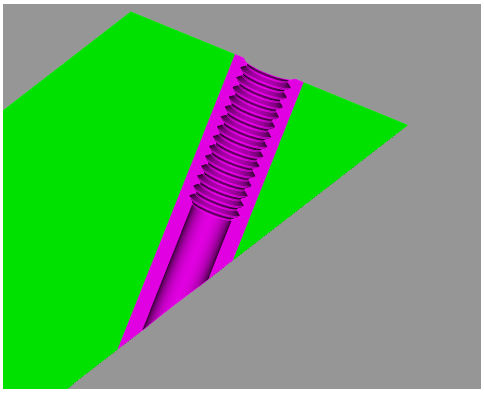
Next

1. With the same settings on the Command Panel, click on the **Operation - Delete Geometry** button.

2. With your cursor in the **Volume ID(s)** field, click on the new volume created from the webcut in the last step. **2** should appear.
3. Click **Apply**.

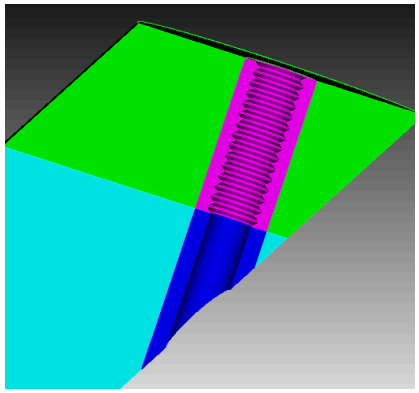
Next

1. With the same settings on the Command Panel, click on the **Operation - Decompose Geometry** button.
2. Select **Cylinder Radius** from the drop-down menu.
3. With your cursor in the **Volume ID(s)** field, select the entity in the graphics window.
4. Enter **2.75** for the **Radius**.
5. Select the **Y Axis**.
6. Click **Preview**.
7. Click **Apply**.



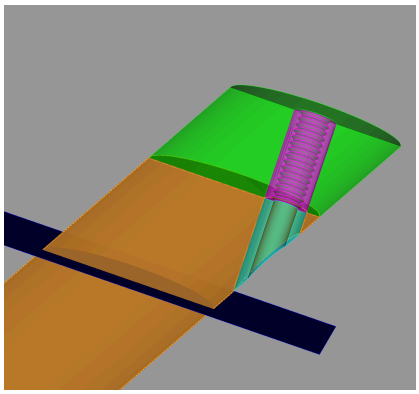
Next

1. With the same setting on the Command Panel, select **General Plane** from the drop-down menu.
2. With your cursor in the **Volume ID(s)** field, click on the two volumes in the graphics window, volumes **1 3**. **Note**: you can hold the Control key on your keyboard to select multiple volumes.
3. Enter **ZX** in the **With Plane** field
4. Click **Preview**.
5. Click **Apply**.



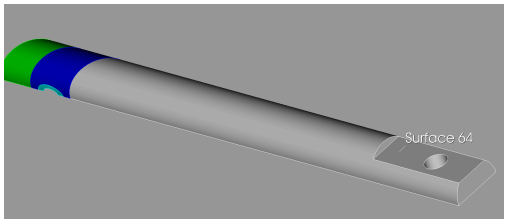
Next

1. With the same settings on the Command Panel, select **General Plane** from the drop-down menu.
2. With your cursor in the **Volume ID(s)** field, click on **Volume 4** (the original body) in the graphics window.
3. Click the … button to select **ZX** in the top box and click on the advanced settings
4. Enter **-15** in the **Offset Value** field.
5. Click **Preview**.
6. Click **Apply**.



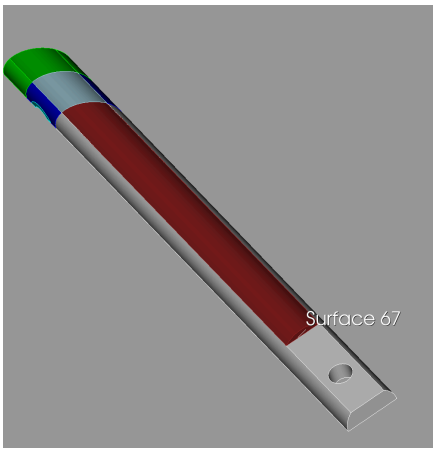
Next

1. With the same settings on the Command Panel, select **Sheet Extended From Surface** from the drop-down menu.
2. With your cursor in the **Volume ID(s)** field, click on **Volume 1**, **Volume 4**, and **Volume 6** in the graphics window.
3. Enter **64** in the **Surface ID** field.
4. Click **Preview**.
5. Click **Apply**.



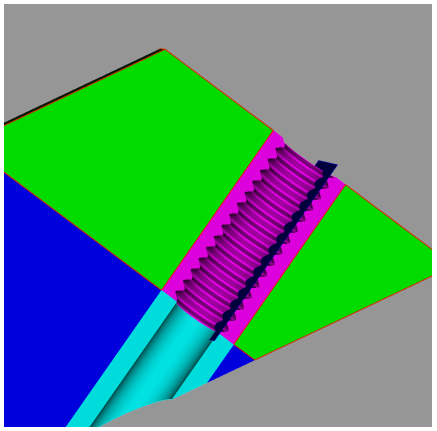
Next

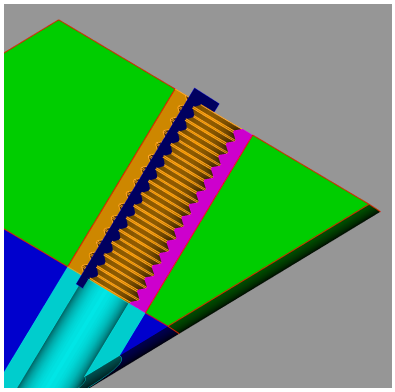
1. With the same settings on the Command Panel , with your cursor in the **Volume ID(s)** field, click on **Volume 6** in the graphics window.
2. With your cursor in the **Surface ID** field, click on surface **67** in the graphics window. (Surface 67 is at the base of the new volume created from the previous step)
3. Click **Preview**.
4. Click **Apply**.



Next

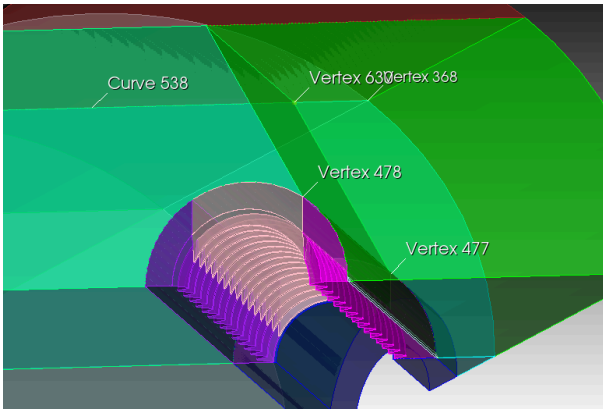
1. With the same settings on the Command Panel, select **General Plane** from the drop-down menu.
2. With your cursor in the **Volume ID(s)** field, click on **Volume 3** in the graphics window.
3. Click the … button to select **XY** in the top box and select advanced options
4. Enter 1.5 in the **Offset Value** field.
5. Click Apply on the window
6. Click **Preview**.
7. Click **Apply**.





1. With the same settings on the Command Panel , with your cursor in the **Volume ID(s)** field, click on **Volume 11**, which is the new volume created from the previous step.
2. Click the … button to select **Z** in the top box and select advanced options
3. Enter **-1.5** in the **Offset Value** field.
4. Click **Preview**.
5. Click **Apply**.

Next

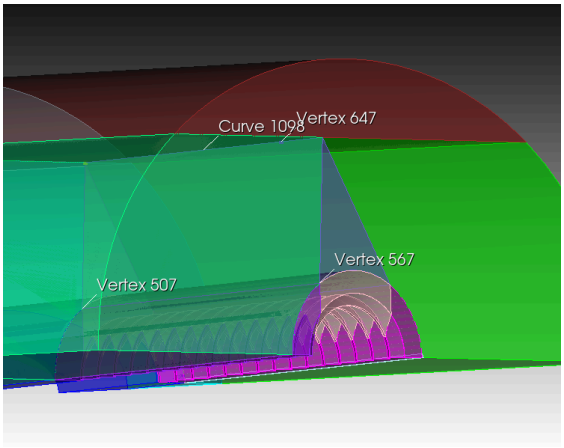


1. On the Command Panel, click on **Geometry** and then **Operation - Create Geometry**.
2. Click on the **Entity - Vertices** button and select **On Curve** from the drop-down menu.
3. Enter **538** in the **Curve ID(s)** field.
4. Click the **Distance** radio button and enter in a value of **2**.
5. Click the **Vertex** button below and enter **368** in the **Vertex ID** field.
6. Click Apply

Next

1. On the Command Panel, click on **Geometry** and then **Operation - Decompose Geometry**.
2. Click the **Entity - Volume** button and select **Plane From Vertex** from the drop-down menu.
3. Enter **1** in the **Volume ID(s)** field and **478 477 330** in the three **Vertex ID** fields.
4. Click **Preview** and **Apply**.

Next

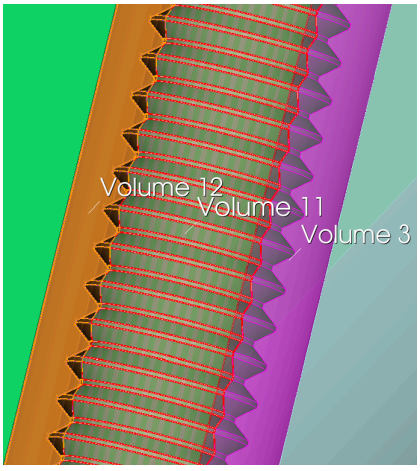


1. On the Command Panel, click on **Geometry** and then **Operation - Create Geometry.**
2. Click the **Entity - Vertices** button.
3. Select **On Curve** from the drop-down menu.
4. Enter **1098** in the **Curve ID(s)** field.
5. Select the **Distance** radio button and enter **3** in the **Distance** field.
6. Select the **Vertex** radio button below and enter **636** in the **Vertex ID** field.
7. Click **Apply**.

Next

1. On the Command Panel, click on **Geometry** and then **Operation - Decompose Geometry**.
2. Click the **Entity - Volume** button and select **Plane from Vertex** from the drop-down menu.
3. Enter **14** in the **Volume ID(s)** field and **507 567 647** in the **Vertex ID** fields.
4. Click **Preview** and **Apply**.

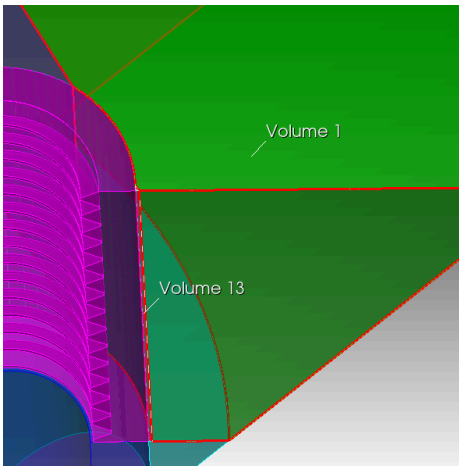
Note: This wedge shape webcut is a method of controlling skew in the final mesh.



1. With the same settings on the Command Panel, click the **Operation - Boolean Operations** button.
2. Select **Unite** from the drop-down menu.
3. Enter **3 11 12** in the **Volume ID(s)** field.
4. Click **Apply**.

1. With the same settings on the Command Panel enter volumes **13** and **1** in the **Volume ID(s)** field.
2. Click **Apply**.

Next



1. On the Command Panel, click on **Geometry** and then **Operation - Delete Geometry**.
2. Click the **Entity - Vertex** button.
3. Enter **all** in the **Vertex ID(s)** field and click **Apply**.

Next, Imprint and Merge the Volumes

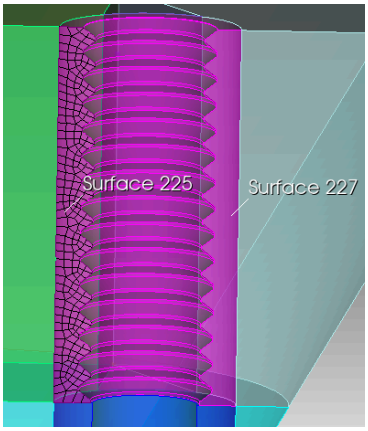
1. Click on **Geometry** and then **Operation - Imprint and Merge**.
2. Click the **Entity - Volume** button.
3. Select **Imprint/Merge** from the drop-down menu and enter **all** in the **Volume ID(s)** field.
4. Click **Apply**.

Next, Set schemes and begin meshing individual volumes

1. On the Command Panel, click on **Mesh** and then **Entity - Volume**.
2. Click the **Intervals** action button.
3. Select **Approximate Size** from the drop-down menu and enter **all** in the **Select Volumes** field.
4. Enter **0.5** in the **Approximate Size** field.
5. Click **Apply Size**.

