

# 5

## Transforms

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One set of selection tools combines selection with transforms. This combination is only natural because once you've selected an object, you typically want to transform it.

The transform tools let you position and adjust your objects in space. Using them, you can move, rotate, and scale any object or selection of objects. The transforms are the workhorse tools in your 3D scene. Because any transform can be keyframed, they also become the foundation for your animations. Transforms are as essential to successful modeling and animation as the selection of objects.

This tutorial examines the transform tools in detail, using the same scene you explored in the Selection tutorial.

## Terminology

The exercises use these terms:

**Transform**—Move, rotate, or scale. These are the three transforms you can apply to a selection. Scale includes uniform and nonuniform scale, along with Squash—a special form of scale that alters the size of an object in one direction along one axis, while altering its size in the opposite direction along the remaining two axes.

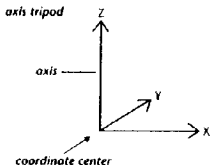
**Axis**—A vector along which geometry is moved or scaled, or about which geometry is rotated. When you work in three dimensions, you use three axes, labeled *X*, *Y*, and *Z*, to define the transforms.

**Orientation**—Rotational angle.

**Transform Coordinate System**—The orientation of the three *X*, *Y*, *Z* axes in space. The three axes are arranged at 90-degree angles to each other. You can define any point in space by measuring an offset distance from the intersection of the three axes, outward.

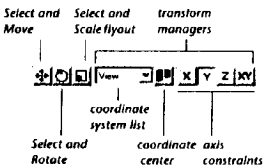
**Coordinate Center**—The intersection of the coordinate system. The *X*, *Y*, *Z* coordinates at the center are 0,0,0.

**Axis Tripod**—A visual representation of the transform coordinate system. In 3DS MAX, an axis tripod appears when you select one or more objects. The tripod displays the three axes as vector lines, labeled *X*, *Y*, and *Z*.



## The Tools

This tutorial explores the nine transform tools on the 3DS MAX toolbar. Three select-and-transform tools let you move, rotate, or scale your selection. Six controls to their right, called the *transform managers*, modify the effect of the three select-and-transform buttons.



From left to right, the transforms tools include:




**Select and Transform**—These are three buttons that let you both select and transform geometry:

- Select and Move
- Select and Rotate
- Select and Scale (a flyout that includes Uniform Scale, Non-Uniform Scale, and Squash).

The remaining controls are the transform managers.

**Coordinate System List**—A pop-up list that lets you select from several coordinate systems. The items in this list determine the *orientation* of your transform coordinate system.

**Coordinate Center Button**—A flyout that lets you choose from three transform centers:

-  **Use Pivot Point Center.** Uses the pivot point of the selected object.
-  **Use Selection Center.** Uses the center of the selection set.
-  **Use Transform Coordinate Center.** Uses the center of the current coordinate system.

**Axis Constraint Buttons**—Four buttons that determine the axis or axes available to the transform.

The following exercises demonstrate each of these controls, until you feel comfortable using them.

## Using Axis Constraints

You'll begin at the right-hand side of the transform managers with the *axis constraint* buttons. Quite simply, these constrain the current transform to one or two axes.

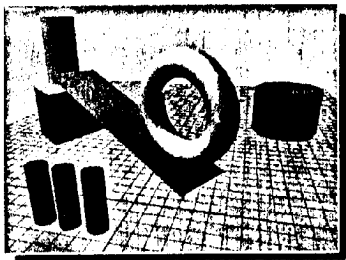
In 3DS MAX, although you operate in 3D space, you never transform your objects along all three axes, or you'd have no control. You always transform along a single axis, or along a 2D plane consisting of two axes.


You've already used the Select and Move tool in previous tutorials. Concentrate here on how the axis constraints affect that tool.

### Set up the scene:

1. Using File/Open, load *tut4\_1.max*.

The familiar scene with the primitives and the ramp appears.



2.  Click Select and Move.
3. In the Perspective viewport, click to select the purple octagon.  
An axis tripod appears in the scene.

The *X* and *Y* vectors of the axis tripod are red, while the *Z* is black. This shows you the available axes along which you can move the octagon.

#### **Move the object:**

1. Drag the octagon in the Perspective viewport, observe its movement in all viewports, and then right-click to cancel the move.

The octagon can move anywhere on the ground plane, because the *X* and *Y* axes are parallel to the ground plane. You cannot move the octagon above or below the ground plane, because the *Z* axis is locked out.

2. Click the *X* axis constraint button.
3. Drag the octagon in the Perspective viewport, and then right-click to cancel. The octagon is constrained to the *X* axis.
4. Click the *Z* axis constraint button.
5. Drag the octagon, and then right-click to cancel. The octagon moves up and down through the ground plane.

The *XY* constraint button is a flyout that lets you switch between three pairs of axes, representing 2D planes: *XY*, *YZ*, and *ZX*.

#### **Switch planes and move the object:**

1. Open the *XY* flyout, and click *ZX*.
2. Move the octagon, and then right-click.

You can now move the octagon up and down, or right and left, in relation to the ground plane, but you can't move toward the front or back.

3. Open the *ZX* flyout, and switch back to *XY*.

There are several keyboard alternates for the axis constraint buttons. The F5 through F8 keys are directly mapped to the axis constraint buttons, from left to right: F5=*X*, F6=*Y*, F7=*Z*, and F8=*XY*. Pressing F8 repeatedly switches among the pairs of axes.

Now that you're accustomed to moving an object around in the Perspective viewport, watch what happens when you switch to an orthographic viewport.

#### **Try moving in a nonperspective view:**

1. While *XY* constraint is active, drag the octagon around in the Perspective viewport, and then right-click to cancel.
2. Activate the Top viewport by clicking its label.
3. Drag the octagon in the Top viewport, and then right-click.

Since the Top viewport looks directly down on the ground plane, moving in the Top view is the same as moving in the Perspective view.

4. While watching the axis tripod, activate the Front viewport. The axis coordinates suddenly switch orientation in all viewports.
5. Drag the octagon in the Front viewport, and then right-click.

The octagon moves parallel to the Front viewport.

While you're in the Front viewport, *X* is still the horizontal direction, but *Y* has become the vertical direction. If you watch the movement in the Perspective viewport, you see the octagon moving vertically off of the ground plane. You couldn't do that using *XY* constraints while the Perspective view was active. Read the next section for an explanation.

## Using Coordinate Systems



The type of coordinate system you use affects the orientation of your axes. As a default, 3DS MAX uses a *View* coordinate system that is actually a hybrid of two other coordinate systems, *World* and *Screen*.

The *View* coordinate system is the default because it's often the most useful. To best understand it, first examine the coordinate systems with which it's made up.

### World Coordinate System

You choose your coordinate system from the coordinate system pop-up list to the right of the transform buttons. As mentioned, the coordinate system specifies the orientation of the axis tripod.

The *World* coordinate system uses the orientation of the world coordinates. In MAX, as seen from the front of the world, the *X* world axis runs horizontally, the *Z* axis runs vertically, and the *Y* axis runs in depth.

When you use the *World* coordinate system, the orientation of the axes remains the same as the construction grids, regardless of the viewport you're in.

Try out the *World* coordinate system:

1. Open the coordinate system pop-up list to the right of the transform buttons, and select *World*.

The axis tripods in all views reorient themselves to match the world system.

2. With the *XY* axis constraint button active, drag the octagon in the Perspective viewport, and then cancel the move.

The octagon moves along the *XY* axes of the ground plane.

3. Try to move the octagon in the Front or Left viewports.

The octagon won't move.

When the axis constraints define a 2D plane that's edge-on to the viewport, you can't move along that plane. You can, however, move along a *single* axis.

4. Click the *X* axis constraint button.

5. Move the octagon in the Front viewport.

The octagon moves along the *X* axis.

Notice, also, the tripod labeling while different viewports are active.

6. Click each of the viewport labels while watching the axis tripod display.

The tripod labeling remains the same, regardless of the active view, because you're working in world coordinates, which don't change.

### Screen Coordinate System

The *Screen* coordinate system reorients the axis tripod to the active viewport—or *screen*. The *X* axis is always horizontal to the active viewport, the *Y* axis is always vertical, and the *Z* axis is

always perpendicular. As you switch active viewports, the axes remain constant to the active viewport, but change relative to world space.

#### Switch to the Screen coordinate system:

1. Open the coordinate system pop-up list, and select Screen.
2. Click the XY axis constraint button.
3. Drag the octagon in the Front viewport, and then cancel the move.

The object moves parallel to the screen in the Front viewport. The axis tripod displays *X* horizontal and *Y* vertical in the Front viewport.

4. Switch to the Left viewport, drag the octagon, and then right-click.

As soon as you click in the Left viewport, the tripod flips in that viewport so that *X* is horizontal and *Y* vertical. The octagon, again, moves parallel to the active viewport.

