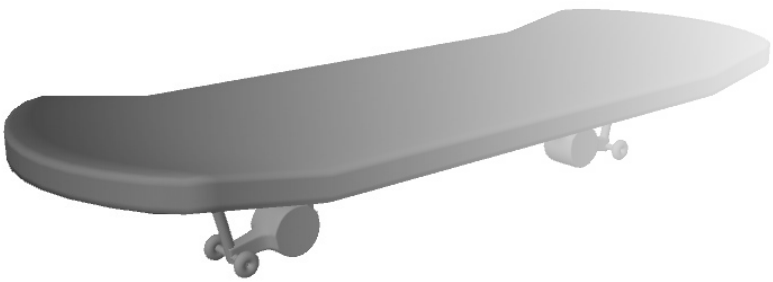
Chapter 2

Polygon Modeling

Learning Objectives

After completing this chapter, you will be able to:

- *Create polygon primitives*
- *Edit polygon primitives*
- *Modify the components of polygon primitives*
- *Create models using polygon primitives*



INTRODUCTION

In this chapter, you will learn to create and edit polygon shapes using polygon modeling techniques. A polygon is made up of different closed planar shapes having straight sides. The most commonly used shapes in 3D polygons are triangles and quadrilaterals. These shapes are formed by vertices, edges, and faces. An edge is a straight line formed by joining two vertices. In a polygon, three vertices join to each other by three edges to form a triangle and four vertices join to each other by four edges to form a quadrilateral. By modifying faces, edges, and vertices of an object, you can create a polygon model as per your requirement.

Note

If you want to create polygon objects using click-drag operations, you need to turn on the ***Interactive Creation*** *option available in the menubar. To do so, choose* ***Create > Objects > Polygon Primitives > Interactive Creation*** *from the menubar. The* ***Interactive Creation*** *option works with all primitives. There are certain parameters that cannot be controlled via interactive creation. These parameters can only be changed from the settings window of the tool.*

This option also affects how Maya shows the tool settings. For example, if the ***Interactive Creation*** *option is selected and you choose* ***Create > Objects > Polygon Primitives > Sphere > Option Box*** *from the menubar, the* ***Tool Settings (Polygon Sphere Tool)*** *panel will be displayed. In this panel, you can set non-interactive attributes such as* ***Axis divisions*** *and* ***Height divisions*** *and then click-drag in the viewport to interactively define the radius of the sphere. If you want to create a sphere with the current settings specified in the panel, just click on the viewport instead of clicking and dragging. You can reset the settings by choosing the* ***Reset Tool*** *button available at the top-right corner of the panel.*

If the ***Interactive Creation*** *option is not selected, the* ***Polygon Sphere Options*** *window will be displayed. In this window, specify the attributes and then choose the* ***Create*** *button to create sphere with specified settings.*

POLYGON PRIMITIVES

In Maya, polygon primitives are classified into various objects. These objects are grouped under **Polygon Primitives** in the menubar. The method of creating different polygon primitives is discussed next.

Creating a Sphere

Menubar:	Create > Objects > Polygon Primitives > Sphere
Shelf:	Polygons > Polygon Sphere

A sphere is a solid object in which every point on its surface is equidistant from its center, as shown in Figure 2-1. The sphere can be created interactively or by entering the values using the keyboard. Both the methods are discussed next.

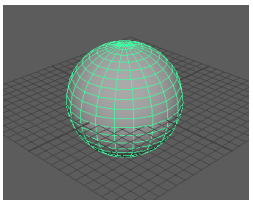


Figure 2-1 *A polygon sphere*

Creating a Sphere Interactively

To create a sphere interactively, first turn on the **Interactive Creation** option and then choose **Create > Objects > Polygon**

Primitives > Sphere from the menubar; you will be prompted to drag the cursor on the grid to draw sphere in the viewport. Press and hold the left mouse button, and drag the cursor up or down to define the radius of the sphere. Now, release the left mouse button to get the desired radius; the sphere will be created and will become visible in the **Smooth Shade All** mode.

Note

*By default, polygon primitives are displayed in the **Smooth Shade All** mode. Press 4 to change the display to the **Wireframe** mode. Alternatively, choose **Shading > Wireframe** from the **Panel** menu. You can also switch back to the **Smooth Shade All** mode by pressing 5 or by choosing **Shading > Smooth Shade All** from the **Panel** menu.*

Creating a Sphere by Using the Keyboard

To create a sphere by using the keyboard, choose **Create > Objects > Polygon Primitives > Sphere > Option Box** from the menubar; the **Tool Settings (Polygon Sphere Tool)** panel will be displayed, as shown in Figure 2-2. In this panel, set the properties of the sphere using the keyboard and then click in the viewport; a sphere will be created. Choose **Reset Tool** at the top of the **Tool Settings (Polygon Sphere Tool)** panel to reset the default values of the sphere. It is recommended that you reset the values while creating a new polygon primitive.

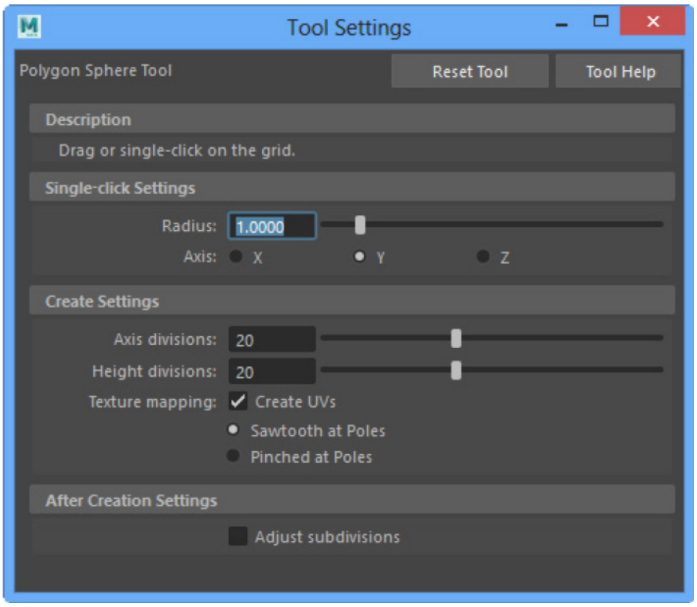


***Figure 2-2** The **Tool Settings (Polygon Sphere Tool)** panel*

Modifying the Name and other Parameters of a Sphere

You can modify the name and other parameters of a sphere. To do so, select the sphere; the **Channel Box / Layer Editor** is displayed on the right of the viewport, refer to Figure 2-3. If the **Attribute Editor** is displayed on the right of the viewport, press **Ctrl+A** to switch to the **Channel Box / Layer Editor**. Now, click on the **pSphere1** label in the **Channel Box / Layer Editor**; the **pSphere1** label is converted into an edit box. Next, enter the desired name in the edit box and press ENTER. To modify the properties of the sphere, expand the **polySphere1** node in the **INPUTS** area; various options will be displayed. Enter the required values in the edit boxes;

the changes will be dynamically reflected on the sphere in the viewport. Alternatively, select the label of the parameter of the sphere that you want to change; the corresponding label of the parameter will be highlighted in the **Channel Box / Layer Editor**. Now, press and hold the middle mouse button and drag the cursor horizontally in the viewport to change that particular value of the corresponding parameter.

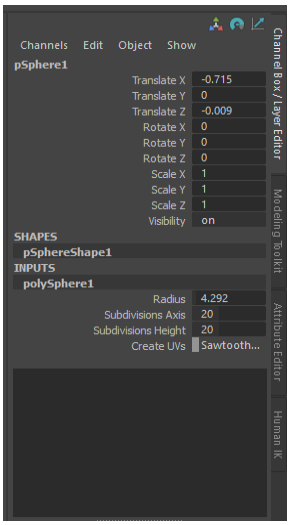


Figure 2-3** The **Channel Box / Layer Editor

Creating a Cube

Menubar:	Create > Objects > Polygon Primitives > Cube
Shelf:	Poly Modeling > Polygon Cube

A cube is a three-dimensional shape with six sides or rectangular faces, as shown in Figure 2-4. To create a cube interactively, choose **Create > Objects > Polygon Primitives > Cube** from the menubar; you will be prompted to drag the cursor on the grid to draw the cube in the viewport.

Press and hold the left mouse button, and drag the cursor on the grid to define the base of the cube. Next, release the left mouse button to get the desired base. Now, press and hold the left mouse button again and drag the cursor up to set the height of the cube and then release the left mouse button; the cube will be created.

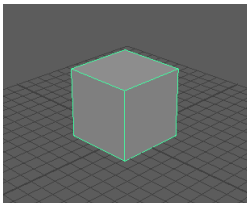


***Figure 2-4** A polygon cube*

Creating a Prism

Menubar:	Create > Objects > Polygon Primitives > Prism

A prism is a polyhedron that has two polygonal faces lying in parallel planes as bases and the other faces as parallelograms, as shown in Figure 2-5. To create a prism interactively, choose **Create > Objects > Polygon Primitives > Prism** from the menubar; you will be prompted to drag the cursor on the grid to draw the prism in the viewport. Press and hold the left mouse button and drag the cursor; the base of the prism is created. Now, release the left mouse button to get the desired base. Again, press and hold the left mouse button and drag the cursor up to set the height of the prism. Next, release the left mouse button; the polygon prism will be created.

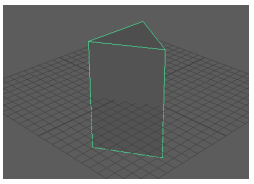


***Figure 2-5** A polygon prism*

Creating a Pyramid

Menubar:	Create > Objects > Polygon Primitives > Pyramid
Shelf:	Poly Modeling > Polygon Pyramid

A pyramid is a geometric shape with a polygonal base and a point called apex. The base and the apex are connected through triangular faces, as shown in Figure 2-6. To create a pyramid interactively, choose **Create > Objects > Polygon Primitives > Pyramid** from the menubar; you will be prompted to drag the cursor on the grid to draw the pyramid in the

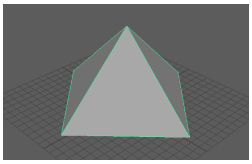


***Figure 2-6** A polygon pyramid*

viewport. Press and hold the left mouse button, and drag the cursor up or down to define the shape of the pyramid, and then release the left mouse button; the pyramid will be created.

Creating a Pipe

Menubar: Create > Objects > Polygon Primitives > Pipe

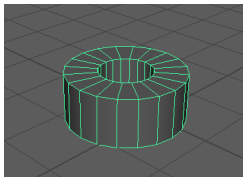


Figure 2-7 *A polygon pipe*

A pipe is similar to a cylinder polygonal shape with thickness, as shown in Figure 2-7. To create a pipe interactively, choose **Create > Objects > Polygon Primitives > Pipe** from the menubar; you will be prompted to drag the cursor on the grid to draw the pipe in the viewport. Press and hold the left mouse button and drag the cursor; the base of the pipe is created. Next, release the left mouse button to get the desired base. Now, press and hold the left mouse button and drag the cursor up to set the height of the pipe. Next, release the left mouse button. Again, press and hold the left mouse button to set the thickness of the polygon pipe; a polygon pipe will be created.

Creating a Helix

Menubar: Create > Objects > Helix

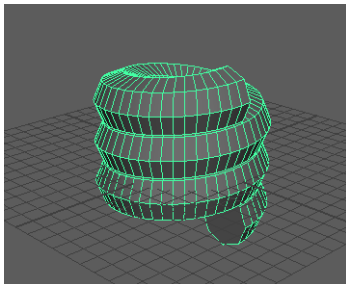


Figure 2-8 *A polygon helix*

A helix is a geometry in three dimensional space that lies on a cylinder and subtends a constant angle to a plane perpendicular to its axis, as shown in Figure 2-8. To create a helix interactively, choose **Create > Objects > Polygon Primitives > Helix** from the menubar; you will be prompted to drag the cursor on the grid. Press and hold the left mouse button and drag the cursor on the grid to define the diameter of the helix and then release the left mouse button. Again, press and hold the left mouse button and drag the cursor up to set the height of the helix, and then release the left mouse button. Next, press and hold the left mouse button and drag the cursor to set the number of coils in the helix and then release the left mouse button. Again, press and hold the left mouse button and drag the cursor to set the section radius; the helix will be created.

Creating a Soccer Ball

Menubar: Create > Objects > Polygon Primitives > Soccer ball

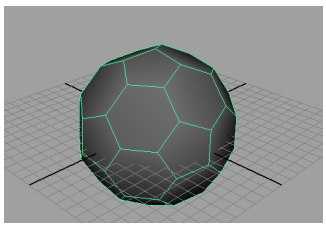


Figure 2-9 *A soccer ball*

A soccer ball polygon primitive created in Maya is very much similar to a real-world soccer ball, as shown in Figure 2-9. A soccer ball is formed by an alternate arrangement of hexagons and pentagons. It has total thirty two faces. To create a soccer ball interactively, choose **Create > Objects > Polygon Primitives > Soccer Ball** from the menubar; you will be prompted to drag the cursor on the grid to draw the soccer ball in the viewport. Press and hold the left mouse button and drag the cursor on the grid; the soccer ball will be created.

Creating a Platonic Solid

Menubar:	Create > Objects > Polygon Primitives > Platonic Solid

In Maya, you can create various types of platonic solids such as tetrahedron, octahedron, dodecahedron, and icosehedron. Platonic solids have identical faces and their all sides are equal, refer to Figure 2-10. To create a platonic solid, choose **Create > Objects > Polygon Primitives > Platonic Solid** from the menubar; a platonic solid will be created in the viewport. To change the solid type, expand the **INPUTS > polyPlatonic#** area in the **Channel Box / Layer Editor** and then select the desired option using the **Primitive** attribute.

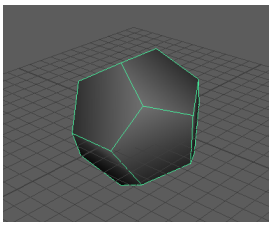


Figure 2-10 *A platonic solid*

Creating a Type Tool Mesh

Menubar:	Create > Objects > Type
Shelf:	Poly Modeling > Polygon Type

The **Polygon Type** tool is used to create polygon 3D text in the viewport. To create 3D text, choose **Create > Type** from the menubar; the text **3D Type** will be displayed in the viewport, as shown in Figure 2-11.

To change the appearance of the text, choose the **type1** tab in the **Attribute Editor**, refer to Figure 2-12. Using the options in this tab, you can change text, font, font size, and so on. You can apply various operations, such as **Extrude** and **Bevel**, on the text using the **typeExtrude1** tab of the **Attribute Editor**.

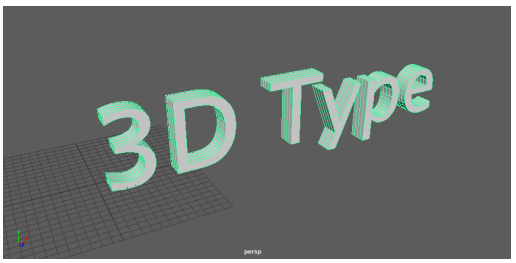


Figure 2-11 *The text **3D Type** displayed*

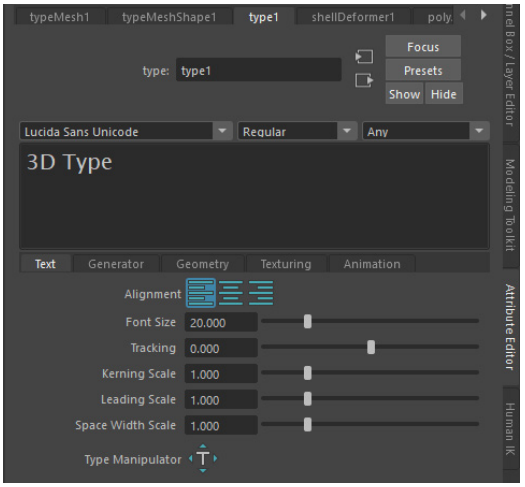


Figure 2-12 *The **type1** tab in **Attribute Editor***

Creating an SVG Mesh

Menubar:	Create > Objects > SVG
Shelf:	Poly Modeling > SVG

This tool is used to create polygon text from an SVG file. To create an SVG mesh, make sure you have an SVG file or SVG content copied to the clipboard. Choose **Create > SVG** from the menubar; the default SVG mesh with the name **svg1** is displayed in the viewport, as shown in Figure 2-13. Now, in the **svg1** tab of the **Attribute Editor**, choose the **Import** button; the **Open** dialog box will be displayed. Navigate to the location where you saved the SVG file, select it, and then choose the **Open** button; the SVG mesh will be displayed in the viewport, refer to Figure 2-14.

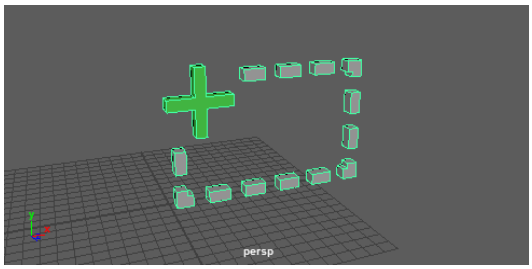


Figure 2-13 *The default SVG mesh displayed*

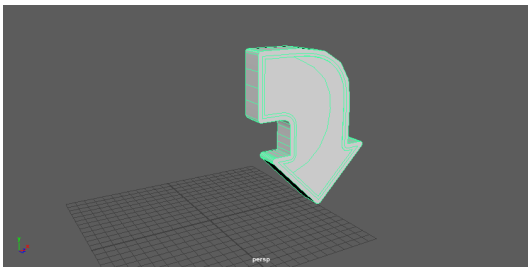


Figure 2-14 *The SVG mesh displayed*

Now, you can manipulate the shape as per the paths of the embedded SVG file. For example, if you want to offset the meshes, select the desired path from the **Path** list of the **Manipulations** area and then use the **Position Z Offset** attribute to offset the mesh, refer to Figure 2-15. Figure 2-16 shows the arrow shaped SVG file used in the example.

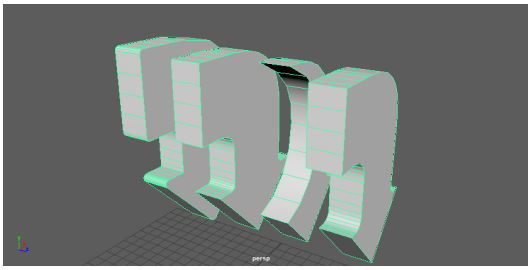


Figure 2-15 *The separated SVG mesh*

Figure 2-16 *The arrow shaped SVG file*

Creating a Disc

Menubar:	Create > Objects > Polygon Primitives > Disc
Shelf:	Poly Modeling > Polygon Disc

The **Disc** tool is used to create a circular disc with varying edge patterns. To create a disc, choose **Create > Objects > Polygon Primitives > Disc** from the menubar; a disc will be created in the viewport. To change the edge pattern, expand the **INPUTS > polyDisc#** area in the **Channel Box / Layer Editor** and then select the desired option using the **Subdivision Mode** attribute. Figure 2-17 shows geometries created using the **Disc** tool.

