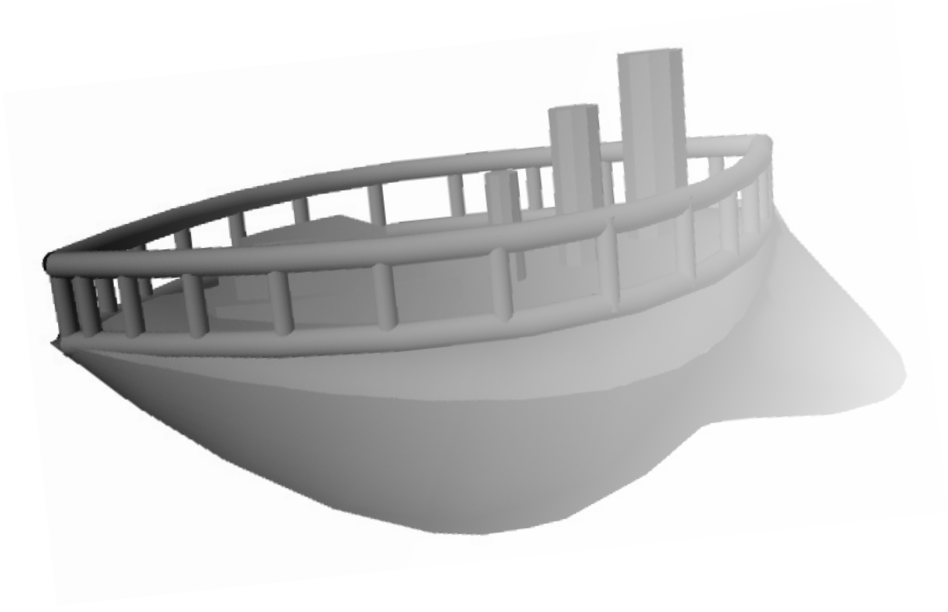
Chapter 4

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.

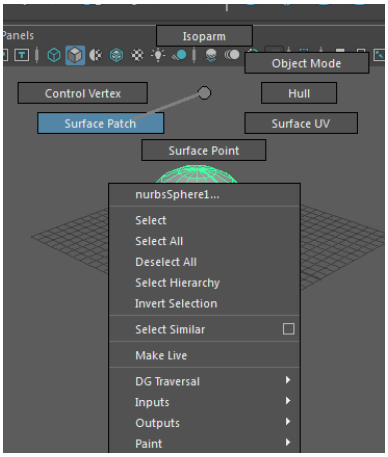


Figure 4-1 *Choosing* ***Surface Patch*** *from the marking menu*

Project Curve on Surface

Menubar: Surfaces > Edit NURBS Surfaces > Project Curve on Surface

The **Project Curve on Surface** tool is used to project a NURBS curve on a NURBS surface. To understand the working of this tool, choose **Create > Objects > NURBS Primitives > Square** from the menubar and create a square in the front-Z viewport. Now, choose **Surfaces > Create > Planar** from the menubar to create a NURBS surface. Next, choose **Create > Curve Tools > EP Curve Tool** from the menubar to create a curve, as shown in Figure 4-2 and make sure the NURBS curve is selected. Press and hold the SHIFT key and select the NURBS surface. Now, choose **Surfaces > Edit NURBS Surfaces > Project Curve on Surface** from the menubar to project the curve on the surface and activate the persp viewport; the NURBS curve will be projected over the NURBS surface, as shown in Figure 4-3.

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Note

The curve will be projected at the exact position as visible through the camera of that particular viewport.

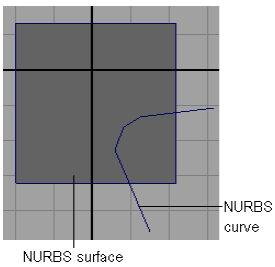

Figure 4-2 *The NURBS curve created*

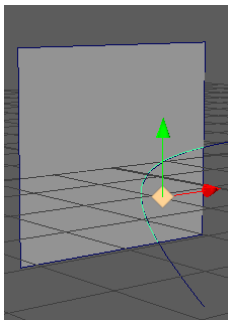

Figure 4-3 *The NURBS curve projected on the NURBS surface*

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 4-4. You can now move these handles to align the intersection point anywhere on the NURBS surface.

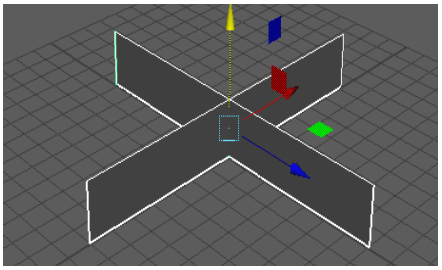

Figure 4-4 *The aligned surfaces and selection handles*

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 4-5. 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.

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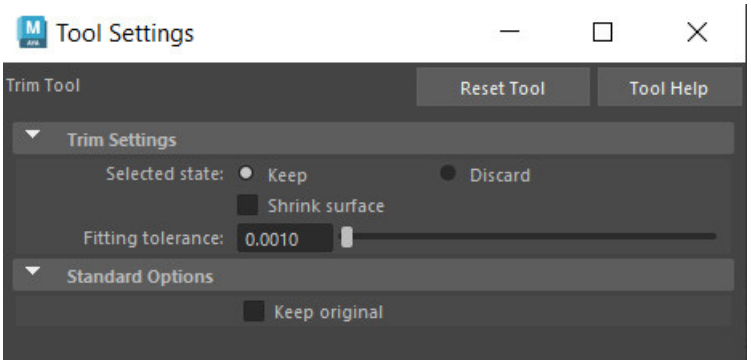

Figure 4-5 *The* ***Tool Settings (Trim Tool)*** *panel*

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.

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, as shown in Figure 4-6. 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, as shown in Figure 4-7. 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 4-8. 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, as shown in Figure 4-9.

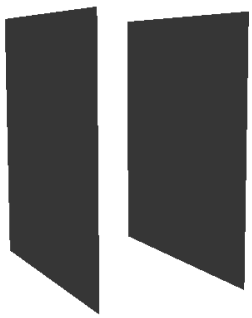

Figure 4-6 *The two NURBS surfaces*

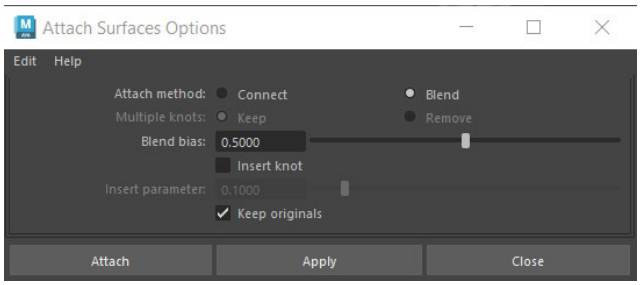

Figure 4-7 *The* ***Attach Surfaces Options*** *window*

Note

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

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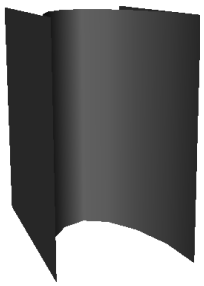

Figure 4-8 *Surfaces connected on selecting the* ***Blend*** *radio button*

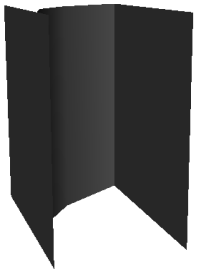

Figure 4-9 *The surfaces connected on selecting the* ***Connect*** *radio button*

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****.*

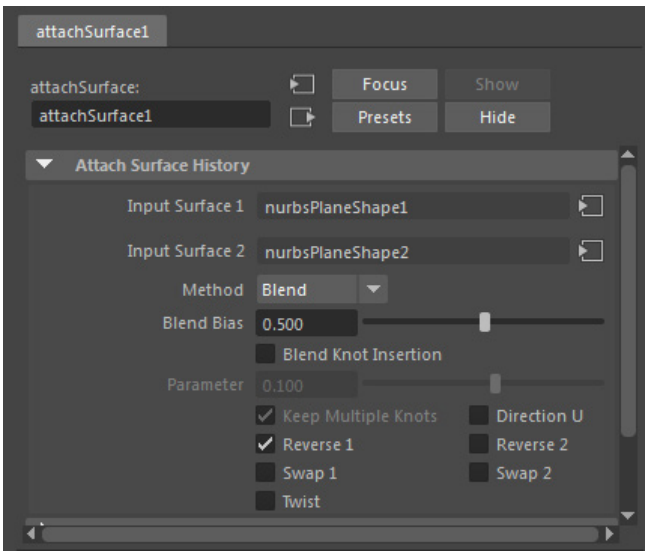

Figure 4-10 *The* ***attachSurface1*** *tab in the* ***Attribute Editor***

Attach Without Moving

Menubar: Surfaces > Edit NURBS Surfaces > Attach Without Moving

The **Attach Without Moving** tool is used to attach two NURBS surfaces or curves by selecting their respective isoparms. To understand the working of this tool, create two NURBS surfaces

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and select two isoparms, one each from the two surfaces. Now, choose **Surfaces > Edit NURBS Surfaces > Attach Without Moving** from the menubar; the two surfaces will be attached along with the two isoparms.

Align

Menubar: Surfaces > Edit NURBS Surfaces > Align

The **Align** tool is used to align the selected NURBS surfaces tangentially. To understand the working of this tool, select the NURBS surfaces that you want to align. Choose **Surfaces > Edit NURBS Surfaces > Align > Option Box** from the menubar; the **Align Surfaces Options** window will be displayed, as shown in Figure 4-11. Now, you can use different options in this window to align the selected NURBS surfaces as required.

