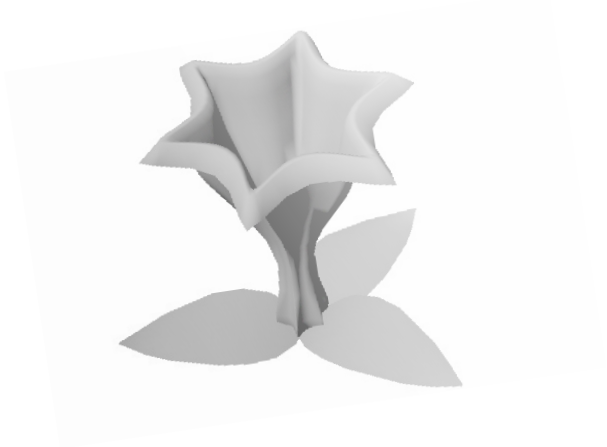
Chapter 3

NURBS Curves and Surfaces

Learning Objectives

After completing this chapter, you will be able to:

- *Create NURBS Primitives*
- *Create NURBS curves*
- *Create surfaces*



INTRODUCTION

In Maya, there are three different types of modeling: NURBS, polygon, and subdivision surface. NURBS, which stands for Non-Uniform Rational B-Splines, is an industry standard for designing and modeling surfaces. NURBS modeling is suitable for modeling surfaces with complex curves. NURBS surfaces can be manipulated interactively with ease. Before modeling an object, you need to visualize it in 3D terms. Visualization of an object in 3D terms helps you in determining the type of modeling that you need to use for creating the object. In this chapter, you will learn about various NURBS modeling tools and techniques.

TOOLS FOR CREATING NURBS CURVES

In Maya, you can create NURBS curves using various tools. The tools used to create NURBS curves are discussed next.

CV Curve Tool

Menubar: Create > Objects > Curve Tools > CV Curve Tool



The **CV Curve Tool** is used to create curves in the viewport. A CV curve comprises of control vertices or CVs. To create a CV curve, choose **Create > Objects > Curve Tools > CV Curve Tool** from the menubar; the cursor will change into a plus sign. Next, click on different places in the viewport to create a curve. The first CV of the curve will be displayed as a box, and the second CV will be displayed as letter U. The box defines the starting point of the curve, and the letter U defines the direction of the curve. Press ENTER to finish the curve creation process. To edit the properties of a curve, choose **Create > Objects > Curve Tools > CV Curve Tool Option Box** from the menubar; the **Tool Settings (CV Curve Tool)** panel will be displayed.



Tip

*By default, **CV Curve Tool** is not present in the **Curves** Shelf tab. To add **CV Curve Tool** to the Shelf, press and hold CTRL+SHIFT and choose **Create > CV Curve Tool** from the menubar; **CV Curve Tool** icon will be displayed in the Shelf.*

EP Curve Tool

Menubar: Create > Objects > Curve Tools > EP Curve Tool
Shelf: Curves/Surfaces > EP Curve Tool



The **EP Curve Tool** is also used to create an outline of a curve by placing edit points on it. To create an outline, choose **Create > Objects > Curve Tools > EP Curve Tool** from the menubar; the cursor sign will change into a plus sign. Now, click on different places in the viewport to create a curve. Next, press ENTER to finish the curve creation process. To modify the properties of the EP curve, choose **Create > Objects > Curve Tools > EP Curve Tool > Option Box** from the menubar; the **Tool Settings (EP Curve Tool)** panel will be displayed. Alternatively, you can invoke this panel from the **Curve / Surfaces** Shelf tab by double-clicking on the icon; the **Tool Settings (EP Curve Tool)** panel will be displayed. The options in the **Tool Settings (EP Curve Tool)** panel are similar to those discussed in the **Tool Settings (CV Curve Tool)** panel.

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Note

*The process of creating a curve using **EP Curve Tool** is different from that of **CV Curve Tool**. In both the cases if **3 cubic** is selected from the **Curve degree** attribute, then the curve created using **CV Curve Tool** will create a smooth curve in the fourth segment whereas in case of **EP curve Tool**, a smooth curve will be created in the third segment.*

Arc Tools

Menubar: Create > Objects > Curve Tools
Shelf: Curves/Surfaces > Three Point Circular Arc



The **Arc Tools** are used to create arc curves by specifying points in the viewport. In Maya, there are two types of arc tools: **Three Point Circular Arc** and **Two Point Circular Arc**. To create an arc, choose **Create > Objects > Curve Tools** from the menubar; a cascading menu will be displayed. Choose **Two Point Circular Arc** from the cascading menu to create an arc by defining the start and end points of the arc. Similarly, choose the **Three Point Circular Arc** from the cascading menu to create an arc by defining the start point, the curve point, and the end point.

