Feature Duplication Tools

When creating similar geometry, incorporating the use of duplication techniques enables you to efficiently create designs. Duplication techniques can include making mirrored copies of features or an entire body, or using patterns to make multiple copies of a feature.

Learning Objectives in this Chapter

- Mirror faces, bodies, and features in a design.
- Create a rectangular pattern of geometry.
- Create a circular pattern of geometry.
- Create a pattern of geometry that follows a sketched path or adjacent edges.

Timeline icon: ⚠

13.1 Mirroring Geometry

The Mirror tool enables you to mirror solid geometry by selecting faces, bodies, or features to be mirrored about a reference plane, as shown in Figure 13–1. If you mirror a body, a second body is created in the design. To start the **Mirror** tool, in the CREATE panel, click ⚠ (Mirror).

The hole feature on the left of the work plane was mirrored to the right.
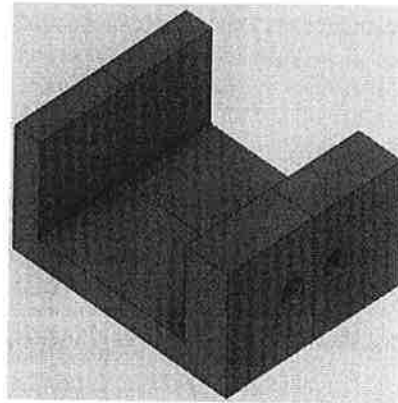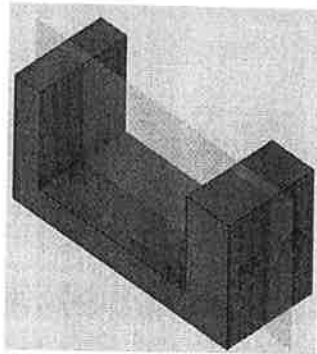
The body was mirrored to the left of the model by selecting the side face.

Figure 13–1

- The *Pattern Type* drop-down list defines whether faces (▢), bodies (▢), features (▣), or components (▢) are to be selected for patterning. Faces are the default type.

When features are being patterned, the object must be selected from the Timeline.

- The mirror plane can be a construction plane or an existing face/plane on a solid feature.

- When you are mirroring features, the *Compute Option* field is added to the MIRROR palette. The options include:
  - **Adjust:** Recalculates each feature based on its mirrored location (e.g., Extent options such as To are recalculated, and mirrored geometry is updated appropriately.).
  - **Optimized:** Use this option when mirroring a large quantity of features.
  - **Identical:** Creates exact mirrored copies of the feature.

- In the Timeline, right-click on ⚠ to access commands for editing or deleting the mirror operation.

13.2 Patterning Features

There are three types of patterns that can be created for duplicating faces, bodies, features, or components: a rectangular pattern, a circular pattern, and a pattern that follows a path. To access the **Pattern** options, click **Pattern** in the CREATE panel.

Rectangular Patterns

Timeline icon:

A rectangular pattern is used to duplicate geometry in either one or two directions. A direction reference can be a linear part edge or a construction axis. The object being patterned is duplicated at a set spacing distance along these directions and you can define the number of instances that are to be generated. Once the layout is defined, you can also individually suppress instances. Figure 13–2 shows how a hole is patterned using a **Rectangular Pattern** option.
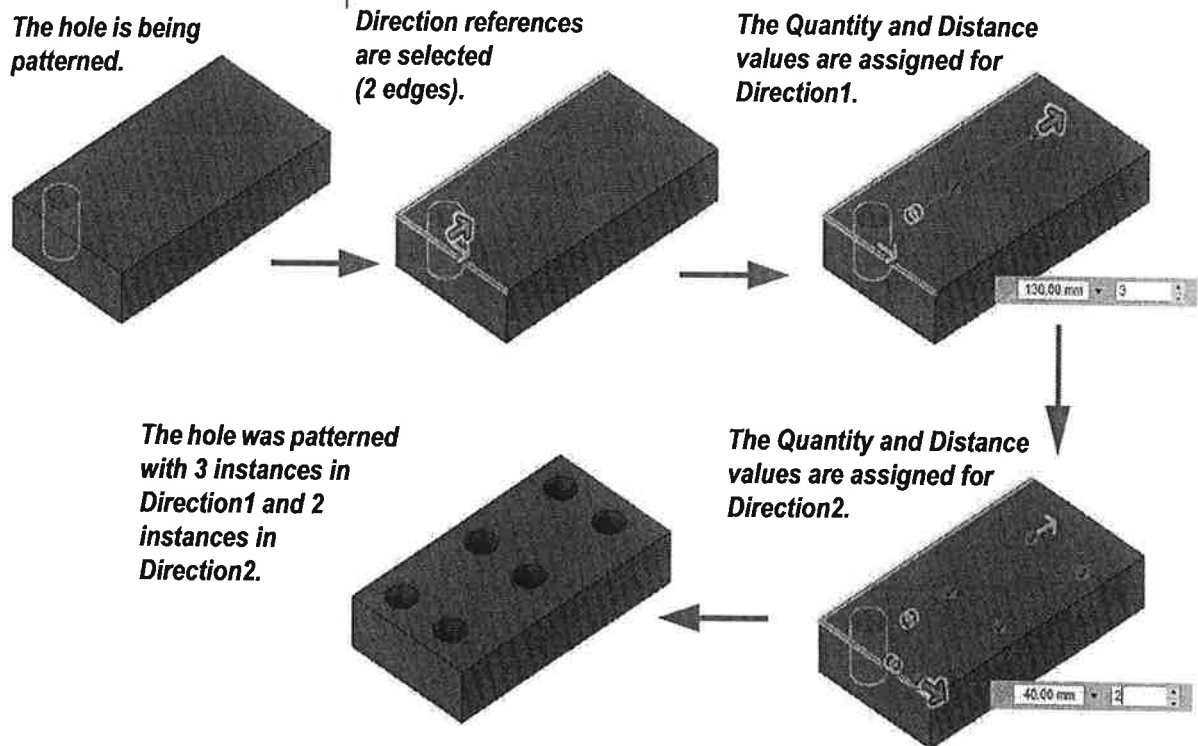
The hole is being patterned.

