

“Fusion 360” Lab

Lecture 4

Lebanese University - Faculty of Engineering – Branch 3

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Dr. Ali HARKOUS



Lecture 4:

Chap8: Equations and Parameters

8.1. Equations

8.2. Parameters

Chap8: Equations and Parameters



Equations help you to incorporate design intent, which ensures that the design behaves as intended when changes occur. Equations are established by creating mathematical relationships between dimensions and parameters.

Learning Objectives in this Chapter

- Create equations between dimensions to incorporate design intent into the design.
- Create user-defined parameters in a design.

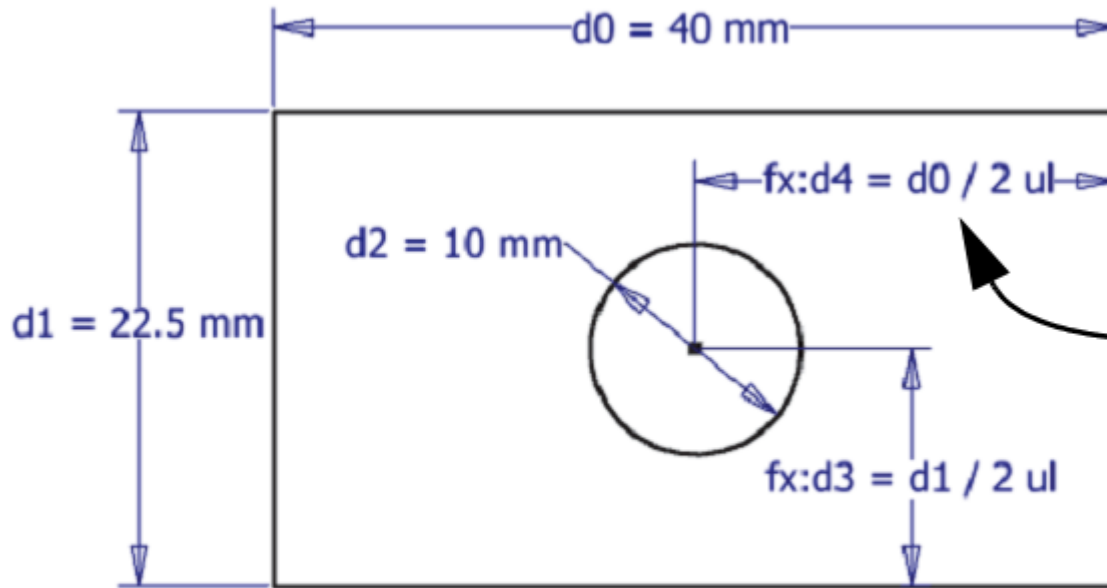
8.1. Equations



Features and sketches generate dimensions in a design. Each dimension is given a unique dimension name that starts with the letter “d” followed by a unique number (e.g., d1, d2, d3, etc.).

You can define relationships between these dimensions using equations, enabling you to control a dimension’s value based on a function of another dimension’s value. Equations can also include user-defined parameters and mathematical expressions. When one dimension references another, the referenced dimension in the equation is considered the driving dimension. The design in Figure 8–1 shows a hole that is located based on an equation.

8.1. Equations



The distance from the center of the hole to the edges of the plate can be defined as half the overall dimension of the plate (i.e., $d4 = d0/2$).

Figure 8–1

When **fx:** displays as part of a dimension name, it indicates that the dimension contains an equation.

8.1. Equations



- When editing a sketch or feature dimension, you can enter an equation directly into the dimension value's input field. The equation can be a mathematical expression that does or does not include other dimensions.
- The width of the sketched rectangle shown in Figure 8–2 is set up as an equation to make the width equal to twice the height. To do this:
 1. Double-click on the width dimension to modify its value.
 2. When the input field is active, select the height dimension. Its name (in this example: d2) is added to the input field for the width dimension.
 3. Input the remainder of the equation (in this example: **d2*2**).

The width will now automatically update whenever the value of the d2 height dimension is modified.

8.1. Equations

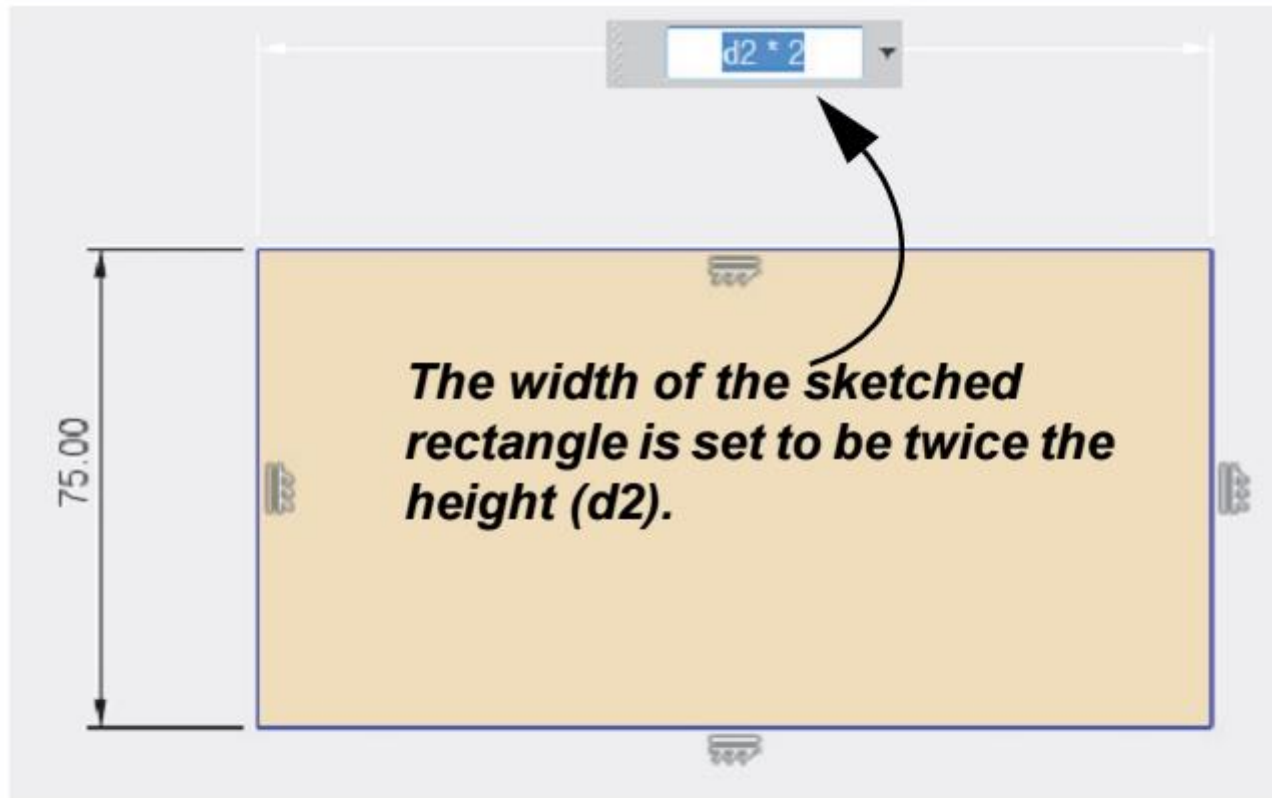


Figure 8–2

8.1. Equations

- You can enter an equation into the entry fields during feature creation, as shown for the *Height* value in Figure 8–3.