Next

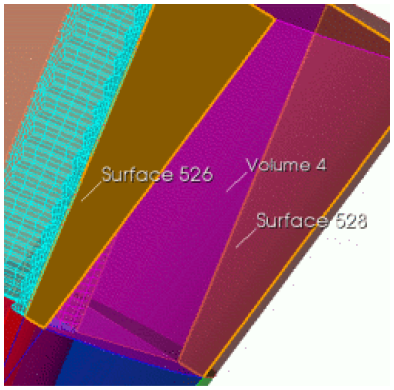
1. With the same settings on the Command Panel, Click **Entity** - **Surface** and then the **Intervals** action button.
2. Select **Approximate Size** from the drop-down menu and enter **225** in the **Select Surfaces** field.
3. Enter 0.25 in the **Approximate Size** field.
4. Click **Apply** and then **Mesh**.



Next

1. With the same settings on the Command Panel, click **Entity - Volume** and then the **Mesh** action button.
2. Select **Sweep** from the drop-down menu, and enter **3** in the **Select Entities to Mesh** field.
3. Enter **225** in the **Source Surface ID(s)** field and **227** in the **Target Surface ID** field.
4. Click **Apply Scheme** and then **Mesh**.

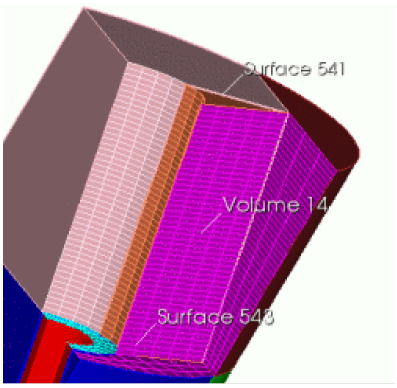
Next



1. With the same setting on the Command Panel, enter **13** in the **Select Entities to Mesh** field.
2. Enter **534** in the **Source Surface ID(s)** field and **528** in the **Target Surface ID** field.
3. Click **Apply Scheme** and then **Mesh**.

Next

1. With the same settings on the Command Panel, enter **15** in the **Select Entities to Mesh** field.
2. Enter **547** in the **Source Surface ID(s)** field and enter **545** in the **Target Surface ID** field.
3. Click **Apply Scheme** and then **Mesh**.



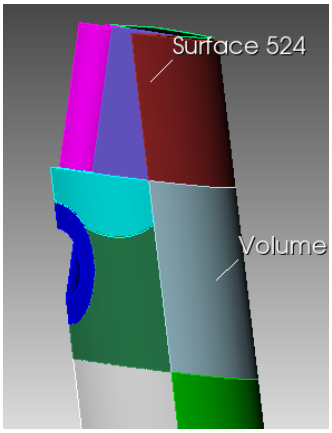
Next

1. On the Command Panel, click **Mesh** and then **Volume**.
2. Click the **Delete** action button.
3. Enter **all** in the **Volume ID(s)** field and click **Apply**.

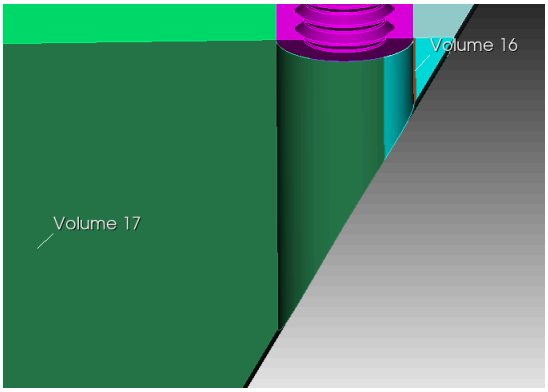
Next

1. On the Command Panel, click on **Geometry** and then **Operation - Imprint and Merge.**.
2. Click the **Entity - Volume** button.
3. Select **Unmerge Volumes** from the drop-down menu.
4. Enter **all** in the **Volume ID(s)** field.
5. Click **Apply**.

Next

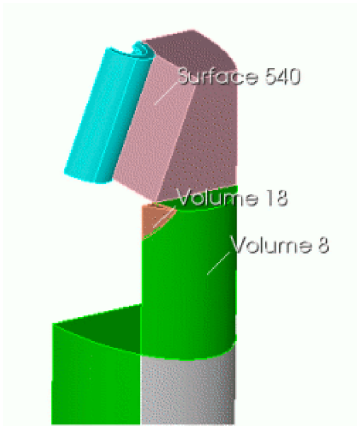


1. With the same settings on the Command Panel, click **Operation - Decompose Geometry** button.
2. Select **Sheet Extended From Suface** from the drop-down menu.
3. Enter **6** in the **Volume ID(s)** field and **524** in the **Surface ID** field.
4. Click **Preview** and then **Apply**.



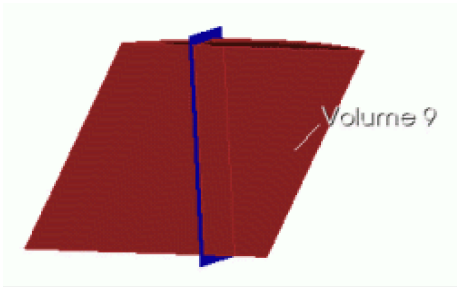
1. With the same settings on the Command Panel, click the **Operation - Boolean Operations** action button.
2. Select **Unite** from the drop-down menu.
3. Enter **16 17** in the **Volume ID(s)** field.
4. Click **Apply**.

Next



1. With the same settings on the Command Panel, click the **Operations - Decompose Geometry** button.
2. Select **Sheet Extended From Surface** from the drop-down menu.
3. Enter **8** in the **Volume ID(s)** field and **524** in the With **Surface ID** field.
4. Click **Preview** and then **Apply**.

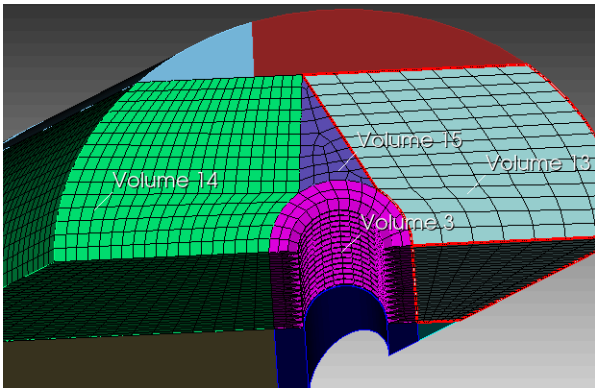
Next



1. With the same settings on the Command Panel, enter **17** in the **Volume ID(s)** field and **540** in the **Surface ID** field.
2. Click **Preview** and then **Apply**.

Next

1. With the same settings on the Command Panel, select **General Plane** from the drop-down menu.
2. Enter **7** in the **Volume ID(s)** field.
3. Click the **XY Plane** radio button and enter **-3** in the **Offset Value** field.
4. Check the **Rotate Cutting Plane** box and enter **5** in the **Angle** field.
5. Click the **X Axis** radio button.
6. Click **Preview** and **Apply**.

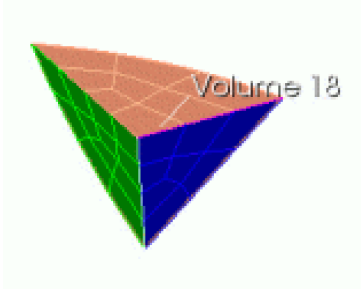


This is another effort to prevent skew in the final mesh

1. With the same setting on the Command Panel, click the **Operation - Imprint and Merge** button
2. Select **Imprint/Merge** from the drop-down menu.
3. Enter **all** in the **Volume ID(s)** field and click **Apply**.

1. Click **Mesh** and then **Volume**.
2. Click the **Mesh** action button and select **Automatically Calculate** from the Drop-down menu.
3. Enter **3** in the **Select Entities to Mesh** field.
4.
5. Click **Apply Scheme** and then **Mesh**.

Next



1. With the same settings on the Command Panel,
   select **Automatically Calculate** from the drop-down menu.

2. enter **13** in the **Select Entities to Mesh** field.
3. Click **Apply Scheme** and then **Mesh**.

Next

1. With the same settings on the Command Panel, select **Automatically Calculate** from the drop-down menu.

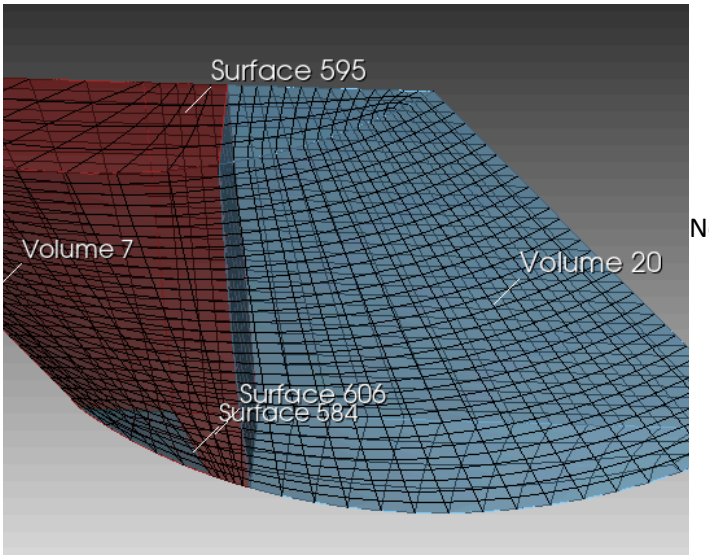
2. Enter **15** in the **Select Entities to Mesh** field.
3.
4. Click **Apply Scheme** and then **Mesh**.

Next

1. With the same settings on the Command Panel, select **Map** from the drop-down menu.

2. Enter **14** in the **Select Entities to Mesh** field.
3. Click **Apply Scheme** and then **Mesh**.

Next



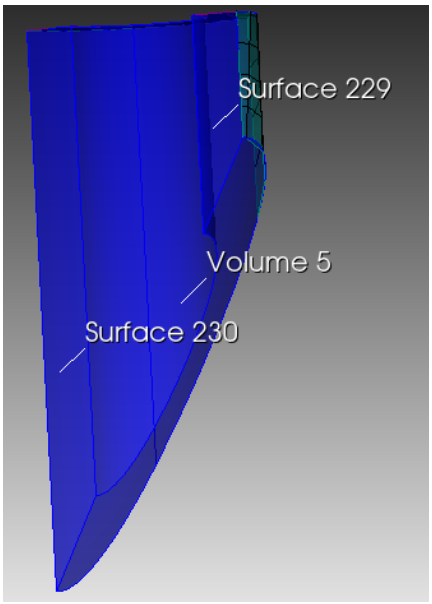
1. With the same settings on the Command Panel, select **TetPrimitive** from the drop-down menu.
2. Enter **4** in the **Select Entities to Mesh** field.
3. Click **Apply Scheme**. (Don't click **Mesh**)

Next

1. Click the **Intervals** action button and Select **Approximate Interval Count** from the drop down menu and enter **18** in the **Select Volumes** field.

2.
3. Enter **3** in the **Interval** field.
4. Click **Apply** and then **Mesh**.

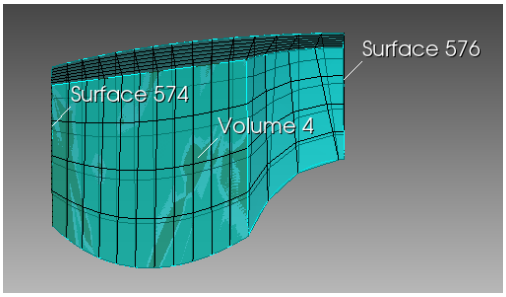
Next



1. Click on the **Mesh** action button and enter **7** in the **Select Entities to Mesh** field.
2. Select **Sweep** from the drop-down menu and click the **Specify Source and Target** radio button.
3. Enter **584 606** in the **Source Surface ID(s)** field and **595** in the **Target Surface ID** field.
4. Click **Apply Scheme** and then **Mesh**.

Next

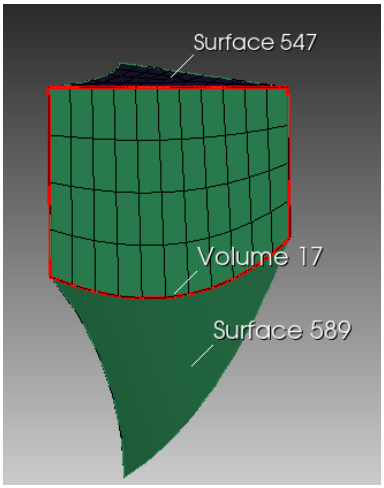
1. With the same setting on the Command Panel, enter **20** in the **Select Entities to Mesh** field.
2. Select **Automatically Calculate** from the drop-down menu.
3. Click **Apply Scheme** and then **Mesh**.



1. With the same settings on the Command Panel, enter **4** in the **Select Entities to Mesh** field.
2. Select **Sweep** from the drop-down menu and click the **Specify Source and Target** radio button.
3. Enter **574** in the **Source Surface ID(s)** field and **576** in the **Target Surface ID** field.
4. Click **Apply Scheme** and then **Mesh**.

