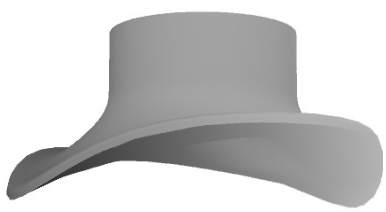
Chapter 4

NURBS Modeling

Learning Objectives

After completing this chapter, you will be able to:

- *Understand NURBS editing techniques*
- *Convert NURBS objects to polygons*



INTRODUCTION

NURBS stands for Non Uniform Rational B-Spline. NURBS are used for creating 3D curves and surfaces, and complex 3D organic models having smooth surfaces and curves. In the previous chapter, you have learned about different methods of creating NURBS surfaces. In this chapter, you will learn about various editing techniques used for modifying NURBS surfaces.

WORKING WITH NURBS TOOLS

The NURBS tools are used to edit NURBS surfaces. The most commonly used tools in NURBS modeling are discussed next.

Duplicate NURBS Patch

Menubar: Surfaces > Edit NURBS Surfaces > Duplicate NURBS Patch

The **Duplicate NURBS Patch** tool is used to create new surface from an existing NURBS patch. To understand the working of this tool, choose **Create > Objects > NURBS Primitives > Sphere** from the menubar and create a NURBS sphere in the viewport. Press and hold the right mouse button over the sphere and then choose **Surface Patch** from the marking menu displayed, as shown in Figure 4-1; the surface patch component of the NURBS sphere will be activated. Now, select the surface patch that you want to duplicate. Choose **Surface > Edit NURBS Surfaces > Duplicate NURBS Patch** from the menubar; a duplicate surface patch will be created. Invoke **Move Tool** from the Tool Box and move the duplicate surface patch away from the NURBS sphere. Note that the pivot point of the duplicate surface patch will remain at the same position as that of the NURBS sphere. To reset the pivot point to the center of the duplicate patch, choose **Modify > Pivot > Center Pivot** from the menubar; the pivot point will be reset.

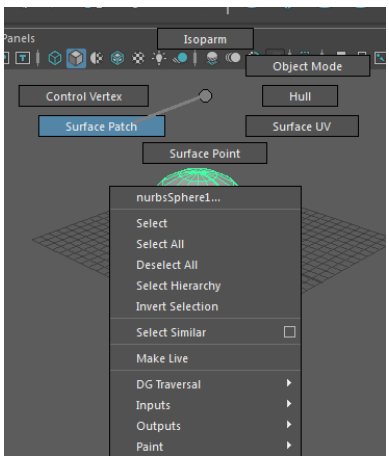


Figure 4-1 *Choosing* ***Surface Patch*** *from the marking menu*

Intersect

Menubar: Surfaces > Edit NURBS Surfaces > Intersect

The **Intersect** tool is used to create a new segment at the intersection of two NURBS surfaces. To understand the working of this tool, consider two surfaces, as discussed earlier, and align them such that they intersect each other, refer to Figure 4-4. Select both the surfaces and choose **Surfaces > Edit NURBS Surfaces > Intersect** from the menubar to create a new segment at the location where the two planes intersect. Choose the **Move Tool** from the Tool Box; the selection handles will be displayed at the intersection point, refer to Figure 4-2. You can now move these handles to align the intersection point anywhere on the NURBS surface.

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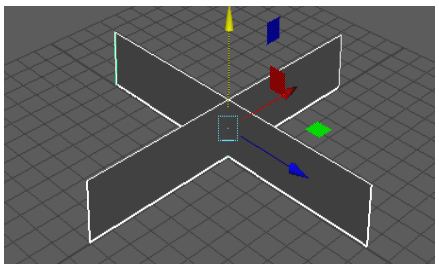