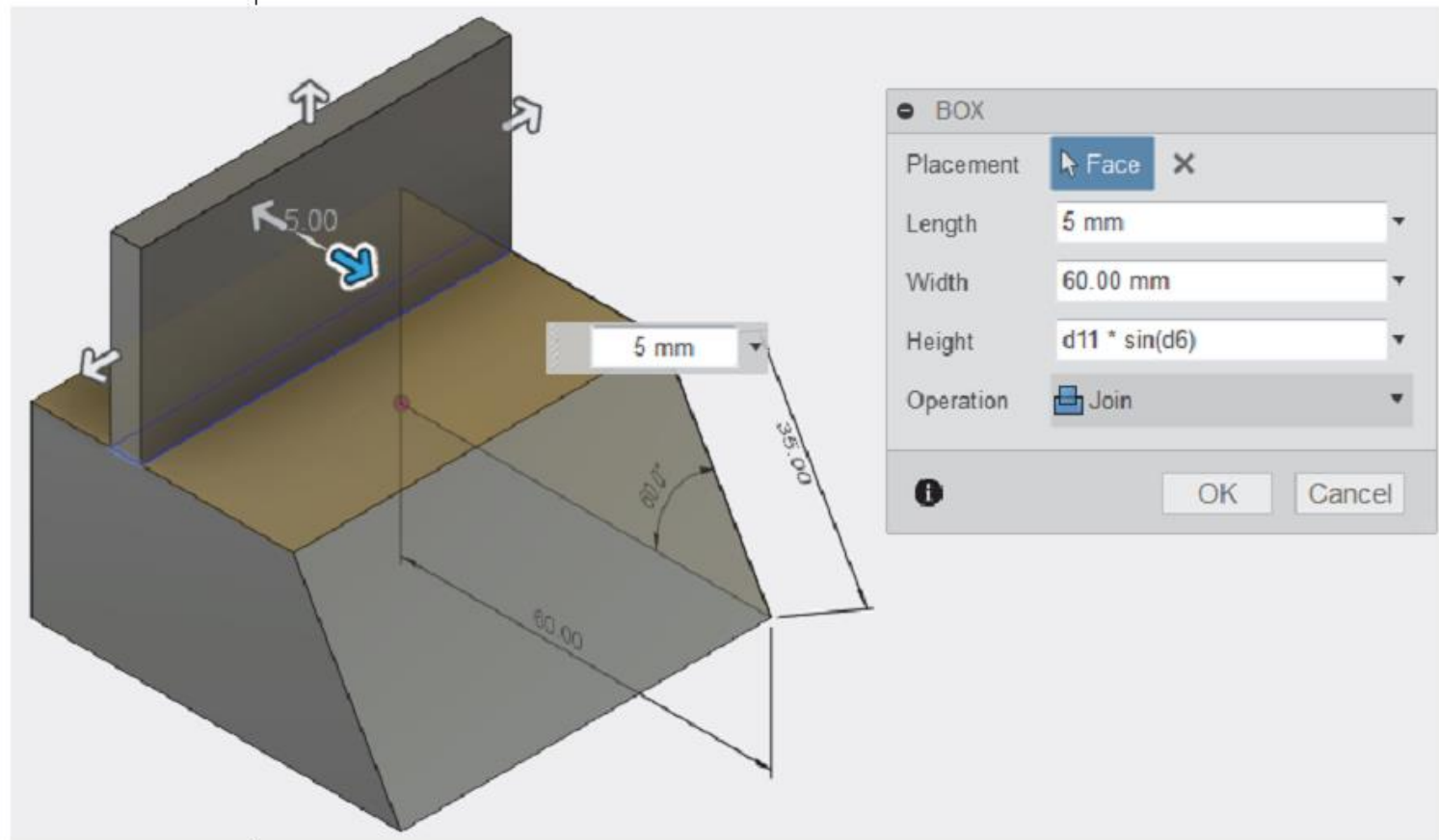



Figure 8–3

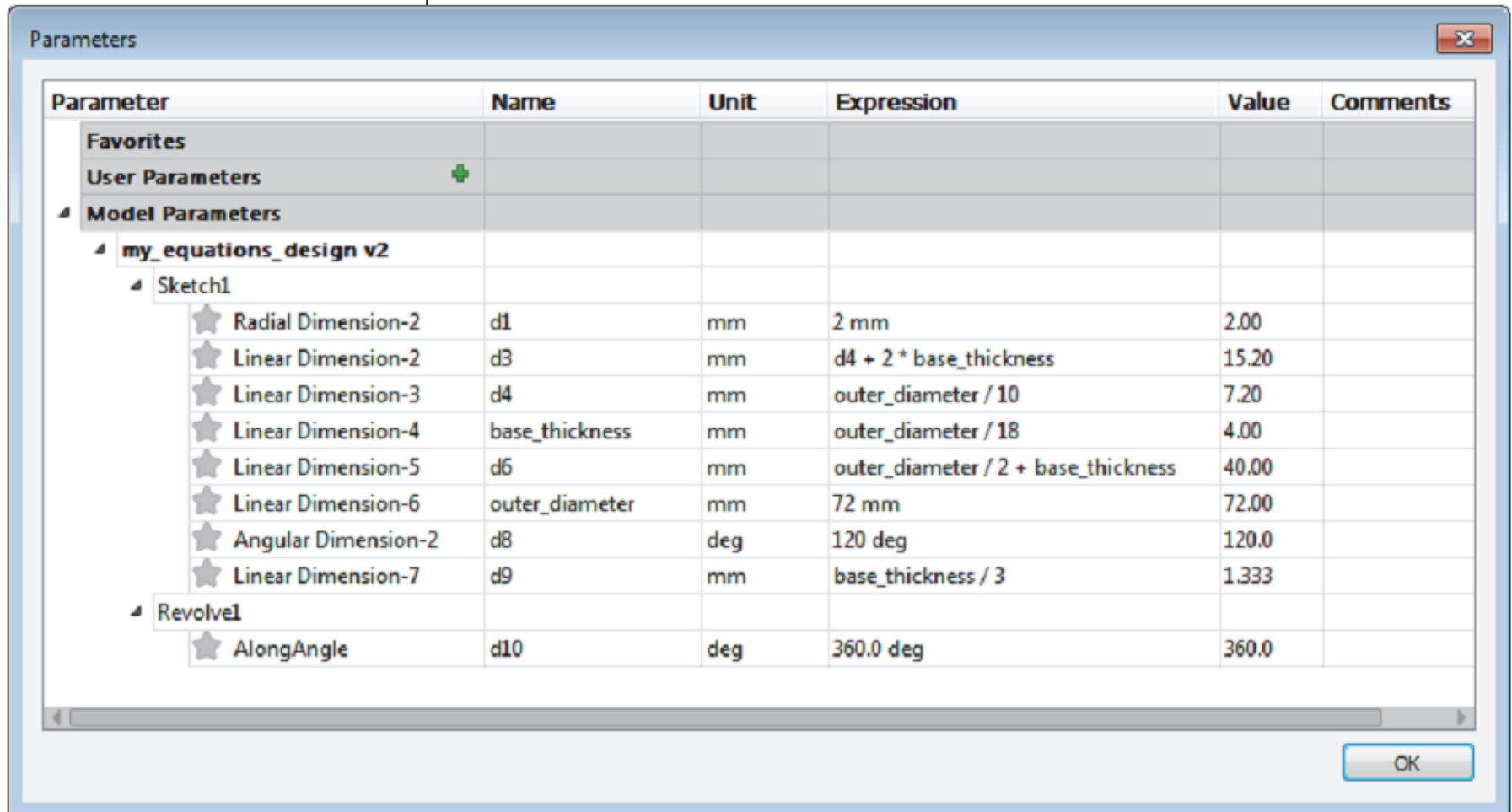
8.1. Equations



- You can enter equations after sketch or feature creation using the Parameters dialog box. This dialog box enables you to review the complete list of all of the parameters (dimension names) and existing equations in the design. To open the Parameters dialog box, in the MODIFY panel, click  (Change Parameters). Equations are entered into the *Expression* column, as shown in Figure 8–4.

In the Parameters dialog box, you can rename model parameters to help recognize what the parameter is controlling.

8.1. Equations



The screenshot shows the 'Parameters' dialog box in Fusion 360. The tree view on the left shows the hierarchy: Favorites > User Parameters > Model Parameters > my_equations_design v2 > Sketch1. The table on the right lists the parameters and their values.

Parameter	Name	Unit	Expression	Value	Comments
Favorites					
User Parameters +					
Model Parameters					
my_equations_design v2					
Sketch1					
★ Radial Dimension-2	d1	mm	2 mm	2.00	
★ Linear Dimension-2	d3	mm	d4 + 2 * base_thickness	15.20	
★ Linear Dimension-3	d4	mm	outer_diameter / 10	7.20	
★ Linear Dimension-4	base_thickness	mm	outer_diameter / 18	4.00	
★ Linear Dimension-5	d6	mm	outer_diameter / 2 + base_thickness	40.00	
★ Linear Dimension-6	outer_diameter	mm	72 mm	72.00	
★ Angular Dimension-2	d8	deg	120 deg	120.0	
★ Linear Dimension-7	d9	mm	base_thickness / 3	1.333	
Revolve1					
★ AlongAngle	d10	deg	360.0 deg	360.0	

OK

Figure 8–4

8.1. Equations



Equations can be written using any of the following operators or functions to capture the intent of the equation.

Mathematical Operators

The following operators can be used in equations:

+	Addition
-	Subtraction
/	Division
*	Multiplication
()	Expression delimiter

8.1. Equations



Functions

The following functions can be used in equations.

<code>sin()</code>	<code>cos()</code>	<code>tan()</code>
<code>sinh()</code>	<code>cosh()</code>	<code>tanh()</code>
<code>tan()</code>	<code>log()</code>	<code>ceil()</code> converts arbitrary real numbers to close integers. The ceil function of a real number x, <code>ceil(x)</code> returns the next highest integer (e.g., <code>ceil(3.2) = 4</code>).
<code>asin()</code>	<code>ln()</code>	
<code>acos()</code>	<code>exp()</code>	<code>floor()</code> converts arbitrary real numbers to close integers. The floor function of a real number x, <code>floor(x)</code> returns the next smallest integer (e.g., <code>floor(3.8) = 3</code>).
<code>atan()</code>	<code>abs()</code>	

8.1. Equations



Once you finish adding an equation, test the design to ensure that the equation captures the required design intent. This is called flexing the design, and should involve editing the driving dimension values to verify that the design changes as expected.