The tripods in the inactive viewports represent the orientation of the axes in the *currently active viewport*. As soon as you switch viewports, the axes will change to represent the newly active viewport.

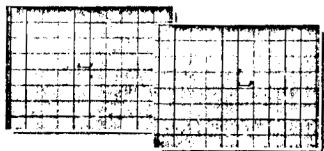
#### Try switching viewports:

1. While the Left viewport is active, observe the orientation of the tripod in the Top viewport.

The red *X* and *Y* axes in the inactive Top viewport seem to indicate that the octagon could only move vertically in that viewport.

2. Drag the octagon in the Top viewport, and then right-click.

As soon as you click the octagon, the Top viewport becomes active, and the axis tripod changes so you can again drag along the *X* and *Y* axes in the Top viewport.



The Screen coordinate system is usually best for orthographic viewports, but becomes problematic in nonorthographic displays, such as the Perspective viewport.

#### Use the Perspective viewport:

1. Drag the octagon in the Perspective viewport while watching its movement in all four viewports.
2. Right-click to cancel the move.

The octagon moves parallel to the Perspective viewport, but at odd angles in the other viewports.

The reason the octagon moves at angles is because the Perspective viewport is at an oblique angle to the world, whereas the orthographic viewports are aligned with world coordinates. Notice also that the axis tripod is parallel with the screen in the Perspective view, but at angles in the orthographic views.

## View Coordinate System

The View coordinate system uses Screen coordinates for orthographic viewports, where it makes the most sense. It switches to World coordinates for non-orthographic views, because that's usually what you want when you're viewing your scene from an oblique angle.

### Switch to the View coordinate system:

1. Click View in the coordinate system list.
2. Drag the octagon in the Perspective viewport, and then right-click.

The octagon moves along the ground plane.

3. Drag the octagon in the Front viewport, and then right-click.

The axis tripod reorients itself to the Front view, and the octagon moves parallel with the Front screen.

You can easily move an object around on the ground plane in the Perspective viewport. When you want to move the object above or below the plane, either switch to a Front or Left viewport, or change the axis constraints.

## Local Coordinate System

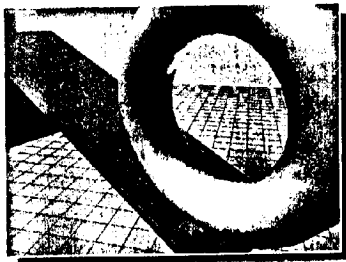
A type of coordinate system that makes sense for both perspective and orthographic views is the *Local* coordinate system. This system uses the local coordinates of the selected object. It's particularly helpful when an object's orientation is no longer the same as the world coordinate system.

For example, notice the ramp in the scene. If you wanted to adjust the ramp by sliding it up or down along its angle, you'd have to use Local coordinates.

### Access the Local coordinates system:

1. Select the ramp object.
2. While watching the axis tripod, choose Local in the coordinate system list.

The axis tripod tilts to match the orientation of the ramp.



3. Click the X axis constraint button.
4. In the Perspective viewport, drag the ramp, and then right-click to cancel.

The ramp slides along its angle, moving through the ground plane.

## Pick Coordinate System

Perhaps the most versatile coordinate system in 3DS MAX is the Pick system. It lets you use the coordinate system of any object you pick in the scene. For example, here's how to move that blue torus along the ramp.

### Access the Pick coordinate system:

1. Select the torus.
2. In the coordinate system list, click the Pick item.

The prompt line instructs you to pick an object.

3. In any viewport, click the ramp object.

The Ramp object name appears in the coordinate-system list, and the axis tripod is reoriented to match the angle of the ramp.

4. Make sure the X axis constraint button is still active.
5. Drag the torus in any viewport, and then right-click to cancel.

The torus moves along the surface of the angled ramp.

You can place up to four pick objects in the coordinate system list. Each object you select, using the Pick item, adds the object name to the bottom of the pop-up list, where you can select it at any time.

## Parent Coordinate System

The Parent coordinate system works exactly the same as the Pick system, except that it uses the hierarchically linked parent of the selected object. If the object has no parent, the world coordinates are used, because an unlinked object is a child of the world, as a default.

## Grid Coordinate System

In addition to the home grid system, 3DS MAX lets you create any number of custom grid objects, which can be placed anywhere in the scene, activated, and used in place of the home grid.

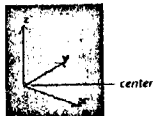
When you choose Grid as your coordinate system the orientation of the axes automatically matches that of the currently active grid system.

For a description of how to use custom grid objects and the Grid coordinate system, see chapter 7, "Precision and Drawing Aids," in the *User's Guide*.






## Using Coordinate Centers

You've seen coordinate systems; now you'll look at coordinate *centers*. These affect the center about which a transform takes place, and only affect scale and rotation transforms.




The Center flyout is to the right of the coordinate system list. It lets you specify the center of your transform. You have a choice of three centers:

-  **Pivot Point**—Uses the local pivot point of the object.
-  **Selection Center**—Uses the center of the current selection.
-  **Coordinate Center**—Uses the center of the current coordinate system.

## Pivot Point Center

The default transform center is the pivot point of the selected object, or objects. The pivot point is what you've been using throughout these tutorials. When you select an object, you see the axis tripod located at the pivot point of the object.

### Rotate about a pivot point:

1.  Click Select and Rotate in the toolbar.
2. Turn on the Y axis constraint.
3. In the Perspective viewport, select one of the orange cylinders.  
The axis tripod appears at the base of the cylinder.
4. Drag to rotate the cylinder, and then right-click to cancel.


The cylinder rotates about its base.

When you make a cylinder, its local pivot point is placed at the base of the cylinder. (You can change the position and orientation of an object's pivot point by using the Pivot tool in the Hierarchy command panel.)

## Selection Center

The Selection Center uses the center of the current selection.


### Rotate about the center of the selection:


1.  Click Use Selection Center in the Coordinate Center flyout.  
The axis tripod jumps to the center of the cylinder.
2. Rotate the cylinder, and then cancel.  
The cylinder rotates about its center.

## Coordinate Center

The Coordinate Center uses the center of the current coordinate system. As you've already seen, the current coordinate system can be any number of places, and can change depending on the viewport.

### Rotate about the current coordinate system:

1. Make sure the Perspective viewport is active.
2.  Click Use Transform Coordinate Center in the Coordinate Center flyout.

The axis tripod jumps to the origin of world space , at the center of the ground plane.

3. Click the Z axis constraint.
4. Rotate the cylinder, and then cancel.

The cylinder swings in an arc about the origin of world space.

5. Rotate the cylinder in the Front viewport, and then right-click to cancel.

As soon as you activate the Front viewport, the axis tripod jumps to the center of the viewport, and the octagon rotates about the center of the viewport.

Because you can use any object as a coordinate system, it follows that you can specify any point in space as your center.

### Change to another coordinate system:

1. Choose Pick in the Coordinate System list.
2. Pick the teal pole at the back of the ramp.

The axis tripod jumps to the base of the pole.

3. In the Perspective viewport, rotate the cylinder, and then cancel.



The cylinder rotates about the pole.

## Using a Point Object


3DS MAX provides a helper object, called a *point* object, that's especially helpful as an adjustable transform center.

The point object is simply a nonrenderable object that provides a single point in space, plus its own coordinate system. Once you've created a point object, you can place it anywhere when you need a "portable" transform center, or you can position several point objects in a scene and then switch between them.

### Create a point object:

1.  Click Helpers in the Create command panel.
2. Click the Point button.
3. Click anywhere in the Perspective view to create a point object. (You can drag the mouse to both create the point object and position it.) The point object appears as a small yellow X.
4.  Click the Select and Move tool.
5. Click the XY button.
6. Position the point object anywhere you want.

### Assign the point object as the center of your transform:

1.  Click Select and Rotate.
2. Click Pick in the pop-up list, and select the point object. The name Point01 appears in the coordinate system list.
3. Make sure the Z axis constraint button is still active.
4. Rotate the cylinder in the Perspective viewport. The cylinder swings around the point object.

## Using Centers with Multiple Objects

3DS MAX stores a different type of center depending on whether a single object is selected, or two or more objects are selected. Although the pivot point is the logical center when you're rotating a single object, you usually want to use the selection center when you're rotating (or scaling) multiple objects. Watch the Center flyout in the following procedure.

### Rotate multiple cylinders:

1. Hold **CTRL**, and click on a second cylinder to add it to the selection set.


The Center flyout switches to Use Selection Center. The tripod moves to the center of the two selected cylinders.

2. Hold **CTRL**, and add the third cylinder to the selection set.
3. Click the Y axis constraint button.
4. Rotate the cylinders, and then right-click to cancel.

The three cylinders rotate as one object about the center of their selection.