Figure 4-2 *The aligned surfaces and selection handles*

Trim Tool

Menubar: Surfaces > Edit NURBS Surfaces > Trim Tool

The **Trim Tool** is used to hide a particular area from the NURBS surface defined by curves. To understand the working of this tool, consider a curve projected on a surface as discussed in the **Project Curve on Surface** section. Next, select the NURBS surface in the viewport and choose **Surfaces > Edit NURBS Surfaces > Trim Tool** from the menubar; the NURBS surface will be displayed in the wireframe mode with a dotted outline. Select the part that you want to retain from the surface and press ENTER; the surface will be trimmed. You can also change the settings of **Trim Tool** as required. To retain the selected part from the NURBS surface and trim the unselected part from the NURBS surface, choose **Surfaces > Edit NURBS Surfaces > Trim Tool > Option Box** from the menubar; the **Tool Settings** (**Trim Tool**) panel will be displayed on the viewport, as shown in Figure 4-3. The **Keep** radio button is used to retain the original surface after the trimming is performed. The **Discard** radio button is used to trim the selected part from the NURBS surface and keep the unselected part intact.

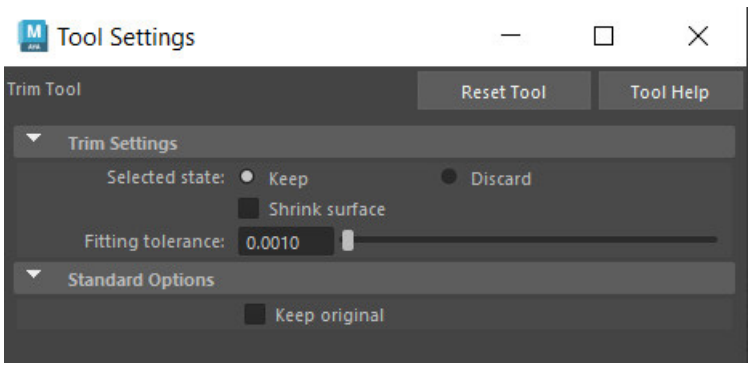

Figure 4-3 *The* ***Tool Settings (Trim Tool)*** *panel*

Untrim

Menubar: Surfaces > Edit NURBS Surfaces > Untrim

The **Untrim** tool is used to untrim the last trimmed surface. To understand the working of this tool, select the trimmed surface and choose **Surfaces > Edit NURBS Surfaces > Untrim** from the menubar; the surface sets back to its original untrimmed state.

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Attach

Menubar: Surfaces > Edit NURBS Surfaces > Attach

The **Attach** tool is used to attach two selected NURBS surfaces. To understand the working of this tool, create two NURBS surfaces in the viewport. Next, select the two surfaces and choose **Surface > Edit NURBS Surfaces > Attach > Option Box** from the menubar; the **Attach Surfaces Options** window will be displayed. By default, the **Blend** radio button is selected in the **Attach method** area. Choose the **Apply** button; the selected surfaces will be connected, as shown in Figure 4-4. You can also select the **Connect** radio button from the **Attach** method area to connect the end of a surface to the end of another surface.



Note

*The **Attach Surfaces** tool does not attach trimmed surfaces. In such cases, surfaces need to be untrimmed before attaching them using this tool.*

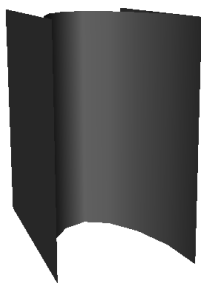

***Figure 4-4** Surfaces connected on selecting the **Blend** radio button*



Tip

*You can make changes in the attached surfaces by using the **attachSurface1** tab in the **Attribute Editor**. To do so, choose **Window > Editors > General Editors > Attribute Editor** from the menubar; the **Attribute Editor** will be displayed. Choose the **attachSurface#** tab from the **Attribute Editor**; the attributes of the attached surface will be displayed, as shown in Figure 4-10. You can apply different styles on the surface by using the parameters in the **Attribute Editor**.*

Insert Isoparms

Menubar: Surfaces > Edit NURBS Surfaces > Insert Isoparms

The **Insert Isoparms** tool is used to insert an isoparm on a NURBS surface. To understand the working of this tool, select a NURBS surface. Next, press and hold the right mouse button on the NURBS surface and choose **Isoparm** from the marking menu; the isoparms will be highlighted on the selected NURBS object. Now, press and hold the left mouse button on any NURBS isoparm and drag the mouse to specify the position for the new isoparm; a yellow dotted line will appear over the NURBS surface, as shown in Figure 4-5. Next, choose **Surfaces > Edit NURBS Surfaces > Insert Isoparms** from the menubar; a new isoparm will be inserted in place of the yellow dotted line.