Lecture 4:

Chap8: Equations and Parameters

8.1. Equations


8.2. Parameters

8.2. Parameters



As features are created in a design, dimensions are used to define the design's shape. The name and value of the dimension are considered a Model Parameter. Model parameters are listed in the Parameters dialog box.

The Parameters dialog box also enables you to create User-Defined parameters, which can be used in equations to help you control the design. Once created, user-defined parameters are listed in the Parameters dialog box in the *User Parameters* area.

To open the Parameters dialog box, in the MODIFY panel, click Σ (Change Parameters). In the User Parameter row, click  to display the Add User Parameter dialog box (shown in Figure 8–5) and define the user parameter. Once defined, click **OK** to add the user parameter.

8.2. Parameters

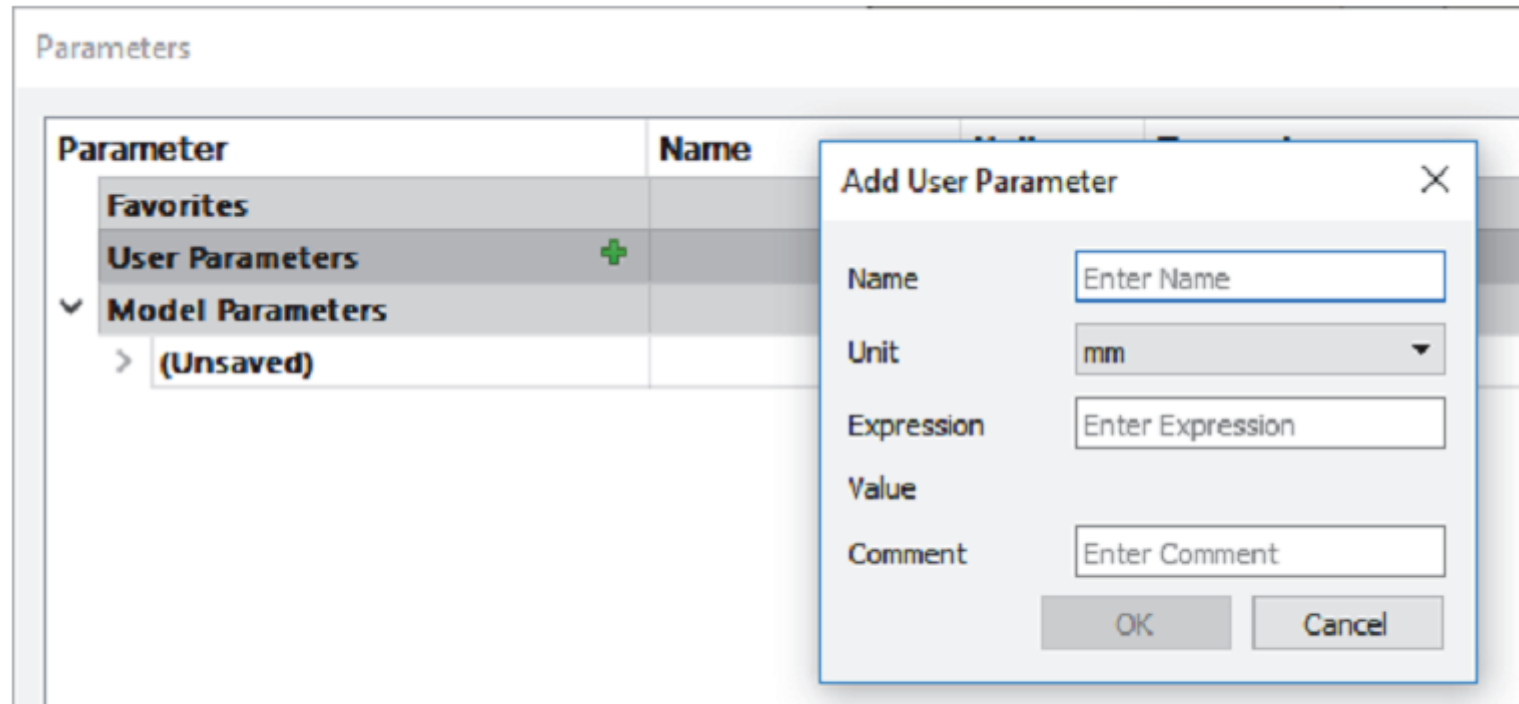




Figure 8–5



Command Summary

Button	Command	Location
	Change Parameters	<ul style="list-style-type: none">• Ribbon: <i>Model Workspace</i>>MODIFY panel• Context Menu: Right-click in the graphics window and select Modify.
	Compute All	<ul style="list-style-type: none">• Ribbon: <i>Model Workspace</i>>MODIFY panel• Context Menu: Right-click in the graphics window and select Modify.

Chap 8

Practice

Practice 1

Adding Equations

Practice Objectives

- Add equations to dimensions in a sketch.
- Add and edit equations using the Parameters dialog box.

In this practice, you will modify dimensions in a part using dimension equations. The completed part is shown in Figure 8–6.

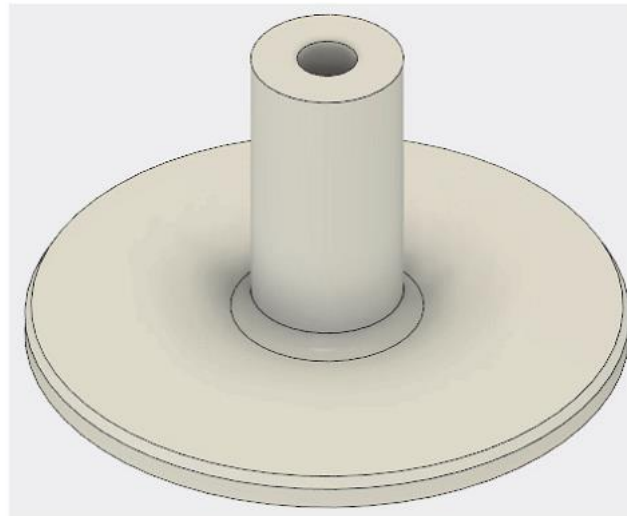



Figure 8–6

Practice 1



Task 1 - Create a new design from file.

1. Click  > **Open**. In the Open window, click **Open from my computer**.
2. In the Open dialog box, navigate to the *C:\Autodesk Fusion 360 Practice Files* folder, select **equations.f3d**, and click **Open**. The design displays as shown in Figure 8–7.

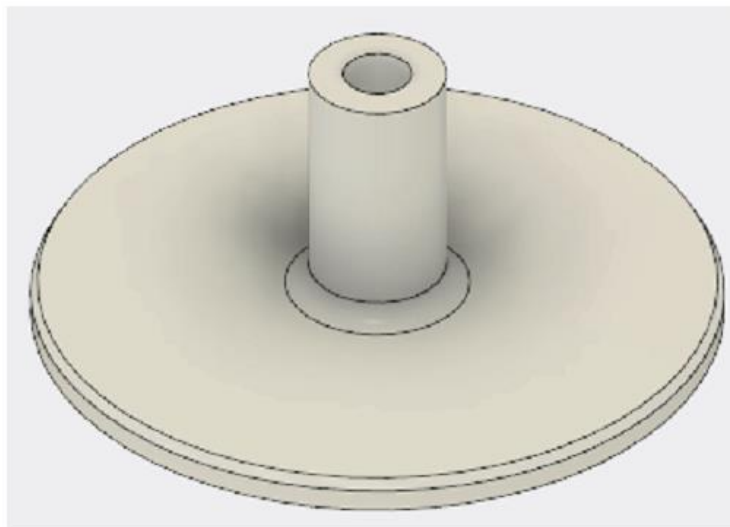


Figure 8–7

Practice 1



3. The Timeline consists of a sketch and a revolve. In the Timeline, right-click on the sketch and select **Edit Sketch**. The sketch displays as shown in Figure 8–8.

