

# Chapter 3

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## ***NURBS Curves and Surfaces***

### **Learning Objectives**

**After completing this chapter, you will be able to:**

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



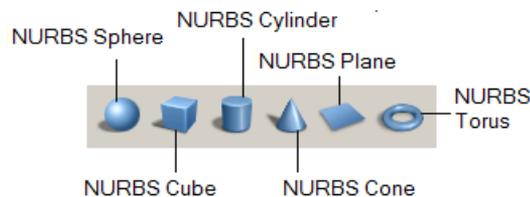
## INTRODUCTION

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.

## NURBS PRIMITIVES

In this chapter, you will learn about NURBS curves and surfaces. NURBS (Non-Uniform Rational B-Spline) is a mathematical representation of 3D geometry that can describe any shape accurately. NURBS modeling is basically used for creating curved shapes and lines.

In Maya, there are default NURBS objects that resemble various geometrical objects. These NURBS objects are grouped together under the NURBS Primitives group in the menubar. To access the NURBS primitives, choose **Create > NURBS Primitives** from the menubar; a cascading menu will be displayed with all the default NURBS primitives. Some of the NURBS primitives can also be accessed from the Shelf, refer to Figure 3-1. In order to access the NURBS modeling tools for NURBS primitives, make sure that the **Surfaces** Shelf tab is chosen from the Shelf. The different types of NURBS Primitives are discussed next.

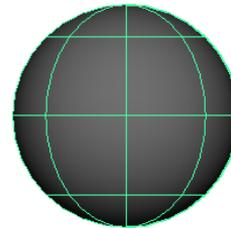


*Figure 3-1 Accessing NURBS primitives from the Shelf*

## Creating a Sphere

<b>Menubar:</b>	Create > NURBS Primitives > Sphere
<b>Shelf:</b>	Surfaces > NURBS Sphere

A sphere is a solid object and every point on its surface is equidistant from its center, as shown in Figure 3-2. To create a sphere, choose **Create > NURBS Primitives > Sphere** from the menubar; the instructions to create a sphere will be displayed on the grid. Alternatively, choose the **NURBS Sphere** tool from the **Surfaces** Shelf tab. You can create a sphere either dynamically or by entering values using the keyboard. Both the methods are discussed next.



*Figure 3-2 The NURBS sphere*

## Creating a Sphere Dynamically

To create a sphere dynamically, choose **Create > NURBS Primitives > Sphere** from the menubar; you will be prompted to drag the cursor on the grid to draw the 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 as required. Now, release the left mouse button; the sphere will be created in all viewports and will be visible in the **Smooth Shade all** mode. Press the numeric key 4 to change the display to the **Wireframe** mode. Alternatively, you can choose **Shading > Wireframe** from the **Panel** menu to change the display to the **Wireframe** mode. Press the numeric key 5 or choose **Shading > Smooth Shade All** from the **Panel** menu to revert to the **Smooth Shade all** mode.

## Creating a Sphere by Using the Keyboard

To create a sphere by using the keyboard, double-click on the **NURBS Sphere** tool in the **Surfaces Shelf** tab; the **Tool Settings (NURBS Sphere Tool)** window will be displayed, as shown in Figure 3-3. In this window, set the properties of the sphere by using the keyboard and then click in the viewport; the sphere will be created in all viewports. Alternatively, choose **Create > NURBS Primitives > Sphere > Option Box** from the menubar to invoke **Tool Settings (NURBS Sphere Tool)** window. Choose **Reset Tool** at the top of the **Tool Settings (NURBS Sphere Tool)** window to reset the settings of the **NURBS Sphere** tool. The most commonly used options in this window are discussed next.

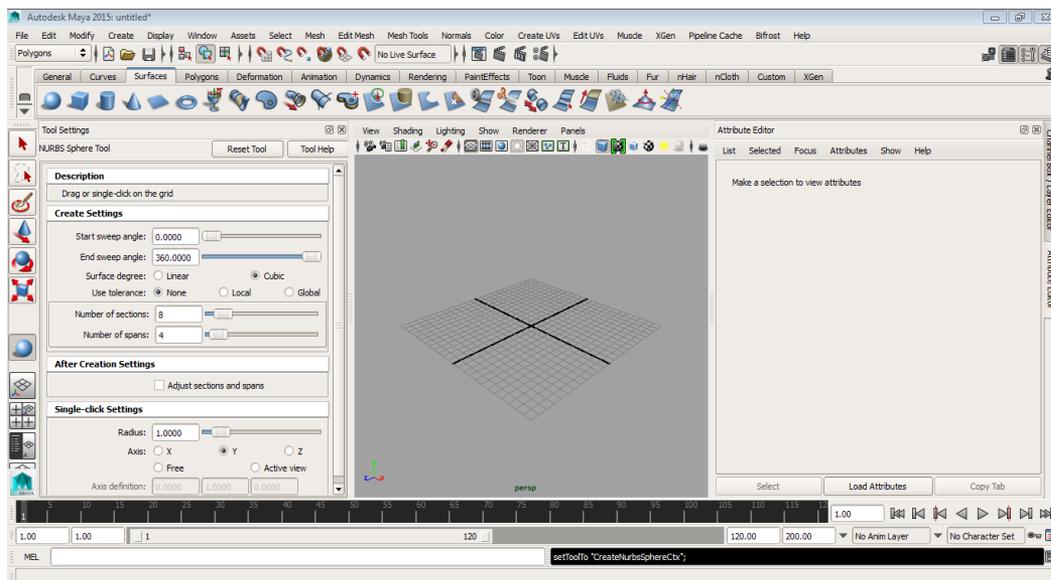


Figure 3-3 The Tool Settings (NURBS Sphere Tool) window

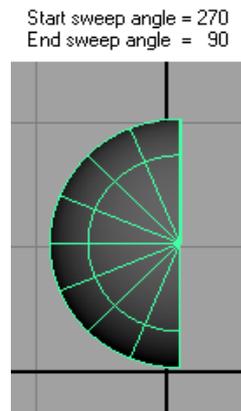
### Description Area

The text in the **Description** area gives you information about the method of creating the sphere in the viewport.

### Create Settings Area

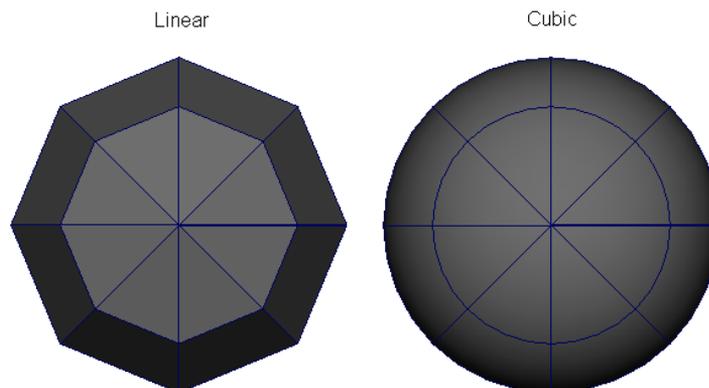
The options in the **Create Settings** area of the **Tool Settings (NURBS Sphere Tool)** window are used to adjust the parameters of the NURBS sphere. The options in this area are discussed next.

**Start sweep angle and End sweep angle:** The **Start sweep angle** and **End sweep angle** options are used to specify the start and end angles of a sphere. Move the sliders on the right of these parameters to change the values or enter the values in their respective text boxes. The values in these sliders range from 0 to 360 degrees. You can create partial sphere by changing the values in the **Start sweep angle** and **End sweep angle** edit boxes, as shown in Figure 3-4.



*Figure 3-4* Partial sphere created by changing the values in the **Start sweep Angle** and **End sweep Angle** edit boxes

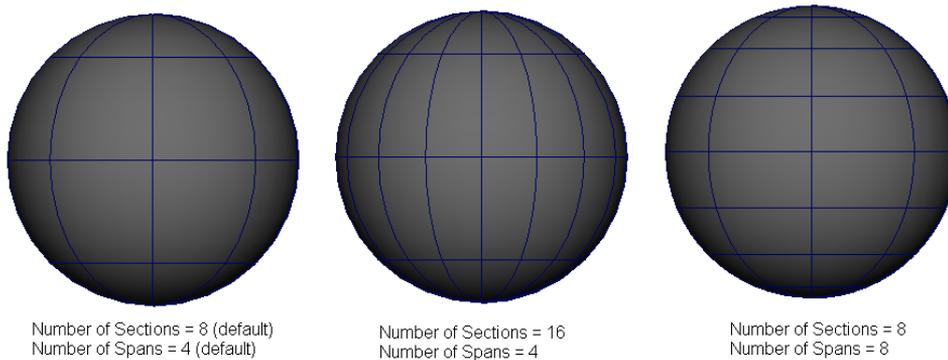
**Surface degree:** The **Surface degree** option is used to create a sphere with a faceted or smooth appearance. This option consists of two radio buttons: **Linear** and **Cubic**. The **Linear** radio button is used to give a faceted appearance to the sphere. The **Cubic** radio button is selected by default and gives a smooth appearance to the sphere, refer to Figure 3-5. Note that the number of segments remains the same on the sphere while using any of these two radio buttons.



*Figure 3-5* The faceted and smooth appearances of spheres

**Use Tolerance:** The **Use Tolerance** option is used to improve the accuracy of the primitive's by increasing or decreasing the number of sections and spans. If the **Use Tolerance** option is set to **None**, you can make the number of sections and spans on a sphere separately. If **Use Tolerance** option is set to **Local**, you can change the number of sections and spans uniformly by moving the slider on the right of the parameter. If the **Use Tolerance** option is set to **Global**, you can change the number of sections and spans by moving the slider on the right of the **Positional** parameter in **Window > Settings/Preferences > Preferences > Settings**.

**Number of sections and Number of spans:** The **Number of sections** and **Number of spans** options are used to adjust the surface curves on a sphere, refer to Figure 3-6. The more the number of sections or spans on a NURBS object, the more will be its smoothness. Surface curves are also known as Isoparms. You can enter the values directly in these edit boxes to set the number of sections/spans on a NURBS object. Alternatively, you can move the sliders on the right of these edit boxes.



*Figure 3-6 The number of sections and spans on spheres*

### After Creation Settings Area

The options in this area are used to adjust the number of sections and spans on a sphere after it is created in the viewport. To do so, select the **Adjust sections and spans** check box from this area and drag the cursor to create a sphere in the viewport. Next, you can drag the cursor to add or reduce sections in the sphere.

### Single-click Settings Area

The options in this area are used to set the radius and axis of formation of the NURBS sphere. The settings of this area will be applicable only if the sphere is created using the single-click method. The options in this area are discussed next.

**Radius:** The **Radius** option is used to set the radius of the sphere by entering the required value in the **Radius** edit box. Alternatively, you can drag the slider on the right of the edit box.

**Axis:** The **Axis** option is used to set the axis for creating a NURBS sphere. It has three radio buttons: **X**, **Y**, and **Z**. By default, the **Y** radio button is selected. You can use these radio buttons to set the axis for creating a NURBS sphere. Figure 3-7 shows the NURBS spheres created on X, Y, and Z axes.

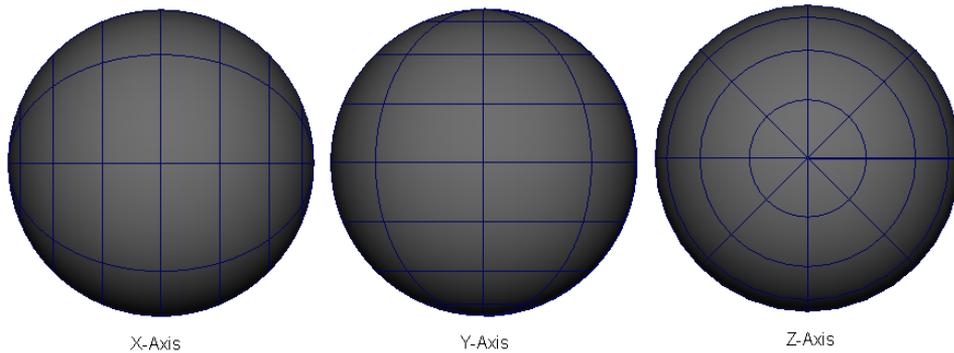


Figure 3-7 Spheres created on X, Y, and Z axes

### Modifying the Names and other Parameters of the Sphere

You can change the name and parameters of a sphere in the viewport. To do so, select a sphere in the viewport; the **Channel Box / Layer Editor** will be displayed, refer to Figure 3-8. Now, to change the name of the selected sphere, click on **nurbsSphere#** in the **Channel Box / Layer Editor**; an edit box will appear. Specify a new name for the sphere and then press ENTER. You can also modify the sphere by using the parameters in the **INPUTS** area of the **Channel Box / Layer Editor**; the change will be reflected on the sphere in the viewport. To dynamically modify the parameters in the **INPUTS** area, select the parameter label in the **Channel Box / Layer Editor**. Next, place the cursor in the viewport, press and hold the middle mouse button, and then drag it horizontally in the viewport to make the changes.

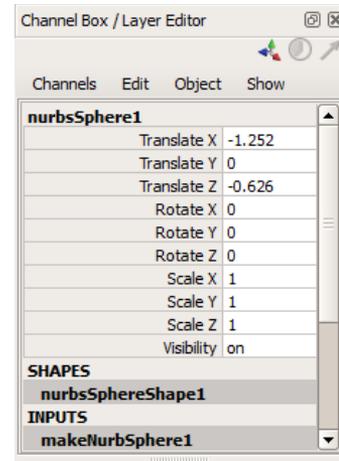


Figure 3-8 The Channel Box / Layer Editor

### Creating a Cube

**Menubar:** Create > NURBS Primitives > Cube  
**Shelf:** Surfaces > NURBS Cube

A cube is a three-dimensional shape with six sides, as shown in Figure 3-9. To create a **NURBS** cube, choose **Create > NURBS Primitives > Cube** from the menubar; the instructions to create the cube will be displayed on the grid. Alternatively, to create a cube, you can choose the **NURBS Cube** tool from the **Surfaces** Shelf tab. You can also create a cube dynamically or by entering values using the keyboard. Both the methods are discussed next.