As a default, selection center is used when two or more objects are selected. Now, look what happens when you rotate multiple objects around their pivot points.

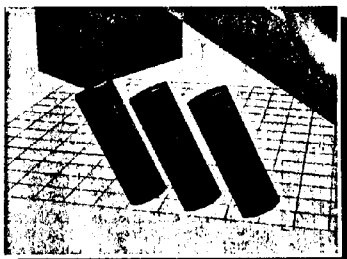
### Rotate a selection set around a pivot point:

1.  Click Use Pivot Point in the Coordinate Center flyout.

Tripods appear at the base of each cylinder.

2. Rotate the cylinders, and then right-click to cancel.


Each of the cylinders rotates about its own pivot.




## Using Scale

You've sampled every transform tool in the toolbar, with one exception—Scale. So, look at that now.

### Use Uniform Scale with default settings:

1.  Click Uniform Scale.

View becomes the current coordinate system.


2.  Click Use Pivot Point in the Coordinate Center flyout.

**Note:** The axis constraints have no effect on Uniform Scale, since it always scales the object in all directions.

3. Drag the octagon to scale it up and down, and then right-click to cancel.

The octagon grows and shrinks in size.

### Use Non-Uniform Scale:


1.  Click Non-Uniform Scale in the Select and Scale flyout.
2. Click the XY constraints (if they're not already active).
3. Scale the octagon in the Perspective viewport, and then right-click.

The octagon grows and shrinks along the *X* and *Y* axes, but doesn't change size along the *Z* axis.

4. Click *Z* constraints.

5. Scale the octagon, and then right-click.

The octagon grows and shrinks only along the *Z* axis. Notice also that it scales to and from the pivot point, at its base.


6.  Click Use Selection Center in the Coordinate Center flyout.

7. Scale the octagon, and then right-click.

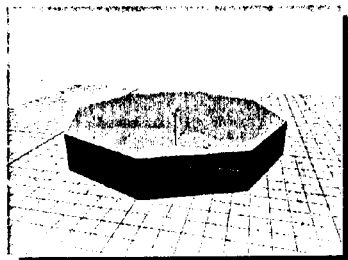
This time, the octagon scales in both directions from its center.

There's one more type of Scale, called *Squash*, that's particularly useful in animation. It lets you scale an object along one axis in one direction while scaling in the opposite direction along the remaining axes.

### Squash the Octagon:

1.  Click Squash in the Select and Scale flyout.
2. While the *Z* constraint is active, scale the octagon, and then right-click.

As the *Z* axis of the octagon scales up, the *X* and *Y* axes scale down, and vice-versa.



3. Click the *XY* constraints.
4. Scale the octagon, and then right-click.



The effect is exactly the same, except the mouse movement is reversed.

The effect is the same because, in the first case, you're scaling the *Z* axis, and the *XY* axes are responding, while in the second case, you're scaling the *XY* axes, and the *Z* axis is responding.


## Animating Transforms

Take a moment to animate the transforms you've learned in this chapter.


### Animate a squash:

1.  Click Use Pivot Point in the Coordinate Center flyout.
2. Go to frame 50, and turn on the Animate button.
3.  Turn on the Percent Snap button (left of the Animate button).

With Percent Snap on, the scaling will snap in 10 percent increments.


4. Squash the octagon down 50 percent on Z. (Watch the status line.)
5. Go to frame 100, and squash the octagon up 300 percent on Z.
6.  Click playback in the time controls.

The octagon squashes down and back up.

7.  Click playback again to stop the animation.

Now, animate the torus so it rolls down the ramp from the top.

### Position the torus:

1. Turn off the Animate button.
2.  Click Select and Move.
3. Choose Ramp in the coordinate system list.
4. Click the X axis constraint.
5. Move the torus up to the top of the ramp.
6. Turn on the Animate button.
7. Go to frame 100.

8. Drag the torus to the bottom of the ramp.

9. Play, and then stop the animation.



The torus glides down the ramp while the octagon squashes and stretches.

## Animation and Transform Centers

Because of the nature of keyframing, all transforms must occur about the object's pivot point. That means that you can use the Selection Center and Coordinate center for *modeling* operations, but you can't use them for *animation*.

As an example, look at what happens if you attempt to animate the rotation of a cylinder about the pole.

### Try rotating about a coordinate center:

1. Turn off the Animate button.
2. Select one of the cylinders.
3.  Click Select and Rotate.
4. Change the coordinate system to Pole.
5.  Click Use Transform Coordinate Center in the Coordinate Center flyout.
6. Click the Z axis constraint.
7. Drag the cylinder, and then right-click.

The cylinder swings around the pole.

8. While watching the Coordinate Center flyout, turn on the Animate button.

The Coordinate Center flyout switches to Use Pivot Point, and the axis tripod moves from the pole to the base of the cylinder. While the Animate button is on, you can't change the Coordinate Center flyout.

How do you get the animation you want? The easiest way is to link your cylinder to another object, such as a dummy object, and then rotate the dummy. This is an advanced animation topic that includes hierarchical linkage, and is covered in Tutorial 10, "Hierarchy and Forward Kinematics."

## Transform Type-Ins

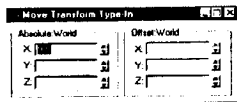
You now know all about the transform tools in the toolbar. There are two more methods of transforming objects in 3DS MAX. One is the Xform modifier, which lets you transform objects in any order in the Modifier Stack. The Xform modifier is introduced in Tutorial 6, "The Modifier Stack."

Another method of transforming objects provides precise control. It's the Transform Type-In dialog.

### Access the Transform Type-In dialog:

- Choose Edit/Transform Type-In.

The Transform Type-In dialog appears.




This is a modeless dialog that you can drag anywhere and leave on screen. You can use it either to apply a transform, or to simply view the current transform values of any object in the scene.

The display in the dialog changes, depending on the current transform settings in the toolbar, and the current selection. With the Transform Type-In dialog, you can apply a transform using either absolute or relative values. The absolute values, in the fields at left, use world coordinates, while the relative values use the current coordinate system.

Here's how to move one of those cylinders exactly 10 units back along the world's Y axis.

### Move one cylinder:

1. Turn off the Animate button.
2.  Click Select and Move, and select View in the coordinate system list.
- The title bar of the Transform Type-In dialog reads Move Transform Type-In. The axis constraints don't matter because the Transform Type-In spinners let you access any single axis.
3. In the Perspective viewport, click one of the orange cylinders.

The Absolute:World spinners display the current location of the cylinder in world coordinates. (The Offset spinners are also labeled World because the Perspective view is active, and it uses world coordinates in the View coordinate system.)

4. In the Y Offset spinner, type 10, and press ENTER.

The cylinder moves back 10 units, the Absolute Y value increases by 10, and the Offset spinner returns to 0.

The Offset spinners always return to 0 after they're adjusted, because they represent the offset value of the transform.

You could use the mouse to move the torus sideways to the edge of the ramp, but the spinners might give you more control.

### **Move the torus up the ramp:**

1. Click the torus.
2. In the coordinate system list, choose **Ramp**.

The axis tripod tilts to match the ramp's coordinate system.

3. While watching the Top viewport, drag the Y Offset spinner until the torus is at the front edge of the ramp (about -15).

## **What's Next?**

Before moving on, try out Rotate and Scale with the Transform Type-In dialog. Remember, if you want to animate any of these transforms, just turn on the Animate button.

Load some other sample scenes, and practice transforming the geometry using the tools you learned in this tutorial.

Be sure and examine the Xform modifier, introduced in Tutorial 6, "The Modifier Stack." The order in which you apply scale transforms is very important, and only the Xform modifier gives you a choice. In addition, the Xform modifier lets you transform geometry at the sub-object level.

***Tip:*** Always select the transform tools from left to right in the toolbar. That is, choose the type of transform (Move, Rotate, or Scale), and then change the transform managers. Since each transform stores its own configuration of manager settings, if you click, say, Z, and *then* switch to Scale, the axis constraint will change to whatever was last stored with the Scale transform.

# 6

## The Modifier Stack

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The Modifier Stack is the central storage location for most modeling operations in 3D Studio MAX. Each object you create carries its own Stack, and the Stack lets you access the complete construction history of every object.

Using the Stack, you can access, alter, and animate the original parameters that went into the creation of an object. You can add modifiers to the Stack to bend, twist, or otherwise distort an object, and then return and adjust—or animate—those distortions.

This tutorial examines the Stack, and the four components that make up the construction history of an object. It shows you how to add items to the Stack, and how to edit the Stack.

The tutorial also covers creation parameters, standard object modifiers, and space warps.



## Examine the Arrangement of the Stack

In 3D Studio MAX, there are several ways you can alter, or *modify* an object. Each method you apply appears in the *Modifier Stack*.