Bezier Curve Tool

Menubar: Create > Objects > Curve Tools > Bezier Curve Tool
Shelf: Curves/Surfaces > Bezier Curve Tool



The **Bezier Curve Tool** is used to create a smooth curved line in the viewport. It consists of two or more control points, which define the size and shape of the line. To create a smooth curved line, choose **Create > Objects > Curve Tools > Bezier Curve Tool** from the menubar; the cursor will change. Next, press and hold the left mouse button and drag the cursor in the viewport to create a curve. To set the properties of the curve, choose **Create > Objects > Curve Tools > Bezier Curve Tool > Option Box** from the menubar; the **Tool Settings (Bezier Tool)** panel will be displayed. Alternatively, you can invoke this panel by double-clicking on the **Bezier Curve Tool** icon in the **Curves/Surfaces** Shelf tab.

TOOLS FOR CREATING SURFACES

Maya provides a number of tools to create complex three dimensional surface models. To view the tools that are used to create various surfaces, select the **Modeling** option from the **Menuset** drop-down list in the Status Line. Next, choose the **Surfaces** menu to display all the surfacing tools in Maya, refer to Figure 3-1.

Loft Tool

Menubar: Surfaces > Create > Loft

The **Loft** tool is used to skin a surface along the profile curves. While using this tool, at least two profile curves are required to create a NURBS surface. To create a NURBS surface by using this tool, create three curves. Next, press and hold the SHIFT key and select the curves in the viewport. Now, choose **Surfaces > Create > Loft** from the menubar; the NURBS curves are lofted with a surface in

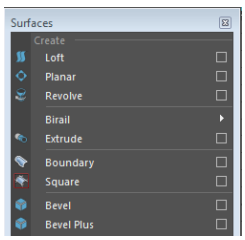

***Figure 3-1** The **Surfaces** floating menu*

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the viewport, as shown in Figure 3-3. To set the properties of the lofted surface created, choose **Surfaces > Create > Loft > Option Box** from the menubar; the **Loft Options** window will be displayed, as shown in Figure 3-4. The options in the **Loft Options** window are discussed next.

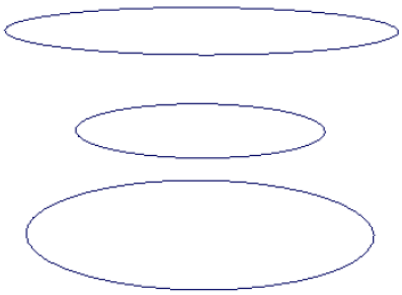

Figure 3-2 *The NURBS curves before applying the* ***Loft*** *tool*

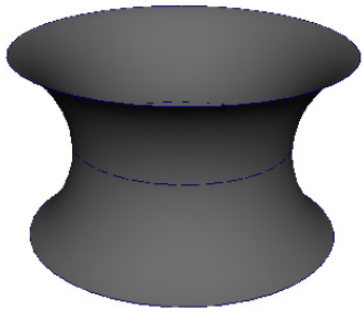

Figure 3-3 *The lofted surface created after applying the* ***Loft*** *tool*

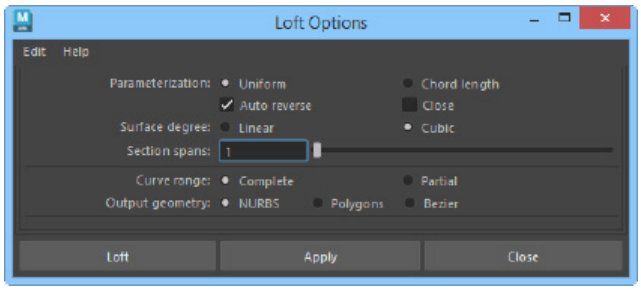

Figure 3-4 *The* ***Loft Options*** *window*

Parameterization

The radio buttons corresponding to the **Parameterization** attribute are used to modify the parameters of the lofted surface. The **Uniform** radio button is used to set the number of control points uniformly along the curve. The **Chord length** radio button is used to parameterize the curve such that its value is proportional to the chord length. The **Auto reverse** check box is selected by default and is used to create a NURBS surface in the reverse order of selection of NURBS curves. Figure 3-5 shows the surface created with the **Close** check box cleared. Figure 3-6 shows the surface created with the **Close** check box selected.

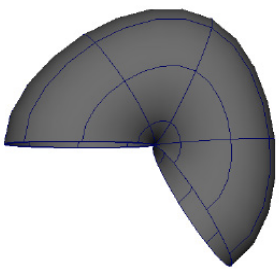

Figure 3-5 *Surface created with the* ***Close*** *check box cleared*

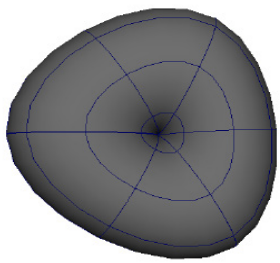

Figure 3-6 *Surface created with the* ***Close*** *check box selected*

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Sweep Mesh Tool

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

The **Sweep Mesh** tool is used to create a polygon mesh on a straight line or on any curve. To create a polygon mesh, select the curve in the viewport, as shown in Figure 3-57. Next, choose **Create > Sweep Mesh** from the menubar; the polygon mesh will be displayed in the viewport.