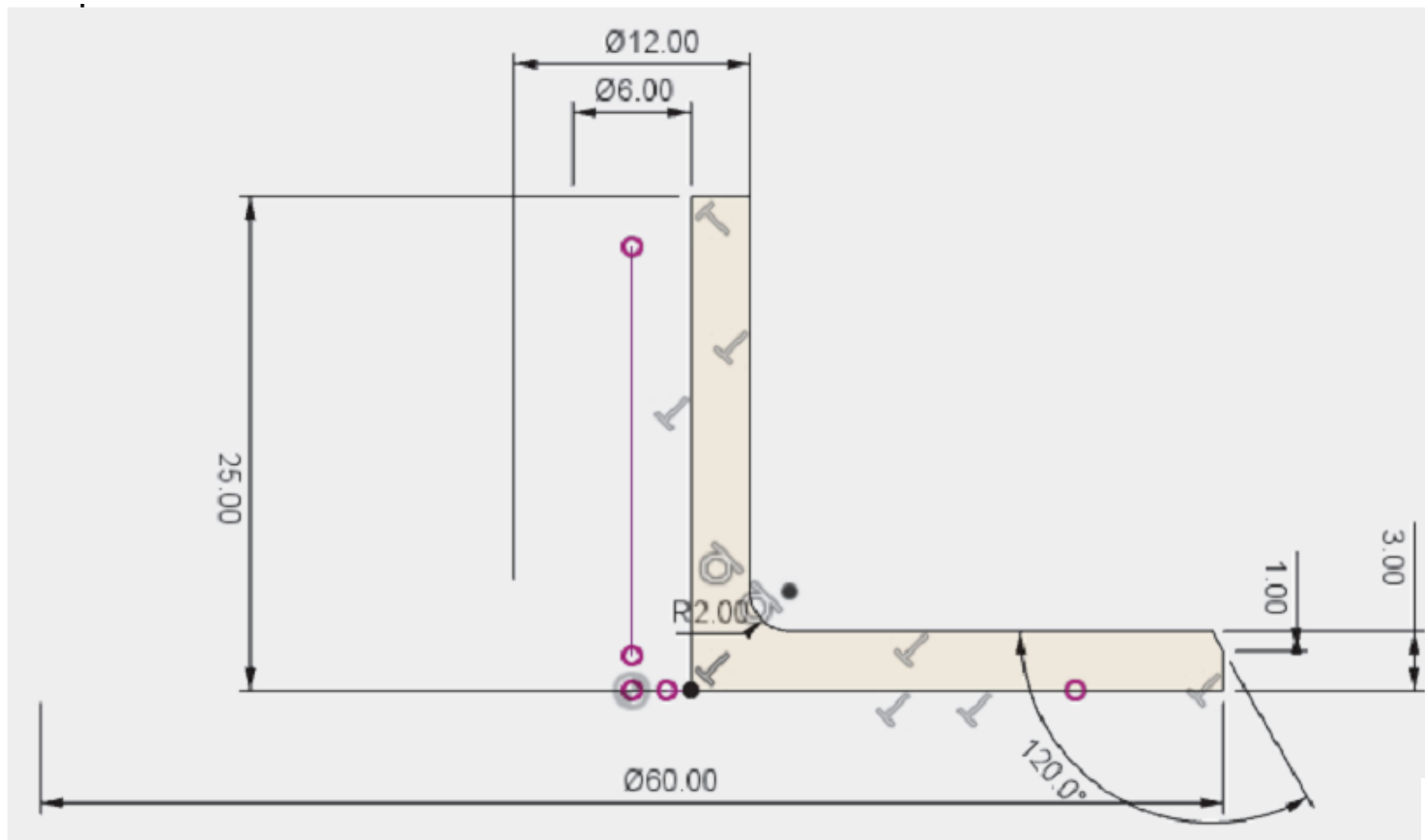


Figure 8–8

Practice 1



4. Change the outside diameter dimension from 60 to **50**. No other dimensions change value because no equations have been created to define relationships between the dimensions.
5. Change the outside diameter dimension back to **60**.

Task 2 - Add an equation to control the inner diameter.

In this task, you will add an equation to set the inner diameter to be 1/10th of the outer diameter.

1. Double-click on the **Ø6.00** inner diameter dimension to display the input field.
2. While the input field is active, click on the **Ø60.00** outer diameter dimension. The dimension parameter d7 is added to the input field, which is the name assigned to the outer diameter dimension.

Practice 1



3. In the entry field, enter **d7/10**. Press <Enter>. The inner diameter dimension now displays as **fx: Ø6.00**. The fx: prefix indicates that the dimension contains an equation.
4. Modify the outside diameter dimension from 60 to **50**. Note that the inner diameter dimension automatically changes to **fx: Ø5.00** to satisfy the equation you entered. The sketch displays as shown in Figure 8–9.

Practice 1

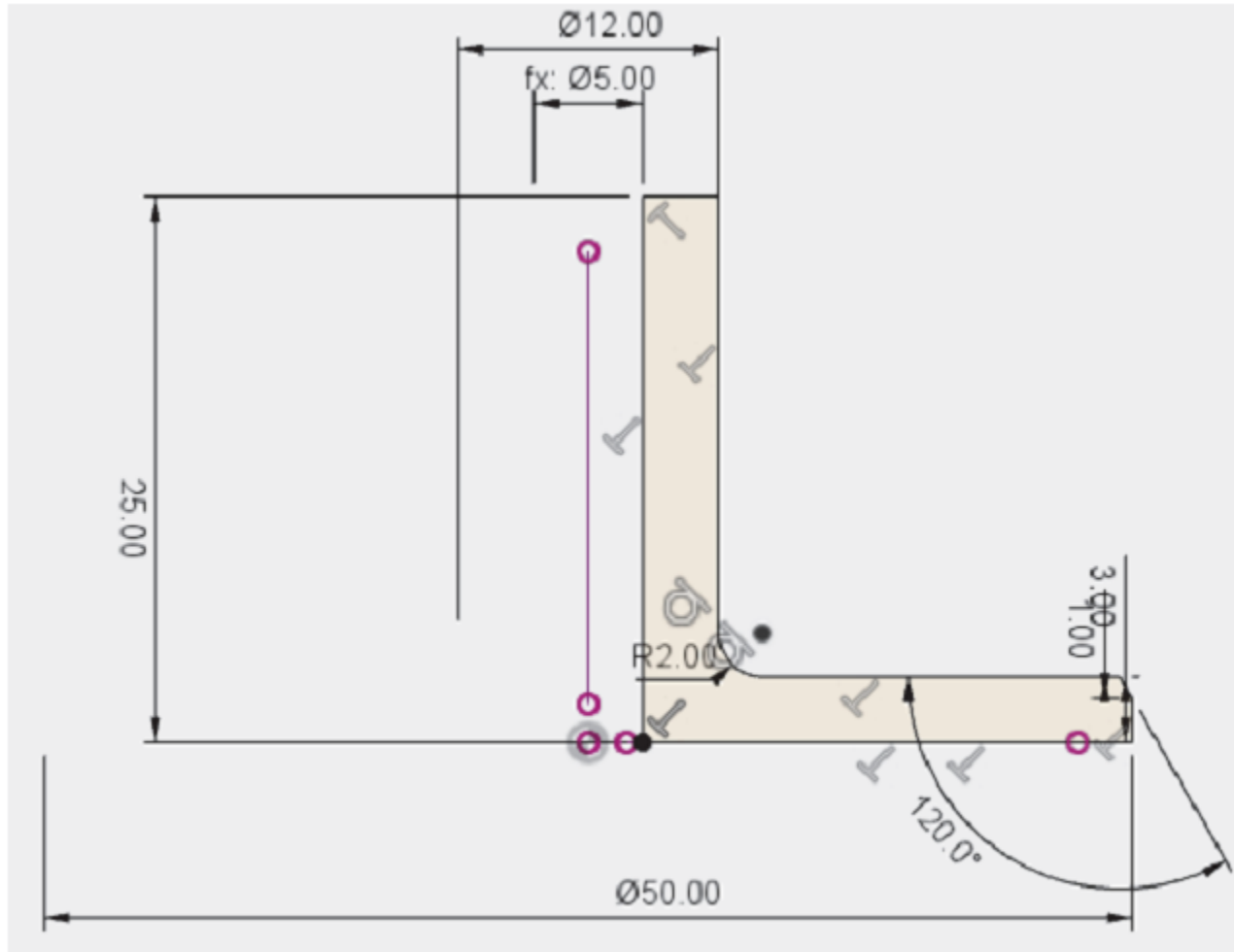


Figure 8–9

Practice 1



Task 3 - Add an equation to drive other dimensions.

In this task, you will add additional equations to drive the wall thickness and height.

1. Edit the **Ø12.00** diameter dimension. The difference between this outer diameter and the inner diameter should maintain a wall thickness that is equal to the thickness of the base.
2. Select the **fx: Ø5.00** dimension.
3. Enter **+ 2***.
4. Select the 3.00 dimension controlling the thickness of the base. The equation in the input field should be **d4 + 2 * d5**.
5. Press <Enter>.



Practice 1

6. Make the 25.00 height dimension equal to half the outer diameter plus the base thickness. The equation should display in the input field as **$d7 / 2 + d5$** .
7. Finally, make the 1.00 dimension equal to one third of the base height. The equation should display in the input field as **$d5 / 3$** .
8. Modify the outside diameter dimension from 50 to **72**.

Note: As of the printing of this learning guide (release 2.0.5966), the software was preventing you from selecting a second dimension value in the sketch to create an equation. This was

previously possible. As a workaround, you can manually enter the dimension symbol to create the equation. Alternatively you can use the Parameters dialog box.