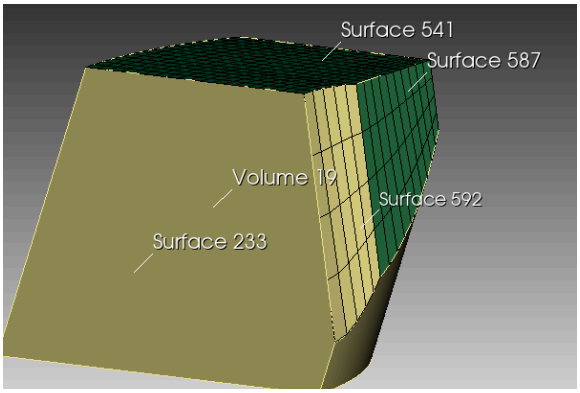
Next

1. With the same settings on the Command Panel, enter **5** in the **Select Entities to Mesh** field.
2. Select **Sweep** from the drop-down menu and click the **Specify Source and Target** radio button.
3. Enter **229** in the **Source Surface ID(s)** field and **230** in the **Target Surface ID** field.
4. Click **Apply Scheme**.



Next

1. On the Command Panel, click on **Mesh** and then **Surface.**
2. Click the **Mesh** action button.
3. Enter **229 230** in the **Select Entities to Mesh** field.
4. Select **Map** from the drop-down menu.
5. Click **Apply Scheme**.
6. Click on the **Volume** entity and then the **Mesh** action button.
7. Enter **3** in the **Select Volumes** field.
8. Click **Mesh**.

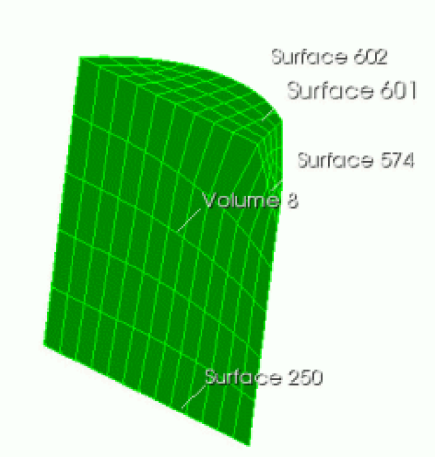


1. Click on the **Mesh** action button and enter **17** in the **Select Entities to Mesh** field.
2. Select **Sweep** from the drop-down menu and click the **Specify Source and Target** radio button.
3. Enter **547** in the **Source Surface ID(s)** field and **589** in the **Target Surface ID** field.
4. Click **Apply Scheme** and then **Mesh**.

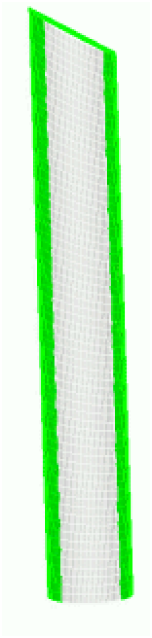
Next

1. With the same settings on the Command Panel, click on the **Mesh** action button.
2. Enter **19** in the **Select Entities to Mesh** field.
3. Select **Sweep** from the drop-down menu and click the **Specify Source and Target** radio button.
4. Enter **541 592 587** in the **Source Surface ID(s)** field and **233** in the **Target Surface ID** field.
5. Click **Apply Scheme** and then **Mesh**.

Next

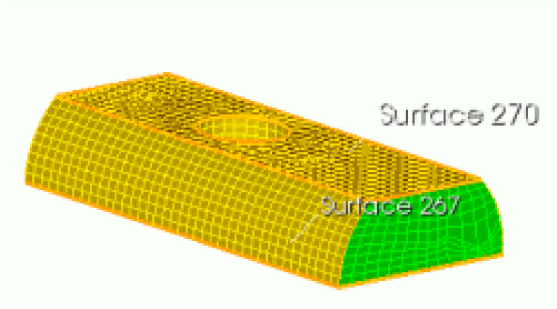


1. With the same settings on the Command Panel, click on the **Mesh** action button.
2. Enter **8** in the **Select Entities to Mesh** field.
3. Select **Sweep** from the drop-down menu and click the **Specify Source and Target** radio button.
4. Enter **574 597 601** in the **Source Surface ID(s)** field and **241** in the **Target Surface ID** field.
5. Click **Apply Scheme** and then **Mesh**.



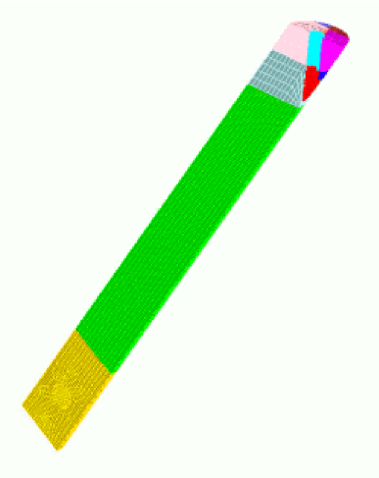
1. With the same settings on the Command Panel, click on the **Intervals** action button.
2. Enter **7** and **1** in the **Select Volumes** field.
3. Select **Approximate Size** from the drop-down menu and enter **2** in the **Approximate Size** field.
4. Click **Apply**.
5. Click the **Mesh** action button and enter **7** and **1** in the **Select Entities to Mesh** field.
6. Select **Automatically Calculate** from the drop-down menu.
7. Click **Apply Scheme** and then **Mesh**.

Next



1. With the same settings on the Command Panel, click on the **Mesh** action button.
2. Enter **10** in the **Select Entities to Mesh** field.
3. Select **Sweep** from the drop-down menu and click the **Specify Source** and **Target** radio button.
4. Enter **270** in the **Source Surface ID(s)** field and **267** in the **Target Surface ID** field.
5. Click **Apply Scheme** and then **Mesh**.

1. On the Command Panel, click **Geometry** and then **Volume.**
2. Click the **Imprint Merge** action button.
3. Select **Unmerge** from the drop-down menu.
4. Enter **all** in the **Volume ID(s)** field.
5. **Apply**.



Next, Copy the geometry to create an identical, meshable volume.

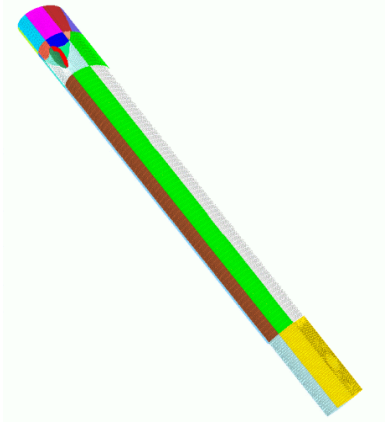
1. With the same settings on the command Panel, click the **Create** action button.
2. Select **Copy** from the drop-down menu.
3. Enter **all** in the **Volume ID(s)** field and check the **Transform Copied Volume(s)** box.
4. Select the **Reflect** radio button and then the **YZ Plane** button.
5. Click **Preview** and then **Apply**.

Next

1. With the same settings on the Command Panel, click the **Imprint Merge** action button.
2. Select **Imprint/ Merge** from the drop-down menu.
3. Enter **all** in the **Volume ID(s)** field.
4. Click **Apply**.

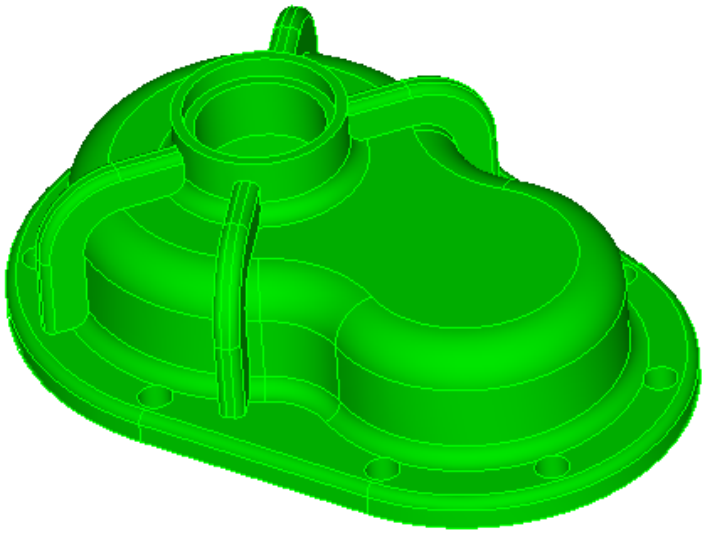
Final mesh

The entire mesh is copied and reflected around the x-axis during the last step. The advantage of symmetry in this example is that it cuts the decomposition in half, and it also ensures a perfectly symmetrical mesh.



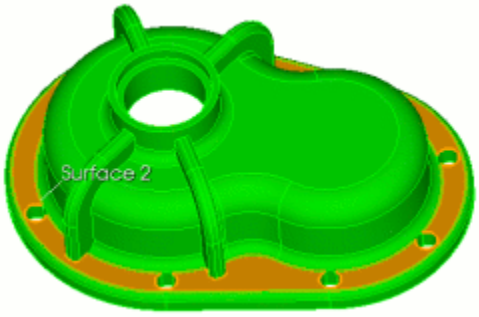
Example 7. Using virtual geometry in geometry decomposition

Virtual geometry is used to change the properties of mesh without changing the underlying geometry. The next example uses virtual geometry to remove unwanted sliver curves, and to create a sweepable volume. The composite curve function is used to combine sliver curves that are created from webcutting a slightly curved surface. Then the partition surface command is used to create additional partitions on a surface to ensure sweepability.



Suggested webcuts

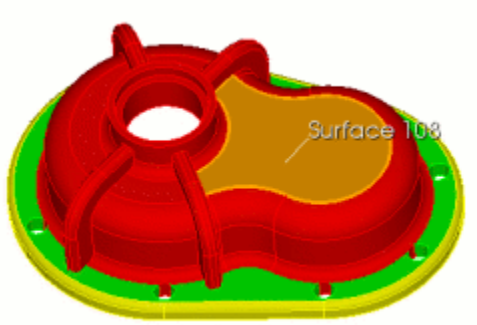
Begin by performing a series of Webcuts



1. On the Command Panel, click on **Geometry** and then **Operation - Decompose Geometry**.

2. Click the **Entity - Volume** button and select **Sweep Surface** from the drop-down menu
3. Enter **1** in the **Volume ID(s)** field and **2** in the **Surface ID** field.
4. Click the **Vector** radio button and enter **0, 0,** and **-1** in the **X Y Z** fields.
5. Make sure the **Through All** box is checked.
6. Click **Preview** and then **Apply**.

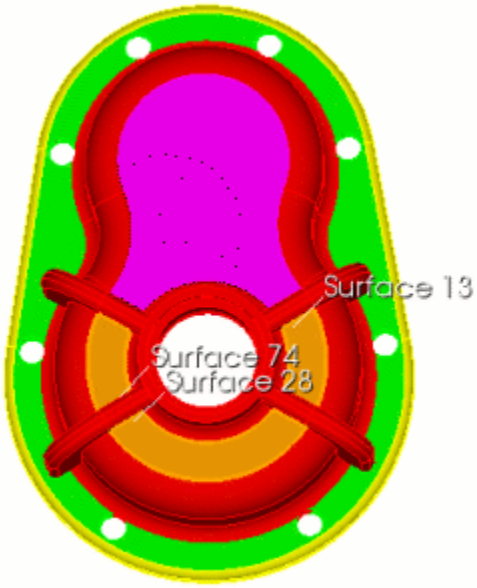
Next



1. With the same settings on the Command Panel, enter **3** in the **Volume ID(s)** field and **108** in the **Surface ID** field.
2. Enter **0 0 -1** in the **X Y Z** field.
3. Click **Preview** and then **Apply**.

Next

1. With the same settings on the Command Panel, enter **3** in the **Volume ID(s)** field and **13** in the **Surface ID** field.
2. The vector will remain the same as the previous step.
3. Click **Preview** and then **Apply**.



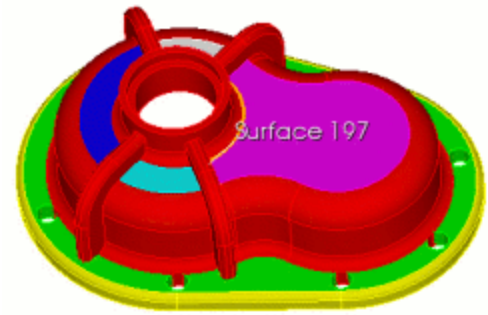
Next

1. With the same settings on the Command Panel, enter **3** in the **Volume ID(s)** field and **28** in the **Surface ID** field.
2. The vector will remain the same as the previous step.
3. Click **Preview** and then **Apply**.

Next

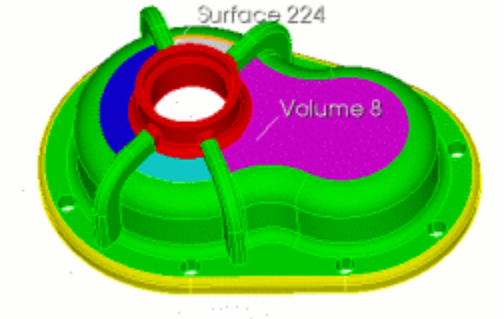
1. With the same settings on the Command Panel, enter **3** in the **Volume ID(s)** field and **74** in the **Surface ID** field.
2. The vector will remain the same as the previous step.
3. Click **Preview** and then **Apply**.