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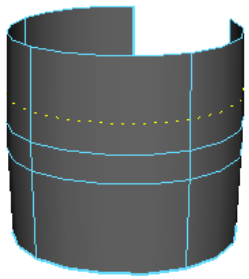

Figure 4-5 *The yellow dotted line displayed on the NURBS surface*



Tip

To create multiple isoparms, press and hold the SHIFT key over a NURBS isoparm and then drag the mouse; multiple yellow dotted lines will appear on the NURBS surface. Now, choose ***Surfaces > Edit NURBS Surfaces > Insert Isoparms*** *from the menubar; multiple isoparms will be created.*

Offset

Menubar: Surfaces > Edit NURBS Surfaces > Offset

The **Offset** tool is used to create a copy of the selected surface by creating an offset at a specified distance. To understand the working of this tool, select a NURBS surface in the viewport and then choose **Surfaces > Edit NURBS Surfaces > Offset** from the menubar; a copy of the selected NURBS surface will be created. To set the properties of the **Offset** tool, choose **Surfaces > Edit NURBS Surfaces > Offset > Option Box** from the menubar; the **Offset Surface Options** window will be displayed, as shown in Figure 4-6. The **Offset distance** attribute in the window is used to specify the distance of the copied surface from the original surface.

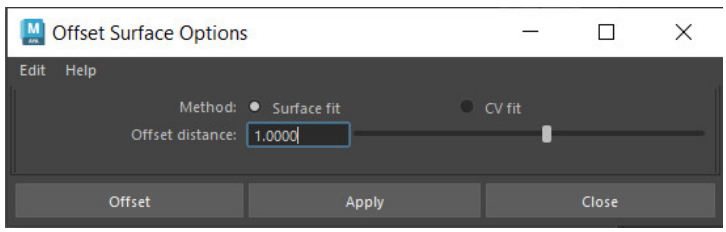

Figure 4-6 *The* ***Offset Surface Options*** *window*

Rebuild

Menubar: Surfaces > Edit NURBS Surfaces > Rebuild

The **Rebuild** tool is used to rebuild the NURBS surface by changing the parameters of the surface, or by increasing or decreasing the number of U and V spans on a selected NURBS surface. To understand the working of this tool, select the NURBS surface that you want to rebuild and choose **Surfaces > Edit NURBS Surfaces > Rebuild > Option Box** from the menubar; the **Rebuild Surface Options** window will be displayed, as shown in Figure 4-7.

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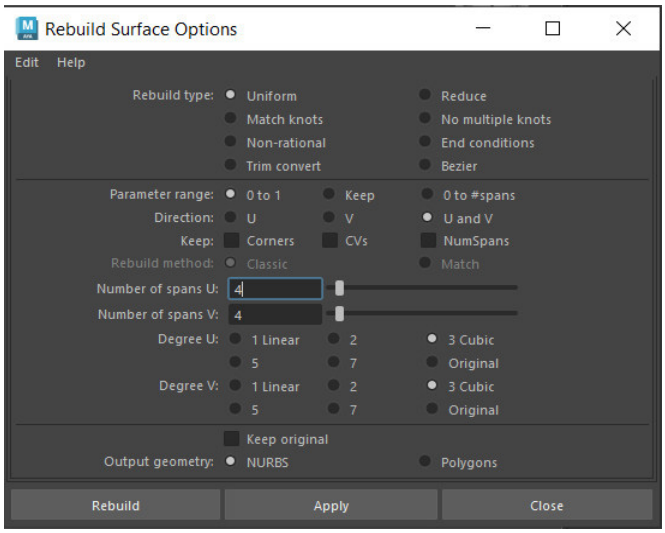

Figure 4-7 *The* ***Rebuild Surface Options*** *window*

TUTORIAL

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

Tutorial 1

In this tutorial, you will create the model of a cowboy hat, as shown in Figure 4-8, using NURBS. **(Expected time: 15 min)**



Figure 4-8 *The model of a cowboy hat*

The following steps are required to complete this tutorial:

a. Create a project folder.
b. Create a NURBS cylinder.
c. Add details to the hat.
d. Change background color of the scene.
e. Save and render the scene.