Direction references are selected (2 edges).

The Quantity and Distance values are assigned for Direction1.

130.00 mm ▼ 3

The hole was patterned with 3 instances in Direction1 and 2 instances in Direction2.

The Quantity and Distance values are assigned for Direction2.

40.00 mm ▼ 2

Figure 13–2

Use the following general steps to create a rectangular pattern:

1. Start the creation of the pattern.
2. Select the *Pattern Type* and the *Objects* to pattern. You can pattern faces, bodies, features, or components.
3. Select the *Directions* for the pattern and enter the quantity and distance values to define the patterned instances.
4. Define additional pattern options, as required.
5. Complete the pattern.

Circular Patterns

A circular pattern is used to create a rotating pattern of objects about a single axis of rotation. The axis of rotation can be a linear or circular edge, axis, or cylindrical face. The object is patterned based on a number of defined instances (Quantity) that are positioned evenly over the defined rotation angle. Once the pattern is defined, you can individually suppress instances as required. Figure 13–3 shows how a hole is patterned using a **Circular Pattern** option.

Timeline icon:

The hole is being patterned about the central axis.

The default pattern defaults to 3 instances about 360° (Full).
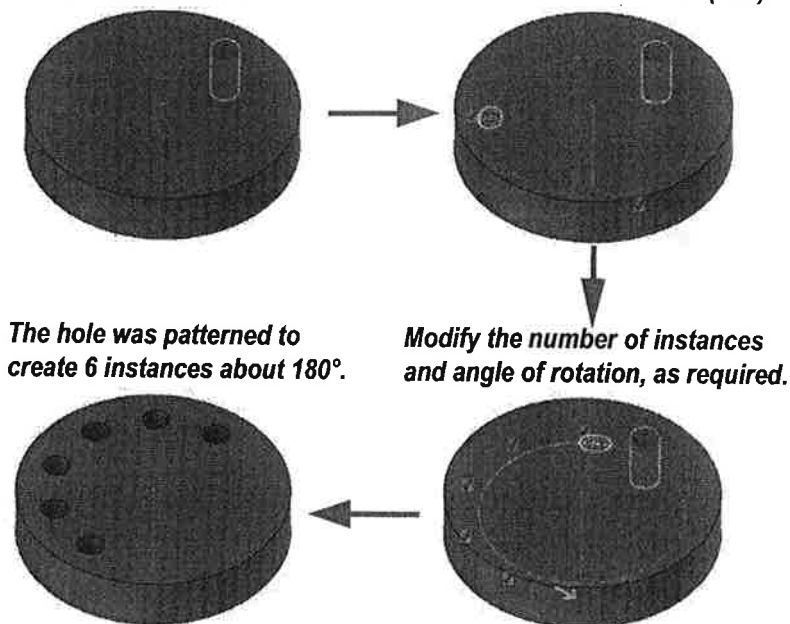
The hole was patterned to create 6 instances about 180°.

Modify the number of instances and angle of rotation, as required.

Figure 13–3

Use the following general steps to create a circular pattern:

1. Start the creation of the pattern.
2. Select the *Pattern Type* and the *Objects* to pattern. You can pattern faces, bodies, features, or components.
3. Select the *Axis* of rotation for the pattern.
4. Select the *Type* and enter the quantity and angular values to define the patterned instances.
5. Define additional pattern options, as required.
6. Complete the pattern.

