Exercise: Creating and editing solid geometry

In this exercise, you will learn:

- What solid geometry is

- What topology is

- What 3-D topology looks like

Solids are geometric entities that define a three-dimensional volume. Geometric entities are defined as follows:

- Point: 0 dimensional; has only x, y, and z coordinates

- Line: one-dimensional; has length, can be curved through three-dimensional space

- Surface: two-dimensional; has an area

- Solid: three-dimensional; has a volume

The use of solid geometry is helpful when dividing a part into multiple volumes--for example, to divide a part into simple, mappable regions for hex meshing.

This exercise uses the model file, `solid_geom.hm`.
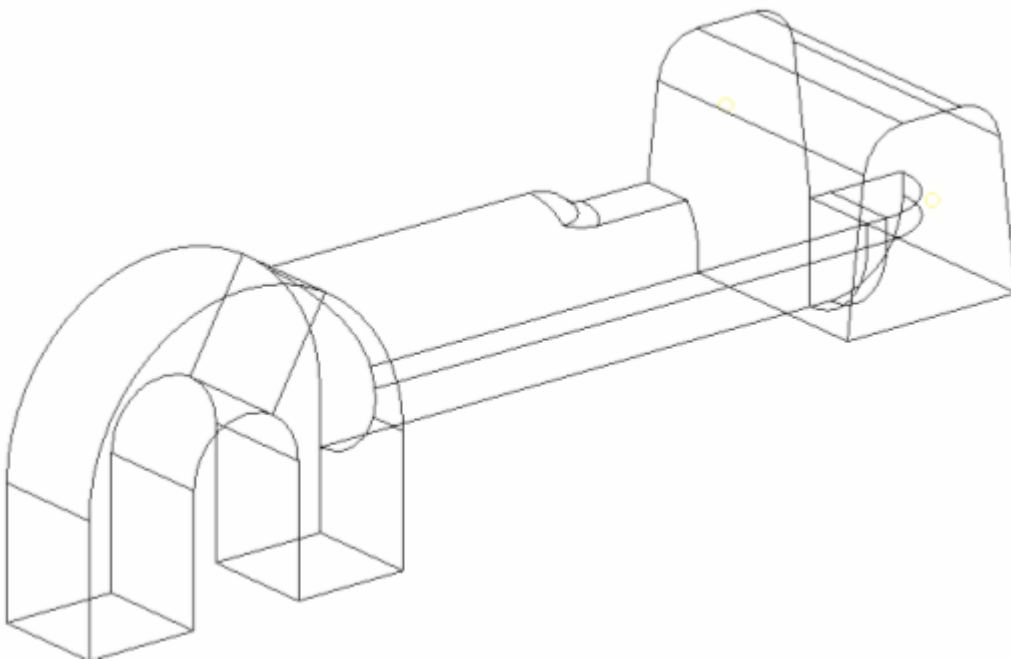
Step 1: Retrieve model file, `solid_geom.hm.`

1. From the menu bar click *File > Open > Model*.

2. Select `solid_geom.hm` and click *Open*.

Step 2: Create solid geometry from the bounding surfaces.

1. From the menu bar click *Geometry > Create > Solids > Bounding Surfaces*.

2. Verify that the *Auto select solid surfaces* option is checked.

3. Select one surface on the part.

   All of the surfaces should automatically be selected.

4. Click *create* to create the solid.

    The **status** bar indicates that a solid has been created. The solids are identified by thicker lines than surfaces.

5. Click *return* to exit the panel.

Step 3: Create a solid geometry cylinder using primitives.

1. From the menu bar click *Geometry > Create > Solids > Cylinder Full*.

2. Click *bottom center* and select one of the temporary nodes (see following image).

   The cursor automatically advances to the *normal vector* button.

Select one of
these nodes
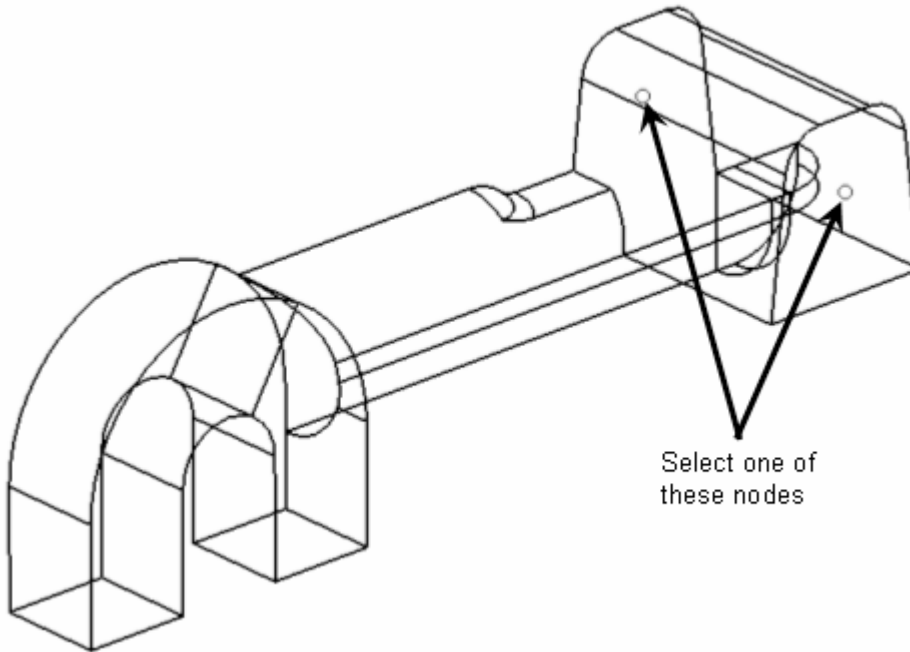
3. Select the remaining temporary node shown in the image.