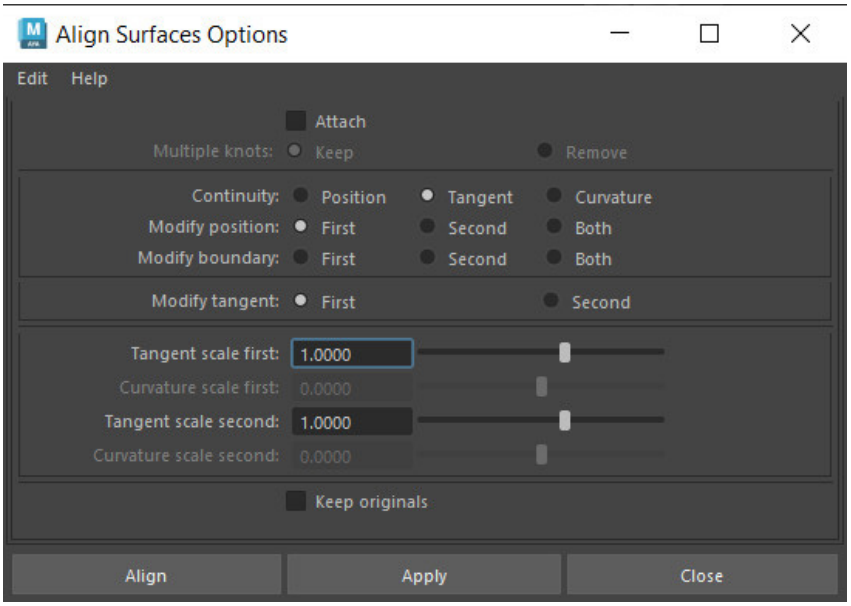

Figure 4-11 *The* ***Align Surfaces Options*** *window*

Detach

Menubar: Surfaces > Edit NURBS Surfaces > Detach

The **Detach** tool is used to break NURBS surfaces into parts. To understand the working of this tool, select the isoparm of a surface and then choose **Surfaces > Edit NURBS Surfaces > Detach** from the menubar; the surface will get detached from the selected isoparm.

Open/Close

Menubar: Surfaces > Edit NURBS Surfaces > Open/Close

The **Open/Close** tool is used to open or close the NURBS surfaces. To open a closed surface, select the closed surface and choose **Surfaces > Edit NURBS Surfaces > Open/Close** from the menubar; the closed surface will be opened, as shown in Figure 4-12. Similarly, to close an

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open surface, select the opened surface in the viewport and choose **Surfaces > Edit NURBS Surfaces > Open/Close** from the menubar; the opened surface will change into a closed surface, as shown in Figure 4-13.

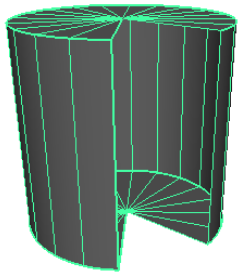

Figure 4-12 *The opened NURBS surface*

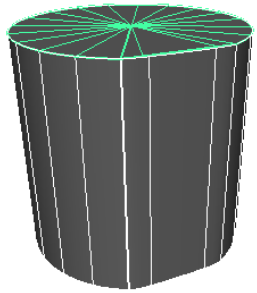

Figure 4-13 *The closed NURBS surface*

Extend

Menubar: Surfaces > Edit NURBS Surfaces > Extend

The **Extend** tool is used to extend a NURBS surface. To extend a NURBS surface, select a NURBS surface in the viewport. Then, press and hold the right mouse button on the NURBS surface and choose **Isoparm** from the marking menu displayed. Now, select the isoparm that you want to extend from the NURBS surface and choose **Surfaces > Edit NURBS Surfaces > Extend** from the menubar; the selected surface will be extended. To set the attributes of the extended surface, choose **Surfaces > Edit NURBS Surfaces > Extend > Option Box** from the menubar; the **Extend Surface Options** window will be displayed, as shown in Figure 4-14. Modify the values in the window to make changes in the working of the **Extend** tool. Figures 4-15 and 4-16 display a hut roof before and after using the **Extend** tool, respectively. Any change made in the original surface will also be displayed in the offset surface created.

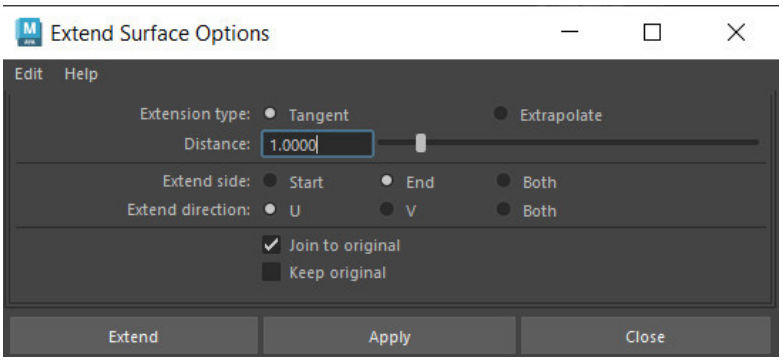

Figure 4-14 *The **Extend Surface Options** window*

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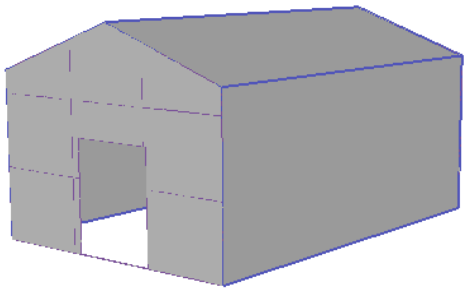

*Figure 4-15 The hut roof before using the **Extend Surfaces** tool*

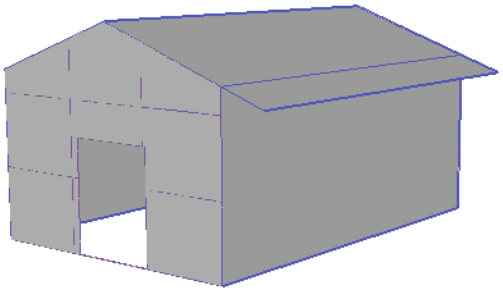

*Figure 4-16 The hut roof after using the **Extend Surfaces** tool*

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 4-17. Next, choose **Surfaces > Edit NURBS Surfaces > Insert Isoparms** from the menubar; a new isoparm will be inserted in place of the yellow dotted line.

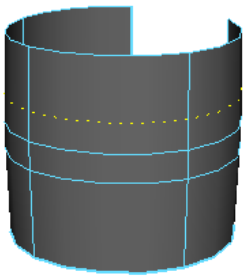

Figure 4-17 The yellow dotted line displayed on the NURBS surface



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 4-18. The **Offset distance** attribute in the window is used to specify the distance of the copied surface from the original surface.

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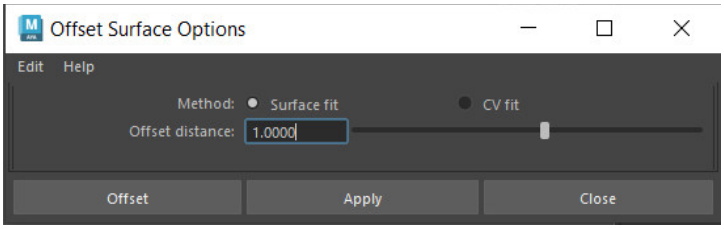

*Figure 4-18 The **Offset Surface Options** window*

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 4-19. The options in this window are discussed next.

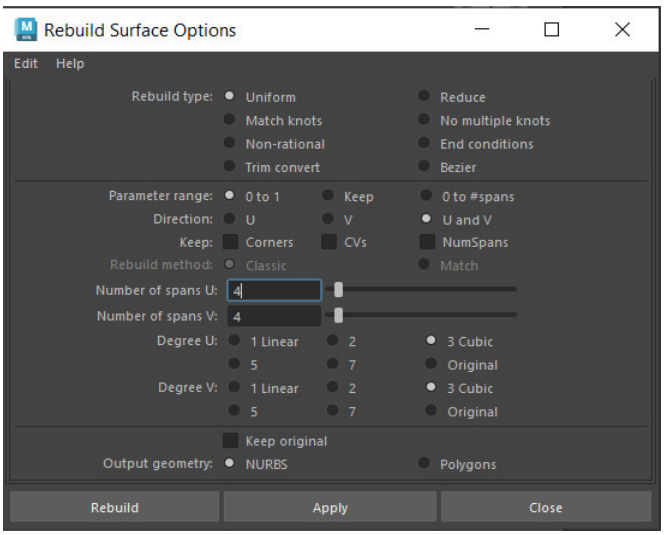

*Figure 4-19 The **Rebuild Surface Options** window*

Rebuild type

The radio buttons corresponding to the **Rebuild type** attribute are used to select the rebuild type. On selecting a rebuild type, various options related to it are displayed in the window. Various rebuild types are discussed next. You need to specify the **Rebuild type** attribute by selecting any of the following radio buttons:

Uniform

The **Uniform** radio button is used to rebuild the surface with uniform parameterization. On selecting this radio button, you can modify the number of U and V spans and their degree as required.

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Reduce

The **Reduce** radio button is used to remove the knots from the selected NURBS surface.

Match knots

The **Match knots** radio button is used to match the curve degree, knot values, number of spans, and sections of other surfaces.

No multiple knots

The **No multiple knots** radio button is used to remove the extra knots formed while rebuilding a surface.

Non-rational

The **Non-rational** radio button is used to convert a rational surface into a non-rational surface.

End conditions

The **End conditions** radio button is used to rebuild the positioning of the CVs and knots of the selected NURBS surface.

Trim convert

The **Trim convert** radio button is used to convert a trimmed NURBS surface into a non-trim NURBS surface.

Bezier

The **Bezier** radio button is used to rebuild a NURBS surface as a bezier surface.

Parameter range

The radio buttons in the **Parameter range** attribute are used to specify how the U and V parameters will be affected while rebuilding a surface. These three radio buttons are discussed next.