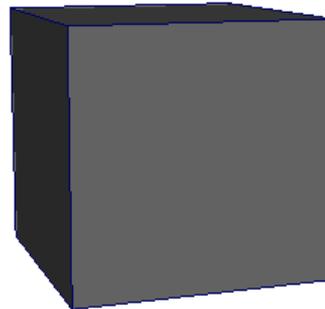


Figure 3-9 The NURBS cube

## Creating a Cube Dynamically

To create a cube dynamically, choose **Create > NURBS Primitives > Cube** from the menubar; you will be prompted to drag the cursor on the grid to draw a 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, as required. Now, release the left mouse button to get the desired base. Next, 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 in all viewports.

## Creating a Cube by Using the Keyboard

To create a cube by using the keyboard, double-click on the **NURBS Cube** tool in the **Surfaces Shelf** tab; the **Tool Settings (NURBS Cube Tool)** window will be displayed on the left of the viewport, as shown in Figure 3-10. In this window, set the properties of the cube by using the keyboard and then click in the viewport; a cube will be created in all viewports. Alternatively, choose **Create > NURBS Primitives > Cube > Option Box** from the menubar to invoke the **Tool Settings (NURBS Cube Tool)** window. Choose **Reset Tool** at the top of the **Tool Settings (NURBS Cube Tool)** window to reset the settings of the **NURBS Cube** tool. The most commonly used options in this window are discussed next.

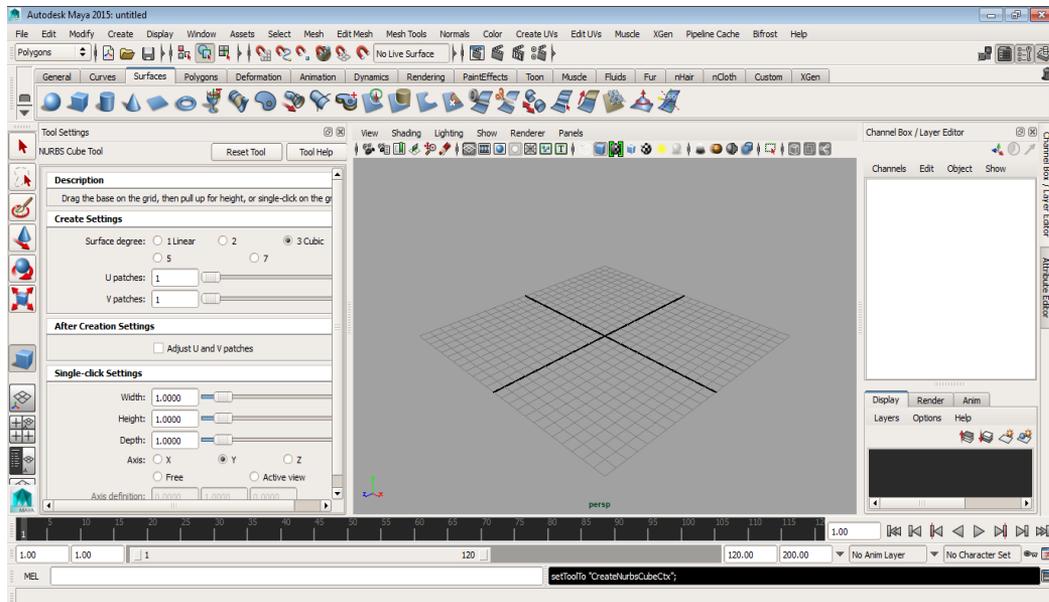


Figure 3-10 The Tool Settings (NURBS Cube Tool) window

### Description Area

The **Description** area displays the information about the method of creating the cube in the viewport.

### Create Settings Area

The options in the **Create Settings** area of the **Tool Settings (NURBS Cube Tool)** window are used to set the parameters of the NURBS cube. Various options in this area are discussed next.

**Surface degree:** The radio buttons in the **Surface degree** parameter are used to create a cube with a faceted or smooth appearance. This parameter consists of five radio buttons: **1Linear**, **2**, **3Cubic**, **5**, and **7**.

**U patches** and **V patches:** The **U patches** and **V patches** option are similar to **Number of sections** and **Number of spans** options in the **Tool Settings (NURBS Sphere Tool)** window and are used to create surface patches on the cube.

**Single-click Settings:** The options in this area are used to set the width, height, and depth for creating the NURBS cube. The settings will be applicable only if the cube is created using the single-click method.

**Width, Height, and Depth:** You can adjust the width, height, and depth of the NURBS cube by entering values in the **Width**, **Height**, and **Depth** edit boxes, respectively. Alternatively, you can set these values by moving the slider on the right of these edit boxes.

### Modifying the Names and Other Properties of the Cube

You can modify the name and other properties of the cube using the **Channel Box / Layer Editor**, as discussed in the NURBS sphere section.

### Creating a Cylinder

<b>Menubar:</b>	Create > NURBS Primitives > Cylinder
<b>Shelf:</b>	Surfaces > NURBS Cylinder

A cylinder is a solid geometry with straight parallel sides and circular sections, as shown in Figure 3-11. To create a cylinder in the viewport, choose **Create > NURBS Primitives > Cylinder** from the menubar; the instructions to create the cylinder will be displayed on the grid in the viewport. Alternatively, you can choose the **NURBS Cylinder** tool from the **Surfaces** Shelf tab. You can create a cylinder either dynamically or by entering values using the keyboard. Both the methods of creating the cylinder are discussed next.

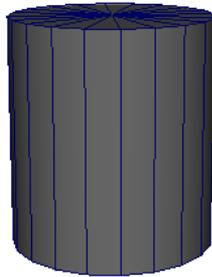


Figure 3-11 The NURBS cylinder

### Creating a Cylinder Dynamically

To create a cylinder dynamically, choose **Create > NURBS Primitives > Cylinder** 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 base of the cylinder. Next, release the

left mouse button to get the desired base. Now, press and hold the left mouse button again, drag the cursor up to set the height of the cylinder and then release the left mouse button; the cylinder will be created in all viewports.

### Creating a Cylinder by Using the Keyboard

To create a cylinder by using the keyboard, double-click on the **NURBS Cylinder** tool in the **Surfaces Shelf** tab; the **Tool Settings (NURBS Cylinder Tool)** window will be displayed, as shown in Figure 3-12. Set the properties of the cylinder to be created in the viewport using various options available in the **Tool Settings (NURBS Cylinder Tool)** window and click in the viewport; a cylinder will be created in all viewports. Alternatively, choose **Create > NURBS Primitives > Cylinder > Option Box** from the menubar to invoke the **Tool Settings (NURBS Cylinder Tool)** window. Choose **Reset Tool** at the top of the **Tool Settings (NURBS Cylinder Tool)** window to reset the settings of the **NURBS Cylinder** tool. The options in the **Tool Settings (NURBS Cylinder Tool)** window are similar to those of the **NURBS Sphere** tool.

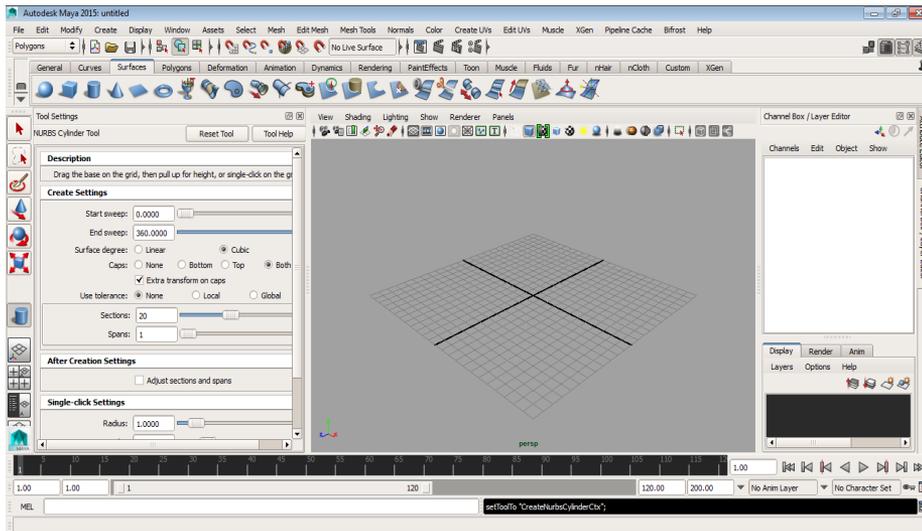


Figure 3-12 The Tool Settings (NURBS Cylinder Tool) window

### Modifying the Names and other Properties of the Cylinder

You can modify the name and properties of the cylinder by using the **Channel Box / Layer Editor**, as discussed in the **NURBS sphere** section.

### Creating a Cone

**Menubar:** Create > NURBS Primitives > Cone  
**Shelf:** Surfaces > NURBS Cone

A cone is an object with a circular base and its sides tapered up to a point, as shown in Figure 3-13. To create a cone, choose **Create > NURBS Primitives > Cone** from the menubar. Alternatively, you can create a cone by invoking the **NURBS Cone** tool from the **Surfaces Shelf** tab. You can

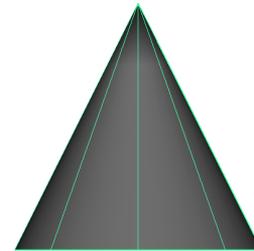


Figure 3-13 The NURBS cone

create a cone either dynamically or by entering values using the keyboard. Both the methods of creating a cone are discussed next.

### Creating a Cone Dynamically

To create a cone dynamically, choose **Create > NURBS Primitives > Cone** 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 base of the cone. 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 cone. Next, release the left mouse button; the cone will be created in all viewports.

### Creating a Cone by Using the Keyboard

To create a cone by using the keyboard, double-click on the **NURBS Cone** tool in the **Surfaces Shelf** tab; the **Tool Settings (NURBS Cone Tool)** window will be displayed on the left of the viewport, as shown in Figure 3-14. In this window, set the properties of the cone by using the keyboard and then click in the viewport; the cone will be created in all viewports. Alternatively, choose **Create > NURBS Primitives > Cone > Option Box** from the menubar to invoke the **Tool Settings (NURBS Cone Tool)** window. Choose **Reset Tool** at the top of the **Tool Settings (NURBS Cone Tool)** window to reset the settings of the **NURBS Cone** tool. The options in the **Tool Settings (NURBS Cone Tool)** window are similar to those of the **NURBS Sphere** tool.

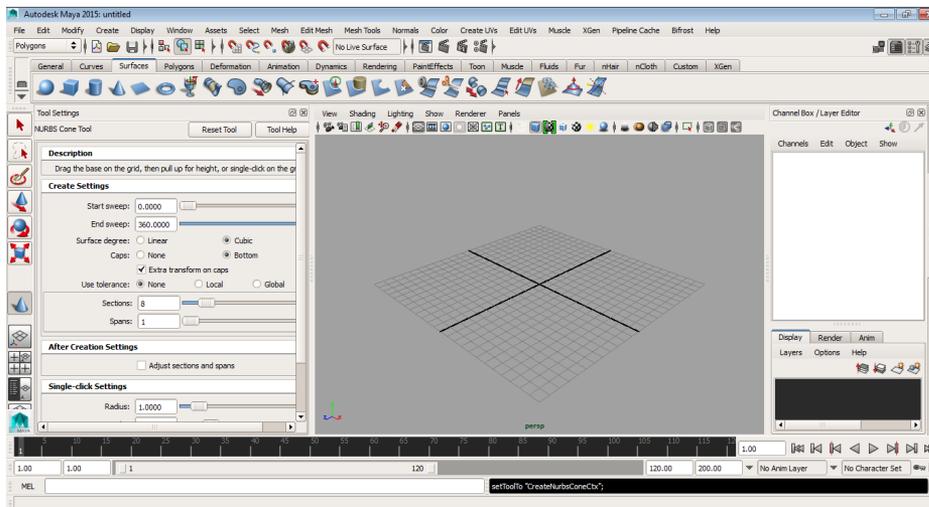


Figure 3-14 The Tool Settings (NURBS Cone Tool) window

### Creating a Plane

**Menubar:** Create > NURBS Primitives > Plane  
**Shelf:** Curves > NURBS Plane

A plane is a two-dimensional flat surface, as shown in Figure 3-15. To create a NURBS plane, choose **Create > NURBS Primitives > Plane** from the menubar. Alternatively, you can create

a plane by invoking the **NURBS Plane** tool from the **Surfaces Shelf** tab. You can create a plane either dynamically or by entering values using the keyboard. Both the methods of creating a plane are discussed next.

### Creating a Plane Dynamically

To create a plane dynamically, choose **Create > NURBS Primitives > Plane** from the menubar; you will be prompted to drag the cursor on the grid. Next, press and hold the left mouse button and drag the cursor on the grid; the plane will be created in all viewports.



Figure 3-15 The NURBS plane

### Creating a Plane by Using the Keyboard

To create a plane by using the keyboard, double-click on the **NURBS Plane** tool in the **Surfaces Shelf** tab; the **Tool Settings (NURBS Plane Tool)** window will be displayed on the left of the viewport, as shown in Figure 3-16. Next, in this window, set the properties of the plane by using the keyboard and then click in the viewport; the plane will be created in all viewports. Alternatively, choose **Create > NURBS Primitives > Plane > Option Box** from the menubar to invoke the **Tool Settings (NURBS Plane Tool)** window. Choose **Reset Tool** at the top of the **Tool Settings (NURBS Plane Tool)** window to reset the settings of the **NURBS Plane** tool. The options in the **Tool Settings (NURBS Plane Tool)** window are similar to those of the **NURBS Cube** tool.