4. For *Base radius=* enter 1.5.

5. For *Height=* enter 25.

6. Click *create*.

    A solid cylinder is created in the middle of the first solid that was created.

7. Click *return* to exit the panel.

## Step 4: Subtract the cylinder's volume from the rest of the part.

1. From the menu bar click *Geometry > Edit > Solids > Boolean* to open the **Edit Solids** panel.

2. Verify that **operation type:** is set to *simple (combine all)*.

3. Set **operation:** to *A-B (remove B from A)*.

4. With the **solids** entity selector for **A:** active, select the original solid.

    Verify that the cursor advances to **solids** next to **B:**.

5. Select the solid cylinder created in step 3.

6. Click *calculate*.

7. To confirm the material has been removed, click *shaded geometry with edges*, ↖, and rotate the model to inspect the part.
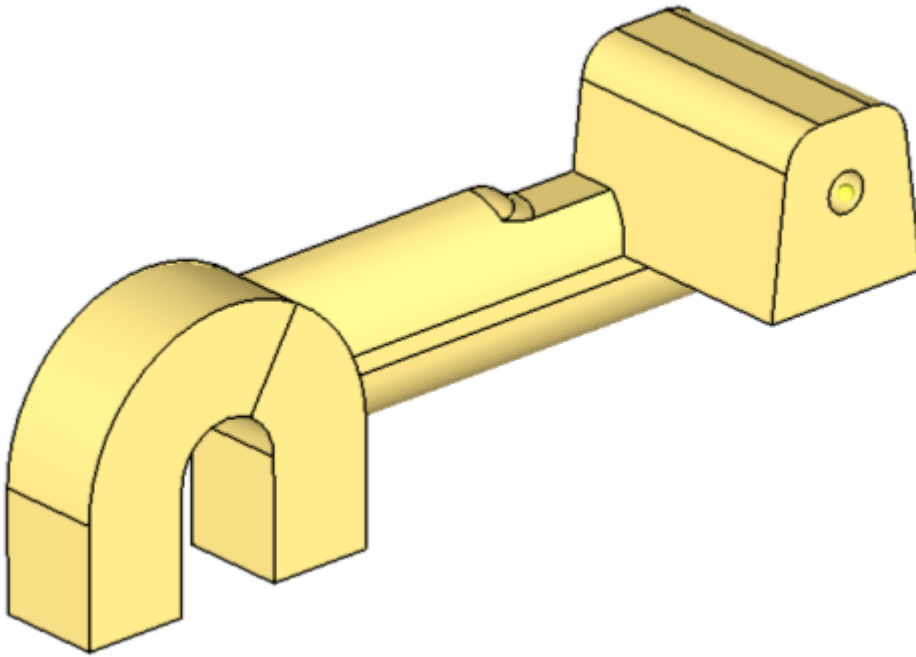
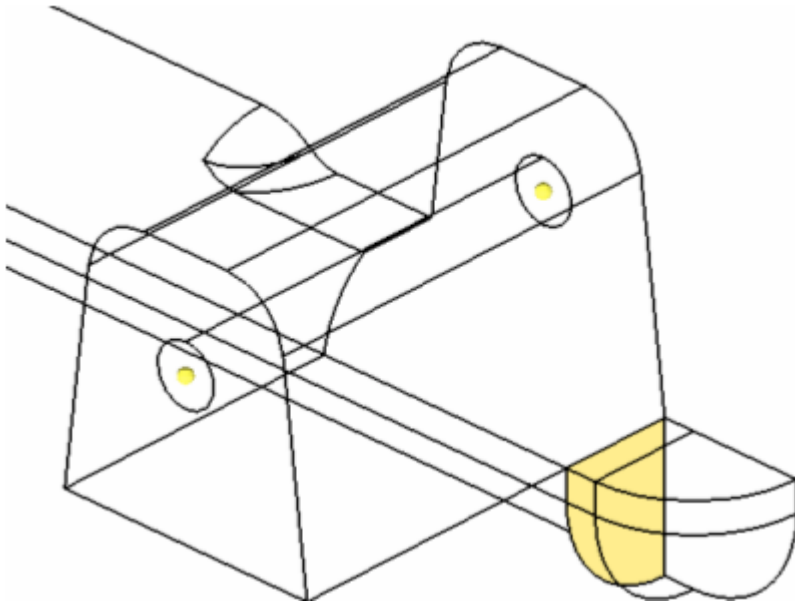## Step 5: Split the solid geometry using bounding lines.