Next



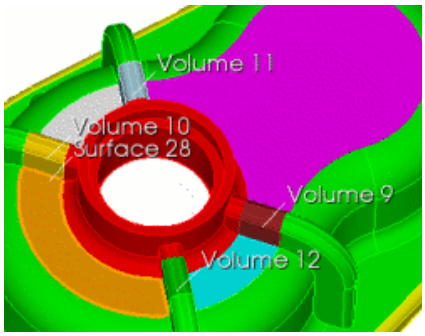
1. With the same settings on the Command Panel, select **Sheet Extended From Surface** from the drop-down menu.
2. Enter **3** in the **Volume ID(s)** field and **197** in the **With Surface ID** field.
3. Click **Preview** and then **Apply**

Next



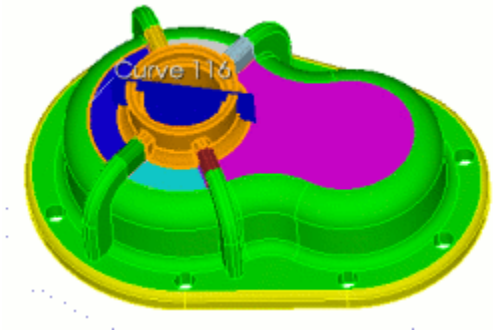
1. With the same settings on the Command Panel, enter **8** in the **Volume ID(s)** field
2. Enter **224** in the **With Surface ID** field.
3. Click **Preview** and then **Apply**.

Next

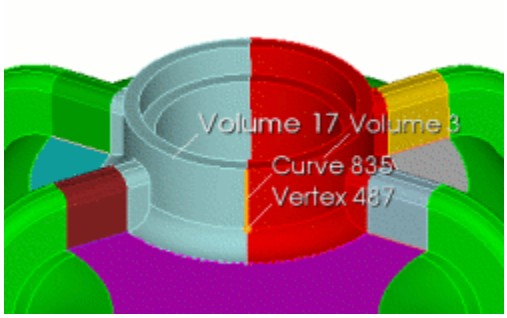


1. With **Sheet Extended From Surface** still selected from the drop-down menu, enter **11 10 12 9** in the **Volume ID(s)** field.
2. Enter **28** in the **Surface ID** field.
3. Click **Preview** and then **Apply**

Next

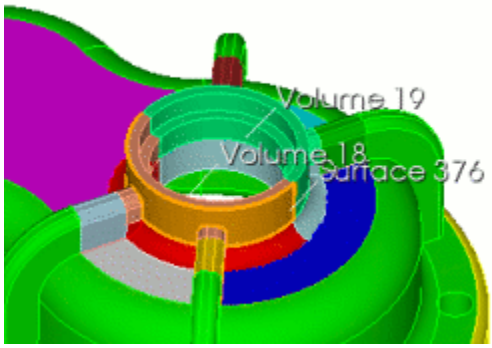


1. With the same settings on the Command Panel, select **Plane FromCurve (vertex)** from the drop-down menu.
2. Enter **3** in the **Volume ID(s)** field.
3. Enter **116** in the **Curve ID** field.
4. Click the **Fraction** radio button
5. Enter **0.5** in the **Value** field
6. Click **Preview** and then **Apply**.



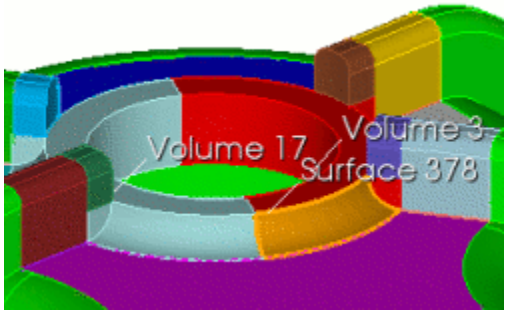
1. With **Plane From Curve** still selected from the drop-down menu enter **3 17** in the **Volume ID(s)** field.
2. Enter **819** in the **Curve ID** field.
3. Click the **Near Vertex** radio button and enter **476** in the **Vertex ID** field.
4. Click **Preview** and then **Apply**.

Next



1. With the same settings on the Command Panel, select **Sheet Extended From Surface** from the drop-down menu.
2. Enter **18 19** in the **Volume ID(s)** field.
3. Enter **376** in the **With Surface ID** field.
4. Click **Preview** and then **Apply**.

Next

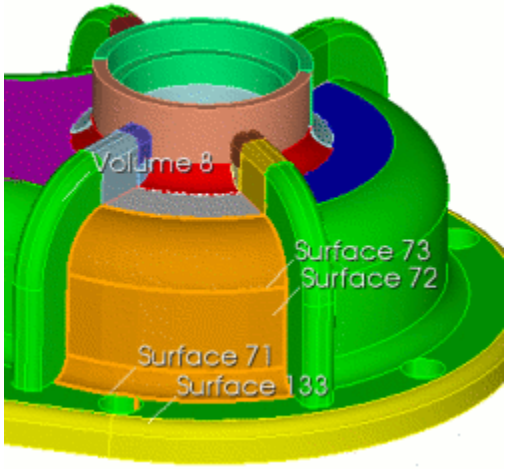


1. With **Sheet Extended From Surface** still selected from the drop-down menu, enter **3 17** in the **Volume ID(s)** field.
2. Enter **378** in the **With Surface ID** field.
3. Click **Preview** and then **Apply**.

Next

1. With the same settings on the Command Panel, enter **8** in the **Volume ID(s)** field and **73** in the **With Surface ID** field.
2. Click **Preview** and then **Apply**.

Next



1. With the same settings on the Command Panel, enter **8** in the **Volume ID(s)** field.
2. Enter **72** in the **With Surface ID** field.
3. Click **Preview** and then **Apply**.

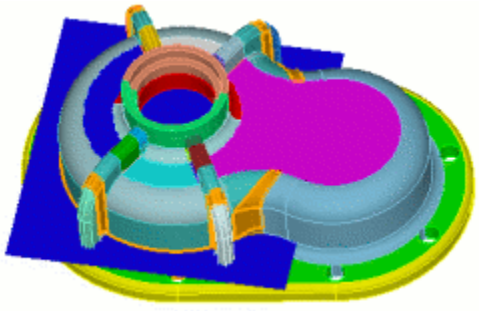
Next

1. With the same settings on the Command Panel, enter **8** in the **Volume ID(s)** field.
2. Enter **133** in the **With Surface ID** field.
3. Click **Preview** and then **Apply**.

Next

1. With the same settings on the Command Panel, enter **8** in the **Volume ID(s)** field.
2. Enter **71** in the **With Surface ID** field.
3. Click **Preview** and then **Apply**.

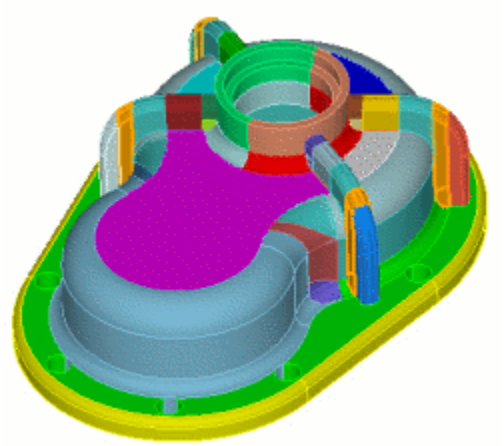
Next



1. With the same settings on the Command Panel, select **Plane From Vertex** from the drop-down menu.
2. Enter **8** in the **Volume ID(s)** field.
3. Enter **709**, **713**, and **702** in the **Vertex ID** fields.
4. Click **Preview** and then **Apply**.

Next

1. With the same settings on the Command Panellick the **Operation - Boolean Operations** button.
2. Select **Unite** from the drop-down menu.
3. Enter **36 45** in the **Volume ID(s)** field.
4. Click **Apply**.



Next

1. With **Unite** still selected from the drop-down menu, enter **37 43** in the **Volume ID(s)** field.
2. Click **Apply**.

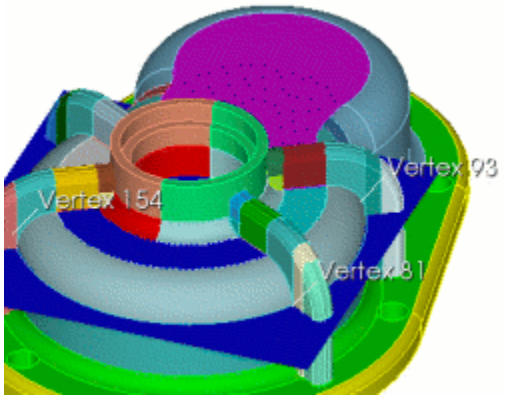
Next

1. With **Unite** still selected from the drop-down menu, enter **35 44** in the **Volume ID(s)** field.
2. Click **Apply**.

Next

1. With **Unite** still selected from the drop-down menu, enter **39 42** in the **Volume ID(s)** field.
2. Click **Apply**.

Next



1. Click the **Operation - Decompose Geometry** button and select **Plane From Vertex** from the drop-down menu.
2. Enter **29** in the **Volume ID(s)** field.
3. Enter **81**, **93**, and **154** in the **Vertex ID** fields.
4. Click **Preview** and then **Apply**.

Next

1.
2. Click the **Operation - Boolean Operations** button.
3. Select **Unite** from the drop-down menu.
4. Enter **33 36 50 11** in the **Volume ID(s)** field.
5. Click **Apply**.

Next

1. With **Unite** still selected from the drop-down menu, enter **10 49 37 31** in the **Volume ID(s)** field.
2. Click **Apply**.

Next

1. With **Unite** still selected from the drop-down menu, enter **12 52 35 34** in the **Volume ID(s)** field.
2. Click **Apply**.

Next

1. With **Unite** still selected from the drop-down menu, enter **9 51 39 32** in the **Volume ID(s)** field.
2. Click **Apply**.

Next

1. With **Unite** still selected from the drop-down menu, enter **9 22 27** in the **Volume ID(s)** field.
2. Click **Apply**.

Next

1. With **Unite** still selected from the drop-down menu, enter **12 23 26** in the **Volume ID(s)** field.
2. Click **Apply**.

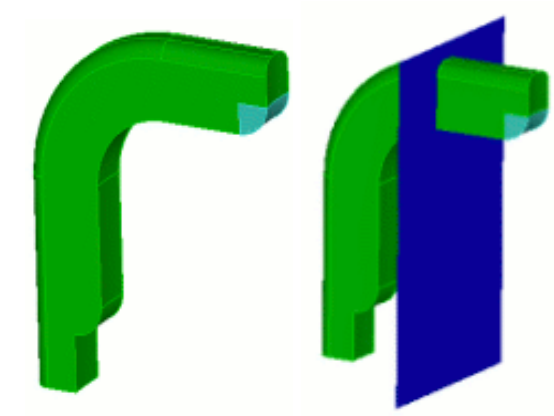
Next

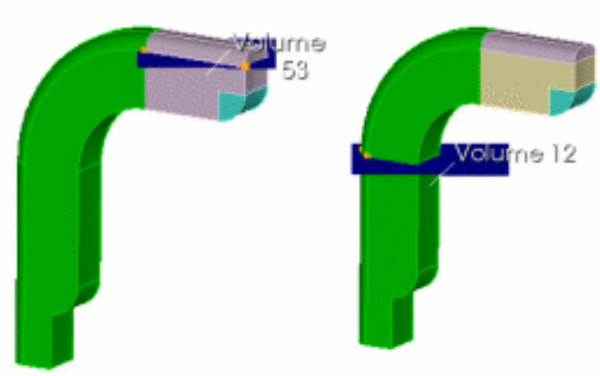
1. With **Unite** still selected from the drop-down menu, enter **20 33 25** in the **Volume ID(s)** field.
2. Click **Apply**.

Next

1. With **Unite** still selected from the drop-down menu, enter **21 10 24** in the **Volume ID(s)** field.
2. Click **Apply**.

Next, Webcut the four arms. Beginning with Arm 1





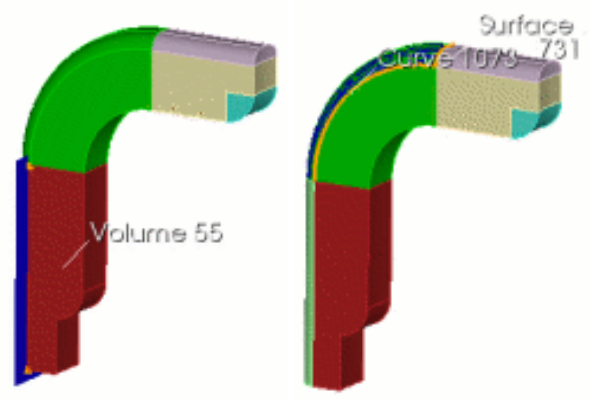
1.
2. Click the **Operation - Decompose Geometry**button.
3. Select **Plane From Vertex** from the drop-down menu.
4. Enter **12** in the **Volume ID(s)** field.
5. Enter **86**, **71**, and **76** in the **Vertex ID** fields.
6. Click **Preview** and then **Apply**.