Pattern on Path

Timeline icon:

A pattern on path is used to create a pattern that follows a predefined path. The path reference can be a sketched curve or existing edges. You can customize the pattern distance, quantity, and orientation using the pattern options. Similar to rectangular and circular patterns, once the pattern is defined you can also individually suppress instances. Figure 13–4 shows how a hole is patterned using a **Pattern on Path** option.
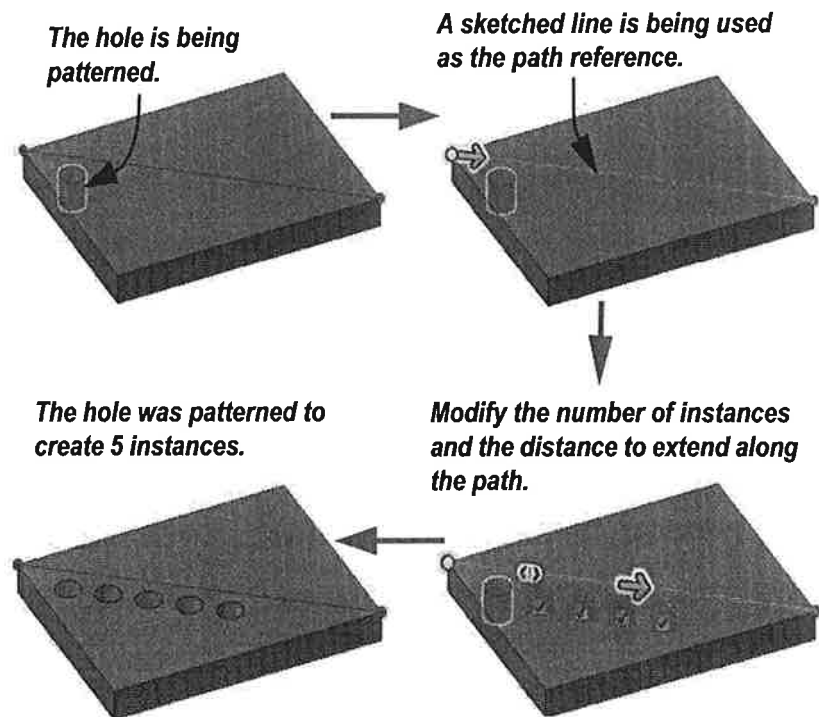
The hole is being patterned.

A sketched line is being used as the path reference.

The hole was patterned to create 5 instances.

Modify the number of instances and the distance to extend along the path.

Figure 13–4

Use the following general steps to create a pattern on a path:

1. Start the creation of the pattern.
2. Define the *Pattern Type* and the *Objects* to pattern. You can pattern faces, bodies, features, or components.
3. Select the *Path* for the pattern. You can select sketched curves or edges on the model geometry as the path reference.
4. Enter the quantity and distance values to define the patterned instances.
5. Define additional pattern options, as required.
6. Complete the pattern.

Practice 13a | Mirroring Geometry

Practice Objective

- Mirror select features and bodies to create required geometry.

In this practice, you will modify a design that has been provided for you. You will begin by creating a construction plane that will be used to mirror features in the model. You will then create several mirror operations to mirror bodies to create the final geometry. Figure 13–5 shows the initial and final models for this practice.
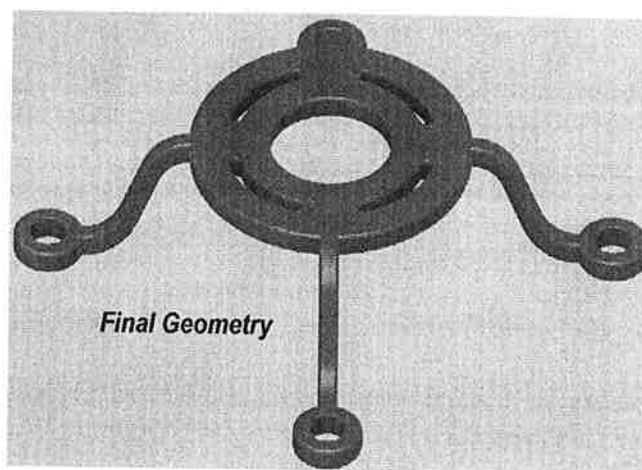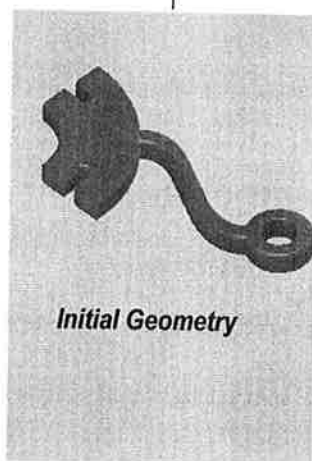

Initial Geometry   **Final Geometry**

Figure 13–5

Task 1 - Open a part file and create a plane mirror features.

