Autodesk®
3ds Max® Design 2012
Fundamentals

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Chapter 3

Basic Modeling Techniques

This chapter introduces:

✓**Model with Primitives**

✓**Applying Transforms**

✓**Sub-Object Mode**

✓**Reference Coordinate Systems and Transform Centers**

✓**Cloning and Grouping**

✓**Poly Modeling with Graphite Tools**

✓**Statistics in Viewport**

3.1 Model with Primitives

Autodesk® 3ds Max® Design software enables you to create and adjust 3D geometry by creating a complex model, as shown in Figure 3–1, from simple 3D objects called primitives.
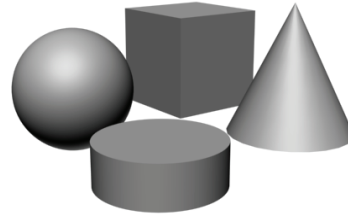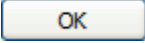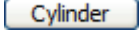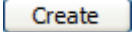

Figure 3–1

- Not everyone works with Autodesk 3ds Max Design as their primary modeling tool. However, even for those who do not, modeling with Autodesk 3ds Max Design primitives might still be useful for additional dressing or background objects to add to your imported scenes.

- Modeling with primitives is only one approach to creating geometry in Autodesk 3ds Max Design. Other processes, such as modeling with modifiers, creating loft compound objects or creating a 3D terrain from 2D contour objects, can also be done.
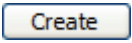
Practice 3a

Estimated time for completion: 10 minutes.

Modeling with Primitives

In this practice you will model the base for the parking lot light fixtures. You will continue with this model in other practices.

1. Open **Modeling with Primitives.max** from your Class Files folder. If you get a dialog box that mentions a File Load: Mismatch, click [OK] to accept the default values.

2. In the Command Panel, select the *Create* tab ( ). Click (Geometry) and verify **Standard Primitives** displays in the drop-down list. In the Object Type rollout, click [Cylinder].

3. If the Keyboard Entry rollout is collapsed, click to expand it.

4. In the Keyboard Entry rollout leave the X, Y, Z coordinates at **0'0"**. Set the *Radius* to **1'0"** and the *Height* to **3'0"**. Click [Create]. You can either enter the values directly in the respective fields or use the spinner arrows to increase or decrease the values.

5. Click (Zoom Extents) to get a closer look at the base. Note that it zooms into the cylinder in the Perspective viewport only, because that is the active viewport (yellow border).

> **Note:** After creating an object, you cannot change the parameters in the Keyboard Entry rollout. Changing the parameters in the Keyboard Entry rollout and clicking [Create] adds a second object. If you created another object, in the Quick Access Toolbar, click once to undo the creation of second object.
>
> After creating an object, use the *Modify* tab ( ) to change the parameters. Select the object if necessary, and select the *Modify* tab.
>
> **Note:** After entering a value in a field, either click in another edit field or press <Enter> to see its affect in the viewports.

6. With the cylinder still selected, in the Command Panel, select the *Modify* tab ( ). At the top of the modifier list, in the name field, rename the object from **Cylinder001** to **LP Base**.

7. In the Parameters rollout, set *Radius* to **1'6"**. You can also set the number of segments and sides for the object. Try changing these values to see what effect they have on the geometry. Set both *Height Segments* and *Cap Segments* to **1** (default) and *Sides* to **20**, as shown Figure 3–2.
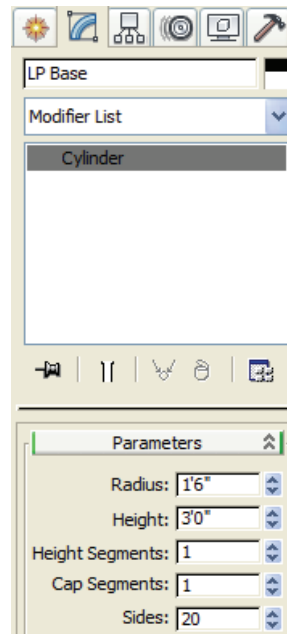

Figure 3–2

8. Select the *Create* tab ( ) and in the Object Type rollout, click Box to create the anchor base plate. In the Keyboard Entry rollout set *X, Y, Z* coordinates to **0'0", 0'0", 3'0"**. Set the *Length* and *Width* to **1'4"** and the *Height* to **0'2"**. Click Create. A box is created on top of the Base cylinder, as shown in Figure 3–3.
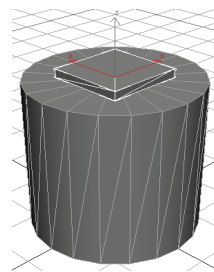

Figure 3–3

9. With the box selected, click the *Modify* tab ( ) and rename the object as **LP Anchor Base**.

10. Click **3DS >Save As** and save your work as **MyLight Pole.max**.

3.2 Applying Transforms

Many CAD and 3D graphic programs consider **Move**, **Rotate**, and **Scale** as modify options similar to **Stretch**, **Break**, and **Trim**. However, in Autodesk 3ds Max Design there is a significant distinction between modifiers and transforms.

- **Modifiers** add geometric and property alterations to objects. They are listed in the Modifier Stack and their parameter values are available for adjustment afterwards.

- **Transforms** are used to translate (move) and scale objects in the scene. The three Autodesk 3ds Max Design transforms are **Move**, **Rotate**, and **Scale**. Transforms are conducted by accessing a transform mode and typing new values or graphically transforming objects on the screen.

- Transforms are applied to objects after basic parameters and modifiers have been taken into account (except world-space modifiers). For example, if you scale a box, the *Length* parameter shown in the Modifier Stack does not take into account the effects of the scale transform.

- An object can have any number of modifiers, but only has a single set of transform values at any time.

- Transforms and almost all object and modifier parameters can be animated in Autodesk 3ds Max Design. For example, a walkthrough animation can be created using Move Transform to move the camera or its target or both.

- Transform modes are initiated by selecting the required buttons in the Main toolbar or by using the Transform modes in the right-click quad menu.

The Transform tools are:

 Select and Move

 Select and Rotate

Select and Scale: Scaling has three flyout options, (Uniform), (Non-uniform), and (Squash). Non-uniform enables you to scale one or two axes independently. Squash enables you to do the same, but scaling one or two axes applies a simultaneous opposite scaling to the other(s). The Scale transform gizmo also has the tools to do Non-uniform scaling.

Hint: It is best not to use the Scale transform directly on objects. Instead, apply an XForm modifier to the objects and then **Scale** the XForm gizmo. This avoids many problems in animation, because you can define when the scale is taking place at the sub-object level.

Transforms can be constrained to one or two axes by selecting one of the buttons in the Axis Constraints toolbar, as shown in Figure 3–4. However, it is more common to use the gizmos or the keyboard shortcuts to constrain the transforms. This toolbar is hidden by default.
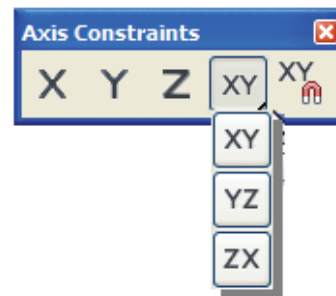

Figure 3–4

When a transform mode is active, a Transform gizmo displays, as shown in Figure 3–5, on the selected object on the screen. If the Transform gizmo is missing, press <X> to toggle it on.
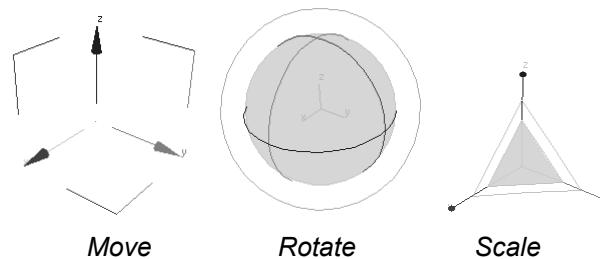

Move   *Rotate*   *Scale*

Figure 3–5

Clicking and dragging over the gizmo enables you to perform the transform interactively on the screen. You can also constrain the transform by highlighting an axis handle on the gizmo before clicking and dragging.

You can apply a transform accurately by entering the required transform values in the *Transform Type-In* area in the Status Bar, as shown in Figure 3–6.
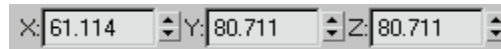

Figure 3–6

You can also right-click on any of the Transform buttons to open a Transform Type-In dialog box, as shown in Figure 3–7 for the **Move** transform.
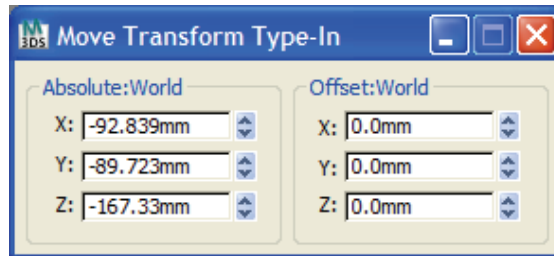

Figure 3–7

The Transform Type-In dialog box can also be accessed by right-clicking the object and clicking ☐ (Settings) to the right of **Move**, **Rotate**, or **Scale**, as shown in Figure 3–8.
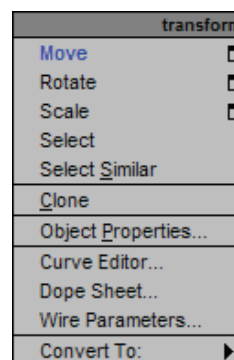

Figure 3–8

Transform modes remain active until they are canceled. One way to cancel a transform mode is by clicking 🔲 (Select Object) in the Main toolbar or pressing <Q>. You should consider selecting **Select** after you have finished a transform to avoid accidentally moving, rotating, or scaling objects while making selections.
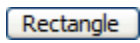
Practice 3b

Estimated time for completion: 20-30 minutes.

Modeling with Modifiers and Transforms

In this practice you will refine the parking lot lighting fixture with Modifiers, then use Transforms to locate objects in the correct scene positions.

Task 1 - Extrude and Adjust the Light Pole.

To create the rectangular light pole, create a 2D cross-section shape and then extrude it into a 3D object. This approach is another way to create 3D geometry.

1. Continue working with the file created in the previous practice, **MyLightPole.max**. If you did not complete it, open **Modeling with Modifiers and Transforms.max** from your Class Files folder.

2. In the *Create* tab (🔆), click 🕀 (Shapes) to create 2D objects. Verify that the **Splines** sub-category is displayed and click ⌜Rectangle⌝, as shown in Figure 3–9.
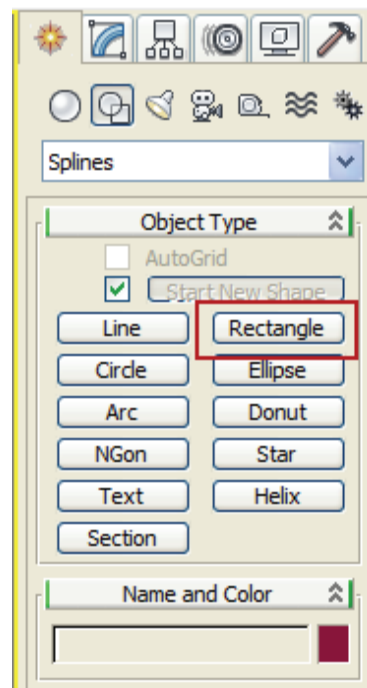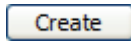

Figure 3–9

3. In the Keyboard Entry rollout set *X, Y, and Z* to **0'0", 0'0",** and **3'2"**. Set *Length* and *Width* to **0'6"** each and set *Corner Radius* to **0'1"**. Click ⌜Create⌝.

4. A 2D rectangle is created on the top of base plate. With the rectangle still selected, open the *Modify* tab ( ). Open the Modifier List by clicking the down arrow next to it. In the Modifier List drop-down list, select **Extrude**. Note that Extrude gets listed in the Modifier Stack, as shown in Figure 3–10.
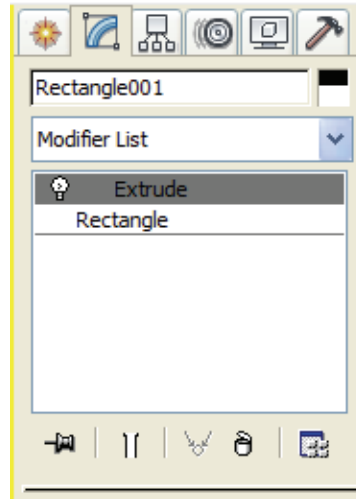

Figure 3–10

5. In the Parameters rollout, set *Amount* to **15'0"** and leave the other parameters at their default settings.

6. Rename the object *Rectangle001* as **LP Pole**.

7. Use (Zoom) to get a closer look at the light pole, as shown in Figure 3–11. Note how much detail the light pole's fillet adds to the model.
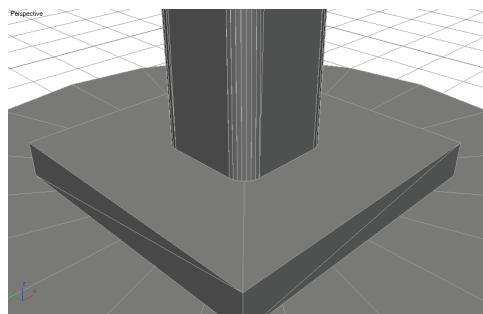

Figure 3–11

Note: You should cut down on any unnecessary detail if the object is meant to be a background item and not the main focus of the visualization. Keeping models simple reduces the file size and speeds up software performance and rendering times.

- The Extrude modifier is listed directly above the Rectangle object in the Modifier Stack. The rectangle's parameters are still accessible and can be changed after the extrude is added.

8. In the *Modify* tab ( ), in the Modifier Stack, select **Rectangle**. it gets highlighted in dark gray. In the Interpolation rollout change *Steps* to **2** and press <Enter>. The fillet divisions are reduced, as shown in Figure 3–12. (In your projects you might change the *Steps* to **0** or not use fillets at all, if the object is not a focal point of the visualization.)
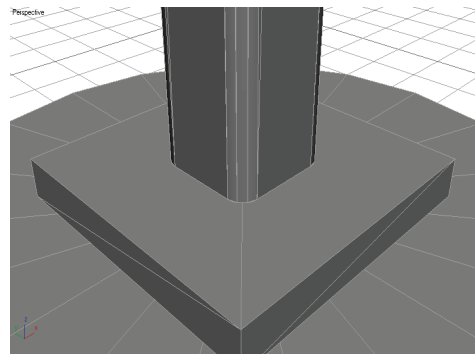
9. Save your work as **MyLightPole01.max**.