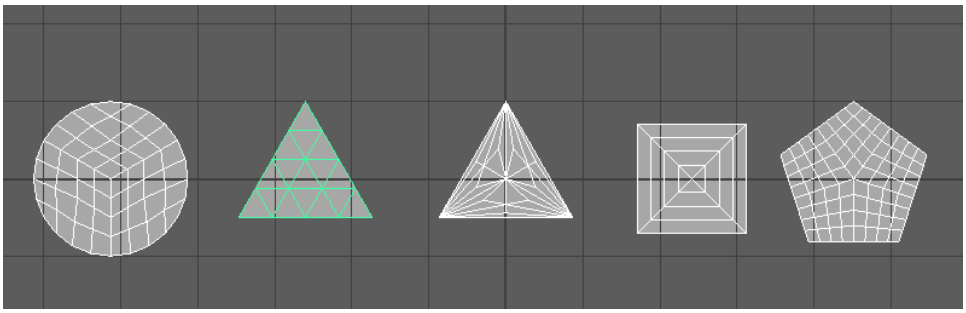


Figure 2-17 *The objects created using the* ***Disc*** *tool*

Creating a Gear

Menubar: Create > Objects > Polygon Primitives > Gear

The **Gear** tool is used to create gear shaped geometries by generating teeth patterns around the pipe shape. To create a gear, choose, **Create > Objects > Polygon Primitives > Gear** from the menubar; a gear will be created in the viewport. To change the settings, expand the **INPUTS > polyGear#** area in the **Channel Box / Layer Editor** and then change the value of the attributes. Figure 2-18 shows the geometries created using the **Gear** tool.

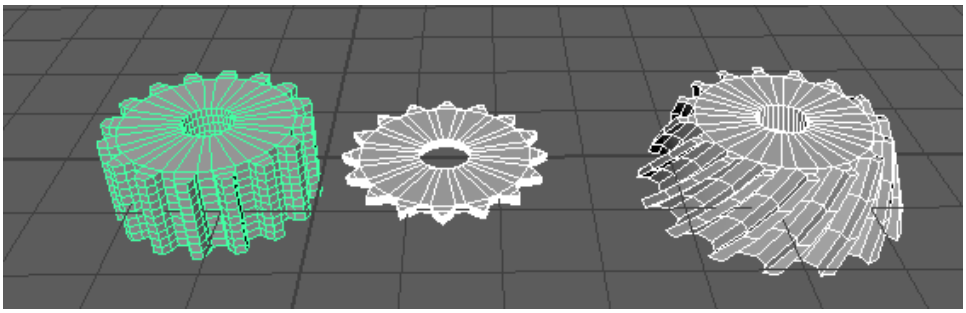


Figure 2-18 *The objects created using the* ***Gear*** *tool*

Creating Super Shapes

Menubar: Create > Objects > Polygon Primitives > Super Shapes > Super Ellipse / Spherical Harmonics / Ultra Shape

The tools under the super shape category in the **Polygon Primitives** menu are used to create complex shapes. These shapes are highly complex in nature and use complex algorithm. To create an ultra shape, choose **Create > Objects > Polygon Primitives > Super Shapes > Super Ellipse/Spherical Harmonics/Ultra Shape** from the menubar; a basic shape with default values will be created in the viewport.

Once you create the shape, **polySuperShape#** node will be displayed in the **Attribute Editor**. To change the algorithm of the basic shape, select **Spherical Harmonics**, **Super Ellipse**, or **Ultra** from the **Shape** drop-down list in the **Poly Super Shape History** area. Now, you can use

the **Random** button available in the **Poly Super Shape History** area to create different shapes. Figure 2-19 shows the shapes created using the **Spherical Harmonics**, **Super Ellipse**, or **Ultra** option, respectively.

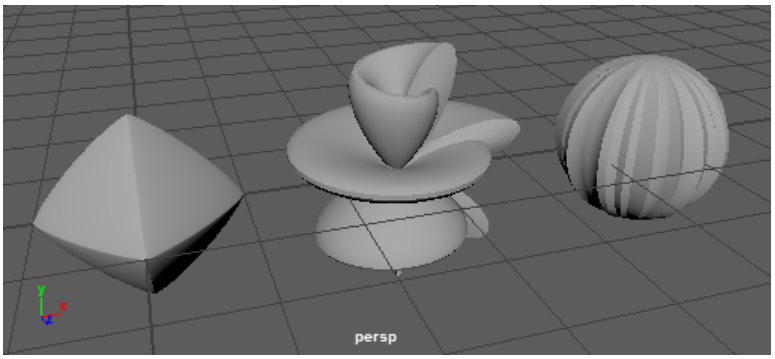


Figure 2-19 *Some super shapes created*

POLYGON EDITING TOOLS

In Maya, the tools are grouped according to the function they perform. For example, the **Boolean**, **Combine**, and **Separate** tools are combined in the **Combine** group, refer to Figure 2-20. The polygon editing tools are used to perform different operations on the polygon objects. These editing tools are available in the **Mesh**, **Edit Mesh**, and **Mesh Tools** menus of the **Modeling** menu set. Figure 2-20 displays different tools in the **Mesh** menu. The most commonly used tools under this menu are discussed next.

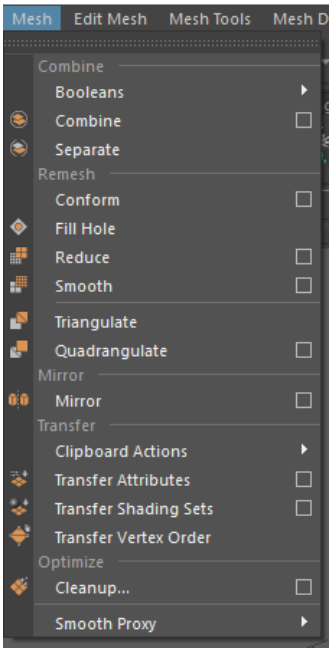


Figure 2-20 *The **Mesh** menu*

Booleans

Menubar: Mesh > Combine > Booleans

The booleans tools are used to combine the polygon objects to create a new object. Using these tools, you can perform three different operations to modify the shape of the new object. The booleans tools are shown in Figure 2-21. The three options of this tool are discussed next.

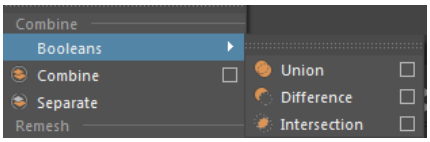


Figure 2-21 *The **Booleans** tools*

Union

Menubar: Mesh > Combine > Booleans > Union

The **Union** tool is used to combine the volume of two polygon meshes. To understand the function of this tool, consider a sphere and a torus placed in the viewport, as shown in Figure 2-22. Using the SHIFT key, select the torus and then the sphere. Next, choose **Mesh > Combine > Booleans > Union** from the menubar; both the objects will get merged and the intersecting geometry between them will be deleted, refer to Figure 2-23.

Difference

Menubar: Mesh > Combine > Booleans > Difference

The **Difference** tool is used to subtract the last selected geometry from the geometry that was selected first. To understand the function of this tool, consider a sphere and a torus placed in the viewport, refer to Figure 2-22. Using the SHIFT key, select the torus and then the sphere. Next, choose **Mesh > Combine > Booleans > Difference** from the menubar; the geometry will be deleted, as shown in Figure 2-24.

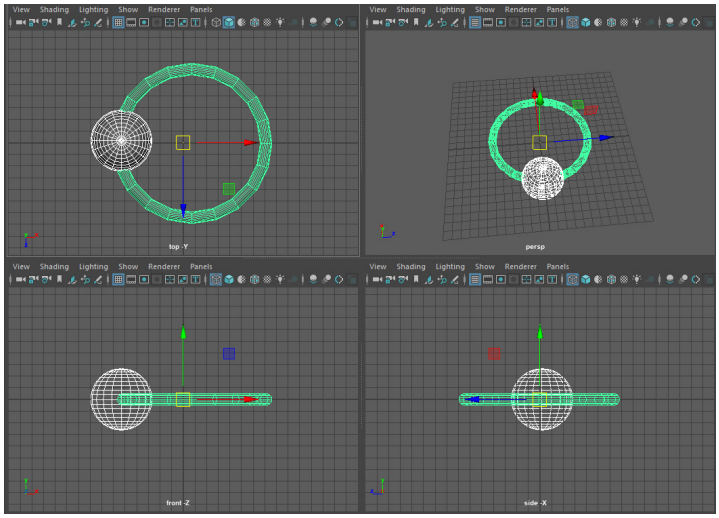


Figure 2-22 *A torus and a sphere placed in the viewports*

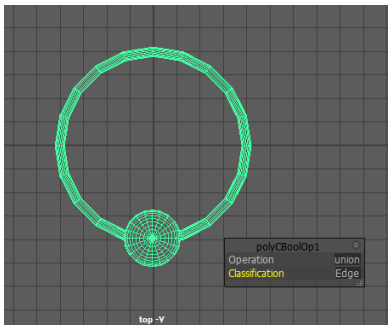


Figure 2-23 *The Union operation carried out on the torus and the sphere*

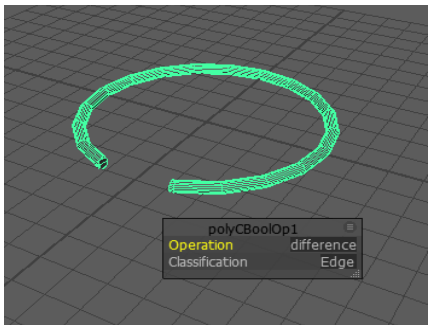


Figure 2-24 *The Difference operation carried out on the torus and the sphere*

Intersection

Menubar: Mesh > Combine > Booleans > Intersection

The **Intersection** tool is used to keep the intersecting geometry between two objects and delete the remaining geometry. To understand the function of this tool, consider a sphere and a torus placed in the viewport, refer to Figure 2-22.

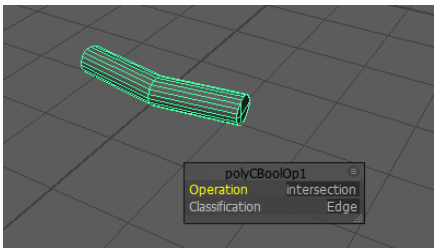


Figure 2-25 The Intersection operation carried out on the torus and the sphere

Using the SHIFT key, select the torus and the sphere. Next, choose **Mesh > Combine > Booleans > Intersection** from the menubar; the intersecting geometry will be displayed and the remaining parts will be deleted, as shown in Figure 2-25.

Note

*When you choose any boolean operation, the **polyCBoolOp# In-View Editor** will be displayed in the viewport. You can change any applied operation by choosing an option from the **Operation** flyout.*

Combine

Menubar: Mesh > Combine > Combine

The **Combine** tool is used to group two or more polygon objects into a single polygon object. To do so, select the polygon objects to be combined in the viewport and then choose **Mesh > Combine > Combine** from the menubar; the selected polygon objects are combined into a single polygon object.

Separate

Menubar: Mesh > Combine > Separate

The **Separate** tool is used to ungroup the combined polygon objects into separate polygon objects. To do so, select the group in the viewport and then choose **Mesh > Combine > Separate** from the menubar; the selected group of polygon objects are separated, refer to Figure 2-26.

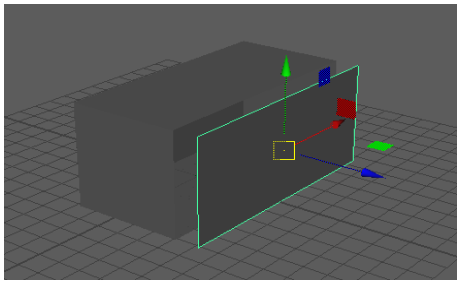


Figure 2-26 The selected face separated from the polygon object

Conform

Menubar: Mesh > Remesh > Conform

The **Conform** tool is used to wrap the vertices of an object onto the surface of another object. To understand the function of this tool, you need at least two wrap polygon objects, refer to

Figure 2-27. Next, select the object on which you want to wrap the vertices and then choose **Modify > Objects > Make Live** from the menubar to make the selected object live. Now, select the geometry that you want to wrap and then choose **Mesh > Remesh > Conform** from the menubar; the wrapper mesh will automatically wrap around the target geometry, refer to Figure 2-28.

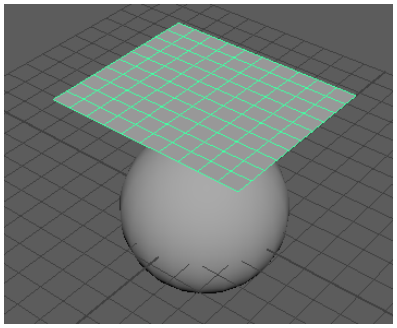


Figure 2-27 *The polygon objects*

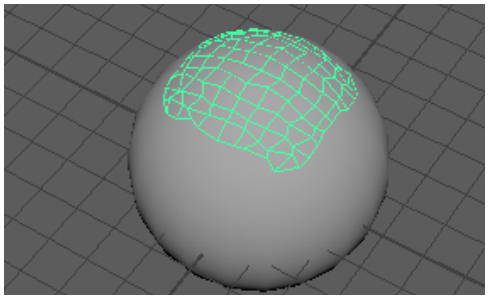


Figure 2-28 *The plane wrapped onto the polygon sphere*

Fill Hole

Menubar: Mesh > Remesh > Fill Hole

The **Fill Hole** tool is used to fill a hole in an object by adding a face to it. To understand the function of this tool, press and hold the right mouse button over an object with a hole; a marking menu will be displayed. Next, choose **Edge** from the marking menu. Now, select the boundary edges, refer to Figure 2-29. Next, choose **Mesh > Remesh > Fill Hole** from the menubar; the empty space will be filled, as shown in Figure 2-30.

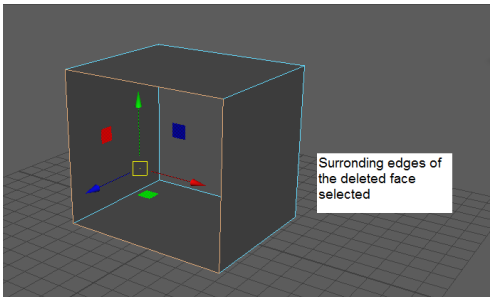


Figure 2-29 *Edges of the deleted face selected*

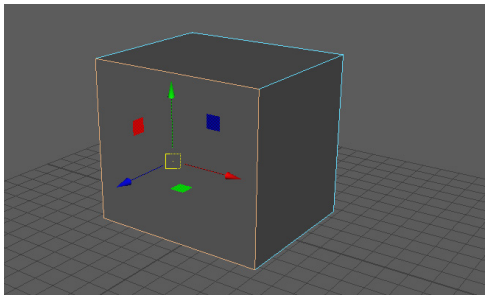


Figure 2-30 *Filled hole of the cube*

Tip

1. You can use the shortcut keys for displaying or activating various components of an object. For example, press F8 for object mode, F9 for vertices, F10 for edges, and F11 for faces.

2. To select four surrounding edges of a deleted face, choose one of the edges and then press the right arrow key on your keyboard; all the four edges will be selected.

Reduce

Menubar: Mesh > Remesh > Reduce

The **Reduce** tool is particularly useful in reducing the number of polygons in a particular area of the mesh. You can also use the UVs or vertex colors to select an area on the mesh. To reduce polygons, select an area and then choose **Mesh > Remesh > Reduce** from the menubar; the **polyReduce1** In-View Editor will be displayed in the viewport. Enter the value in the **Percentage** edit box. You can change reduction method by clicking on the **Reduction Method** attribute. The other two methods are **Vertex Count** and **Triangle Count**.

Remesh

Menubar: Mesh > Remesh > Remesh

The **Remesh** tool is used to create a uniformly tessellate triangular mesh or add details to specific regions of the mesh surface. To do so, create a polygonal object in the viewport, as shown in Figure 2-31 and then choose **Mesh > Remesh > Remesh** from the menubar; the **polyRemesh1** In-View Editor will be displayed in the viewport and triangulated mesh is displayed in the polygon object, as shown in Figure 2-32.

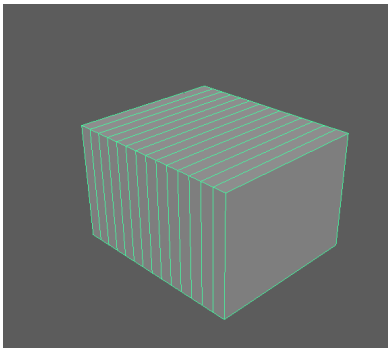


Figure 2-31 *The polygon object*

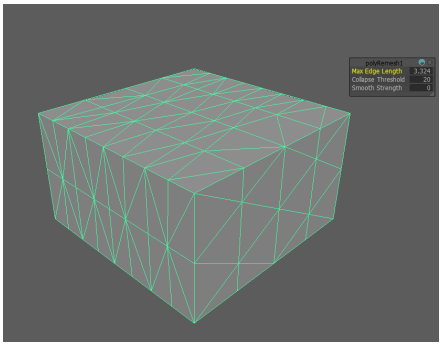


Figure 2-32 *Triangulated mesh of a polygon object*

Retopologize

Menubar: Mesh > Remesh > Retopologize

The **Retopologize** tool is used to generate smooth surface features of a selected mesh while ensuring all the faces are quads. To do so, create a polygonal object in the viewport, as shown in Figure 2-33 and then choose **Mesh > Remesh > Retopologize** from the menubar; the polygonal object is smoothened and quad surfaces are created, as shown in Figure 2-34.

Smooth

Menubar: Mesh > Remesh > Smooth

The **Smooth** tool is used to make a polygon object smooth by adding divisions to it. To do so, create a polygonal object in the viewport and then choose **Mesh > Remesh > Smooth** from the menubar; the **polySmoothFace1** In-View Editor will be displayed in the viewport. Set the desired smoothing level by entering a value in the **Divisions** edit box. The default subdivision level is 1.

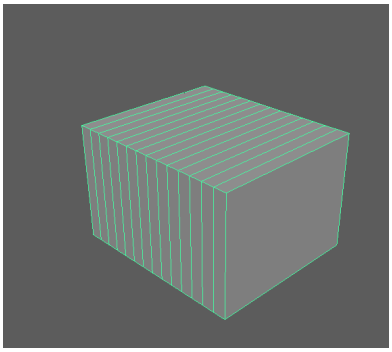


Figure 2-33 The polygon object

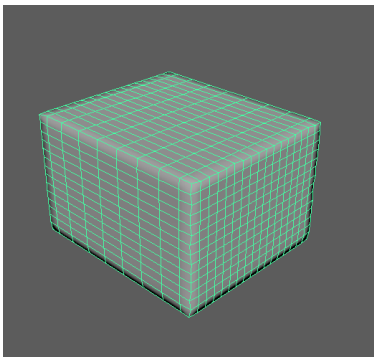


Figure 2-34 The smooth polygon object

Triangulate

Menubar: Mesh > Remesh > Triangulate

The **Triangulate** tool is used to convert polygon faces into triangles.

Quadrangulate

Menubar: Mesh > Remesh > Quadrangulate

The **Quadrangulate** tool is used to convert the polygon faces into quadrangles.