To change the appearance of the polygon mesh, make sure the **Sweep Profiles** rollout is expanded in the **sweepMeshCreator1** tab of the **Attribute Editor**. Using the options in this tab, you can change the appearance of the polygon mesh. For example, you can change the type of polygon mesh using the **Circle** or **Star** radio button. Also, you can increase the segments in the **Sides** slider. The **Cap** check box is used to put cap on the open area of the mesh. You can also apply various operations on the polygon mesh using the sliders such as **Scale Profile**, **Rotate Profile**, **Twist**, and **Taper** available in the **Transformation** rollout of the **Attribute Editor**.

TUTORIALS

The tutorials given next are available in video format. Scan the QR code or visit the following link to get access to the video tutorials:
https://www.cadcim.com/maya-2025-video-tutorials

Tutorial 1

In this tutorial, you will create model of a 3D flower, as shown in Figure 3-7, using curve tools and the loft method. **(Expected time: 30 min)**

The following steps are required to complete this tutorial:

a. Create a project folder.
b. Create a profile shape.
c. Create leafs.
d. Change the background color of the scene.
e. Save and render the scene.

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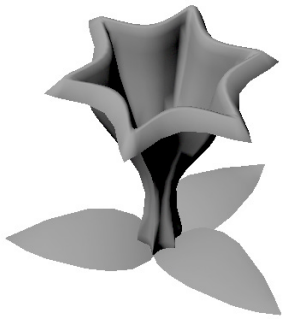

Figure 3-7 *The flower model*

Creating a Project Folder

Create a new project folder with the name *c03_tut1* at *\Documents\maya2025* and then save the file with the name *c03tut1*, as discussed in Tutorial 1 of Chapter 2.

Creating a Profile Shape

In this section, you will create a profile shape of the flower using the **Circle** tool.

1. Turn off the **Interactive Creation** option as discussed earlier. Choose the **Four View** button from the Tool Box to switch to four views. Move the cursor to the top-Y viewport and then press the SPACEBAR key to maximize the top-Y viewport. Choose **Create > NURBS Primitives > Circle > Option Box** from the menubar; the **NURBS Circle Options** window is displayed in the viewport. Enter required values in the **NURBS Circle Options** window, as shown in Figure 3-8.

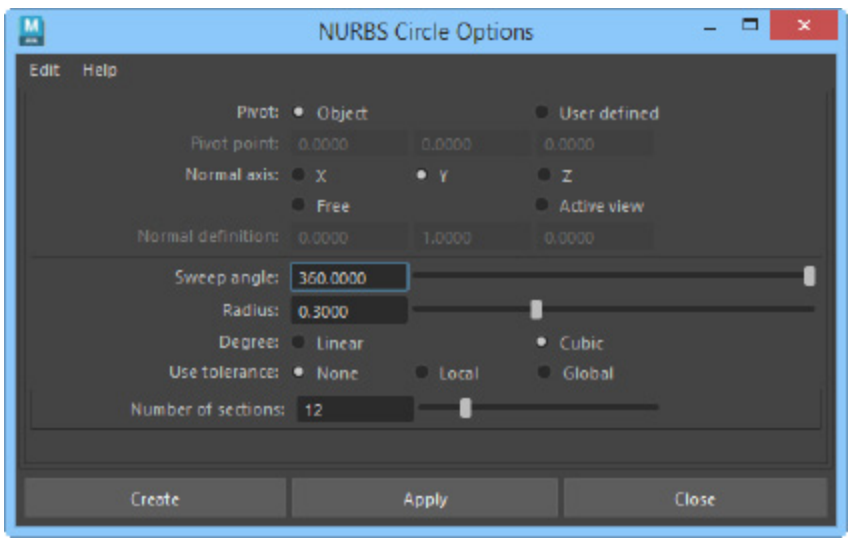

Figure 3-8 *The* ***NURBS Circle Options*** *window*

2. Choose **Edit > Duplicate > Duplicate** from the menubar; a copy of the circle is created in the viewport. Select **Move Tool** from the Tool Box and then move the duplicate circle along the Y-axis in the persp viewport.

3. Press and hold the right mouse button and choose **Control Vertex** from the marking menu. The control vertices will be displayed in the viewport. Select every second vertex in the top-Y viewport, as shown in Figure 3-9.

4. Choose **Scale Tool** from the Tool Box and scale the selected control vertices, as shown in Figure 3-10.

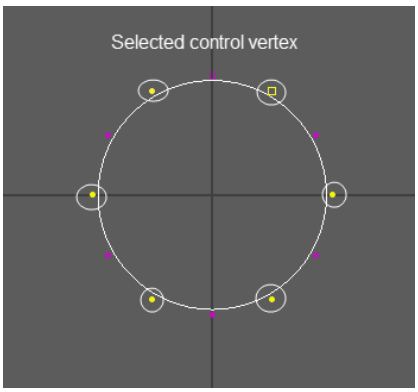

Figure 3-9 *Selected control vertices*

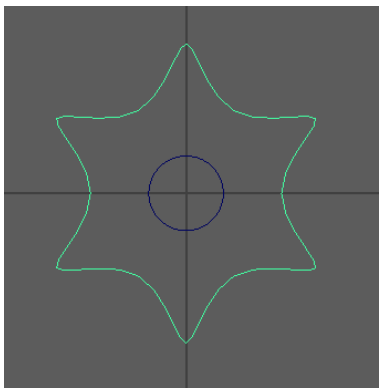

Figure 3-10 *Control vertices after scaling*

5. Create 5 copies of the modified circle and then align them, as shown in Figures 3-11 and 3-12.

6. First select the shape marked as 1 as given in Figure 3-11 and then select other shapes using the SHIFT key in the order shown in Figure 3-. Choose **Surfaces > Create > Loft** from the menubar; a surface is created, as shown in Figure 3-13.