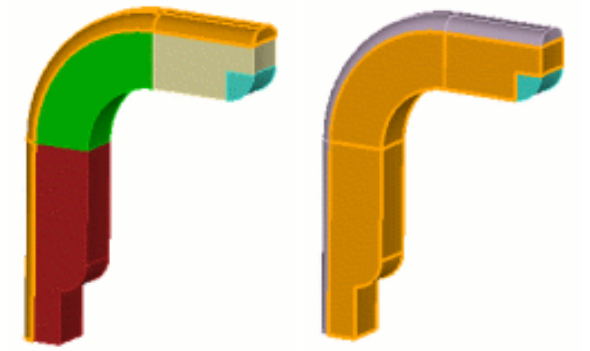
Next

1. With **Plane From Vertex** still selected from the drop-down menu, enter **53** in the **Volume ID(s)** field.
2. Enter **734**, **87**, and **737** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

Next

1. With **Plane From Vertex** still selected from the drop-down menu, enter **12** in the **Volume ID(s)** field.
2. Enter **72**, **85**, and **74** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.





1. With **Plane Vertex** still selected from the drop-down menu, enter **55** in the **Volume ID(s)** field.
2. Enter and **750**, **205**, and **208** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

Next

1. elect **Sweep Surface** from the drop-down menu.
2. Enter **12** in the **Volume ID(s)** field and **727** in the **Sweep Surface ID** field.
3. Click the **Along Curve** radio button and enter **1073** in the field.
4. Click **Preview** and then **Apply**.

Next

1. Click the **Operation - Boolean Operations** button and select **Unite** from the drop-down menu.
2. Enter **53 57 56** in the **Volume ID(s)** field.
3. Click **Apply**.

Next

1. With the same settings.
2. Enter **54 12 55** the **Volume ID(s)** field.
3. Click **Apply**.

Webcut Arm 2

1. Click the **Operation - Decompose Geometry**button and select **Plane From Vertex** from the drop-down menu.
2. Enter **9** in the **Volume ID(s)** field.
3. Enter **99**, **101**, and **103** in the **Vertex ID** fields.
4. Click **Preview** and then **Apply**.

1. With **Plane From Vertex** still selected from the drop-down menu, enter **58** in the **Volume ID(s)** field.
2. Enter **765**, **98**, and **768** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

Next

1. With **Plane From Vertex** still selected from the drop-down menu, enter **9** in the **Volume ID(s)** field.
2. Enter **106**, **104**, and **100** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

Next

1. With **Plane From Vertex** still selected from the drop-down menu enter **60** in the **Volume ID(s)** field.
2. Enter **777**, **201**, and **198** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

Next

1. With the **Operation - Decompose Geometry** button still selected, select **Sweep Surface** from the drop-down menu.
2. Enter **9** in the **Volume ID(s)** field and **760** in the **Sweep Surface ID** field.
3. Select the **Along Curve** radio button and enter **1078** in the field.
4. Click **Preview** and then **Apply**.

Next

1. Click the **Operation - Boolean Operations**button and select **Unite** from the drop-down menu.
2. Enter **58 62 60** in the **Volume ID(s)** field.
3. Click **Apply**.

Next

1. With the same settings.
2. Enter **59 9 61** in the **Volume ID(s)** field.

Click **Apply**.

Webcut Arm 3

1. Click the **Operation - Decompose Geometry**button and select **Plane From Vertex** from the drop-down menu.
2. Enter **20** in the **Volume ID(s)** field.
3. Enter **140**, **138**, and **135** in the **Vertex ID** fields.
4. Click **Preview** and then **Apply**.

Next

1. With **Plane From Vertex** still selected from the drop-down menu, enter **63** in the **Volume ID(s)** field.
2. Enter **139**, **137**, and **134** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

Next

1. With **Plane From Vertex** still selected from the drop-down menu, enter **20** in the **Volume ID(s)** field.
2. Enter **141**, **140**, and **136** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

Next

1. With **Plane From Vertex** still selected from the drop-down menu, enter **64** in the **Volume ID(s)** field.
2. Enter **799**, **220**, and **223** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

Next

1. With the **Operation - Decompose Geometry**still selected, selected **Sweep Surface** from the drop-down menu.
2. Enter **63** in the **Volume ID(s)** field.
3. Enter **799** in the **Sweep Surface ID** field.
4. Click the **Along Curve** radio button and enter **1239** in the field.
5. Click **Preview** and then **Apply**.

Next

1. Click on the **Operation - Boolean Operations** button and select **Unite** from the drop-down menu.
2. Enter **20 67 66** in the **Volume ID(s)** field.
3. Click **Apply**.

Next

1. With the same settings.
2. Enter **65 63 64** in the **Volume ID(s)** field.
3. Click **Apply**.

Webcut Arm 4

1. Click the **Operation - Decompose Geometry**button and select **Plane From Vertex** from the drop-down menu.
2. Enter **21** in the **Volume ID(s)** field.
3. Enter **165**, **163**, and **160** in the **Vertex ID** fields.
4. Click **Preview** and then **Apply**.

1. With **Plane From Vertex** still selected from the drop-down menu, enter **68** in the **Volume ID(s)** field.
2. Enter **164**, **162**, and **159** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

Next

1. With **Plane From Vertex** still selected from the drop-down menu, enter **21** in the **Volume ID(s)** field.
2. Enter **165**, **169**, and **161** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

Next

1. With **Plane From Vertex** still selected from the drop-down menu, enter **69** in the **Volume ID(s)** field.
2. Enter **828**, **826**, and **213** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

Next

1. With the **Operation - Decompose Geometry** button still selected, select **Sweep Surface** from the drop-down menu.
2. Enter **68** in the **Volume ID(s)** field and **834** in the **Sweep Surface ID** field.
3. Click the **Along Curve** radio button and enter **1129** in the field.
4. Click **Preview** and then **Apply**.

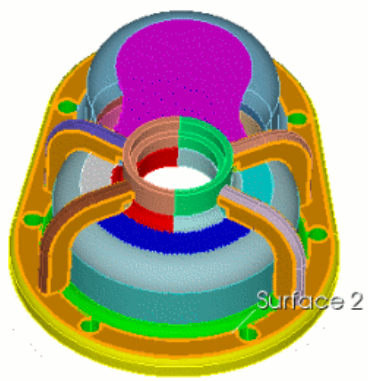
Next

1. Click the **Operation - Boolean Operations**button and select **Unite** from the drop-down menu.
2. Enter **70 72 69** in the **Volume ID(s)** field.
3. Click **Apply**.

Next

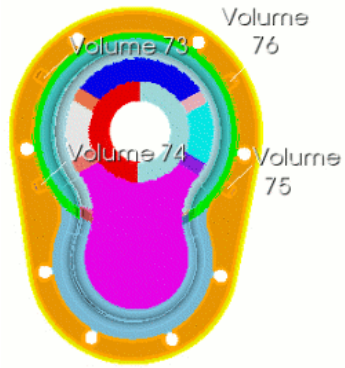
1. With the same settings

2. Enter **21 68 71** in the **Volume ID(s)** field.
3. Click **Apply**.



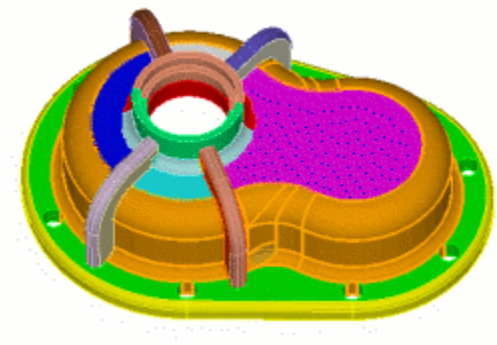
1. Click the **Operation - Decompose Geometry**button and select **Plane From Surface** from the drop-down menu.
2. Enter **21 65 59 54** in the **Volume ID(s)** field
3. Enter **2** in the **Surface ID** field.
4. Click **Preview** and then **Apply**.

Next

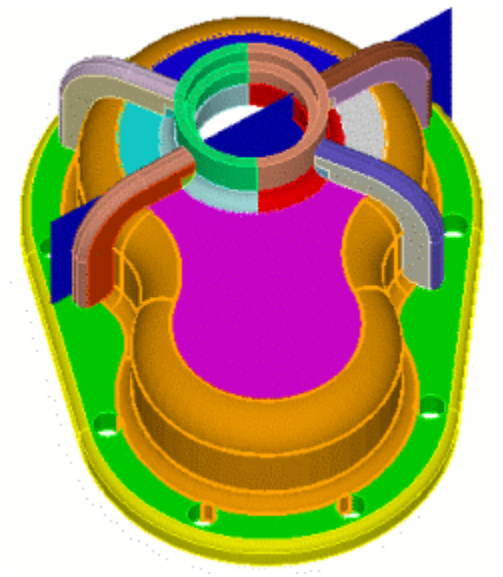


1. Click the **Operation - Boolean Operations**button and select **Unite** from the drop-down menu.
2. Enter **1 76 75 73 74** in the **Volume ID(s)** field.
3. Click **Apply**.

Next



1. With the same settings
2. Enter **28 47 46 41 48 38 8 30 29 40** in the **Volume ID(s)** field.
3. Click **Apply**.



1. Click the **Operation - Decompose Geometry**button and select **Plane From Surface** from the drop-down menu.
2. Enter **28** in the **Volume ID(s)** field.
3. Enter **866** in the **Surface ID** field.
4. Click **Preview** and then **Apply**.

Next

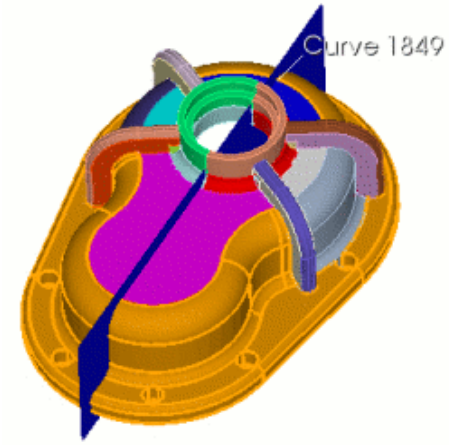
1. With **Plane From Surface** still selected from the drop-down menu, enter **28 77** in the **Volume ID(s)** field.
2. Enter **867** in the **Surface ID** field.
3. Click **Preview** and then **Apply**.

Next

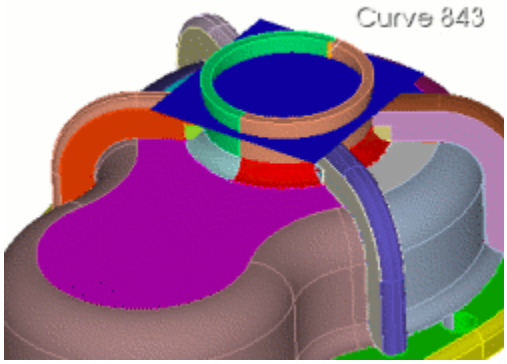
1. With **Plane From Surface** still selected from the drop-down menu, enter **28 77** in the **Volume ID(s)** field.
2. Enter **874** in the **Surface ID** field.
3. Click **Preview** and then **Apply**.

Next

1. With **Plane From Surface** still selected from the drop-down menu, enter **28 77** in the **Volume ID(s)** field.
2. Enter **875** in the **Surface ID** field.
3. Click **Preview** and then **Apply**.



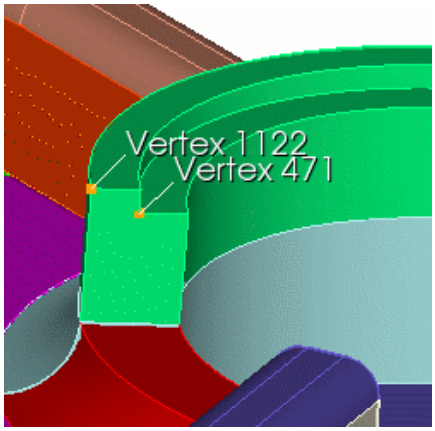
1. select **Plane From Curve**
2. Enter **1 81 2 82** in the **Volume ID(s)** field.
3. Enter **1839** in the **Curve ID** field.
4. Click the **Fraction** radio button and enter **0.5** in the **Value** field.
5. Click **Preview** and then **Apply**.



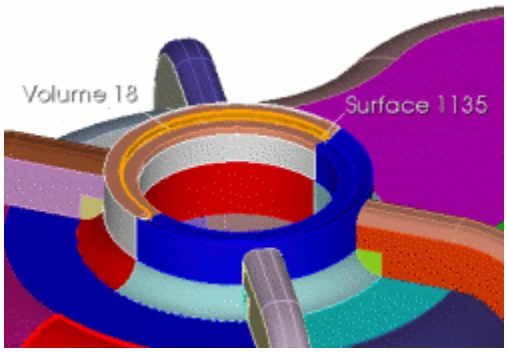
Next

1. In the same command panel, enter **19 18** in the **Volume ID(s)** field.
2. Enter **847** in the **Curve ID** field.
3. Enter **0.75** in the **Value** field.
4. Click **Preview** and then **Apply**.

Next



1. On the Command Panel, click **Geometry** and then **Operation - Create Geometry**.
2. Click the **Entity - Curve**button.
3. Select **Line** from the drop-down menu and click the **Vertex ID**s radio button.
4. Enter **1115 471** in the **Vertex IDs** field.
5. Click **Apply**.



1. On the Command Panel, click **Geometry** and then **Operation - Decompose Geometry**.
2. Click the **Entity - Volume**button.
3. Select **Sweep Curve** from the drop-down menu.
4. Enter **19** in the **Volume ID(s)** field.
5. Enter **2065** in the **Sweep Curve ID** field.
6. Click the **Along Curve** radio button and enter **858** in the field.
7. Click **Preview** and then **Apply**.