Mirror

Menubar: Mesh > Mirror > Mirror

The **Mirror** tool is used to create duplicate of a selected object across an invisible mirror plane. To create a mirror object, select the object that you want to mirror and then choose **Mesh > Mirror > Mirror** from the menubar; the **polyMirror1** In-View Editor will be displayed in the viewport. Select the desired mirror axis using the **Axis** attribute. Now, use the **Offset** attribute to adjust the spacing between the objects.

EDITING THE POLYGON COMPONENTS

In the previous section, you learned to modify simple polygon primitives. In this section, you will learn to edit the components of polygon primitives to create complex objects from it. To do so, select a polygon object in the viewport and then press and hold the right mouse button over it; the marking menu of the corresponding object will display various components of the object such as vertex, edge, face, and UV, refer to Figures 2-35 to 2-38. To access various tools for editing the polygon primitives, select **Modeling** from the **Menuset** drop-down list in Status Line. Next, choose the **Edit Mesh** menu from the menubar. The most commonly used component editing tools are discussed next.

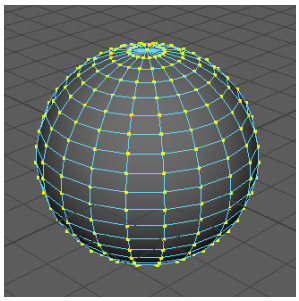


Figure 2-35 *Vertices of the sphere*

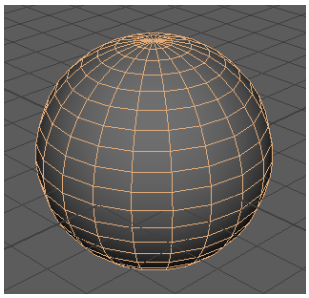


Figure 2-36 *Edges of the sphere*

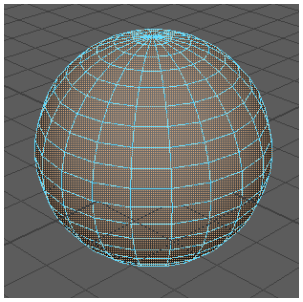


Figure 2-37 *Faces of the sphere*

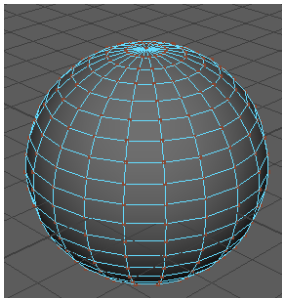


Figure 2-38 *UVs of the sphere*

Note

1. The face selection mode in the marking menu allows you to select the faces of the active object. When you move the cursor on a face, the face will be highlighted in red. Next, when you click on the highlighted face, it will turn green indicating that it is now selected. In this way, you can identify the selected and unselected faces.

*2. The **Multi** option allows you to select all components at a time without switching between the components. To select all components, press and hold the right mouse button on the already selected component, and then choose the **Multi** option from the marking menu. Next, select a face on the object, press and hold the SHIFT key, and then select the next required component.*

Add Divisions

Menubar:	Edit Mesh > Components > Add Divisions

The **Add Divisions** tool is used to subdivide the edges or faces of a polygon object to smaller components. To add divisions, select the edges or faces that you want to divide and then choose **Edit Mesh > Components > Add Divisions > Option Box** from the menubar; the **Add Divisions to Face Options** panel will be displayed.

Set the required attributes in this panel and then choose the **Add Divisions** button to subdivide the selected area. You can also change the number of divisions by using the **Divisions** attribute in the **polySubFace1** In-View Editor.

Bevel

Menubar: Edit Mesh > Components > Bevel

The **Bevel** tool is used to expand the vertex or the face of a polygon object. This adds smoothness to a sharp object by adding fillets on the edges. The bevel operation adds fillet to the edges by creating new faces on the selected polygon object. To do so, create a polygon object in the viewport and select it. Next, choose **Edit Mesh > Components > Bevel** from the menubar; the selected polygon object will be beveled, as shown in Figure 2-39. The **Bevel** tool is also used to bevel the components such as face, vertex, and edge of a polygon object individually. Create a polygon object in the viewport and right-click on it; the marking menu will be displayed. Next, choose **Edge** from the marking menu; the edge selection mode will be activated. Now, select any edge of the object and then choose **Edit Mesh > Components > Bevel** from the menubar; the selected edge will be beveled, refer to Figure 2-40.

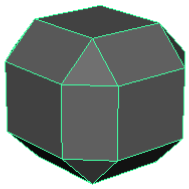


Figure 2-39 *Selected polygon object beveled*

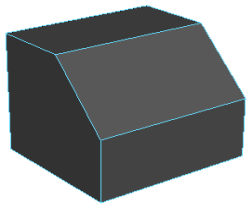


Figure 2-40 *Selected edge beveled*

To adjust the bevel parameters, select the object in the viewport; the **Channel Box / Layer Editor** is displayed on the right of the viewport. Next, expand **polyBevel1** in the **INPUTS** area of the **Channel Box / Layer Editor** and then set the bevel parameters; the changes will be reflected on the selected object in the viewport.

You can also change the bevel parameters from the **Attribute Editor**. Press CTRL+A to open the **Attribute Editor** and then choose the **polyBevel1** tab from the **Attribute Editor**; the bevel parameters will be displayed in the **Attribute Editor**, as shown in Figure 2-41. Set the parameters as per your requirement.

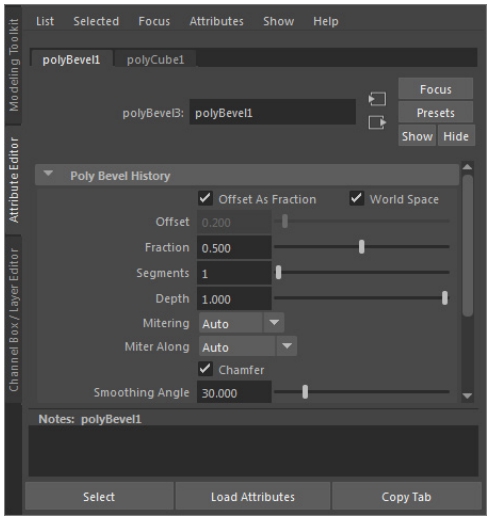


Figure 2-41 *Various bevel attributes in the* ***Attribute Editor***

Bridge

The **Bridge** tool is used to construct faces between pair of the border edges. The connection between the edges or faces can be straight or curved, depending on the options you choose from the **Bridge Options** window.

To create a bridge between the border edges of an object, select the edges and then choose **Edit Mesh > Components > Bridge > Option Box** from the menubar; the **Bridge Options** window will be displayed. In this window, choose the type of bridge you want to create by selecting the radio button corresponding to the **Bridge type** attribute and then choose the **Bridge** or **Apply** button; a bridge will be created, as shown in Figure 2-42.

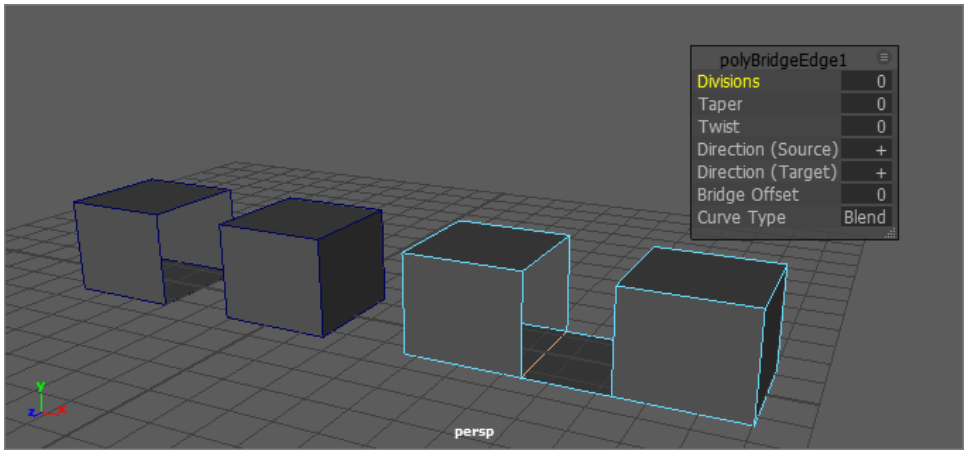


Figure 2-42 *The **Bridge** connection between the two edges*

Note

*To create a bridge between two separate objects, you need to combine the two objects by choosing **Mesh > Combine > Combine** from the menubar.*

Circularize

Menubar: Edit Mesh > Components > Circularize

The **Circularize** tool allows you to organize the vertices of a selected component into a circular shape. To understand working of this tool, consider a polygon plane object with **Subdivision Width** and **Subdivision Height** set to **10** each. Switch to the **Vertex** selection mode and then select some vertices, refer to the Figure 2-43(a). Now, choose **Edit Mesh > Components > Circularize** from the menubar; the selected vertices will be arranged in a circular shape and the **polyCircularize1** In-View Editor will be displayed, refer to Figure 2-43(b). You can add divisions to the selection by using the **Add Divisions** attribute of the In-View Editor to make a perfect round shape.

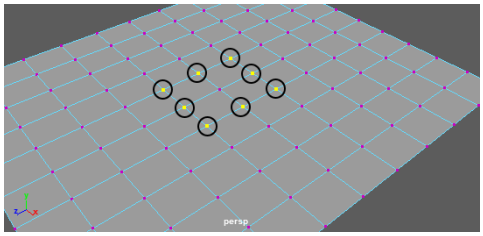


Figure 2-43(a) *Selected vertices*

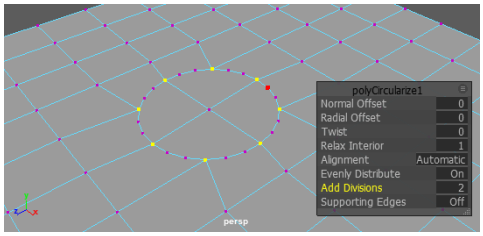


Figure 2-43(b) *A circular shape created using the **Circularize** command*

Collapse

Menubar: Edit Mesh > Components > Collapse

The **Collapse** tool is used to collapse edges and then it merges the associated vertices for each collapsed edge separately. To collapse the edges of an object, select the required edges and then choose **Edit Mesh > Components > Collapse** from the menubar; the selected edges will be collapsed and their vertices will be merged.

Note

*This tool also works on faces. But it generates unpredictable results. If you want to merge the faces, use the **Merge to Center** option which is available in the **Edit Mesh** menu.*

Connect

Menubar: Edit Mesh > Components > Connect

The **Connect** tool is used to connect selected vertices or faces via edges. To use this tool, select faces or edges on an object and then choose **Edit Mesh > Components > Connect** from the menu bar to connect the selected component, refer to Figure 2-44.

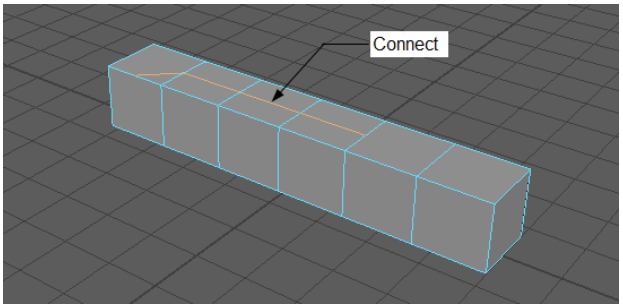


Figure 2-44 *The connected edge displayed*

Detach

Menubar: Edit Mesh > Components > Detach

The **Detach** tool is used to split a vertex into multiple vertices. To understand working of this tool, consider a polygon object in the viewport and press and hold the right mouse button over it; a marking menu will be displayed. Choose **Vertex** from the marking menu; the vertex selection mode will be activated. Select a vertex of the object that needs to be split. Next, choose **Edit Mesh > Components > Detach** from the menubar; the selected vertex gets split into multiple vertices, refer to Figure 2-45. This tool also detaches the faces. When faces of an object are selected and you use this tool, it detaches the face selection along its perimeter edges.

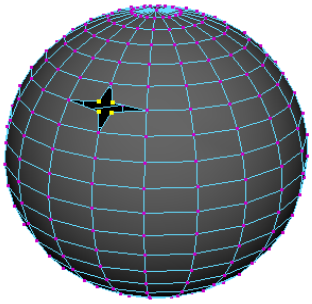


Figure 2-45 *Selected vertex gets split into multiple vertices*

Extrude

Menubar: Edit Mesh > Components > Extrude

The **Extrude** tool is used to extrude various components such as vertex, face, or an edge of a polygon object inward or outward. To extrude a vertex, select the vertex that needs to be extruded. Next, choose **Edit Mesh > Components > Extrude** from the menubar; the selected vertex will be extruded and the **polyExtendedVertex#** In-View Editor will be displayed. You can change the width, length, and, division of the extruded vertex by entering the values in the **Width**, **Length**, and **Divisions** edit boxes, as shown in Figure 2-46. To extrude an edge, select it and then choose **Edit Mesh > Components > Extrude** from the menubar; the **polyExtendedEdge#** In-View Editor will be displayed. Enter the desired value in the **Thickness** edit box of the **polyExtendedEdge#** In-View Editor, refer to Figure 2-47. If the value in the edit box is negative, the face will be extruded inward and for a positive value, it will be extruded outward.

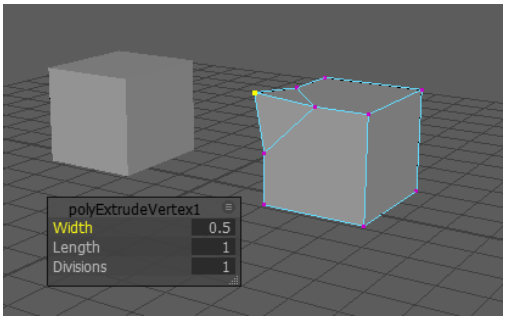


Figure 2-46 *The extruded vertex*

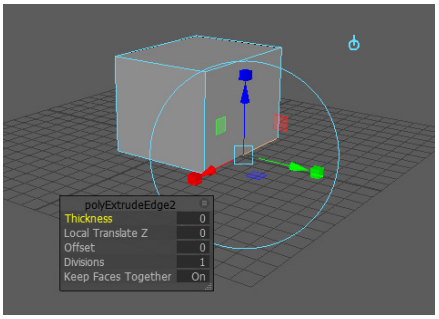


Figure 2-47 *The* ***polyExtrudedEdge#*** *In-View Editor*

To extrude a face, select it and then choose **Edit Mesh > Components > Extrude** from the menubar; the **polyExtrudeFace#** In-View Editor will be displayed. Enter the desired value in the **Thickness** edit box of the **polyExtrudeFace#** In-View Editor. If the value in the edit box is negative, the face will be extruded inward and for a positive value, it will be extruded outward, as shown in Figure 2-48.

Merge

Menubar: Edit Mesh > Components > Merge

The **Merge** tool is used to merge two vertices. To merge two vertices, select a object in the viewport and press and hold the right mouse button over it; a marking menu will be displayed. Choose **Vertex** from the marking menu; the vertex selection mode will be activated. Now, select four vertices of top polygon and then choose **Edit Mesh > Components > Merge > Option Box** from the menubar; the **Merge Vertices Options** window will be activated. Set the value for the **Threshold** attribute and then choose **Merge** from the window; the selected vertices will be merged, refer to Figure 2-49.

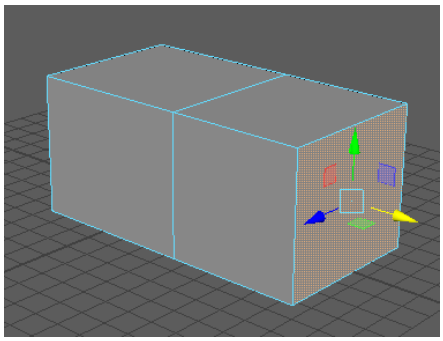


Figure 2-48 *The extruded face*

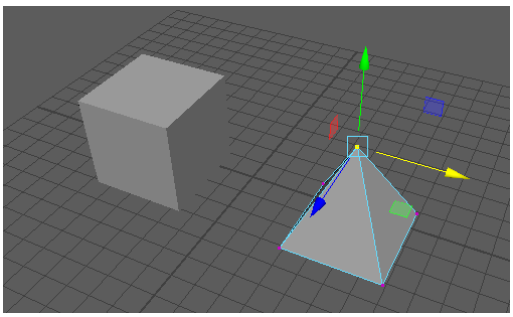


Figure 2-49 *Top vertices to be merged*

You can also use the **Merge to Center** tool for merging the selected vertices. To do so, choose **Edit Mesh > Components > Merge to Center**; the vertices will be merged to the center of the two vertices, refer to Figure 2-50.

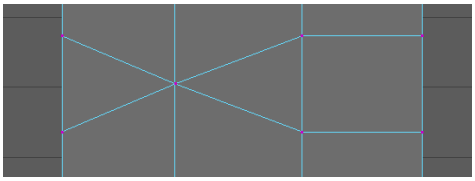


Figure 2-50 *Center vertices to be merged*

Average Vertices

Menubar: Edit Mesh > Vertex > Average Vertices

The **Average Vertices** tool is used to control the level of smoothing applied to the selection, refer to Figure 2-51. You can set the amount of smoothing in the **Iteration** edit box of the **polyAverageVertex1** In-View Editor.

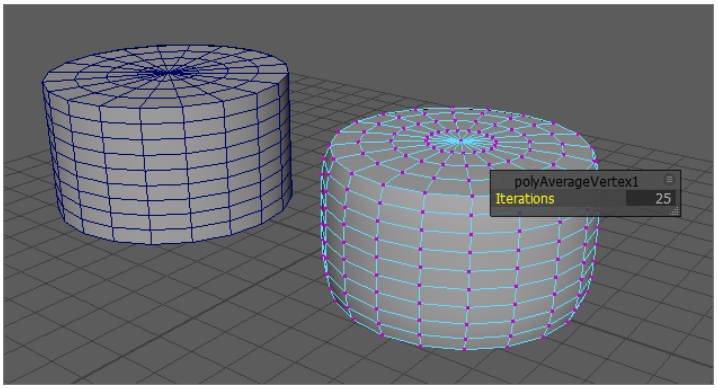


Figure 2-51 *Smoothing applied to the selection*

Chamfer Vertices

Menubar: Edit Mesh > Vertex > Chamfer Vertices

The **Chamfer Vertices** tool is used to replace a vertex to create a chamfered corner. To use this tool, consider a polygon object in the viewport and press and hold the right mouse button over it; a marking menu will be displayed.

Choose **Vertex** from the marking menu; the vertex selection mode will be activated. Select a vertex (or vertices) of the object. Next, choose **Edit Mesh > Vertex > Chamfer Vertices** from the menubar; a new polygon face will be created, refer to Figure 2-52.

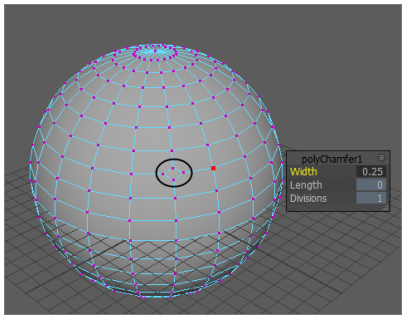


Figure 2-52 *A new polygon face created using the* ***Chamfer Vertices*** *tool*

Delete Edge/Vertex

Menubar: Edit Mesh > Edge > Delete Edge/Vertex

The **Delete Edge/Vertex** tool is used to delete the selected edges or vertices of a polygon object. To do so, select vertices of an object that you want to delete and then choose **Edit Mesh > Edge > Delete Edge/Vertex** from the menubar; the selected vertices will be deleted. Similarly, using the **Delete Edge/Vertex** tool, you can delete the selected edges of the polygon object.