0 to 1

The **0 to 1** radio button is used to specify the U and V parameters from 0 to 1 of the rebuild surface.

Keep

The **Keep** radio button is used to match the U and V parameters with that of the original surface.

0 to #spans

The **0 to #spans** radio button is used to get the rebuild surface spans to have integers knot values.

Direction

The radio buttons in this area are used to determine the parametric direction of the surface for removing the knots in the **U**, **V**, or both **U** and **V** directions.

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Keep
The **Keep** attribute is used to ensure that some particular characteristics of the original object or surface are retained while creating a new surface. Select the **Corners**, **CVs** or **NumSpans** radio button to retain the corresponding characteristics.

Rebuild Method
The **Rebuild Method** radio buttons are activated only when the **Match Knots** radio button is selected from the **Rebuild type** parameter. The radio buttons in this area are used to rebuild the surface by specifying the quality of the new surface. Select the **Classic** radio button to get the surface quality similar to that obtained with the version 5.0 and earlier versions of Maya. Select the **Match** radio button to get a better quality for surfaces having multiple knots at the end.

Number of spans U and Number of spans V
The **Number of spans U** and **Number of spans V** options are used to set the number of spans in the U and V directions of the rebuilt surface respectively.

Degree U and Degree V
The **Degree U** and **Degree V** attributes are used to set the degree of the rebuilt surface.

Keep original
The **Keep original** check box is used to keep the original surface and rebuild a new surface.

Use tolerance
The **Use tolerance** area will be available only on selecting the **Non-Rational** or **Reduce** radio button in the **Rebuild type** area. The radio buttons in this area are used to set the distance between a point on the original and rebuilt surfaces. The **Global** radio button is used to set the positional value as the original value. The **Local** radio button is used to enter the tolerance value manually. The smaller the tolerance value, the more the rebuild surface will resemble the original surface.

Output geometry
The **Output geometry** attribute is used to specify the geometry type for the rebuilt surface. You can select the **NURBS** or **Polygons** radio button to specify the output geometry.

Reverse Direction

Menubar: Surfaces > Edit NURBS Surfaces > Reverse Direction

The **Reverse Direction** tool is used to reverse or swap the U and V directions of a selected surface. To understand the working of this tool, select a NURBS surface in the viewport and then choose **Surfaces > Edit NURBS Surfaces > Reverse Direction > Option Box** from the menubar; the **Reverse Surface Direction Options** window will be displayed, as shown in Figure 4-20. Select the required radio button from the **Surface direction** area of this window and then choose the **Reverse** button to reverse or swap the surface direction.

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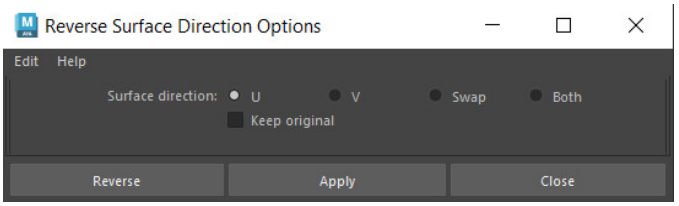

*Figure 4-20 The **Reverse Surface Direction Options** window*

Sculpt Geometry Tool

Menubar: Surfaces > Edit NURBS Surfaces > Sculpt Geometry Tool

The **Sculpt Geometry** is used to sculpt a NURBS or polygon object manually in the viewport. On invoking this tool, the cursor will change into a brush icon. To sculpt an object, select the NURBS surface in the viewport and choose **Surfaces > Edit NURBS Surfaces > Sculpt Geometry Tool > Option Box** from the menubar; the **Tool Settings (Sculpt Geometry Tool)** panel will be displayed on the viewport, as shown in Figure 4-21.

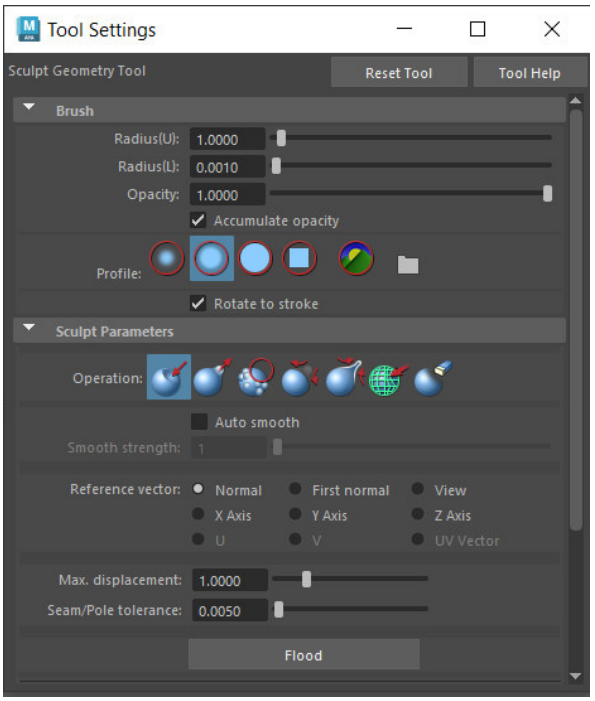

*Figure 4-21 Partial view of the **Tool Settings (Sculpt Geometry Tool)** panel*

The more the number of segments on an object, the better sculpting can be done on it using the **Sculpt Geometry Tool**. You can sculpt an object using seven different options: **Push**, **Pull**, **Smooth**, **Relax**, **Pinch**, **Slide** and **Erase**. All these methods are discussed next.

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Push



The **Push** option is used to push down the selected NURBS mesh. To do so, consider a NURBS plane in the viewport. Next, choose **Surfaces > Edit NURBS Surfaces > Sculpt Geometry Tool > Option Box** from the menubar; the **Tool Settings (Sculpt Geometry Tool)** panel will be displayed on the viewport, refer to Figure 4-21. Choose the **Push** button in the **Sculpt Parameters** area; the cursor will be displayed, as shown in Figure 4-22. Press and hold the left mouse button and move the cursor over the NURBS plane to sculpt the NURBS plane. Figure 4-23 shows a NURBS plane before sculpting and Figure 4-24 shows the NURBS plane sculpted using the **Push** tool.

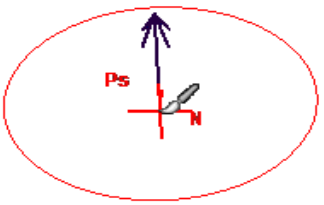

Figure 4-22 *The* ***Sculpt Geometry Tool*** *cursor*

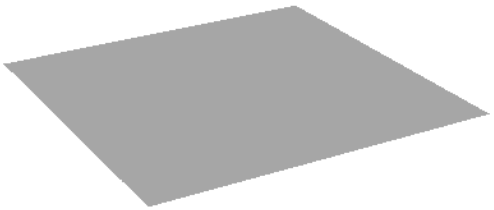

Figure 4-23 *The NURBS plane before sculpting*

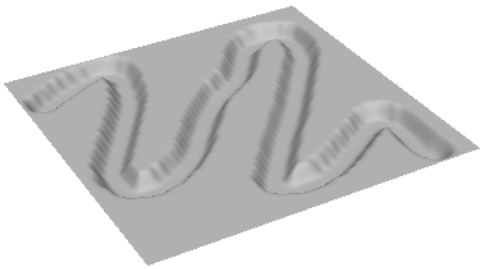

Figure 4-24 *The NURBS plane sculpted using the* ***Push*** *tool*

Pull



The **Pull** tool is used to pull the NURBS mesh from the surface. This tool works similar to the **Push** tool and the method to apply it on a NURBS plane is same as that of the **Push** tool. Figure 4-25 shows a NURBS plane sculpted using the **Pull** tool.

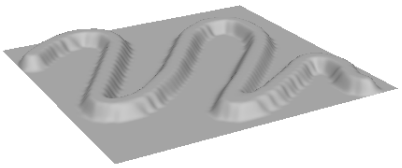

Figure 4-25 *The NURBS plane sculpted using the* ***Pull*** *tool*

Smooth



The **Smooth** tool is used to paint on a mesh to give it a smoother look. To use this tool, follow the same procedure as discussed in the **Push** tool and choose the **Smooth** button from the **Sculpt Parameters** area of the **Tool Settings (Sculpt Geometry Tool)** panel. Figure 4-26 shows a surface before smoothening and Figure 4-27 shows the surface after smoothening.

Relax



The **Relax** tool works similar to the **Smooth** tool. It is used to relax the bumps over the surface, thus maintaining the overall shape of the mesh.

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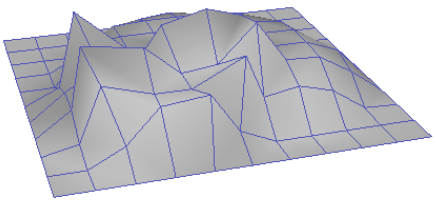

Figure 4-26 *Surface before smoothening*

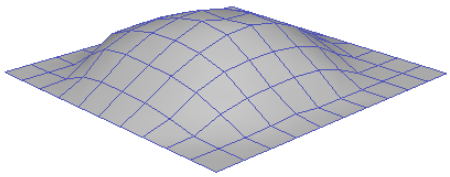

Figure 4-27 *Surface after smoothening*

Pinch



The **Pinch** tool is used to pull selected vertices toward each other. It helps in bringing the vertices closer in order to make sharp or well defined creases.

Slide



The **Slide** tool is used to slide the vertices of the surface in the direction of the stroke Figure 4-28 shows a surface before sliding the vertices and Figure 4-29 shows the surface after sliding the vertices.