Practice 1

9. Modify the base thickness from 3 to 4. The sketch should display as shown in Figure 8–10.

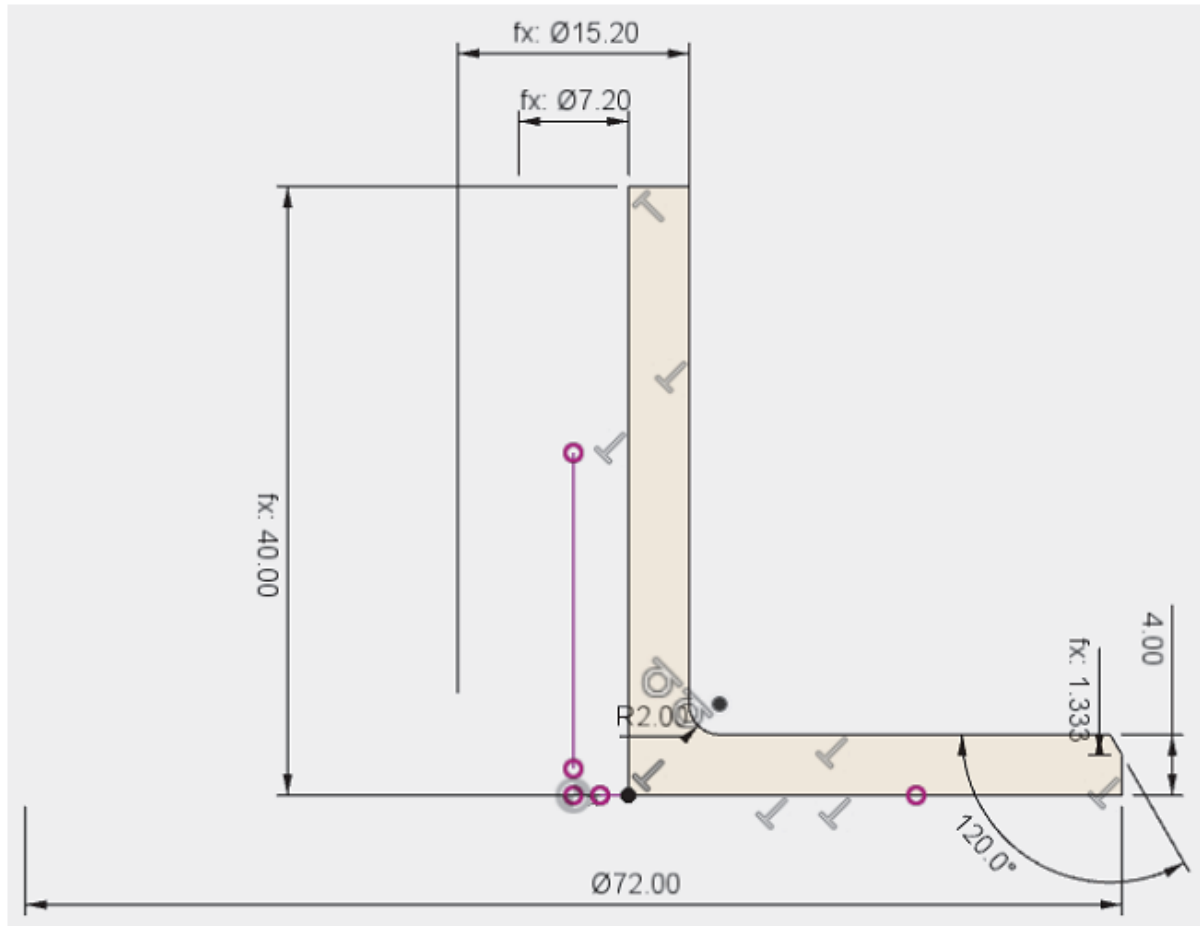


Figure 8–10

Practice 1




10. Stop the sketch.
11. In the BROWSER, expand the **Sketches** folder and toggle on the display of the sketch.
12. In the BROWSER, right-click on the sketch and select **Show Dimension**.
13. Double-click on the **Ø72.00** dimension and change its value to **60**. The equations you created in the sketch are still evaluated.
14. Save the design with the name **My_Equations_Design** to your *Autodesk Fusion 360 Practice Files* project.

Practice 1



Task 4 - Rename dimensions and add a user-defined parameter.

1. In the MODIFY panel, click  (Change Parameters). The Parameters dialog box opens.
2. Expand the **Model Parameters** node.
3. Expand the **My_Equations_Design** node. The **Sketch1** and **Revolve1** features are listed and contain all of the dimension parameters for each.
4. Expand the **Sketch1** node. Note that all of the dimension parameters that you worked with in the sketch are listed. Also note that the equations you set up are listed in the *Expression* column, as shown in Figure 8–11.

Practice 1

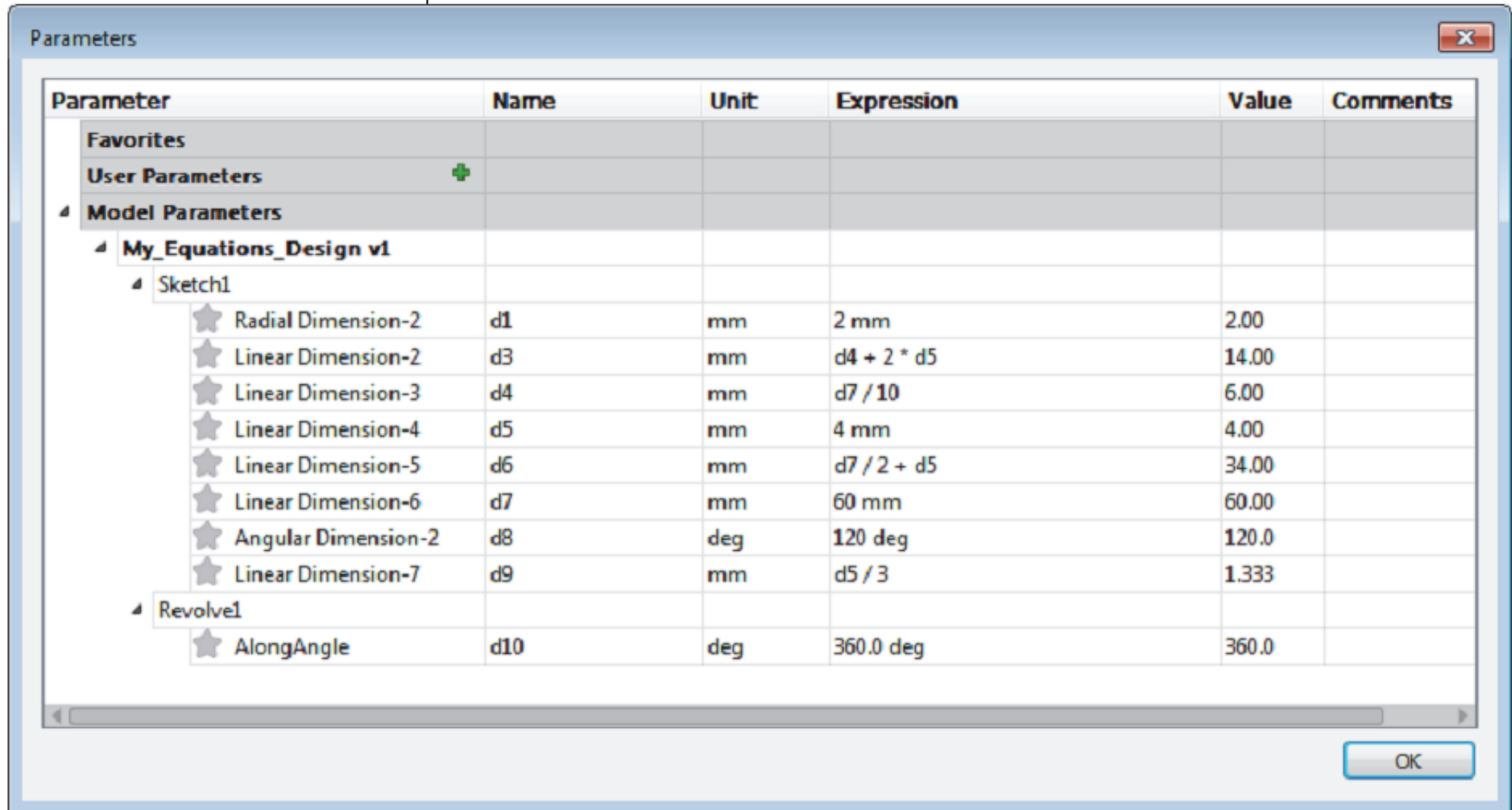


Figure 8–11

*If you have not already saved the design with a new name, **Unsaved** is listed in the Model Parameters node.*