Tip

You can also delete the selection using the DEL key. However, you cannot delete a vertex when it shares more than two edges.

Edit Edge Flow

Menubar: Edit Mesh > Edge > Edit Edge Flow

The **Edit Edge Flow** tool is used to modify the position of edges along the curve of the surrounding mesh. To do so, select the two non-adjacent edges of an object and choose **Edit Mesh > Edge > Edit Edge Flow** from the menubar; the edges move along the curvature of the object.

Duplicate

Menubar: Edit Mesh > Face > Duplicate

The **Duplicate** tool is used to create the duplicate copies of the selected faces. To use this tool, consider a cube in the viewport. Select the polygon cube created and then press and hold the right mouse button on it; a marking menu will be displayed. Next, choose **Face** from the marking menu; the face selection mode will be activated. Choose **Move Tool** from the Tool Box. Next, select a face on the polygon cube and choose **Edit Mesh > Face > Duplicate** from the menubar; a duplicate copy of the selected face will be created in the viewport. Now, to see the duplicate face, move it away from the centre using the **Move Tool**.

EDITING THE POLYGON COMPONENTS USING MESH TOOLS

In the previous section, you learned to modify simple polygon primitives. In this section, you will learn to edit the polygon objects using the polygon components such as face, vertex, and edge. To access various tools for editing the polygon components, select **Modeling** from the **Menuset** drop-down list in the Status Line. Next, choose the **Mesh Tools** menu from the menubar. The most commonly used tools under this menu are discussed next.

Create Polygon

Menubar: Mesh Tools > Tools > Create Polygon

The **Create Polygon** tool is used to create polygons by placing vertices in the viewport. To do so, choose **Mesh Tools > Tools > Create Polygon** tool from the menubar. Next, click in the viewport; a vertex point will be created in the viewport.

Next, depending on the shape required, keep on clicking in the viewport to connect the points and then press ENTER; a shape will be created, refer to Figure 2-53.

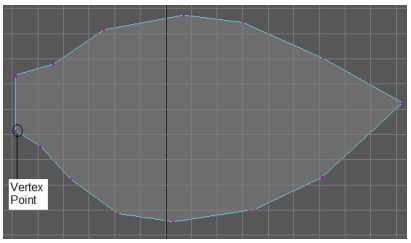


Figure 2-53 *A shape created using the* ***Create Polygon*** *tool*

Insert Edge Loop

Menubar: Mesh Tools > Tools > Insert Edge Loop

The **Insert Edge Loop** tool is used to add segments to the selected object. The segment created by using this tool ends at the same point from where it starts, thus forming a loop. To use this tool, consider a polygon object in the viewport and choose **Mesh Tools > Tools > Insert Edge Loop** tool from the menubar; the edges of the object will turn blue. Next, click on an edge; a new segment will be created on the selected object, as shown in Figure 2-54. Note that the **Insert Edge Loop** tool works only with objects that have quads (quads are faces with four sides). If the sides of a face are more or less than four, then this tool will not work. To set the properties of this tool, choose **Mesh Tools > Tools > Insert Edge Loop > Option Box** from the menubar; the **Tool Settings (Insert Edge Loop tool)** panel will be displayed, refer to Figure 2-55.

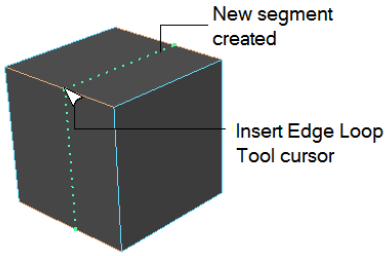


Figure 2-54 *A new segment created using the* ***Insert Edge Loop***

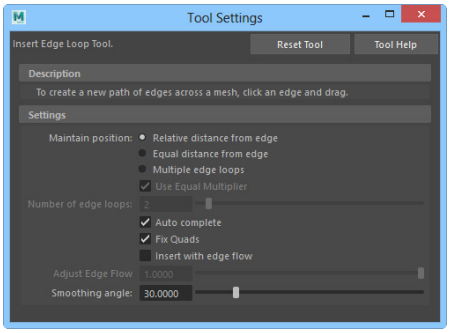


Figure 2-55 *The* ***Tool Settings (Insert Edge Loop tool)*** *panel*

Multi-Cut

Menubar: Mesh Tools > Tools > Multi-Cut

The **Multi-Cut** tool is used to manually add segments between two edges of an object. To add segments between two edges, select the polygon object and then choose **Mesh Tools > Tools > Multi-Cut** from the menubar.

Click on the edge to choose the starting point of the segment. Next, click on the edge where you want to end the segment and press ENTER; a segment will be added between the two edges, refer to Figure 2-56.

You can also make a cut in loop by using the **Multi-Cut** tool. To do so, choose the **Multi-Cut** tool from the **Mesh Tools** menubar, press the CTRL key and then click on edge; a new segment will be created on the selected object.

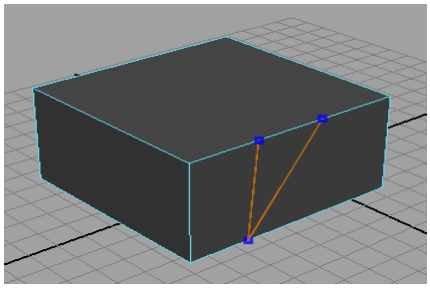


Figure 2-56 *Segments added using the* ***Multi-Cut*** *tool*

Offset Edge Loop

Menubar: Mesh Tools > Tools > Offset Edge Loop

The **Offset Edge Loop** tool works similar to the **Insert Edge Loop** tool with the only difference that it creates segments on both sides of the selected edges.

To use this tool, create a polygon object in the viewport and choose **Mesh Tools > Tools > Offset Edge Loop** tool from the menubar. Next, click and drag the cursor to the already existing edges to create new segments on both sides of the selected object, as shown in Figure 2-57.

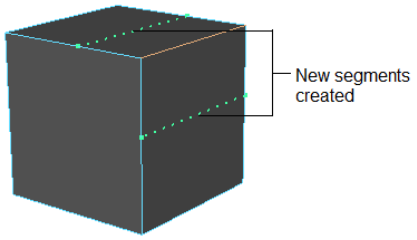


Figure 2-57 *New segments created using the* ***Offset Edge Loop*** *tool*

TUTORIALS

Tutorial 1

In this tutorial, you will create model of a coffee mug shown in Figure 2-58 using the polygon modeling techniques. (**Expected time: 20 min**)

Figure 2-58 *The model of a coffee mug*

The following steps are required to complete this tutorial:

a. Create a project folder.
b. Create the basic shape of the mug.
c. Create the handle of the mug.
d. Change the background color of the scene.
e. Save and render the scene.

Creating a Project Folder

Before starting a new scene, it is recommended that you create a project folder. It will help you keep all the files of a project in an organized manner. To do so, open Windows Explorer and browse to the *Documents* folder. In this folder, create a new folder with the name *maya2022*. The *maya2022* folder will be the main folder and it will contain all the projects folders that you will create while doing tutorials of this textbook. Now, you will create a project folder for Tutorial 1 of this chapter. To do so, you need to follow the steps given next.

1. Start Autodesk Maya 2022 by double-clicking on its icon on the desktop.

2. Choose **File > Project > Project Window** from the menubar; the **Project Window** is displayed. Choose the **New** button; the **Current Project** and **Location** text boxes are enabled. Now, enter **c02_tut1** in the **Current Project** text box.

3. Click on the folder icon next to the **Location** text box; the **Select Location** dialog box is displayed. In this dialog box, browse to the *\Documents\maya2022* folder and choose the **Select** button to close the dialog box. Next, choose the **Accept** button in the **Project Window** dialog box; the *\Documents\maya2022\c02_tut1* folder will become the current project folder.

4. Choose **Save Scene** from the **File** menu; the **Save File As** dialog box is displayed.

Note

The scenes created in Maya are saved with the .ma or .mb extension. As the project folder is already created, the path \Documents\maya2022\c02_tut1\scenes is displayed in the ***Look in*** *drop-down list of the* ***Save As*** *dialog box.*

Tip

After setting the project folder, when you open or save a scene, Maya uses the scenes folder inside the project folder by default.

5. Enter **c02tut1** in the **File name** edit box and then choose the **Save As** button to close the dialog box.

Note

It is recommended that you frequently save the file while you are working on it by pressing the CTRL+S keys.

Creating the Basic Shape of the Mug

In this section, you will use the **Cylinder** polygon primitive to create the basic shape of the mug.

1. Choose **Create > Objects > Polygon Primitives > Cylinder > Option Box** from the menubar; the **Tool Settings** (**Polygon Cylinder Tool**) panel is displayed in the viewport. Enter the values in the **Tool Settings** (**Polygon Cylinder Tool**) panel, as shown in Figure 2-59.

2. Click in the persp viewport; a cylinder is created, refer to Figure 2-60. Close the **Tool Settings** (**Polygon Cylinder Tool**) panel.

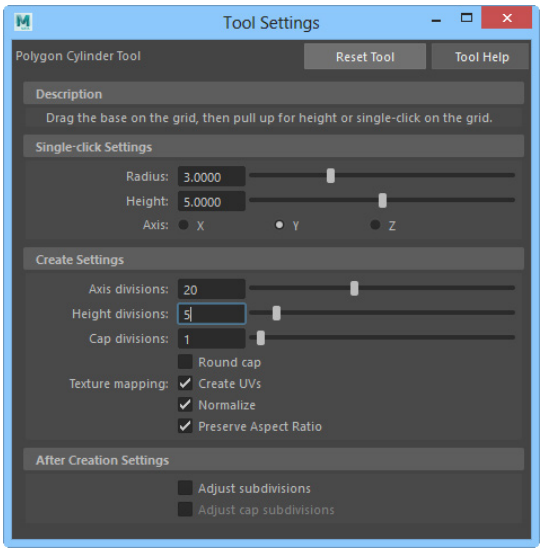


Figure 2-59 *The* ***Tool Settings*** *(****Polygon Cylinder Tool****) panel*

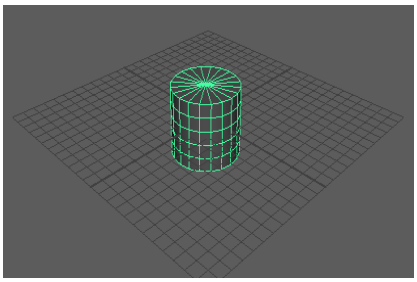


Figure 2-60 *Cylinder created in the viewport*

3. In the **Channel Box / Layer Editor**, click on the **pCylinder1** tab; a text box is activated. Next, type **mug** in the text box and press ENTER; the **pCylinder1** tab is renamed as *mug*.

4. Hover the cursor in the persp viewport and press SPACEBAR; the four viewports are displayed. Next, hover the cursor on the front-Z viewport and press SPACEBAR; the front-Z viewport is maximized.

   Select *mug* if it is not selected and then press and hold the right mouse button; a marking menu is displayed.

5. Choose **Vertex** from the marking menu; the vertex selection mode is activated.

6. Select the vertices at the bottom of *mug*, refer to Figure 2-61. Next, invoke the **Scale Tool** by pressing the R key.

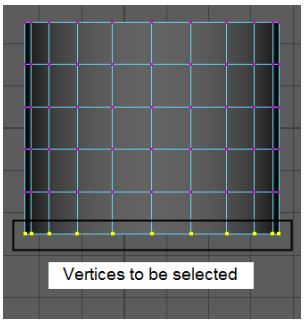


Figure 2-61 *Bottom vertices of the cylinder selected*

7. Scale down the selected vertices of *mug* inward uniformly, as shown in Figure 2-62. Similarly, select the other loops of vertices and scale them to form the shape of a mug, refer to Figure 2-63.

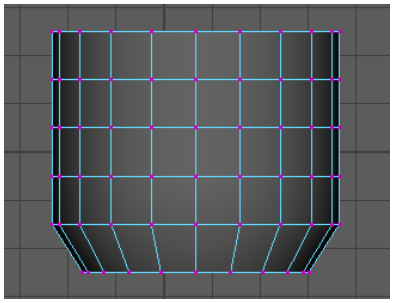


Figure 2-62 *Bottom vertices of the cylinder scaled*

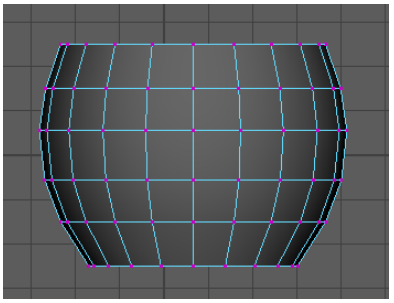


Figure 2-63 *Basic shape of the mug created*

Next, you need to add segments at the top and bottom.

8. Make sure the **Modeling** menuset is selected in the **Menuset** drop-down list. Choose **Mesh Tools > Tools > Insert Edge Loop** from the menubar. Next, click at the top and bottom region of *mug*; two edges are inserted, refer to Figure 2-64. Deactivate the **Insert Edge Loop** tool by pressing the W key.

9. Maximize the persp viewport. Make sure *mug* is selected and then press and hold the right mouse button; a marking menu is displayed. Choose **Face** from the marking menu; the face selection mode is activated. Now, select the top faces of *mug* using the SHIFT key, refer to Figure 2-65. Next, choose **Edit Mesh > Components > Extrude** from the menubar.

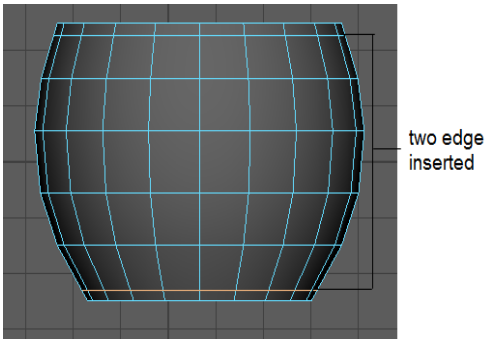


Figure 2-64 *Two edges inserted at the top and bottom of the cylinder*

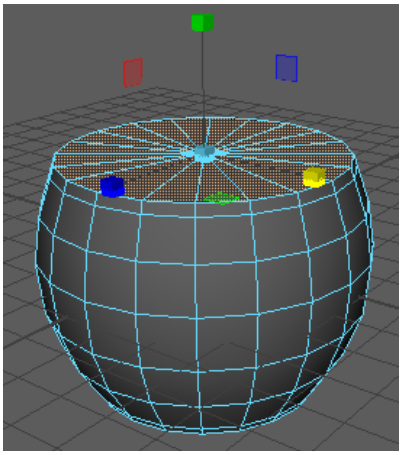


Figure 2-65 *Top faces of the cylinder selected*

10. Invoke the **Scale Tool** and scale down the selected faces uniformly, refer to Figure 2-66.

11. Again, choose **Edit Mesh > Components > Extrude** from the menubar; the **polyExtrudeFace#** In-View Editor is displayed in the viewport, refer to Figure 2-67. Enter **-0.3** in the **Thickness** edit box of the **polyExtrudeFace#** In-View Editor, refer to Figure 2-67; the shaded faces are extruded.

12. Press the G key to invoke the **Extrude** tool again and enter the value **-1.6** in the **Thickness** edit box; the top faces of *mug* are extruded downward.

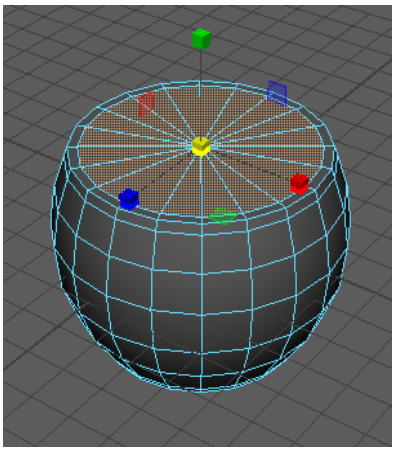


Figure 2-66 *The top selected faces of the mug scaled down using the* ***Scale Tool***

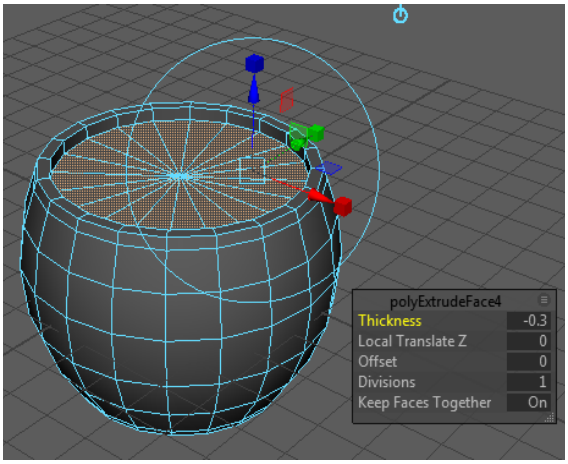


Figure 2-67 *The* ***polyExtrudeFace#*** *In-View Editor displayed*

Note

The G key is used to repeat the last performed action in Maya.

13. Press G again to invoke the **Extrude** tool, and enter the value **-2** in the **Thickness** edit box. Next, enter **0.8** in the **Offset** edit box; the selected polygon is extruded inward. Deactivate the **Extrude** tool.

14. Maximize the top-Y viewport such that you can view the inner area of *mug*. Press 3 to view the object in the smooth mode. To rectify the distortion in the geometry, you need to add edges. Press 1 and choose **Mesh Tools > Tools > Insert Edge Loop** tool; the shape of the cursor changes and then insert two edges inside the mug, refer to Figure 2-68. Deactivate the **Insert Edge Loop** tool by pressing W.

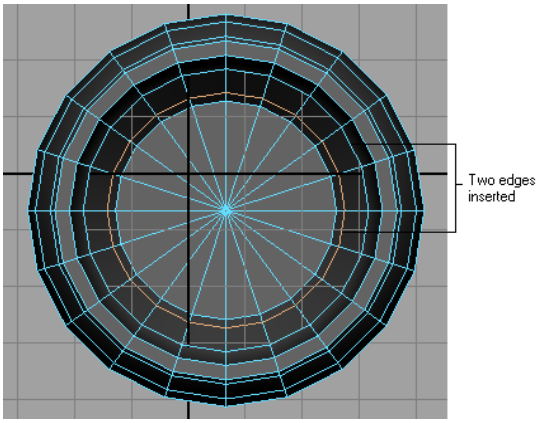


Figure 2-68 *Two edge loops added inside the mug*

Creating the Handle of the Mug

In this section, you need to create the handle of the mug.

1. Maximize the side-X viewport. Move the cursor over *mug* and then press and hold the right mouse button; a marking menu is displayed. Choose **Edge** from the marking menu; the edge selection mode is activated.