You should still be in the **Solid Edit** panel.

1. Go to the **trim with lines** subpanel.

2. Under **with bounding lines:**, activate the *solids* entity selector, and click anywhere on the model to select it.

3. Activate the *lines* entity selector and, in the graphics area, select the lines shown in the following image.
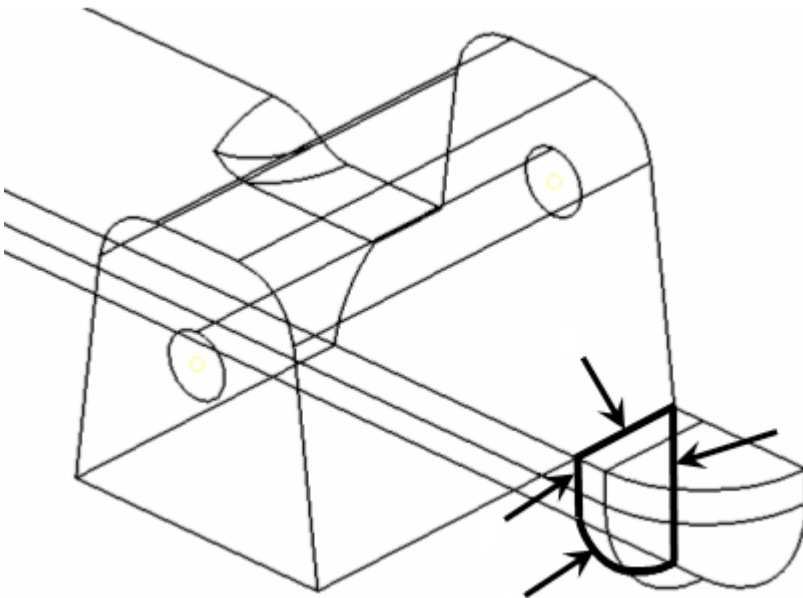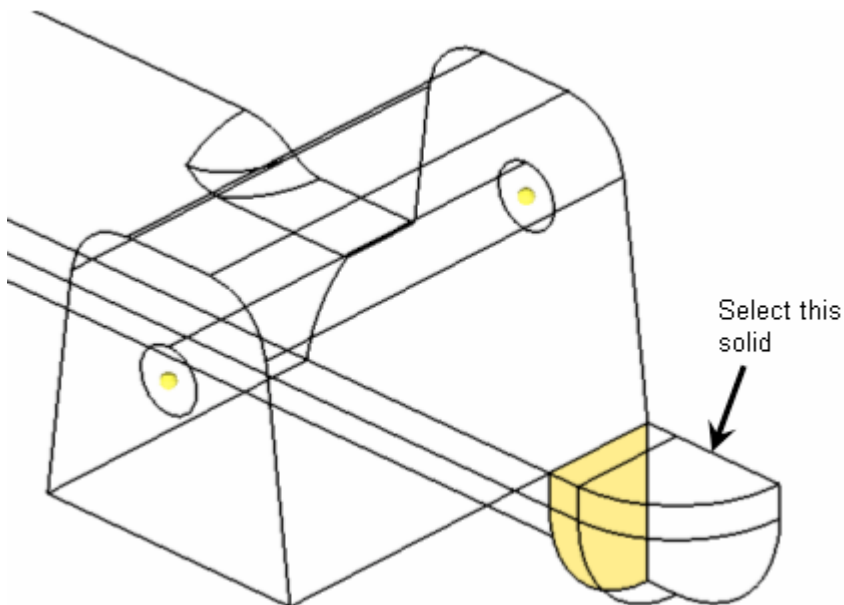

4. Click *trim* to trim the model.

   A plane was trimmed. Note that two solids now intersect.

Step 6: Split the solid geometry using a cut line.

You should still be in the **Solid Edit** panel, **trim with lines** subpanel.

1. Under **with cut line:**, activate the **solids** entity selector, and select the small, tetrahedral shaped solid created in step 5.


Select this solid

2. In the **Model Browser** click the ⊞ next to the **View1** view in the **Views** folder.

3. Click **drag a cut line**.

4. Pick two locations on screen such that they define the end points of a line that roughly divides the tetrahedral solid in half, as shown, following.

Select these screen
points to draw cut line
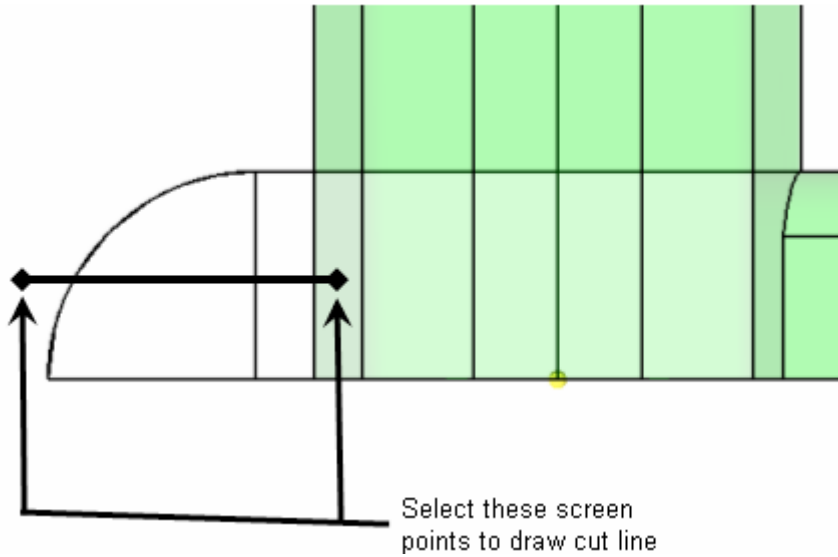
5. Click the middle-mouse button to split the solid.