Figure 3–12

Task 2 - Taper the Light Pole.

The modifiers in the Modifier drop-down list are placed in groups and then listed alphabetically. Click and drag the scroll bar on the right of the Modifier drop-down list to display the modifiers at the bottom of the list.

1. In the Modifier Stack, select **Extrude** (so that the next modifier Taper is applied after the Extrude). In the Modifier List, select **Taper**, located at the bottom of this list. Note that the Taper displays above the **Extrude** in the Modifier Stack. The Modifier Stack lists modifiers in reverse historical order.

2. In the *Taper* area of the Parameters rollout, set *Amount* to **-0.5**, which relates to approximately a 50% size reduction over the height of the object. Press <Enter>. You can still adjust the original **Rectangle** and **Extrude** parameters in the Modifier Stack.

3. Click (Zoom Extents All) to see all the objects in the viewport. Note the taper on the pole towards the top.

4. Click **>Save As**. In the Save File As dialog box, click to automatically save your work incrementally as **MyLightPole02.max**.

Task 3 - Create the Fixture Housing and Globe.

Previously you created primitives by keying in exact values in the Keyboard Entry rollout. Now you will roughly size the primitive shapes by clicking and dragging with the mouse in the viewport.

1. In the *Create* tab ( ), click (Geometry). In the Standard Primitives drop-down list, select **Extended Primitives** as a sub-category. In the Object Type rollout, click ChamferCyl .

2. Next to the base (LP Base), click and drag the left mouse button to size the radius to roughly **2'0"** (Keep looking in the Parameters rollout in the Command Panel where the Radius changes interactively as you move your mouse). After releasing the mouse button, move your cursor up the screen slightly to give the cylinder a height of approximately **1'0"**. Click a second time to set the cylinder height. Then move the cursor up and down the screen until you can roughly define a **0'2"** fillet. Complete the object creation process with a third click. The object should display as shown in Figure 3–13.
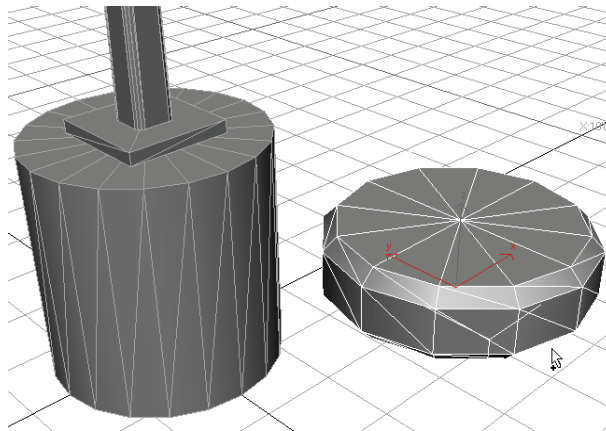

Figure 3–13

- All primitives can be sized by clicks and drags as you did here. You can enter the parameters of the object before creating it or you can sketch in an object this way and fix its dimensions and position after creating it.

3. With the object, **ChamferCyl**, still selected, in the Command Panel, select the *Modify* tab ( ) and modify the parameters, as shown in Figure 3–14.
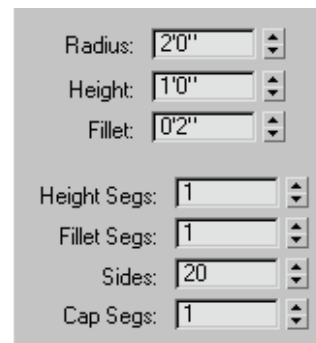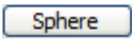
Figure 3–14

4. Name the object **LP Fixture Housing**.

5. In the *Create* tab ( ), click (Geometry). In the drop-down list, select **Standard Primitives** as a sub-category. In the Object Type rollout, click Sphere to create the fixture's globe. Click and drag anywhere on the screen to size a sphere of approximately **1'0"** in radius. Select the *Modify* tab ( ) and assign the parameters, as shown in Figure 3–15. Note the effects that each of them has on the model, specifically the **Hemisphere** and **Smooth** values.
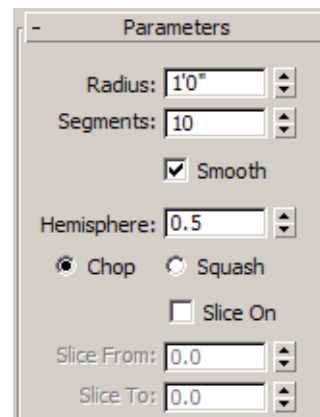

Figure 3–15

6. Select the **Squash** option in the rollout. This option generates more faces and creates a smoother appearance. Since the globe is often where the viewer's attention will be focused when looking at the light pole, you should make it look as good as possible while keeping the polygon count low.

7. Rename the hemisphere **LP Fixture Globe**.

8. Click >**Save As** and click to automatically save your work incrementally as **MyLightPole03.max**.

Task 4 - Use Transforms to Position Objects.

To complete this practice you will rotate and move the light pole fixture housing and globe into position.

1. Select the **LP Fixture Housing** (the chamfered cylinder) and in the Main toolbar, click (Select and Move).

2. In the Main toolbar, set the *Reference Coordinate System* to **World** by selecting it from the drop-down list and click . (Use Pivot Point Center), as shown in Figure 3–16.
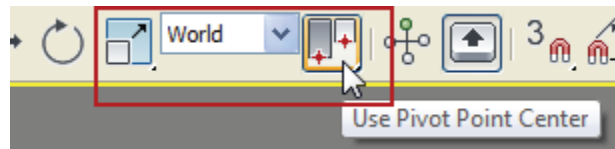

Figure 3–16

If the Transform gizmo is missing, press <X> to toggle it on.

3. The **Move** gizmo displays over the object, as shown in Figure 3–17. Move the fixture housing by clicking and dragging the gizmo's axis handles and plane handles, noting how each constrains the movement to a certain axis or plane. By default, the gizmo displays at the object's pivot point.
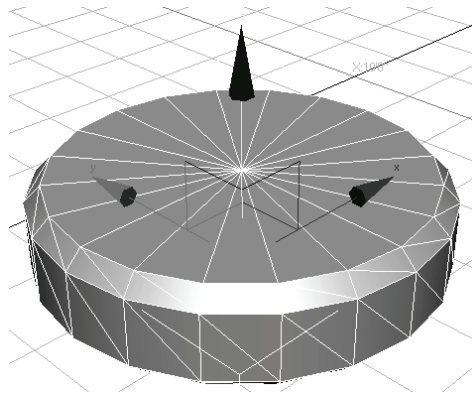

Figure 3–17

4. To position the object precisely, use the Transform Type-In controls located in the Status Bar at the bottom of your screen.

5. Verify that (Absolute Mode Transform Type-In) is displayed in the Status Bar. The **Absolute Mode** button toggles with (Offset Mode). The (Absolute Mode Transform Type-In) should display.

■ If the values are entered in **Offset Mode**, they are added to the current coordinates. **Offset Mode** is useful if you want to move an object a certain distance but are not sure what the resulting coordinates will be.

6. Set *X* to **0'0"**, *Y* to **-6'0"**, and *Z* to **19'0"**, as shown in Figure 3–18, and press <Enter>.

Figure 3–18

7. As the **Move** transform and **Absolute Mode** are already active, select **LP Fixture Globe** (hemisphere) and enter the same X, Y, Z coordinates. The globe moves inside the fixture housing.

8. With the globe still selected, in the Main toolbar, click (Select and Rotate).

9. The *X, Y, Z Transform Type-In* fields display the current rotations which are **0**. Set *X* to**180** and note the position of the globe is inverted. The object should display as shown in Figure 3–19.
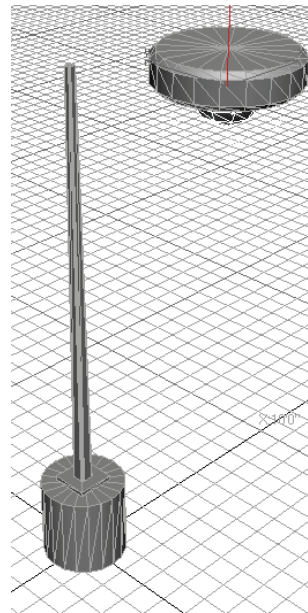
Figure 3–19

10. Click (Select Object) to end the **Rotate** transform as a precaution to avoid rotating objects accidentally.

11. Click **>Save As** and click to automatically save your work incrementally as **MyLightPole04.max**.

3.3 Sub-Object Mode

Many of the objects and modifiers in Autodesk 3ds Max Design contain sub-objects that can be independently adjusted through transforms and special modifier controls.

These sub-objects are adjusted through a special Autodesk 3ds Max Design state called Sub-object mode. For example, the **Taper** modifier in the column has **Gizmo** and **Center** sub-objects, as shown in Figure 3–20, that can be adjusted to position the Taper.
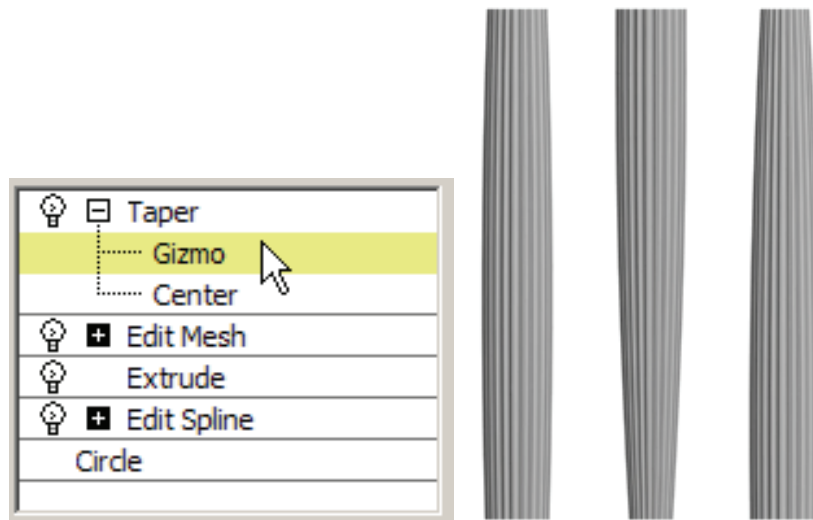
Figure 3–20

Working in Sub-Object Mode

Sub-object mode is activated through the Modifier Stack. You can expand the modifier by clicking ▥ next to the name of an object or modifier that has sub-objects, then clicking sub-object level to be adjusted.

- You normally can have only a single object selected to enter the Sub-object mode.

- When Sub-object mode is active, the Sub-object level (or the modifier name if the Sub-object list has not been expanded) is highlighted in yellow (with the default user interface settings).

- Normally you cannot clear the currently selected object while in Sub-object mode. Therefore, to edit another object you must first exit Sub-object mode. To do so, select the level of the Modifier Stack presently highlighted in yellow, or select the name of the modifier where you are in Sub-object mode.

■ If you see your Modifier Stack highlighted in yellow accidentally, (where you did not intend to be in Sub-object mode) simply select the yellow highlighted item to exit the mode.

Geometric Edits through Sub-objects

A whole range of explicit geometric changes can be made through Sub-object mode.

■ Objects imported into Autodesk 3ds Max Design often take the shape of **Editable Splines** or **Editable Meshes**. These have Sub-object controls that can be edited directly. For example, a group of vertices in an Editable Mesh could be selected and moved, or deleted separate from the rest of the geometry.

■ Many Autodesk 3ds Max Design objects can also have these controls applied to them through an **Edit Spline** modifier (for 2D objects) or an **Edit Mesh** or **Edit Poly** modifier (for 3D objects). This includes geometry linked to AutoCAD drawings that list only as *Linked Geometry* in the *Modify* tab.

■ Figure 3–21 shows a Box that is being edited geometrically by lowering two of its vertices with the **Move** transform.
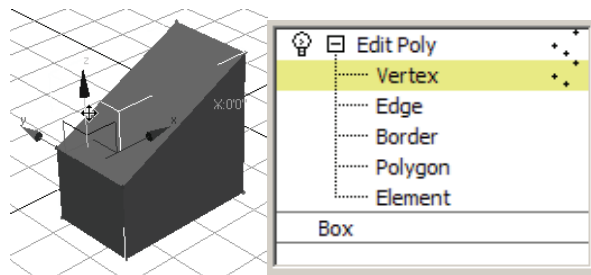

Figure 3–21

■ The **Edit Mesh** modifier is best for objects based on a triangular mesh, such as triangulated terrain models. The **Edit Poly** modifier is best for objects with faces of more than three vertices, such as rectangular objects.

■ In general it is best to adjust objects through their core parameters (such as the length, width, and height of a Box primitive) and standard modifiers whenever possible. This makes it easier to review the changes and adjust them. For cases where this is not possible, Spline, Mesh, and Poly editing can be an effective alternative.

Geometric Sub-Objects

The Editable Spline, Editable Mesh, and Editable Poly objects (as well as any other object with an Edit Spline, Edit Mesh, or Edit Poly Modifier applied to it) share a number of common Sub-object modes. These are:

- **Vertex:** The individual 3D points that define an object (Edit Spline, Edit Mesh, or Edit Poly).

- **Segment:** A single line or curve segment of an Editable Spline.

- **Spline:** A series of one or more connected Editable Spline segments. Segments are considered connected if they share a common vertex.

- **Edge:** The linear segments connecting vertices with Edit Mesh or Edit Poly. Three edges are shown in the button.

- **Face:** The triangular surface area defined by three edges (Edit Mesh only).

- **Border:** A series of edges that define an opening in an Editable Poly (only).

- **Polygon:** Enables you to work with coplanar faces (Edit Mesh) or a defined polygon (Edit Poly).