2. Select two edges of *mug*, refer to Figure 2-69. Next, choose **Edit Mesh > Components > Bevel > Option Box**; the **Bevel Options** window is displayed. Now, enter **1** in the **Width** edit box and choose the **Bevel** button; the selected edges will be beveled, as shown in Figure 2-70.

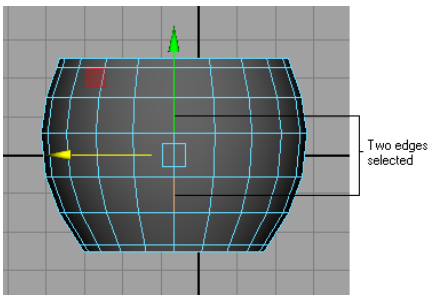


Figure 2-69 *Two edges of mug selected*

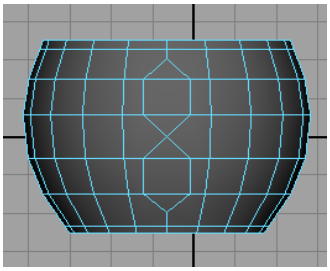


Figure 2-70 *Selected edges beveled*

3. Move the cursor over *mug* and then press and hold the right mouse button; a marking menu is displayed. Choose **Face** from the marking menu; the face selection mode is activated. Next, select a face of *mug*, as shown in Figure 2-71.

4. Choose **Edit Mesh > Components > Extrude** from the menubar. Next, invoke the **Scale Tool** by pressing the R key and scale down the selected face of *mug* uniformly upto 70%. You can check the scale size in the status line, as shown in Figure 2-72.

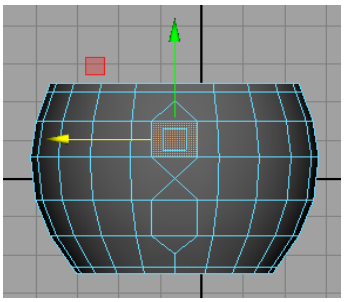


Figure 2-71 *A face of mug selected*

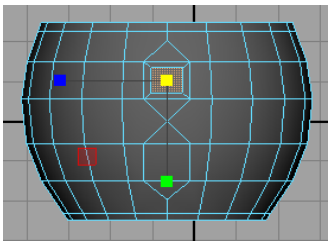


Figure 2-72 *Face of the mug scaled down*

5. Select the face of *mug*, as shown in Figure 2-73. Repeat the procedure as done in Step 4 to scale down the face, refer to Figure 2-74.

6. Maximize the persp viewport. Make sure that both the scaled faces are selected, and then invoke the **Extrude** tool by pressing the G key. Next, enter the value **0.8** in the **Thickness** edit box of the **polyExtrudeFace#** In-View Editor.

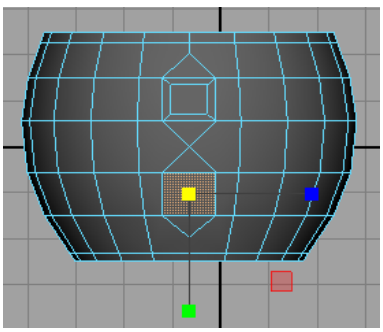


Figure 2-73 *A face of the mug selected*

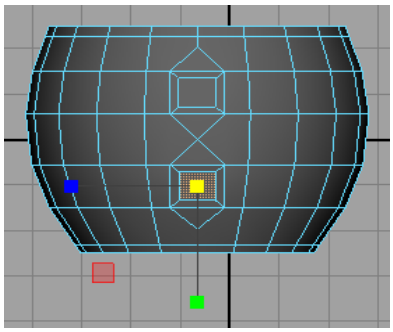


Figure 2-74 *A face of the mug scaled down*

7. Deactivate the **Extrude** tool by pressing the W key. Make sure the two extruded faces are selected. Next, choose **Edit Mesh > Components > Bridge > Option Box** from the menubar; the **Bridge Options** window is displayed. Enter values in the **Bridge Options** window, as shown in Figure 2-75. Next, choose the **Apply** button and close the window; the extruded faces are connected to each other.

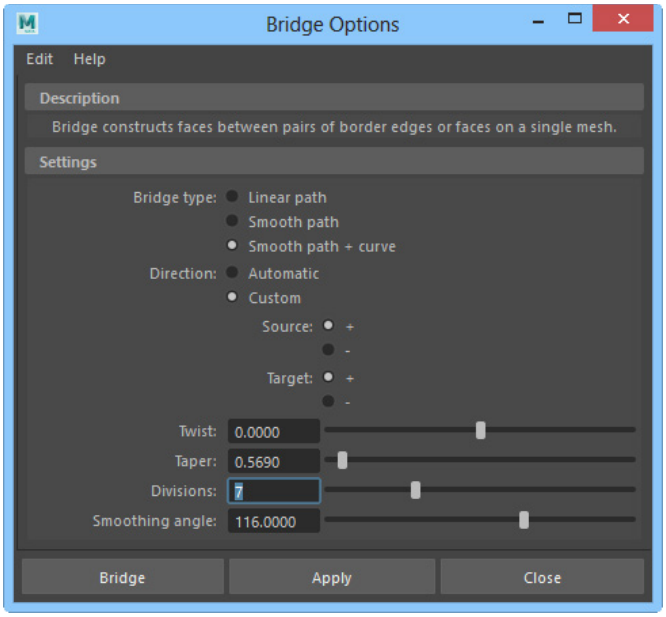


Figure 2-75 *The* ***Bridge Options*** *window*

8. Make sure *mug* is selected and then press and hold the right mouse button on it; a marking menu is displayed. Next, choose **Object Mode** from the marking menu; the object selection mode is activated.

9. Select *mug* and then choose **Mesh > Remesh > Smooth** from the menubar; the mesh of *mug* is smoothened. Press SPACEBAR; the four viewports display the *mug* after applying **Smooth Tool**, as shown in Figure 2-76.

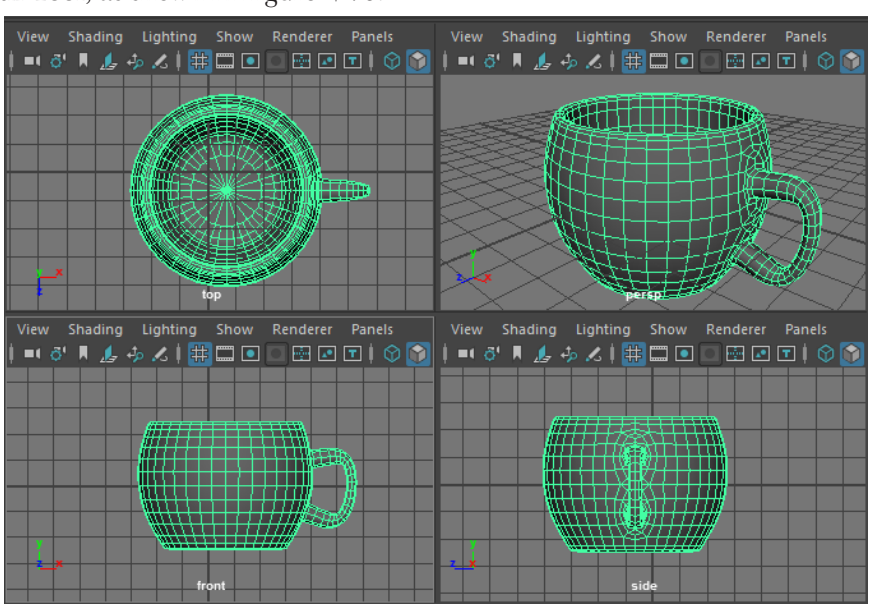


Figure 2-76 *The mug displayed in all viewports*

Changing the Background Color of the Scene

In this section, you will change the background color of the scene.

1. Choose **Windows > Editors > Outliner** from the menubar; the **Outliner** window is displayed. Select the **persp** camera in the **Outliner** window; the **perspShape** tab is displayed in **Attribute Editor**.

2. In the **perspShape** tab, expand the **Environment** node and drag the **Background Color** slider bar toward right to change the background color to white.

Saving and Rendering the Scene

In this section, you will save the scene that you have created and then render it. You can view the final rendered image of the scene by downloading the *c02_maya_2022_rndr.zip* file from *www.cadcim.com*. The path of the file is as follows: *Textbooks > Animation and Visual Effects > Maya > Autodesk Maya 2022: A Comprehensive Guide*

1. Choose **File > Save Scene** from the menubar.

2. Maximize the persp viewport if not already maximized. Choose the **Display render setting** button from the Status Line; the **Render Settings** window is displayed. In this window, select **Maya Software** in the **Render Using** drop-down list and then close the window. Choose the **Render the current frame** button from the Status Line to render the scene, refer to Figure 2-58.

Tutorial 2

In this tutorial, you will create the model of a skateboard, as shown in Figure 2-77, using the polygon modeling techniques. (**Expected time: 30 min**)

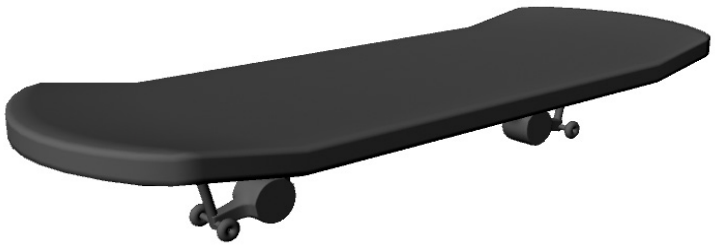


Figure 2-77 *The model of a skateboard*

The following steps are required to complete this tutorial:

a. Create a project folder.
b. Create the deck.
c. Create the base.
d. Create the wheels.
e. Change the background color of the scene.
f. Save and render the scene.

Creating a Project Folder

Create a new project folder with the name *c02_tut2* at *\Documents\maya2022* and then save the file with the name *c02tut2*, as discussed in Tutorial 1.

Creating the Deck

In this section, you need to create the deck of the skateboard using the **Cube** tool.

1. Maximize the top-Y viewport. Choose **Create > Objects > Polygon Primitives > Cube > Option Box** from the menubar; the **Tool Settings (Polygon Cube Tool)** panel is displayed on the left of the viewport. Enter the required values in the **Tool Settings (Polygon Cube Tool)** panel, as shown in Figure 2-78. Next, click in the top-Y viewport; a cube is created in the top-Y viewport, as shown in Figure 2-79. Close the **Tool Settings (Polygon Cube Tool)** panel.

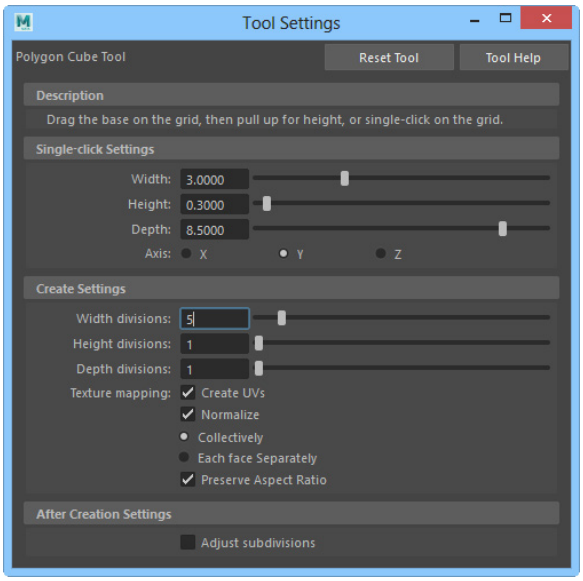


Figure 2-78 *The* ***Tool Settings (Polygon Cube Tool)*** *panel*

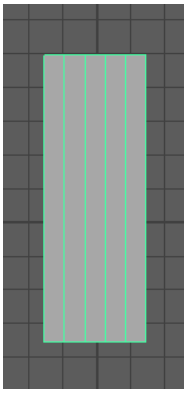


Figure 2-79 *A cube created*

2. In the **Channel Box / Layer Editor**, click on **pCube1**. Next, enter **deck** in the text box and press ENTER; the **pCube1** is renamed as *deck*.

3. In the top-Y viewport, press and hold the right mouse button on *deck*; a marking menu is displayed. Choose **Vertex** from the marking menu; the vertex selection mode is activated. Next, select the vertices, as shown in Figure 2-80. Next, choose the **Scale Tool** by pressing the R key and scale the vertices uniformly, refer to Figure 2-81.

4. Similarly, scale the other vertices to create the basic shape of *deck*, as shown in Figure 2-82.

5. Press and hold the right mouse button on *deck*; a marking menu is displayed. Next, choose **Object Mode** from the marking menu; the object selection mode is activated. Select *deck* and maximize the front-Z viewport.

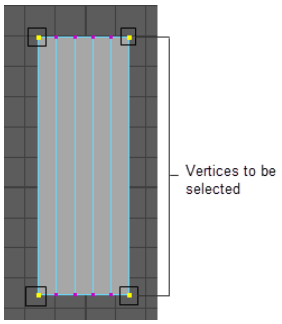


Figure 2-80 *The vertices selected*

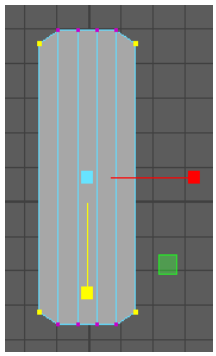


Figure 2-81 *The selected vertices scaled*

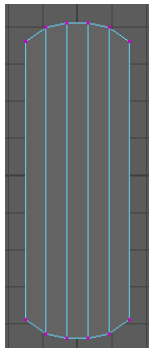


Figure 2-82 *The basic shape of the deck*

6. Make sure the **Modeling** menuset is selected from the **Menuset** drop-down list in the Status Line. Next, choose **Mesh Tools > Tools > Insert Edge Loop** tool from the menubar; the shape of the cursor changes. Click on the top and bottom vertical edge and create two new segments on *deck*, as shown in Figure 2-83.

7. Maximize the top-Y viewport and repeat the previous step to create two segments on *deck*, as shown in Figure 2-84. Choose the **Select Tool** to deactivate the **Insert Edge Loop** tool.

Figure 2-83 *Two new segments created in the front-Z viewport*

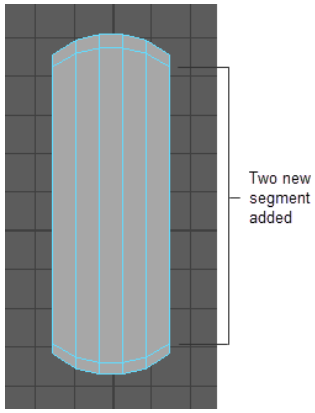


Figure 2-84 *Two segments created in the top-Y viewport*

8. Press and hold the right mouse button on *deck*; a marking menu is displayed. Choose **Object Mode** from the marking menu; the object selection mode is activated.

9. Make sure *deck* is selected and choose **Mesh > Remesh > Smooth > Option Box** from the menubar; the **Smooth Options** window is displayed. In the **Smooth Options** window, make sure the **Division levels** value is set to **1**. Now, choose the **Smooth** button; the geometry of *deck* is smoothened.

Creating the Base

In this section, you need to create the base of the skateboard using the **Cube** polygon primitive.

1. Maximize the front-Z viewport. Choose **Create > Objects > Polygon Primitives > Cube > Option Box** from the menubar; the **Tool Settings (Polygon Cube Tool)** panel is displayed in the viewport. Enter the required values in the **Tool Settings (Polygon Cube Tool)** panel, as shown in Figure 2-85. Next, click in the front-Z viewport; a cube is created in the front-Z viewport, as shown in Figure 2-86.

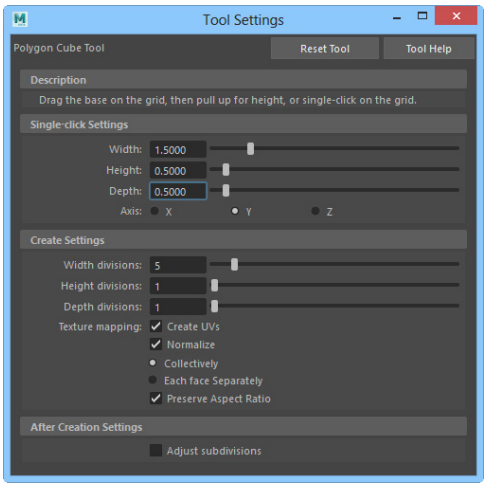


Figure 2-85 *The* ***Tool Settings (Polygon Cube Tool)*** *window*

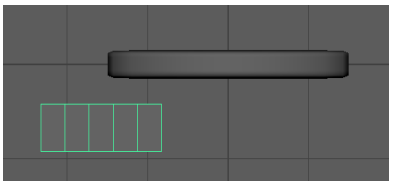


Figure 2-86 *The cube created*

2. In the **Channel Box / Layer Editor**, click on **pCube1** tab. Next, enter **base** in the text box and press ENTER; **pCube1** tab is renamed as *base*.

3. In the front-Z viewport, press and hold the right mouse button on *base*; a marking menu is displayed. Choose **Vertex** from the marking menu; the vertex selection mode is activated. Next, select the two bottom center vertices and then choose the **Move Tool** from the Tool Box. Now, adjust the vertices on *base* to get the result shown in Figure 2-87.

4. Maximize the side-X viewport. Select the left most vertices in the side-X viewport and then drag them along the -Z axis to reduce the size of *base*, as shown in Figure 2-88.

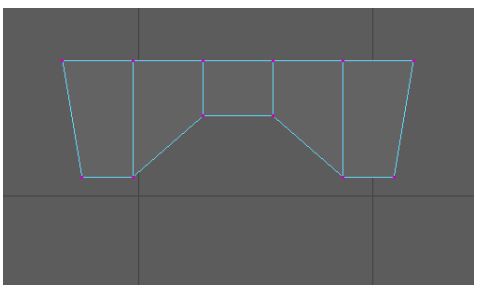


Figure 2-87 *The adjusted vertices of the base*

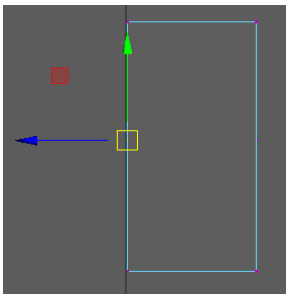


Figure 2-88 *Dragging the selected vertices along the -Z axis*

5. Press and hold the right mouse button on *base*; a marking menu is displayed. Next, choose **Object Mode** from the marking menu; the object selection mode is activated.

6. Select *base* and maximize the front-Z viewport. Next, choose **Mesh Tools > Tools > Insert Edge Loop** tool from the menubar. Using this tool, insert four new segments, as shown in Figure 2-89. Choose the **Select Tool** to deactivate the **Insert Edge Loop** tool.

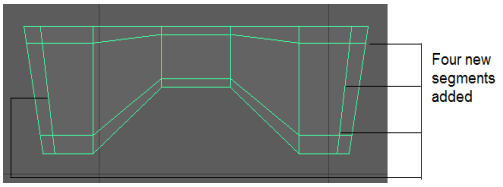


Figure 2-89 *Four new segments inserted in the front-Z viewport*

7. Press and hold the right mouse button on *base*; a marking menu is displayed. Choose **Object Mode** from the marking menu; the object selection mode is activated.