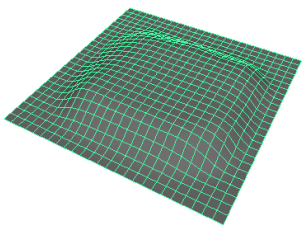

Figure 4-28 *Surface before sliding*

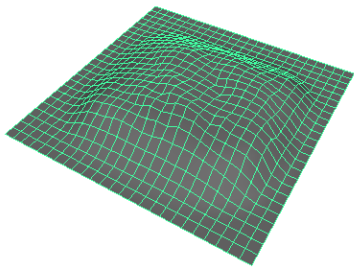

Figure 4-29 *Surface after sliding*

Erase



The **Erase** tool is used to erase the changes made on the surface by using the other **Sculpt Geometry** tools like **Push** or **Pull**. Figure 4-30 shows a surface before erasing changes on it and Figure 4-31 shows the surface after erasing changes on it.

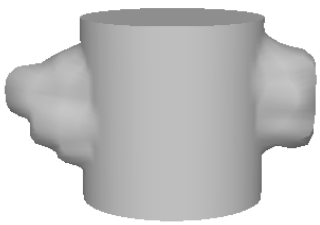

Figure 4-30 *Surface before erasing*

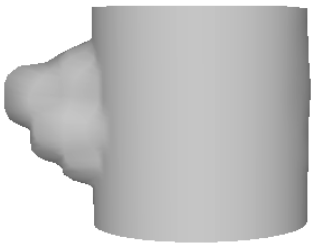

Figure 4-31 *Surface after erasing*

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CONVERTING OBJECTS

In Maya, you can convert the form of an object. To do so, select an object in the viewport and choose **Modify > Objects > Convert** from the menubar; a cascading menu will be displayed. Choose the conversion type from the cascading menu to specify the output geometry for the selected object. The most commonly used options in this cascading menu are discussed next.

Converting NURBS to Polygons

Menubar: Modify > Objects > Convert > NURBS to Polygons

The **NURBS to Polygons** conversion tool is used to convert a NURBS mesh into a polygonal object. To do so, select a NURBS mesh to be converted and then choose **Modify > Objects Convert > NURBS to Polygons > Option Box** from the menubar; the **Convert NURBS to Polygons Options** window will be displayed in the viewport, as shown in Figure 4-32. You can use this window to set the options for the conversion of the object from NURBS to polygons. Some of the options in this window are discussed next.

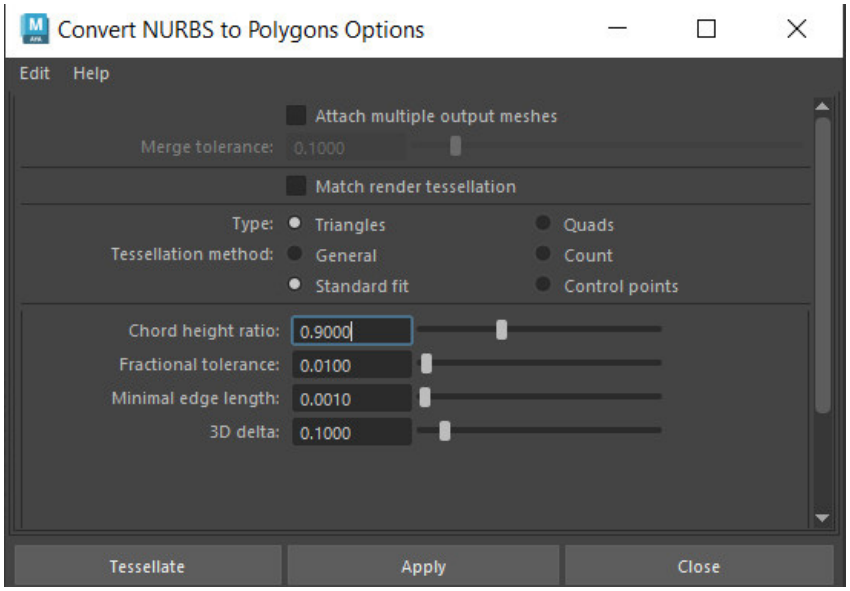

***Figure 4-32** The **Convert NURBS to Polygons Options** window*

Type

The **Type** attribute is used to set the output of the geometry after the conversion has taken place. If you select the **Triangles** radio button, then three-sided polygons will be created on the surface, as shown in Figure 4-33. If you select the **Quads** radio button, then four-sided polygons will be created on the surface, as shown in Figure 4-34.

Tessellation method

The **Tessellation method** attribute is used to convert a NURBS mesh into a set of polygons. In Maya, there are four tessellation methods that are discussed next. You can select a radio button corresponding to this parameter to specify the tessellation method to be used.

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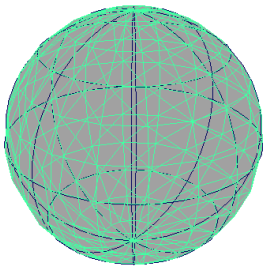

Figure 4-33 Surface created on selecting the ***Triangles*** *polygon type radio button*

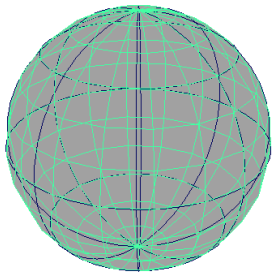

Figure 4-34 Surface created on selecting the ***Quads*** *polygon type radio button*

General

The **General** radio button is used to define the number of polygons in the U or in the V direction. On selecting this radio button, various options for setting the tessellation are displayed.

Standard fit

The **Standard fit** radio button is selected by default. This method is used to determine when to stop the tessellation by setting the fractional tolerance value. On selecting this radio button, the options related to it are displayed.

Count

The **Count** radio button is used to specify the polygon count in the mesh after the mesh has been converted into polygons. The more the count value, the smoother will be the object.

Control points

The **Control points** radio button is used to create a new mesh while matching its CVs to the original NURBS surface. The resulting polygons will be quads by default.

Converting NURBS to Subdiv

Menubar: Modify > Objects > Convert > NURBS to Subdiv

The **NURBS to Subdiv** conversion tool is used to convert a NURBS mesh into a subdiv mesh. To do so, select the NURBS object in the viewport and choose **Modify > Objects > Convert > NURBS to Subdiv > Option Box** from the menubar; the **Convert NURBS/Polygons to Subdiv Options** window will be displayed, as shown in Figure 4-35. Some of the options in the **Convert NURBS/Polygons to Subdiv Options** window are discussed next.

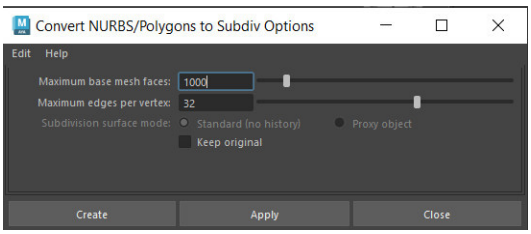

Figure 4-35 The ***Convert NURBS/Polygons to Subdiv Options*** *window*

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Maximum base mesh faces

The **Maximum base mesh faces** attribute is used to set the maximum number of faces that the original surface can have, such that it can be successfully converted into a subdivision surface.

Maximum edges per vertex

The **Maximum edges per vertex** attribute is used to set the maximum number of edges that each vertex can have in the original surface, such that it can be successfully converted into a subdivision surface.

Keep original

The **Keep original** check box is used to keep the original NURBS object mesh after creating the new subdivision surface.

TUTORIALS

Tutorial 1

In this tutorial, you will create the model of a cowboy hat, as shown in Figure 4-36, using NURBS. **(Expected time: 15 min)**



Figure 4-36 *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.

Creating a Project Folder

Create a new project folder with the name *c04_tut1* at *\Documents\maya2023* 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 4-37.

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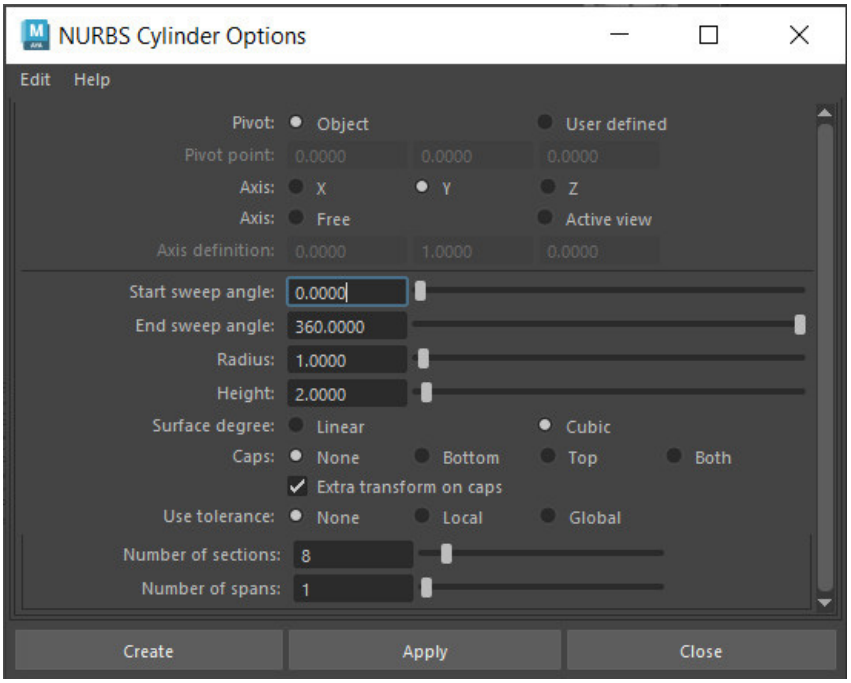

Figure 4-37 *The* ***NURBS Cylinder Options*** *window*

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 4-38. Next, invoke **Scale Tool** from the Tool Box and scale up the vertices uniformly in the front-Z viewport, as shown in Figure 4-39.

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 4-40.