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Creating a Project Folder

Create a new project folder with the name *c04_tut1* at *\Documents\maya2025* and then save the file with the name *c04tut1*, as discussed in Tutorial 1 of Chapter 2.

Creating a NURBS Cylinder

In this section, you will create a NURBS cylinder to form the base structure of the cowboy hat.

1. Maximize the top-Y viewport and then choose **Create > Objects > NURBS Primitives > Cylinder > Option Box** from the menubar; the **NURBS Cylinder Option** window is displayed on the viewport. Set the values of the parameters, as shown in Figure 4-9.

2. Select **nurbsCylinder1** on the viewport and rename **nurbsCylinder1** to *hat*.

3. In the front-Z viewport, press and hold the right mouse button on the *hat*; a marking menu is displayed. Choose **Control Vertex** from the marking menu; the vertex selection mode is activated. Now, select the vertices, as shown in Figure 4-10. Next, invoke **Scale Tool** from the Tool Box and scale up the vertices uniformly in the front-Z viewport, as shown in Figure 4-11.

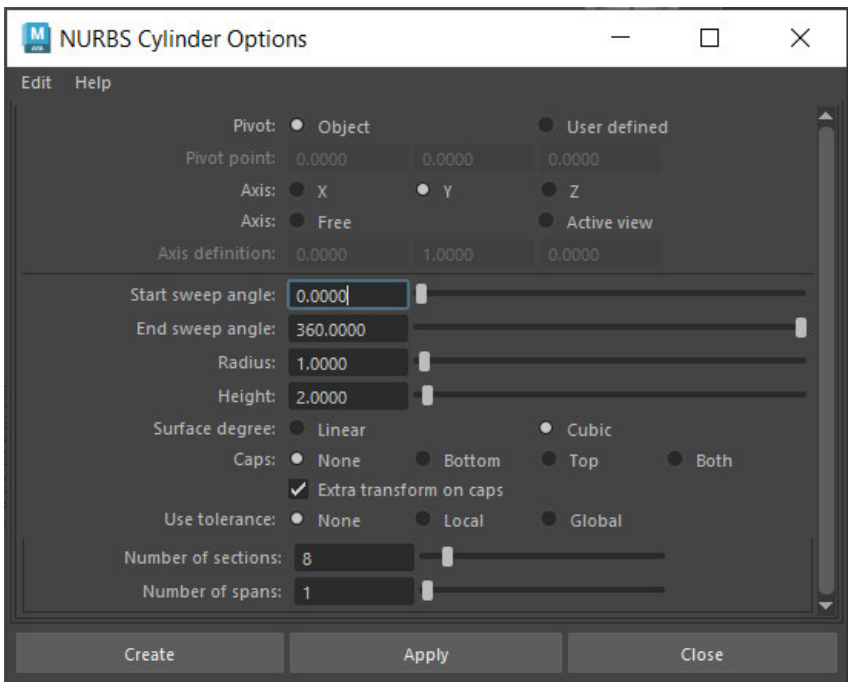

Figure 4-9 *The* ***NURBS Cylinder Options*** *window*

4. Make sure the vertices of *hat* are selected. Select the green handle of **Scale Tool** and scale the selected vertices downward along the Y-axis; the mesh gets modified, as shown in Figure 4-12

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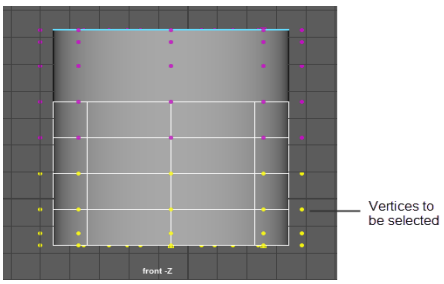