8. Select *base* and choose **Mesh > Remesh > Smooth** from the menubar; the geometry of *base* is smoothened.

   Next, you need to create the bolts.

9. Choose **Create > Objects > Polygon Primitives > Cylinder > Option box** from the menubar; the **Tool Settings (Polygon Cylinder Tool)** panel is displayed. Enter the required values in the **Tool Settings (Polygon Cylinder Tool)** panel, as shown in Figure 2-90. Click in the front-Z viewport; a cylinder is created.

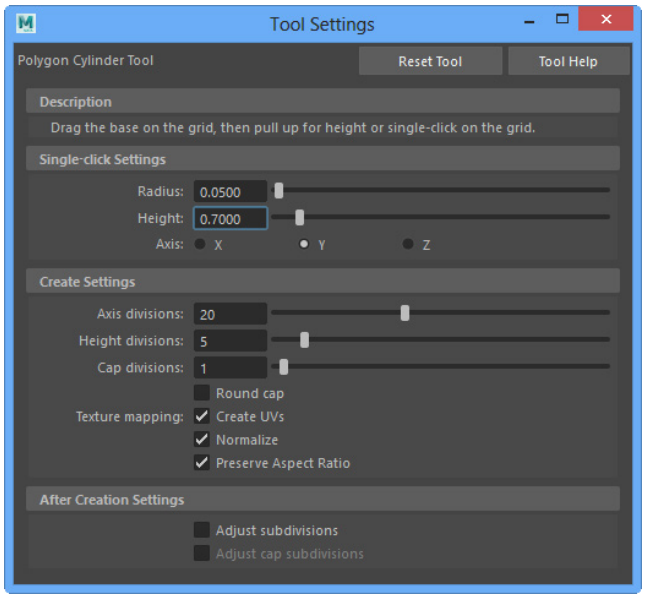


Figure 2-90 *The **Tool Settings (Polygon Cylinder Tool)** panel*

10. In the **Channel Box / Layer Editor**, click on **pCylinder1**. Next, enter **bolt** in the text box and press ENTER; **pCylinder** is renamed as *bolt*.

11. Choose **Move Tool** from the Tool Box and align *bolt* with base in all viewports. Next, choose the **Rotate Tool** from the Tool Box to rotate and align it with both front-Z and side-X viewports, as shown in Figures 2-91 and 2-92.

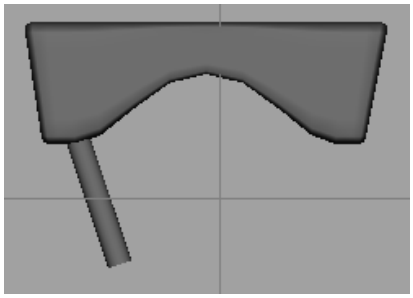


Figure 2-91 *The cylinder rotated and aligned in the front-Z viewport*

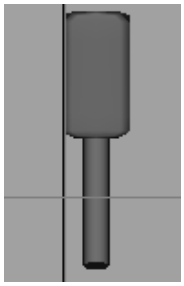


Figure 2-92 *The cylinder rotated and aligned in the side-X viewport*

12. Activate the side-X viewport. Make sure *bolt* is selected and press CTRL+D; a duplicate copy of *bolt* is created with the name *bolt1*. Set the following parameters in the **Channel Box / Layer Editor** of *bolt1*:

Rotate X: **90** Rotate Z: **0**

13. Choose the **Scale Tool** from the Tool Box and scale *bolt1* uniformly. Next, choose the **Move Tool** from the Tool Box and align it in all viewports, as shown in Figure 2-93.

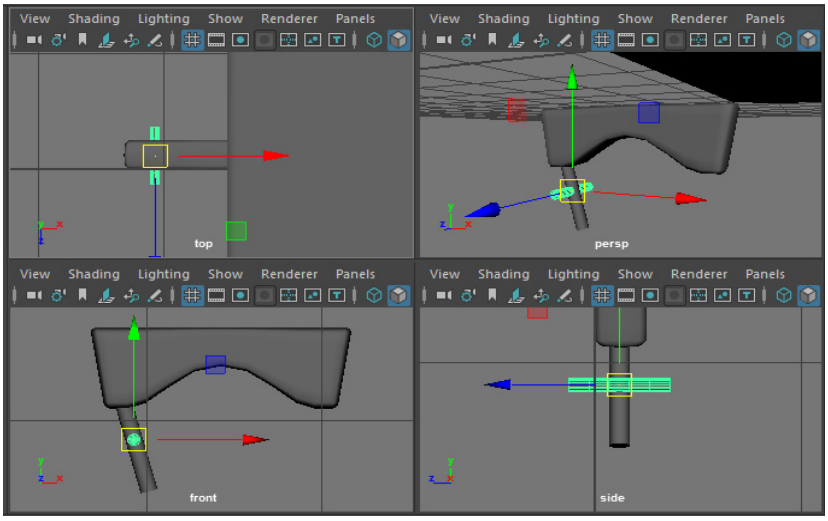


Figure 2-93 *Aligning bolt1 in all viewports*

Next, you need to create *truck*.

14. Maximize the front-Z viewport. Choose **Create > Objects > Polygon Primitives > Cylinder > Option box** from the menubar; the **Tool Settings (Polygon Cylinder Tool)** panel is displayed in the viewport. In the **Tool Settings (Polygon Cylinder Tool)** panel, set the parameters as follows:

Radius: **0.25** Height: **1** Axis: **Z**
Axis divisions: **10** Height divisions: **3** Cap Divisions: **10**

Next, click in the viewport; the cylinder is created .

15. In the **Channel Box / Layer Editor**, click on **pCylinder1**. Next, enter **truck** in the text box and press ENTER; the **pCylinder1** is renamed as *truck*.

16. Maximize the persp viewport. Press and hold the right mouse button over *truck* and choose **Face** from the marking menu displayed; the face selection mode is activated. Select the faces 1 and 5 of *truck*, refer to Figure 2-94. Next, choose **Edit Mesh > Components > Extrude** from the menubar; the **polyExtrudeFace2** In-View Editor is displayed. Enter **1** in the **Thickness** edit box; the faces of *truck* are extruded, as shown in Figure 2-95.

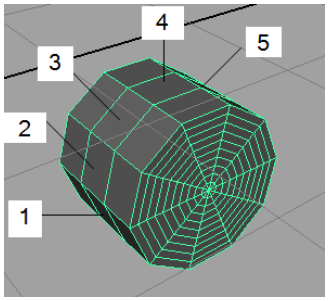


Figure 2-94 *The cylinder after extrusion in the persp viewport*

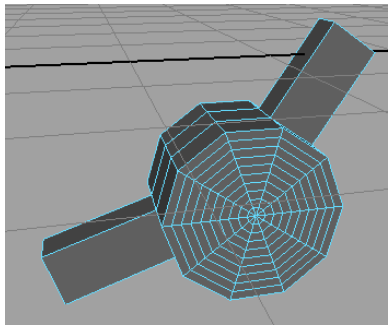


Figure 2-95 *The cylinder after extrusion in the persp viewport*

17. Maximize the front-Z viewport. Choose the **Mesh Tools > Tools > Insert Edge Loop** tool from the menubar and add new segments to *truck,* as shown in Figure 2-96. Choose **Select Tool** to deactivate the **Insert Edge Loop** tool.

18. Press and hold the right mouse button on *truck*; a marking menu is displayed. Choose **Object Mode** from it; the object selection mode is activated. Next, select *truck* and choose **Mesh > Remesh > Smooth > Option Box** from the menubar; the **Smooth Options** window is displayed.

19. In the window, enter **2** in the **Division levels** edit box and then choose the **Smooth** button; the geometry of *truck* is smoothened. Next, align *truck*, *base, bolt* and *bolt1* in all viewports using **Move Tool**, **Rotate Tool**, and **Scale Tool** uniformly, refer to Figure 2-97.

20. Press and hold the SHIFT key and select *base*, *truck*, *bolt,* and *bolt1* in the persp viewport. Next, choose **Mesh > Combine > Combine** from the menubar; the selected parts are combined and a group with the name **base1** is created.

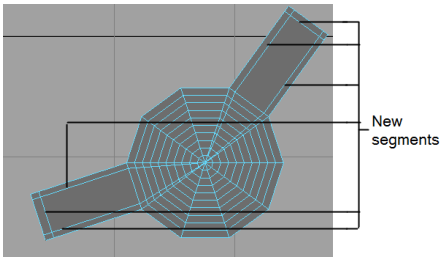


Figure 2-96 *New segments added to truck*

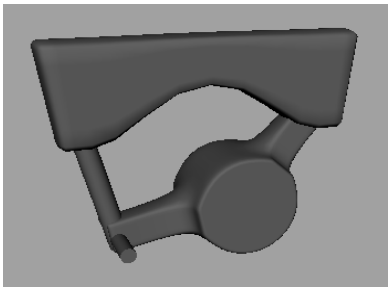


Figure 2-97 *The parts aligned with base in the front-Z viewport*

21. In the **base1** area of the **Channel Box / Layer Editor**, enter **90** in the **Rotate Y** edit box and then press the ENTER key.

22. Align **base1** in all viewports using the **Move Tool** and the **Scale Tool** from the Tool Box to make it proportional with the deck, as shown in Figure 2-98.

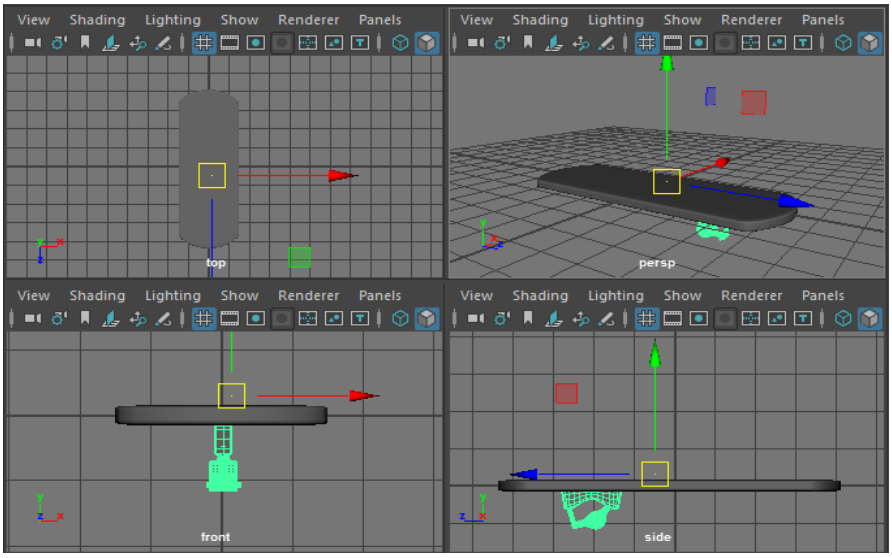


Figure 2-98 *The **base1** aligned in all viewports*

Creating Wheels

In this section, you need to create wheels for the skateboard using the **Torus** polygon primitive.

1. Choose **Create > Objects > Polygon Primitives > Torus** from the menubar. Next, click in the top-Y viewport to create a torus.

2. In the **INPUTS** area of the **Channel Box / Layer Editor**, expand the **polyTorus1** node and set the following parameters:

   Radius: **0.1** Section Radius: **0.1**

3. In the **pTorus1** area of the **Channel Box/Layer Editor**, enter **90** in the **Rotate Z** edit box.

4. In the **Channel Box / Layer Editor**, rename **pTorus1** as *wheel*, as done earlier.

5. Scale and align *wheel* with *bolt1* in all viewports using the **Move Tool** from the Tool Box, as shown in Figure 2-99.

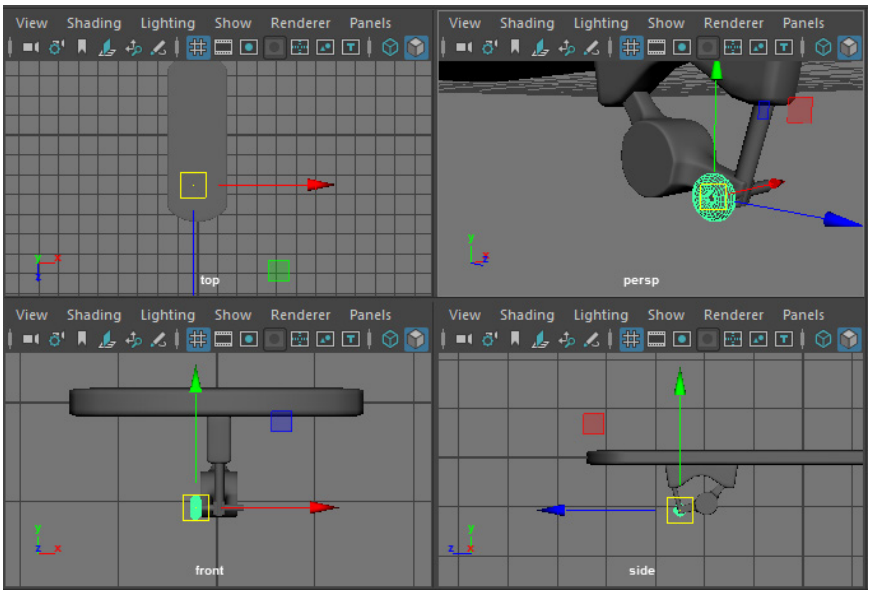


Figure 2-99 *The wheel aligned with bolt1 in all viewports*

6. Maximize the front-Z viewport. Make sure *wheel* is selected and then press CTRL+D; a duplicate copy of *wheel* is created with the name *wheel1*. Next, move *wheel1* in a direction opposite to *wheel*, as shown in Figure 2-100.

7. Maximize the persp viewport. Select *base1*, *wheel*, and *wheel1* by using the SHIFT key and then choose **Mesh > Combine > Combine** from the menubar; the selected parts are combined to form a single polygon object with the name **base2**.

8. Choose **Modify > Pivot > Center Pivot** from the menubar; the pivot point of the combined **base2** is set to center. Next, press CTRL+D; a duplicate copy of the selected mesh is created in the viewport.

9. Maximize the side-X viewport. Next, move *base3* along the Z axis to align with *deck* and also enter **180** in the **Rotate Y** edit box to rotate *base3*, refer to Figure 2-101.

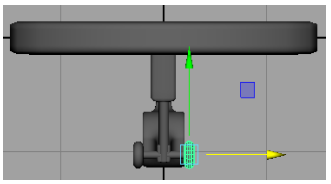


Figure 2-100 *The wheel1 moved to opposite direction of wheel*

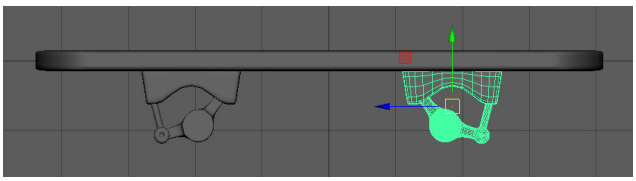


Figure 2-101 *The base3 moved and rotated*

10. Select *deck*. Press and hold the right mouse button on *deck*; a marking menu is displayed. Choose **Vertex** from the marking menu; the vertex selection mode is activated. Next, select the vertices and move up along the Y axis using **Move Tool**, as shown in Figure 2-102.

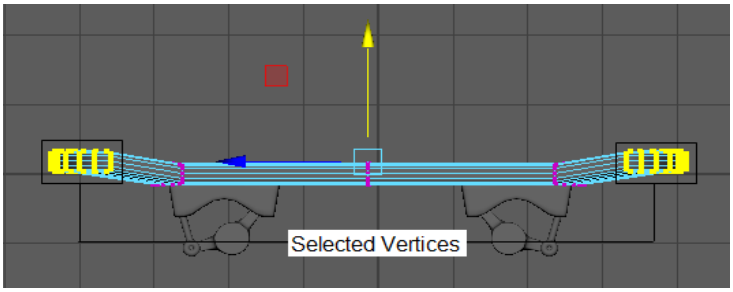


Figure 2-102 *Moving the selected vertices up along the Y axis*

11. Press and hold the right mouse button on *deck*; a marking menu is displayed. Choose **Object Mode** from the marking menu; the object selection mode is activated.

12. Maximize the persp viewport and select all parts of the skateboard in the persp viewport. Next, choose **Mesh > Combine > Combine** from the menubar; the selected parts are combined.

Changing the Background Color of the Scene

In this section, you will change the background color of the scene.

1. Choose **Windows > Editors > Outliner** from the menubar; the **Outliner** window is displayed. Select the **persp** camera in the **Outliner** window; the **perspShape** tab is displayed in the **Attribute Editor**.

Note

*If the **Attribute Editor** is not visible in the interface, press CTRL + A to make it visible.*

2. In the **perspShape** tab, expand the **Environment** area and drag the **Background Color** slider bar toward right to change the background color to white.

Saving and Rendering the Scene

In this section, you will save the scene that you have created and then render it. You can view the final rendered image of the model by downloading the *c02_maya_2022_rndr.zip* file from *www.cadcim.com*. The path of the file is as follows: *Textbooks > Animation and Visual Effects > Maya > Autodesk Maya 2022: A Comprehensive Guide*.

1. Choose **File > Save Scene** from the menubar.

2. Maximize the persp viewport if not already maximized. Choose the **Display render setting** button from the Status Line; the **Render Settings** window is displayed. In this window, select **Maya Software** from the **Render Using** drop-down list and then close the window. Choose the **Render the current frame** button from the Status Line to render the scene, refer to Figure 2-77.

Tutorial 3

In this tutorial, you will create the model of a hand, as shown in Figure 2-103, using the polygon modeling techniques. (**Expected time: 40 min**)

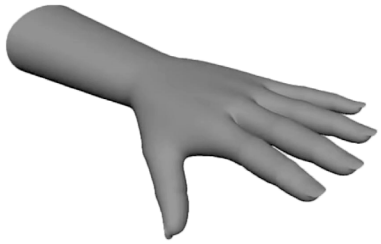


Figure 2-103 *The model of a hand*

The following steps are required to complete this tutorial:

a. Create a project folder.
b Create the structure of a hand.
c. Create Fingers.
d. Create the nails.
e. Add the edges for hand.
f. Change the background color of the scene.
g. Save and render the scene.

Creating a Project Folder

Create a new project folder with the name *c02_tut3* at *\Documents\maya2022* and then save the file with the name *c02tut3*, as discussed in Tutorial 1.

Creating the Structure of a Hand

In this section, you need to create a structure of hand using the **Cube** Tool.

1. Choose **Create > Objects > Polygon Primitives > Cube** from the menubar: the cube is created in the Viewport.

2. In the **Channel Box / Layer Editor**, click on **pCube1**. Next, enter **hand** in the text box and press ENTER; the **pCube1** is renamed as *hand*.

3. In the **INPUTS** area of the **Channel Box / Layer Editor**, expand the **polyCube1** node and set the following parameters:

   Width: **4** Height: **1** Depth: **4**

4. In the top-Y viewport, press and hold the right mouse button on *hand*; a marking menu is displayed. Choose **Vertex** from the marking menu, as shown in Figure 2-104; the vertex selection mode is activated. Next, select the vertices and scale them uniformly using the **Scale Tool** by pressing the R key, refer to Figure 2-105.