- **Element:** Enables you to work with all the faces or polygons that form a contiguous whole (Edit Mesh or Edit Poly).

Smoothing

One of the most important properties controlled at the face or polygon sub-object level is smoothing. Figure 3–22 shows the same geometry with and without smoothing applied.

Figure 3–22

- Autodesk 3ds Max Design can have two adjacent faces appear to be smooth or faceted. This distinction becomes very important when dealing with curved or gently undulating objects. When smoothed, faces appear smooth but Autodesk 3ds Max Design does not adjust the actual geometry.

■ Smoothing is controlled by smoothing groups. Each face or polygon can be a member of up to 32 smoothing groups. If two adjacent faces share a common smoothing group, Autodesk 3ds Max Design attempts to blend the surfaces together to disguise the edge that separates them.

■ As an example of the controls for polygon smoothing groups (in Edit Mesh and Edit Poly), Figure 3–23 indicates the smoothing groups for the selected faces. When some but not all selected faces fall into a particular smoothing group, that group's box is shown without a number.
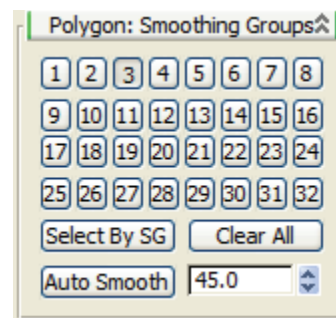
Figure 3–23

As an alternative to manually assigning smoothing groups there is an Auto Smooth feature. This feature automatically places adjacent selected faces into smoothing groups if their normal vectors have an angle of separation equal to or less than the Auto Smooth angle. (Normals are formally described in the rendering material).

Note: You can also use the **Graphite Modeling Tools** located in the Modeling Ribbon, to perform modeling with Edit Poly techniques.

Practice 3c

Modeling with Edit Poly in Sub-Object Mode

Estimated time for completion: 10 minutes.

In this practice you will add some detail to the concrete base of the light pole by chamfering (beveling) the outside top of the cylinder.

1. Continue with the file created in the previous practice **MyLightPole04.max**. If you did not complete it, open **Modeling with Edit Poly in Sub-Object Mode.max** from your Class Files folder.

2. Select **LP Base** and click ⬛ (Zoom Extents Selected).

3. In the *Modify* tab (🖊), select **Edit Poly** from the Modifier List. Click ⊞ for Edit Poly and select **Polygon** to activate Sub-object mode at the Polygon level. The yellow highlighting in the Modifier Stack indicates that you are now in Sub-object mode, as shown in Figure 3–24.
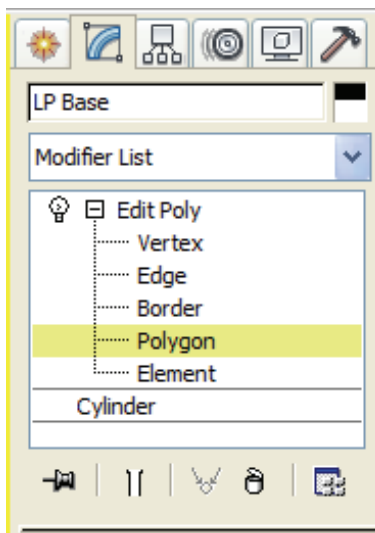
Figure 3–24

Note: You can also perform all the commands through the **Graphite Modeling Tools** located in the Modeling Ribbon. With the object selected, select *Polygon Modeling* tab under the Graphite modeling tools. In the drop-down list, select the

Apply Edit Poly Mod, as shown in Figure 3–25. Click ▢ for Polygon sub-object level. Note that the selections that you make in the Ribbon (Graphite Modeling Tools) are reflected in the Command Panel and vice versa.
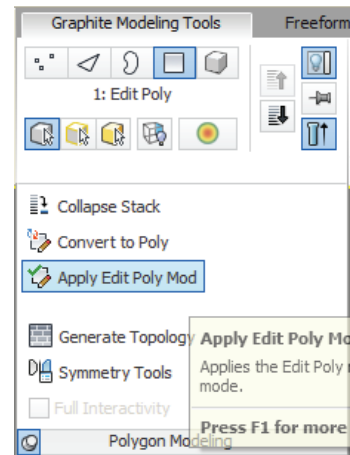

Figure 3–25

4. Select the polygon at the top of the cylinder, as shown in Figure 3–26.
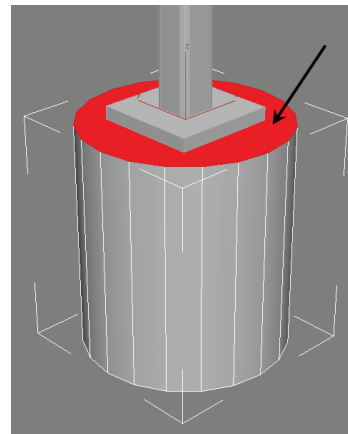
Figure 3–26

Note: Creating a 1" bevel will raise the cylinder top by 1". In preparation you will first lower the top of the cylinder by that same 1".

5. In the Main toolbar, click ⊹ (Select and Move). Note that the move gizmo is displayed.

6. In the Status Bar, click ⊡ (Absolute Mode Transform) to change into ⊛ (Offset Mode Transform) and set *Z* to -**0'1"** and press <Enter>. The cylinder geometry is adjusted.

7. In the Command Panel, in the Edit Polygons rollout, next to Bevel , click ▢ (Settings), as shown in Figure 3–27. You might have to scroll down to locate this rollout.
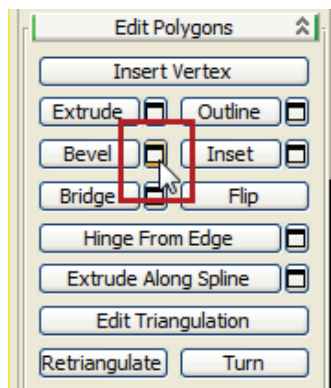

Figure 3–27

8. The heads-up display opens on the screen. In the heads-up display, set ▯ *Height* of **0'1"** and an ▢ *Outline Amount* of -**0'1"**, as shown in Figure 3–28. Click ✓.
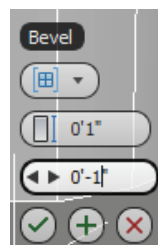
Figure 3–28

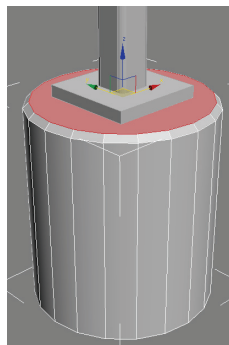■ The base is beveled as shown in Figure 3–29.

Figure 3–29

9. To make the newly created faces smooth you will adjust the smoothing groups. While still in Polygon sub-object mode, in the pull-down menu, select **Edit>Select All**. In the Command Panel, in the Polygon: Smoothing Groups rollout, click [Clear All] to remove the existing smoothing. Set the *AutoSmooth angle* to **30**, as shown in Figure 3–30, and click [Auto Smooth].
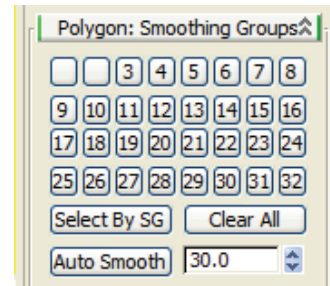

Figure 3–30

10. To better see the effect of this change, turn off the **Edged Faces** in the Viewport Shading label, if enabled. The angle of 30 degrees enabled the newly created faces to smooth across each other, but those faces are not smoothed with the top of the cylinder, as shown in Figure 3–31. This is the *chamfered* appearance that was originally intended. A larger smoothing angle enables the chamfered faces between the top and sides to smooth out.
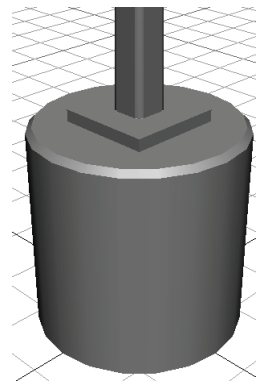

Figure 3–31

11. To end Sub-object mode, in the Command Panel Modifier Stack, click on the yellow highlighted **Polygon** to clear the selection. The top Modifier **Edit Poly** is highlighted as dark gray.

12. In the Main toolbar, click [icon] (Select Object) to end the Move Transform mode as a precaution to avoid moving objects accidentally while making further selections.

13. Save your work as **MyLightPole05.max** or use [+] in the Save As dialog box if using the **MyLightPole04.max** file.

3.4 Reference Coordinate Systems and Transform Centers

All geometry in Autodesk 3ds Max Design is referenced to a base coordinate system called the Home Grid.

■ You can create your own coordinate systems by creating and locating grid objects, available in the Helpers Category in the *Create* tab.

■ User Coordinate Systems created in AutoCAD® can automatically be brought into Autodesk 3ds Max Design as grid objects.

■ You can also create objects in AutoGrid mode, which creates a temporary Grid aligned in 3D to the object directly under the crosshairs. The option to enable **AutoGrid** is located in the *Create* tab, in the Object Type rollout, as shown Figure 3–32 (AutoGrid is similar to the Dynamic UCS feature introduced in AutoCAD 2007). If you hold down <Alt>, the AutoGrid remains available for future use. If you use AutoGrid without any key pressed, the grid disappears after object creation.
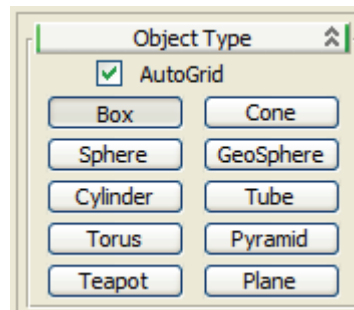

Figure 3–32

Reference Coordinate Systems

Although a single grid is active at any one time, the current Reference Coordinate System might differ depending on which view you are in and which transform is active. It is recommended that new users stay in the **World** system as much as possible to avoid confusion from changing axis labels. The Default Reference Coordinate system is set to **View**.

■ In the Main toolbar, the options listed in the Reference Coordinate System drop-down list, as shown Figure 3–33, controls how transform values are read.
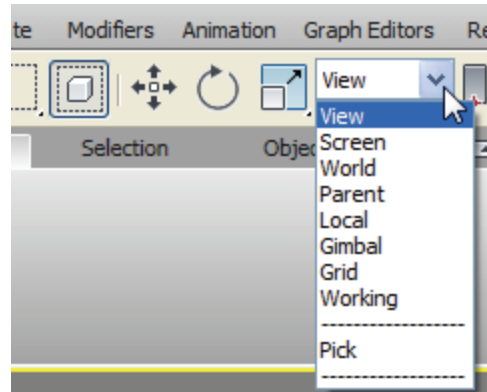

Figure 3–33

■ In the **World** coordinate system the X, Y, and Z axes are interpreted based on the Home Grid, even if a user-defined grid is active. To use the coordinates of the active user-defined grid instead, select the **Grid** option.

■ In the **Screen** coordinate system the X-axis is always measured along the bottom of the viewport, the Y-axis is always measured along the side, and the Z-axis is measured perpendicularly out of the screen. For example, in a front view using the Screen reference system the Y-axis is measured "up" the screen. That same view in the World system would measure Z-axis "up" the screen instead.

■ The **View** system is a combination of World and Screen. In an orthographic view the Screen system is used, while other views use the World system.

■ The **Pick** option enables you to pick any object in the viewport or from a list and use the reference coordinate system of that object as the reference for transforms. You can use XRef objects with the **Pick** option.

■ The **Working** option enables you to use the Working Pivot. It is a temporary modeling pivot tool you create from the Hierarchy panel's Pivot tab. Generally you need to assign a hotkey to **Use Working Pivot** and **Edit Working Pivot** to make them functional tools.

Transform Centers

Transforms are applied through a Transform Center point indicated by the Transform Gizmo. There are three options for the Transform Center and can be accessed in the Main toolbar, in the Transform Center flyout, as shown Figure 3–34.
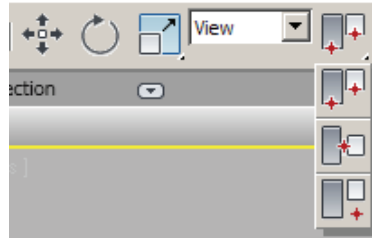

Figure 3–34

Pivot Point Center: Transforms are applied through each selected object's pivot point. Pivots often default to the bottom center or geometric center of objects. Pivot points can be adjusted through controls in the *Hierarchy* tab. Select this option if you want to rotate many objects, each around its own center.

Selection Center: Transforms are applied through the geometric center of all selected objects.

Transform Coordinate Center: Transforms are applied through the origin point of the current Reference Coordinate System. For example, if you wanted to rotate objects around their individual pivot points about the World Z-axis, you would select the World Coordinate System and Pivot Point Transform Center. Alternatively, to rotate all of the objects around the origin, you would do the same with the Transform Coordinate Center.

- The Transform Center might automatically change depending on if one or multiple objects are selected, and which transform is active.

- The Reference Coordinate System and Transform Center can be held using **Constant** in **Customize > Preferences >** *General* tab, as shown in Figure 3–35.
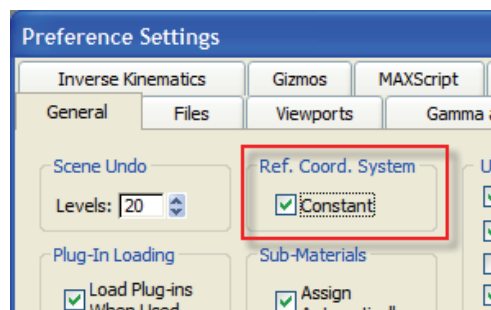
Figure 3–35

Practice 3d

Estimated time for completion: 10 minutes.

Modeling with Coordinate Systems

For the next step in the Light Pole model you will add the Light Pole Mounting Arm.

1. Continue with the file **MyLightPole05.max** created in the previous practice. If you did not complete it, open **Modeling with Coordinate Systems.max** from your Class Files folder.

2. Click ⬛ (Maximize Viewport) to display multiple viewports.

3. The Front viewport is unavailable. Click on one of the Top viewports, click in the **Point of View** label (Top), and select **Front**. Make sure that the **Front** viewport is active.