The Modifier Stack is accessed as a pop-up list in the Modify command panel. Depending on the changes you make to an object, there are four categories of adjustment that can alter an object's geometry—either relative to itself, or relative to the 3D world. Starting at the bottom, they appear in the Stack in the following order.

**Creation Parameters**—The parameters you set when you first create an object. They subsequently become available through the Modify command panel.

For a parametric object, such as a cylinder, they might consist of the radius, length, number of segments, number of sides, and so on. A nonparametric object, such as a mesh that you import from another program, would have no adjustable parameters, but a placeholder would appear anyway at the bottom of the Stack. There is only one item in the Stack to represent the creation parameters.

**Object Modifiers**—Applied to an object from the Modify command panel. They let you alter an object's geometry, relative to the object itself.

3D Studio MAX ships with three categories of object modifier: *MAX Standard* modifiers, which generally provide deformations, *MAX Edit* modifiers, which provide sub-object editing, and *MAX Surface* modifiers, which provide tools to alter the smoothing and the direction of the face normals.

**Transforms**—The transforms (move, rotate, and scale) are applied as soon as an object is created. They place the object in 3D space, and maintain its size and orientation. Each object has one set of transforms, but their values can change over time, resulting in animation. Transform values are accessed through the toolbar, and only appear as a placeholder in the Stack when space warp bindings are present.

**Space Warp Bindings**—Similar to object modifiers, in that they alter an object's geometry. However, the space warp itself is an independent object that alters another object based on the relative position of the two objects in 3D space (and on various settings in the space warp). An object must be *bound* to a space warp in order for it to be affected by it. The binding is placed at the top of the Stack. You can have as many space warp bindings in the Stack as you want.






When you create an object, creation parameters define its dimensions and topology, and transform values specify its place, orientation, and size in the 3D world. You can add as many object modifiers as you wish to alter the object's geometry relative to itself, and you can bind space warps to the object, which alter the object based on the relative position of the object to the space warp.

The remaining controls are the transform managers.

**Coordinate System List**—A pop-up list that lets you select from several coordinate systems. The items in this list determine the *orientation* of your transform coordinate system.

**Coordinate Center Button**—A flyout that lets you choose from three transform centers:

-  **Use Pivot Point Center.** Uses the pivot point of the selected object.
-  **Use Selection Center.** Uses the center of the selection set.
-  **Use Transform Coordinate Center.** Uses the center of the current coordinate system.

**Axis Constraint Buttons**—Four buttons that determine the axis or axes available to the transform.

The following exercises demonstrate each of these controls, until you feel comfortable using them.

## Using Axis Constraints

You'll begin at the right-hand side of the transform managers with the *axis constraint* buttons. Quite simply, these constrain the current transform to one or two axes.

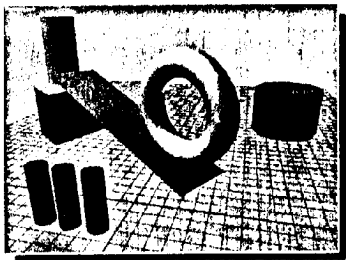
In 3DS MAX, although you operate in 3D space, you never transform your objects along all three axes, or you'd have no control. You always transform along a single axis, or along a 2D plane consisting of two axes.


You've already used the Select and Move tool in previous tutorials. Concentrate here on how the axis constraints affect that tool.

**Set up the scene:**

1. Using File/Open, load *tut4\_1.max*.

The familiar scene with the primitives and the ramp appears.



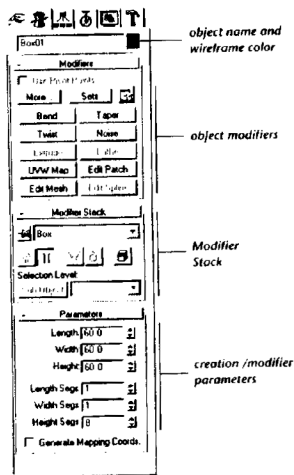
2.  Click Select and Move.
3. In the Perspective viewport, click to select the purple octagon.  
An axis tripod appears in the scene.

## Applying Modifiers

You'll now apply an object modifier. Modifiers are a form of object themselves that are applied to other objects and stay with them, altering, or modifying, the object's local geometry.

As you'll see, you can manipulate the object modifiers themselves, apply several to an object, and, at any time, go back and either adjust or delete the modifier.

## Modify Command Panel Layout



The Modify command panel is arranged in four general areas.

At the top of the Modify panel is the name of the selected object. This appears in all command panels and, as always, you can edit this field at any time to rename the object. To the right of the field is the wireframe color button. Clicking on this displays the Object Color dialog, in which you can change the wireframe color of the object.

Below the object name is the Modifiers rollout, containing a check box and three buttons, followed by two columns of modifier buttons. Only modifiers that are valid for the current selection are enabled.

Next comes the Modifier Stack rollout. You'll be examining that in detail throughout these exercises.

The last panel currently contains the creation parameters for the box. This panel contains parameters for whichever item is current in the Stack.

## Customizing the Button Set

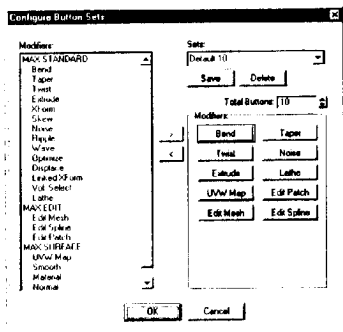
Because you can't fit all available modifiers in the command panel, 3DS MAX provides methods that let you access additional modifiers. For example, if there are more available modifiers than those displayed in the rollout, the More button is enabled. When you click the More button, a list of all additional modifiers appears, and you can select one from the list.

In addition, you can create your own custom button sets. In the following steps, you'll create a custom set, called *Tutorial 6 Modifiers*, containing four modifiers that you can use during this tutorial.

## Create a custom button set:


1.  Click the Custom Button Sets button.

The Configure Button Sets dialog appears.



2. Set the Total Buttons spinner to 4.

Four buttons remain in the Modifiers area. You can assign modifiers one at a time, but it's easier to select them all from the list, and then assign them all at once.

3. Hold **CTRL**, and click *Bend*, *Taper*, *Twist*, and *XForm* in the Default Deformations section of the Modifiers list.
4.  Click the right-arrow button to assign the selection to the four buttons.
5. Click in the Sets field, and type: **Tutorial 6 Modifiers**.
6. Click Save. Your new set will now be available whenever you run 3DS MAX.
7. Click OK.

The new set of buttons is displayed in the Modifier rollout.

You can switch between buttons sets by clicking the Sets button.

## Switch button sets:

1. Click Sets.

A menu of button sets appears.

2. Choose Default 10 from the menu.

The default 3DS MAX button set appears in the Modifier rollout.

3. Click Sets and choose Tutorial 6 Modifiers.

Your new custom set appears.

## Applying a Taper

You'll apply a Taper modifier, but first, notice the name in the Modifier Stack field is Box. That's because you're at the very bottom of the Stack, at the creation parameter level.

## Apply a Taper modifier:

- Click the Taper button.

An orange, wireframe box surrounds the object. The field in the Modifier Stack rollout now reads Taper, and the Parameters rollout changes to display the appropriate parameters for the Taper modifier.

Although the box has not apparently changed (it isn't tapered), you *have* applied the Taper modifier. It's been added to the Modifier Stack (above the creation parameters), and all that's left for you to do is adjust its parameters to taper the box.

## Look in the Stack:

- Click the arrow beside the Stack list.

The Stack contains the current Taper, and the creation parameters (Box).

Also notice that the Select and Move button in the toolbar is still green—you're in Move mode. You clicked on Taper to apply the modifier, the Taper parameters appear in the Modify panel and are available, but you're still in Select and Move mode. This is an example of the modeless state of the Modify page.


## Adjusting the Taper Parameters

The parameters for the current Taper let you adjust the amount of taper, the curvature of the sides of the taper, the axis of the taper, and the limit of the taper effect.

### Set the Taper parameters:

1. Adjust the Amount and Curve spinners and watch their effect on the box.

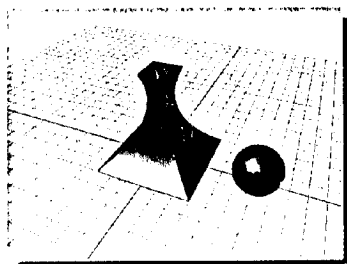
You're in a modeless state at this point. You can use the viewport navigation controls, change viewports, and even transform the object.

2. Right-click the Perspective viewport label, and choose Smooth + Highlight.
3.  Click Arc-Rotate and adjust the rotation of the viewport.
4. While in Arc-Rotate mode, adjust the Amount and Curve spinners.
5. Right-click in the viewport to exit Arc-Rotate mode, and return to Select and Move mode.
6. Select the sphere.