1. Click (File)>**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 **Stand.f3d**, and click **Open**.

*The **Midplane** option does not require that the reference faces or planes be parallel.*

3. Create a construction plane through the middle of the existing body, as shown in Figure 13–6. Use the **Midplane** option and select the two planar faces to define its location.
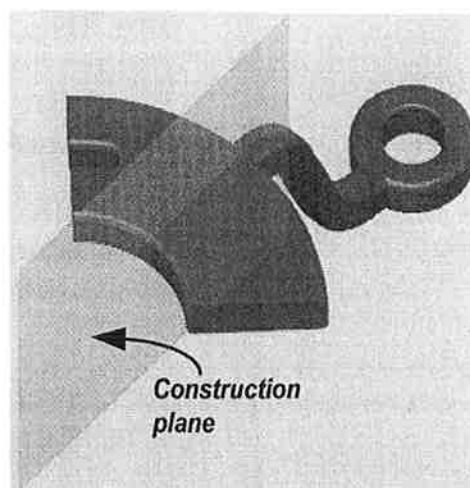
Construction plane

Figure 13–6

Task 2 - Mirror features in the model.

When you are selecting features to be mirrored or patterned, you must select the features in the Timeline. You cannot select features in the BROWSER or graphics window.

1. In the *SOLID* tab>CREATE panel, click ◿ (Mirror).

2. In the MIRROR palette, in the *Pattern Type* drop-down list, select **Features** as the type of object to be mirrored.

3. In the Timeline, select the **Extrude1** and **Fillet1** features.

4. In the MIRROR palette, click **Select** in the *Mirror Plane* field. In the graphics window, select **Plane1** as the mirror plane reference.

5. Ensure the *Compute Option* is set to **Adjust**. This will recalculate each mirrored feature based on its mirrored location.

6. Click **OK** to mirror the features. The model displays as shown in Figure 13–7. The construction plane has been removed from the display in this image for clarity.
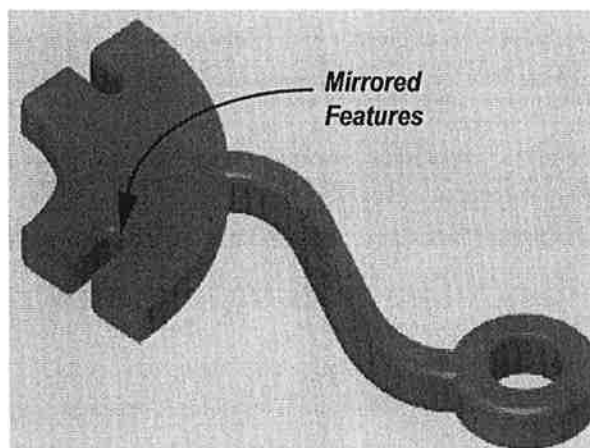

Mirrored Features

Figure 13–7

Task 3 - Mirror the part.

1. In the CREATE panel, click ⚠ (Mirror).

2. In the MIRROR palette, in the *Pattern Type* drop-down list, select **Bodies** as the object type to be mirrored. In the graphics window, select the model. The entire solid body is selected.

3. Click **Select** in the *Mirror Plane* field. Select the face shown in Figure 13–8 as the mirror plane reference.
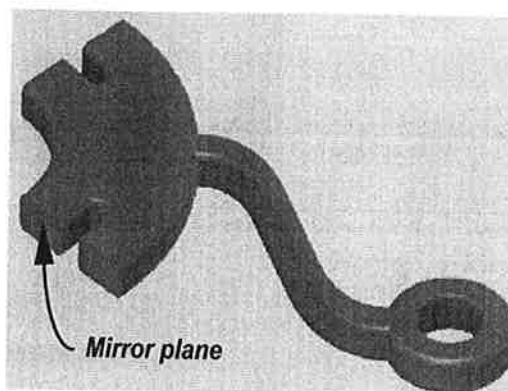

Figure 13–8

4. Click **OK** to mirror the model as shown in Figure 13–9.

5. Complete the part by creating another mirror feature as shown in Figure 13–10.

   • Note that when you are selecting the bodies to mirror you are required to select two bodies. When a body is mirrored it is created as its own body.

   • Change the *Visual Style* to **Shaded with Visible Edges Only** to display that they are all separate bodies.

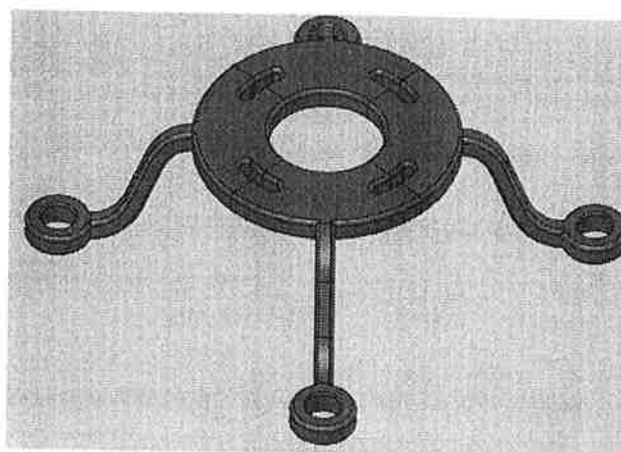   • In the next task, you will learn how to combine these separate bodies into one.

Figure 13–9

Figure 13–10

Task 4 - Combine the three mirror bodies with the initial body.