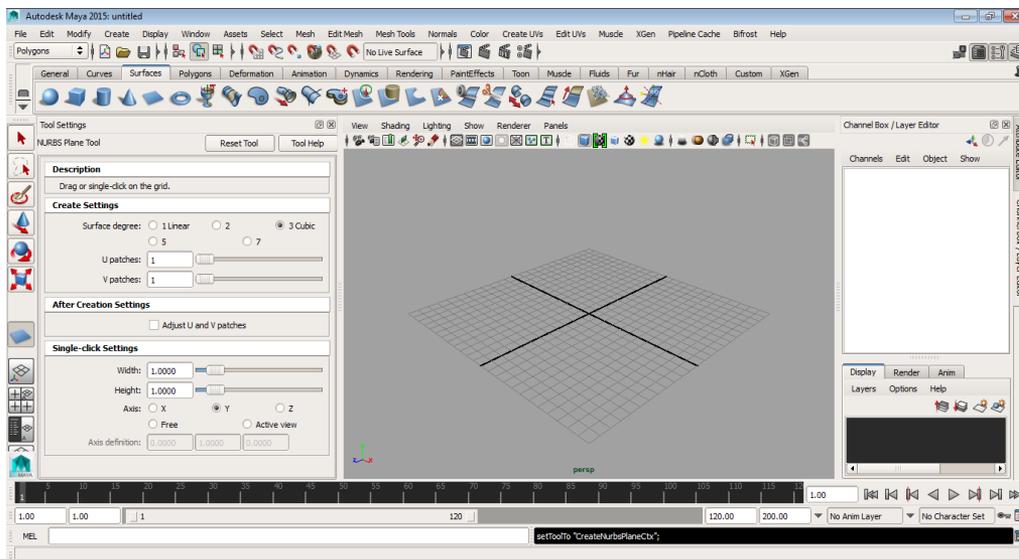


Figure 3-16 The Tool Settings (NURBS Plane Tool) window

## Creating a Torus

**Menubar:** Create > NURBS Primitives > Torus  
**Shelf:** Surfaces > NURBS Torus

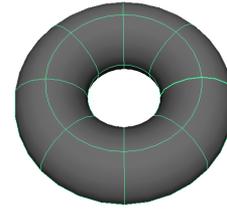


Figure 3-17 The NURBS torus

A torus is created by revolving a circular profile around a circular or an elliptical path, as shown in Figure 3-17. To create a NURBS torus, choose **Create > NURBS Primitives > Torus** from the menubar. Alternatively, you can create a torus by choosing the **NURBS Torus** tool from the **Surfaces** Shelf tab. You can create a torus either dynamically or by entering values using the keyboard. Both the methods of creating a torus are discussed next.

### Creating a Torus Dynamically

To create a torus dynamically, choose **Create > NURBS Primitives > Torus** from the menubar; you will be prompted to drag the cursor on the grid to create a torus in the viewport. Press and hold the left mouse button, drag the cursor on the grid to define the radius of the torus, and then release the left mouse button. Now, press and hold the left mouse button again and drag the cursor to edit the section radius. Next, release the left mouse button; the torus will be created in all viewports.

### Creating a Torus by Using the Keyboard

To create a torus by using the keyboard, double-click on the **NURBS Torus** tool in the **Surfaces** Shelf tab; the **Tool Settings (NURBS Torus Tool)** window will be displayed, as shown in Figure 3-18. In this window, set the properties of the torus by using the keyboard and then click in the viewport to create a torus. Alternatively, choose **Create > NURBS Primitives > Torus > Option Box** from the menubar to invoke the **Tool Settings (NURBS Torus Tool)** window. Choose the **Reset Tool** button at the top of the **Tool Settings (NURBS Torus Tool)** window to reset the settings of the **NURBS Torus** tool. The options in the **Tool Settings (NURBS Torus Tool)** window are similar to those of the **NURBS Sphere** tool.

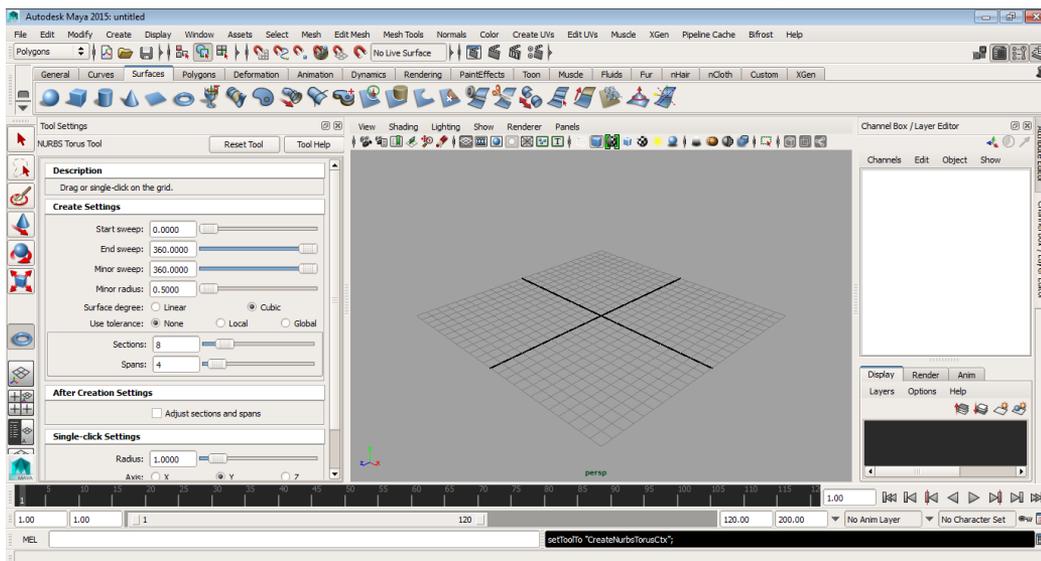


Figure 3-18 The Tool Settings (NURBS Torus Tool) window

## Creating a Circle

**Menubar:** Create > NURBS Primitives > Circle  
**Shelf:** Curves > NURBS Circle

A circle is a closed plane curve in which every point on the curve is equidistant from the center, as shown in Figure 3-19. To create a circle, choose **Create > NURBS Primitives > Circle** from the menubar. Alternatively, you can create a circle by choosing the **NURBS Circle** tool from the **Curves Shelf** tab. You can create a circle either dynamically or by entering values using the keyboard. Both the methods of creating a circle are discussed next.

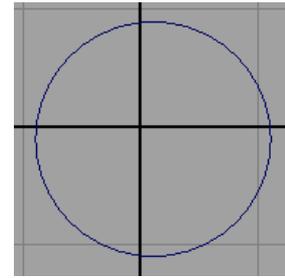


Figure 3-19 The NURBS circle

## Creating a Circle Dynamically

To create a circle dynamically, choose **Create > NURBS Primitives > Circle** 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 and then release the left mouse button; the circle will be created in all viewports.

## Creating a Circle by Using the Keyboard

To create a circle by using the keyboard, double-click on the **NURBS Circle** tool in the **Curves Shelf** tab; the **Tool Settings (NURBS Circle Tool)** window will be displayed, as shown in Figure 3-20. In this window, set the properties of the circle by using the keyboard and then click in the viewport to create a circle in all viewports. Alternatively, choose **Create > NURBS Primitives > Circle > Option Box** from the menubar to invoke the **Tool Settings (NURBS Circle Tool)** window. Choose the **Reset Tool** button at the top of the **Tool Settings (NURBS Circle Tool)** window to reset the settings of the **NURBS Circle** tool. The options in this window are similar to those of the **NURBS Sphere** tool.

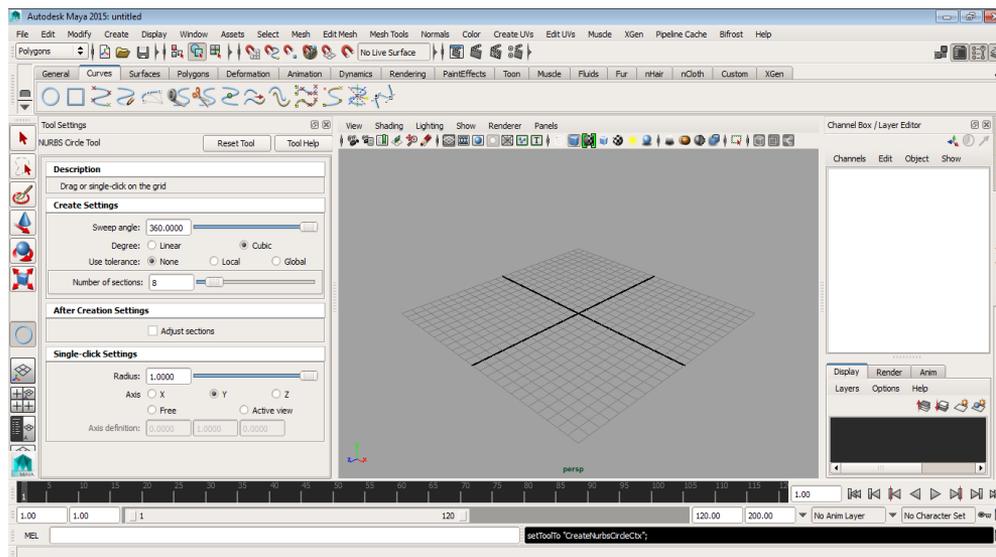


Figure 3-20 The Tool Settings (NURBS Circle Tool) window

## Creating a Square

**Menubar:** Create > NURBS Primitives > Square  
**Shelf:** Curves > NURBS Square

A square is a four-sided regular polygon with equal sides, as shown in Figure 3-21. To create a square, choose **Create > NURBS Primitives > Square** from the menubar. Alternatively, you can create a square by invoking the **NURBS Square** tool from the **Curves** Shelf tab. You can create a square either dynamically or by entering values by using the keyboard. Both the methods of creating a square are discussed next.

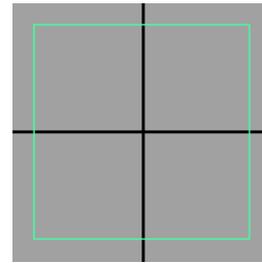


Figure 3-21 The NURBS square

## Creating a Square Dynamically

To create a square dynamically, choose **Create > NURBS Primitives > Square** 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. Next, release the left mouse button; the square will be created in all viewports.

## Creating a Square by Using the Keyboard

To create a square by using the keyboard, double-click on the **NURBS Square** tool in the **Curves** Shelf tab; the **Tool Settings (NURBS Square Tool)** window will be displayed on the left of the viewport, as shown in Figure 3-22. Set the properties of the square using various options available in the **Tool Settings (NURBS Square Tool)** window and click in the viewport to create a square in all viewports. Alternatively, choose **Create > NURBS Primitives > Square > Option Box** from the menubar to invoke the **Tool Settings (NURBS Square Tool)** window. Choose the **Reset Tool** button at the top of the **Tool Settings (NURBS Square Tool)** window to reset the settings of the **NURBS Square** tool. The options in this window are similar to those discussed in the **NURBS Cube** tool.

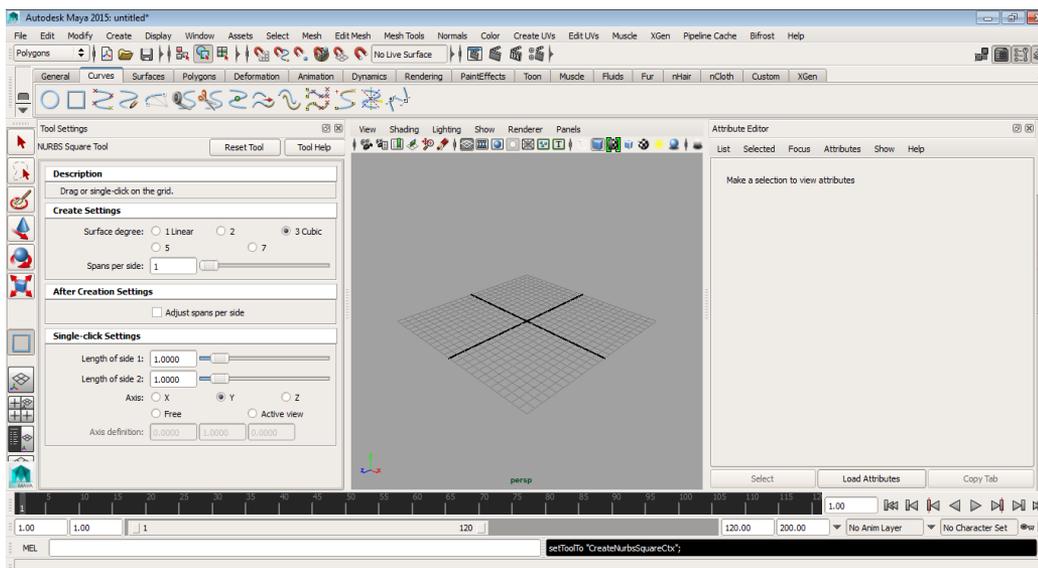


Figure 3-22 The Tool Settings (NURBS Square Tool) window

## Interactive Creation

**Menubar:** Create > NURBS Primitives > Interactive Creation

The **Interactive Creation** option is used to create objects dynamically. It is a toggle on/off option in the **NURBS Primitives** cascading menu. The **Interactive Creation** option is selected by default. To deselect this option, choose **Create > NURBS Primitives > Interactive Creation** from the menubar. Therefore, it allows you to edit the object as required. If you clear this option, you need to modify the object using the **Channel Box**.

## Exit on Completion

**Menubar:** Create > NURBS Primitives > Exit on Completion

The **Exit on Completion** option is used to end the command of creating tools with the creation of an object in the viewport. To do so, choose **Create > NURBS Primitives > Exit on Completion** from the menubar. Deselect this option to interactively create multiple primitives of the same type until another tool is chosen. This option is activated only when the **Interactive Creation** option is selected.