The creation parameters for the sphere appear in the Modify panel.

7. Adjust the sphere's radius.
8. Select the box. The Taper parameters reappear.
9. Set the Amount to -0.7, and the Curve to -1.5.

The box is now an inward curved column.



## Animating the Taper Parameters

Almost everything in 3DS MAX can be animated, including modifier parameters. The Taper Axis settings are absolute and cannot be animated, but the spinner values can.

### Animate the Taper parameters:

1. Turn on the Animate button.
2. Go to frame 50.
3. Change the Amount spinner to whatever you like.
4. Go to frame 100.
5. Change the Curve to whatever you like.
6. Play, and then stop the animation.

The box changes shape over time.

## Adjusting the Gizmo

An object modifier is a kind of object. The orange wireframe you see represents the structure of the Taper modifier, called the *gizmo*. You can use any transform to alter the position, rotation, or scale of the gizmo relative to the object. This changes the relationship of the Taper effect to the box. When the Animate button is on, the effect is animated.

Since the gizmo is a part of the modifier, you access it by turning on the Sub-Object button.

### Animate the Gizmo:

1. Click the Sub-Object button.

The list field at right becomes active, and the gizmo wireframe turns from orange to yellow. (If you look in the Sub-Object pop-up list, you'll also see a Center item. This is the center of the modifier. By selecting it, you can transform the center of the modification effect.)

2. Leave the Animate button on.
3. Go to frame 30.

**Tip:** To go directly to a frame, enter its number in the current frame field, to the right of the Animate button, and press ENTER.

4. Making sure the Select and Move tool is still active, drag over the yellow wireframe to move the gizmo. As you move the yellow gizmo, the box is distorted.
5. Go to frame 60, and move the gizmo in a different direction.
6. Go to frame 100 and move the gizmo again.
7. Play, and then stop the animation.

The box changes its tapering shape, and distorts as the gizmo moves in relation to it.

## Adding Modifiers to the Stack

Each time you apply a modifier, it's added on top of the current modifier in the Stack.

### Add a Twist modifier:

1. Click the Twist button.

The Stack field now contains a Twist item. The controls in the Parameters rollout change to those of the Twist modifier, and the Sub-Object button is turned off.

2. Make sure the Animate button is still on, and move to frame 30.
3. Adjust the Angle spinner to approximately 180 degrees.

The box is twisted.

## Accessing the Creation Parameters

The edges of the twist are not smooth because the box, as created, doesn't have enough segments along its height. Go back to the creation parameters at the bottom of the Stack and increase the number of segments.

### Move back in the Stack:

1. Right-click the Perspective viewport label, and choose Wireframe.
2. Click to open the pop-up list in the Modifier Stack rollout.

Twist  
Taper

Box

The list shows you the current modification history of the object. At the top is the latest modifier, the Twist. Below that is the Taper you applied. At the bottom is "Box," representing the creation parameters.

3. Select Box from the list.

The box's creation parameters appear in the Parameters rollout.

4. Increase the Height Segs spinner until the twist is smooth (about 30–40 segments).

**Note:** Don't confuse the Height Segs spinner with the Height spinner.

Because you've adjusted the segments at frame 30, with the Animate button active, you've actually animated the increase in segments.

5. Drag the time slider between frame 0 and 30.

You can see the segments increase over the range of frames.

6. Right-click the viewport label, and choose Smooth + Highlight.

7. Play the animation.

The box twists and writhes over 100 frames.

8. Stop the animation.

Thus, you can actually change the topology of your objects over time. At frame 0, where you don't need the extra segments, the object is relatively simple. At frame 30 where you need the segments, the complexity is there.

## Editing the Stack

As mentioned, the Modifier Stack holds the entire construction history for an object. You've just increased the segments in your creation parameters. Continue with your Twist adjustment.

### Edit the Twist:

1. Click to open the pop-up list in the Modifier Stack rollout, and select Twist at the top of the Stack.

The Twist parameters appear.

2. With the Animate button still on, move to frame 60 and change the angle of the Twist, and then move to frame 100, and change the angle again.

Next, you decide you want to go back and adjust the Taper.


### Edit the Taper:

1. Open the Stack list, and choose Taper.



The Taper parameters appear.

2. Go to any frame in the animation and adjust the Amount and Curve spinners.



## Using Show End Result

Say you want to adjust the Taper, but need to see what the object looks like at this spot in the Stack, without the additional Twist. The buttons below the Stack list provide various functions that affect the current item in the Stack. One of these is the Show End Result button , which is usually on. By turning it off, you see only the effect of the Stack history up to the current level of the Stack.

### Use Show End Result:

1.  →  Turn off Show End Result, below the Stack field.

The Twist effect disappears, and the object looks just like it did before you applied the Twist.



2. Adjust the Taper.
3.  →  Turn on Show End Result.

The Twist returns.

## Deactivating a Modifier

You can also temporarily deactivate any modifier in the Stack to see what your object might look like without that item. The modifier stays with the object, but remains inactive until you go into the Stack and turn it back on.

### Deactivate the Taper:

1.  →  Turn off Active/Inactive Modifier Toggle.

The Taper modification is removed from the object.

2. Go up in the Stack list to the Twist modifier, and deactivate it as well. Only the box remains.

3. Reactivate both the Twist and the Taper modifiers. The animated, twisting box is restored.

## Deleting a Modifier

If you apply a modifier and it just doesn't work out, or you apply a modifier to the wrong place in the Stack, you can simply delete it.

Each item in the Stack is applied to the geometry from the bottom of the Stack, upward. Therefore, the effect of any modifier on your object depends on where in the Stack you apply it.

A typical mistake is to go back and adjust the creation parameters, and then apply another modifier, forgetting to first move up to the top of the Stack. Here's an example of how this error might occur:

### Adjust creation parameters, and then apply a Bend:

1. Choose Box from the Stack list to display the creation parameters.

At this point, you might adjust the parameters, but then, forgetting to go back to the top of the Stack, apply another modifier.


2. Apply a Bend modifier.
3. Adjust the Angle spinner.

The result is strange because you're actually bending the box *before* the Taper and Twist modifiers are applied.



You decide you've made a horrible mistake, but you can easily fix it by removing the Bend and reapplying it at the top of the Stack.

#### Delete the Bend and apply it again:

1.  Click Remove Modifier below the Stack field.

The Bend is removed from the Stack.

2. Choose Twist from the Stack list.

You're now at the top of the modifier list.

3. Click the Bend button.

4. Adjust the Angle spinner.

The tapered, twisted box bends over.

5. Turn off the Animate button.

6. Use File/Save As to save your scene as *mytut6.max*.

## Using Space Warps

From the bottom up, the box's Stack now consists of creation parameters, a Taper, a Twist, and a Bend. Although you can't see it in the Stack list, the object's transforms follow the modifiers.

Now, you'll add the last type of item to the Stack—the space warp binding.

Space warps, as their name implies, warp space. They affect an object based on the relative position of the object to the space warp.



The space warp itself is an object in the 3D Scene. It can be transformed, but it's not rendered.

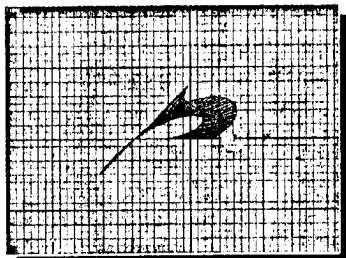
## Creating a Ripple


Because a space warp is an object, you create it like any other object. In the following, you'll create a Ripple space warp, adjust it, and then bind the box to the Ripple.

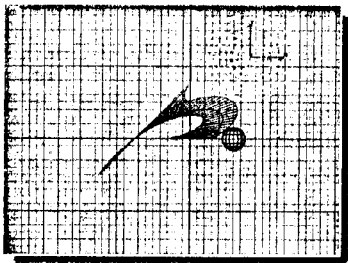
The Ripple space warp generates a circular sine wave from its center outward. Objects that are bound to it are distorted by the generated wave.

#### Adjust the viewpoints and create the Ripple:

1.  Click Min/Max Toggle in the navigation controls to display all four viewpoints.
2.  Use Zoom to zoom out the Front viewport so there's some room around the two objects.




3.  Click Space Warps in the Create command panel.
4. Click the Ripple button.
5. In the Front viewport, to the right and slightly above the box, drag the mouse to define the Wave Length of the ripple (about 30 should be fine).
6. Release the mouse, move it to define the amplitude (about 5 for Amplitude 1 and Amplitude 2), and then click to create the Ripple.



## Binding the Object

The space warp object only affects those objects in the scene that you *bind* to it. You can bind any number of objects to a single space warp, or bind a single object to any number of space warps.

### Bind the box to the space warp:

1.  Click Bind to Space Warp in the toolbar, and select the box.

**Note:** This is one of the combination selection tools mentioned but not demonstrated in the Selection tutorial.

2. Point the mouse over the box.

The cursor changes to a bind cursor.