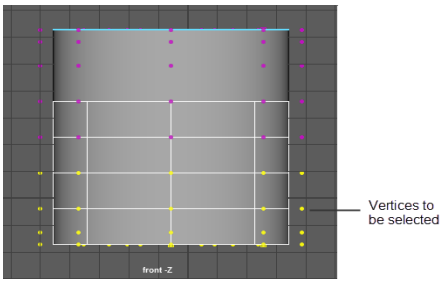

Figure 4-38 *Vertices to be selected*

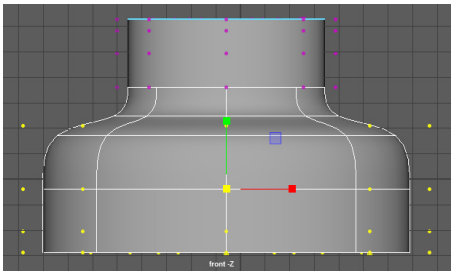

Figure 4-39 *Scaling the selected vertices uniformly*

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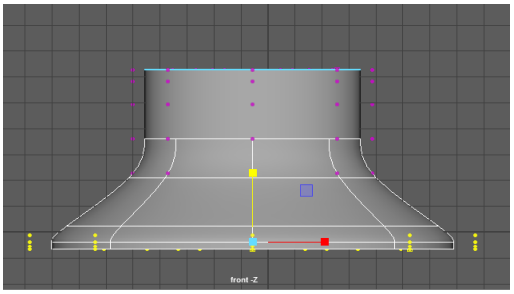

Figure 4-40 *Scaling the selected vertices along the Y axis*

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 4-41. 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 4-42.

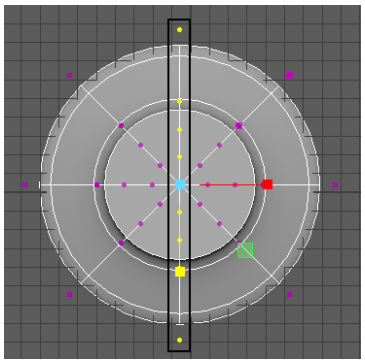

Figure 4-41 *The vertices selected*

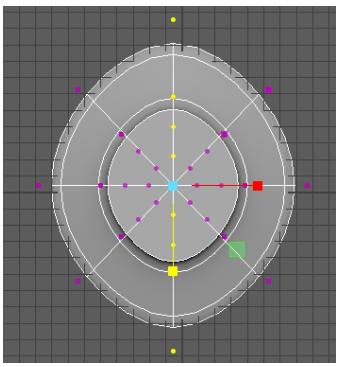

Figure 4-42 *Scaled mesh*

2. Maximize the side-X viewport. Next, marquee-select the vertices using the SHIFT key, as shown in Figure 4-43. Next, choose **Move Tool** and move the vertices downward along the Y-axis, as shown in Figure 4-44.

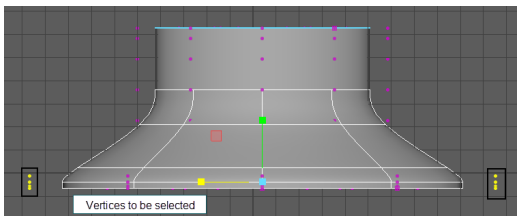

Figure 4-43 *Vertices to be selected*

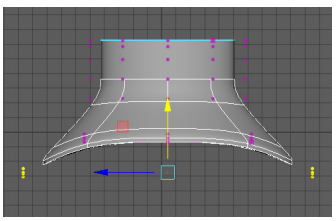

Figure 4-44 *The modified mesh after moving the vertices*

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.

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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 4-45. 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 4-46.

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 4-47. Next, invoke **Move Tool** from the Tool Box, and move the vertices upward along the Y axis, as shown in Figure 4-48.

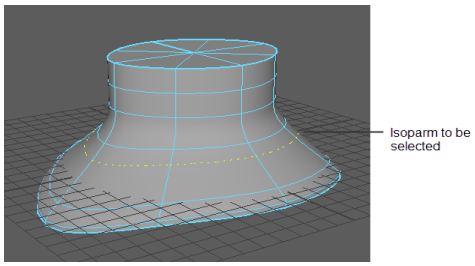

Figure 4-45 *Selecting an isoparm*

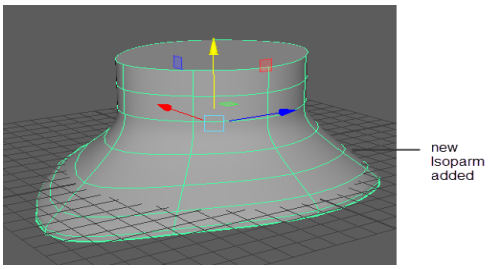

Figure 4-46 *A new isoparm added*

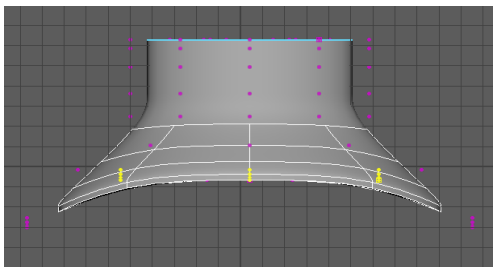

Figure 4-47 *Vertices to be selected*

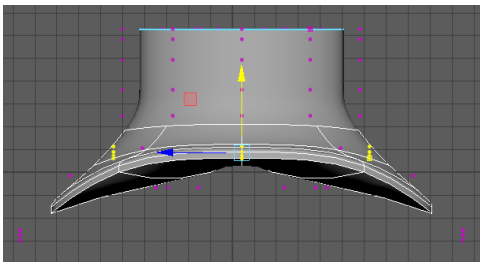

Figure 4-48 *The modified mesh*

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.

9. Insert two new isoparms on *hat*, as discussed in steps 4 and 5. Figure 4-49 displays two isoparms added to *hat* in the bottom viewport.

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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 4-50.

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 4-51.

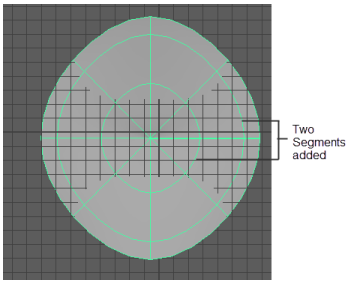

Figure 4-49 *The two new isoparms added*

Changing the Background Color of the Scene

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

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

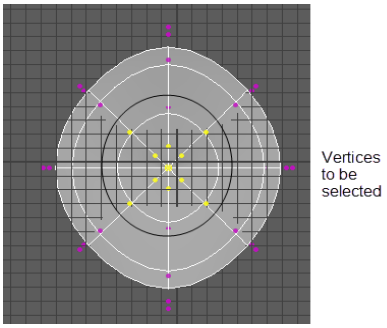

Figure 4-50 *Selecting vertices*

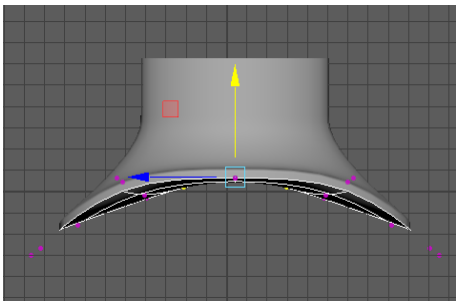

Figure 4-51 *The final output*

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_2023_rndr.zip* file from *www.cadcim.com*. The path of the file is as follows: *Textbooks > Animation and Visual Effects > Maya > Autodesk Maya 2023: A Comprehensive Guide*

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

2. Maximize the persp viewport if not already maximized. Choose the **Display render setting** button from the Status Line; the **Render Settings** window is displayed. In this window, select **Maya Software** in the **Render Using** drop-down list and then close the window. Choose the **Render the current frame** button from the Status Line to render the scene, refer to Figure 4-36.

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Tutorial 2

In this tutorial, you will create the model of a ship, as shown in Figure 4-52, using the NURBS and polygon tools. **(Expected time: 30 min)**

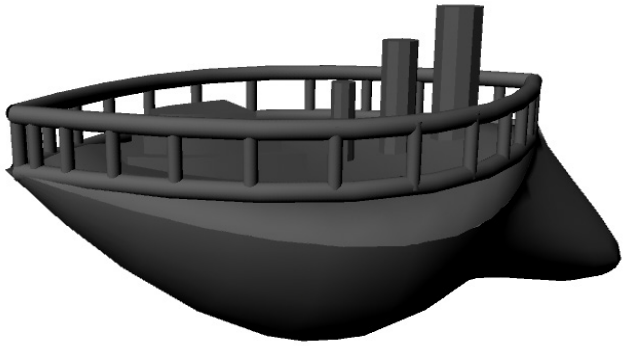

Figure 4-52 *Model of a ship*

The following steps are required to complete this tutorial:

a. Create a project folder.
b. Create the hull of the ship.
c. Create railings.
d. Create the deck.
e. Create the chimney.
f. Change the background color of the scene.
g. Save and render the scene.

Creating a Project Folder

Create a new project folder with the name *c04_tut2* at *\Documents\maya2023* and then save the file with the name *c04tut2*, as discussed in Tutorial 1 of Chapter 2.

Creating the Hull of the Ship

In this section, you will create the hull of the ship using the NURBS curves and the loft method.

1. Maximize the side-X viewport and choose **Create > Objects > Curve Tools > EP Curve Tool > Option Box** from the menubar; the **Tool Settings (EP Curve Tool)** window is displayed on the left of the viewport. In this window, select the **5** radio button from the **Curve Degree** attribute. Next, create a curve for the base of the ship in the side-X viewport, as shown in Figure 4-53.

   To get the exact shape, select the curve and right-click on it to display a marking menu. Next, choose **Control Vertex** from the marking menu; the vertex mode is activated.