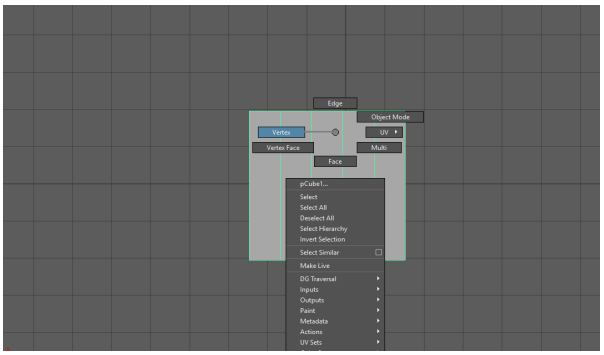


Figure 2-104 *Choosing* ***Vertex*** *from marking menu*

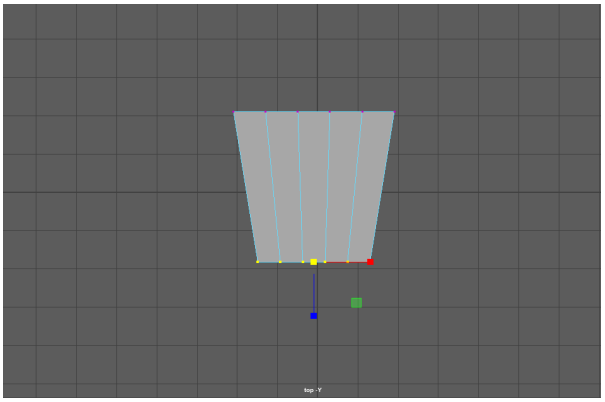


Figure 2-105 *Scaling selected vertices uniformly*

5. Align the other vertices to create the basic shape of hand, as shown in Figure 2-106.

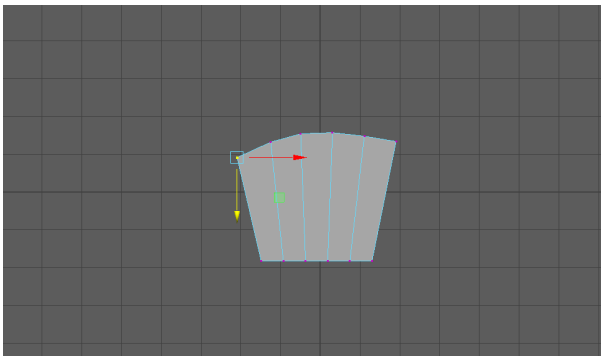


Figure 2-106 *Aligning the vertices*

6. Maximize the persp viewport. Again check and align the vertices of hand. In the persp viewport, press and hold the right mouse button on *hand*; a marking menu is displayed. Choose **Face** from the marking menu; the face selection mode is activated. Next, select the faces of the wrist side and delete them, refer to Figure 2-107.

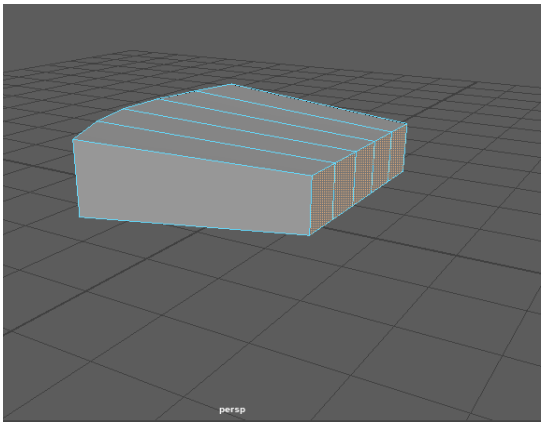


Figure 2-107 *Selected faces of wrist side*

Creating Fingers

In this section, you need to create the fingers of a hand.

1. Press SPACEBAR to maximize all viewports. Make sure the **Modeling** menuset is selected in the **Menuset** drop-down list. In the persp viewport, select the middle face, refer to Figure 2-108.

2. Choose **Edit Mesh > Components > Extrude** from the menubar; the **polyExtrudeFace1** In-View Editor is displayed. Enter the value in In-View Editor, as shown in Figure 2-109; the face of middle finger is extruded. Click on the empty area of viewport; the **polyExtrudeFace1** In-View Editor is closed.

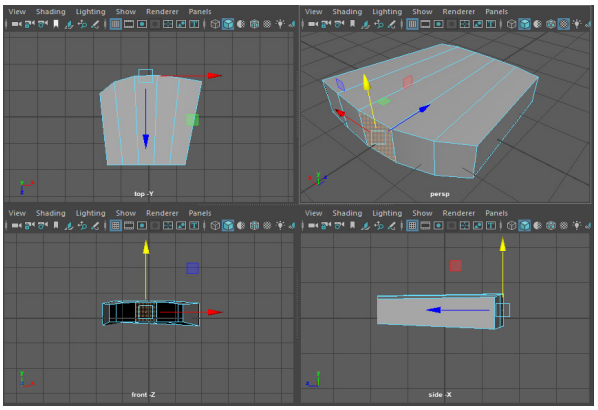


Figure 2-108 *The face selected*

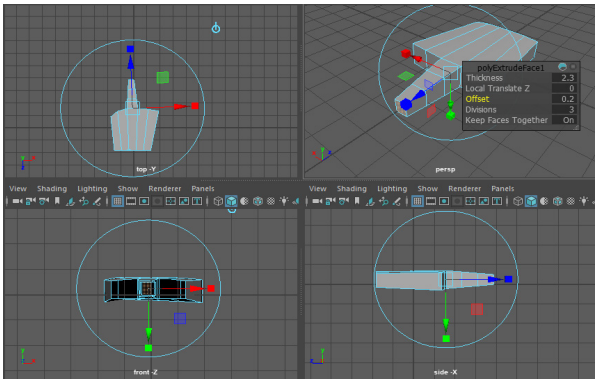


Figure 2-109 *The selected face extruded*

3. Make sure all viewports are maximized. Select the faces of the middle finger in the persp viewport, refer to Figure 2-110. Press E to activate the **Rotate Tool** and slightly rotate the selected faces in the side-X viewport. Similarly, select the top faces of middle finger in the side-X viewport and rotate slightly, as shown in Figure 2-111.

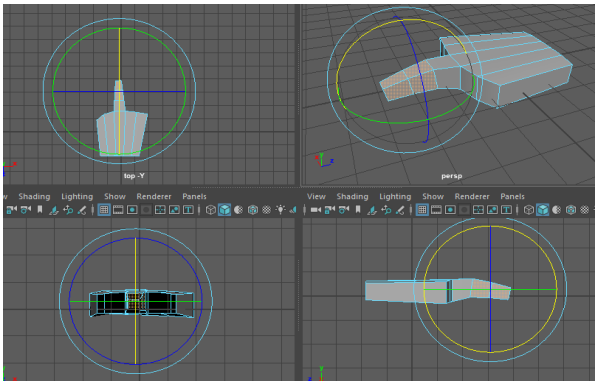


Figure 2-110 *Selected faces of the middle finger*

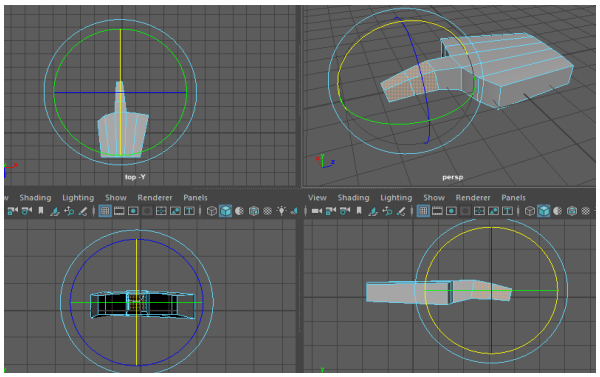


Figure 2-111 *The selected faces rotated*

4. Press and hold the right mouse button on *hand*; a marking menu is displayed. Choose **Object** from the marking menu; the object selection mode is activated. Press W to activate the **Move Tool**. Next, choose **Mesh Tools > Tools > Insert Edge Loop** tool from the menubar, as shown in Figure 2-112. Using this tool, insert one new edge, as shown in Figure 2-113. Choose **Select Tool** to deactivate the **Insert Edge Loop** tool.

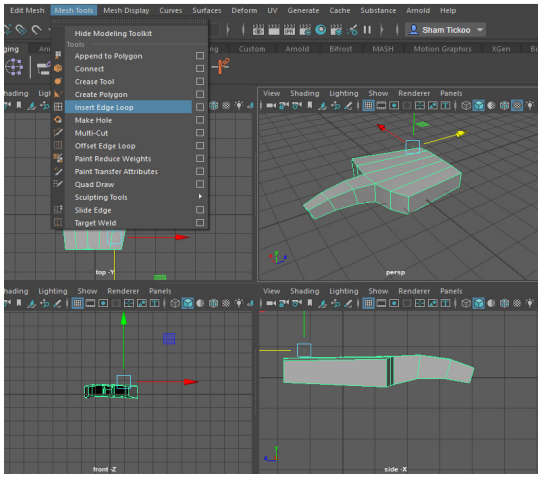


Figure 2-112 *Choosing* ***Insert Edge Loop*** *from the menubar*

5. Press and hold the right mouse button on *hand*; a marking menu is displayed. Choose **Face** from the marking menu; the face selection mode is activated. Select the faces of all fingers using the SHIFT key, as shown in Figure 2-114.

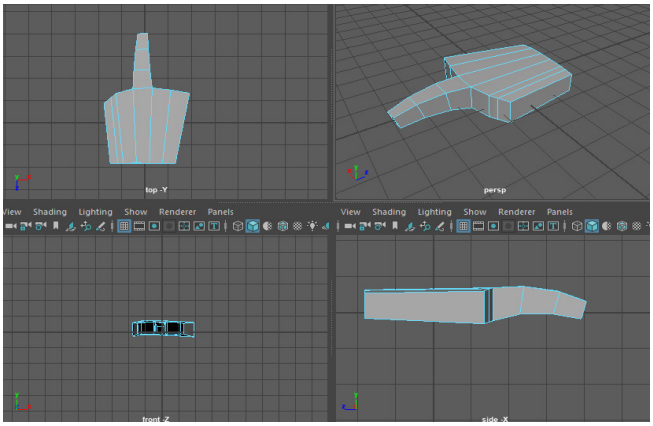


Figure 2-113 *New edge added to the hand*

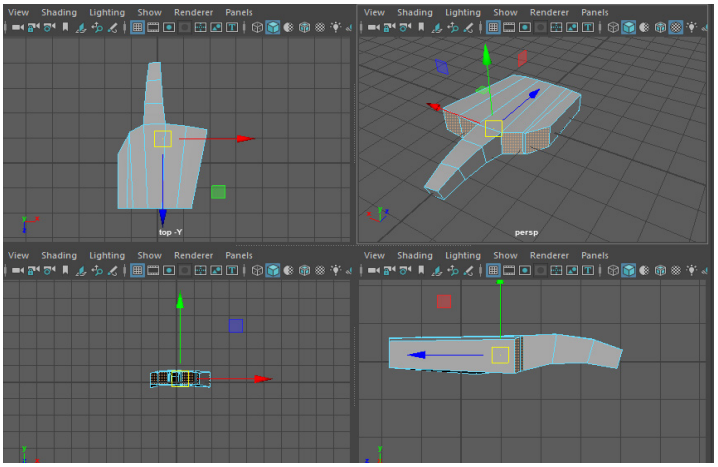


Figure 2-114 *Faces selected*

6. Choose **Edit Mesh > Components > Extrude** from the menubar; the **polyExtrudeFace2** In-View Editor is displayed. Enter **2.1** and **3** in the **Thickness** and **Division** edit box, respectively. Next, click in the **Keep Faces Together** edit box so that it displays off. Next, enter **0.2** in the **Offset** edit box. The selected faces are extruded, as shown in Figure 2-115. Click in the empty area of viewport; the **polyExtrudeFace2** In-View Editor is closed.

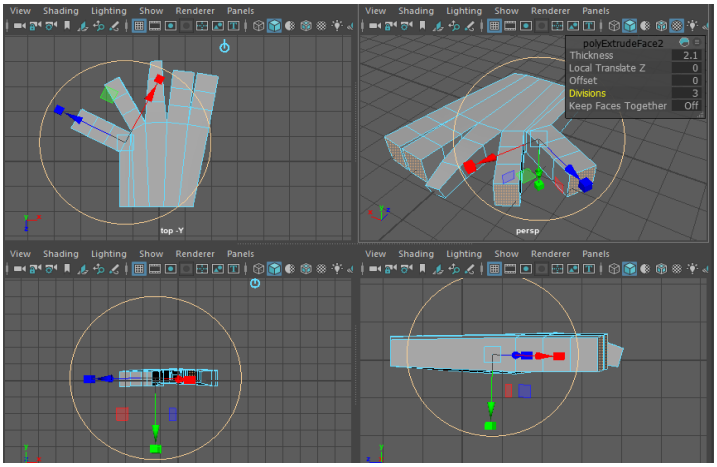


Figure 2-115 *Selected faces extruded*

7. Press and hold the right mouse button on *hand*; a marking menu is displayed. Choose **Vertex** from the marking menu; the vertex selection mode is activated. Next, align vertices of all the fingers using **Scale**, **Move**, and **Rotate** tools to get the shape of hand, as shown in Figures 2-116 through 2-118.

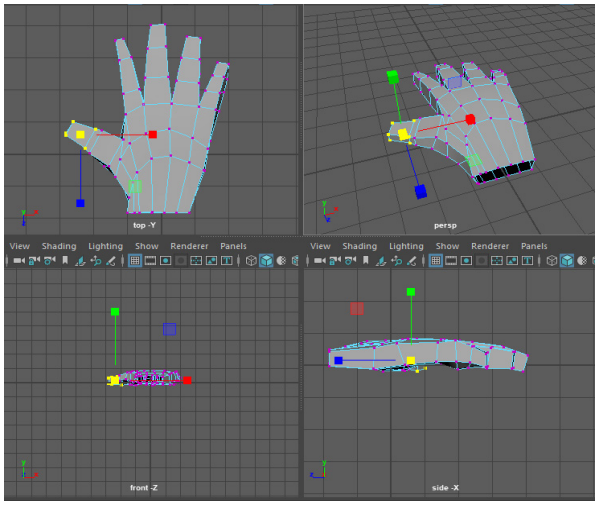


Figure 2-116 *Aligning the vertices of fingers using the* ***Scale*** *tool*

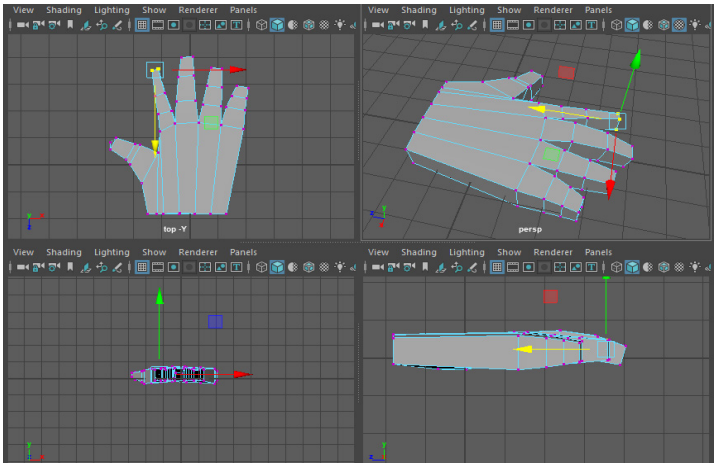


Figure 2-117 *Aligning the vertices of fingers using the* ***Move*** *tool*

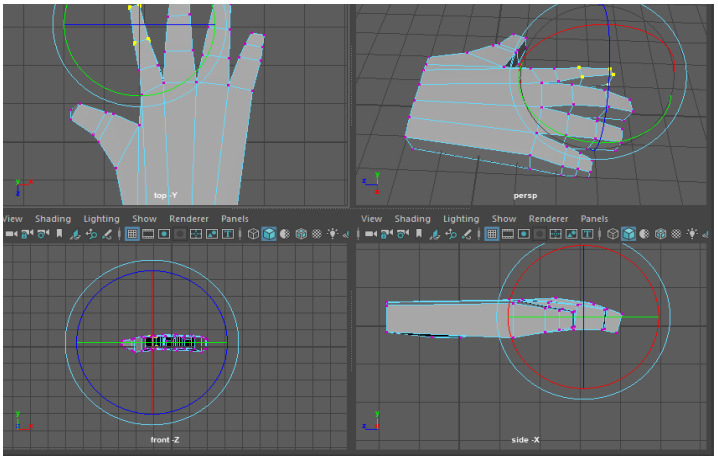


Figure 2-118 *Aligning the vertices of fingers using the* ***Rotate*** *tool*

8. Maximize the persp viewport and press 3 for preview of the smooth hand, as shown in Figure 2-119. Press 1 to turn off the smoothening of the object.

9. Make sure the persp viewport is maximized. Also make sure *hand* is selected. Next, choose **Mesh Tools > Tools > Insert Edge Loop** tool from the menubar. Using this tool, insert two new edges, refer to Figure 2-120. Choose **Select Tool** to deactivate the **Insert Edge Loop** tool.

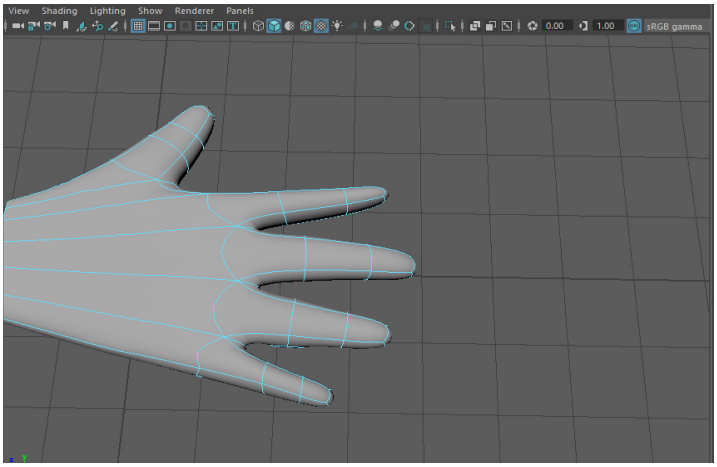


Figure 2-119 *Preview of the smooth hand*

Creating the Nails

In this section, you need to create the nails.

1. Press and hold the right mouse button on *hand*; a marking menu is displayed. Choose **Face** from the marking menu; the face selection mode is activated. Select the top faces of the nail area of all fingers using the SHIFT key, as shown in Figure 2-120.