Note

*By default, the **Two sided Lighting** option is not enabled in Maya. As a result, the inner surface appears black in the viewport. To view the objects in uniform shading, choose **Lighting > Two Sided Lighting** from the **Panel** menu.*

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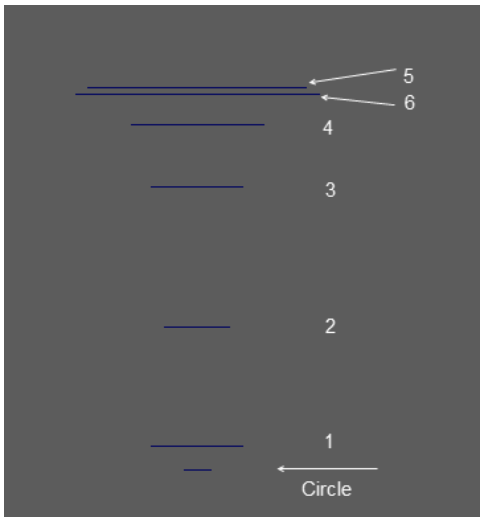

Figure 3-11 *Shapes aligned in the viewport*

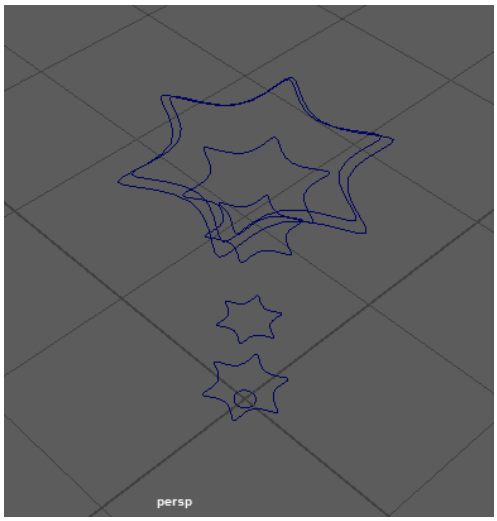

Figure 3-12 *Shapes aligned in the persp viewport*

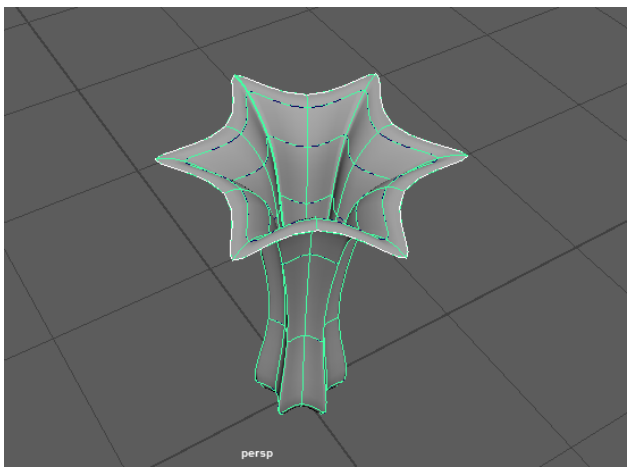

Figure 3-13 *Surface created*

7. Now, you can select the curves and scale them as per your requirement, refer to Figure 3-14.

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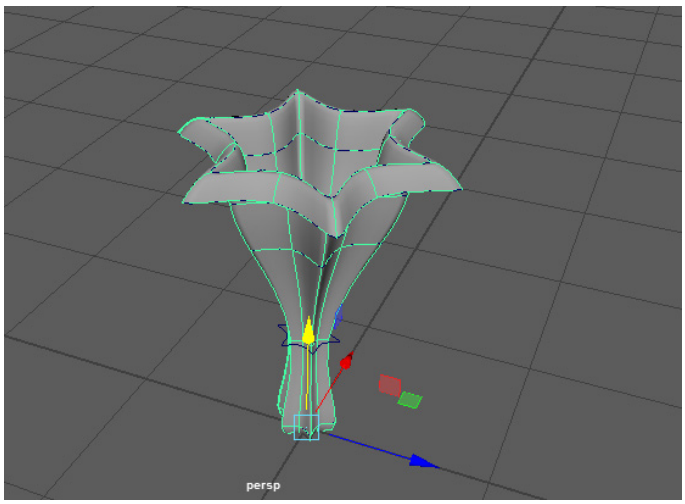

Figure 3-14 *The scaled shape of the flower*

Creating Leaves

In this section, you will create leaves of the flower using the **CV Curve /Tool**.

1. Maximize the top-Y viewport. Choose **Create > Curve Tools > CV Curve Tool > Option Box** from the menubar; the **Tool Settings (CV Curve Tool)** panel is displayed. Select the **5** radio button corresponding to the **Curve degree** attribute.