Figure 4-10 *Vertices to be selected*

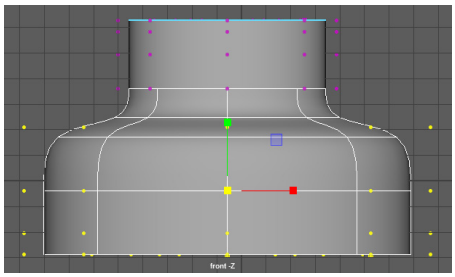

Figure 4-11 *Scaling the selected vertices uniformly*

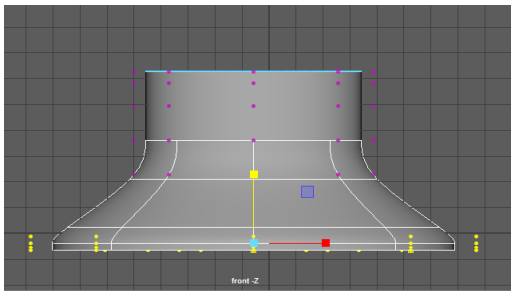

Figure 4-12 *Scaling the selected vertices along the Y axis*

Adding Details to the Hat

In this section, you will add details to the hat to give it the look of a cowboy hat.

1. Maximize the top-Y viewport. Next, press and hold the SHIFT key and marquee-select the vertices, refer to Figure 4-13. Choose **Scale Tool** from the Tool Box, and scale the selected vertices inward along the Z-axis using the yellow handle; the mesh gets scaled, as shown in Figure 4-14.

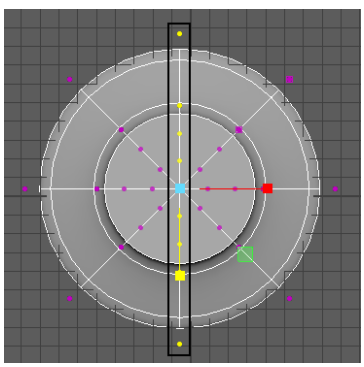

Figure 4-13 *The vertices selected*

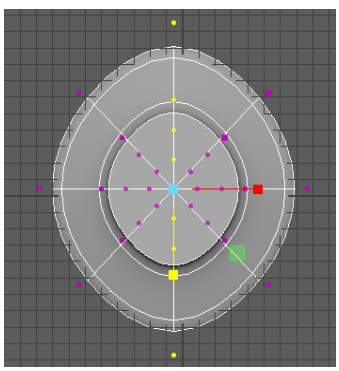

Figure 4-14 *Scaled mesh*

2. Maximize the side-X viewport. Next, marquee-select the vertices using the SHIFT key, as shown in Figure 4-15. Next, choose **Move Tool** and move the vertices downward along the Y-axis, as shown in Figure 4-16.

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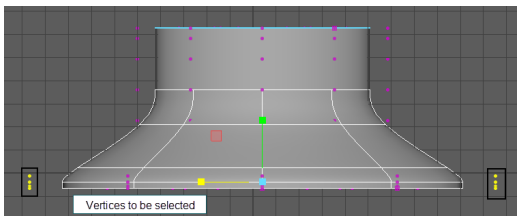

Figure 4-15 *Vertices to be selected*

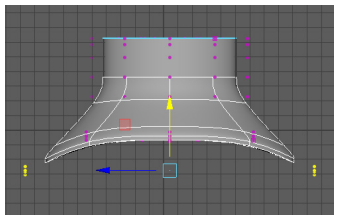

Figure 4-16 *The modified mesh after moving the vertices*

3. Maximize the persp viewport. Press and hold the right mouse button over the lower part of *hat*; a marking menu is displayed. Next, choose **Object Mode** from the marking menu; the object selection mode is activated.

4. Select the model in the persp viewport. Next, press and hold the right mouse button over the lower part of *hat* and choose **Isoparm** from the marking menu; the color of the edges of *hat* turns blue.