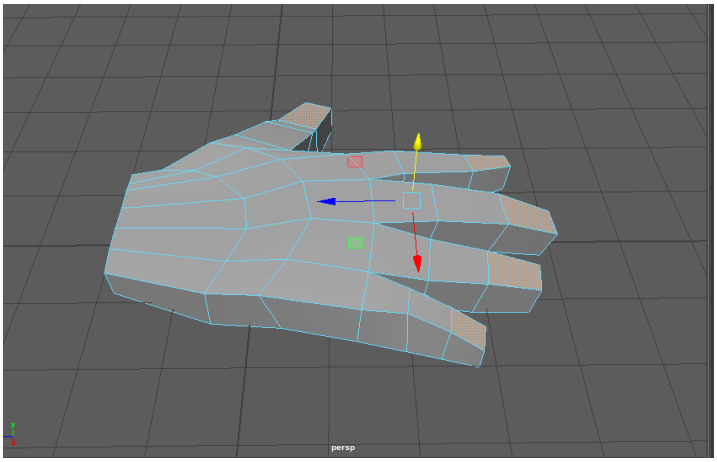


Figure 2-120 *Top faces of the nail area selected*

2. Choose **Edit Mesh > Components > Extrude** from the menubar; the **polyExtrudeFace3** In-View Editor is displayed. Enter the required values, as shown in Figure 2-121. Also, slightly rotate the extruded faces. Click on the empty area of viewport; the **polyExtrudeFace3** In-View Editor is closed.

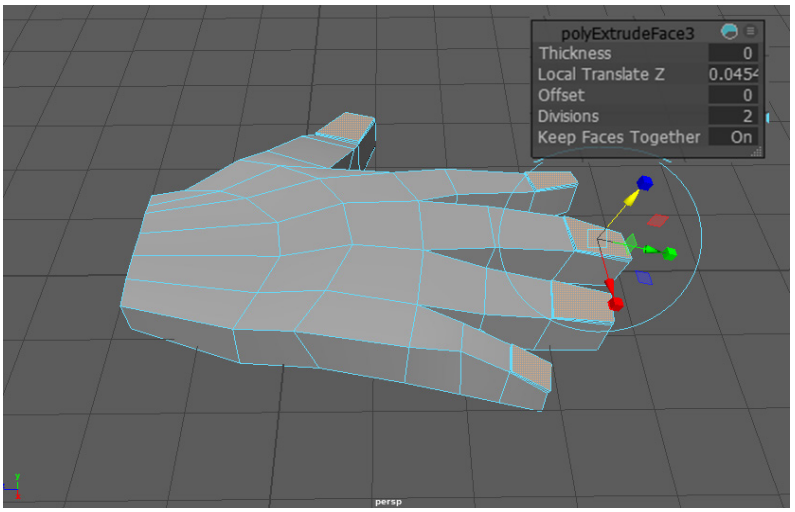


Figure 2-121 *The values set in the* ***polyExtrudeFace3*** *In-View Editor*

3. Similarly select the faces of nail tip using the SHIFT key. Next, choose **Edit Mesh > Components > Extrude** from the menubar; the **polyExtrudeFace4** In-View Editor is displayed. Enter the value, as shown in Figure 2-122. Now, click on the empty area of viewport; the **polyExtrudeFace4** In-View Editor is closed.

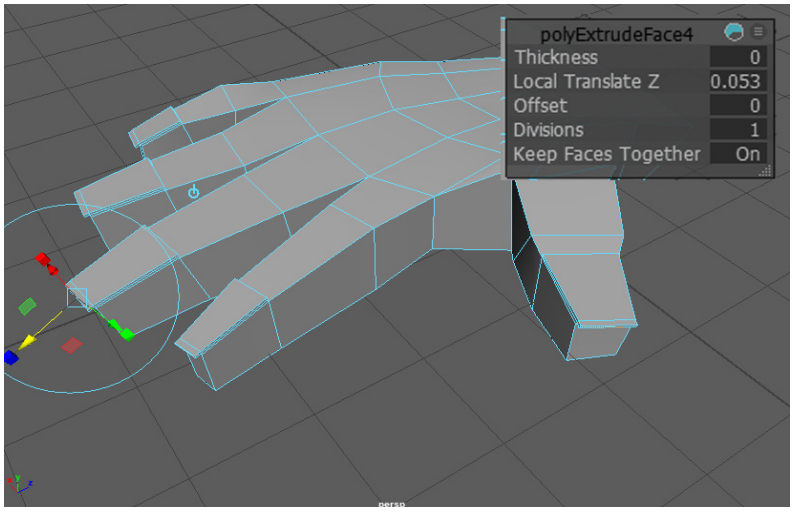


Figure 2-122 *The values set in the* ***polyExtrudeFace4*** *In-View Editor*

4. Press and hold the right mouse button on *hand*; a marking menu is displayed. Choose **Object** from the marking menu; the object selection mode is activated. Press 3 for preview of the smooth hand, as shown in Figure 2-123. Press 1 for turning off smoothness preview.

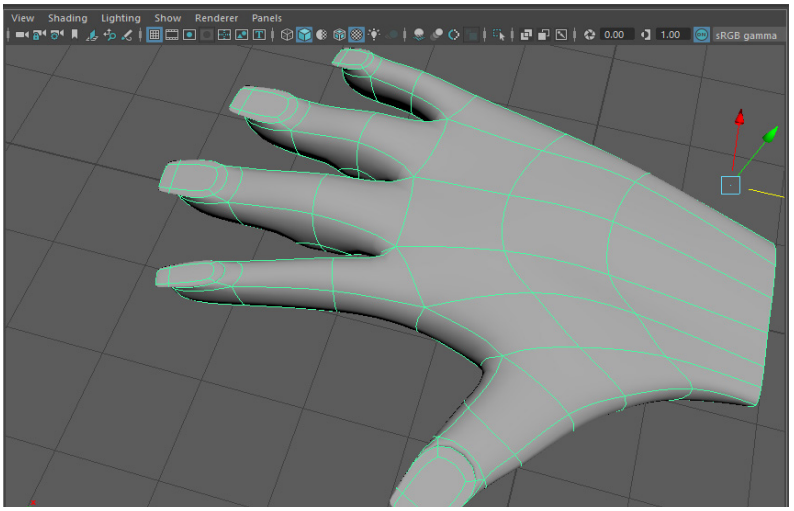


Figure 2-123 *Preview of the hand*

Adding the Edges

In this section, you need to add the edges to give the perfect shape to hand.

1. Make sure the persp viewport is maximized. Also, make sure *hand* is selected. Next, choose **Mesh Tools > Tools > Insert Edge Loop** tool from the menubar. Using this tool, insert two new edge loops in the wrist area, as shown in Figure 2-124. Choose **Select Tool** to deactivate the **Insert Edge Loop** tool.

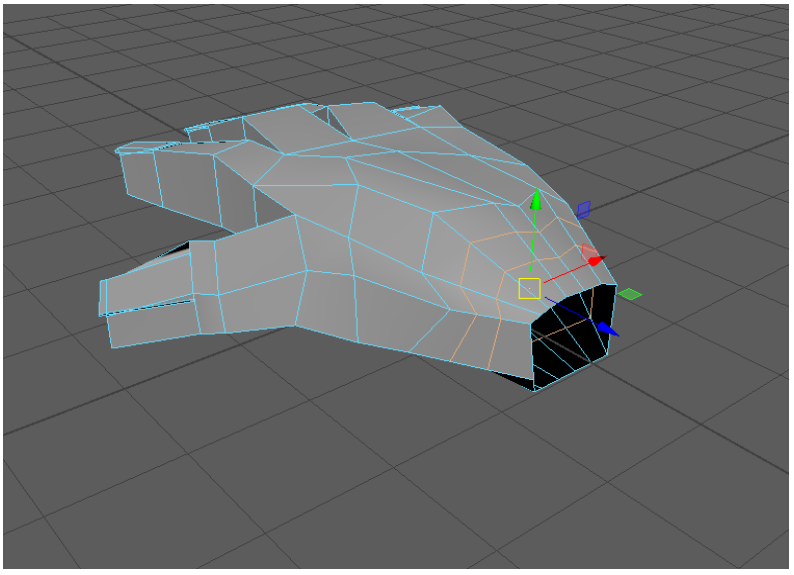


Figure 2-124 *Two new edge loops added*

2. Select the edge and then press W to activate **Move Tool** and then move the edge, as shown in Figure 125. Now, adjust both the edges using **Move Tool**.

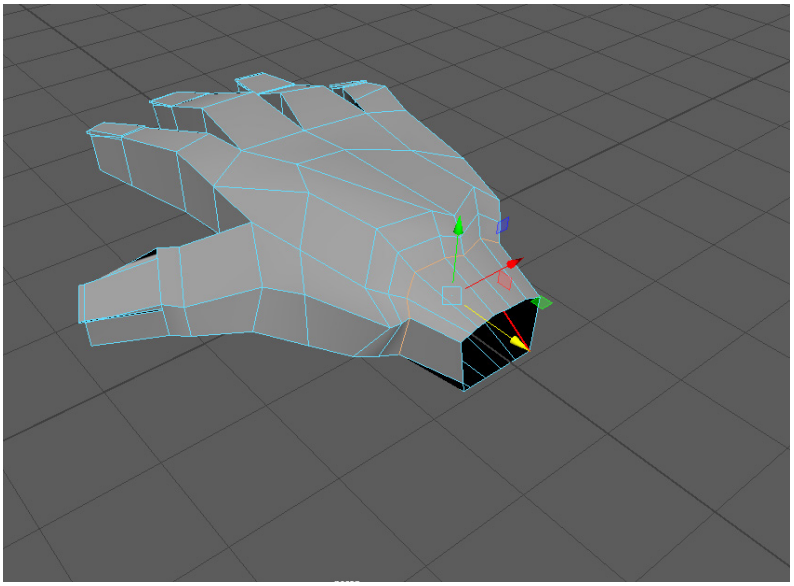


Figure 2-125 *Moving the selected edge upward*

3. Select the last edge of the wrist and move it using **Move Tool**, as shown in Figure 2-126. Next, choose **Mesh Tools > Tools > Insert Edge Loop** tool from the menubar. Using this tool, insert edges, as shown in Figure 2-127.

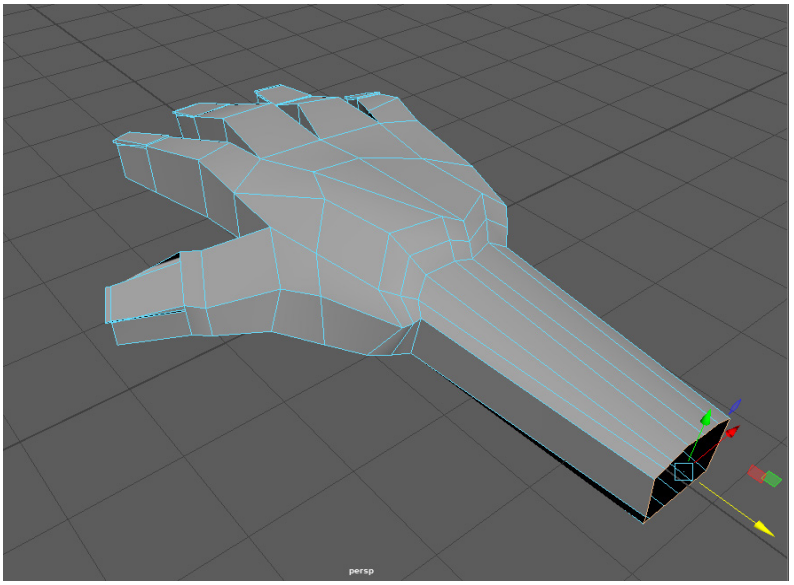


Figure 2-126 *Moving the selected edge*

4. Adjust all edges using **Move Tool**, **Scale Tool**, and **Rotate Tool** for perfect shape. Press 3 for preview of the smooth hand, as shown in Figure 2-128.

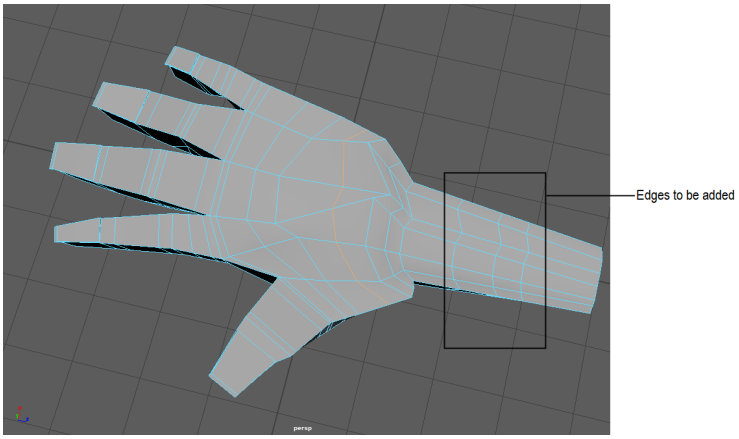


Figure 2-127 *Added edges for perfect shape*

5. Make sure **Modeling** is selected in the **Menuset** drop-down list. Next, select the hand and then choose **Mesh>Retopologize** from the menubar; the hand is smoothened.

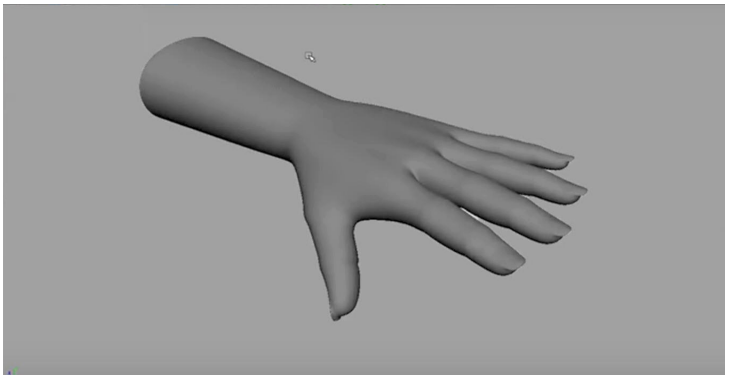


Figure 2-128 *The preview of the smooth hand*

Changing the Background Color of the Scene

In this section, you will change the background color of the scene.

1. Choose **Windows > Editors > Outliner** from the menubar; the **Outliner** window is displayed. Select the **persp** camera in the **Outliner** window; the **perspShape** tab is displayed in the **Attribute Editor**.

2. In the **perspShape** tab, expand the **Environment** area and drag the **Background Color** slider bar toward right to change the background color to white.

Saving and Rendering the Scene

In this section, you will save the scene that you have created and then render it. You can view the final rendered image of the model by downloading the *c02_maya_2022_rndr.zip* file from *www.cadcim.com*. The path of the file is as follows: *Textbooks > Animation and Visual Effects > Maya > Autodesk Maya 2022: A Comprehensive Guide*

1. Choose **File > Save Scene** from the menubar.

2. Maximize the persp viewport if not already maximized. Choose the **Display render setting** button from the Status Line; the **Render Settings** window is displayed. In this window, select **Maya Software** from the **Render Using** drop-down list and then close the window. Choose the **Render the current frame** button from the Status Line to render the scene, refer to Figure 2-103.

Self-Evaluation Test

Answer the following questions and then compare them to those given at the end of this chapter:

1. Which of the following geometric shapes is formed by connecting a polygonal base and an apex?

   (a) **Prism** (b) **Pyramid**
   (c) **Sphere** (d) **Cube**

2. Which of the following shortcuts can be used to display an object in the object selection mode?

   (a) **F8** (b) **F9**
   (c) **F10** (d) **F11**

3. The _____ is used to merge two vertices together.

4. The _____ option is used to subtract the last selected geometry from the geometry that was selected first.

5. A _____ is a curve in three dimensional space such that its angle to a plane perpendicular to the axis is constant.

6. The _____ solids are those primitives in which all sides and angles are equal and all faces are identical.

7. The _____ tool is used to reduce the number of polygons in the selected region of an object.

8. The **Insert Edge Loop Tool** is used to create beveled transition surfaces on a profile curve. (T/F)

9. The **Chamfer** tool is used to merge the selected edges and vertices that are within a numerically specified threshold distance from each other. (T/F)

10. The **Bridge** tool is used to connect two edges or two faces of a polygon object. (T/F)

Review Questions

Answer the following questions:

1. Which of the following tools is used to add smoothness to a sharp edge?

   (a) **Extrude** (b) **Duplicate face**
   (c) **Bevel** (d) **Merge to Center**

2. Which of the following primitives is formed by an alternate arrangement of hexagons and pentagons?

   (a) **Prism** (b) **Helix**
   (c) **Soccer ball** (d) **Sphere**

3. The _____ option is used to create a duplicate copy of a selected face.

4. The _____ tool is used to add segments on both the sides of a selected edge.

5. The _____ tool is used to ungroup the combined polygon objects into separate polygon objects.

6. The _____ tool is used to make a polygon object smooth by adding divisions to it.

7. The _____ operation is used to merge two intersecting objects by deleting the intersecting geometry between them.

8. The **Combine** tool is used to group two or more polygon meshes into a single polygon object. (T/F)

9. The **Multi-Cut** tool is used to manually add segments between two edges of an object. (T/F)

10. The **Detach** tool is used to split a vertex into multiple vertices. (T/F)

EXERCISES

The rendered output of the models used in the following exercises can be accessed by downloading the file *c02_maya_2022_exr.zip* from *www.cadcim.com*. The path of the file is as follows: *Textbooks > Animation and Visual Effects > Maya > Autodesk Maya 2022: A Comprehensive Guide*

Exercise 1

Using various polygon modeling techniques, create the model of a USB cable, as shown in Figure 2-129. **(Expected time: 30 min)**

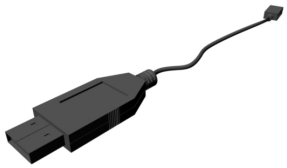


Figure 2-129 *Model to be created in Exercise 1*

Exercise 2

Using various polygon modeling techniques, create a scene, as shown in Figure 2-130. **(Expected time: 30 min)**

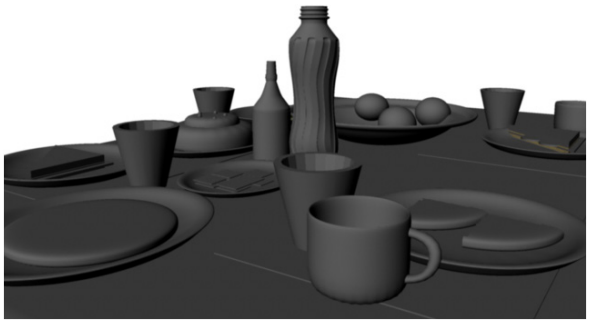


Figure 2-130 *Scene to be created in Exercise 2*

Exercise 3

Using polygon primitive modeling techniques, create a scene, as shown in Figure 2-131. **(Expected time: 30 min)**

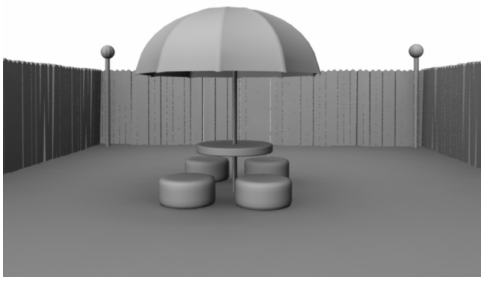


Figure 2-131 *Scene to be created in Exercise 3*

Answers to Self-Evaluation Test

1. b, **2.** a, **3. Merge Tool**, **4. Difference**, **5.** helix, **6.** platonic, **7. Reduce**, **8.** F, **9.** F, **10.** T