2. Create **3** profile curves for the leaf in the top-Y viewport, as shown in Figure 3-15.

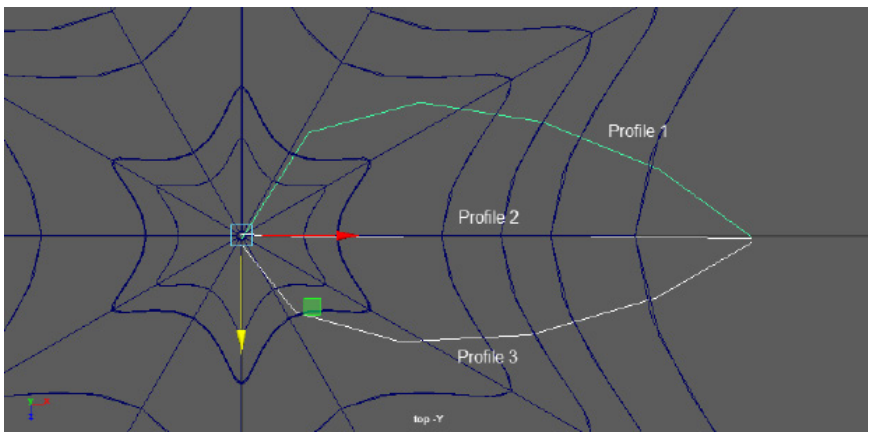

Figure 3-15 *Profile curves for leaf*

3. Activate the persp viewport, select profile 1 and right-click on it; a marking menu is displayed. Choose **Control Vertex** from the marking menu. Now, press SHIFT and select profile 2 and choose **Control Vertex** from the marking menu. Repeat the process for third profile as well.

4. Modify the shapes of leaf using control vertices, as shown in Figure 3-16.

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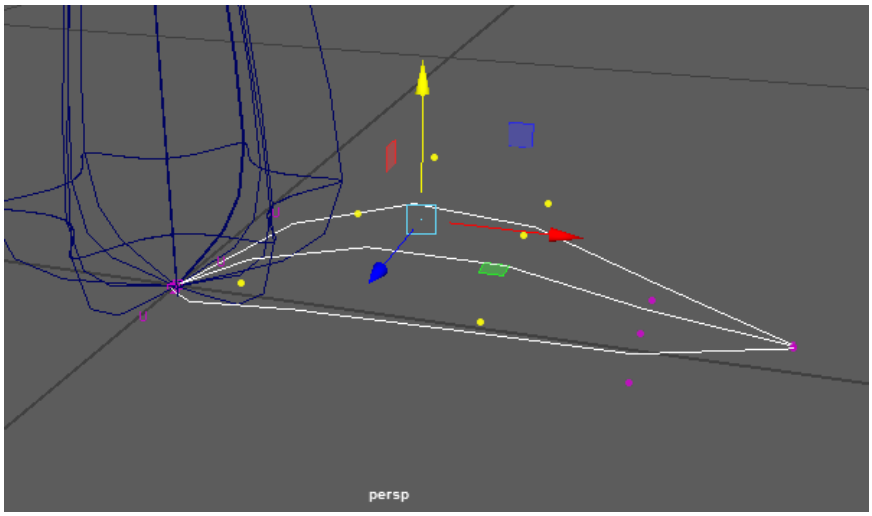

Figure 3-16 *Profile curves modified*

5. Now, select profiles in an order using SHIFT and then choose **Surfaces > Create > Loft** from the menubar; a surface is created on the selected profile curves, refer to Figure 3-17. If leaf appears smaller in size, select surface and scale it by using **Scale Tool** from the Tool Box.

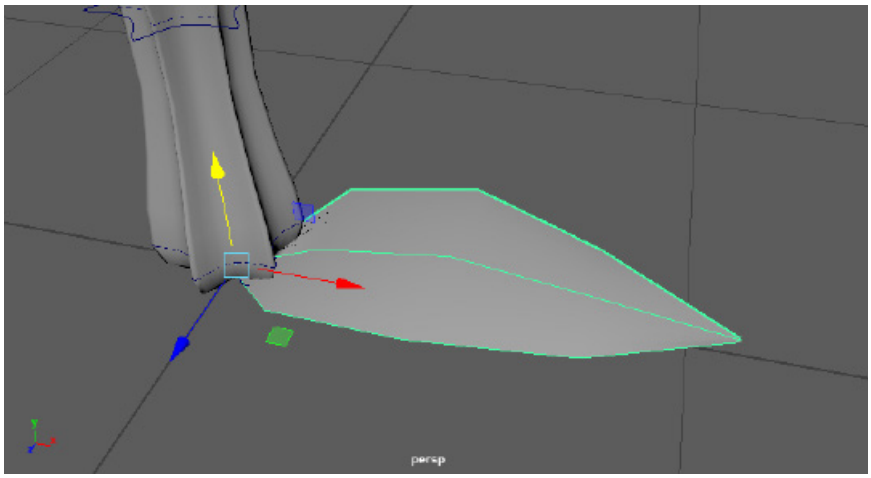

Figure 3-17 *Leaf created by using loft*

6. Select leaf in the viewport and then choose **Edit > Duplicate > Duplicate** from the menubar. Choose **Rotate Tool** from the Tool Box and rotate leaf along the Y axis. Similarly, create duplicate copies of leaf and then rotate and align them, refer to Figure 3-18.