6. Select the half of the original tetrahedral solid as shown in the following image.

Select this solid

7. Use **with cut line:** to split the solid as shown in the following image.
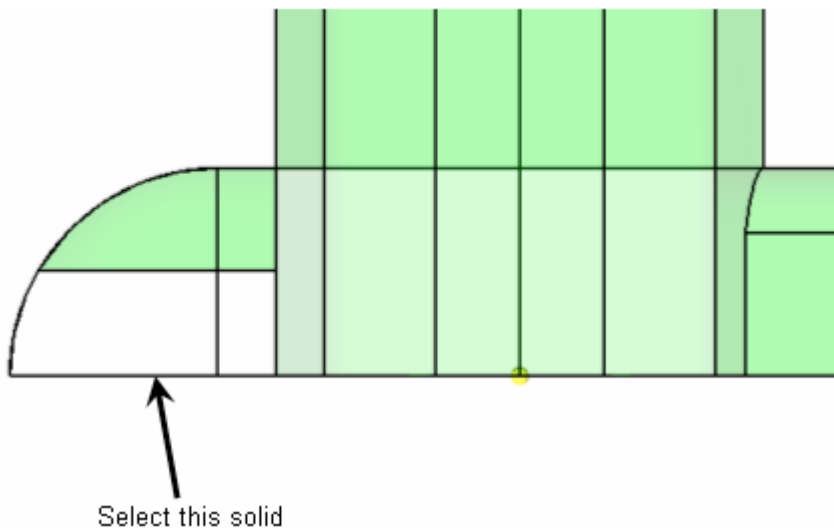
Select these screen
points to draw cut line
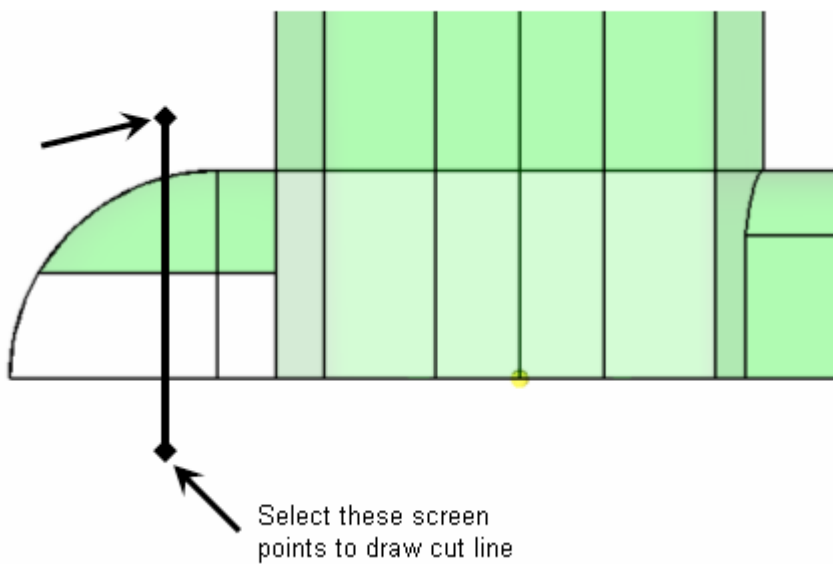
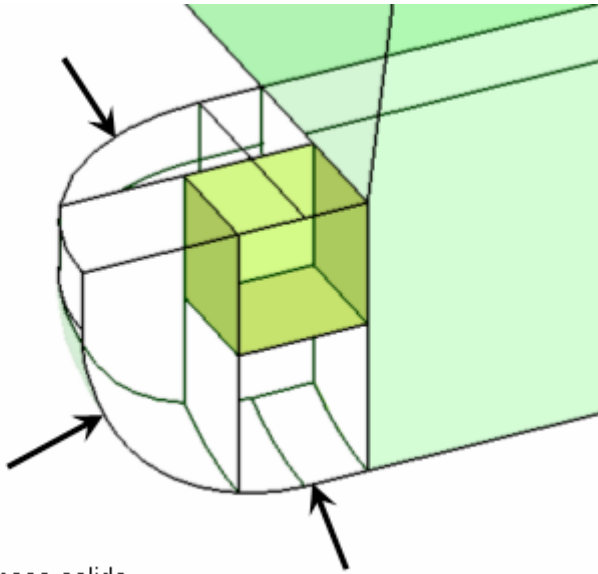8. Select the solid shown in the following image.