5. In the persp viewport, select the isoparm, as shown in Figure 4-17. Drag the isoparm outward; a dotted isoparm is displayed on *hat*. Next, choose the **Modeling** menuset from the **Menuset** drop-down list in the Status Line and then choose **Surfaces > Edit NURBS Surfaces > Insert Isoparms** from the menubar; a new isoparm is added, as shown in Figure 4-18.

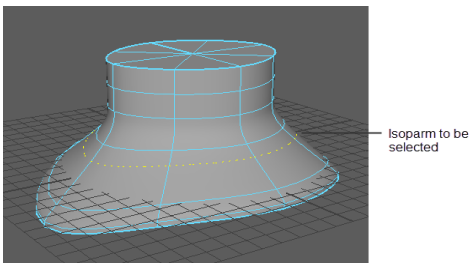

Figure 4-17 *Selecting an isoparm*

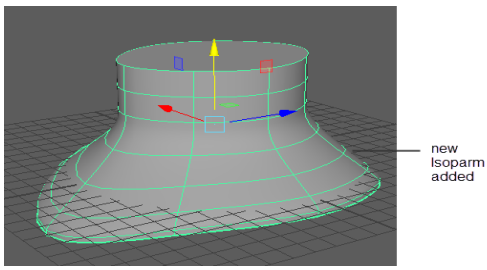

Figure 4-18 *A new isoparm added*

6. Make sure *hat* is selected. Next, choose **Edit > Delete > Delete All by Type > History** from the menubar; the history of all actions performed on the model is deleted.

7. Maximize the side-X viewport. Next, press and hold the right mouse button on *hat*; a marking menu is displayed. Choose **Control Vertex** from the marking menu; the vertex selection mode is activated. Next, marquee-select the vertices of *hat* by using the SHIFT key, as shown in Figure 4-19. Next, invoke **Move Tool** from the Tool Box, and move the vertices upward along the Y axis, as shown in Figure 4-20.

8. Press and hold the right mouse button over *hat* and choose **Object Mode** from the marking menu displayed; the object selection mode is activated. Maximize the top-Y viewport. Choose **View > Predefined Bookmarks > Bottom** from the **Panel** menu; the bottom viewport is activated.

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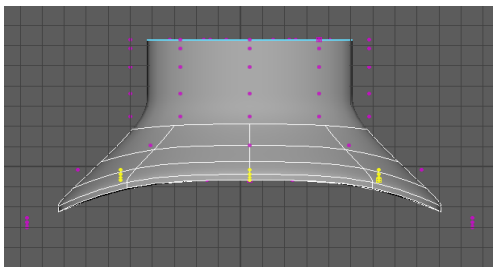

Figure 4-19 *Vertices to be selected*

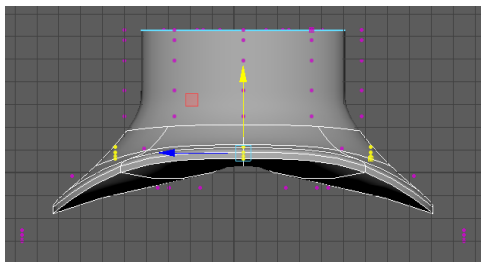

Figure 4-20 *The modified mesh*

9. Insert two new isoparms on *hat*, as discussed in steps 4 and 5. Figure 4-21 displays two isoparms added to *hat* in the bottom viewport.

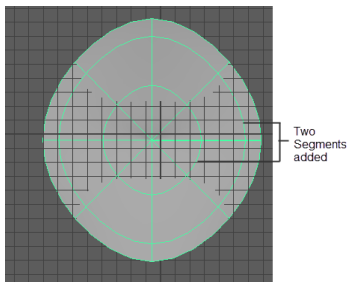

Figure 4-21 *The two new isoparms added*

10. Press and hold the right mouse button over the cylinder and choose **Control Vertex** from the marking menu displayed; the vertex selection mode is activated. Next, select the vertices using the SHIFT key, as shown in Figure 4-22.

11. Choose **View > Predefined Bookmarks > Right Side** from the **Panel** menu; the right side-X viewport is activated. Choose **Move Tool** from the Tool Box and move the selected vertices upward along the Y axis to get the final output, refer to Figure 4-23.