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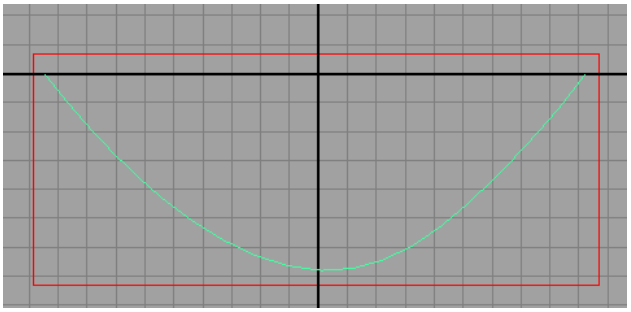

Figure 4-53 *Curve created for the base of the ship*

Now, you can select a vertex and modify the shape by using **Move Tool**.

2. Choose **Move Tool** from the Tool Box. Next, press and hold the d key and set the pivot point to the right end of the curve by moving the manipulators.

3. Make sure the curve is selected. Choose **Edit > Duplicate > Duplicate Special > Option Box** from the menubar; the **Duplicate Special Options** window is displayed, refer to Figure 4-54. Enter the values in the window, as shown in Figure 4-54, and then choose the **Duplicate Special** button; duplicate curves are created in the viewport.

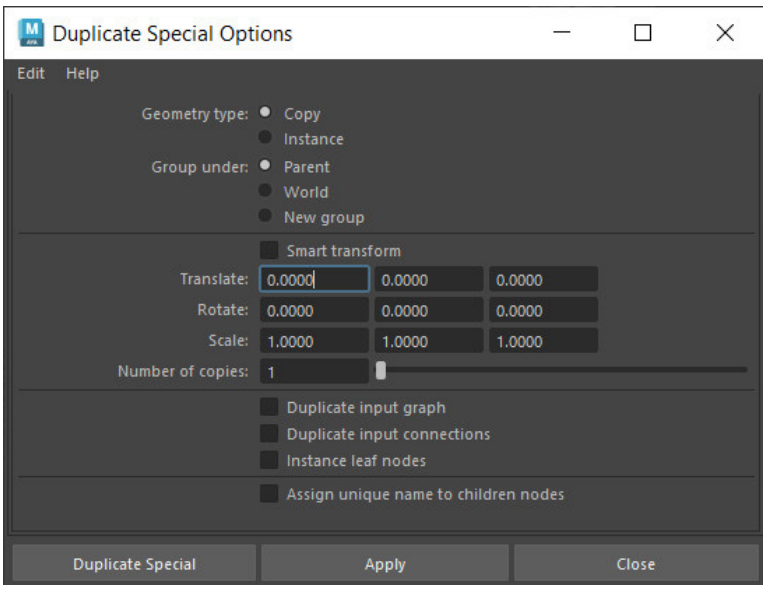

Figure 4-54 *The* ***Duplicate Special Options*** *window*

4. Select the duplicate curves one by one and rotate them along the Z axis using **Rotate Tool**, as shown in Figure 4-55.

5. Press and hold the SHIFT key and then select all the curves in the viewport one by one from bottom to top.

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6. Choose **Surfaces > Create > Loft** from the menubar; a surface is created defining half of the ship base, as shown in Figure 4-56.

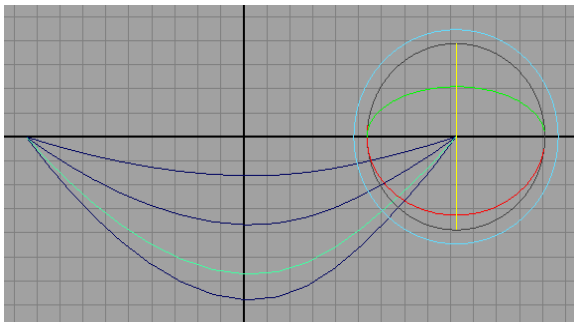

Figure 4-55 *The duplicate curve rotated*

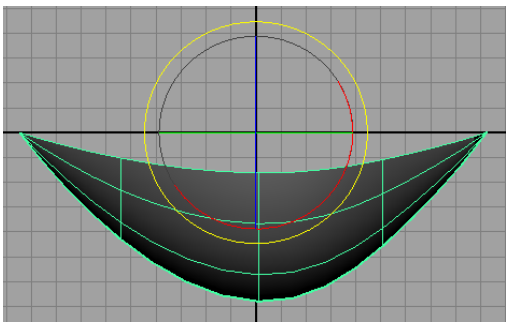

Figure 4-56 *Surface created*

7. Make sure the lofted surface is selected and then choose **Move Tool**. Next, press and hold the D key and set the pivot point to the right end of the surface by moving the manipulators.

8. Choose **Window > Editors > Outliner** from the menubar; the **Outliner** window is displayed. In the **Outliner** window, select all the curves by using the SHIFT key. Next, choose **Display > Object > Hide > Hide Selection** from the menubar; the selected curves are hidden. Close the **Outliner** window.

9. In the side-X viewport, select the NURBS surface. Now, choose **Surfaces > Edit NURBS Surfaces > Rebuild > Option Box** from the menubar; the **Rebuild Surface Options** window is displayed. Set the parameters in this window, as shown in Figure 4-57, and then choose the **Rebuild** button; the selected surface is rebuilt.

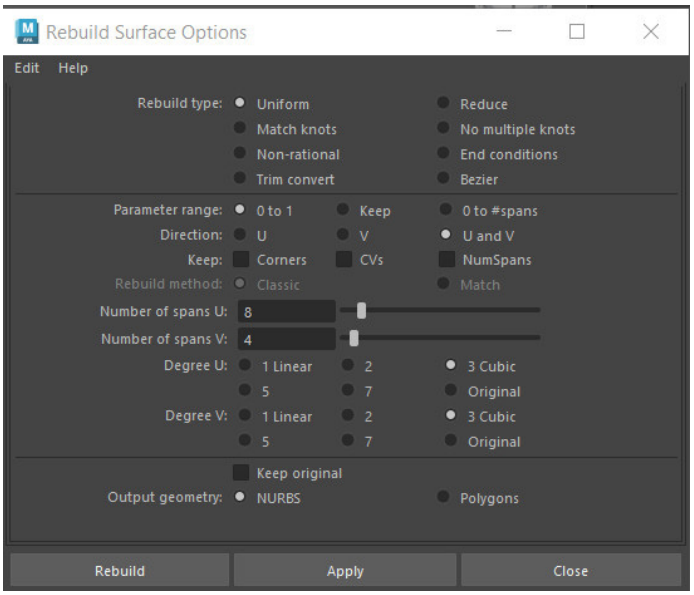

Figure 4-57 *The* ***Rebuild Surface Options*** *window*

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10. Make sure the rebuilt surface is selected. Next, press and hold the right mouse button over it and choose **Control Vertex** from the marking menu displayed; the vertex selection mode is activated. Next, marquee-select the vertices using the SHIFT key, as shown in Figure 4-58. Move the vertices downward to create tail of the ship, as shown in Figure 4-59.

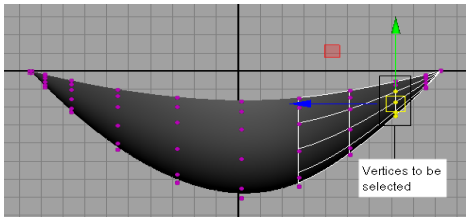

Figure 4-58 *Selecting vertices*

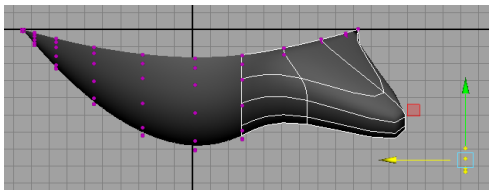

Figure 4-59 *Vertices moved downward to create the tail of the ship*

11. Maximize the persp viewport. Press and hold the right mouse button; a marking menu is displayed. Choose **Object Mode** from the marking menu; the object selection mode is activated. Select the surface of the ship and choose **Edit > Duplicate > Duplicate Special > Option Box** from the menubar to create a copy of the half part of the ship; the **Duplicate Special Options** window is displayed. In this window, select the **Copy** radio button and make sure **-1** is entered in the first **Scale** edit box and enter **1** in the **Number of copies** edit box.

    Next, choose the **Duplicate Special** button; a copy of the selected surface is created in the persp viewport, refer to Figure 4-60.

12. Make sure the copy of the surface is selected. Next, choose **Curves > Reverse Direction** from the menubar; the curve direction of the selected surface is reversed, as shown in Figure 4-60.

13. Make sure that one of the surfaces is selected. Press and hold the right mouse button over the surface; a marking menu is displayed. Choose **Isoparm** from the marking menu; the isoparm selection mode is activated.

14. Press and hold the right mouse button over another surface; a marking menu is displayed. Choose **Isoparm** from the marking menu; the isoparm selection mode is activated. Next, press SHIFT and select the topmost isoparm of both the surfaces, as shown in Figure 4-61. Next, choose **Surfaces > Create > Loft** from the menubar; a surface is created between the selected isoparms.

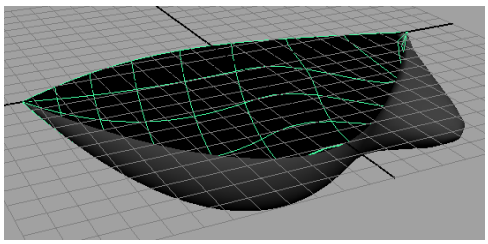

Figure 4-60 *The duplicate surface created*

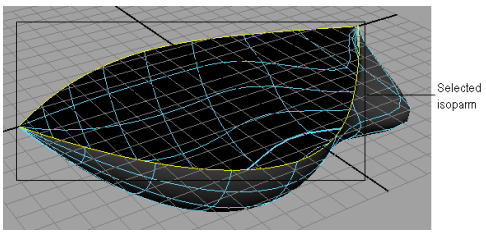

Figure 4-61 *The two selected isoparms*

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15. Make sure the newly created surface is selected and choose **Surfaces > Edit NURBS Surfaces > Rebuild > Option Box** from the menubar; the **Rebuild Surfaces Options** window is displayed. In this window, make sure **8** is entered in the **Number of spans U** edit box. Next, choose the **Rebuild** button; the newly created surface is rebuilt.