## WORKING WITH NURBS COMPONENTS

Each NURBS object has certain components such as **Isoparm**, **Hull**, **Surface Patch**, **Surface UV**, **Control Vertex**, and **Surface Point**, refer to Figures 3-23 to 3-28. To view components of the NURBS object, select the NURBS object in the viewport and choose **Display > NURBS** from the menubar; a cascading menu will be displayed. Choose the component that you want to modify from the cascading menu; the selected component will be displayed in the viewport. Alternatively, press and hold the right mouse button over the object and choose the required component from the marking menu.

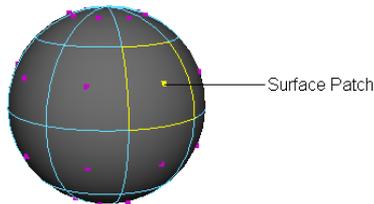


Figure 3-23 Surface Patch of the NURBS

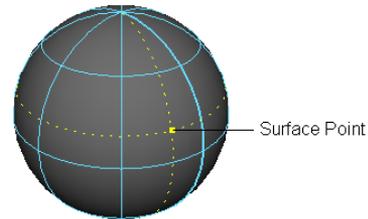


Figure 3-24 Surface Point of the NURBS

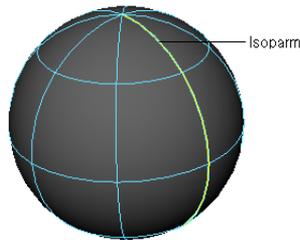


Figure 3-25 Isoparm of the NURBS

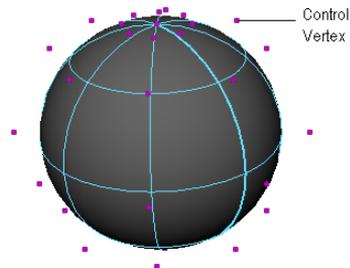


Figure 3-26 Control Vertex of the NURBS

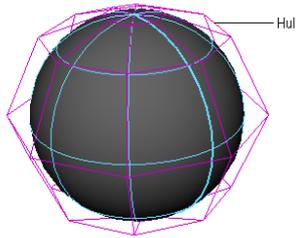


Figure 3-27 Hull of the NURBS

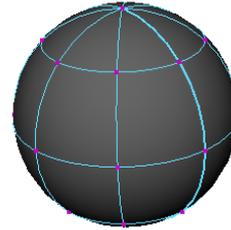


Figure 3-28 Surface UV of the NURBS

## 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 > 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 > 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 > CV Curve Tool > Option Box** from the menubar; the **Tool Settings (CV Curve Tool)** window will be displayed, as shown in Figure 3-29. The options in the window are discussed next.

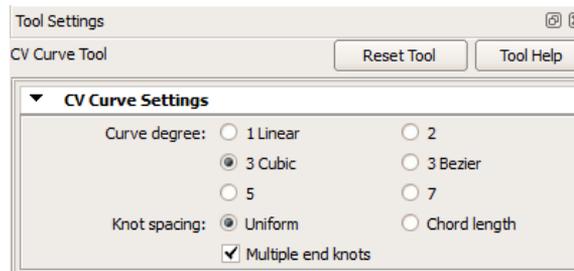


Figure 3-29 The Tool Settings (CV Curve Tool) window

### Curve degree

The radio buttons corresponding to the **Curve degree** option are used to define the smoothness of a curve. By default, the **3 Cubic** radio button is selected in the **Curve degree** area. The higher the degree of curve, the smoother it will be.

### Knot spacing

The radio buttons corresponding to the **Knot spacing** option are used to define the distribution of the knots on the curve. Knots are the parametric locations(u) along the curve. The **Knot spacing** options has two radio buttons: **Uniform** and **Chord length**. The **Uniform** radio button

is selected by default and is used to create the U parametric location values that are easier to predict. The **Chord length** radio button is used to distribute the curvature in such a way that the surface displays a symmetrical texture applied over it.



**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 > EP Curve Tool  
**Shelf:** Curves > 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 > 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 > EP Curve Tool > Option Box** from the menubar; the **Tool Settings (EP Curve Tool)** window will be displayed. Alternatively you can invoke this window from the **Curves Shelf** tab by double-click on the icon in the Shelf tab; the **Tool Settings (EP Curve Tool)** window will be displayed. The options in the **Tool Settings (EP Curve Tool)** window are similar to those discussed in the **Tool Settings (CV Curve Tool)** window.



### 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.*

## Pencil Curve Tool

**Menubar:** Create > Pencil Curve Tool  
**Shelf:** Curves > Pencil Curve Tool



The **Pencil Curve Tool** works similar to the brush tool in other softwares. This tool is used to draw a freehand NURBS curve. To do so, choose **Create > Pencil Curve Tool** from the menubar; the cursor will change into a pencil sign. 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 > Pencil Curve Tool > Option Box** from the menubar; the **Tool Settings (Pencil Curve Tool)** window will be displayed. Alternatively you can invoke this window from the **Curves Shelf** tab by double-click on the icon in the **Curves Shelf** tab; the **Tool Settings (Pencil Curve Tool)** window will be displayed. The options in the **Tool Settings (Pencil Curve Tool)** window are similar to those discussed in the **Tool Settings (EP Curve Tool)** window.

## Arc Tools

**Menubar:** Create > Arc Tools  
**Shelf:** Curves > 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 > Arc 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.

## 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 **Surfaces** 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 3-30.

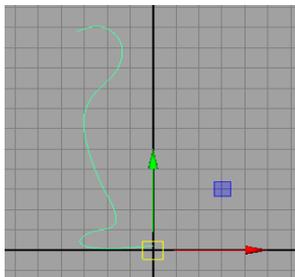


*Figure 3-30 Surfaces floating menu*

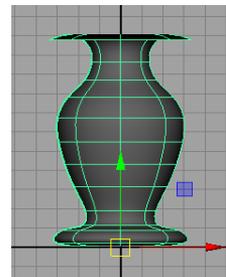
## Revolve Tool

**Menubar:** Surfaces > Revolve

The **Revolve** tool is used to create a surface around a profile curve along a selected axis. The axis of revolution depends on the location of the pivot point of an object. To create a revolved surface, choose **Create > EP Curve Tool** from the menubar and then create a profile curve in the front viewport, refer to Figure 3-31. Select the profile curve and choose **Surfaces > Revolve** from the menubar; the profile curve will rotate around its pivot point, thus creating a revolved surface, as shown in Figure 3-32. Alternatively, you can choose **Surfaces > Revolve > Option Box** from the menubar; the **Revolve Options** dialog box will be displayed, as shown in Figure 3-33. The options in this dialog box are discussed next.



*Figure 3-31 The profile curve created*



*Figure 3-32 The NURBS surface created after using the Revolve tool*

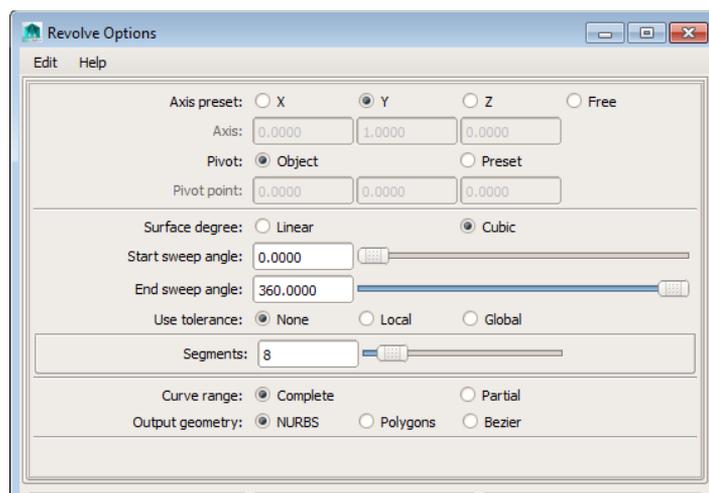


Figure 3-33 The Revolve Options dialog box

### Axis preset

The options corresponding to the **Axis preset** parameter are used to set the axis about which the curve will revolve. You can select the required radio button to set the axis of revolution of the curve. By default, the revolution axis is Y. You can also select the **Free** radio button to enter the value of the axis manually.

### Axis

The edit boxes corresponding to the **Axis** parameter are inactive by default. On selecting the **Free** radio button in the **Axis preset** parameter, the **Axis** edit boxes will be enabled. Now, you can specify the axis about which you want to revolve the NURBS curve in the viewport.

### Pivot

The options corresponding to the **Pivot** parameter are used to define the rotation of the object from the default pivot location. It has two radio buttons: **Object** and **Preset**. The **Object** radio button is selected by default and is used to rotate an object at the default pivot location (0, 0, 0). Select the **Preset** radio button to change the X, Y, and Z location of the pivot point.

### Surface degree

The **Surface degree** option is used to determine that whether the direction of the surface created will be linear or cubic. It has two radio buttons: **Linear** and **Cubic**. If you select the **Linear** radio button, the surface will be formed with edgy facets. If you select the **Cubic** radio button, the edgy facets of the surface will become smooth.

### Start sweep angle and End sweep angle

The **Start sweep angle** and **End sweep angle** edit boxes are used to define the degree of revolution of a curve. By default, the values in these edit boxes are set to 0 and 360, respectively. You can drag the slider next to these edit boxes to change the values as required.

## Use tolerance

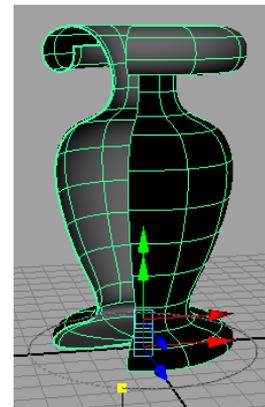
The radio buttons corresponding to the **Use tolerance** parameter are used to define the accuracy of the revolved NURBS surface. There are three radio buttons in this area: **None**, **Local**, and **Global**. By selecting the **None** radio button, you can make changes in the number of segments of the NURBS surface. The more the number of segments, the more will be the smoothness of the NURBS surface.

## Segments

The **Segments** parameter is used to set the number of segments that are used to create the revolved surface. More the number of segments, more will be the smoothness of the surface. Either enter the required value in the edit box or drag the slider next to it. The default value in this edit box is 8.

## Curve range

The **Curve range** parameter is used to determine whether the entire profile will be revolved or only a part of profile curve will be revolved about its pivot point. There are two radio buttons corresponding to the **Curve range** parameter: **Complete** and **Partial**. The **Complete** radio button is selected by default and is used to revolve the entire profile curve about the pivot point. The **Partial** radio button is used to create a revolved surface by revolving a part of profile curve about its pivot point. You can also edit the curve range for rotation. To do so, select the revolved surface in the viewport; the **Channel Box / Layer Editor** will be displayed. Next, choose **subCurve1** from the **INPUTS** area; the **subCurve1** options will be displayed in the **Channel Box / Layer Editor**. Set the **Min Value** and the **Max Value** of **subCurve1** in the **Channel Box / Layer Editor**. Alternatively, you can edit **subCurve1** by using the **Show Manipulator Tool**. Choose **Modify > Transformation Tools > Show Manipulator Tool** from the menubar. Next, drag the Curve Segment Manipulator to set the partial curve range, refer to Figure 3-34, and then choose the **Revolve** tool to create the NURBS surface.



Curve Segment Manipulator

**Figure 3-34** Dragging the Curve Segment Manipulator

## Output geometry

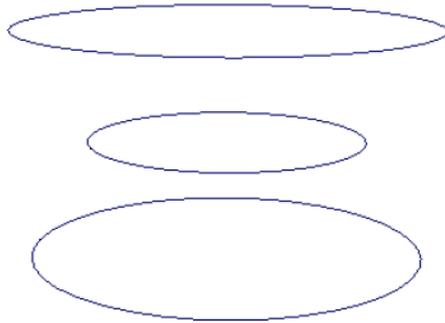
The **Output geometry** parameter is used to define the type of geometry to be created using NURBS curve. The radio buttons in this area are used to convert the NURBS curve into four different types of geometries: NURBS, Polygons, Subdiv, and Bezier (Subdiv refers to subdivision surfaces). Select the required geometry to set the type of output geometry.

## Loft Tool

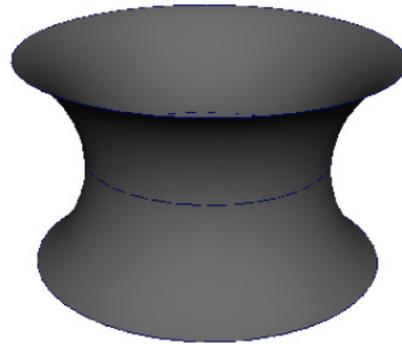
**Menubar:** Surfaces > Loft

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, as shown in Figure 3-35. Next, press and hold the SHIFT key and select the curves in the viewport. Now, choose **Surfaces > Loft** from the menubar;

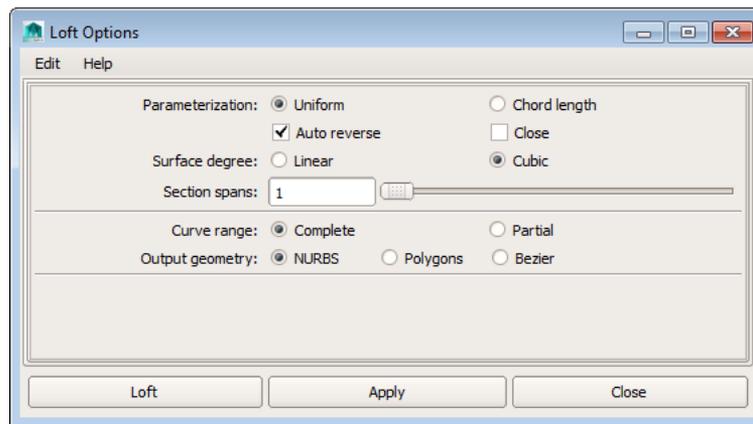
the NURBS curves are lofted with a surface in the viewport, as shown in Figure 3-36. To set the properties of the lofted surface created, choose **Surfaces > Loft > Option Box** from the menubar; the **Loft Options** dialog box will be displayed, as shown in Figure 3-37. The options in the **Loft Options** dialog box are discussed next.