4. Use a combination of **Zoom** and **Pan** to zoom into the top portion, as shown in Figure 3–36. If the Grid is showing in the Front view, in the viewport label, click [+] and select **Show Grids** to clear it.
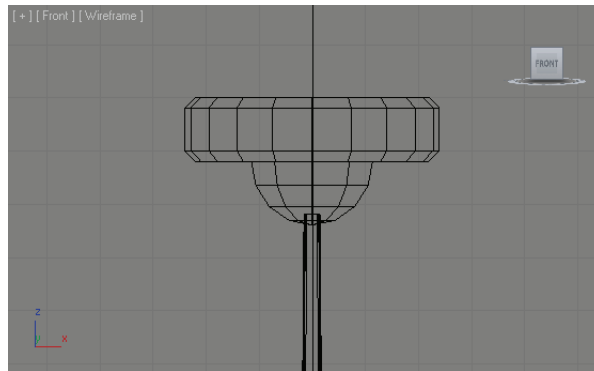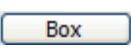
Figure 3–36

5. In the *Create* tab (⬛) > ⬛ (Geometry), click [Box]. Using the mouse, create a small box and center it on the top of the light pole, as shown in Figure 3–37.
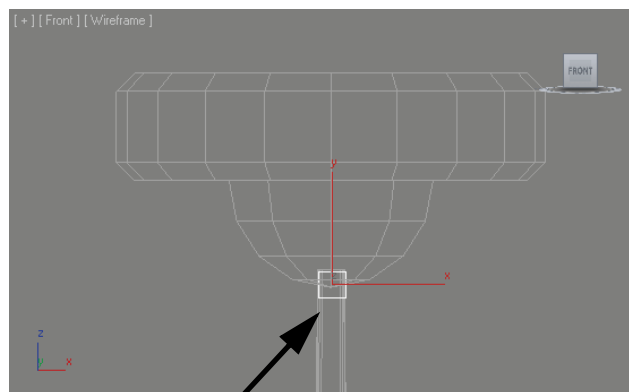
Figure 3–37

6. With this box still selected, in the *Modify* tab ( ), in the Parameters rollout, set *Length* and *Width* to **0'3"** and *Height* to **4'6"**. Set the *Height Segs* to **6** and rename it to **LP Mounting Arm**.

7. Since you created the box in the **Front** viewport (rather than the Perspective viewport) the height of the box is measured perpendicular to the view, in this case along the world Y-axis, as shown in Figure 3–38.
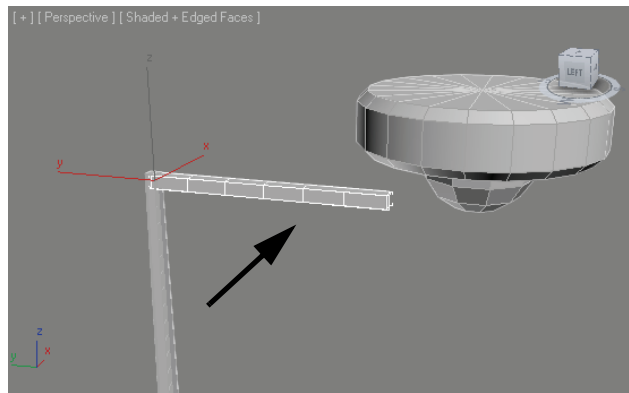

Figure 3–38

8. Click (Select and Move). In the Status Bar, set transform mode to (Absolute mode) and set the location of the mounting arm as shown in Figure 3–39.
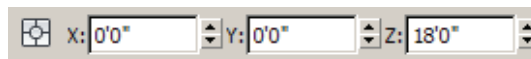
Figure 3–39

9. With the mounting arm selected, in the Modifier List, select **Bend** to curve the arm to the housing. Set *Bend Angle* to **30** and *Direction* to **-90** degrees, and note the effect of each change. The arm is bent as shown in Figure 3–40.
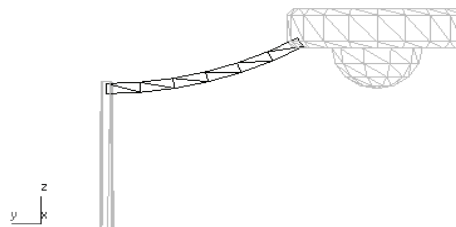
Figure 3–40

10. Save your work as **MyLightPole06.max** or use in the Save As dialog box if using the **MyLightPole05.max** file.

3.5 Cloning and Grouping

Cloning

In Autodesk 3ds Max Design objects can be duplicated with the **Clone** option (**Edit > Clone**). When cloning you have the option of enabling the duplicate object to maintain a dynamic link to the source object. Selecting **Edit > Clone** opens the Clone Options dialog box, as shown in Figure 3–41.
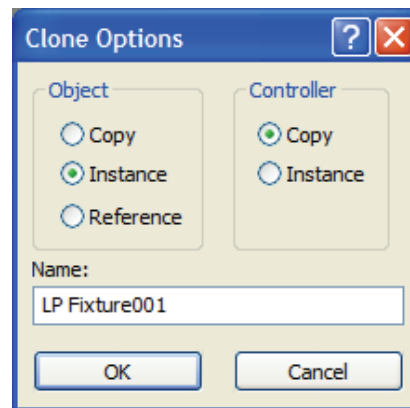

Figure 3–41

Copy	Makes an independent copy without a dynamic link to the source object.
Instance	Makes the duplicate and original Instances of each other. Changes made to any Instance automatically update all Instances, including changes to Modifiers, property changes, and material assignments (but not Transforms).
Reference	A one-directional link where changes made to the original object affect the duplicate, but you can apply Modifiers to the Reference without affecting the Source object.

■ You can also clone an object by holding down <Shift> while transforming through a click and drag on the Transform Gizmo. In this procedure you also have the option of specifying the number of copies you want to make, which are arrayed at the same Transform value.

■ The *Controller* area in the Clone Options dialog box applies to objects in a group or hierarchy and refers to transform controllers. For now, leave this choice set to **Copy**.

■ Objects that are instanced or referenced display with the Modifier Stack text in bold type. Instancing or referencing can be disabled by right-clicking the item in the Modifier Stack and selecting **Make Unique**.

Grouping

Grouping enables multiple objects to be treated as a single unit for selection and transforms. The **Group** options are available in the Group pull-down menu, as shown in Figure 3–42.
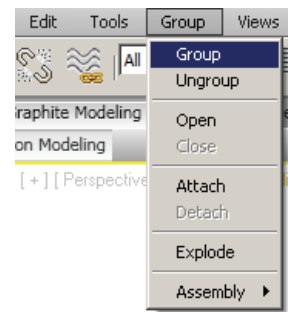
Figure 3–42

Group	Creates a group out of all the currently selected objects. Groups can have other groups inside them (nested groups).
Ungroup	Dissolves any selected groups back into their constituent objects. Explode dissolves the selected groups and any groups nested inside.
Open/Close	Enables you to select, modify, and transform individual group members as if they were not in a group. The group is still defined; however, it can be Closed to treat the objects as a single unit again.
Attach	Enables you to add another object to a group. First select the objects to be attached then select the **Attach** option in the **Group** menu. When prompted select a closed group to which to add the objects.
Detach	Enables you to remove selected objects from a group. You must first open the group to select the objects to be detached.
Explode	Dissolves the selected groups and any groups nested inside them.
Assembly	Special case object grouping that are intended for creation of lighting assemblies called luminaires, and for character assemblies. Assemblies have a special helper object called a "head" that helps build groups that will be animated.

■ Groups are located in the Command Panel> *Modify* tab, with group name in **bold type**, and a blank Modifier Stack. The Modifier Stack of individual group members is displayed if it is opened.

■ Groups can be copied, instanced, and referenced. AutoCAD blocks imported into Autodesk 3ds Max Design can be brought in as instanced versions of the same group.
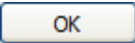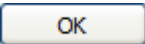
Hint: Avoid the use of Grouping on objects that are linked into a hierarchy and then animated.

Practice 3e

Estimated time for completion: 10 minutes.

Cloning and Grouping

In this practice you will complete the model of the light pole using Cloning and Groups.

1. Continue with the file **MyLightPole06.max** created in the previous practice. If you did not complete it, open **Cloning and Grouping.max** from your Class Files folder.

2. Click ![icon] (Select by Name) or press <H> (shortcut key) to open the Select From Scene dialog box. In the dialog box, click

   ![icon] (Display Geometry) and select **LP Fixture Housing**, **LP Globe**, and **LP Mounting Arm** (hold down <Ctrl> to select

   multiple items). Click [OK] to close the dialog box. All three items are now selected in the scene.

3. In the pull-down menu, select **Group > Group** to combine the three objects together into a single, selectable unit. In the Group dialog box, name the group **LP Fixture**, as shown in Figure 3–43

   and click [OK].
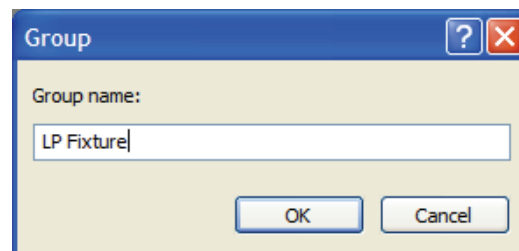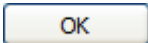
Figure 3–43

4. Click ![icon] (Select by Name) or press <H> to open the Select From

   Scene dialog box again. Click ![icon] (Display Groups) and review the new **LP Fixture** group. The group name is identified with the

   ![icon] symbol. Verify that the group is selected and close the dialog box.

5. With the **LP Fixture** still selected, in the pull-down menu, select **Group > Open**. The group still remains intact indicated by the pink bounding box. Once opened you can now select, manipulate, and transform the three component objects separately.

6. With one or more of the group components selected, select **Group > Close**. The pink bounding box is replaced with the white bounding box.

7. With the **LP Fixture** group closed and selected, create a second fixture by selecting **Edit > Clone**. In the Clone Options dialog box, as shown in Figure 3–44, select **Instance** for the object so that the original group and the copy share identical geometries. Leave the other options at their default values. Click [OK].
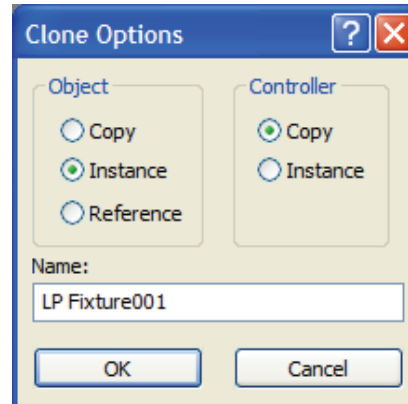
Figure 3–44

8. The original and the copy now directly overlay each other. Click

    (Select by Name) or press <H> and in the Select From Scene dialog box, verify that only **LP Fixture001** is selected (highlighted). Close the dialog box. You will now rotate the second light fixture.

9. In the Main toolbar, click (Select and Rotate).

10. The position of the transform gizmo is dependent on the active

    Use Transform. If you use (Use Pivot Point Center) or

    (Use Selection Center), the position of the transform gizmo is at the center of your current selection, but the rotation does not

    place **LP Fixture001** in the correct position. Click (Use Transform Coordinate Center), as shown in Figure 3–45, to use the coordinate system origin as the center of rotation. Note that the Rotation gizmo moves to the base which is the coordinate system origin.
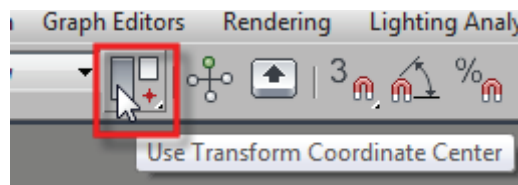
Figure 3–45

11. In the Status Bar, in the *Transform Type-In* area, set *Z* to **180.0**, as shown in Figure 3–46, to rotate **LP Fixture001** by **180°** about the Z axis. Press <Enter>. The round off error might result in a -180° value. This is a common occurrence and is not necessarily indicative of a problem.
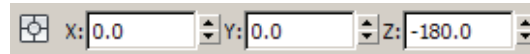
Figure 3–46

12. The cloned group is moved opposite to the original group, as shown in Figure 3–47.
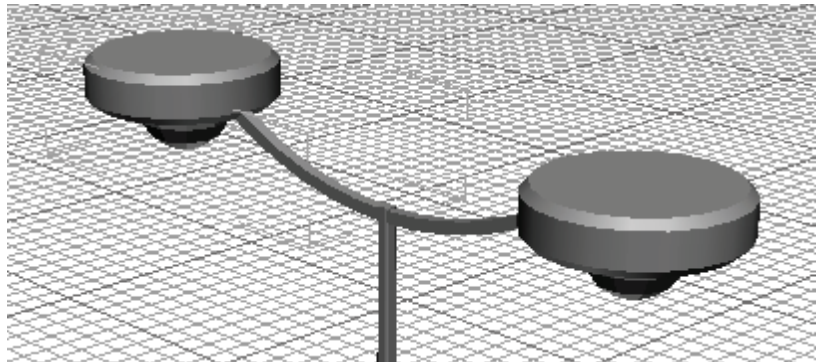
Figure 3–47

13. Click (Select Object) to end the Rotate transform mode.

14. To verify that the groups are instanced, with **LP Fixture001** selected, select **Group > Open**. Select **LP Fixture Housing001** (chamfered cylinder). In the *Modify* tab, reduce the *Height* from a **1'0"** to **0' 8"**. Both Fixture Housings update and have reduced height as shown in Figure 3–48.
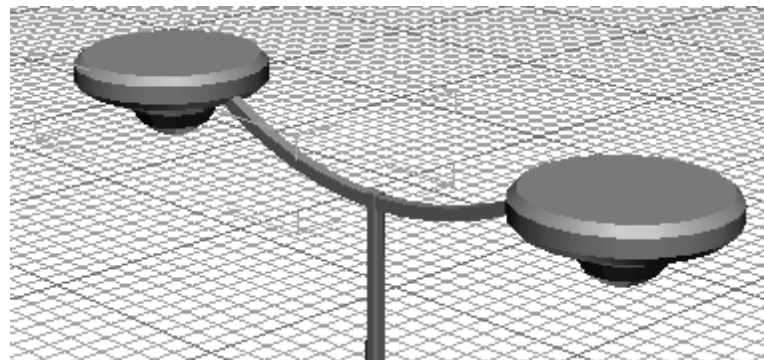
Figure 3–48

15. Select **Group > Close** to close **LP Fixture001**.

16. Save your work as **MyLightPole07.max** or use in the Save As dialog box if using the **MyLightPole06.max** file.

3.6 Poly Modeling with Graphite Tools

Autodesk 3ds Max Design is a powerful environment for creating 3D models of virtually anything you can imagine. The "box modeling" technique is probably the most popular method of construction. It is also called polygon modeling or mesh modeling. Essentially it is the interactive creation of vertices, edges, faces, and surfaces in a free and artistic way. The term box modeling comes from the common practice of starting by building a box. The original components of the box are manipulated to create the entire model. You could as easily start with a plane, or any other 3D primitive, or a 2D Shape object.