Watch the box during the next step.

3. Drag the mouse from the box over the space warp, and then release the mouse.

As you drag the mouse, a dashed line appears from the pivot point of the box to the cursor. When the cursor is over the Ripple (or any valid space warp in your scene), the cursor changes shape. When you release the mouse button, the Ripple flashes, the box is bound

to the Ripple, and it's immediately affected by it.



## Adjusting the Warp Effect

There are three basic ways you can change (and animate) the effect of a space warp on a bound object:

- Alter the relative position between the space warp and the bound object.
- Adjust the parameters of the space warp.
- Adjust the parameters of the space warp binding.

In the following steps, you'll look at the first two methods.

### Adjust the position between the two objects:

1. Activate the Perspective viewport.
2.  Click Min/Max Toggle to enlarge the Perspective viewport to full size.
3. Go to any frame of your animation.
4.  Click Select and Move.
5. Drag the box around, watch the effect of the Ripple on it, and then right-click to cancel.

As you move the box, it wriggles, depending on its position, relative to the Ripple.

6. Select and move the Ripple object around the scene, and then right-click to cancel.

The box wriggles as the Ripple is moved in the scene.

Those are two methods of animating the box. You can either animate the box flying past the ripple, or you can leave the box stationary and animate the movement of the Ripple object.


Another method is to animate the space warp parameters.

### Animate a Ripple Parameter:

1. Go to frame 100.
2. Turn on the Animate button.
3. Open the Modify panel, and select the Ripple object (if it's not already selected).
4. Set the Phase spinner to about 0.5.
5. Turn off the Animate button.
6. Play the animation.

The box writhes and twists from the modifiers, and wriggles because of the Ripple. You can also see the animated phase shift in the wireframe Ripple.

7. Stop the animation.

*Tip:* Depending on the speed of your hardware and your display, the animation might appear very jerky. As a default, 3D Studio MAX plays viewport animations in real time, skipping frames where necessary. You can turn this off by clicking Time Configuration  in the time controls, and then unchecking Real Time in the Playback area of the Time Configuration dialog box. When Real Time is turned off, all frames are displayed during playback. The playback will appear slow, but you'll know that you're seeing every frame. You can also speed viewport animation by minimizing your viewports to quarter size.

## Another Look at the Stack

Now that you've added the final type of item, the space warp, to the box's Modifier Stack, take another look.

1. Select the box.
2. Click to open the Stack list.

### Ripple Binding

=====

Bend

Twist

Taper

.....

Box

You can see that the elaborately complex object in your scene starts with a box (the creation parameters). Above this are three object modifiers that are distorting the creation parameters—a Taper, followed by a Twist, followed by a Bend. Above the three modifiers, a double-dashed line (=====) represents the ever-present transforms, and above the transforms is the binding to the space warp, in this case, a Ripple.


As with the modifiers, you can deactivate, or even delete the space warp bindings at any time.

## Changing the Stack Order

The order of the items in the Stack can alter the end effect on the object. Although you can't change the order of modifiers already in the Stack, you can specify where a new modifier will be inserted when you first apply it. Modifiers are inserted just above your current location in the Stack.

See what happens to two identical cylinders when you apply a Taper and a Bend in different orders.


### Start fresh, and create a cylinder:

1. Reset MAX, and answer Yes to save your changes.
2. Create a cylinder with a Radius of **10**, a Height of **50**, and **12** Height Segments.
3.  Click Select and Move, and XY axis constraints.
4. In the Perspective viewport, hold SHIFT, and drag the cylinder to the right.

The Clone Options dialog appears.


5. Make sure Copy is selected, and then click OK.

Two identical cylinders are in the scene.

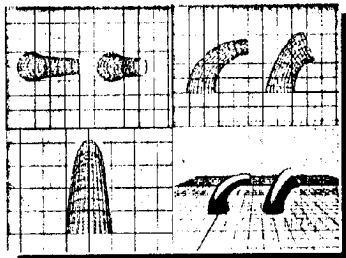
6.  Click Zoom Extents All.
7. Set the Perspective viewport to Smooth + Highlight.
8. Choose Edit/Hold.

You'll now apply a Taper followed by a Bend to the first cylinder, and the same two modifiers in reverse order to the second.

### Taper and bend the cylinders:

1. Select the first cylinder.
2. In the Modify command panel, click Taper, and set the Amount to **-0.5**.
3. Click Bend
4. Set the Angle to **90**.
5. Select the second cylinder.
6. Apply a Bend with an Angle of **90**.
7. Apply a Taper with an Amount of **-0.5**.
8.  Click Zoom Extents All.

The two cylinders are distorted differently.





The cylinders are different because, in the first case, you bent a tapered cylinder, while in the second, you tapered a bent cylinder.

## Using the XForm Modifier

You can specify the order of the *object modifiers* in the Stack, but what do you do about *transforms*, which are always applied after modifiers?

The following steps show you a typical problem you might run into when using non-uniform scaling transforms.

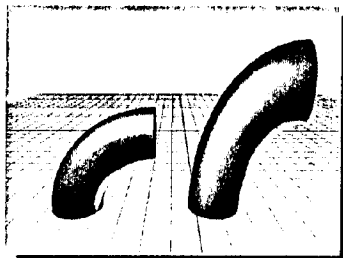
### Apply Non-Uniform Scale and a Bend:

1. Choose Edit/Fetch, and answer Yes at the prompt.
2.  Click Non-Uniform Scale in the Scale fly-out.
3. Click the Z axis constraint button.
4.  Turn on Percent Snap in the prompt line.
5. In the Perspective viewport, select and scale the second cylinder up 150 percent along the Z axis.

The second cylinder is now taller than the first.

6. Select the first cylinder.
7. Apply a Bend, and set the Angle to 90.
8. Select the second cylinder.
9. Apply a Bend, and set the Angle to 90.

The two cylinders are bent differently.




Because transforms are always applied after modifiers, the non-uniform scale, applied to an already bent cylinder, distorts the bend effect. To get the bend you want, you need to apply the scale *before* the bend, which is something you can't do directly using the transform tools in the toolbar.

The solution is to use a *transform modifier*. Actually, the modifier is called the *XForm* modifier. It lets you apply transforms to an object as part of the modifier list. You apply the XForm modifier wherever you want in the Stack, and then transform the modifier's gizmo, which, in turn, transforms the geometry.

### Use the XForm modifier:

1. Choose Edit/Fetch, and answer Yes at the prompt.
2. Select the second cylinder.
3. Click the XForm button in the Modify command panel.

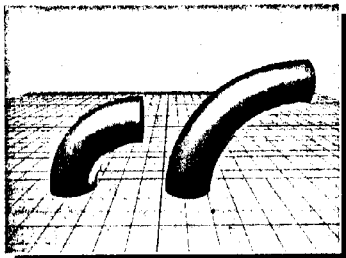
The XForm modifier appears in Sub-Object mode with its gizmo already selected.

4.  In the Perspective viewport, use Non-Uniform Scale to scale the gizmo **150 percent** along the Z axis.

The cylinder is scaled along with the gizmo.

5. Turn off Sub-Object
6. Select the first cylinder, apply a Bend, and set the Angle to **90**.
7. Select the second cylinder, and apply a Bend with an Angle of **90**.



Both cylinders are bent in the same way.



Examine the Stack list of the second cylinder, and you'll see that the XForm modifier carrying the non-uniform scale comes *before* the Bend. This is the reason the bend is working properly.

You can duplicate the previous scaling problem by changing the order of the Bend in the Stack.

#### Change the order of the Bend:

1.  →  Turn off the Active/Inactive modifier toggle to turn off the Bend in the second cylinder.
2. Move down the Stack to the creation parameters (Cylinder.)
3. Apply a Bend, and set the Angle to **90**.

The cylinder is bent strangely as it was at the beginning of this exercise.

XForm is an extremely valuable modifier. Not only does it let you specify exactly where in the Stack you want a transform, but you can also use it to transform sub-object geometry, as you'll see in the next tutorial.

## Modifying Multiple Objects

Now that you know how to navigate the Stack, and the difference between a modifier and a space warp, it's time to look at what happens when you apply modifiers to a selection set of objects.

There are two things to remember when you apply a modifier to two or more objects at once:

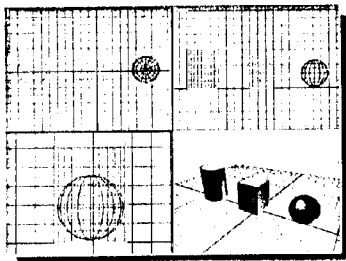
- You can modify each object in the selection individually, or modify the selection set as a whole.
- Regardless of which method you choose, an *instance* of the same modifier is applied to all of the objects in the selection set.