*Figure 3-35 The NURBS curves before applying the **Loft** tool*



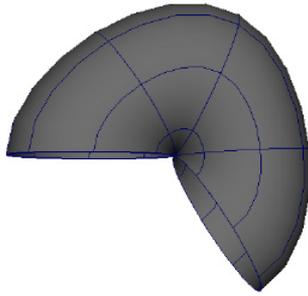
*Figure 3-36 The lofted surface created after applying the **Loft** tool*



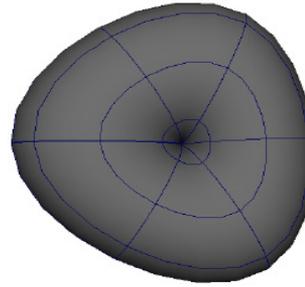
*Figure 3-37 The **Loft Options** dialog box*

### 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 3-38 shows the surface created with the **Close** check box cleared. Figure 3-39 shows the surface created with the **Close** check box selected.



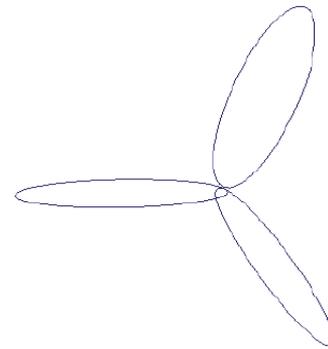
*Figure 3-38* Surface created with the **Close** check box cleared



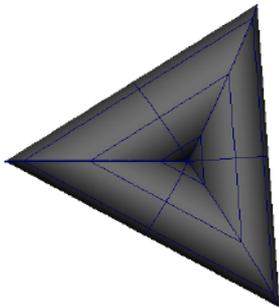
*Figure 3-39* Surface created with the **Close** check box selected

### Surface degree

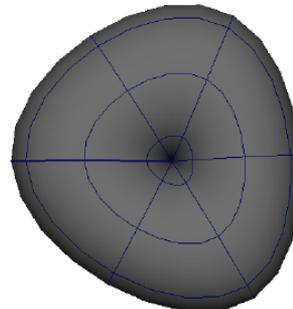
The **Surface degree** attribute is used to specify the smoothness of a NURBS surface. The **Cubic** radio button corresponding to this attribute is selected by default. The **Linear** radio button is used to create the surface with edgy facets. To create a NURBS surface, choose **Create > CV Curve Tool** from the menubar and then create NURBS curves in the viewport, as shown in Figure 3-40. Next, select the **Linear** or **Cubic** radio button corresponding to the **Surface degree** parameter in the **Loft Options** dialog box; the NURBS surfaces will be displayed, as shown in Figures 3-41 and 3-42.



*Figure 3-40* NURBS curves for creating a surface



*Figure 3-41* Surface created on selecting the **Linear** radio button



*Figure 3-42* Surface created on selecting the **Cubic** radio button

### Section spans

The **Section spans** edit box is used to specify the number of spans on the NURBS surface. To do so, enter a value in the edit box to specify the number of sections in the NURBS surface. Alternatively, adjust the slider on the right of the **Section spans** edit box. More the number of spans, more will be the smoothness of the NURBS surface.

## Output geometry

The options in the **Output geometry** are used to specify the type of outputs of the NURBS surface. Select the required radio button to get the output surface as **NURBS**, **Polygons**, or **Bezier**. After setting the options in the **Loft Options** dialog box, choose the **Loft** button to create a NURBS surface.

Alternatively, choose the **Apply** button to create a NURBS surface. The function of the **Loft** and the **Apply** buttons is quite similar. On choosing the **Loft** button, the loft command will be applied to the NURBS curves and the **Loft Options** dialog box will be closed. On the other hand, on choosing the **Apply** button, the loft command will be applied to the NURBS curves without closing the **Loft Options** dialog box.

## Planar Tool

**Menubar:** Surfaces > Planar

The **Planar** tool is used to create a NURBS surface with all the vertices lying on the same plane. To create a NURBS surface using this tool, create a close curve using any curve tool. The curve should form a close loop and should at least have three sides. Next, choose **Surfaces > Planar** from the menubar; a NURBS surface will be created. To set the properties of the NURBS surface, choose **Surfaces > Planar > Option Box** from the menubar; the **Planar Trim Surface Options** dialog box will be displayed, as shown in Figure 3-43. The options in this dialog box are discussed next.

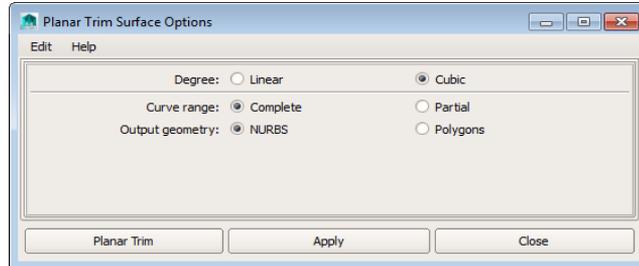


Figure 3-43 The Planar Trim Surface Options dialog box

### Degree

The radio buttons corresponding to the **Degree** attribute are used to add smoothness to the edges of the surface created. By default, the **Cubic** radio button is selected. As a result, a planar surface with smooth edges is created. You can select the **Linear** radio button to create a planar surface with rough edges.

### Curve range

The radio buttons corresponding to the **Curve range** attribute are used to set curves for creating a planar surface. The **Complete** radio button is selected by default and is used to create a planar surface along the selected curve. The **Partial** radio button is used to display manipulators on the planar surface using **Show Manipulator** tool and edit the plane along the input curve.

## Output geometry

The **Output geometry** parameter specifies the type of geometry to be created. Select the **NURBS** radio button to set the output geometry as NURBS. Select the **Polygons** radio button to set the output geometry as polygon.

## Extrude Tool

**Menubar:** Surfaces > Extrude

The **Extrude** tool is used to extrude a particular object by sweeping its profile curve along the path curve. To extrude a surface, two curves are required: a profile curve and a path curve. The profile curve gives shape to a surface, whereas the path curve defines the path on which the shape will sweep to create a surface. To create an extruded surface, select the two curves in the viewport. The first curve selected will act as the profile curve, whereas the second curve will act as the path curve. Now, choose **Surfaces > Extrude** from the menubar to extrude the surface. You can use this method to create objects such as curtains, parts of a vehicle, and so on. To adjust the properties of the **Extrude** tool, choose **Surfaces > Extrude > Option Box** from the menubar; the **Extrude Options** dialog box will be displayed, as shown in Figure 3-44. The options in this dialog box are discussed next.

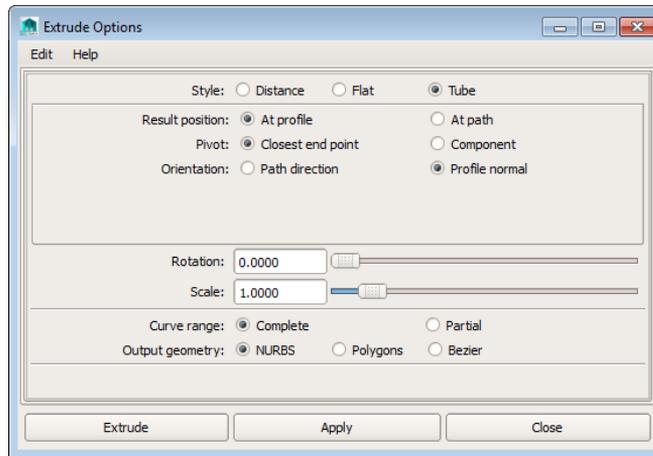


Figure 3-44 The **Extrude Options** dialog box

## Style

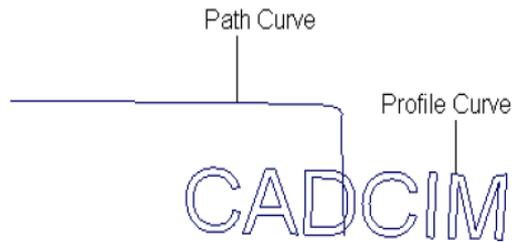
The **Style** parameter consists of three radio buttons: **Distance**, **Flat**, and **Tube**. The **Tube** radio button is selected by default and is used to maintain a cross-section along the path, with the reference vector remaining tangent to the path. The **Distance** radio button is used to extrude the profile in a straight line. The **Flat** radio button is used to maintain the orientation path of the profile curve.

## Result position

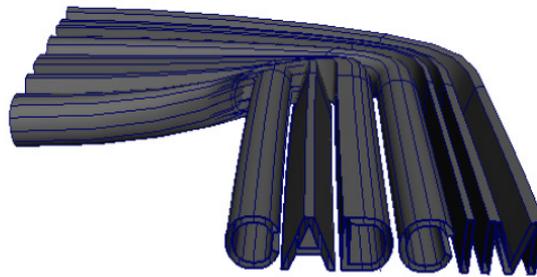
The radio buttons corresponding to the **Result position** attribute are used to set the position at which the extruded surface will be created. By default, the **At profile** radio button is selected. It is used to position the extruded surface along the profile curve. The **At path** radio button is used to set the position of the extruded surface along the path curve. This option is available only if you set the **Style** to **Tube** or **Flat**.

### Pivot

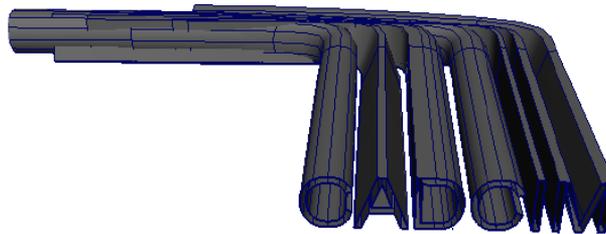
The **Pivot** attribute is used to set the pivot point of an extruded surface and will be activated only when the **Tube** radio button is selected in the **Style** attribute. The two radio buttons corresponding to the **Pivot** attribute are: **Closest end point** and **Component**. By default, the **Closest end point** radio button is selected. As a result, an extruded surface is created close to the center of the bounding box of the profile curves. The **Component** radio button is used to create an extruded surface along the components of the profile curve. Figure 3-45 shows a profile curve and a path curve to create an extruded surface. Figures 3-46 and 3-47 show extruded surfaces created on selecting the **Closest end point** and **Component** radio buttons, respectively.



*Figure 3-45 The profile curve and the path curve for creating an extruded surface*



*Figure 3-46 Extruded surface created on selecting the **Closest end point** radio button*



*Figure 3-47 Extruded surface created on selecting the **Component** radio button*

### Orientation

The radio buttons corresponding to the **Orientation** attribute are used to set the orientation of an extruded surface. The **Orientation** attribute is available only when the **Tube** radio button is selected in the **Extrude Options** dialog box. The **Path direction** radio button is used to

extrude the profile curve along the direction of path curve. By default, the **Profile normal** radio button is selected. The **Profile normal** radio button is used to extrude the surface such that the path curve is created normal to the profile curve.

## Rotation

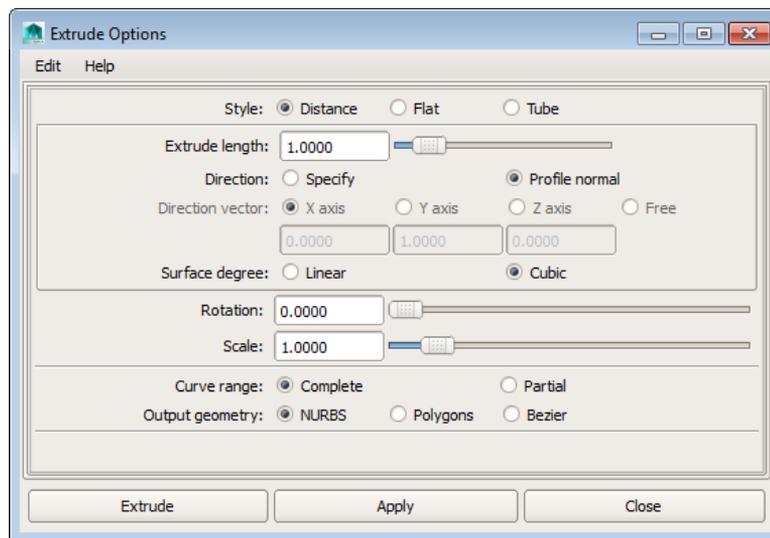
The **Rotation** edit box is used to rotate the profile curve along the path. To do so, specify the angle of rotation in this edit box.

## Scale

The **Scale** edit box is used to scale the profile while extruding it along the path curve. To do so, specify the scale factor in this edit box.

## Curve range and Output geometry

The radio buttons corresponding to the **Curve range** and **Output geometry** attributes are the same as discussed in the revolved surface section. On selecting the **Distance** radio button from the **Style** parameter, some other options are displayed, as shown in Figure 3-48. These options are discussed next.



*Figure 3-48 The Extrude Options dialog box with the Distance radio button selected*

## Extrude length

The **Extrude length** edit box is used to define the length of extrusion.

## Direction

The radio buttons corresponding to the **Direction** attribute is used to define the direction of extrusion. It consists of two radio buttons: **Specify** and **Profile normal**. The **Profile normal** radio button is used to set the direction of the path to normal. The **Specify** radio button is used to manually set the direction for creating the surface in a particular axis. For example, if you select the X-axis, the extrusion will take place only in the X-direction.