Practice 1



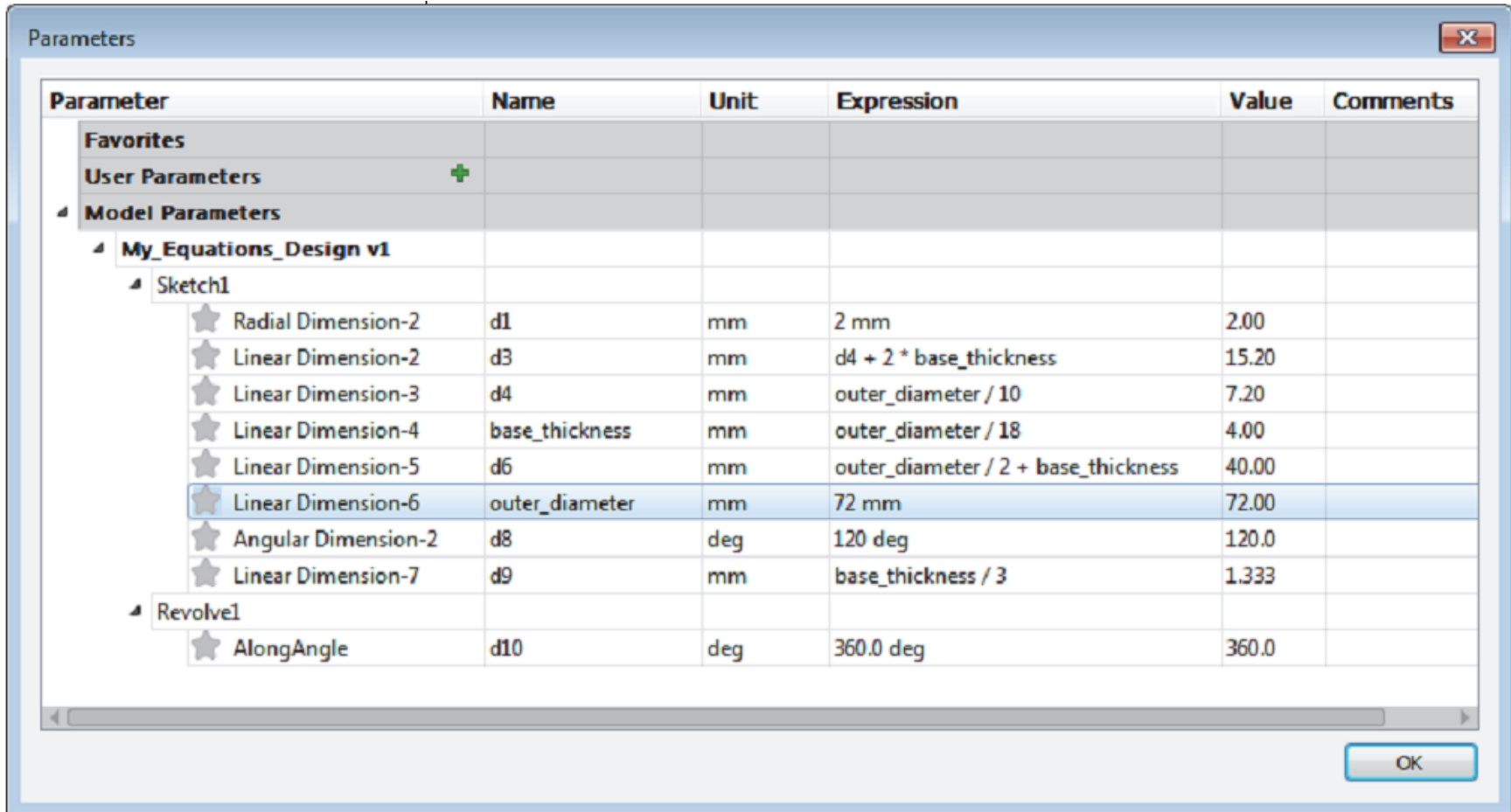
5. The dimension d7 controls the outer diameter in the sketch and currently has a value of 60.00. Select the cell containing d7. Enter the name **outer_diameter** and press <Enter>. Note that the expressions for the parameters that referenced d7 have updated to reflect the new name of that parameter.
6. The dimension d5 controls the base thickness in the sketch and currently has a value of 4.00. Select the cell containing d5. Enter the name **base_thickness** and press <Enter>.
7. Select the *Expression* cell for the **base_thickness** parameter which is set to 4mm.
8. Enter **outer_diameter/18** as the new expression.

Practice 1



9. Assign the equation for d6 as shown in Figure 8–12.
10. Change the expression for the **outer_diameter** parameter from 60 mm to **72 mm**. The Parameters dialog box should display as shown in Figure 8–12.

Practice 1



Parameter	Name	Unit	Expression	Value	Comments
Favorites					
User Parameters +					
Model Parameters					
My_Equations_Design v1					
Sketch1					
★ Radial Dimension-2	d1	mm	2 mm	2.00	
★ Linear Dimension-2	d3	mm	$d4 + 2 * \text{base_thickness}$	15.20	
★ Linear Dimension-3	d4	mm	$\text{outer_diameter} / 10$	7.20	
★ Linear Dimension-4	base_thickness	mm	$\text{outer_diameter} / 18$	4.00	
★ Linear Dimension-5	d6	mm	$\text{outer_diameter} / 2 + \text{base_thickness}$	40.00	
★ Linear Dimension-6	outer_diameter	mm	72 mm	72.00	
★ Angular Dimension-2	d8	deg	120 deg	120.0	
★ Linear Dimension-7	d9	mm	$\text{base_thickness} / 3$	1.333	
Revolve1					
★ AlongAngle	d10	deg	360.0 deg	360.0	

Figure 8–12

Practice 1

11. Click **OK** to close the Parameters dialog box. The design should display as shown in Figure 8–13.

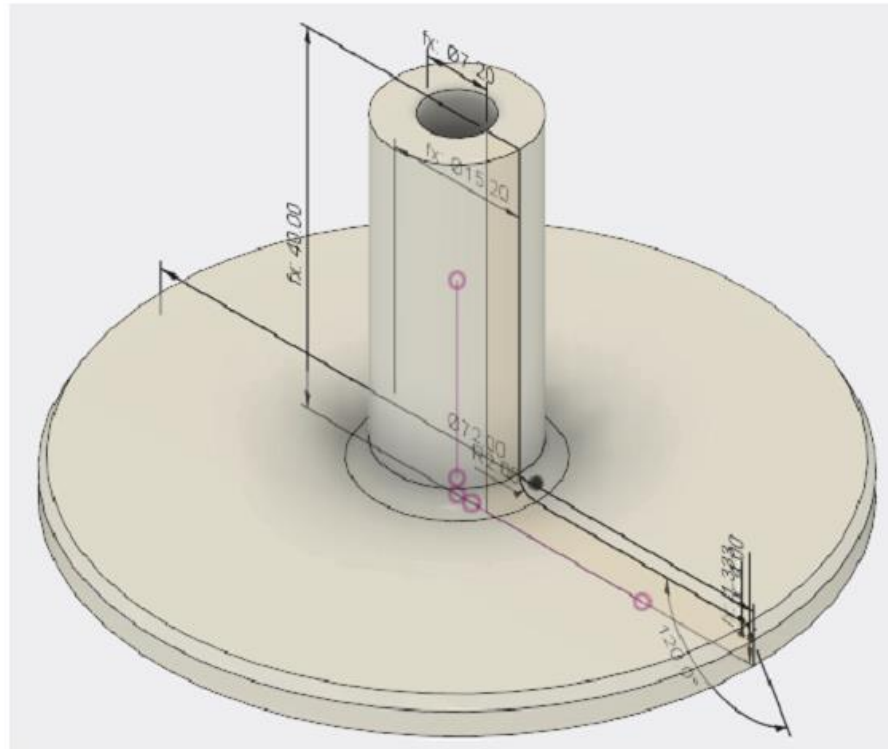


Figure 8–13

12. Save the design and close the file.

Add Parameters

Practice Objectives

- Add equations to a design using the Parameters dialog box and Edit Feature dialog boxes.
- Create user-defined parameters for use in equations.

In this practice, you will modify dimensions in a part using model parameters and then add user-defined parameters. The completed design is shown in Figure 8–14.

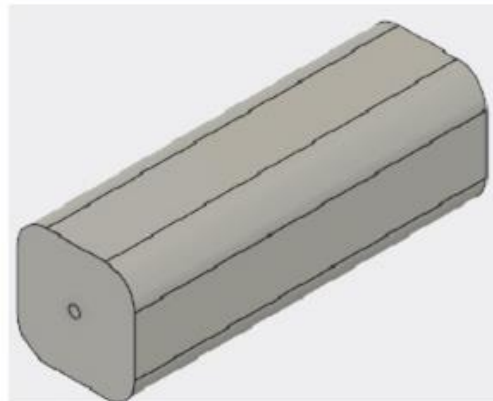



Figure 8–14

Practice 2



Task 1 - Create a new design from file.

1. Click  > **Open**. In the Open window, click **Open from my computer**.
2. In the Open dialog box, navigate to the *C:\Autodesk Fusion 360 Practice Files* folder, select **parameters.f3d**, and click **Open**.
3. Toggle on the visibility of the sketch and its dimensions. The design displays as shown in Figure 8–15.