1. In the BROWSER, expand the **Bodies** folder and note that there are four bodies in the model.

2. In the MODIFY panel, click ![icon] (Combine).

3. By default, the *Target Body* field is active. In the BROWSER, select **Body1** as the target for the combine operation.

4. Ensure that the *Tool Bodies* field is activated, and then select **Body2**, **Body3**, and **Body4**.

5. For the *Operation* value, ensure that **Join** is selected. Click **OK** to combine the four bodies into one.

Task 5 - Modify the model.

1. In the Timeline, right-click on **Extrude1** and select **Edit Profile Sketch**. The sketch that was used to create this extrusion is opened.

2. Change the 12.5° angular dimension to **25.0°**. Complete the sketch. Note how all of the mirrored features update to reflect the change, as shown in Figure 13–11.
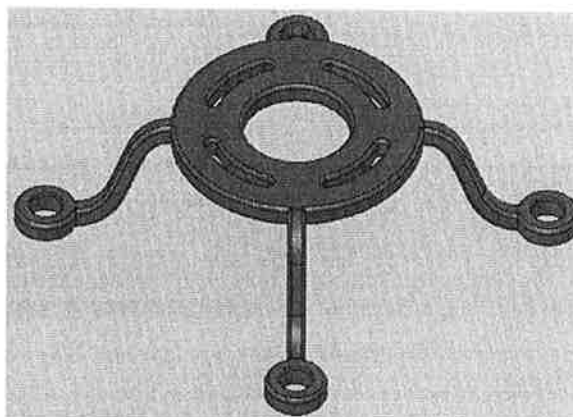

Figure 13–11

3. Save the design with the name **Stand** to your *Autodesk Fusion 360 Practice Files* project.

4. Close the file.

Practice 13b | Patterning Geometry

Practice Objective

- Pattern geometry using the Rectangular, Circular, and Pattern on Path options.

In this practice, you will open a model and create three different patterns. Each pattern will be created using one of the three patterning options.

Task 1 - Create a rectangular pattern of features in the model.

In this task, you will create the rectangular pattern of features shown in Figure 13-12.
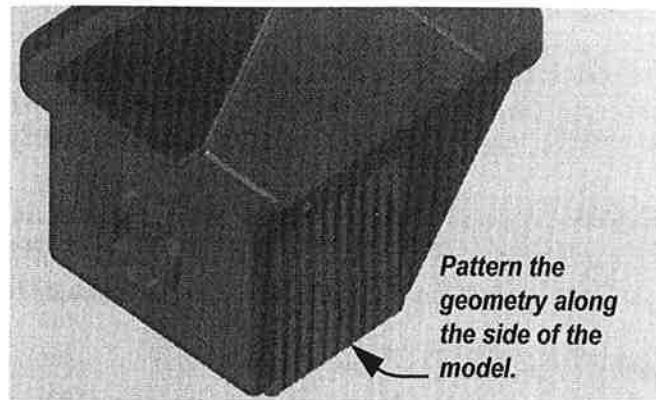

Pattern the geometry along the side of the model.

Figure 13-12

1. Click ![File icon] (File)>**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 **AirBox.f3d**, and click **Open**.

3. In the toolbar, click ![Rectangular Pattern icon] (Rectangular Pattern) in the CREATE panel. The RECTANGULAR PATTERN palette opens as shown in Figure 13-13.

Figure 13–13

4. For the *Pattern Type,* select **Features** in the drop-down list.

5. In the Timeline, select **Extrude4** as the feature to be patterned. Once the object is selected, the *Objects* field in the palette indicates that 1 item has been selected and the object highlights in blue.

6. In the RECTANGULAR PATTERN palette, activate the *Directions* field by clicking **Select**. Select the edge shown in Figure 13–14 as the direction reference.
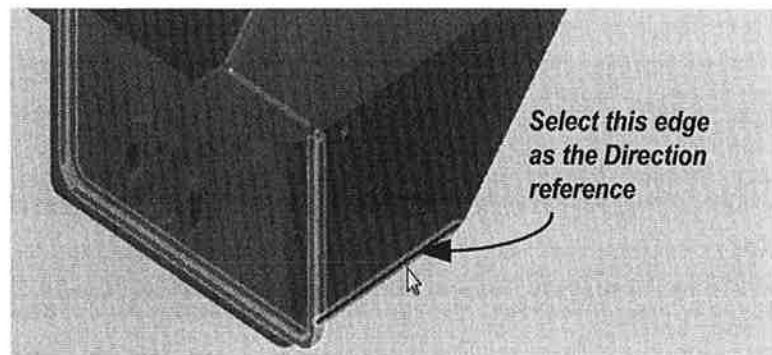

Select this edge as the Direction reference

Figure 13–14

7. For the *Distance Type* option, ensure that **Extent** is selected. This assigns the overall pattern distance value from the start of the first instance to the start of the last instance.

8. Select and drag the arrow manipulator into the model. By default, three copies of the patterned extrusion extend out in an equal distance from one another. You can adjust the number of extrudes to be patterned by either using the *Quantity* input value boxes, or by dragging the small double arrow manipulators.