Select this solid
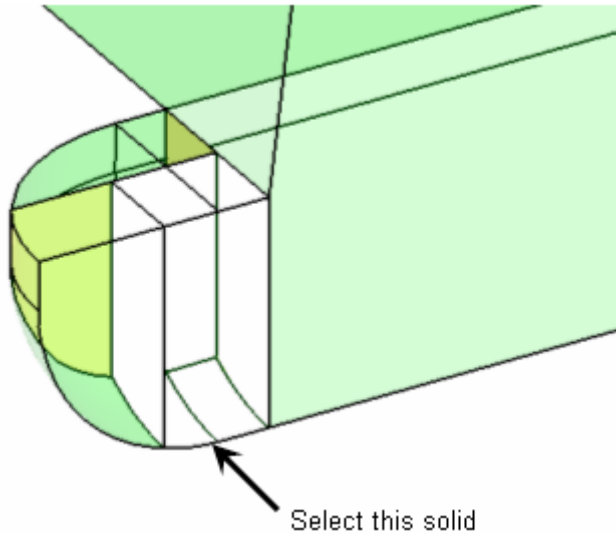
9. In the **Model Browser** click the ⊞ next to *View2* to set the view.
10. Use **with cut line:** to split the solid as shown in the following image.

Select these screen
points to draw cut line
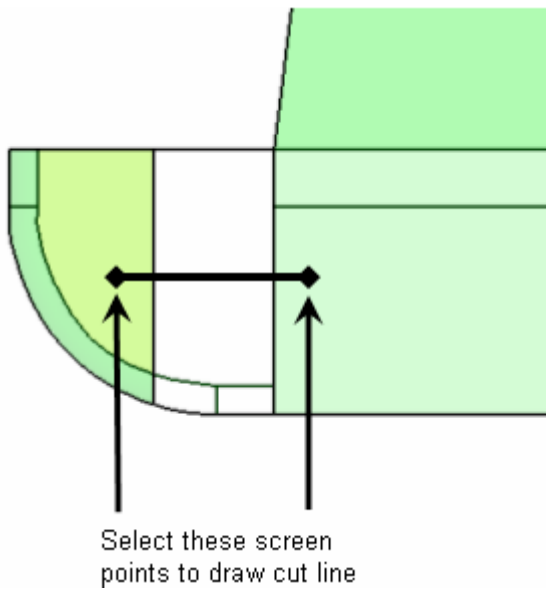
Step 7: Merge solids together.

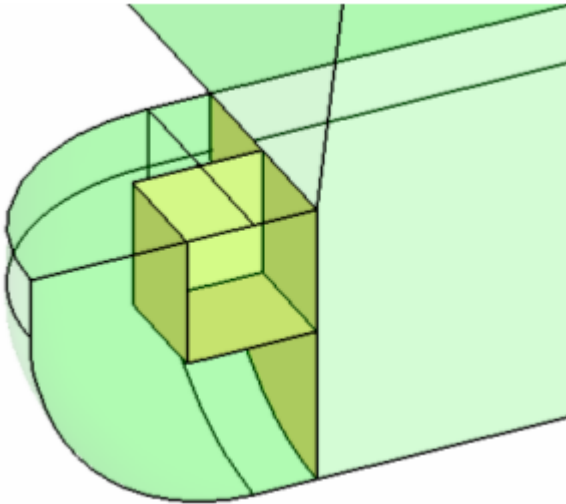You should still be in the **Solid Edit** panel.

1. Go to the **merge** subpanel.
2. With the **solids** entity selector under **to be merged:** active, select the three solids shown in the following image.

Select these solids

3. Click *merge* to merge the solids.

   The resulting solids in the tetrahedral area should look like the following image. There should be two solid entities, with one of them being hexahedral in shape in the corner.

Step 8: Split the solid geometry with a user-defined plane.

You should still be in the **Solid Edit** panel.

1. Go to the **trim with plane/surf** subpanel.

2. In the **Model Browser** click the 🔲 next to the *View3* to restore the view.

3. With the **solids** entity selector under **with plane:** active, select the large solid representing the majority of the part.

Select this solid
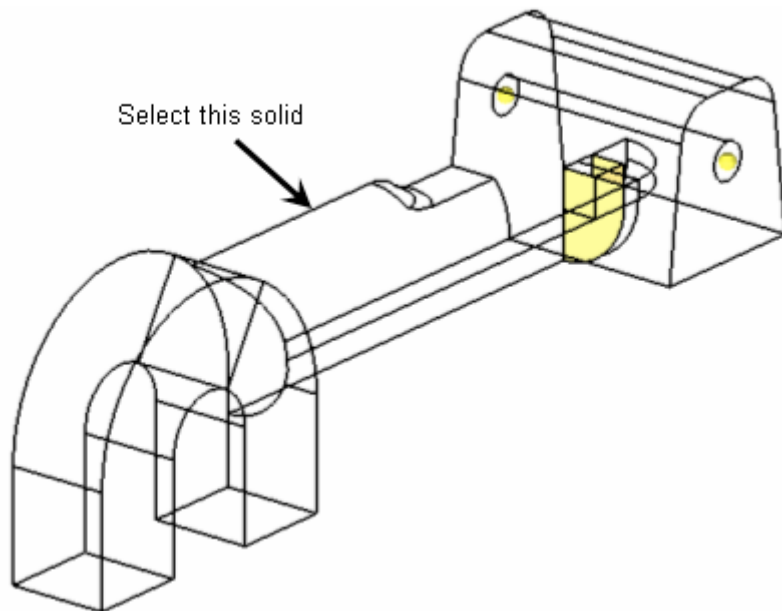
4. Set the **plane** selector to *N1, N2, N3*.