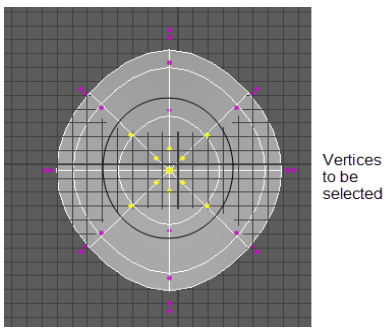

Figure 4-22 *Selecting vertices*

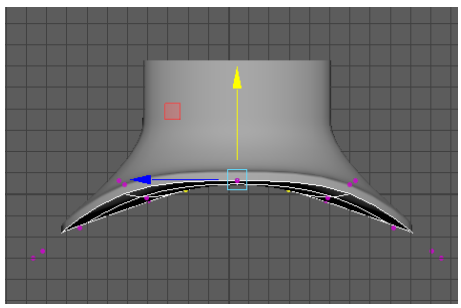

Figure 4-23 *The final output*

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Changing the Background Color of the Scene

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

1. In the **Outliner** window, click on the **persp** camera; the **perspShape** tab is displayed in the **Attribute Editor**; the **perspShape** tab is displayed in the **Attribute Editor**.

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

Saving and Rendering the Scene

In this section, you will save the scene that you have created and then render it. You can view the final rendered image of this scene by downloading the *c04_maya_2025_rndr.zip* file from *www.cadcim.com*. The path of the file is as follows: *Textbooks > Animation and Visual Effects > Maya > Autodesk Maya 2025: A Tutorial Approach*

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

2. Maximize the persp viewport if not already maximized. Choose the **Display render setting** button from the Status Line; the **Render Settings** window is displayed. In this window, select **Maya Software** in the **Render Using** drop-down list and then close the window. Choose the **Render the current frame** button from the Status Line to render the scene, refer to Figure 4-8.

Self-Evaluation Test

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

1. What does NURBS stand for?

   (a) Non-Uniform Rectangular B-Spline (b) Non-Uniform Rational B-Spline
   (c) Normal Uniform Rational B-Spline (d) Non-Universal Rational B-Spline

2. Which tool is used to duplicate a portion of a NURBS surface?

   (a) **Attach** (b) **Duplicate NURBS Patch**
   (c) **Trim Tool** (d) **Rebuild**

3. The _____ tool is used to create a new segment at the intersection of two NURBS surfaces.

4. The _____tool is used to create a copy of the selected surface by creating an offset at a specified distance.

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5. The **Duplicate NURBS Patch** tool creates a new surface from an existing NURBS patch. (T/F)

6. The **Attach** tool can be used to attach trimmed surfaces without any additional steps. (T/F)

Review Questions

Answer the following questions:

1. Which tool allows you to specify the distance at which a copied surface is created?

   (a) **Offset** (b) **Insert Isoparms**
   (c) **Trim** (d) **Duplicate NURBS Patch**

2. The **Rebuild** tool is used to:

   (a) Hide parts of the NURBS surface (b) Create a copy of a surface
   (c) Increase or decrease U and V spans on a surface (d) None of these

3. The _____tool is used to attach two selected NURBS surfaces.

4. The _____ tool is used to rebuild the NURBS surface by changing its parameters or modifying the number of U and V spans.

5. The **Trim** tool removes the selected part of a surface permanently. (T/F)

6. The **Insert Isoparms** tool adds additional control lines (isoparms) to a NURBS surface. (T/F)

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EXERCISE

The rendered output of the models used in the exercise can be accessed by downloading the *c04_maya_2025_exr.zip* from *www.cadcim.com*. The path of the file is as follows: *Textbooks > Animation and Visual Effects > Maya > Autodesk Maya 2025: A Tutorial Approach*.

Exercise 1

Use various NURBS modeling techniques to create the model of a chair, as shown in Figure 4-24. **(Expected time: 30 min)**



Figure 4-24 *The model of a chair*

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Answers to Self-Evaluation Test

1. b, **2.** c, **3. Intersect**, **4. Offset**, **5.** T **6.** F

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