## Surface degree

The **Surface degree** attribute is used to give smoothness or sharpness to the surface created. This option consists of two radio buttons: **Linear** and **Cubic**. The **Linear** radio button is used to create sharp edges near the isoparms. The **Cubic** radio button is used to create smooth surfaces.

## Birail Tool

**Menubar:** Surfaces > Birail

The **Birail** tool works similar to the **Extrude** tool. This tool is used to create surfaces using one curve or two profile curves along two path curves. You can create complex NURBS surfaces using this tool. Maya has three different types of **Birail** tools: **Birail 1 Tool**, **Birail 2 Tool**, and **Birail 3+ Tool**. Before creating a NURBS surface using different **Birail** tools, the following points should be kept in mind:

1. The profile curves and the path curves must touch each other and have continuity with their respective positions.
2. All profile curves should have the same number of CVs.
3. All path curves should also have the same number of CVs.
4. Press V to snap the vertex of the profile curve and the path curve together.
5. If the profile curve and path curve do not have the same number of CVs, you will have to draw the curve again.

## Boundary Tool

**Menubar:** Surfaces > Boundary

The **Boundary** tool is used to create a surface by filling the boundary curves. This tool creates a NURBS surface by filling the space between curves. It is not necessary for the curves to have a closed loop, but they should intersect with each other at some point. To apply the **Boundary** tool, create four curves in the viewport, as shown in Figure 3-49. Press and hold the SHIFT key and select all the curves in opposite pairs to maintain continuity. Now, choose **Surfaces > Boundary** from the menubar to create the NURBS surface. To adjust the properties of the **Boundary** tool, choose **Surfaces > Boundary > Option Box** from the menubar; the **Boundary Options** dialog box will be displayed, as shown in Figure 3-50. The options in this dialog box are similar to those discussed in other surfacing tools.

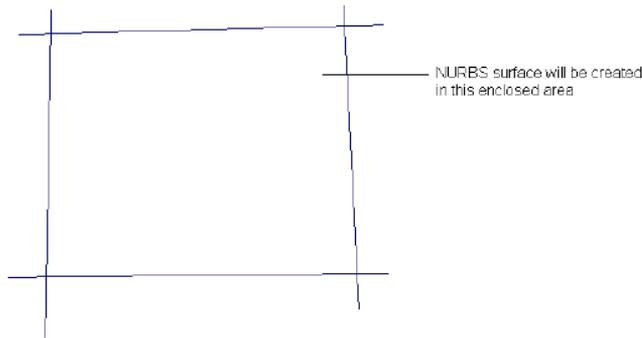


Figure 3-49 Four NURBS curves created

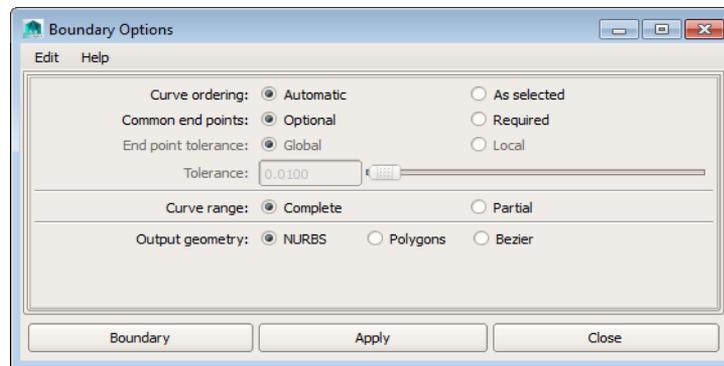


Figure 3-50 The *Boundary Options* dialog box

## Square Tool

**Menubar:** Surfaces > Square

The **Square** tool is used to create a four-sided NURBS surface from the intersecting curves. On choosing this tool, a NURBS surface is created by filling the region defined by four intersecting curves. This tool is similar to the **Boundary** tool with the only difference that in the **Boundary** tool, you can select curves in any order, whereas in the **Square** tool, you need to select them in the clockwise or counterclockwise direction. To use this tool, create four intersecting curves in the viewport. Next, press and hold the SHIFT key and select the curves either in clockwise or counterclockwise direction. Now, choose **Surfaces > Square** from the menubar; the NURBS surface will be created.

## Bevel Tool

**Menubar:** Surfaces > Bevel

The **Bevel** tool is used to create a NURBS surface by using the three-dimensional edge effect applied on the selected curves. The surface created by **Bevel** tool has an open area that can be filled by using the **Planar** tool. To create a surface by using the **Bevel** tool, create a NURBS circle in the top viewport, as shown in Figure 3-51. Next, choose **Surfaces > Bevel** from

the menubar; a beveled surface will be created, as shown in Figure 3-52. You can adjust the properties of the beveled surface in the **Channel Box / Layer Editor** by changing the values in the **bevel1** node of the **INPUTS** area, as required, refer to Figure 3-53.

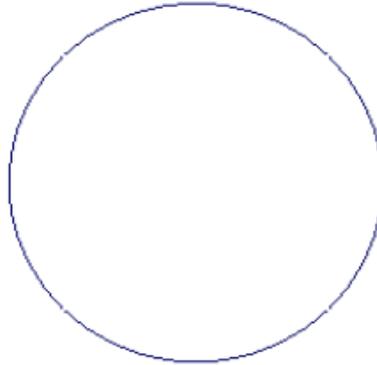


Figure 3-51 A NURBS circle

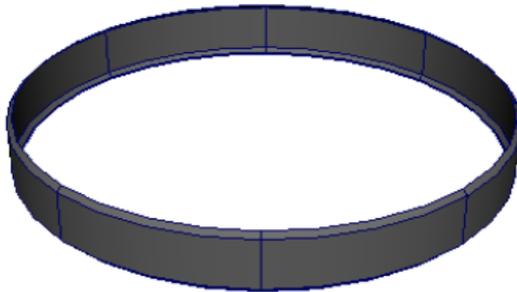


Figure 3-52 The bevel surface created

INPUTS	
<b>bevel1</b>	
Width	0.1
Depth	0.1
Extrude Depth	1
Corner Type	Circular
Bevel Shape Type	Straight Cut

Figure 3-53 The **bevel1** node in the **INPUTS** area

### Bevel Plus Tool

**Menubar:** Surfaces > Bevel Plus

The **Bevel Plus** tool is used to extrude the closed curves and add beveled transition to the extruded surface. To create a surface by using this tool, create a NURBS circle in the top viewport, as shown in Figure 3-54 and then choose **Surfaces > Bevel Plus** from the menubar; a beveled surface will be created, as shown in Figure 3-55. You can adjust the properties of the beveled surface in the **Channel Box / Layer Editor** by changing the values in the **bevelPlus1** node of the **INPUTS** area, as required, refer to Figure 3-56.

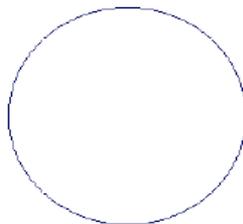


Figure 3-54 A NURBS circle created in the top viewport

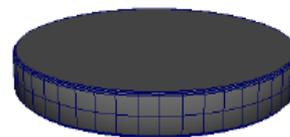


Figure 3-55 The beveled surface created using the **Bevel Plus** tool

You can also create the beveled text by using the **Bevel Plus** tool. To do so, choose **Create > Text > Option Box** from the menubar; the **Text Curves Options** dialog box will be displayed, as shown in Figure 3-57. By default, **Maya** is displayed in the **Text** edit box. Replace it with the text that you want to display in the viewport in the edit box. You can also set the font of the text. To do so, choose the arrow shaped button on the right of the **Font** attribute; the **Select Font** dialog box will be displayed, as shown in Figure 3-58. Set the font, font style, size, and other font attributes in this dialog box and choose the **OK** button to close the dialog box. Next, choose the **Create** button from the **Text Curves Options** dialog box; the text will be displayed in the **Wireframe** mode in the viewport, as shown in Figure 3-59. Next, select the letter curves one by one and choose **Surfaces > Bevel Plus** from the menubar. Repeat this step for every letter; the text in the wireframe mode will be extruded and a NURBS surface is added to it, as shown in Figure 3-60.

INPUTS	
polyPlanarProj1	
bevelPlus1	
Bevel Inside	off
Width	0.1
Depth	0.1
Extrude Depth	0.25

Figure 3-56 The *bevelPlus1* node displayed in the *INPUTS* area

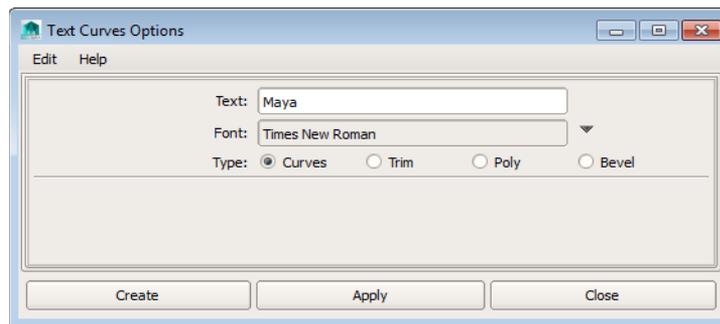


Figure 3-57 The *Text Curves Options* dialog box

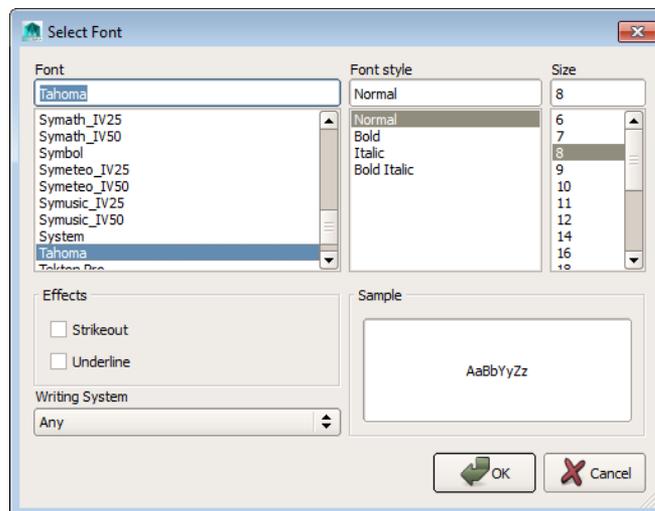


Figure 3-58 The *Select Font* dialog box



*Figure 3-59* Text displayed in the wireframe mode

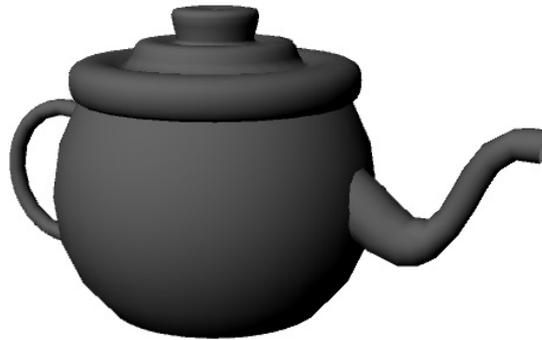


*Figure 3-60* The text displayed on choosing the **Bevel Plus** tool

## TUTORIALS

### Tutorial 1

In this tutorial, you will create the 3D model of a teapot, as shown in Figure 3-61, using the curve tools and the surface tools. **(Expected time: 15 min)**



*Figure 3-61* The teapot model

The following steps are required to complete this tutorial:

- Create a project folder.
- Create the body of the teapot.
- Create the handle of the teapot.
- Create the spout of the teapot
- Create the lid of the teapot.
- Change the background color of the scene.
- Save and render the scene.

### Creating a Project Folder

Create a new project folder with the name *c03\_tut1* at `\Documents\maya2015` and then save the file with the name *c03tut1*, as discussed in Tutorial 1 of Chapter 2.

## Creating the Body of the Teapot

In this section, you will create the body of the teapot using the **NURBS Circle** and the **Loft** tools.

1. Select the **Surfaces** menuset from the **Menuset** drop-down list in the Status Line. Choose the **Four View** button from the Tool Box to switch to four views. Move the cursor to the top viewport and then press the SPACEBAR key to maximize the top viewport.
2. Choose **Create > NURBS Primitives > Circle** from the menubar and click in the top viewport; a NURBS Circle is created in the viewport.
3. In the **Channel Box / Layer Editor**, expand the **makeNurbCircle1** area of the **INPUTS** area in the **Channel Box / Layer Editor** and enter **3** in the **Radius** edit box, refer to Figure 3-62.

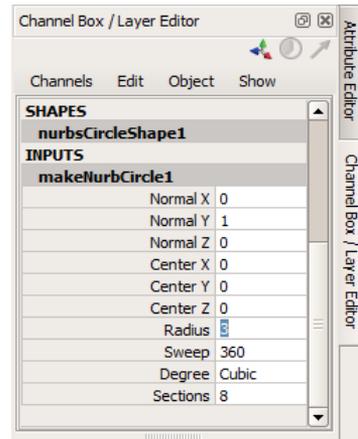


Figure 3-62 The Channel Box / Layer Editor for the circle

4. Choose the **Four View** button from the Tool Box to switch to four views. Move the cursor to the front viewport and then press the SPACEBAR key to maximize the front viewport. In the front viewport, make sure **NURBS Circle** is selected and choose **Edit > Duplicate** from the menubar; another copy of the circle is created. Next, choose **Move Tool** from the Tool Box and move the duplicate circle up along the Y-axis, refer to Figure 3-63.
5. Make sure the duplicate circle is selected and then press CTRL + D; a copy of the circle is created. Next, choose **Move Tool** from the Tool Box and move the third circle and place it in the middle of the first and second circles, as shown in Figure 3-64.