5. With *N1* active, press and hold the left mouse button, and move the mouse cursor over one of the two edges shown in the following image.

   The edge should highlight.
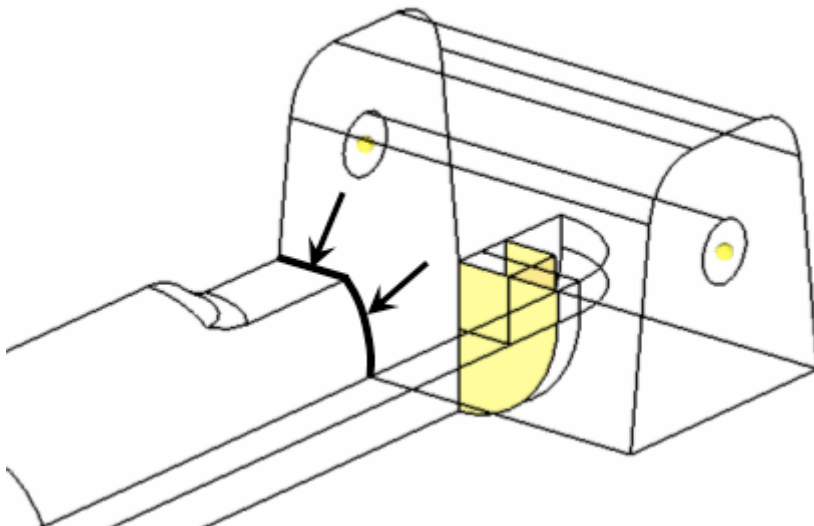
6. Release the mouse button, and left-click in the middle of the edge.

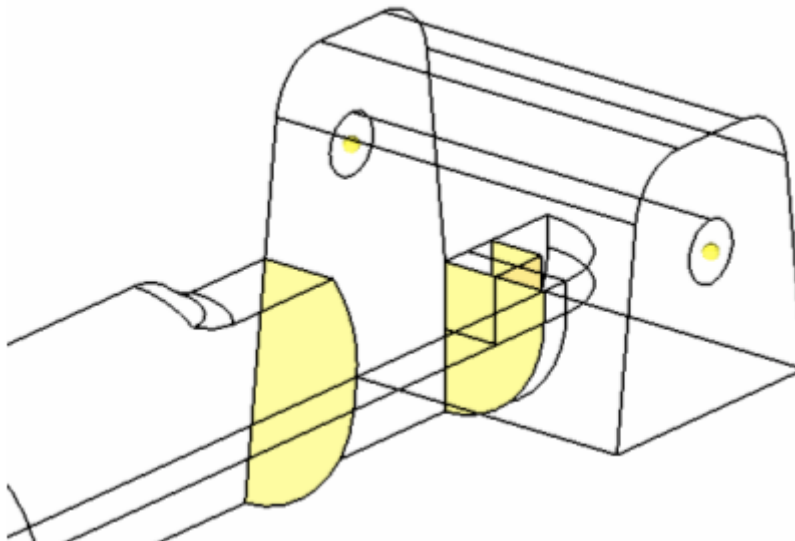   A green temp node appears at the location to indicate the selection for **N1**.The plane selector is advanced to the **N2** selection.

7. In the same manner, highlight the other line shown in the image and select two nodes along its length.

   Your selection should look similar to the following image.
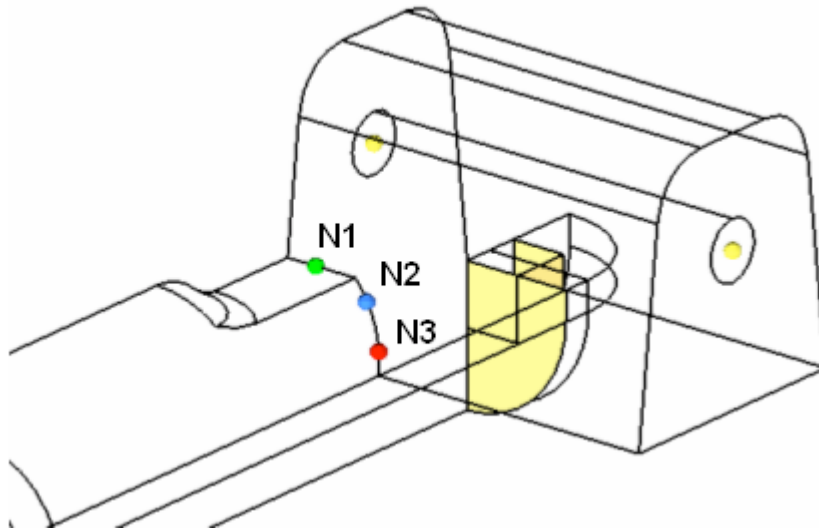
8. Click *trim* to trim the solid.