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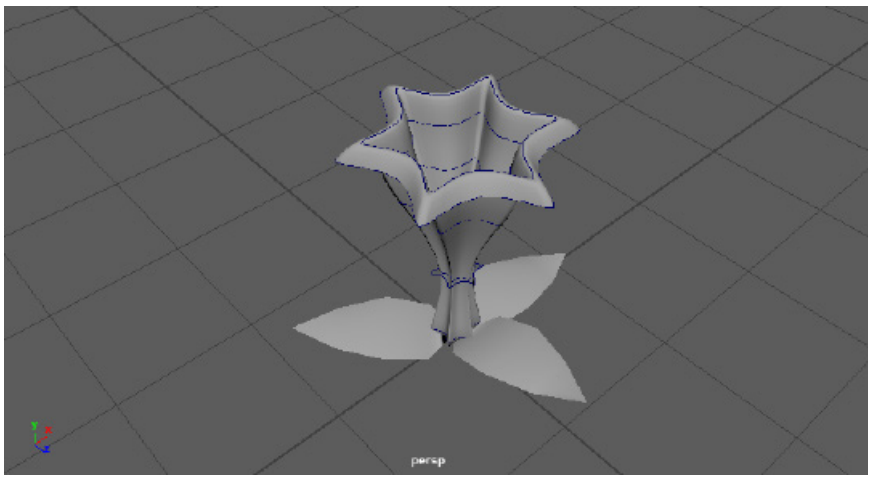

Figure 3-18 *Leaves created by using loft*

Changing the Background Color of the Scene

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

1. In the **Outliner** window, click on the **persp** camera; the **perspShape** tab is displayed in the **Attribute Editor**. 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 scene by downloading the *c03_maya_2025_rndr.zip* file from *www.cadcim.com*. The path of the file is mentioned in Tutorial 1.

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 3-7.

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Tutorial 2

In this tutorial, you will create the 3D model of a tea cup, as shown in Figure 3-19, using curve tools and surface methods. **(Expected time: 30 min)**

The following steps are required to complete this tutorial:

a. Create a project folder.
b. Create a profile curve.
c. Create the tea cup using the **Revolve** tool.
d. Create creases in the tea cup.
e. Create the handle of the tea cup.
f. Change the background color of the scene.
g. Save and render the scene.



Figure 3-19 *The tea cup*

Creating a Project Folder

Create a new project folder with the name *c03_tut2* at *\Documents\maya2025* and then save the file with the name *c03tut2*, as discussed in Tutorial 1 of Chapter 2.

Creating a Profile Curve

In this section, you will create a profile curve for the tea cup using **CV Curve Tool**.

1. Choose the **Four View** button from the Tool Box to switch to four views. Move the cursor to the front-Z viewport and then press the SPACEBAR key to maximize the front-Z viewport. Choose **Create > Objects > Curve Tools > EP Curve Tool** from the menubar.

2. In the front-Z viewport, create a profile curve starting from the origin, as shown in Figure 3-20. Next, press the ENTER key.

Creating the Tea Cup Using the Revolve Tool

In this section, you will create the tea cup using the **Revolve** tool.

1. Choose the **Four View** button from the Tool Box to switch to four views. Move the cursor to the persp viewport and then press the SPACEBAR key to maximize the persp viewport. Select the profile curve in the viewport. Next, choose **Surfaces > Create > Revolve** from the menubar; the tea cup is created, as shown in Figure 3-21.

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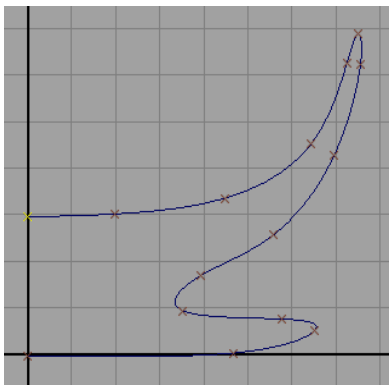

Figure 3-20 *The profile curve for the tea cup*

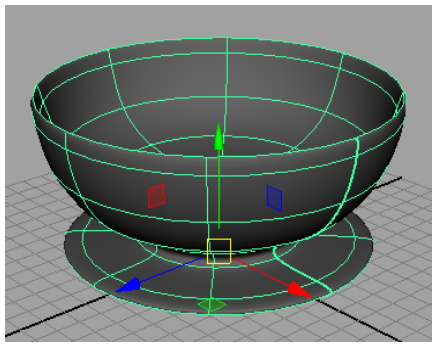

Figure 3-21 *The tea cup created*

Creating Creases in the Tea Cup

In this section, you will add creases to the tea cup to give it the required shape.

1. In the persp viewport, make sure the tea cup is selected. Next, press and hold the right mouse button over the tea cup; a marking menu is displayed. Choose **Isoparm** from the marking menu.

