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. At this time, you do not model the physics that describe the operation of the heat sink.

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 5-1. If you neglect the effects at the ends of the elongated heat sink, you can simplify the model and obtain a decent estimate of the heat dissipated by creating a 2D cross section.

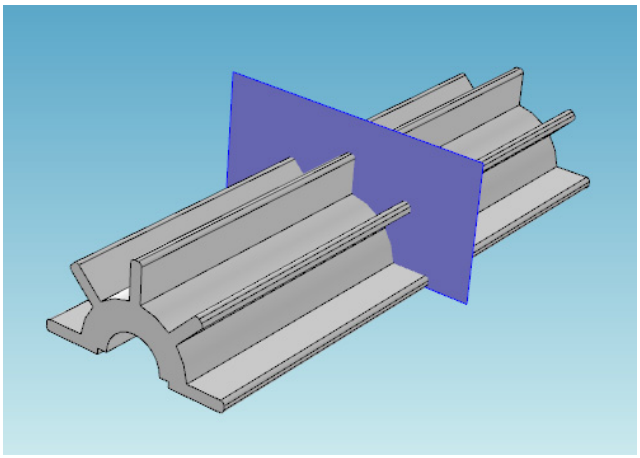


Figure 5-1: Example of a 3D heat sink model with cross section.

CREATING A BASIC 2D GEOMETRY MODEL

1 Double-click the COMSOL icon to launch COMSOL.

The **Model Wizard** opens.

2 On the **Select Space Dimension** page, click the **2D** button.

3 Click the **Finish** button ( ).

CREATING PARAMETERS FOR GEOMETRY PARAMETERIZATION

The following steps explain how to create two circles to form the core of the heat sink in Figure 5-1. 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 In the **Model Builder**, right-click **Global Definitions** ( ) and select **Parameters** ( ).

2 In the **Parameters** table, enter these settings:

NAME	EXPRESSION	VALUE	DESCRIPTION
R1	5[mm]	0.0050 m	Radius Circle 1
R2	2.5[mm]	0.0025 m	Radius Circle 2
d	1[mm]	0.0010 m	Height
L	5[mm]	0.0050 m	Width

ADDING TWO CIRCLES WITH PREDEFINED PARAMETERS

1 In the **Model Builder**, right-click **Geometry 1** and select **Circle** ( ).

2 Under **Size**, enter R1 in the **Radius** field.

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

A circle with radius R1 displays in the Graphics window.

4 Right-click **Geometry 1** and select **Circle** ( ).

5 Under **Size**, enter R2 in the **Radius** field.

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

A circle with radius R2 displays in the Graphics window. Click the **Zoom Extents** button ( ) to see both circles.

SUBTRACTING THE SMALLER CIRCLE

1 In the **Model Builder**, right-click **Geometry 1** and select **Boolean Operations> Difference** ( ).

2 Under **Difference**, click the **Activate Selection** button ( ) to activate the **Objects to add** list for choosing objects.

3 In the **Graphics** window, select the object **c1** (the larger circle) by left- and then right-clicking it.

C1 is highlighted in red, then blue and added to the **Objects to add** list.

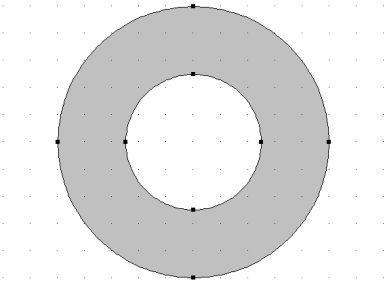
4 Click the **Activate Selection** button ( )to activate the **Objects to subtract** list.

5 Select the object **c2** (the smaller circle) by left- and then right-clicking it.

C2 is highlighted in red, then blue and added to the **Objects to subtract** list.

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

The object **dif1** is created by subtracting the smaller circle from the larger circle.



INTERSECTING WITH RECTANGLE

1 In the **Model Builder**, right-click **Geometry 1** and select **Rectangle** ( ).

2 Under **Size**:

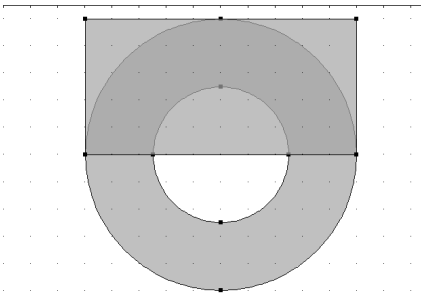
   a In the **Width** field enter `2*R1`.

   b In the **Height** field, enter `R1`.

3 Under **Position**, enter `-R1` in the **x** field.

4 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.

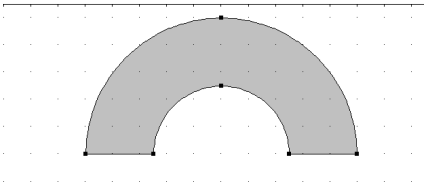


5 In the **Model Builder**, right-click **Geometry 1** and select **Boolean Operations> Intersection** ( ).

6 Select both objects, **dif1** (the combined circle) and **r1** (the rectangle), by left-clicking and then right-clicking them.

Each object is highlighted in red, then blue and added to the **Input Objects** list.

7 Click the **Build Selected** button ( ) to create the object int1.



ADDING A RECTANGLE TO CREATE A FLANGE

1 In the **Model Builder**, right-click **Geometry 1** and select **Rectangle** ( ).

2 Under **Size**:

   a In the **Width** field, enter `L`.

   b In the **Height** field, enter `d`.