Step 9: Split the solid geometry with a swept line.

You should still be in the **Solid Edit** panel.

1. Go to the **trim with lines** subpanel.

2. With the **solids** entity selector under **with sweep lines:** active, select the solid with the cylinder removed.

3. Activate the *line list* entity selector and select the edges used in step 8 to define *N1*, *N2*, and *N3*.

Select these edges

4. Under **sweep to:**, switch the plane selector from **N1, N2, N3** to **x-axis**.

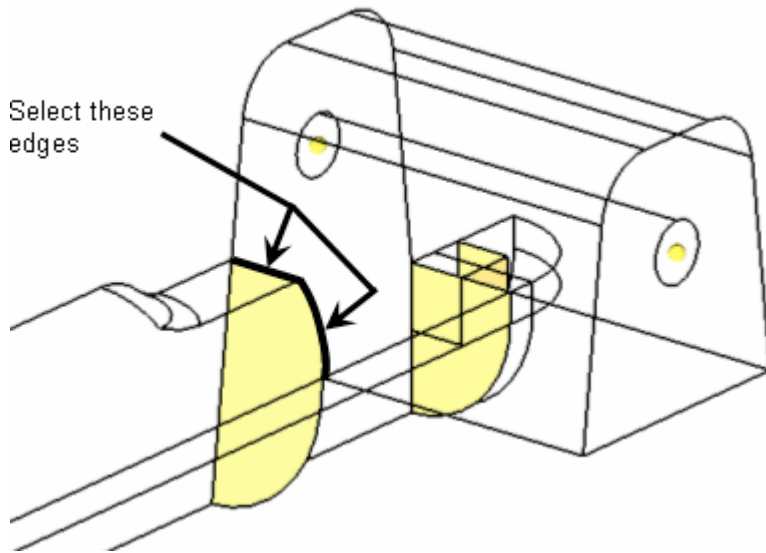5. Verify that the panel is set to **sweep all** below the **plane** selector.

6. Click **trim** to trim the solid.

Step 10: Split the solid geometry with a principal plane.

You should still be in the **Solid Edit** panel.

1. Go to the **trim with plane/surf** subpanel.

2. With the **solids** entity selector under **with plane:** active, select the solid with the cylinder removed.

3. Switch the plane selector from **N1, N2, N3** to **z-axis**.

4. Press and hold the left mouse button, and move the mouse cursor over the edge shown in the following image.

    The edge should highlight.


Select this edge
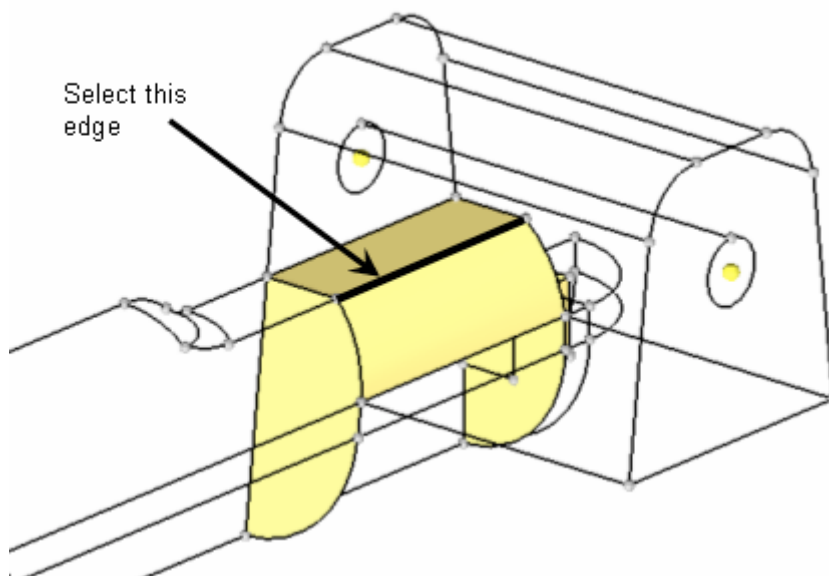
5. Release the mouse button, and left-click anywhere along the edge.

6. A purple temp node appears at the location to indicate the selection for the base node.

7. Click **trim** to trim the solid.

8. Click **return** to exit the panel.

Step 11: Split the solid geometry by creating surfaces inside the solids.