Practice 2

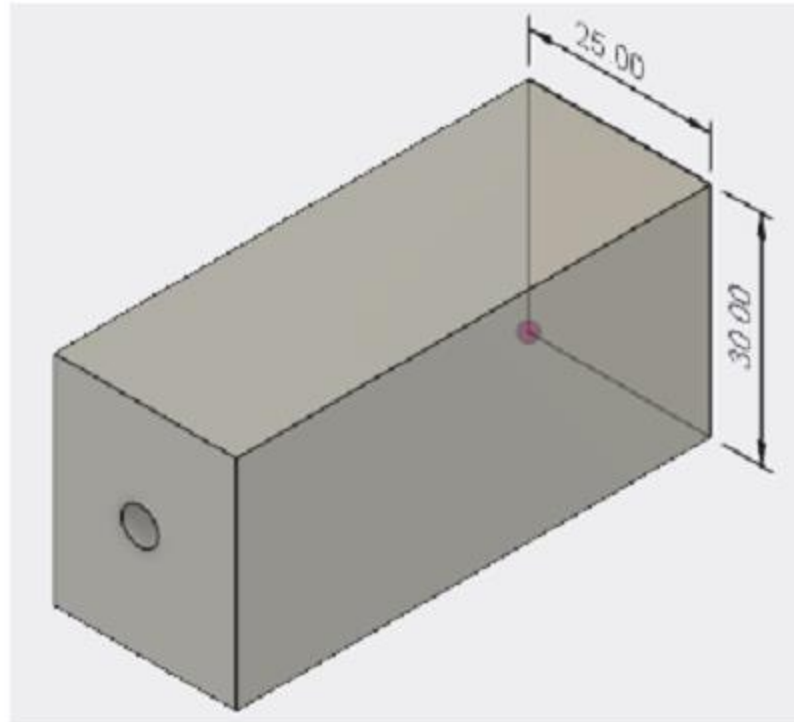


Figure 8–15

Practice 2



Task 2 - Change the model parameter names.

1. In the MODIFY panel, click Σ (Change Parameters).
2. In the Parameters dialog box, expand the nodes under *Model Parameters* to find the dimensions for **Sketch1**.
3. In the *Name* column, select the **d1** dimension and change the name to **width**.
4. Change the name of **d2** to **height**.
5. Expand the **Extrude1** node and change the name of **d3** to **length**.
6. Expand the **Hole1** node and change the name of **d6** to **diameter**.

Practice 2



7. Select the *Expression* cell for the **height** parameter and enter **width**. The height dimension is now driven by the width value.
8. Select the *Expression* cell for the **length** parameter and enter **width*3**. The Parameters dialog box displays as shown in Figure 8–16.

Practice 2



Parameters

Parameter	Name	Unit	Expression	Value	Comments
Favorites					
User Parameters +					
Model Parameters					
Untitled(1)					
Sketch1					
★ Linear Dimension-2	width	mm	25 mm	25.00	
★ Linear Dimension-3	height	mm	width	25.00	
Extrude1					
★ AlongDistance	length	mm	width * 3	75.00	
★ TaperAngle	d4	deg	0.0 deg	0.0	
Hole1					
★ HoleDepth	d5	mm	65.00 mm	65.00	
★ HoleDiameter	diameter	mm	5.00 mm	5.00	
★ TipAngle	d7	deg	118.0 deg	118.0	

OK

Figure 8–16

Practice 2

9. Click **OK** to close the Parameters dialog box.
10. in the Timeline, right-click on the Extrude1 icon and select **Edit Feature**. Note that **width * 3** displays in the *Distance* field, as shown in Figure 8–17.

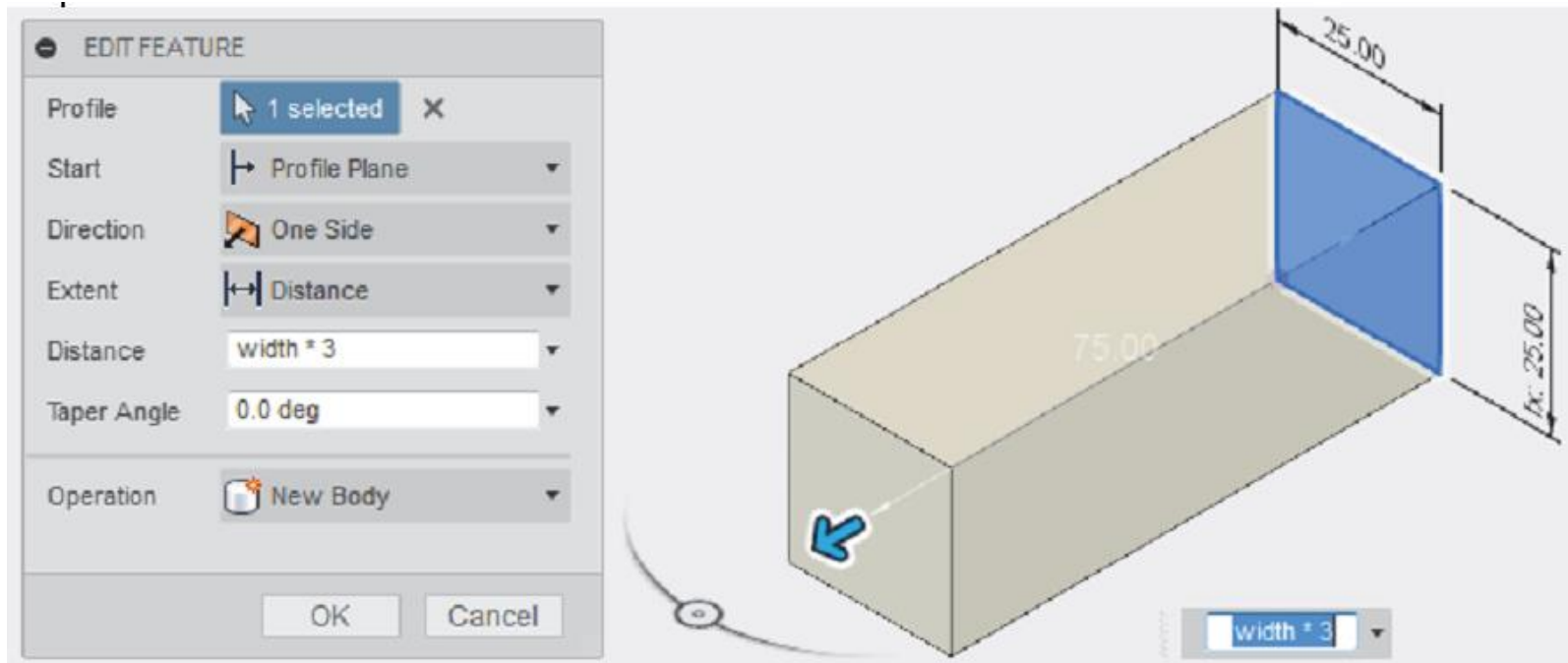




Figure 8–17

Practice 2



11. Click **Cancel** to close the EDIT FEATURE dialog box without making any changes.

Task 3 - Add a user-defined parameter.

1. In the MODIFY panel, click  (Change Parameters).
2. In the *User Parameters* row, click  to add a new user-defined parameter.
3. Set the following in the Add User Parameter dialog box:
 - *Name*: Enter **size**
 - *Unit*: Select **No Units**
 - *Expression*: Enter **1**
 - *Comment*: Enter **determine overall size**

The Add User Parameter dialog box should display as shown in Figure 8–18.

Practice 2

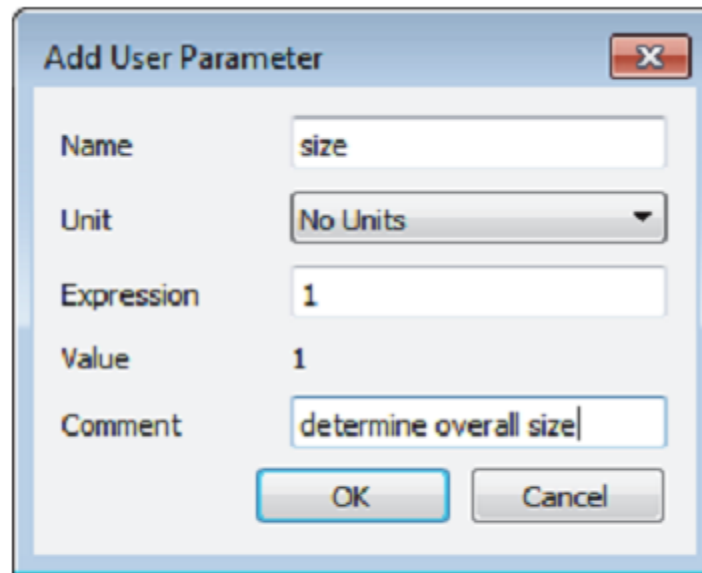



Figure 8–18

4. Click **OK**.

Practice 2



Task 4 - Add a second user-defined parameter.