Next

1. With **Sweep Curve** still selected from the drop-down menu, enter **18** in the **Volume ID(s)** field.
2. Enter **2065** in the **Sweep Curve ID** field.
3. Enter **836** in the **Along Curve** field.
4. Click **Preview** and then **Apply**.

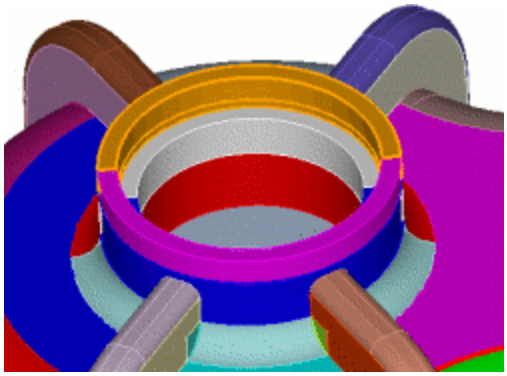
Next

1. On the Command Panel, click **Geometry** and then **Operation - Delete Geometry**.
2. Click the **Entity Curve**button.
3. Enter **2065** in the **Curve ID(s)** field.
4. Click **Apply**.

Next

1. Click **Operation - Boolean Operations**button and then the **Volume**button.
2. Select **Unite** from the drop-down menu.
3. Enter **91 89** in the **Volume ID(s)** field.
4. Click **Apply**.

1. With the same settings

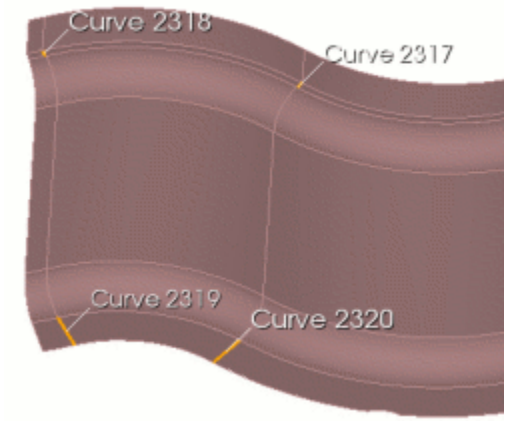


2. Enter **19 88**in the **Volume ID(s)** field.
3. Click **Apply**.

Next

1. Click the **Operation - Imprint and Merge** button and select **Imprint/Merge** from the drop-down menu.
2. Enter **all** in the **Volume ID(s)** field.
3. Click **Apply**

Next



1. Click **Geometry** and then **Operation - Modify Virtual Geometry**.
2. Click the **Entity** - **Surface** button.
3. Select **Partition** from the drop-down menu.
4. Select **Create With Vertices** in the second drop-down menu.
5. Enter **1073** in the **Surface ID(s) field**.
6.
7. Enter **311 175** in the **Vertex ID(s)** field.
8. Click **Apply**.

Keep the same settings on the Command Panel for the remaining Partitioning steps.

1. Enter **1073** in the **Surface ID(s)** field.
2. Enter **174 312** in the **Vertex ID(s)** field.
3. Click **Apply**

Next

1. Enter **1069** in the **Surface ID(s)** field.
2. Enter **123 294** in the **Vertex ID(s)** field.
3. Click **Apply**.

Next

1. Enter **1241** in the **Surface ID(s)** field.
2. Enter **170 226** in the **Vertex ID(s)** field.
3. Click **Apply**.

Next

1. Enter **1067** in the **Surface ID(s)** field.
2. Enter **195 115** in the **Vertex ID(s)** field.
3. Click **Apply**.

1. Enter **1067** in the **Surface ID(s)** field.
2. Enter **242 116** in the **Vertex ID(s)** field.
3. Click **Apply**.

Next

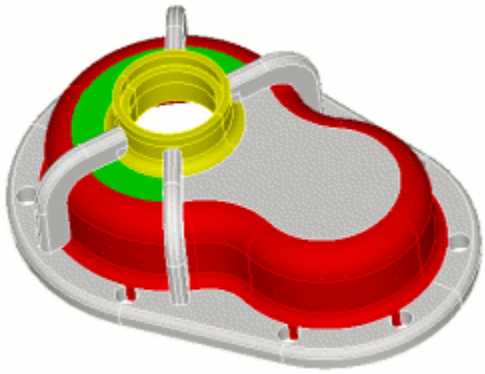
1. Enter **1063** in the **Surface ID(s)** field.
2. Enter **117 309** in the **Vertex ID(s)** field.
3. Click **Apply**.

Next

1. Enter **1245**in the **Surface ID(s)** field.
2. Enter **118 310** in the **Vertex ID(s)** field.
3. Click **Apply**.

Type into the command line: reset volume all

Next



1. Click **Mesh** and then **Volume**.
2. Click on the **Intervals** action button.
3. Select **Approximate Size** from the drop-down menu.
4. Enter **all** in the **Select Volumes** field.
5.
6. Enter **0.1** in the **Approximate Size** field.
7. Click **Apply**.

Next

1. Click the **Mesh** action button.
2. Select **Automatically Calculate** from the drop-down menu.
3. Enter **all** in the **Select Entities to Mesh** field.
4.
5. Click **Apply Scheme**.

Next

1. With the **Mesh** action button still selected, enter **85** in the **Select Entities to Mesh** field.
2. Select **Sweep** from the drop-down menu.
3. Enter **975** in the **Source Surface ID(s)** field and **1057** in the T**arget Surface ID**.
4. Click **Apply Scheme**.

Next

1. With **Sweep** still selected from the drop-down menu, enter **81** in the **Select Entities to Mesh** field.
2. Enter **1057** in the **Source Surface ID(s)** field.
3. Enter **885** in the **Target Surface ID** field.
4. Click **Apply Scheme**.

Finish by Meshing the Geometry

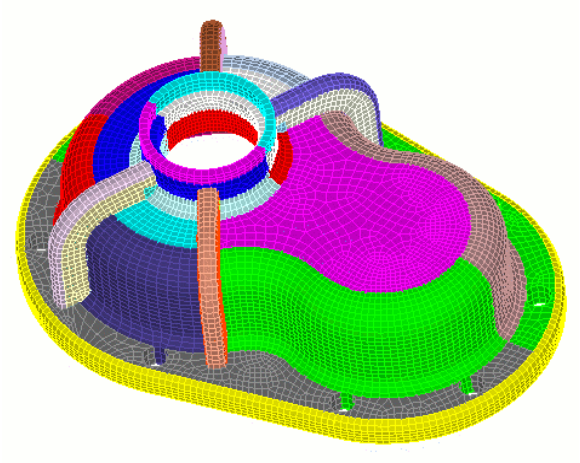
1. With the **Mesh** action button still selected, enter **5 6 7 13 14 15 16** in the Select Entities to Mesh field.
2. Click **Mesh**

Next

1. With the **Mesh** action button still selected, enter **85 81 77 83 78 82 87 28 80 79** in the Select Entities to Mesh field.
2. Click **Mesh**

Next

1. With the **Mesh** action button still selected, enter **18 19 91 90 17 3** in the Select Entities to Mesh field.
2. Click **Mesh**



Next

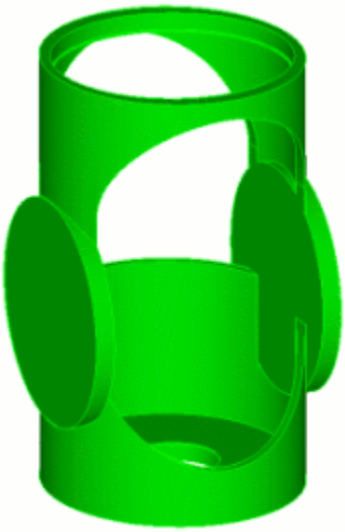
1. With the **Mesh** action button still selected, select **Sweep** from the drop-down menu.
2. Enter **4** in the **Select Entities to Mesh** field.
3. Enter **108** in the **Source Surface ID(s)** field and **207** in the **Target Surface ID** field.
4. Click **Apply Scheme**.

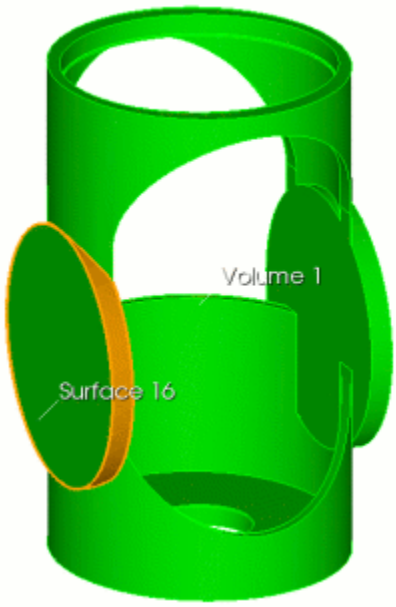
Next

1. With the **Mesh** action button still selected, enter **not is_meshed** in the **Select Entities to Mesh** field.
2. Click **Mesh**.

Example 8. Sweeping volumes with narrow angles and surfaces

Narrow angles are a challenge for sweeping algorithms. In the next example, a well-placed webcut shaves off the end of the small angle to create an additional surface for the sweeping algorithm.

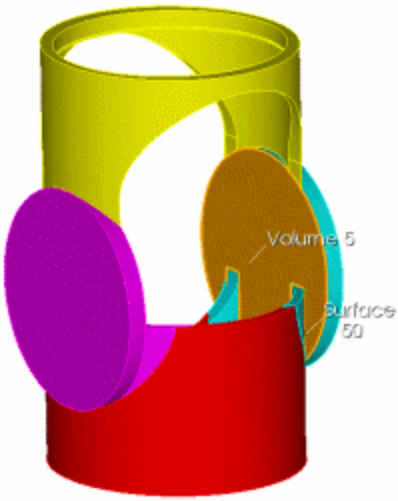




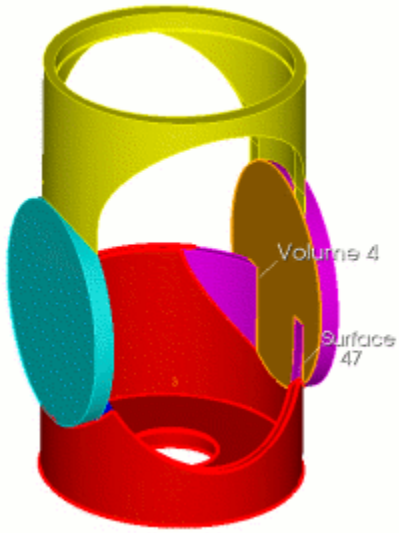
Suggested webcuts

Begin by performing a series of Webcuts

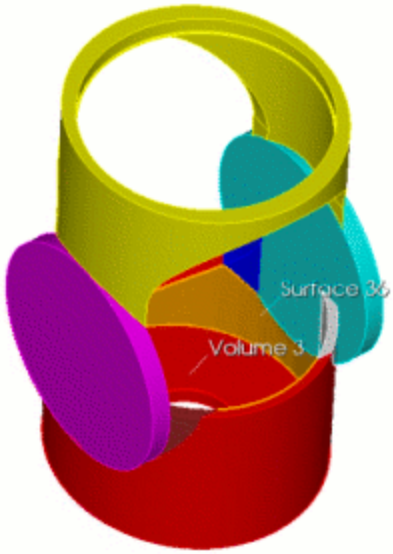
1. Click **Geometry** and then **Operation - Decompose Geometry**.
2. Click **Volume**and select **Sheet Extended From Surface** from the drop-down menu.
3. Enter **1** in the **Volume ID(s)** field.
4. Enter **16** in the **Surface ID(s)** field.
5. Click **Preview** and then **Apply**.



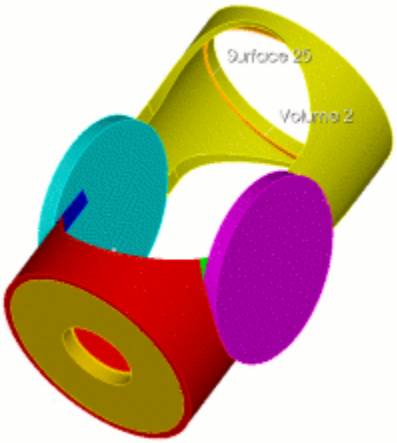
1. With **Sheet Extended From Surface** still selected from the drop-down menu, enter **5** in the **Volume ID(s)** field.
2. Enter **50** in the **Surface ID(s)** field.
3. Click **Preview** and then **Apply.**



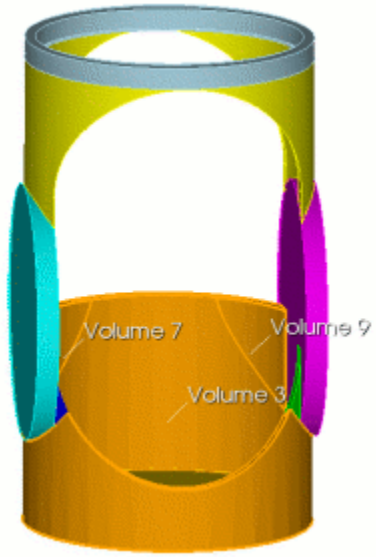
1. With **Sheet Extended From Surface** still selected from the drop-down menu, enter **4** in the **Volume ID(s)** field.
2. Enter **47** in the **Surface ID(s)** field.
3. Click **Preview** and then **Apply**.