### Use Pivot Points

Begin by loading a sample file, selecting several objects, and applying a modifier.

**Load a sample file and apply a Taper:**

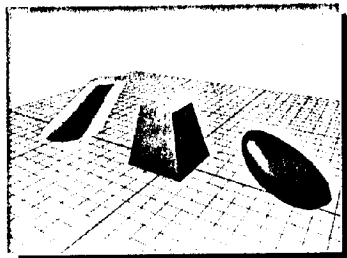
1. Using File/Open, load *tut6\_2.max*.
2. Choose Edit/Hold.



3. Select all three objects in the scene.

4. Open the Modify command panel, and make sure that Use Pivot Points is not checked.
5. Apply a Taper modifier.
6. Adjust the Amount to about  $-0.7$ .

All three objects are tapered as though they were one object. In other words, the selection set as a whole is tapered.




When Use Pivot Points is turned off, the entire selection set is treated as if it were a single object, and modified accordingly. This is the effect you might want if you had several 3D letters forming a word, and you wanted to bend the word.

You'll return to this effect later, but note that you must select your pivot point option *before* you apply the modifier. You can't go back and change it after the fact. Luckily, if you make a mistake, you can simply delete the modifier from the Stack, switch the option, and then reapply the modifier.

Say you want to taper each object individually.

### Delete the modifier and apply again:

1.  Click Remove Modifier to remove the Taper from the Stack.
2. Select Use Pivot Points.
3. Apply a Taper.
4. Adjust the Amount to about  $-0.7$ .  
Each object is individually tapered.

### Instanced Modifiers

Although you see a Taper gizmo around each of the selected objects, only one Taper actually exists in the scene. Moreover, the Stack for each object contains the same Taper modifier. When you apply a modifier to a selection of objects, each object receives an *instance* of the same modifier.

An instance is something that appears more than once in a scene. It can be in different locations, but when you adjust one instance, all other instances are affected identically. Although you see different modifiers, they're actually the same modifier in two or more places.

The concept of instances is used throughout 3DS MAX; see Tutorial 8, "Copies, Instances, and References."

Look at what happens when you adjust the Taper modifier in only one of the objects.

### Adjust the Taper for the sphere:

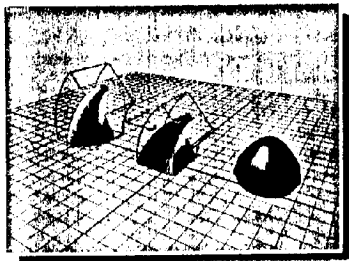
1. Deselect the objects.
2. Select only the sphere.  
Taper gizmos appear around the cylinder and box as well as the sphere.
3. Adjust the Amount spinner.

All three objects are modified.

### Change the selection and add a Bend:

1. Select the cylinder and the box.
2. Apply a Bend.
3. Adjust the Angle to about 50 degrees.

The cylinder and box bend, the sphere doesn't change.





You now have a single Taper applied to all three objects, and a single Bend applied to the box and the cylinder. The modifiers available in the Stack depend on the current selection.

### Change selections and observe the Stack:

1. Select the sphere.

The Taper appears in the Stack, and the Taper gizmo surrounds all three objects.

2. Adjust the Amount spinner.

All three objects are modified.

3. Select either the cylinder or the box.

The Bend modifier appears in the Stack.

4. Adjust the Angle spinner.

Only the cylinder and box are modified.

5. Select all three objects.

The Stack is blank.

The Stack is blank because there is no longer *commonality* among the three objects. The sphere doesn't share the Bend with the box and cylinder. As a result, when you select all three objects, there's nothing to display.

Commonality is only maintained in the Stack when each object in the selection set shares a common modifier at the *top* of the Stack. When the last modifier in the Stack is not shared by every object in the selection set, the Stack is no longer common to all.

You can, however, always access modifiers that were previously common by selecting a single object, and then going down in its stack to the instanced modifier. When you adjust the instanced modifier, all objects that share it will be affected, regardless of the state of the selection.

## Show Dependencies

Objects that share instanced modifiers (or objects that are themselves instanced) are dependent on each other. 3D Studio MAX provides a function that helps you determine which objects in your scene are dependent on each other because of instancing. It's called Show Dependencies.

### Display Dependencies:

1. Choose Views/Show Dependencies.

2. Select only the sphere.

The wireframe displays and the brackets of the box and cylinder turn bright green.

3. Adjust the Taper parameters.

The current selection and the green objects are all affected.

When Show Dependencies is on, deselected objects that are dependent on the current function applied to the current selection turn bright green.

In the previous example, when the sphere is selected, its last modifier is the Taper, instanced between all three objects. As a result, the box and cylinder turn green. .

### Select the cylinder; then the box:

1. Select the cylinder.

Only the box turns green.

2. Select the box.

Only the cylinder turns green.

The box and cylinder share their Bend modifier, which is currently at the top of their stacks. Since the sphere doesn't share this modifier, it doesn't turn green.

The green display is completely dependent on the current modifier in the Stack, as you'll see in the following steps.

#### Change the Stack location:

1. While the box is selected, move down in its Stack list to the Taper.

The cylinder and sphere turn green.

2. Move down to the creation parameters (Box).

None of the objects are green.

When you move to the Taper modifier, it's instanced in all three objects, so both the cylinder and sphere turn green. However, the creation parameters of the box are shared by no other objects, so none of the objects is green when you're at that position in the Stack.


#### Make Unique

Applying modifiers to selection sets is a fast way to place the same modifier on a collection of objects. After applying the modifier, you might want each object to be modified in a *unique* manner.

#### Make the Taper Unique:

1. With the box selected, move to the Taper modifier in its stack.

The cylinder and sphere turn green.

2.  Click Make Unique in the Modifier Stack rollout.

The green highlighting is turned off and the gizmos disappear around the cylinder and sphere.

3. Adjust the Amount spinner.

Only the box is affected.

4. Select the sphere.

The cylinder turns green, but not the box.

5. Adjust the Amount spinner.

Only the sphere and cylinder are affected.

As soon as you clicked Make Unique, the Taper in the box's Stack became unique, and was no longer instanced. The Taper applied to the cylinder and sphere, however, remains instanced, unless you make it unique as well.

You can make all instanced modifiers in a selection set unique with a single click of the button, but there's an interesting side effect you should be aware of.

#### Make a selection set unique:

1. Select all three objects.

2. Apply a Twist.

3. Adjust the Angle a bit.

All three object twist.

4.  Click Make Unique.

The Stack becomes blank.

The Stack becomes blank because, once you've made the Twist for each object in the selection unique, the selected objects no longer have commonality in their Stacks. Thus, to access each Twist, you must now select each object individually.

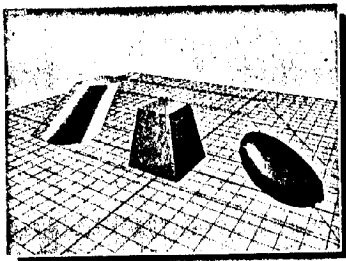
## Modifying the Selection Set

At the start of this exercise, you saw the effect of applying a modifier while Use Pivot Points was off. Look at that again.

**In the original scene, apply a modifier:**

1. Choose Edit/Fetch, and answer Yes at the prompt.
2. Select all three objects.
3. Uncheck Use Pivot Points.
4. Apply a Taper, and adjust the Amount to about  $-0.6$ .

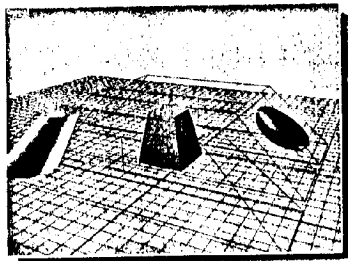
All three objects are tapered as if one.



Judging from the gizmo, it *looks* as if a single modifier is affecting the three objects. But you still have three instances of that single modifier. When you first apply the modifier to the selection, the gizmo for each object is overlaid and looks like one, but look what happens when you move the objects.

**Move the objects:**

1. Click Select and Move.
  2. Select only the sphere, and move it back and away from the box.
  3. Move the cylinder forward and away from the box and sphere.
- Each object has its own gizmo.



4. While the cylinder is selected, adjust the Amount spinner.
5. Click Make Unique, and adjust the Amount spinner.

The gizmo now surrounds only the cylinder, and only the cylinder is modified.

As you can see, the rule for instanced modifiers is the same whether you apply the modifier with or without Use Pivot Points checked.



## The Cylinder Table

In this exercise, you'll pull together the concepts of applying modifiers to single and multiple objects by creating an animated table made up entirely of five cylinders. You'll also get your first taste of *instanced objects*.