2. Choose a vertical isoparm of the tea cup and then drag the cursor; a dotted impression of the isoparm is created on the cup, refer to Figure 3-22.

3. Press and hold the SHIFT key and similarly create dotted impression of other vertical isoparms, as shown in Figure 3-22. You may need to rotate the viewport to select the vertical isoparms.

4. Make sure that **Modeling** is selected from the **Menuset** drop-down list in the Status Line. Choose **Curves > Insert Knot** from the menubar; the new isoparms are created on the tea cup, as shown in Figure 3-23.

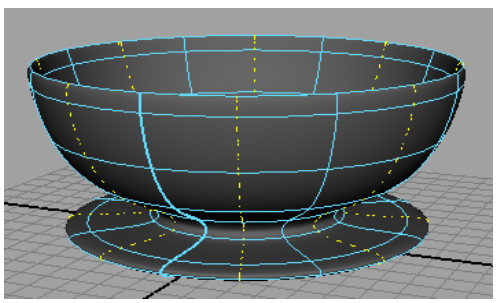

Figure 3-22 *Dotted impression of the isoparms*

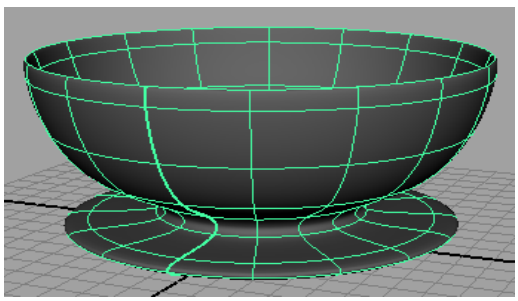

Figure 3-23 *New isoparms created*

5. Choose the **Four View** button from the Tool Box to switch to four views. Move the cursor to the front-Z viewport and then press the SPACEBAR key to maximize the front-Z viewport.

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6. Press and hold the right mouse button over the tea cup; a marking menu is displayed. Choose **Control Vertex** from the marking menu; the vertex selection mode is activated. Next, press and hold the SHIFT key to select the vertices, as shown in Figure 3-24.

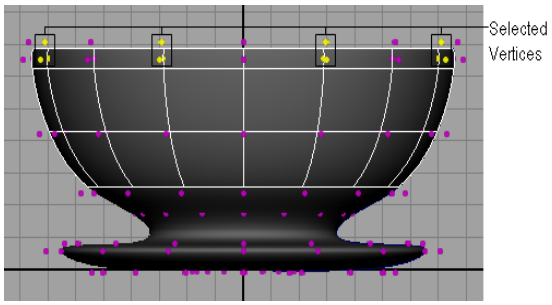

Figure 3-24 *Vertices selected*

7. Choose **Move Tool** from the Tool Box and move the selected vertices downward along the Y-axis; creases are created in the tea cup, as shown in Figure 3-25.

8. Choose the **Four View** button from the Tool Box to switch to four views. Move the cursor to the top-Y viewport and then press the SPACEBAR key to maximize the top-Y viewport.

9. Make sure that the vertices are selected in the top-Y viewport. Next, choose the **Scale Tool** from the Tool Box and scale the selected vertices outward uniformly, as shown in Figure 3-26.

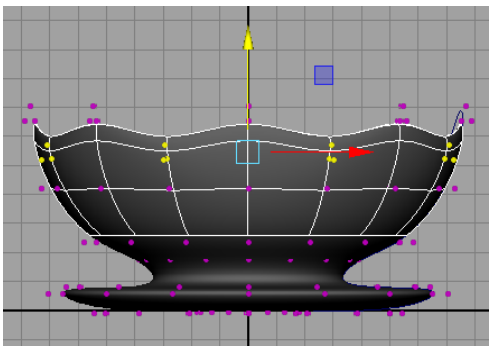

Figure 3-25 *Crease created in the tea cup*

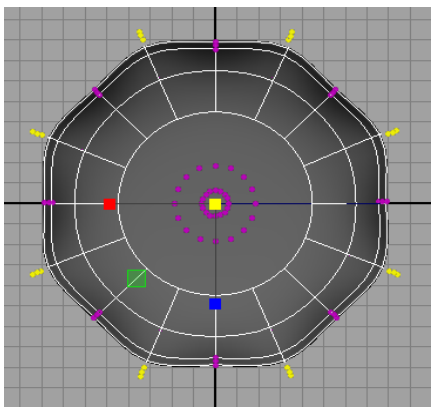

Figure 3-26 *Selected vertices scaled outward*

Creating the Handle of the Tea Cup

In this section, you will create the handle of the cup by using **CV Curve Tool**.

1. Choose the **Four View** button from the Tool Box to switch to four views. Move the cursor to the front-Z viewport and then press the SPACEBAR key to maximize the front-Z viewport. Choose **Create > Objects > Curve Tools > CV Curve Tool** from the menubar and draw a profile curve, as shown in Figure 3-27, and then press the ENTER key.