16. Maximize the top-Y viewport and press and hold the right mouse button on the selected surface; a marking menu is displayed. Choose **Isoparm** from the marking menu displayed and insert the two isoparms using the SHIFT key, as shown in Figure 4-62. Now, choose **Surfaces > Edit NURBS Surfaces > Insert Isoparms** from the menubar; two new isoparms are added to the surface.

17. Maximize the side-X viewport. Invoke **Move Tool** and move the newly created surface up along the Y axis.

18. In the side-X viewport, press and hold the right mouse button over the newly created surface; a marking menu is displayed. Choose **Control Vertex** from the marking menu; the vertex selection mode is activated. Select all the vertices of the newly created surface. Next, maximize the top-Y viewport and deselect the center vertices by pressing the SHIFT key and select all the corner vertices, as shown in Figure 4-63.

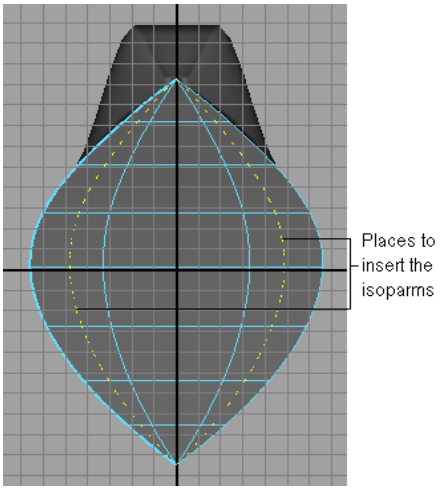

Figure 4-62 *Inserting isoparms*

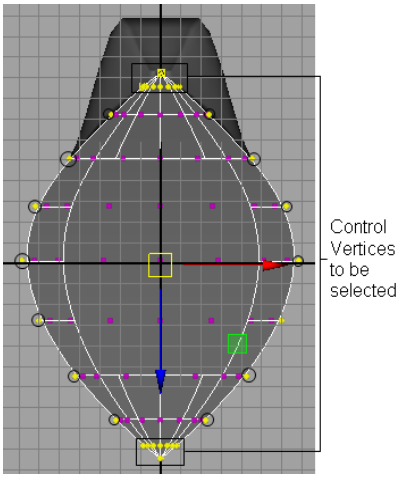

Figure 4-63 *The vertices selected*

19. Maximize the persp viewport and then choose **Move Tool** from the Tool Box and move the selected vertices downward along the Y axis, as shown in Figure 4-64.

Creating Railings

In this section, you will create railings for the ship by using the NURBS cylinder and then align the cylinders on a curve.

1. Maximize the top-Y viewport. Choose **Create > Objects > Curve Tools > EP Curve Tool** from the menubar and create a curve, refer to Figure 4-65. Now, move the curve using **Move Tool**. Figure 4-65 displays the position of the NURBS curve in all viewports.

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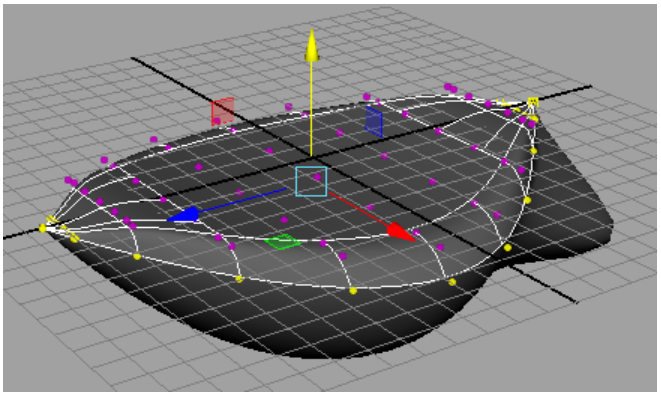

Figure 4-64 *Moving the vertices along the Y axis*

2. Maximize the persp viewport and choose **Create > Objects > NURBS Primitives > Cylinder** from the menubar and create a cylinder in the viewport. Next, select the upper cap of the cylinder and delete it. Similarly, delete the lower cap of the cylinder.

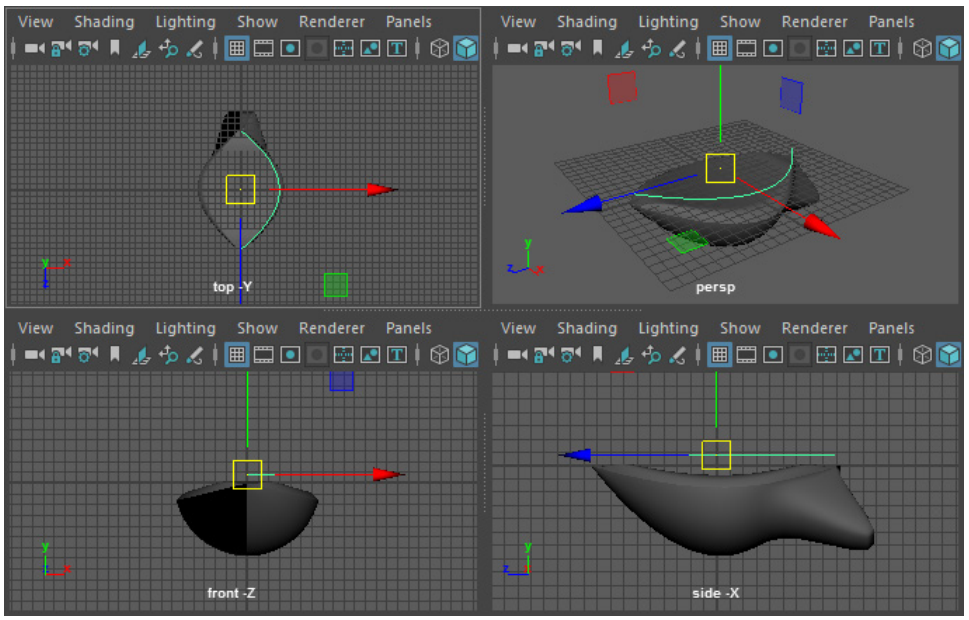

Figure 4-65 *The NURBS curve aligned in all viewports*

3. Select the cylinder. In **Channel Box / Layer Editor**, expand **makeNurbCylinder1** node in the **INPUTS** area and set the following parameters of the cylinder:

   Radius: **0.2** Sections: **10** Height Ratio: **10**

4. Select the **Animation** menuset from the **Menuset** drop-down list in the Status Line. Next, select the curve and then press and hold the SHIFT key and select the cylinder. Choose **Constrain > Motion Paths > Attach to Motion Path > Option Box** from the menubar; the **Attach to Motion Path Options** window is displayed in the viewport.

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5. In this window, choose **Start/End** radio button in the **Time range** attribute and make sure **30** is entered in the **End Time** edit box. Next, choose the **Attach** button; the cylinder gets attached to the curve.

6. Choose **Visualize > Snapshot > Create Animation Snapshot > Option Box** from the menubar; the **Animation Snapshot Options** window is displayed in the viewport. Enter **30** in the **End Time** edit box, **2** in the **Increment** edit box, and then choose the **Snapshot** button; the cylinders are aligned on the curve surface, as shown in Figure 4-66.

Note

*The value in the **End Time** edit box may vary depending on the size of the NURBS surface created.*

7. Maximize the front-Z viewport and choose **Create > Objects > NURBS Primitives > Circle** from the menubar and create a circle on the curve in the viewport, refer to Figure 4-67. Make sure the circle is selected in the front-Z viewport. In the **Channel Box / Layer Editor**, enter **90** in the **Rotate X** and **-38** in the **Rotate Y** edit boxes. Next, expand **makeNurbCircle1** node in the **INPUTS** area of the **Channel Box / Layer Editor** and set the radius of the circle to **0.3**.

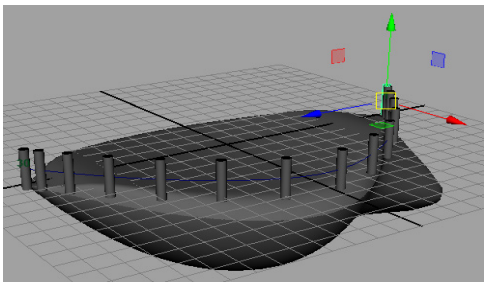

Figure 4-66 *The cylinders aligned on the curve surface*

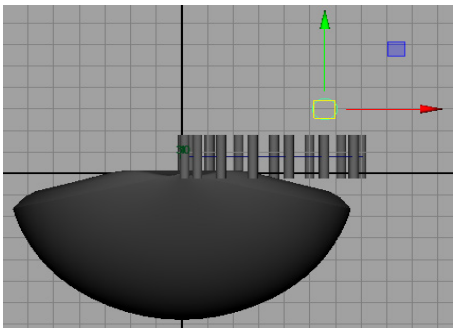

Figure 4-67 *The handrail created*

8. Select the **Modeling** menuset from the **Menuset** drop-down list in the Status Line. Now, select the circle and then the curve from the viewport. Choose **Surfaces > Extrude > Option Box** from the menubar; the **Extrude Options** window is displayed. In this window, make sure the **Tube** radio button corresponding to the **Style** attribute is selected. Also, select the **At path** radio button corresponding to the **Result position** attribute and **Component** radio button corresponding to the **Pivot** attribute. Next, choose the **Extrude** button; the circle is extruded and the handrail is created, refer to Figure 4-68.