Box modeling can be performed using either the **Edit Mesh** or **Edit Poly** modifiers, or be converted to an **Editable Mesh** or **Editable Poly** object. Any of these methods give you the access to the sub-object levels needed to do this type of modeling. The **Edit Poly** modifier is the most recent modeling technology added to Autodesk 3ds Max Design, so it should be the preferred choice in many cases. However, if you find unexpected results using Edit Poly, you can always convert the object to an editable mesh or editable poly object and discard the modifier. You can also use the Edit Mesh modifier which is the older technology and should be the most stable.
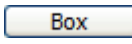
Practice 3f

Estimated time for completion: 40 minutes.

Box Modeling an Armchair

In this practice you will learn some of the tools and techniques of box modeling using the Edit Poly modifier.

Task 1 - Model the Armchair.

1. Click ![3DS icon] > **Reset** to reset Autodesk 3ds Max Design.

2. In the *Create* tab (![icon]) > ![icon] (Geometry), click [Box] in the Object Type rollout to activate the Box tool.

3. Click ![icon] (Maximize Viewport) to display multiple viewports.

4. In the Perspective viewport, click and drag to define the length and width of the rectangle. Click and continue moving the mouse upwards to define the height.

5. Initially you can use the Parameters rollout in the *Create* tab to edit the values. You can also use the *Modify* tab to edit the values. Set the *Length* to **0'50" (4'2")**, *Width* to **0'33"** (2'9"), and *Height* to **0'10"**. The box should look similar to the one in Figure 3–49.
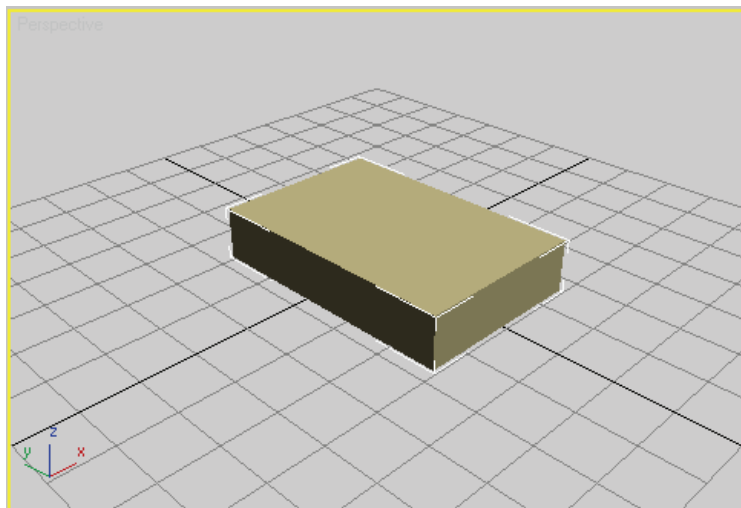
Figure 3–49

6. In the Name and Color rollout, name the object **armchair**.

7. To better see the edges, change the display mode to wireframe. Click the Viewport Shading label (Realistic) and select **Wireframe**.

8. Press <G> to hide the grid.

9. If the Graphite Modeling Ribbon is only displaying tabs, click ⊡ to display the commands in the panel.

10. Select the *Graphite Modeling Tools* tab if it is not already active. In the Graphite Modeling Tools Ribbon, expand the Polygon Modeling panel and click **Apply Edit Poly Mod**, as shown in Figure 3–50. This adds an Edit Poly modifier to the object. This is also reflected in the Command Panel. Note that the modifier Stack displays the **Edit Poly** modifier.
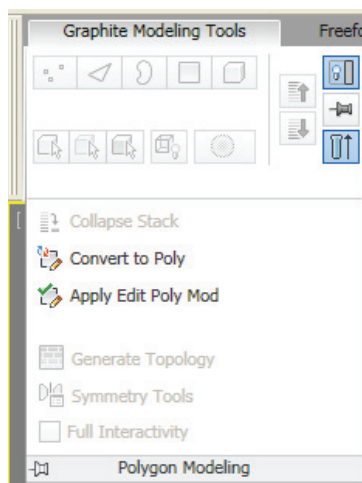
Figure 3–50

11. Click [⊿] (Edge) in the Polygon Modeling panel, as shown in Figure 3–51, to activate Edge Selection. Alternatively, you can press <2>.
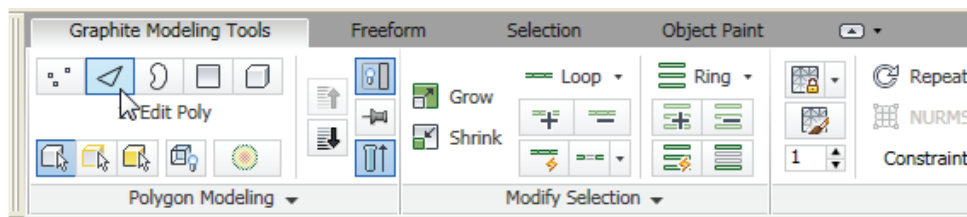
Figure 3–51

12. In the Navigation toolbar, click 🔲 (Zoom Extents All Selected).

13. Hold down <Ctrl> and select the upper two long edges, as shown in Figure 3–52.
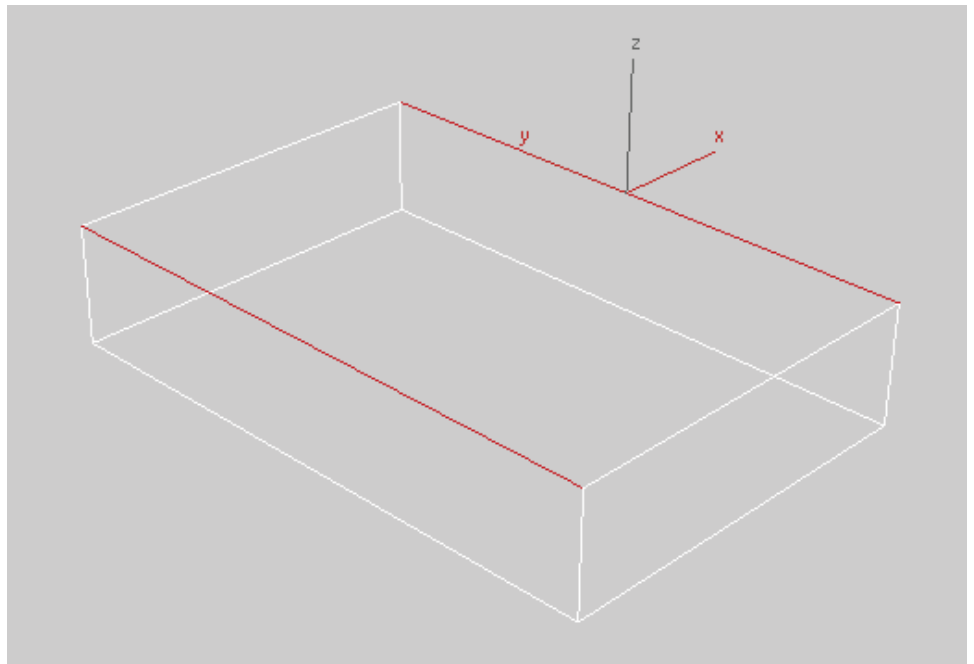
Figure 3–52

14. In the Modeling Ribbon, in the Loops panel, press and hold <Shift> and click 🔲 (Connect) to open the Connect Edges heads-up display.

15. In the Connect Edges heads-up display, set *Segments* to **2**, *Pinch* to **70**, and click ⊕. Note that 2 edges are placed along the two short edges, as shown in Figure 3–53.
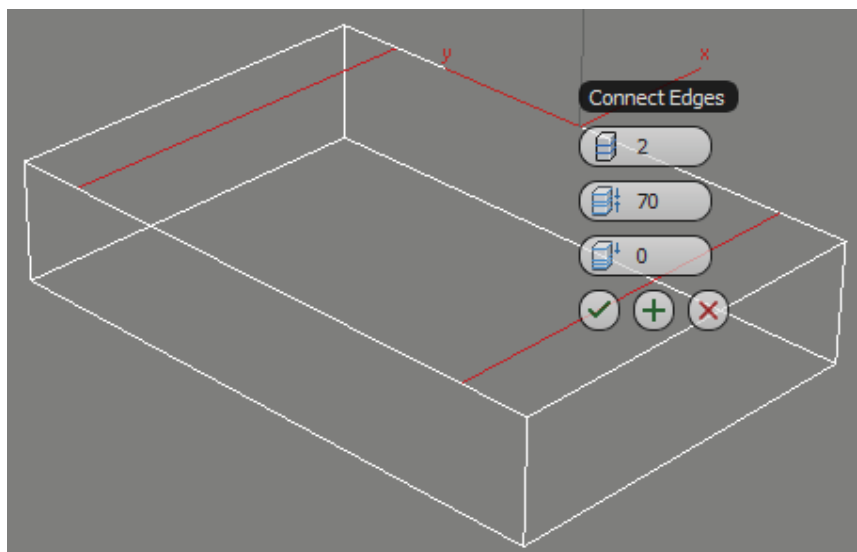
Figure 3–53

16. Click ⊕ again to place a new set of segments along the long edge of the box.

17. Change the *Pinch* and *Slide* values (*Pinch* brings the lines closer to one another and *Slide* moves them in the X-direction) to create a rectangle towards the back of the armchair, as shown in Figure 3–54. You can drag their slider arrows in either direction till you get the required results. The values of Pinch and Slide are around -**30** and **-180** respectively. Press <Enter> each time you enter a new value to see how it affects the lines. Click ✓.
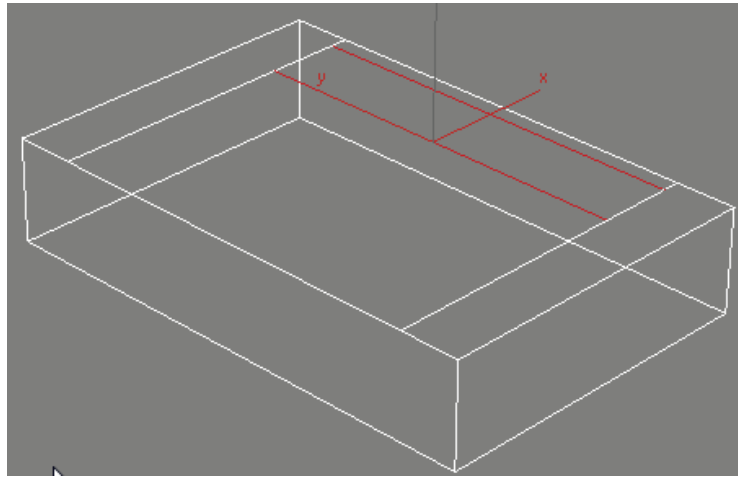
Figure 3–54

18. In the Polygon Modeling panel, click ☐ (Polygon), or press <4> to change the sub-object selection level from **Edge** to **Polygon**. In the Perspective viewport, right-click and select **Select**. Hold down <Ctrl> and select the two polygons, as shown in Figure 3–55.
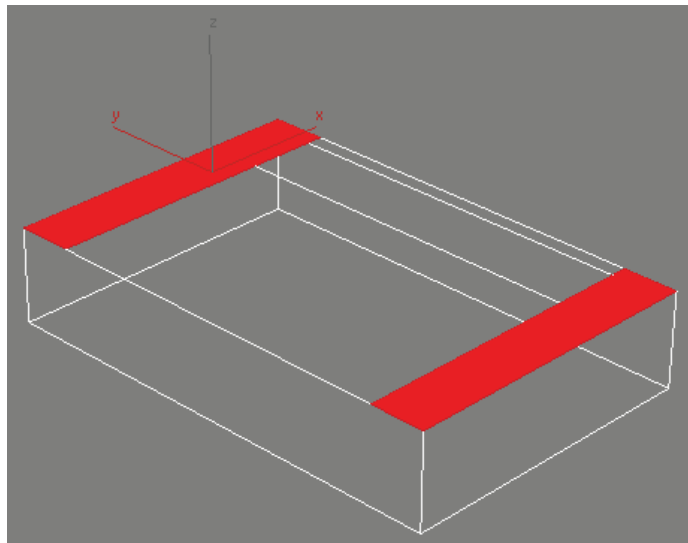
Figure 3–55

19. In the Modeling Ribbon, in the Polygons panel, press and hold
<Shift> and click ⬛ (Extrude) to access the Extrude Polygons
heads-up display. Set *Height* to **0'2"** and click ✓, as shown in
Figure 3–56.
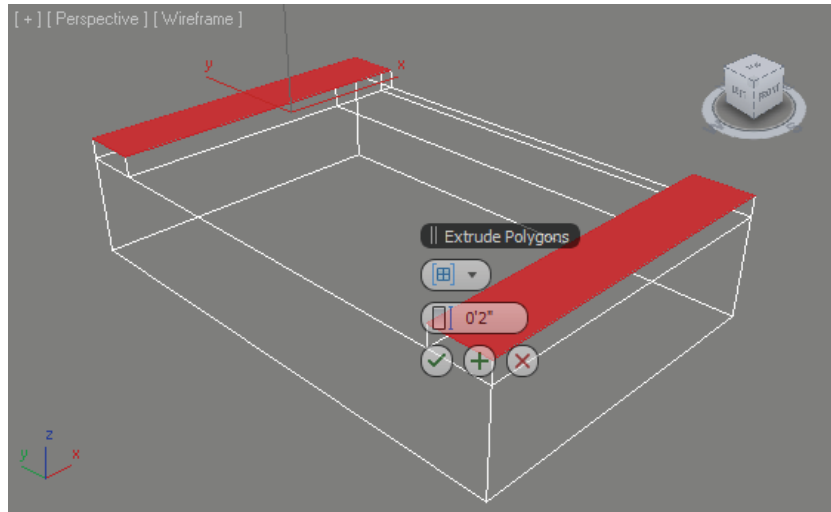
Figure 3–56