9. Change the *Quantity* value to **10** using either method.

10. Change the top *Distance* value to **110 mm**. The model displays as shown in Figure 13–15.
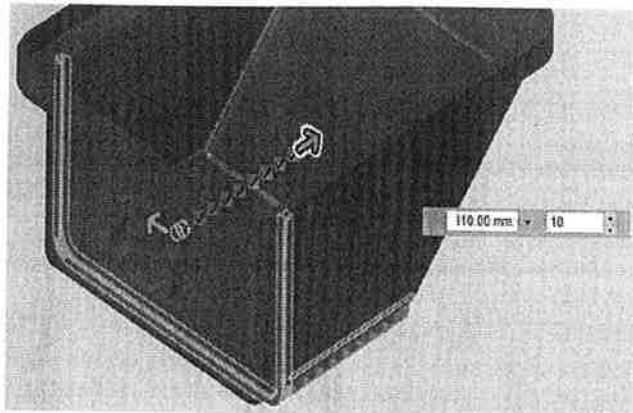

Figure 13–15

11. In the *Direction Type* drop-down list, ensure that **One Direction** is selected.

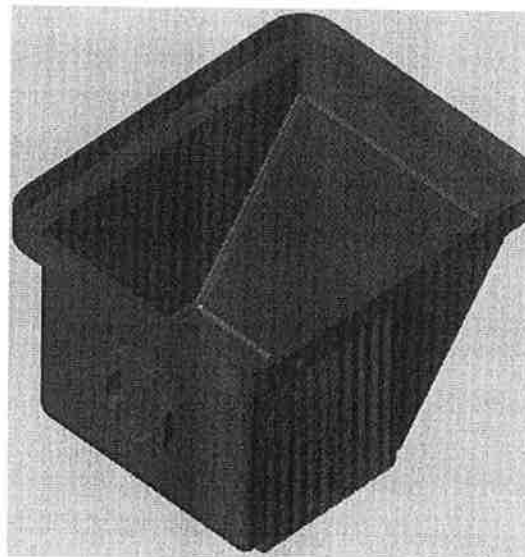12. Click **OK** to create the pattern. The pattern is created as shown in Figure 13–16.

Figure 13–16

Task 2 - Create a circular pattern of holes.

In this task, you will create a circular pattern of features shown in Figure 13–17.

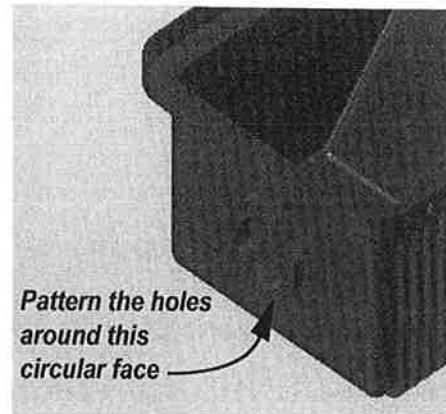
Pattern the holes around this circular face

Figure 13–17

1. In the toolbar, expand the CREATE panel and select **Pattern>Circular Pattern**.

2. For the *Pattern Type,* ensure that **Features** is selected in the drop-down list. The CIRCULAR PATTERN palette displays as shown in Figure 13–18.

Figure 13–18

You must used the Timeline to select the features that are being patterned.

3. Select the hole shown in Figure 13–19 as the feature to be patterned. Once the object is selected, the *Objects* field in the palette indicates that 1 item has been selected, and the object highlights in blue.
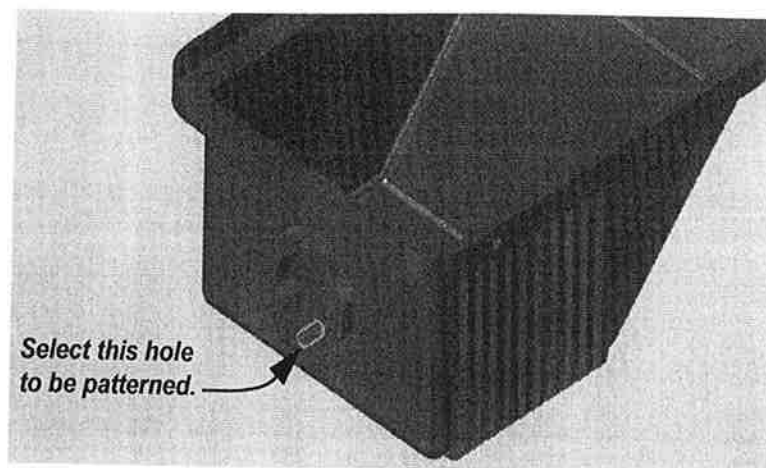

Figure 13–19

4. Click **Select** in the *Axis* field to activate it.

5. Select the outer edge of the cylinder as the rotation axis reference.

6. Increase the *Quantity* to **6** by either inputting it in the palette or dragging the manipulator until six instances of the hole display.