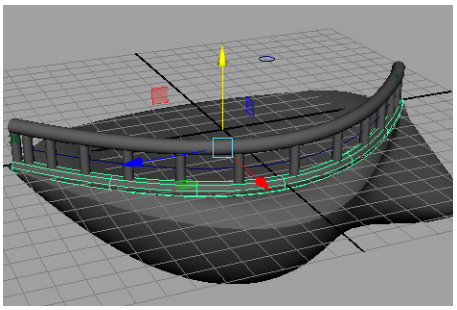

Figure 4-68 *The handrail aligned*

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9. Maximize the persp viewport. Next, invoke the **Move Tool** and move the handrail up along the Y axis to align it, refer to Figure 4-68. Now, press CTRL+D; a copy of handrail is created and then align it using **Move Tool**, as shown in Figure 4-68.

10. Choose **Windows > Editors > Outliner** from the menubar; the **Outliner** window is displayed. In the **Outliner** window, select the **curve5** and the **nurbsCircle1** curve; the nurb circle and the handrail curve is selected in the viewport. Next, choose **Display > Object > Hide > Hide Selection** from the menubar to hide the selected curves.

11. Select the complete railing and press CTRL+G; the selected railing is grouped. Choose **Edit > Delete > Delete by Type > History** from the menubar; the history of the surfaces created earlier is deleted. Next, choose **Modify > Transform > Freeze Transformations** from the menubar and then press D to set pivot at the center of the ship if not at the center.

12. Make sure the complete railing is selected and choose **Edit > Duplicate > Duplicate Special** from the menubar; a copy of the railings is created and gets placed on the other half of the ship. Next, choose **Curves > Edit >Reverse Direction** from the menubar; the curve direction of the copied railing surface is reversed, as shown in Figure 4-69.

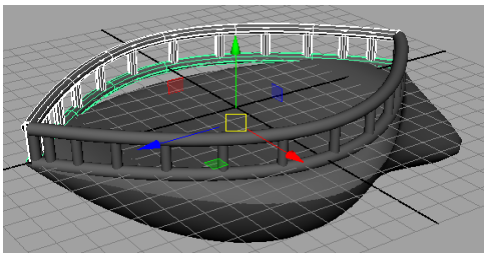

Figure 4-69 *Copied railing surface is reversed*

Creating the Deck

In this section, you will create the deck of the ship using the polygon modeling method.

1. Maximize the top-Y viewport. Choose **Create > Objects > Polygon Primitives > Cube** from the menubar. Next, create a cube in the viewport. In the **Channel Box / Layer Editor**, expand the **polyCube1** node of the **INPUTS** area and set the parameters as follows:

   Width: **5** Subdivisions Width: **2**
   Height: **1** Subdivision Depth: **4**
   Depth: **5**

2. Press and hold the right mouse button on the cube; a marking menu is displayed. Choose **Vertex** from the marking menu displayed. Next, choose **Scale Tool** from the Tool Box and adjust the vertex of the cube to form the shape, as shown in Figure 4-70.

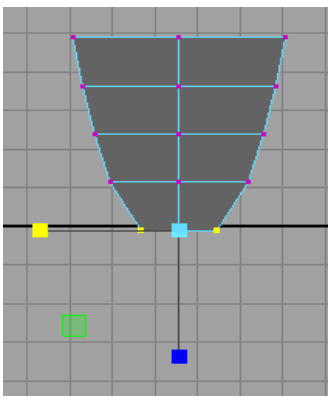

Figure 4-70 *The shape of the deck created*

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3. Maximize the persp viewport. Press and hold the right mouse button on the cube; a marking menu is displayed. Choose **Object Mode** from the marking menu displayed. Next, select the cube and choose **Edit > Duplicate > Duplicate** from the menubar; a copy of the cube is created. Similarly, create one more duplicate of the deck. Choose **Move Tool** and then **Scale Tool** to align the duplicated decks on the ship, as shown in Figure 4-71.

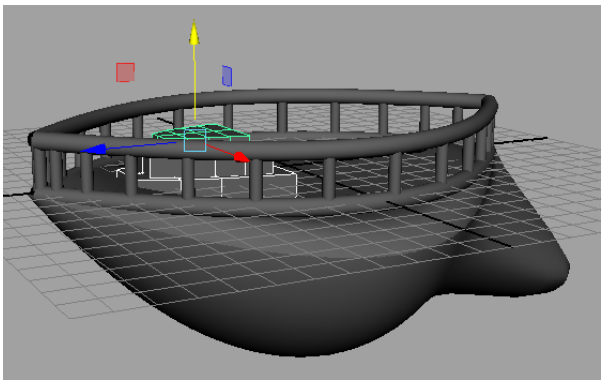

Figure 4-71 *The duplicate decks aligned together*

Creating the Chimney

In this section, you will create the chimney for the ship using the **Polygon Cylinder** tool.

1. Maximize the top-Y viewport. Choose **Create > Objects > Polygon Primitives > Cylinder** from the menubar and create three cylinders in the viewport. The cylinders will act as chimneys for the ship. In the **Channel Box / Layer Editor**, set the parameters as given next.

Cylinder	Radius	Height
Cylinder1	0.8	8
Cylinder2	0.6	6
Cylinder3	0.4	4



Note

The radius and height of the cylinders may vary depending on the size of the ship. Therefore, you need to set the respective values accordingly.

2. Maximize the persp viewport and align the cylinders to create the chimneys, as shown in Figure 4-72.

Changing the Background Color of the Scene

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

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

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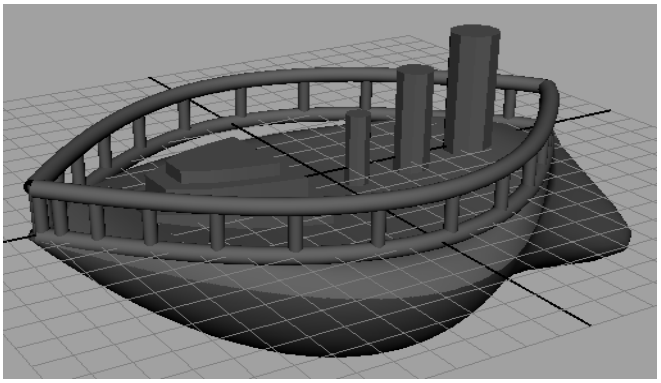

Figure 4-72 *The chimneys created*

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_2023_rndr.zip* file from *www.cadcim.com*. The path of the file is as follows: *Textbooks > Animation and Visual Effects > Maya > Autodesk Maya 2023: A Comprehensive Guide*.

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

2. Maximize the persp viewport if not already maximized. Choose the **Display render setting** button from the Status Line; the **Render Settings** window is displayed. In this window, select **Maya Software** in the **Render Using** drop-down list and then close the window. Choose the **Render the current frame** button from the Status Line to render the scene, refer to Figure 4-52.

Self-Evaluation Test

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

1. Which of the following tools is used to create a new segment at the intersection of two surfaces?

(a) **Intersect Surfaces** (b) **Untrim Surfaces**
(c) **Attach Surfaces** (d) None of these

2. Which of the following tools is used to paint a mesh to give it a smoother look?

(a) **Pull** (b) **Push**
(c) **Smooth** (d) **Relax**

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3. The _____ tool is used to rebuild the U and V spans.

4. The _____ tool is used to undo the last trim operation.

5. The _____ tool is used to reverse the U and V directions of selected surface.

6. The _____ **Geometry Tool** is used to sculpt a NURBS or polygon object manually in the viewport.

7. The **NURBS to Subdiv** conversion tool is used to convert a NURBS mesh into a subdiv mesh. (T/F)

8. The **Sculpt Geometry Tool** is used to sculpt a NURBS or polygon object manually in the viewport. (T/F)

9. The **Offset Surfaces** tool is used to create copy of a selected surface at a particular distance. (T/F)

10. The **Insert Isoparms** tool is used to insert an isoparm into an existing NURBS surface. (T/F)

Review Questions

Answer the following questions:

1. Which of the following operations is used to relax bumps over a surface?

(a) **Push** (b) **Pull**
(c) **Relax** (d) **Erase**

2. Which of the following tools is used to create a copy of the selected surface by creating an offset at a specified distance?

(a) **Offset Surface** (b) **Attach Surface**
(c) **Align Surface** (d) **Detach Surface**

3. The _____ tool is used to extend an edge of the NURBS surface.

4. The _____ radio button is used to remove extra knots formed while rebuilding a surface.

5. The **Pinch** operation is used to pull the selected vertices toward each other while using the **Sculpt Geometry Tool**. (T/F)

6. The **Extend Surfaces** tool is used to extend the edge of a NURBS surface. (T/F)

7. The **Reverse Surface Direction** tool is used to reverse or swap the U and V directions of a selected surface. (T/F)

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8. The **Erase** operation is used to push the NURBS mesh inside a surface. (T/F)

9. The **Extend Surfaces** tool is used to rebuild a NURBS surface. (T/F)

10. The **Detach** tool is used to detach a surface by selecting isoparm. (T/F)

EXERCISES

The rendered output of the models used in the following exercises can be accessed by downloading the *c04_maya_2023_exr.zip* from *www.cadcim.com*. The path of the file is as follows: *Textbooks > Animation and Visual Effects > Maya > Autodesk Maya 2023: A Comprehensive Guide.*

Exercise 1

Use various NURBS modeling techniques to create the model of a handbag, as shown in Figure 4-73. **(Expected time: 45 min)**



Figure 4-73 *The model of a handbag*

Exercise 2

Use various NURBS modeling techniques to create the model of a chair, as shown in Figure 4-74. **(Expected time: 30 min)**



Figure 4-74 *The model of a chair*

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Answers to Self-Evaluation Test

1. a, **2.** c, **3. Rebuild Surfaces**, **4. Untrim Surfaces**, **5. Reverse Surface Direction**, **6. Sculpt**, **7.** T, **8.** T, **9.** T, **10.** T

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