Geometry Modeling Examples

Creating a 2D Geometry Model

This section describes how to build a 2D cross section of a heat sink and introduces 2D geometry operations in COMSOL Multiphysics.

Assume that you want to estimate the maximum amount of heat dissipated by a heat sink placed around a resistor for high-power applications. The heat sink consists of an extruded aluminum profile as in Figure 7-8. If the effects at the ends of the elongated heat sink are neglected, the model can be simplified and a decent estimate obtained of the heat dissipated by creating a 2D cross section.

![Figure 7-8: Example of a 3D heat sink model with cross section.](image)

CREATING A BASIC 2D GEOMETRY MODEL

1. Double-click the COMSOL Multiphysics icon to launch COMSOL.
2. Add a 2D Component, either when Creating a New Model or adding The Component Node.

CREATING PARAMETERS FOR GEOMETRY PARAMETERIZATION

The following steps explain how to create two circles to form the core of the heat sink in Figure 7-8. To investigate different dimensions of the heat sink, parameterize the geometry. Start by defining the radius of the outer arc of the heat sink, the radius of the inner arc, and the thickness and the length of the heat sink flanges.

1. On the Home toolbar click Parameters (p).
2. In the Parameters table, enter, or copy and paste the values in the table below. The Value column automatically displays the Expression value.

<table>
<thead>
<tr>
<th>NAME</th>
<th>EXPRESSION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>5[mm]</td>
<td>Radius circle 1</td>
</tr>
<tr>
<td>R2</td>
<td>2.5[mm]</td>
<td>Radius circle 2</td>
</tr>
</tbody>
</table>

See Toolbars and Keyboard Shortcuts for links and information about all the available toolbars. Also see The COMSOL Desktop Menus and Toolbars.

It is also useful to review Working with Geometric Entities and Named Selections before continuing with these instructions.
### ADDING TWO CIRCLES WITH PREDEFINED PARAMETERS

1. Under Component 1, right-click the Geometry 1 node and choose Circle ( ).

2. On the Settings window for Circle under Size and Shape, enter $R_1$ in the Radius field.

3. Click the Build Selected button ( ).

   A circle (c1) with radius $R_1$ displays in the Graphics window.

4. Add another circle. Right-click Geometry 1 and select Circle ( ).

5. On the Settings window for Circle under Size and Shape, enter $R_2$ in the Radius field.

6. Click the Build Selected button ( ).

   A circle with radius $R_2$ displays in the Graphics window. Click the Zoom Extents button ( ) to see both circles.

### SUBTRACTING THE SMALLER CIRCLE

1. On the Geometry toolbar, from the Booleans and Partitions menu, select Difference ( ).

2. On the Settings window, under Difference, the Active button is On ( ) by default. It activates the Objects to add list for choosing objects.

3. In the Graphics window, click to select object $c_1$ (the larger circle). $c_1$ is added to the Objects to add list.

4. Under Objects to subtract click the Active button to toggle ( ) and activate this section.

5. Select the object $c_2$ (the smaller circle). This can be done by clicking it in the Graphics window. Or open the Selection List window (from the Home toolbar, More Windows>Selection List) and right-click $c_2$ (solid) to Add to Selection.
6 Click the **Build Selected** button ( ). The object dif1 is created by subtracting the smaller circle from the larger circle.

![Image of the subtracted circles]

**INTERSECTING WITH RECTANGLE**

1 Under Component 1, right-click the **Geometry 1** node and choose **Rectangle** ( ).

2 On the **Settings** window for **Rectangle**, under **Size**:
   
a In the **Width** field enter $2 \times R_1$, and in the **Height** field, enter $R_1$.
   
b Under **Position**, enter $-R_1$ in the x field.

3 Click the **Build Selected** button ( ).

The interaction operation creates the object r1 (not related to the circle radius), which coincides with the intersecting area of the two input objects.

![Image of the intersecting rectangle and circle]

4 Click the **Geometry 1** node. On the **Geometry** toolbar, from the **Booleans and Partitions** menu, select **Intersection** ( ).

5 In the **Graphics** window click to select each object — dif1 (the combined circle) and r1 (the rectangle).

After each click, the object is added to the **Input Objects** list.
Click the \textbf{Build Selected} button ( ) to create the object int1.