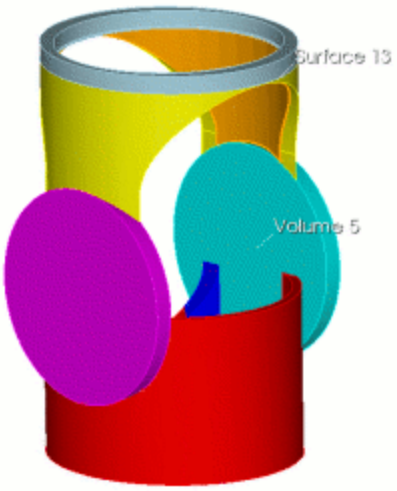
1. With **Sheet Extended From Surface** still selected from the drop-down menu, enter **3** in the **Volume ID(s)** field.
2. Enter **36** in the **Surface ID(s)** field.
3. Click **Preview** and then **Apply**.



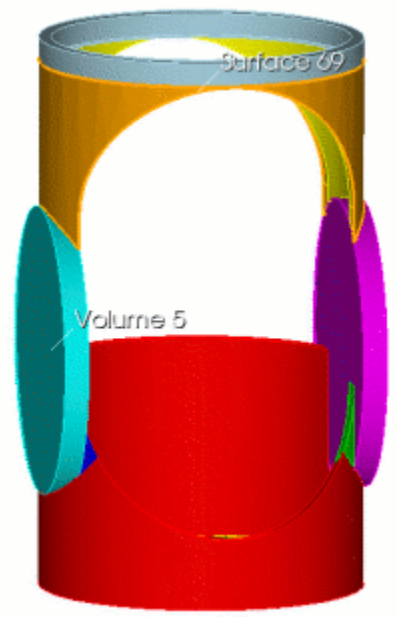
1. With **Sheet Extended From Surface** still selected from the drop-down menu, enter **2**in the **Volume ID(s)** field.
2. Enter **25** in the **Surface ID(s)** field.
3. Click **Preview** and then **Apply**.



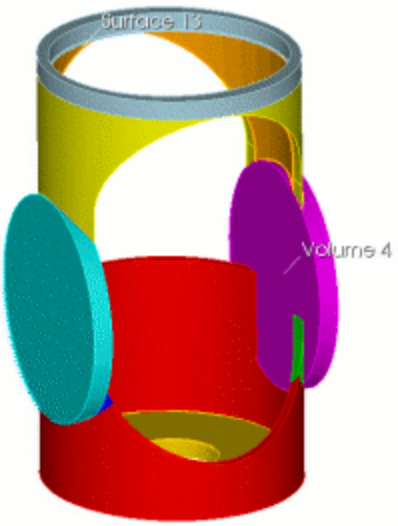
1. Click **Geometry** and then **Operation - Boolean Operations**.
2. Click **Volume**and select **Unite** from the drop-down menu.
3. Enter **3 7 9** in the **Volume ID(s)** field.
4. Click **Apply**.



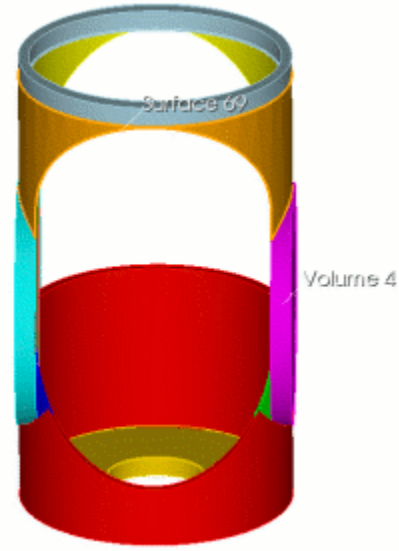
1. Click the **Operation - Decompose Geometry**button and select **Sheet Extended From Surface** from the drop-down menu.
2. Enter **5** in the **Volume ID(s)** field.
3. Enter **13** in the **Surface ID(s)** field.
4. Click **Preview** and then **Apply**.



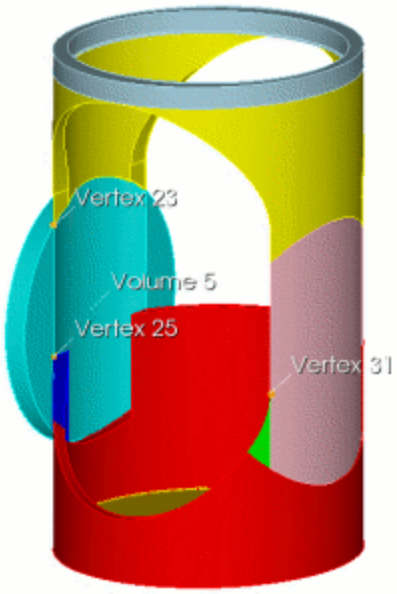
1. With **Sheet Extended From Surface** still selected from the drop-down menu, enter **5** in the **Volume ID(s)** field.
2. Enter **69** in the **Surface ID(s)** field.
3. Click **Preview** and then **Apply**.



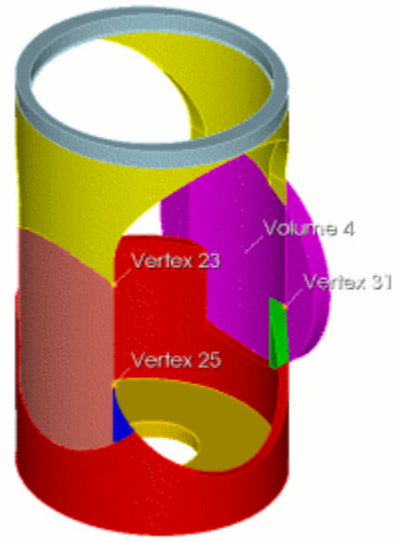
1. With **Sheet Extended From Surface** still selected from the drop-down menu, enter **4** in the **Volume ID(s)** field.
2. Enter **13** in the **Surface ID(s)** field.
3. Click **Preview** and then **Apply**.



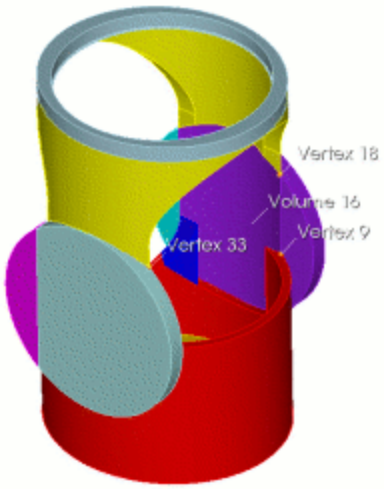
1. With **Sheet Extended From Surface** still selected from the drop-down menu, enter **4** in the **Volume ID(s)** field.
2. Enter **69** in the **Surface ID(s)** field.
3. Click **Preview** and then **Apply**.



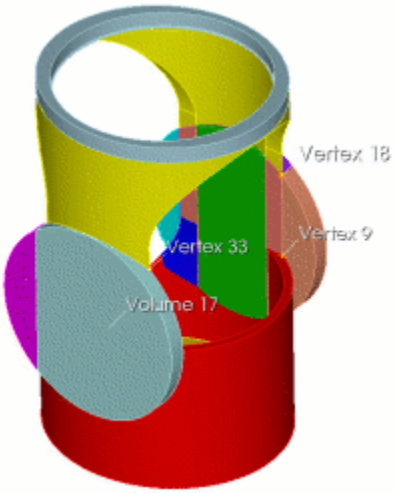
1. With the same settings still selected, selected **Plane From Vertex** from the drop-down menu
2. Enter **5** in the **Volume ID(s)** field.
3. Enter **23 25** and **31** in the **Vertex ID** fields.
4. Click **Preview** and then **Apply**.



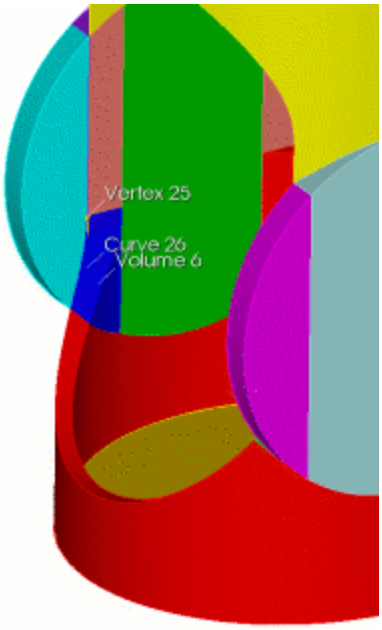
1. With **Plane From Vertex** still selected from the drop-down menu, enter **4** in the **Volume ID(s)** field.
2. Enter **23 25 31** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.



1. With **Plane From Vertex** still selected from the drop-down menu, enter **16** in the **Volume ID(s)** field.
2. Enter **18 9 33** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

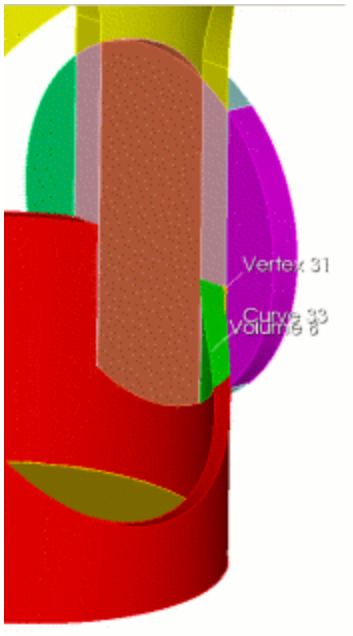


1. With **Plane From Vertex** still selected from the drop-down menu, enter **17** in the **Volume ID(s)** field.
2. Enter **18 9 33** in the **Vertex ID** fields.
3. Click **Preview** and then **Apply**.

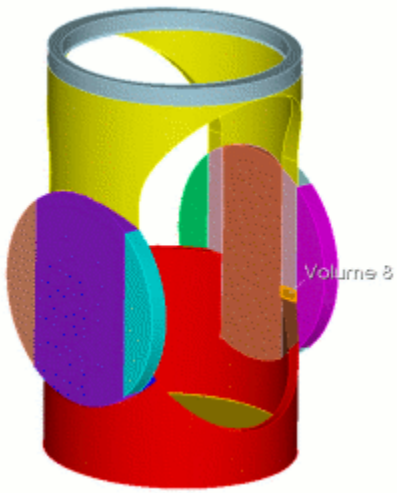


1. With the same settings still selected, select **General Plane** from the drop-down menu.
2. Enter **6** in the **Volume ID(s)** field.
3. Click **…** next to the **Plane** field.
4. Select **Normal to Curve** in the drop-down menu and enter **26** in the **Curve ID** field.
5. Select **Distance Along Curve** in the second drop-down menu and enter **0.6** in the **Distance** field.
6. Click the **Vertex 25** radio button.
7. Click **Apply** to close the menu.
8. Click **Preview** and then **Apply** on the command panel.

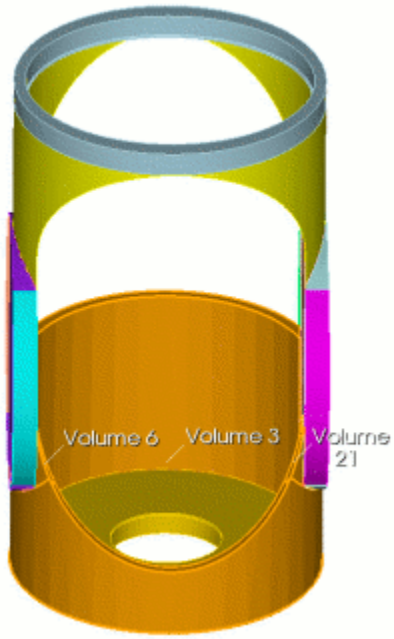
1. Click **Geometry** and then **Operation - Delete Geometry**.
2. Click the **Entity - Volume**button.
3. Enter **20** in the **Volume ID(s)** field.
4. Click **Apply**.



1. Click **Geometry** and then **Operation - Decompose Geometry**.
2. Click **Volume**and select **General Plane** from the drop-down menu.
3. Enter **8** in the **Volume ID(s)** field.
4. Click **...** next to the **Plane** field.
5. Select **Normal to Curve** in the drop-down menu and enter **33** in the **Curve ID** field.
6. Select **Distance Along Curve** in the second drop-down menu and enter **0.6** in the **Distance** field.
7. Click the **Vertex 31** radio button.
8. Click **Apply** to close the menu.
9. Click **Preview** and then **Apply** on the command panel.



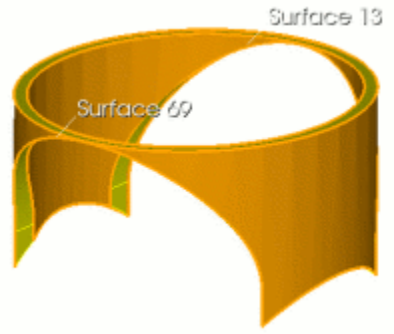
1. Click **Geometry** and then **Operation - Delete Geometry**.
2. Click the **Entity** - **Volume** button and enter **8** in the **Volume ID(s)** field.
3. Click **Apply**.