20. In the Polygons panel, press and hold <Shift> and click
⬛ (Bevel) to access the Bevel heads-up display. Set *Height* to
0'1" and the *Outline* to **-0'1"**, then click ✓, as shown in
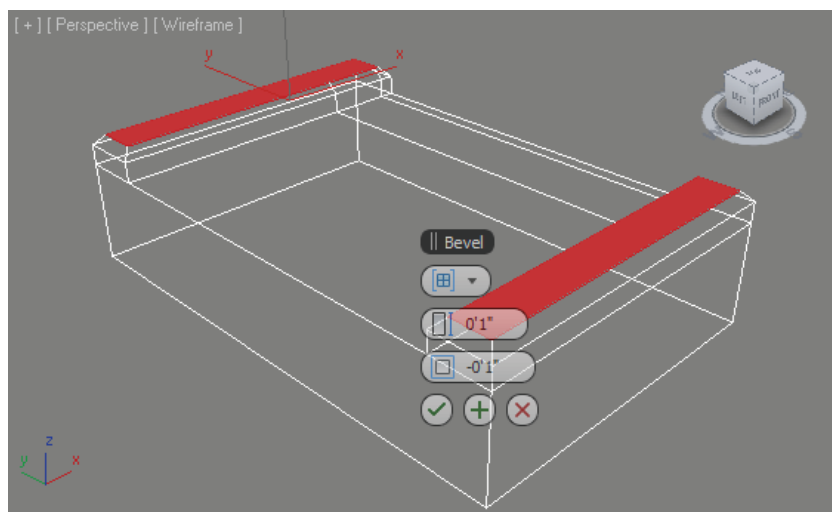Figure 3–57.

Figure 3–57

21. Orbit the viewport so that you can see the back of the armchair.
The shortcut for Orbit is <Alt>+middle mouse button.

22. Select the long rectangle that will become the back of the chair. In the Polygons panel, press and hold <Shift> and click

    ![Extrude icon] (Extrude) to open the Extrude Polygons heads-up display.

    Extrude the back of the armchair to **0'5"** and click ✓, as shown in Figure 3–58.
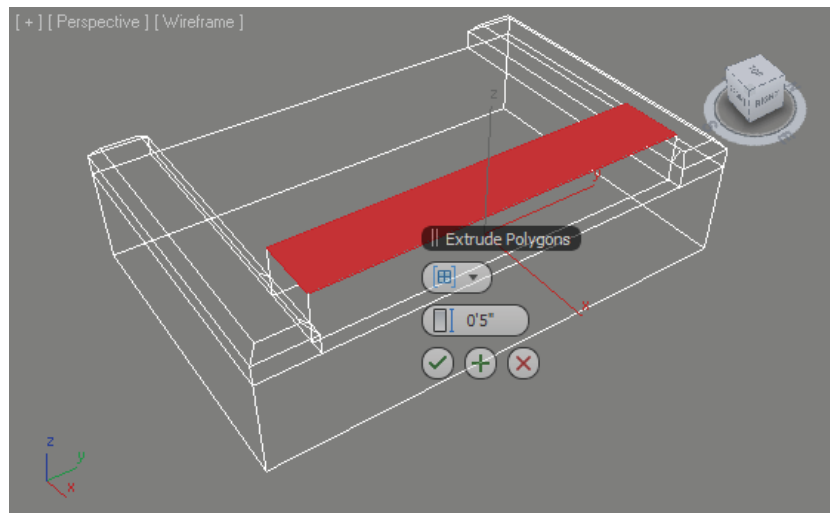
Figure 3–58

23. In the Polygons panel, press and hold <Shift> and click ![Bevel icon] (Bevel) to access the Bevel heads-up display. Bevel up the back of the chair, as shown in Figure 3–59. Be careful not to bevel so

    much that the edges overlap. Click ✓.
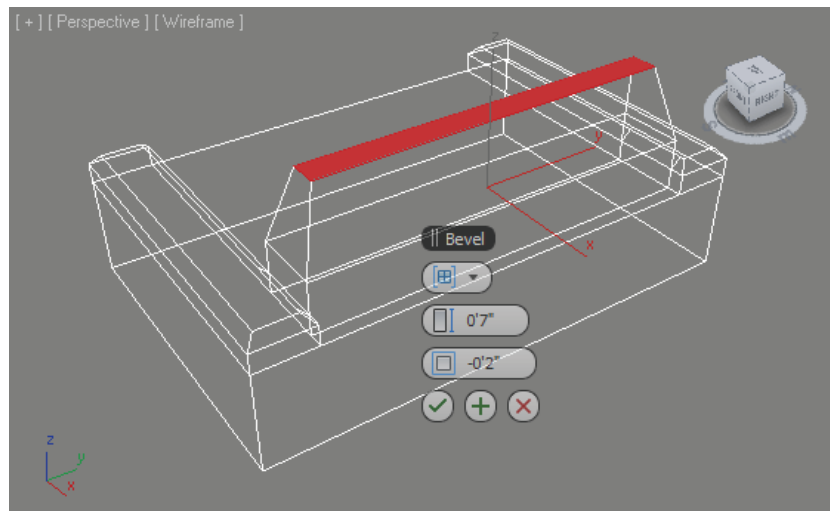
Figure 3–59

24. Click ![icon](Select and Move) and move the selected polygons backwards along the X-axis, as shown in Figure 3–60. Orbit the viewport to view the design.
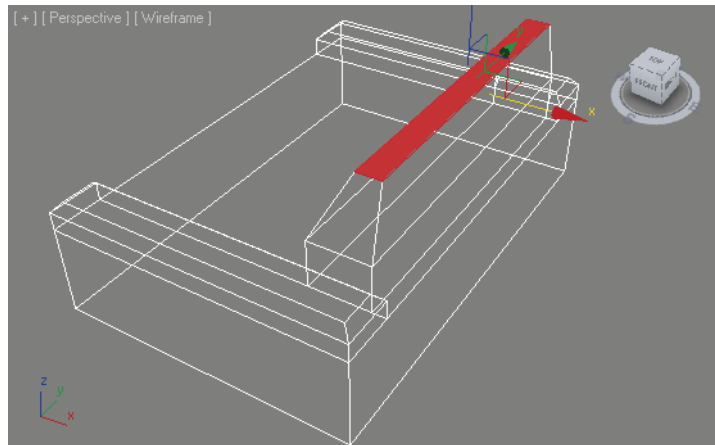
Figure 3–60

25. Press <2> to change to the **Edge Selection** level. As an alternative, click in the Polygon Modeling panel.

26. In the Modify Selection panel, click ![icon](Ring Mode). This enables to select a ring of edges when a single edge is selected.

27. Select one of the long edges at the top of the chair.

28. In the Modify Selection panel, click ![icon](Ring Mode) again to disable it.

29. Hold down <Alt> and clear the selection of one edge in front and one edge in the back. Only six edges are selected, as shown in Figure 3–61.
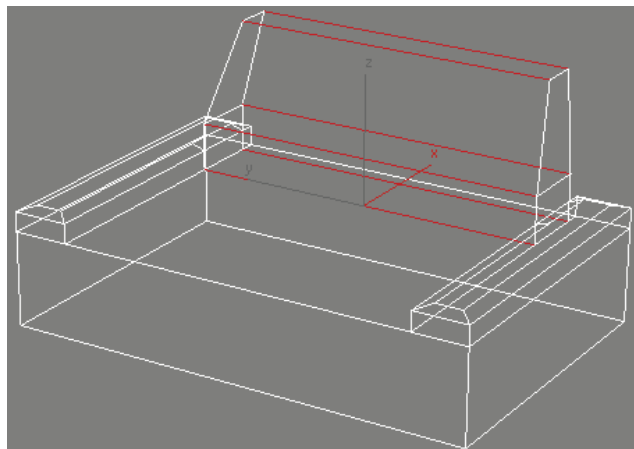

Figure 3–61

30. In the Loops panel, press and hold <Shift> and click ⊞▾ (Connect). In the Connect Edges heads-up display, reset the Pinch and Slide to 0, and set the segments to **21**, as shown in Figure 3–62. Click ⊕ and ✓.
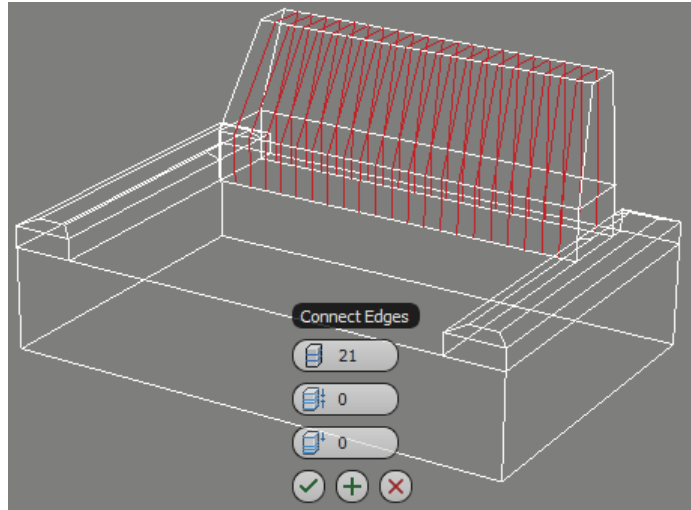

Figure 3–62

31. In the Loops panel, press and hold <Shift> and click ⊞▾ (Connect). In the Connect Edges heads-up display, change the *Segments* to **3** and click ✓. This adds lots of segments to the armchair back. Next, you will use Soft Selection to sculpt an organic curve to the back of the chair.

> **Note:** In the Graphite Modeling Tools, many options can be used to sculpt the back of the chair, but you will first learn the original method using the Command Panel.

32. Click in the **Left** viewport to make it active. Maximize the viewport by clicking ◳ (Maximize Viewport).

33. In the Modeling Ribbon, in the Polygon Modeling panel, click ⬚ (Vertex) to switch to Vertex selection mode.

34. In the Main toolbar, click ✛ (Select and Move). Drag a selection rectangle around the row of vertices at the top middle edge of the chair, leaving the 4 vertices on each side unselected, as shown on left in Figure 3–63.

35. Click ⬚ (Maximize Viewport) again to display all the four viewports. In the Perspective view verify that you have selected the correct row (only the top most row) of vertices, as shown on the right in Figure 3–63.
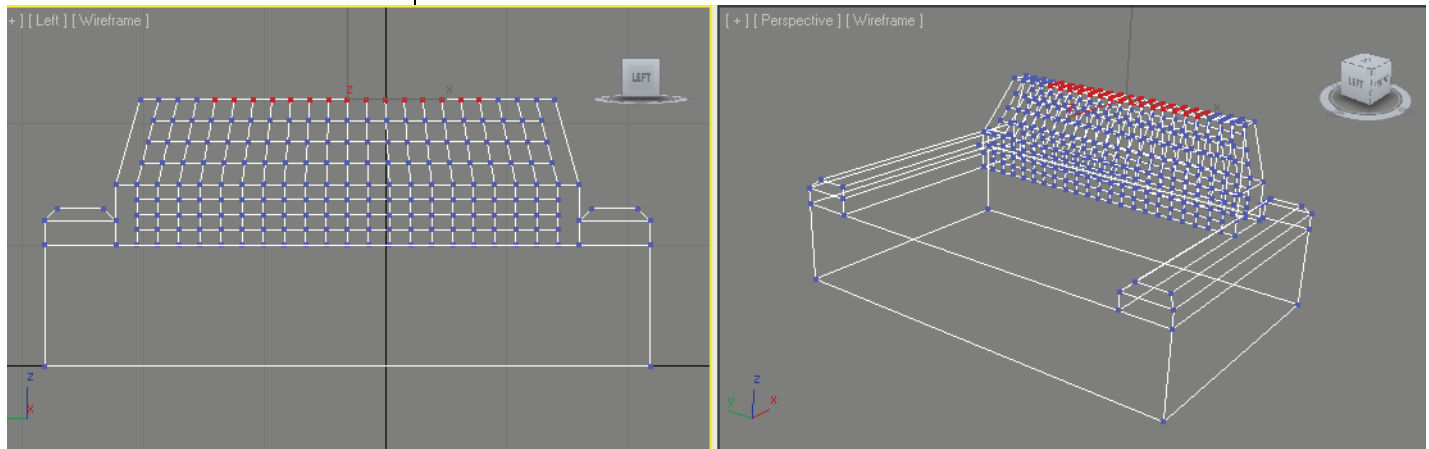