1. From the menu bar click *Geometry > Create > Surfaces > Spline/Filler* to open the **Surfaces** panel.

2. Deactivate the *Auto create (free edges only)* and *keep tangency* options.

3. Select the five lines shown in the following image:
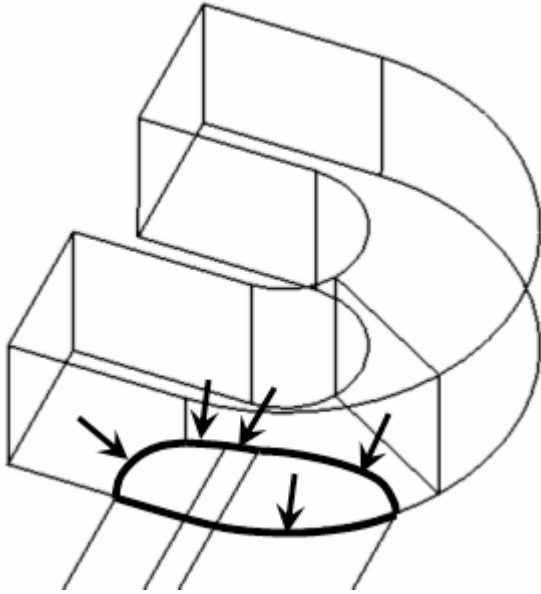
4. Click *create* to create the surface.

5. Click *return* to exit the panel.

6. Click *Geometry > Edit > Solids > Trim with Plane/Surfaces* to open the **Solid Edit** panel.

7. Under **with surfs:**, with the *solid* entity selector active, select the solid in the graphics area.

8. Under **with surfs**:, with the *surfs* entity selector active, select the surface in the graphics area that was just created.

9. Click *trim*.

10. Click *return*.

11. Click *Geometry > Create > Surfaces > Spline/Filler* to open the **Surface** panel.

12. Select the four lines shown in the following image.
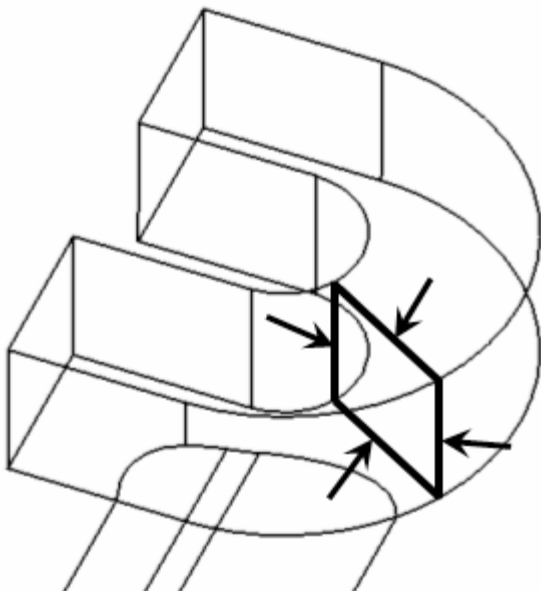
13. Click *create*.

14. Click *return*.

15. Click *Geometry > Edit > Solids > Trim with Plane/Surface* to open the **Solid Edit** panel.

16. Under **with surfs:** activate *solids* and click the solid in the graphics area.

17. Under **with surfs:**, with the *surfs* entity selector active, select the surface in the graphics area that was just created.

18. Uncheck the **Extend Trimmer** box.

19. Click *trim*.

20. Click *return* to exit the panel.

Step 12: Suppress extraneous edges on the part.

1. Click *Geometry > Edit >Surface Edge >(Un)Suppress* to open the **Edge Edit** panel.

3. Select *lines >> by geoms*.

4. With the **solids** entity selector active, select the four solids shown in the following image.
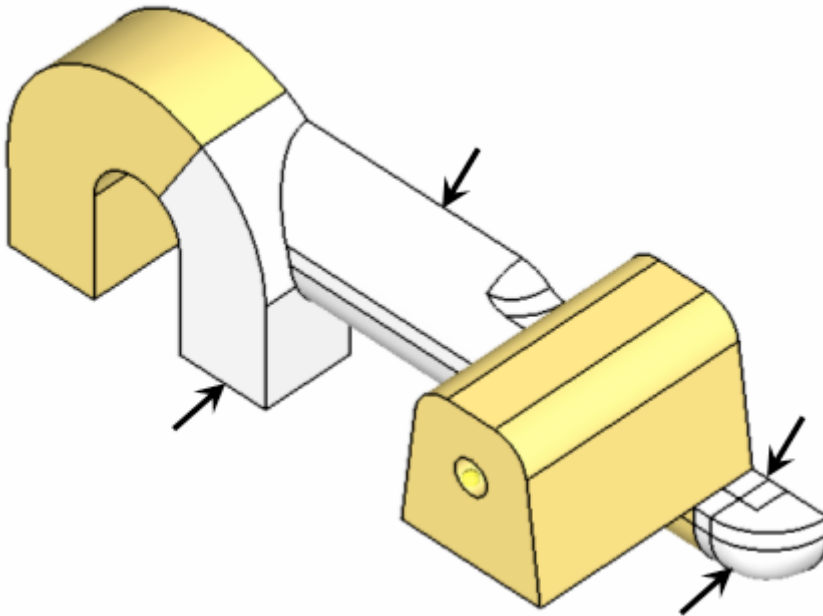
5. Click *add to selection*.

6. Set *breakangle =* to 45.

7. Click *suppress* to suppress the edges.

8. Click *return* to exit the panel.