\section*{Adding a Rectangle to Create a Flange}

1. Right-click the Geometry 1 node and choose Rectangle ( ).
2. On the Settings window for Rectangle under Size:
   a. In the Width field, enter L.
   b. In the Height field, enter d.
3. Under Position, in the x field enter \(-\frac{2}{3}R_1+L\), and in the y field enter \(-\frac{d}{2}\).
4. Click the \textbf{Build Selected} button ( ). On the Graphics window toolbar, click the \textbf{Zoom Extents} button ( ).
   The object \(r_2\) (not related to the circle radius) is created. Next, round the sharp edges of the flange by using fillets.

\section*{Adding a Fillet to Round the Flange Edges}

1. On the Geometry toolbar, from the Booleans and Partitions menu, select Fillet ( ).
2. On object \(r_2\) (the small rectangle) click each vertex (1 and 4, located in the left-hand corners, highlighted in blue the figure) to add these to the selection lists.
3. On the Settings window for Fillet under Radius, enter \(\frac{d}{3}\) in the Radius field.
4. Click the \textbf{Build Selected} button ( ) to create object \(f1\).

\section*{Adding Rotate Operations to Create Five Flanges}

Rotate the flange 45 degrees and keep the original input object to create five flanges on top of the heat sink.

Adding Rotate \(I\) to Create Object \(Rot1\)

1. On the Geometry toolbar, from the Transforms menu, select Rotate ( ).
2 In the Graphics window, click to select object fil1 (the filleted rectangle). It is added to the Input objects list.

3 On the Settings window for Rotate under Input, select the Keep input objects check box.

4 Under Rotation Angle, enter -45 -90 -135 -180 in the Rotation field.

5 Click Build Selected ( ) to create the object rot1. Click Zoom Extents ( ).

REMOVING INTERIOR BOUNDARIES IN UNION OPERATIONS

1 On the Geometry toolbar, from the Booleans and Partitions menu, select Union ( ).

2 In the Graphics window click the objects int1, fil1, rot1(1), rot1(2), rot1(3), and rot1(4). These are added to the Input objects section (or click the Select All button ( ) on the Graphics toolbar).

3 On the Settings window for Union, click to clear the Keep interior boundaries check box to remove the interior boundaries in the union operation. This is good practice if these boundaries do not define separate parts with different materials, for example.

4 Click the Build All Objects button ( ). Click the Zoom Extents button ( ). The final geometry is shown in Figure 7-9.

**Figure 7-9**: Final 2D object created in the Model Builder.

VIEWING THE GEOMETRY SEQUENCE

Figure 7-10 shows the geometry sequence used to create Figure 7-9. All primitive objects and the fillet operation are parameterized through the radius of the inner and outer heat sink arcs, the length and thickness of the flanges, and the radius of the fillets. You can change the parameter values in the Parameters table or for any object to create alternative heat sink geometries. The sequence still remains, and when you click the Build All button ( ), a new geometry is created.
Figure 7-10: An example of a 2D geometry sequence.

**RE-RUNNING THE GEOMETRY SEQUENCE WITH DIFFERENT PARAMETERS**

1. On the Home toolbar, click Parameters (P1) (or click the Parameters node under Global Definitions).
2. On the Settings window under Parameters, enter these settings in the table. Replace the previous data:

<table>
<thead>
<tr>
<th>NAME</th>
<th>EXPRESSION</th>
<th>VALUE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>4 [mm]</td>
<td>0.0040 m</td>
<td>Radius Circle 1</td>
</tr>
<tr>
<td>R2</td>
<td>2.5 [mm]</td>
<td>0.0025 m</td>
<td>Radius Circle 2</td>
</tr>
<tr>
<td>d</td>
<td>1 [mm]</td>
<td>0.0010 m</td>
<td>Height</td>
</tr>
<tr>
<td>L</td>
<td>7 [mm]</td>
<td>0.0070 m</td>
<td>Width</td>
</tr>
</tbody>
</table>

3. In the Model Builder click Geometry 1.
4. Click the Build All button ( ). Click the Zoom Extents button ( ) to view the geometry as defined by the new parameters.