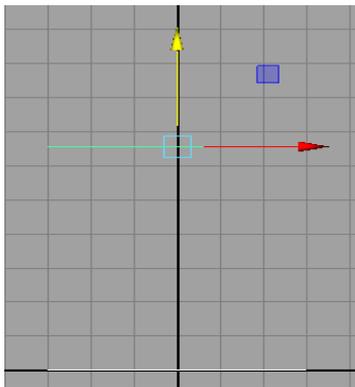
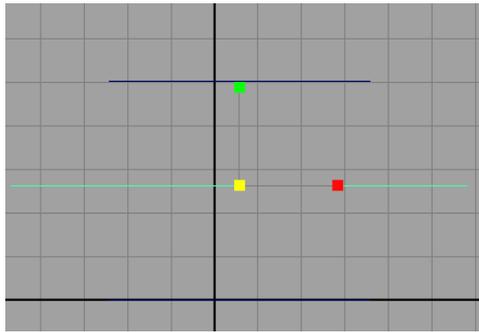


Figure 3-63 Duplicate copy of the circle created in the front viewport



Figure 3-64 Third copy of the circle placed between the first and second circles

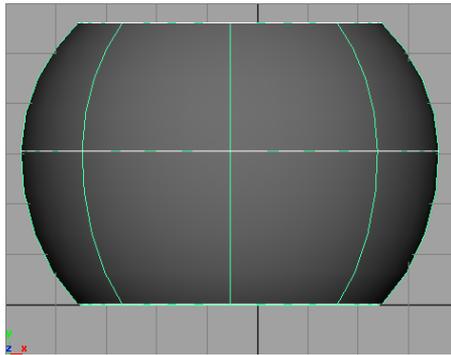
6. Invoke **Scale Tool** and scale the third circle uniformly, refer to Figure 3-65.



**Figure 3-65** The third circle scaled using **Scale Tool** in the front viewport

Next, you will create a NURBS surface.

7. Press and hold the SHIFT key and select the first, third and second circles. Choose **Surfaces > Loft** from the menubar; the lofted surface is created in the viewport, refer to Figure 3-66. Press 5 to view the surface in shaded mode.



**Figure 3-66** The three circles lofted using the **Loft** tool

8. Select the first circle and choose **Surfaces > Planar** from the menubar; a flat surface is created at the bottom.

### Creating the Handle of the Teapot

In this section, you will create the handle of the teapot by using the **Three Point Circular Arc** and **Extrude** tools.

1. Choose **Create > Arc Tools > Three Point Circular Arc** from the menubar and create an arc in the front viewport by defining the start point, the curve point, and the endpoint, refer to Figure 3-67.

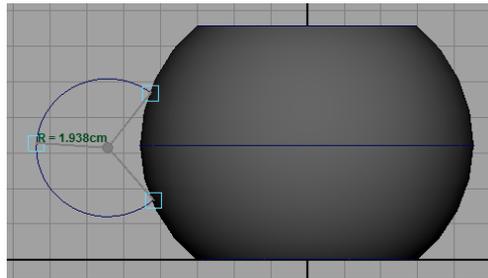


Figure 3-67 An arc created using the *Three Point Circular Arc* tool

2. Choose **Create > NURBS Primitives > Circle** from the menubar and click in the front viewport; a circle is created in the viewport. In the **Channel Box / Layer Editor**, expand the **makeNurbCircle2** node in the **INPUTS** area. Next, enter **0.25** in the **Radius** edit box.
3. Make sure the circle is selected. Enter **90** in the **Rotate X** edit box in the **Channel Box / Layer Editor**. Figure 3-68 displays the circle created in the front viewport.

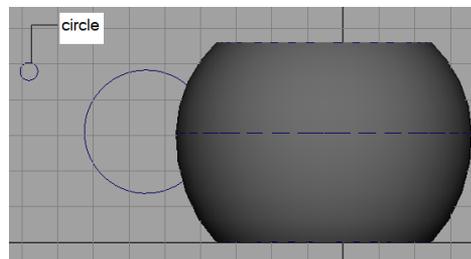


Figure 3-68 A circle created in the front viewport

4. Make sure the circle is selected and then select the arc by using the SHIFT key. Next, choose **Surfaces > Extrude > Option Box** from the menubar; the **Extrude Options** dialog box is displayed. In this dialog box, set the parameters, as shown in Figure 3-69. Next, choose the **Apply** button and then the **Close** button; the circle is extruded along the arc.

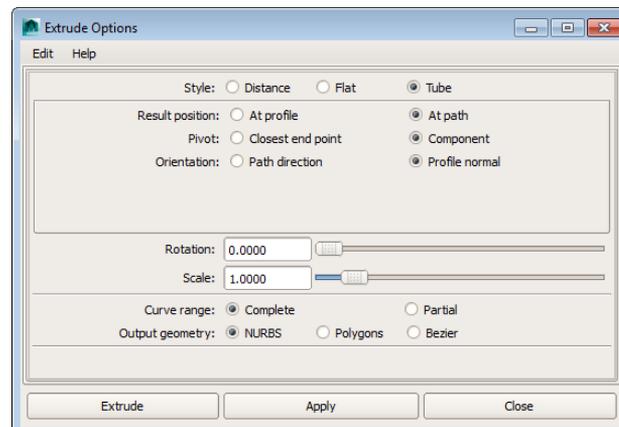


Figure 3-69 The *Extrude Options* dialog box

- 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. Press 5 to view the surface in the shaded mode, if not in the shaded mode. Choose **Move Tool** and **Rotate Tool**, if required. Next, align the handle on the body of the teapot, as shown in Figure 3-70.

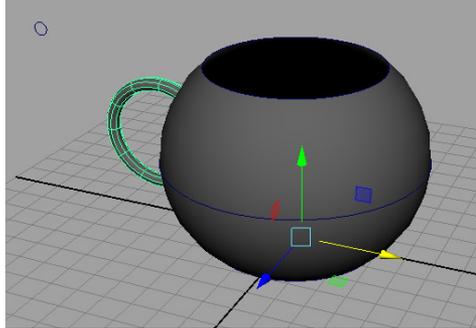


Figure 3-70 Handle aligned with the teapot

### Creating the Spout of the Teapot

In this section, you will create the spout of the teapot by using **EP Curve Tool** and the **Extrude** tool.

- Choose the Four View button from the Tool Box to switch to four views. Move the cursor to the front viewport and then press the SPACEBAR key to maximize the front viewport. Choose **Create > EP Curve Tool > Option Box** from the menubar; the **Tool Settings (EP Curve Tool)** window is displayed. Select the 5 radio button corresponding to the **Curve degree** attribute.
- Create a profile curve in the front viewport from bottom to top, as shown in Figure 3-71 and then press ENTER.

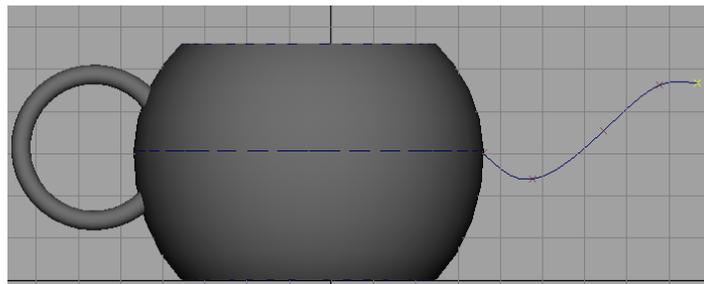


Figure 3-71 Profile curve created for the spout

- Choose **Create > NURBS Primitives > Circle** from the menubar and click in the front viewport; a circle is created in the viewport. Make sure the circle is selected in the viewport. In the **Channel Box / Layer Editor**, expand the **makeNurbCircle3** node in the **INPUTS** area and enter **0.4** in the **Radius** edit box and **90** in the **Rotate X** edit box; the circle is rotated in the front viewport, as shown in Figure 3-72.

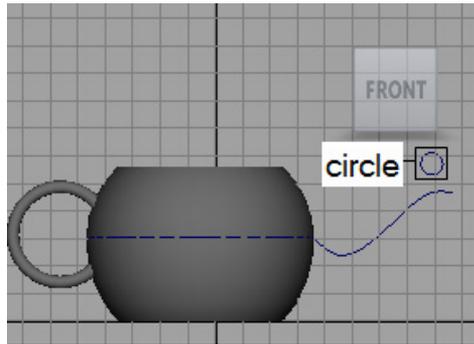


Figure 3-72 A circle created in the front viewport



**Tip:** To get the exact shape of the curve, you need to modify it. To do so, select the curve and then right click on it. Next, choose **Control Vertex** from the marking menu displayed. Now, you can select a vertex and modify the shape of the curve by using the **Move Tool**.

- In the front viewport, make sure the circle is selected and select then the profile curve of the spout by using the SHIFT key. Next, choose **Surfaces > Extrude > Option Box** from the menubar; the **Extrude Options** dialog box is displayed. In this dialog box, set the parameters, refer to Figure 3-73. Choose the **Apply** button and then the **Close** button; the profile curve of the spout is extruded.

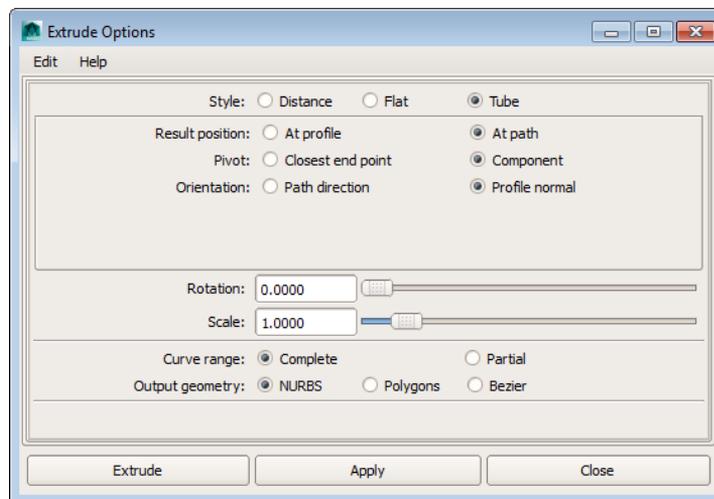
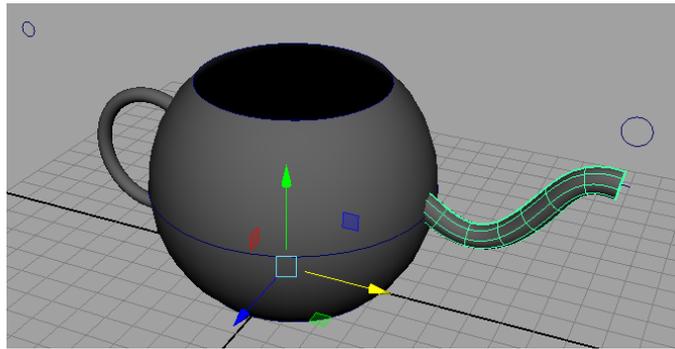


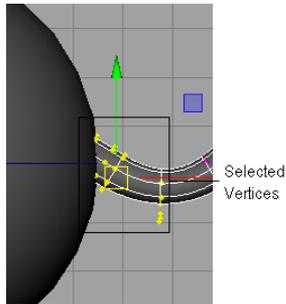
Figure 3-73 The **Extrude Options** dialog box

- 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. Place the spout on the body of the teapot using **Move Tool**, if required, as shown in Figure 3-74.



*Figure 3-74 The spout placed on the teapot*

6. Make sure the spout is selected. Press and hold the right mouse button over the spout; a marking menu is displayed. Choose **Control Vertex** from the marking menu; vertex selection mode is activated.
7. Choose the **Four View** button from the Tool Box to switch to four views. Move the cursor to the front viewport and then press the SPACEBAR key to maximize the front viewport. Select the vertices of the spout, as shown in Figure 3-75. Next, invoke **Scale Tool** and scale the selected vertices uniformly, as shown in Figure 3-76.

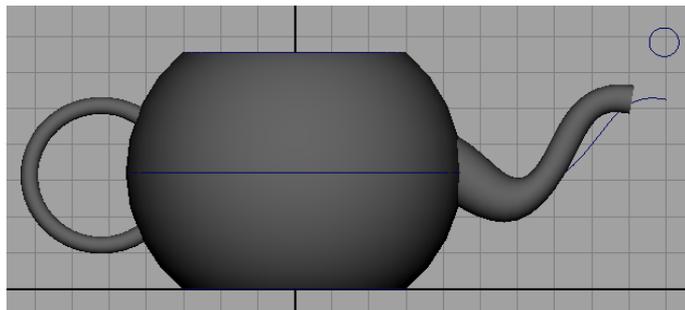


*Figure 3-75 Vertices of the spout selected*



*Figure 3-76 Selected vertices scaled*

8. Modify the shape of the spout to refine it using **Scale Tool** and **Move Tool**, as shown in Figure 3-77.

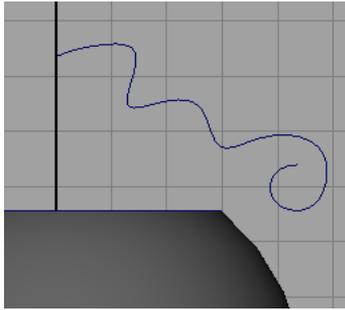


*Figure 3-77 The refined shape of the spout*

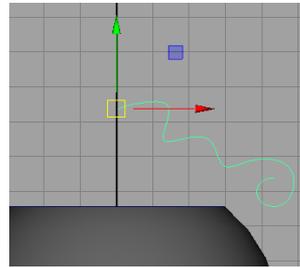
## Creating the Lid of the Teapot

In this section, you will create the lid of the teapot using **EP Curve Tool** and the **Revolve** tool.