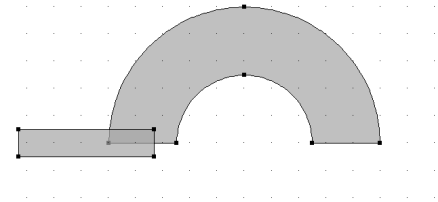
3 Under **Position**:

   a In the **x** field enter `-(2/3*R1+L)`.

   b In the **y** field enter `-d/2`.

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

The object r2 (not related to the circle radius) is created. Next, round the sharp edges of the flange by using fillets. Click the **Zoom Extents** button ( ).



ADDING A FILLET TO ROUND THE FLANGE EDGES

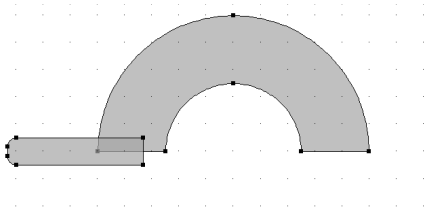
1 In the **Model Builder**, right-click **Geometry 1** and select **Fillet** ( ).

2 Select **Vertices 1** and **4** (the left-hand corners) on object **r2** (the small rectangle).

3 Click the **Add to Selection** button ( ) to add these points to the **Vertices to fillet** section.

4 On the **Fillet** page, under **Radius**, enter `d/3` in the **Radius** field.

5 Click the **Build Selected** button ( ) to create object `fil1`.



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 1 to Create Object Rot1

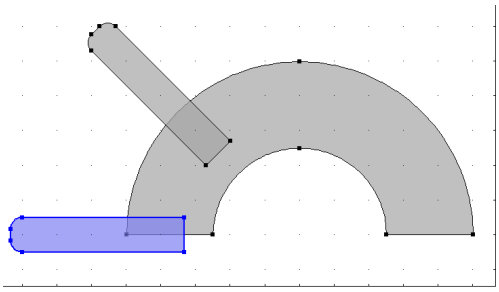
1 In the **Model Builder**, right-click **Geometry 1** and select **Transforms>Rotate** ( ).

2 Select object **fil1** (the filleted rectangle) and add it to the **Input Objects** list.

3 On the **Rotate** page, under **Input**, select the **Keep input objects** check box.

4 Under **Rotation Angle**, enter `-45` in the **Rotation** field.

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



Adding Three More Rotations to the Model

1 In the **Model Builder**, right-click **Geometry 1** and select **Transforms>Rotate** ( ).

2 Select the object **rot1** (the resulting rotated filleted rectangle) to add it to the **Input Objects** list.

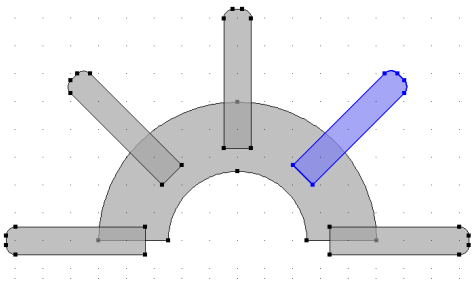
3 On the **Rotate** page, under **Input**, select the **Keep input objects** check box.

4 Under the **Rotation Angle** section, enter `-45` in the **Rotation** field.

5 Click the **Build Selected** button ( ). to create object **rot2**.

6 Repeat the above steps to create object **rot3** and **rot4**. Use object **rot2** to create **rot3** and object **rot3** to create **rot4**.

7 When done, click the **Zoom Extents** button ( ) to view the completed object.



REMOVING INTERIOR BOUNDARIES IN UNION OPERATIONS

1 In the **Model Builder**, right-click **Geometry 1** and select **Boolean Operations> Union** ( ).

2 Select the objects **int1**, **fil1**, **rot1**, **rot2**, **rot3**, and **rot4**.

3 Under **Union**, click to clear the **Keep interior boundaries** check box to remove the internal boundaries in the union operation.

4 Click the **Build All** button ( ). Click the **Zoom Extents** button ( ). The final geometry is shown in Figure 5-2.

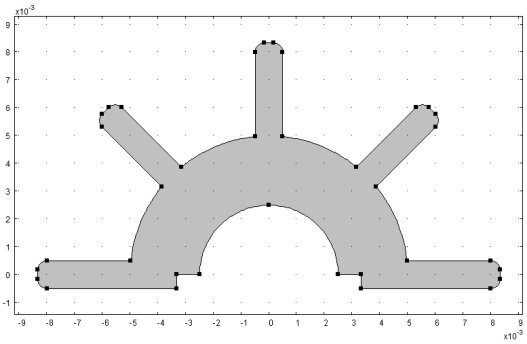


Figure 5-2: Final 2D object created in the Model Builder.

VIEWING THE GEOMETRY SEQUENCE

Figure 5-3 shows the geometry sequence used to create Figure 5-2. 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.

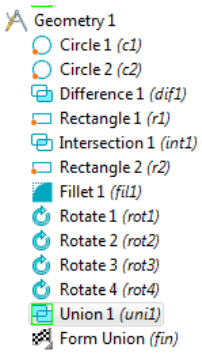


Figure 5-3: an example of a 2D geometry sequence.

RE-RUNNING THE GEOMETRY SEQUENCE WITH DIFFERENT PARAMETERS

1 In the **Model Builder**, under **Global Definitions**, click **Parameters** ( ).

2 Under **Parameters**, enter the following settings in the table. Replace the previous data:.

NAME	EXPRESSION	VALUE	DESCRIPTION
R1	4e-3[m]	0.0040 m	Radius Circle 1
R2	2.5e-3[m]	0.0025 m	Radius Circle 2
d	1e-3[m]	0.0010 m	Height
L	7e-3[m]	0.0070 m	Width

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.