7. Ensure that the *Type* option is set to **Full**. This creates the pattern in a complete 360° degree circle.

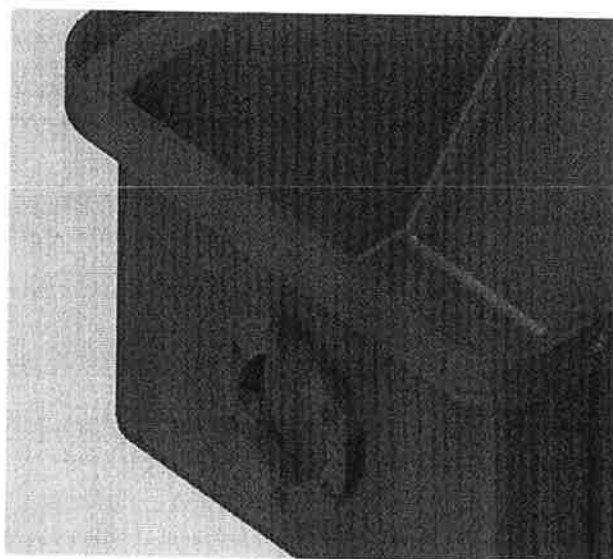8. Click **OK** to create the pattern. The model displays as shown in Figure 13–20.

Figure 13–20

Task 3 - Pattern a hole along a path.

In this task, you will pattern the hole on the top lip of the model so that it follows the path of the top edge, as shown in Figure 13–21.
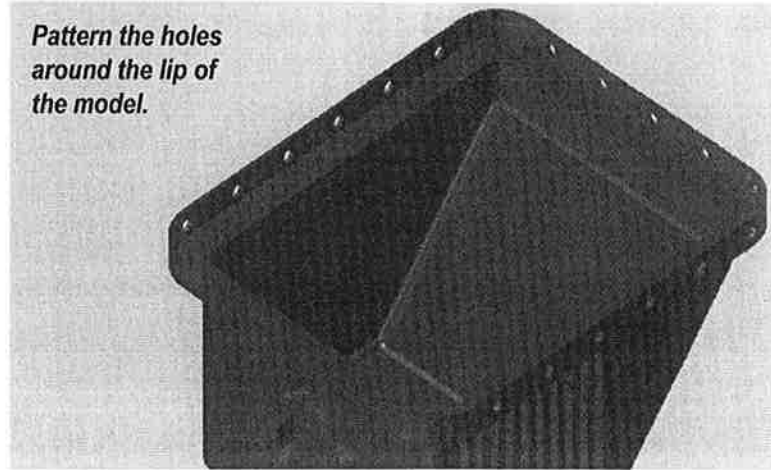

Pattern the holes around the lip of the model.

Figure 13–21

1. In the toolbar, expand the CREATE panel and select **Pattern>Pattern on Path**.

2. For the *Pattern Type*, ensure that **Faces** is selected in the drop-down list. The PATTERN ON PATH palette displays as shown in Figure 13–22.

Figure 13–22

3. Select the cylindrical face of the hole as the face to be patterned, as shown in Figure 13–23. Once the face is selected, the *Objects* field in the palette indicates that 1 item has been selected and the face highlights in blue.
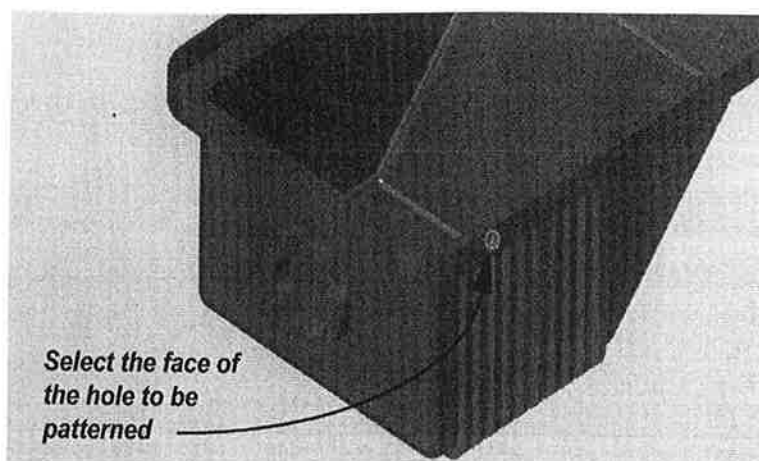

Select the face of the hole to be patterned

Figure 13–23

4. In the palette, activate the *Path* field by clicking **Select** in it.

5. Select the outside-top edge of the lip as the path reference.

6. Once both of these fields are defined, an arrow displays that enables you to drag additional instances of the pattern along the path. As an alternative to dragging the arrow all of the way around the edge, enter a *Distance* value of **1008 mm**. This is the length of the edge.

7. Increase the *Quantity* to **25** and keep the remaining defaults in the palette.

8. Click **OK** to create the pattern. Note how the pattern is not created correctly and the holes do not cut through the lip correctly.