1. Click the **Operation - Boolean Operations**button and select **Unite** from the drop-down menu.
2. Enter **3 21 6** in the **Volume ID(s)** field.
3. Click **Apply.**
4. Click the **Operation - Imprint and Merge** button and select **Imprint /Merge** from the drop-down menu.
5. Enter **all** into the **Volume ID(s)** field.
6. Click **Apply.**

Then begin to apply meshing schemes:

1. Click **Mesh** and then **Volume.**
2. Click the **Intervals** action button.
3. Select **Approximate Size** in the drop-down menu and enter **0.3** in the **Approximate Size** field.
4. Enter **all** in the **Select Volumes** field.
5.
6. Click **Apply Size.**
7. Select the **Mesh** Action button above and Select **Automatically Calculate** in the drop-down menu
8. Enter **all** in the **Select Entities to Mesh** field. andclick **Apply Scheme.**

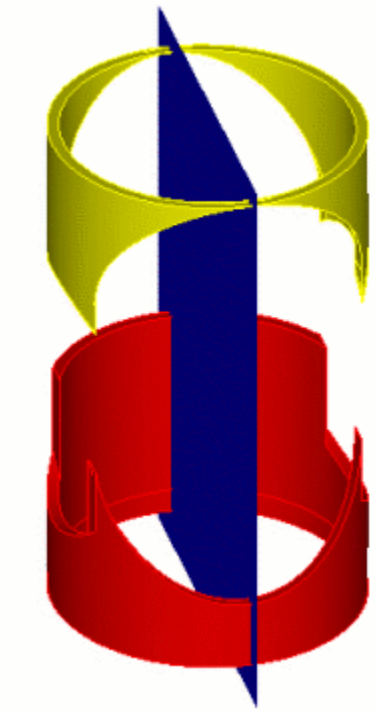


1. With the **Mesh** action button still selected, Select **Sweep** from the drop-down menu and click the **Specify Source and Target** button.
2. enter **2** in the **Select Entities to Mesh** field.
3.
4. Enter **13** in the **Source Surface ID(s**).
5. Enter **69** in the **Target Surface ID** field.
6. Click the **Advanced** button and select **Translate**from the **TransformMethod** drop-down menu.
7. Check the **Automatically Smooth the Target Surface** box .
8. Click **Apply Scheme.**

1. NextClick **Geometry** and then **Operation - Imprint and Merge.**
2. Click the **Entity - Volume**button.
3. Select **Unmerge** from the drop-down menu.
4. Enter **all** in the **Volume ID(s)** field.

5. Click **Apply.**

Next



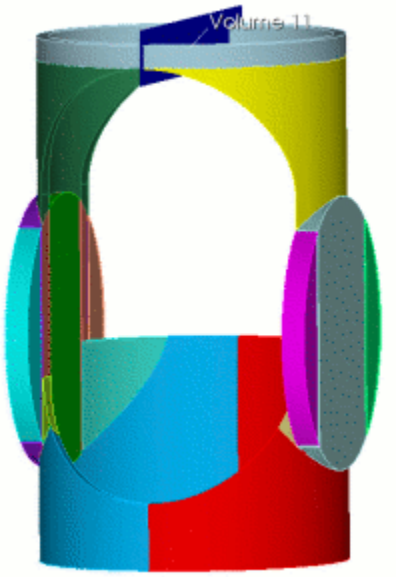
1. Click the **Operation - Decompose Geometry**button and select **General Plane** from the drop-down menu.
2. Enter **2 3** in the **Volume ID(s)** field.
3. Click **...** next to the **Plane** field and select **Coordinate Plane** from the drop-down menu.
4. Click the **XY** button and click **Apply.**
5. Click **Preview** and then **Apply** on the Command Panel**.**

Next

1. With the same settingsstill selected, select **Sheet Extended From Surface** from the drop-down menu.
2. Enter **3** in the **Volume ID(s)** field.
3. Enter **154** in the **Surface ID** field.
4. Click **Preview** and then **Apply.**

Next

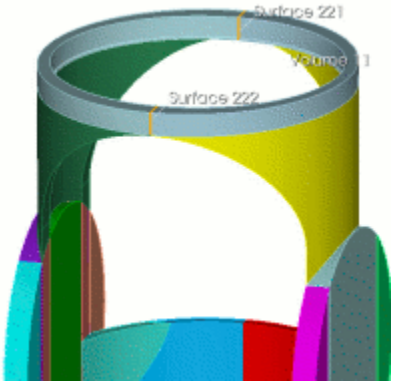
1. With **Sheet Extended From Surface** still selected from the drop-down menu, enter **23** in the **Volume ID(s)** field.
2. Enter **153** in the **Surface ID(s)** field.
3. Click **Preview** and then **Apply.**



1. With the same settingsstill selected, select
2. **General Plane** from the drop-down menu.
3. Enter **11** in the **Volume ID(s)** field.
4. Click **...** next to the **Plane** field and select **Coordinate Plane** from the drop-down menu.
5. Click the **XY** button and click **Apply**.
6. Click **Preview** and then **Apply** on the Command Panel.

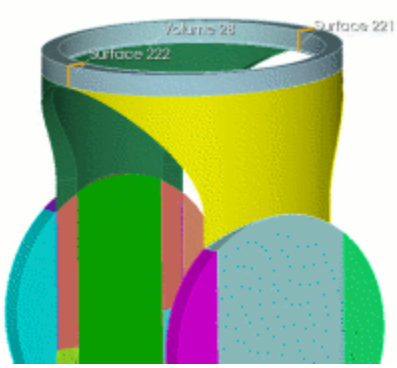
1. NextClick the **Operation - Imprint and Merge** button and select **Imprint/Merge** from the drop-down menu.
2. Enter **all** in the **Volume ID(s)** field.
3. Click **Apply**.

Apply the meshing schemes:



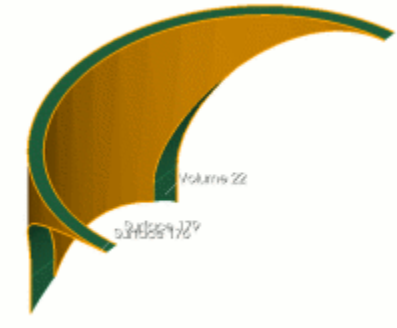
1. Click **Mesh** and then **Volume**.
2. Click the **Mesh** action button.
3. Select **Sweep** from the drop-down menu.
4. Enter **11** in the **Select Volumes** field.
5. Enter **221** in the **Source Surface ID(s)** field.
6. Enter **222** in the **Target Surface ID** field.
7. Click the **Advanced** button and select **Translate**from **TransformMethod** drop-down menu.
8. Check the **Automatically Smooth the Target Surface** box and
9. Click **Apply Scheme**.

Next



1. With **Sweep** still selected from the drop-down menu, enter **28** in the **Select Volumes** field.
2. Enter **222** in the **Source Surface ID(s)** field.
3. Enter **221** in the **Target Surface ID** field.
4. Click the **Advanced** button and select **Translate**from **TransformMethod** drop-down menu.
5. Check the **Automatically Smooth the Target Surface** box.
6. Click **Apply Scheme.**

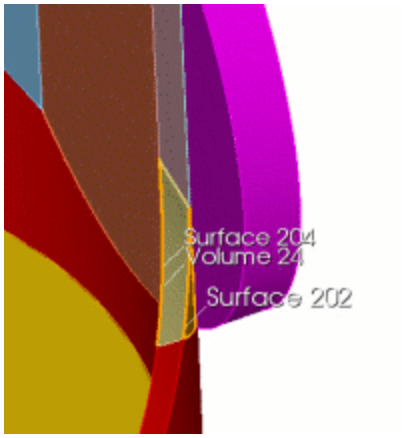
Next



1. With **Sweep** still selected from the drop-down menu, enter **22** in the **Select Volumes**field.
2. Enter **176** in the **Source Surface ID(s)** field.
3. Enter **179** in the **Target Surface ID** field.
4. Click the **Advanced** button and select **Translate**from **TransformMethod** drop-down menu.
5. Check the **Automatically Smooth the Target Surface** box.
6. Click **Apply Scheme.**

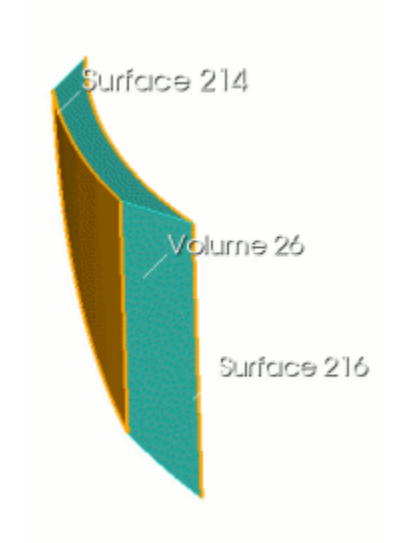
Next

1. With **Sweep** still selected from the drop-down menu, enter **2** in the **Select Volumes** field.
2. Enter **173** in the **Source Surface ID(s)** field.
3. Enter **170** in the **Target Surface ID** field.
4. Click the **Advanced** button and select **Translate**from **TransformMethod** drop-down menu.
5. Check the **Automatically Smooth the Target Surface** box.
6. Click **Apply Scheme.**

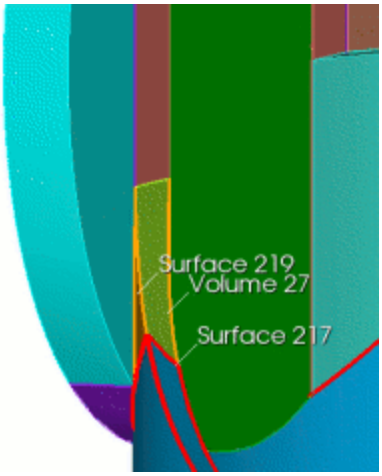


1. With **Sweep** still selected from the drop-down menu, enter **24** in the **Select Volumes** field.
2. Enter **204** in the **Source Surface ID(s)** field.
3. Enter **202** in the **Target Surface ID** field.
4. Click the **Advanced** button and select **Translate**from **TransformMethod** drop-down menu.
5. Check the **Automatically Smooth the Target Surface** box.
6. Click **Apply Scheme.**

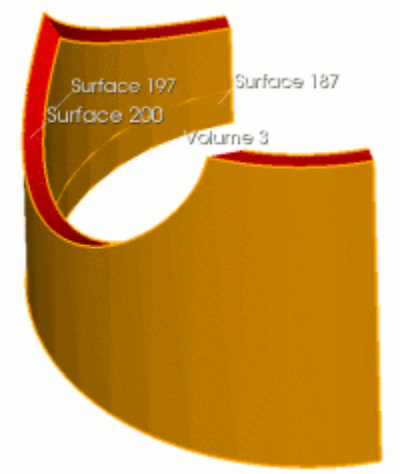
1. With **Sweep** still selected from the drop-down menu, enter **25** in the **Select Volumes** field.
2. Enter **205** in the **Source Surface ID(s)** field.
3. Enter **207** in the **Target Surface ID** field.
4. Click the **Advanced** button and select **Translate**from **TransformMethod** drop-down menu.
5. Check the **Automatically Smooth the Target Surface** box.
6. Click **Apply Scheme.**



1. With **Sweep** still selected from the drop-down menu, enter **26** in the **Select Volumes** field.
2. Enter **214** in the **Source Surface ID(s)** field.
3. Enter **216** in the **Target Surface ID** field.
4. Click the **Advanced** button and select **Translate**from **TransformMethod** drop-down menu.
5. Check the **Automatically Smooth the Target Surface** box.
6. Click **Apply Scheme**.



1. With **Sweep** still selected from the drop-down menu, enter **27** in the **Select Volumes** field.
2. Enter **217** in the **Source Surface ID(s)** field.
3. Enter **219** in the **Target Surface ID** field.
4. Click the **Advanced** button and select **Translate**from **TransformMethod** drop-down menu.
5. Check the **Automatically Smooth the Target Surface** box.
6. Click **Apply Scheme.**



1. With **Sweep** still selected from the drop-down menu, enter **3** in the **Select Volumes** field.
2. Enter **197 187** in the **Source Surface ID(s)** field.
3. Enter **200** in the **Target Surface ID f**ield.
4. Click the **Advanced** button and select **Translate**from **TransformMethod** drop-down menu.
5. Check the **Automatically Smooth the Target Surface** box.
6. Click **Apply Scheme**.

1. With **Sweep** still selected from the drop-down menu, enter **23** in the **Select Volumes** field.
2. Enter **212 193** in the **Source Surface ID(s)** field.
3. Enter **210** in the **Target Surface ID** field.
4. Click the **Advanced** button and select **Translate**from **TransformMethod** drop-down menu.
5. Check the **Automatically Smooth the Target Surface** box.
6. Click **Apply Scheme.**

Meshing:

1. Click the **Intervals** action button and Select **Approximate Size** from the drop-down menu and enter **0.2** in the **Approximate Size** field.
2. enter **all** in the **Select Volumes** field.
3.

4. Click **Apply Size** and then **Mesh.**