Figure 3–63

36. In the Command Panel, click ⬚ (Modify), expand the Soft Selection rollout. Select **Use Soft Selection** and adjust the *Falloff* as shown on the left of Figure 3–64. A rainbow color display indicates which vertices will be moved (Red/ Yellow/ Orange/ Green) and which are unaffected (Blue). Using soft selection, you can verify the vertices that will be affected. The resulting model might differ from the illustration in Figure 3–64, based on the values and vertices you selected.
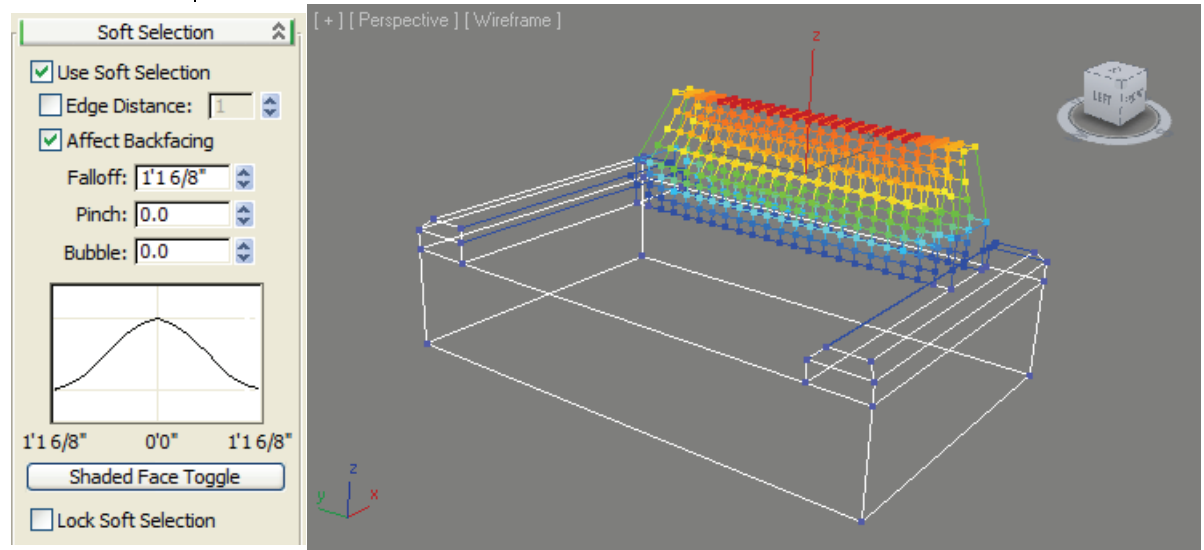

Figure 3–64

37. In the Main toolbar, click ⬚ (Select and Move) and move the selected vertex up in the Z-axis to create the curved chair back, as shown in Figure 3–65.
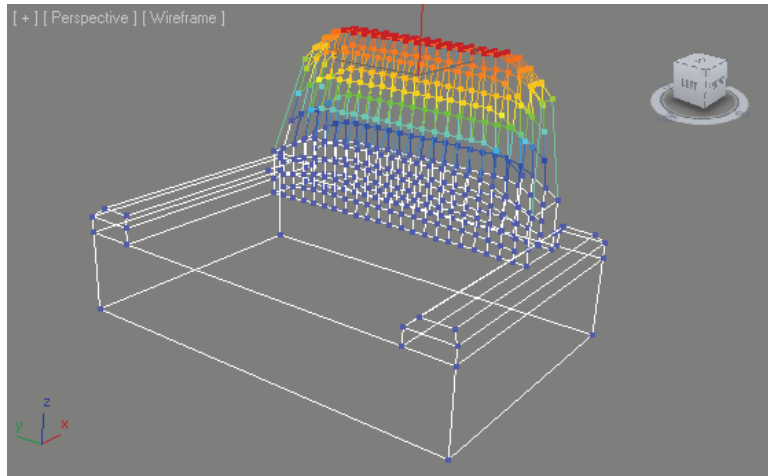

Figure 3–65

Hint: You can change the size of the transform gizmo by using the + and – keys (also – and =).

Note: You can assign a hotkey to interactively adjust the Soft selection falloff and pinch in the viewport. To do this, assign a hotkey to **Edit Soft Selection Mode**. For the exact procedure see: To edit a soft selection in the Viewport in the Autodesk 3ds Max Help.

38. Click at the top of the Modifier Stack to turn off sub-object selection. The Edit Poly modifier is highlight as gray.

39. Press <F3> to toggle from Wireframe to Realistic mode and <F4> to turn on Edged Faces mode. Alternatively, you can click the Viewport Shading menu and select **Realistic** and **Edged Faces**. Your model displays as shown in Figure 3–66.
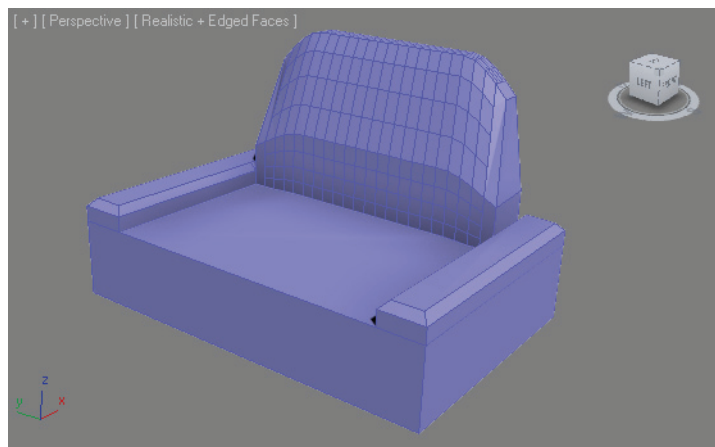

Figure 3–66

40. Select **Rendering > Environment** to open the Environment and Effects dialog box. In the *Background* area, click on the *Color* swatch and select **White** (color) in the Color Selector dialog box.

   In the Main toolbar, click (Render Production) or press <F9>. Your rendering should displays as shown in Figure 3–67.
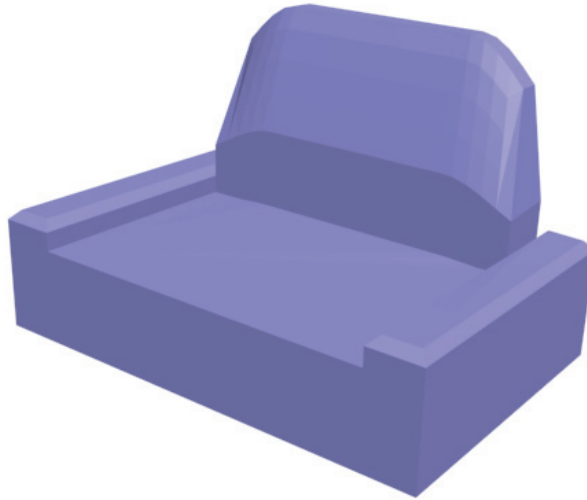

Figure 3–67

41. Note that there are some problems with smoothing. The chair looks extremely faceted. In the Modifier Stack, select Polygon or press<4> to access the Polygon sub-object level.

42. Expand the Polygon Smoothing groups rollout. Press <Ctrl>+<A> to select all the polygons, then click Auto Smooth in the rollout, as shown in Figure 3–68. Click in open space in the viewport to deselect all. You will note a subtle change in the viewport display, the edge is softened in the upright chair back
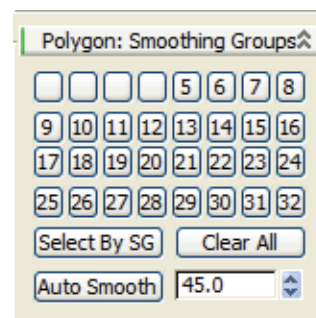

Figure 3–68

43. Render the scene by clicking (Render Production) or by pressing <F9>. The rendering shows the smoothing problem has been fixed, as shown in Figure 3–69.
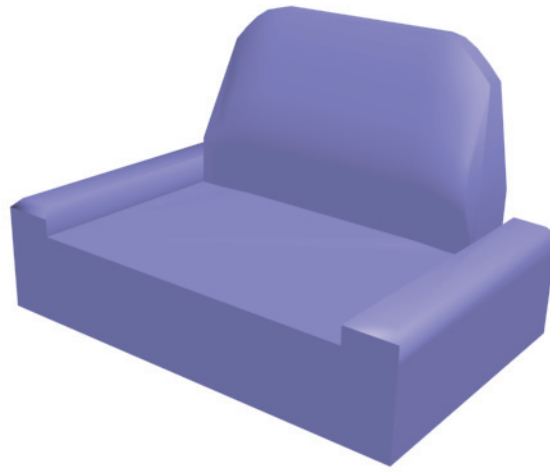

Figure 3–69

Task 2 - Apply Geometric Smoothing.

You can add Geometry Smoothing through MSmooth operation.

1. Select all the polygons by pressing <Ctrl>+<A>. If they are completely red, press <F2> to only display the faces in red outline.

2. In the Modeling Ribbon, in the Subdivision panel, press and hold <Shift> and click (MSmooth). Click . Msmooth changes the geometry by adding density to the mesh, as shown in Figure 3–70. Note the mesh is very dense in some parts and not dense enough in others.
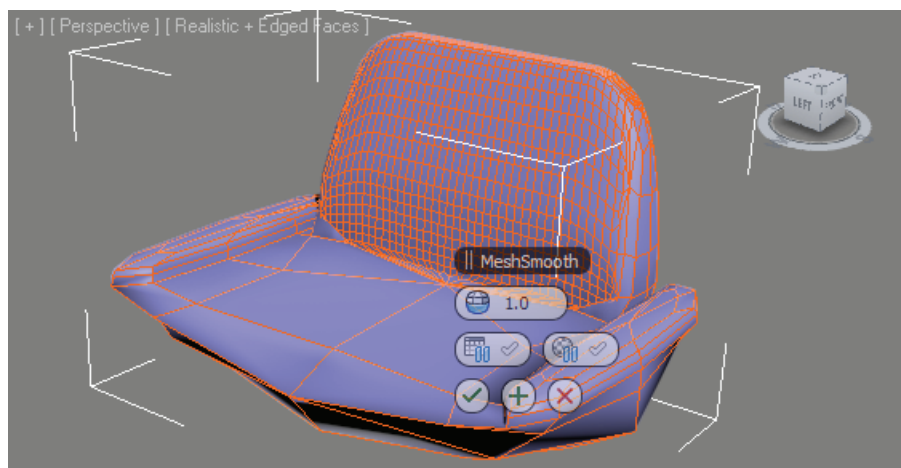

Figure 3–70

Task 3 - Subdivide the Seat.

The back is dense, but the seat is not. You need to select all the polygons that need subdivision and then add a Subdivide modifier to them.

1. Verify that the Polygon level is still active and all the polygons are still selected. If not, press <Ctrl>+<A>. Also press <F2> to display the faces as completely red.

2. In the Main toolbar, expand ▢ (Rectangular Selection Region) flyout and click 🔧 (Paint Selection), as shown in Figure 3–71.
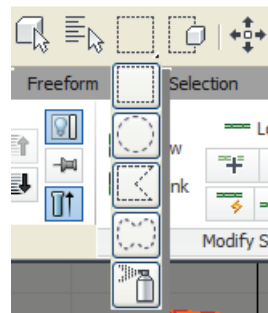

Figure 3–71

3. In the Perspective Viewport, hold <Alt> and paint to remove the dense polygons from the selection set. Leave only the polygons that need subdivision added, as shown in Figure 3–72. Orbit to a different location and continue. If necessary, press <Ctrl> to add polygons back into the set.
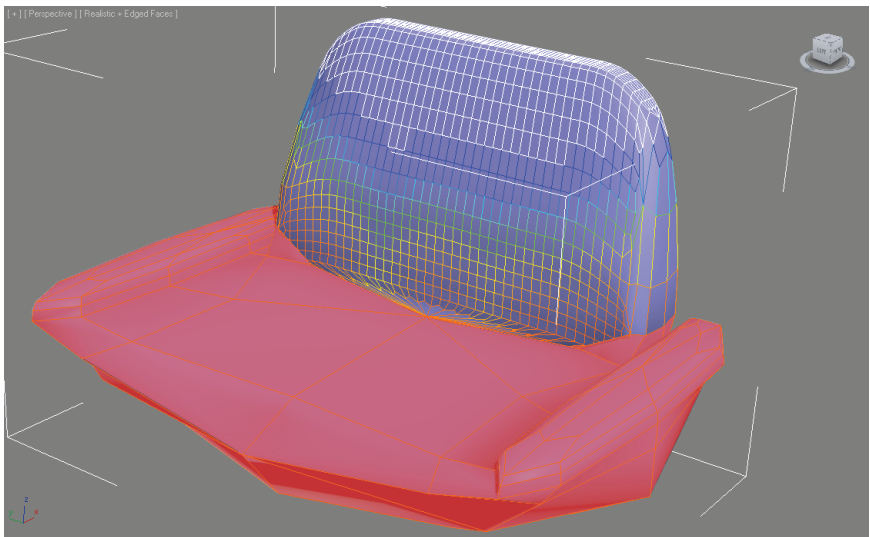

Figure 3–72

4. In the Modifier list, select **Subdivide**. The chair displays as shown in Figure 3–73. Click anywhere in empty space to remove selection.
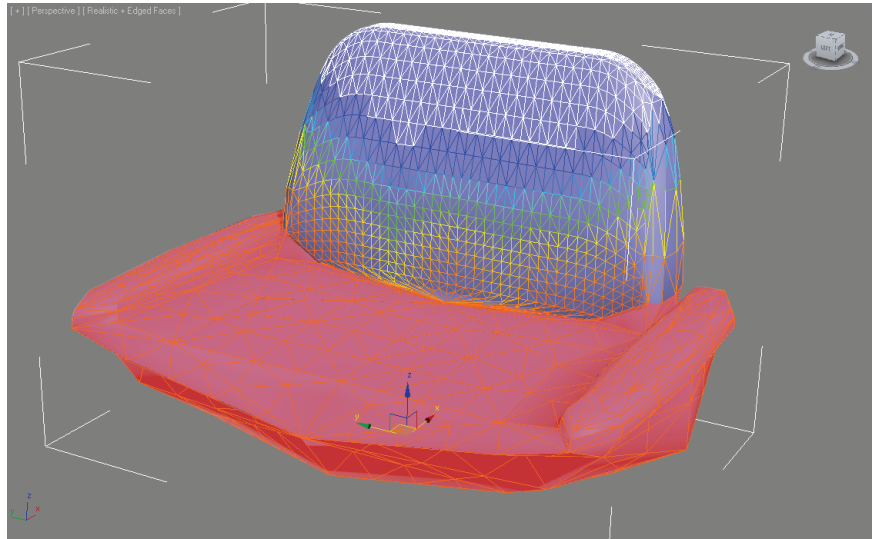

Figure 3–73

5. Save your file as **My Armchair.max**.

Task 4 - Continue Modeling the Armchair.

You can soften up your model using the Freeform tools.