9. Edit the path pattern feature and change the *Orientation* option to **Path Direction**. Click **OK**. The pattern now cuts through the lip correctly because the orientation of the hole relative to the path was kept for the entire path.

10. Note how the final hole overlaps the first hole and there are holes on each of the corners. Edit the path pattern again. In the preview of the pattern, clear the checkbox that identifies the final patterned instance. This removes the instance from the pattern.

11. Continue to remove any holes that are patterned on the corners of the lip so that the model displays similar to that shown in Figure 13–24.
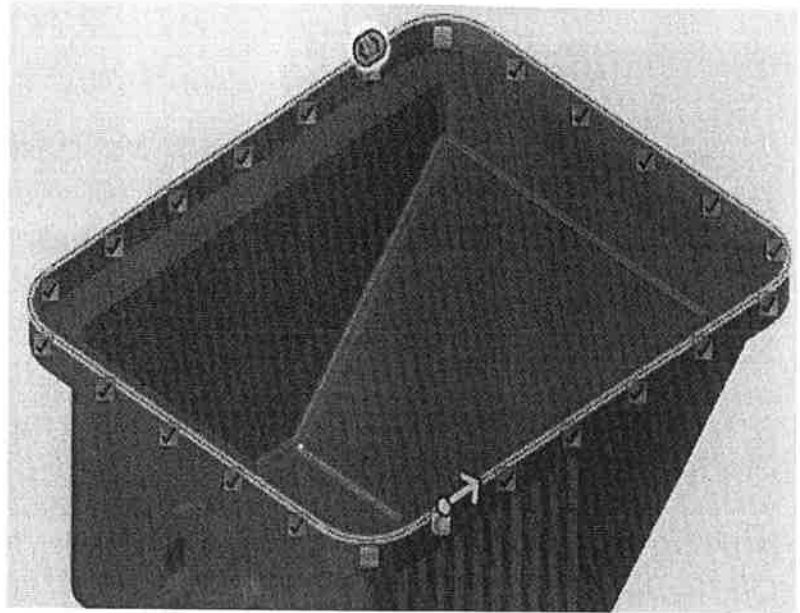
Figure 13–24

12. Complete the pattern. The model should display similar to that shown in Figure 13–25
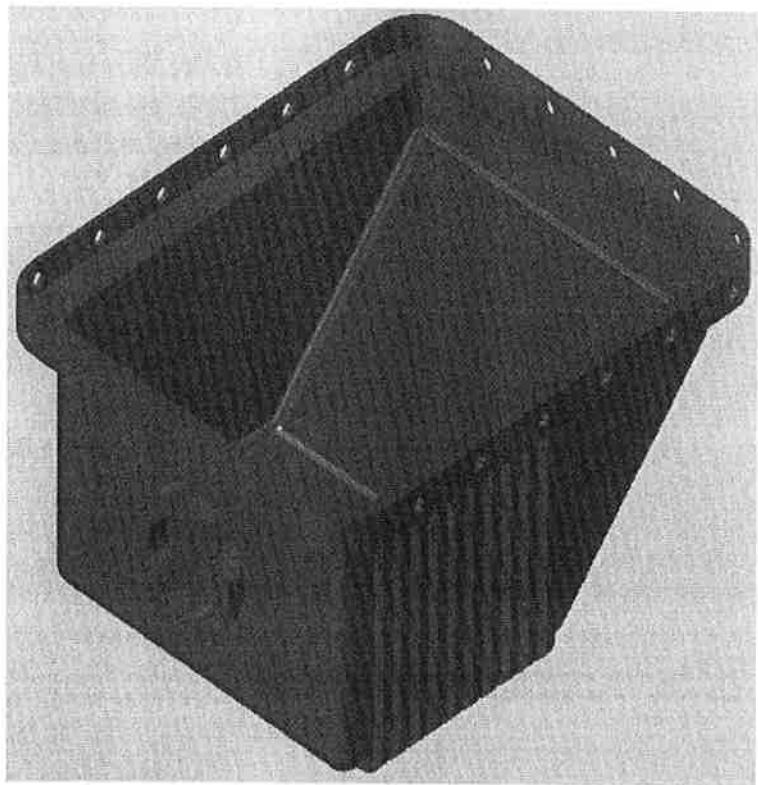

Figure 13–25

13. Save the design with the name **AirBox** to your *Autodesk Fusion 360 Practice Files* project.

14. Close the file.

Command Summary

Button	Command	Location
	Circular Pattern (feature)	• **Toolbar:** *DESIGN* Workspace>*SOLID* tab>CREATE panel
	Combine	• **Toolbar:** *DESIGN* Workspace>*SOLID* tab>MODIFY panel
	Mirror (feature)	• **Toolbar:** *DESIGN* Workspace>*SOLID* tab>CREATE panel
	Pattern on Path (feature)	• **Toolbar:** *DESIGN* Workspace>*SOLID* tab>CREATE panel
	Rectangular Pattern (feature)	• **Toolbar:** *DESIGN* Workspace>*SOLID* tab>CREATE panel