1. In the *User Parameters* row, click  to add a new user-defined parameter.
2. Set the following options:
 - *Name*: Enter **round_1**
 - *Units*: Select **mm**
 - *Expression*: Enter **3.175**
 - *Comment*: Enter **fillet radius**
3. Click **OK**.

Practice 2



4. Select the *Expression* cell for the width dimension and enter **25mm*size**. The Parameters dialog box should display as shown in Figure 8–19.
 - The user-defined size parameter drives the width dimension. Since the size parameter does not have any units, you must multiply it by a distance to obtain a distance value.

Parameter names are case sensitive.

Practice 2



Parameters

Parameter	Name	Unit	Expression	Value	Comments
Favorites					
▾ User Parameters					
★ User Parameter	size		1	1	determine overall size
★ User Parameter	round_1	mm	3.175 mm	3.175	fillet radius
Model Parameters					
▾ Untitled(1)					
▾ Sketch1					
★ Linear Dimension-2	width	mm	25 mm * size	25.00	
★ Linear Dimension-3	height	mm	width	25.00	
▾ Extrude1					
★ AlongDistance	length	mm	width * 3	75.00	
★ TaperAngle	d4	deg	0.0 deg	0.0	
▾ Hole1					
★ HoleDepth	d5	mm	65.00 mm	65.00	
★ HoleDiameter	diameter	mm	5.00 mm	5.00	
★ TipAngle	d7	deg	118.0 deg	118.0	

OK

Figure 8–19

Practice 2



5. Click **OK** to close the Parameters dialog box.

Task 5 - Add fillets.

In this task, you will add fillets to the design and use the parameters you defined to modify the fillets.

1. Start the creation of the fillet and add constant radius fillets to the four long edges of the design, as shown in Figure 8–20.
2. In the FILLET palette, in the *Radius* field, enter **round_1** as shown in Figure 8–20.

Practice 2

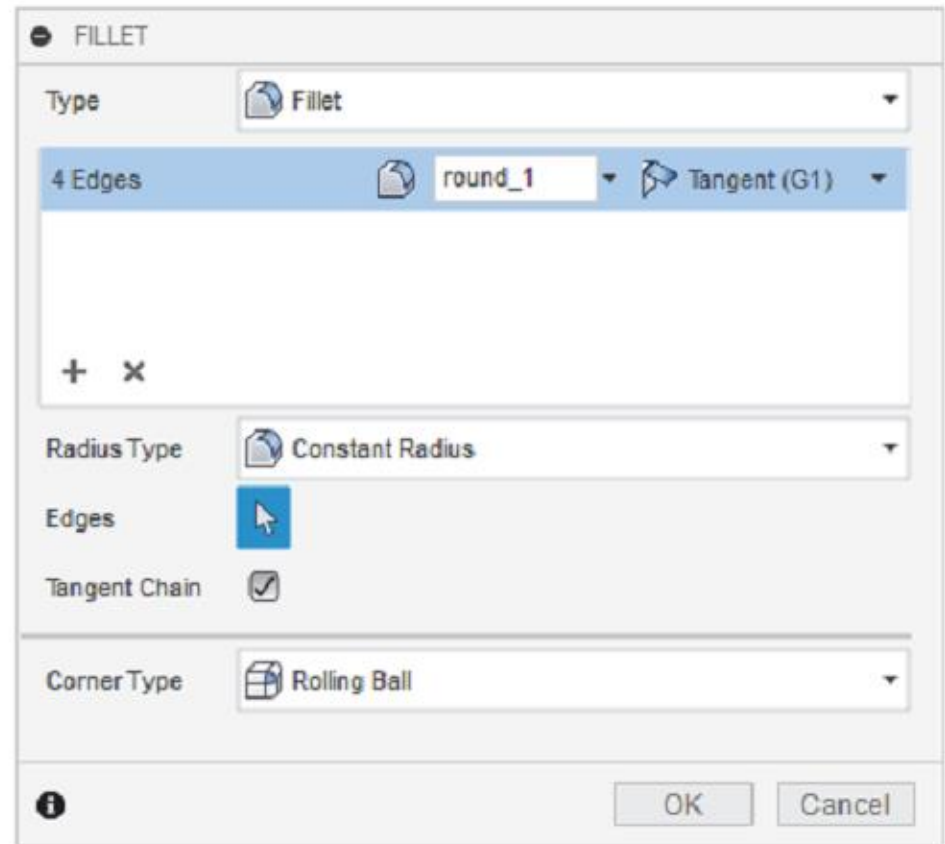
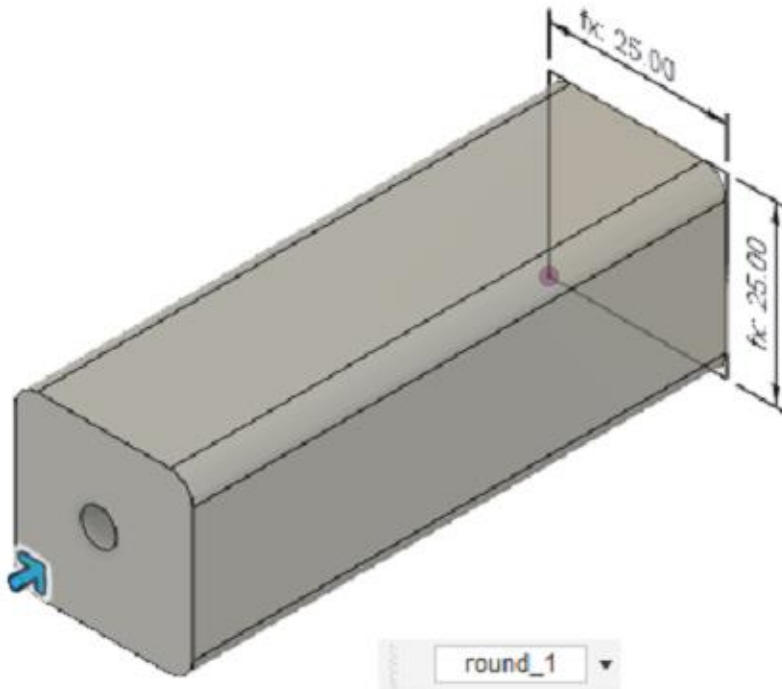


Figure 8–20

Practice 2



3. Complete the fillet.
4. In the Parameters dialog box, change the expression of the **round_1** parameter to **12.5**. The design displays as shown in Figure 8–21.
5. Change the equation of the size parameter to **2**. The updated design displays as shown in Figure 8–22.

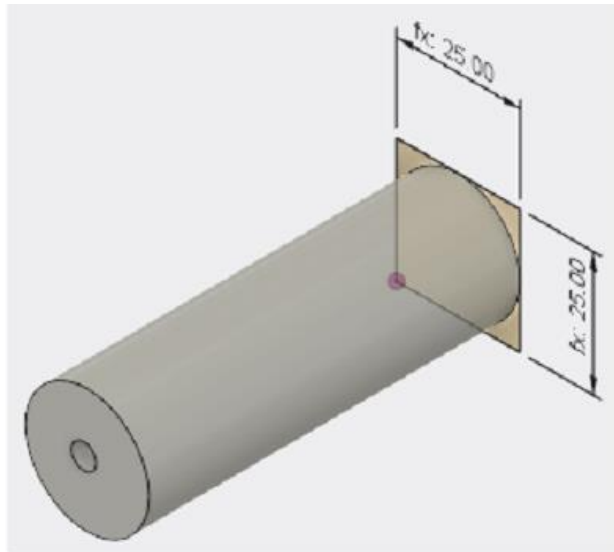


Figure 8–21

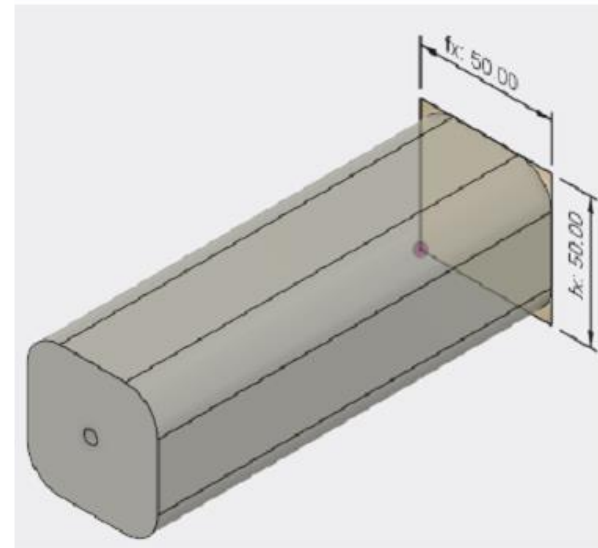


Figure 8–22

Practice 2



6. Close the Parameters dialog box.
7. Save the design with the name **parameters** to your *Autodesk Fusion 360 Practice Files* project.
8. Close the file.