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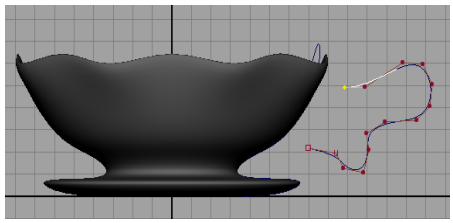

Figure 3-27 *The profile curve drawn*

2. Choose the **Four View** button from the Tool Box to switch to four views. Move the cursor to the top-Y viewport and then press the SPACEBAR key to maximize the top-Y viewport. Choose **Create > Objects > NURBS Primitives > Circle** from the menubar and create a circle in the top-Y viewport.

3. Make sure the NURBS Circle is selected in the viewport. Set the parameters in the **nurbsCircle1** area of the **Channel Box / Layer Editor**, as shown in Figure 3-28.

4. In the **Channel Box / Layer Editor**, expand the **makeNurbCircle1** node in the **INPUTS** area and enter **0.2** in the **Radius** edit box.

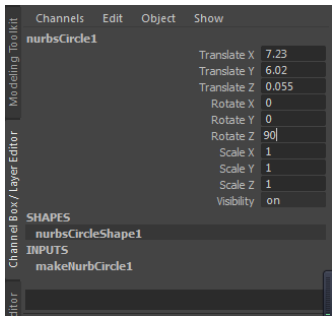

Figure 3-28 *The **nurbsCircle1** area in the **Channel Box / Layer Editor***

5. Choose the **Four View** button from the Tool Box to switch to four views. Move the cursor to the persp viewport and then press the SPACEBAR key to maximize the persp viewport.

6. Make sure the NURBS circle is selected and then select the profile curve using the SHIFT key. Next, choose **Surfaces > Create > Extrude** from the menubar; the extruded surface is created, refer to Figure 3-29. Next, select the extruded surface. In the **extrude1** tab of the **Attribute Editor**, make sure the **Component Pivot** is selected from the **Use Component Pivot** drop-down list.

7. Choose **Move Tool** and **Rotate Tool** to adjust the handle with the tea cup to get the final output, as shown in Figure 3-30.

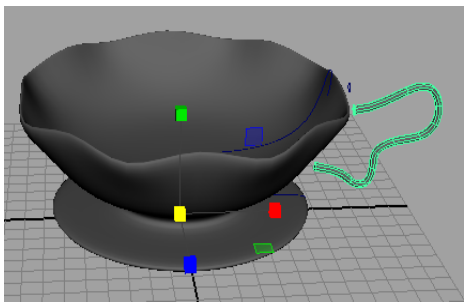

Figure 3-29 *The extruded surface displayed*

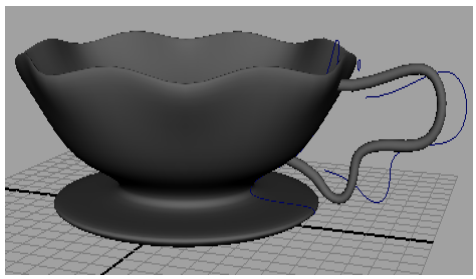

Figure 3-30 *Final output of the cup*

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Changing the Background Color of the Scene

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

1. In the **Outliner** window, click on the **persp** camera; the **perspShape** tab is displayed in the **Attribute Editor**. 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 scene by downloading the *c03_maya_2025_rndr.zip* file from *www.cadcim.com*. The path of the file is mentioned in Tutorial 1.

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.

Self-Evaluation Test

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

1. Which tool is used to create a polygon mesh on a straight line or curve?

   (a) **Loft** tool
   (b) **Sweep Mesh** tool
   (c) **Bezier Curve** tool
   (d) **EP Curve** tool

2. The _____ tool is used to skin a surface along profile curves.

3. The _____ radio button in the **Loft Options** window is used to set the number of control points uniformly along the curve.

4. The **Bezier Curve Tool** does not allow smooth curved lines. (T/F)

5. The **Sweep Mesh Tool** can be used to create both polygon meshes and NURBS surfaces. (T/F)

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Review Questions

Answer the following questions:

1. Which of the following is not a component of NURBS surface?

(a) **Isoparm** (b) **Vertex**
(c) **Hull** (d) **Surface patch**

2. Which tool is used to create curves with control vertices (CVs)?

(a) **EP Curve Tool** (b) **CV Curve Tool**
(c) **Bezier Curve Tool** (d) **Arc Tool**

3. In the **Sweep Mesh** tool, the _____ check box is used to put a cap on the open area of the mesh.

4. The **CV Curve** tool uses control vertices to define the shape of a curve. (T/F)

EXERCISES

The rendered output of the models used in the following exercises can be accessed by downloading the *c03_maya_2025_exr.zip* file from *www.cadcim.com*. The path of the file is as follows: *Textbooks > Animation and Visual Effects > Maya > Autodesk Maya 2025: A Tutorial Approach*.

Exercise 1

Create the model of an apple, as shown in Figure 3-31. **(Expected time: 15 min)**



Figure 3-31 *Model of an apple*

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Exercise 2

Create the model of a lantern, as shown in Figure 3-32. **(Expected time: 15 min)**



Figure 3-32 *Model of a lantern*

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Answers to Self-Evaluation Test

1.Sweep Mesh tool, **2. Loft**, **3. Uniform**, **4.** F, **5.** F