1. Choose **Create > EP Curve Tool > Option Box** from the menubar; the **Tool Settings (EP Curve Tool)** window is displayed. Select the **3 Cubic** radio button corresponding to the **Curve Degree** attribute.
2. In the front viewport, create a profile curve from bottom to top for the lid of the teapot using **EP Curve Tool**, as shown in Figure 3-78 and press ENTER. Next, press and hold the **D** key and set the pivot point of the curve, as shown in Figure 3-79.

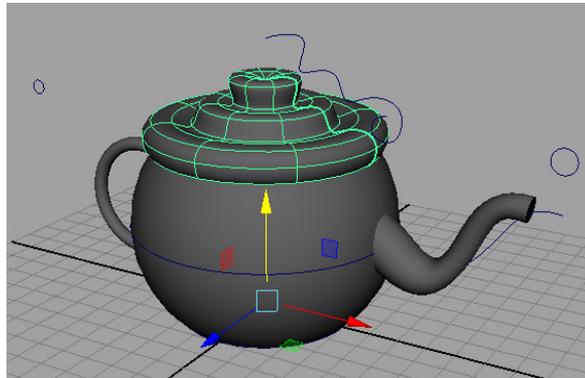


*Figure 3-78* Profile curve created for the lid



*Figure 3-79* Pivot point of the curve aligned

3. Make sure the profile curve is selected. Next, choose **Surfaces > Revolve** from the menubar; the profile curve rotates at 360 degrees and the lid is created.
4. 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. Scale and align the lid on the body of the teapot using **Move Tool** and **Scale Tool**, as shown in Figure 3-80.



*Figure 3-80* The lid placed on the teapot

**Note**

To set the pivot point of any surface, press the **INSERT** key; the shape of the gizmo will change. Before applying the **Revolve** tool on the selected curve, adjust the pivot point to the center of the curve from where the new surface will be created. If you delete the profile curve after applying the **Revolve** tool, you cannot modify the shape.

**Changing the Background Color of the Scene**

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

1. Choose **Window > 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 scene by downloading the *c03\_maya\_2015\_rndr.zip* file from [www.cadcam.com](http://www.cadcam.com). The path of the file is as follows: *Textbooks > Animation and Visual Effects > Maya > Autodesk Maya 2015: A Comprehensive Guide*

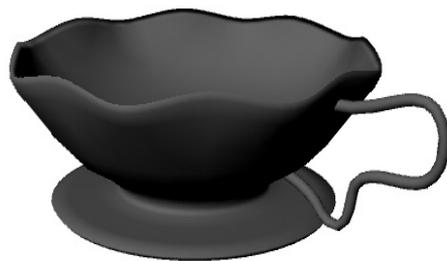
1. Choose **File > Save Scene** from the menubar.
2. Maximize the persp viewport, if it is not already maximized. Choose the **Render the current frame** button from the Status Line; the **Render View** window is displayed. This window shows the final output of the scene, refer to Figure 3-61.

**Tutorial 2**

In this tutorial, you will create the 3D model of a tea cup, as shown in Figure 3-81, using the curve tools and the 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 3-81 The tea cup*

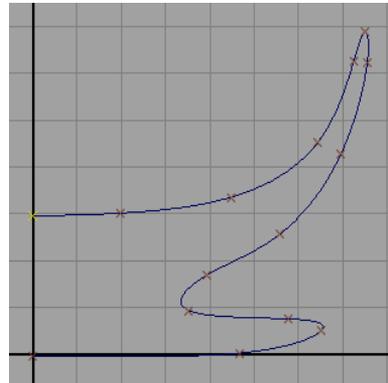
## Creating a Project Folder

Create a new project folder with the name *c03\_tut2* at *\Documents\maya2015* 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 viewport and then press the SPACEBAR key to maximize the front viewport. Choose **Create > EP Curve Tool** from the menubar.
2. In the front viewport, create a profile curve starting from the origin, as shown in Figure 3-82. Next, press the ENTER key.



*Figure 3-82* The profile curve for the tea cup

## Creating the Tea Cup Using the Revolve Tool

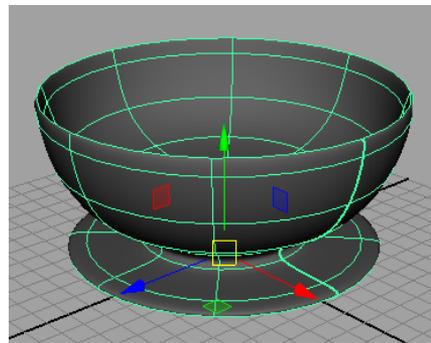
In this section, you will create the tea cup using the **Revolve** tool.

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 > Revolve** from the menubar; the tea cup is created, as shown in Figure 3-83.

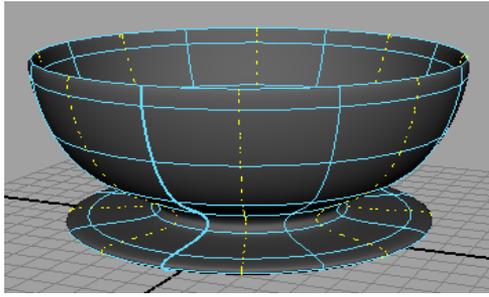
## Creating Creases in the Tea Cup

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 3-84.
3. Press and hold the SHIFT key and similarly create dotted impression of other vertical isoparms, as shown in Figure 3-84. You may need to rotate the viewport to select the vertical isoparms.

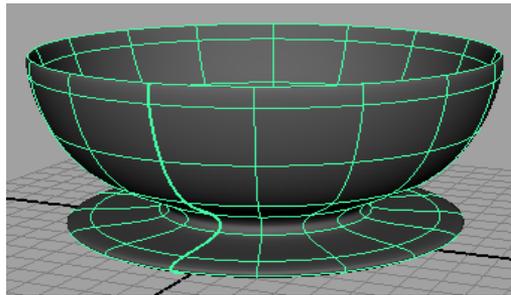


*Figure 3-83* The tea cup created



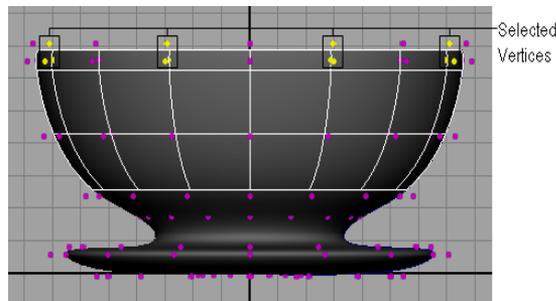
*Figure 3-84 Dotted impression of the isoparms*

4. Make sure that **Surfaces** menuset is selected from the **Menuset** drop-down list in the Status Line. Choose **Edit Curves > Insert Knot** from the menubar; the new isoparms are created on the tea cup, as shown in Figure 3-85.



*Figure 3-85 New isoparms created*

5. Choose the **Four View** button from the Tool Box to switch to four views. Move the cursor to the front viewport and then press the SPACEBAR key to maximize the front viewport.
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 3-86.



*Figure 3-86 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 3-87.



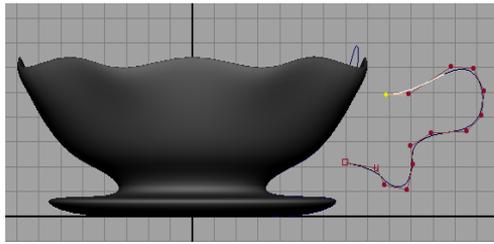


Figure 3-89 The profile curve drawn

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 3-90.
4. In the **Channel Box / Layer Editor**, expand the **makeNurbCircle1** node in the **INPUTS** area and enter **0.2** in the **Radius** edit box.
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.

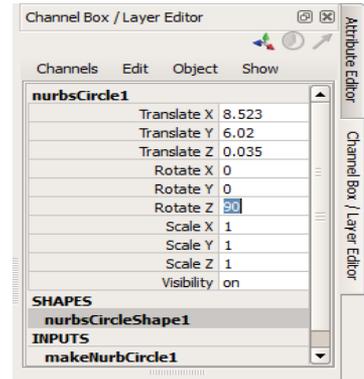


Figure 3-90 The nurbsCircle1 area in the Channel Box / Layer Editor

6. Make sure the NURBS circle is selected and then select the profile curve using the SHIFT key. Next, choose **Surfaces > Extrude** from the menubar; the extruded surface is created, refer to Figure 3-91. 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 3-92.

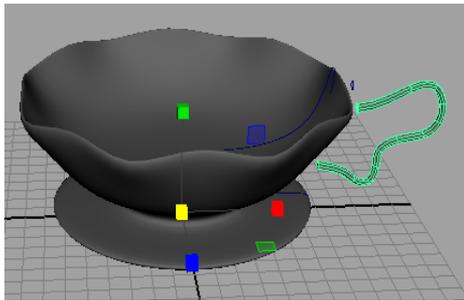


Figure 3-91 The extruded surface displayed

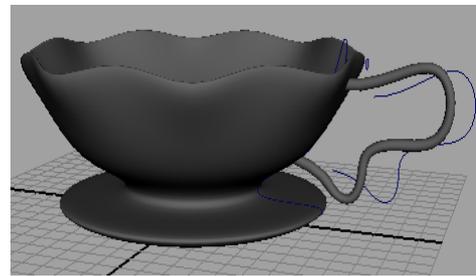


Figure 3-92 Final output of the cup

### Changing the Background Color of the Scene

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

1. Choose **Window > 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**.

- 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\_2015\_rndr.zip* file from [www.cadcam.com](http://www.cadcam.com). The path of the file is mentioned in Tutorial 1.

- Choose **File > Save Scene** from the menubar.
- Maximize the persp viewport, if it is not already maximized. Choose the **Render the current frame** button from the Status Line; the **Render View** window is displayed. This window shows the final output of the scene, refer to Figure 3-81.

### Self-Evaluation Test

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

- Which of the following objects has a circular base and its sides tapered to a point?
 

(a) Cone	(b) Cylinder
(c) Torus	(d) Square
- Which of the following objects has every point equidistant from its center?
 

(a) Plane	(b) Circle
(c) Torus	(d) Sphere
- The options in the \_\_\_\_\_ area are used to define the distribution of the knots on the curve.
- NURBS stands for \_\_\_\_\_.
- The default NURBS objects in Maya are grouped together under \_\_\_\_\_.
- The \_\_\_\_\_ tool is used to create a surface around a profile curve along a selected axis.
- You can switch from the wireframe mode to the object mode by pressing 4 on the keyboard. (T/F)
- A cube is a two-dimensional shape with six square or rectangular sides. (T/F)
- A square is a six-sided regular polygon with six equal sides and six right angles. (T/F)
- The **Boundary** tool is used to create a surface by filling a surface between the boundary curves. (T/F)

**Review Questions**

Answer the following questions:

- Which of the following is not a component of NURBS surface?
  - Isoparm**
  - Vertex**
  - Hull**
  - Surface patch**
- Which of the following tools works similar to the brush tool in other software?
  - EP Curve Tool**
  - CV Curve Tool**
  - Pencil Curve Tool**
  - Arc Tool**
- Which of the following keys is required to adjust the center pivot of an object?
  - SPACEBAR
  - HOME
  - CTRL
  - INSERT
- \_\_\_\_\_ is a four-sided regular polygon with equal sides.
- The \_\_\_\_\_ option is used to determine that whether the direction of the surface created will be linear or cubic.
- \_\_\_\_\_ is the addition of surface between two or more specified curves.
- The \_\_\_\_\_ option is used to create a sphere with a faceted or a smooth appearance.
- The \_\_\_\_\_ is a solid object in which the surface is at an equal distance from the center.
- The **Square** tool is used to create a surface from the intersecting NURBS curves. (T/F)
- The NURBS curves, which are used to create the NURBS surfaces by using the **Loft** tool, should have curves with equal number of vertices. (T/F)

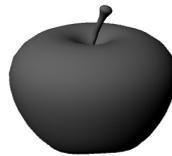
## EXERCISES

The rendered output of the models used in the following exercises can be accessed by downloading the *c03\_maya\_2015\_exr.zip* file from *www.cadcim.com*. The path of the file is as follows: *Textbooks > Animation and Visual Effects > Maya > Autodesk Maya 2015: A Comprehensive Guide*

### Exercise 1

Create the model of an apple, as shown in Figure 3-93.

(Expected time: 15 min)



*Figure 3-93 Model of an apple*

### Exercise 2

Create the model of a lantern, as shown in Figure 3-94.

(Expected time: 15 min)

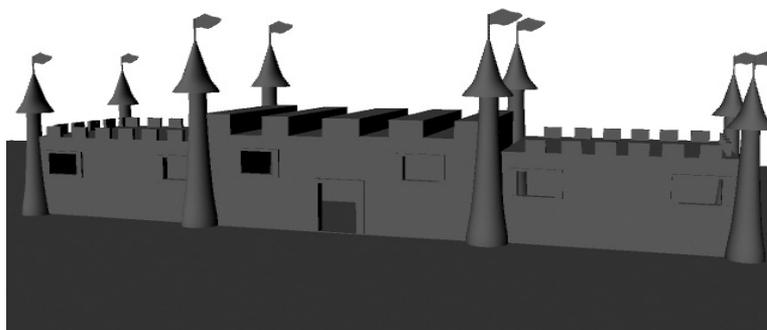


*Figure 3-94 Model of a lantern*

**Exercise 3**

Create the model of a castle, as shown in Figure 3-95.

(Expected time: 30 min)



*Figure 3-95 Model of a castle*

**Exercise 4**

Create the model of a candle stand, as shown in Figure 3-96.

(Expected time: 15 min)



*Figure 3-96 Model of a candle stand*

## Exercise 5

Create the model of a table, as shown in Figure 3-97.

(Expected time:15 min)



*Figure 3-97 Model of a Table*

### Answers to Self-Evaluation Test

1. a, 2. d, 3. **Knot Spacing**, 4. Non uniform rational B-Spline, 5. NURBS Primitives, 6. **Revolve**, 7. F, 8. F, 9. F, 10. T