1. Continue on the armchair.

2. In the *Graphite Modeling Tools* tab, in the Polygon Modeling panel, select **Apply Edit Poly Mod** and click ▢ (Polygon). You can also select **Edit Poly** in the Command Panel Modifier List. Press <Ctrl>+<A> to select all of the polygons.

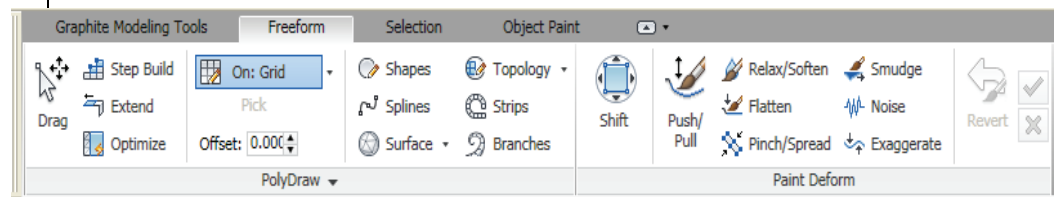3. Select the *Freeform* tab, as shown in Figure 3–74.

Figure 3–74

4. In the Paint Deform panel, click (Push/Pull). Access the help in the tool tip by pausing your cursor on the command, as shown in Figure 3–75.
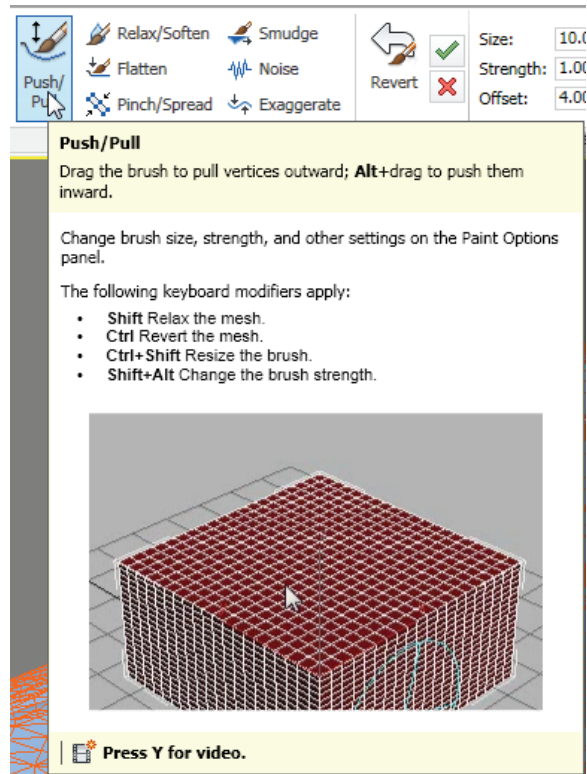

Figure 3–75

5. Use Push/Pull to create a cushion for sitting. Drag the brush to pull the vertices outward and hold down <Alt> to push them in. Change the brush size using <Ctrl>+<Shift> and the brush strength using

<Shift>+<Alt>. In the Quick Access Toolbar, click (Undo) if you pushed/pulled the wrong vertex.

6. In the Paint Deform panel, click (Shift).

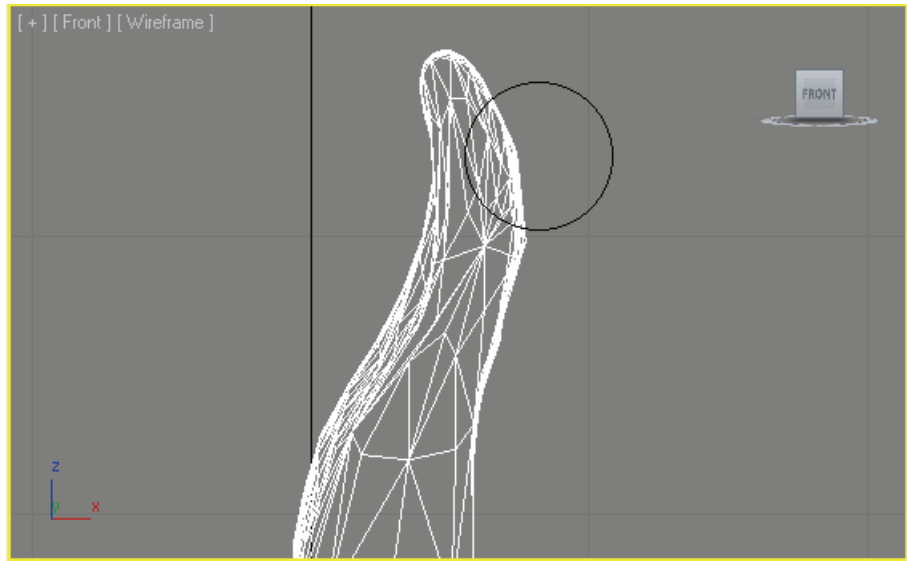7. In the Front view, use the Shift tool to stretch and deform the chair back, as shown in Figure 3–76.

Figure 3–76

8. In the Perspective view, orbit the viewport so that the chair model displays similar to the one shown in Figure 3–77.
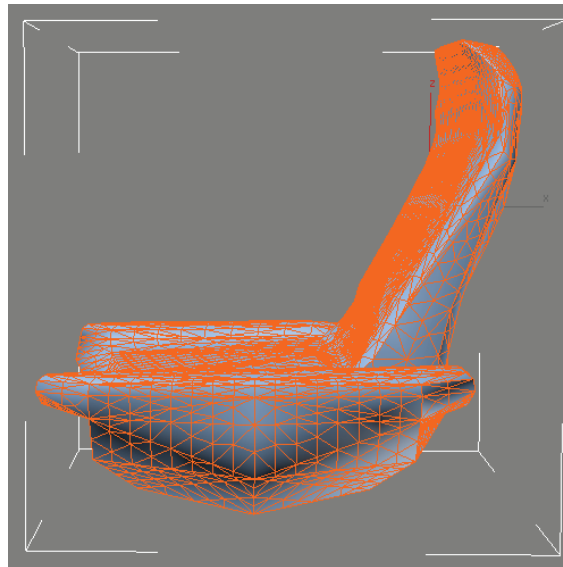

Figure 3–77

Task 5 - Optimize the Mesh.

The shape of the chair has been softened; now you need to reduce the polycount so the file can be used efficiently. The ProOptimizer modifier will achieve this.

1. Select the **Edit Poly** modifier in the stack to disable sub-object mode. In the Modifier drop-down list, select **ProOptimizer**. It will be displays in the Modifier Stack, as shown in Figure 3–78.
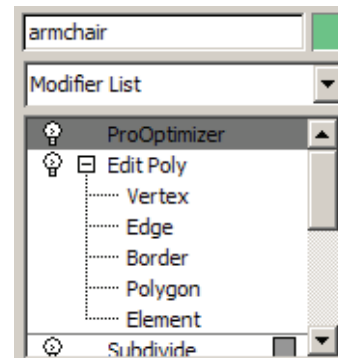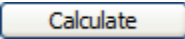

Figure 3–78

2. In the Modify panel, in the Optimization Levels rollout, click Calculate. Change the *Vertex %* to **22**. Use the spinner to move it up or down while watching the viewport as shown in Figure 3–79.
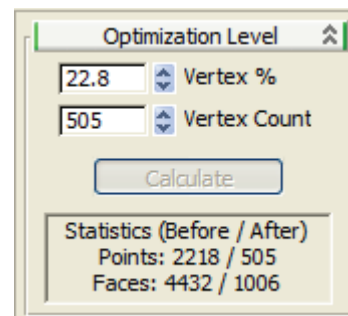

Figure 3–79

3. Save your work as **Myarmchair_softened.max**.

3.7 Statistics in Viewport

While Box modeling it is a good idea to frequently review the status of your model. You can click [3DS icon] > **Properties > Summary Info** to find out a lot of information about your file. You can also **Show Statistics** directly in the viewport. To launch statistics, in the viewport label, click [+] > **xView** and select **Show Statistics**. The total number of polygons, vertices, and Frames Per Second are displayed in the viewport, as shown in Figure 3–80, and are dependant on the options selected in the Viewport Configuration dialog box. Alternately, press <7> to toggle the statistics display in the viewport on and off.
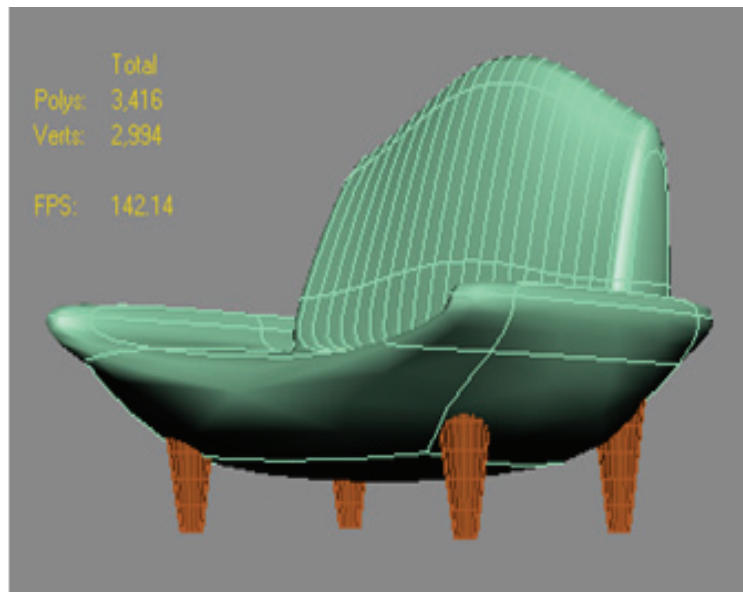

Figure 3–80

The statistics options can be controlled by selecting **Views>Viewport Configuration** and in the *Statistics* tab of the Viewport configuration dialog box, as shown in Figure 3–81. Alternately, in the viewport label, click [+] and select **Configure Viewports** to open the Viewport Configuration dialog box. In the Viewport Configuration dialog box, in the *Statistics* tab customize the display (e.g., **Polygon Count**, **Triangle Count**, **Edge Count**, **Vertex Count**, etc.).
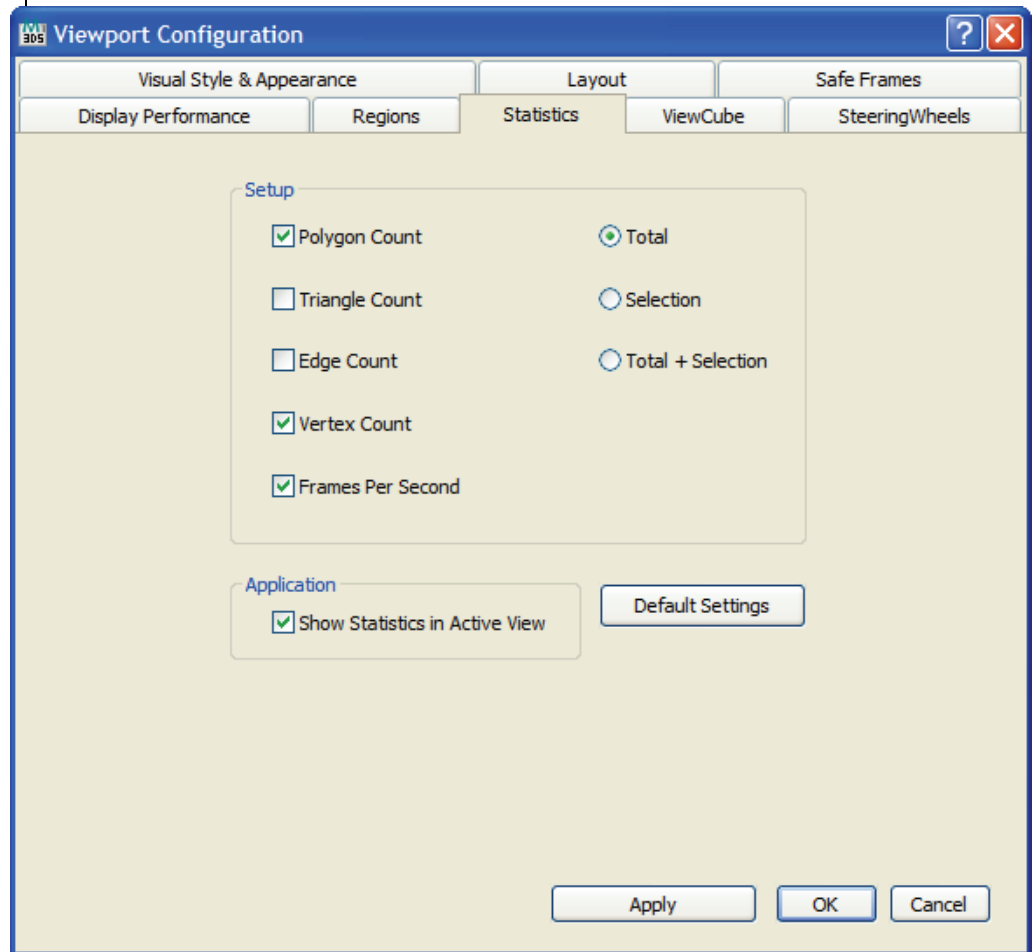
Figure 3–81

> **Hint:** When designing, it is a good idea to keep your **Polygon Count** or **Triangle Count** as low as possible to speed up rendering and viewport performance. If you are creating real time models, this impacts the interactive viewport navigation and playback speed.

■ When working in Autodesk 3ds Max Design, you can toggle the view of the statistics on and off when you need to see it. Performance might be improved if you keep this off when not in use.

> **Hint:** Sometimes **Show Statistics** does not seem to give correct results. To check the information, select **File>Summary Info** and compare the Vertex/Face/Poly count displayed there.

Chapter Review Questions

1. Where can you change the parameters of an object after you have created it?

2. How do you display the transform (Move, Rotate, or Scale) gizmo if it is missing on the object in the viewport?

3. How do you access Sub-object modes to modify an object or a modifier of an object?

4. How are the X, Y, and Z axis measured in the Screen Coordinate system?

5. Which cloning option would you use when you want the changes made to the source object to affect the duplicate object, but when any changes are made to the duplicate, they do not affect the source object?