### Making the Top and Legs

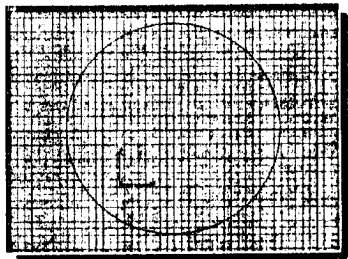
Begin by resetting 3DS MAX, and then creating the necessary geometry.


#### Create the table top:

1. Reset 3DS MAX (but don't save your changes).
2.  Turn on 2D Snap in the prompt line.
3. Set the Perspective viewport to Smooth + Highlight.
4. In the Create command panel, click the Cylinder button.
5. In the Top viewport, create a cylinder in the center of the ground plane with a radius of 150 units, and a height of 10 units.
6. Set the Sides spinner to **40** to smooth out the edge of the table top.
7. In the Name field, type **Table Top**, and press ENTER.
8.  Click Zoom Extents All.

#### Create the first leg:

1. Make sure the Cylinder tool is still selected.
2. In the Top viewport, point the mouse inside the table top toward the lower-left quadrant, and drag to define a radius of **20** units. (See the following illustration.)




3. Release the mouse, and then move it to define a height of **160** units.  
You'll use square legs for the table, so adjust the cylinder's parameters accordingly.
4. In the Parameters rollout, change the number of sides to **4**.
5. Uncheck Smooth.
6. In the Name field, type **Leg**, and press ENTER.
7.  Click Zoom Extents All.

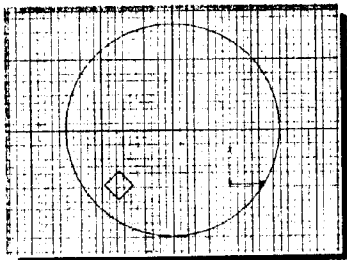
## Instanting the Legs

To create three more legs, you'll make *instanced* copies so you can easily modify all four legs by adjusting any one of them. The concept of instanced copies is covered in detail in Tutorial 8, "Copies, Instances, and References."

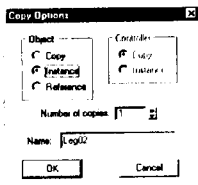
As with the instanced modifiers, demonstrated earlier, three instanced objects in your scene, are the *same* object in three different locations. Any modifications you make to one of the objects affects the others.

### Make instances of the leg:

1.  Click the Select and Move button in the toolbar.
2. Click the X axis constraint button (or press F5).
3. In the Top viewport, hold SHIFT, point the mouse at the leg, and drag to the right until the copy is about same distance from the opposite edge of the table top.



When you release the mouse, the Clone Options dialog appears.



4. Choose the Instance option, and then click OK.

An instance of the table leg is created.

Although it looks like you have two leg objects, both are the same object displayed in two places in the scene.

### Make a total of four instances:



1. Drag the mouse to region select both legs.  
(Or, hold CTRL and click the deselected leg to add it to the selection.)
2. Click the Y axis constraint button (or press F6).
3. Hold SHIFT and drag the two legs up to the opposite side of the table top.
4. In the Clone Options dialog, make sure that Instance is still selected, and click OK.

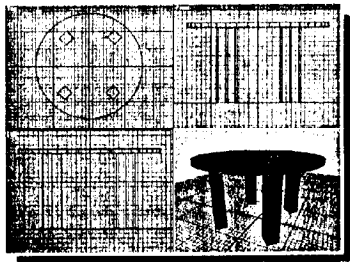
You now have four instanced table legs.

## Moving the Table Top

Before you do anything else with the legs, you'll raise the table top. Since Y axis constraint is active, the Front viewport is the logical place to do this.

### Position the table top:

1.  Turn off 2D Snap.
2. In the Front viewport, drag the table top up until it barely overlaps the tops of the legs.
3. Turn on XY axis constraint and, in the Top viewport, move the table top so it appears centered over the table legs.
4.  Use the Arc-Rotate button in the Perspective viewport to adjust the viewing angle on the table.



## Modifying a Leg

Because the legs are all instances, you adjust any single one to modify all of them.

### Taper the legs:

1. In the Perspective viewport, click to select one of the legs. (If you're still in Arc Rotate mode, first right-click to exit the mode.)

2. In the Modify command panel, click the Taper button.

A taper is applied to the leg, and all of the instances.

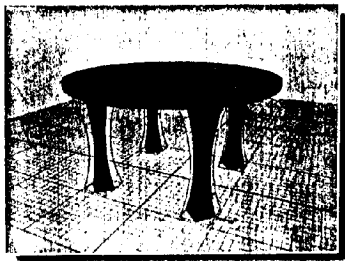
3. Set the Taper Amount spinner to 0.36.

You decide you want to curve the legs, but they don't have enough segments. Luckily, they're instances, so adjusting the creation parameters on one leg is the same as adjusting them for all the legs.

### Increase the segments, and curve the legs:

1. Open the Stack list, and go down to the creation parameters (Cylinder).
2. Set the Height Segments spinner to 14.  
Segments appear in all four legs.
3. In the Stack list, return to the Taper modifier.
4. Set the Curve spinner to -2.5.

All four legs are identically tapered and curved.



## Taper the Selected Legs

You now have an opportunity to apply what you learned in the previous exercise about modifying selection sets.

You decide you want all four legs to curve outward from the table. To achieve this, you're going to taper and curve the four legs as if they were a single object.

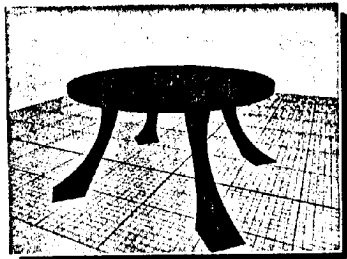
### Taper the four legs:

1. Select all four legs.
2. Make sure that Use Pivot Points is not checked.
3. Click the Taper button to apply another taper to the legs—this time to their selection.

The Taper gizmo surrounds the four legs.

4. Set the Taper Amount spinner to **0.17**, and the Curve spinner to **-0.85**.

The four legs now have a pronounced curve.



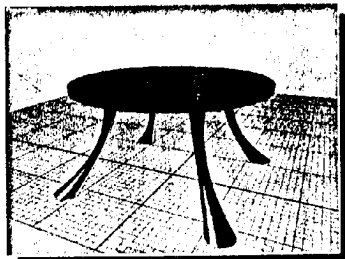
## Changing Your Mind

In 3DS MAX, it's easy to change your mind. Say you no longer like the effect of square legs. Because they're instances, what you do to one, you can do to all. Here's how make them into cylinders.

### Circle the squares:

1. Select any one of the legs.
2. Open the Modifier Stack list, and click Cylinder to access the creation parameters.
3. Increase the Sides to **20**.
4. Check Smooth.
5. Decrease the Radius to **12**.

The legs are now slender, curved cylinders.



## A Bit of Animation

The table could use some animation to bring it to life. Twist the legs and animate the result.

### Twist the legs:

1. Select all four table legs.
2. Click the Twist button.

The orange Twist gizmo surrounds the legs.

You'll want the tops of the legs to remain where they are, while the rest of them twist. To do this, you move the center of the Twist gizmo.

### Adjust the Gizmo Center:

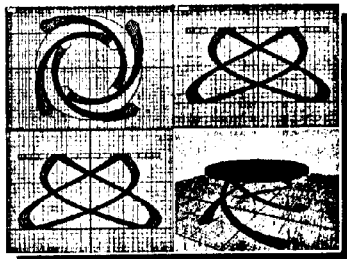
1. Click the Sub-Object button.
2. Choose Center in the Sub-Object list.

The gizmo center appears as a yellow axis tripod.

3. Click the Y axis constraint button.
4. In the Front viewport, move the center of the Twist gizmo to the top of the legs.

### Animate the Twist:

1. Turn on the Animate button.
2. Go to frame 50.
3. Set the Angle spinner to **180**. The legs twist around themselves.
4. Go to frame 100.
5. Set the Angle spinner to **0**. The legs straighten out.
6. Turn off the Sub-Object button.
7. Turn off the Animate button.
8. Activate the Perspective viewport.
9. Play, and then stop the animation. The table legs twist around and then return to their original position.



## Grouping the Table

Assume you're finished with this table, but you want to treat it as a single object in your scene. That is, you want to be able to click on any part of the table and drag it around the room. If you did that right now, you'd come away with the table top, or a spare leg.



In 3DS MAX, you can use grouping to hold things together. Here's how to do it.

#### Group the table:

1. Choose Edit/Select All.

All objects are selected.

2. Choose Group/Group.

The Group naming dialog appears.

3. Type **Table** in the Group dialog, and click OK.

The table top and the four legs are grouped into a single "object," called Table.

4. Go to frame 100, and turn on the Animate button.

5. Click the XY axis constraint button, and make sure Select and Move is still selected.

Just to prove that you can select any part of the table:

6. Click outside of the table to deselect everything.

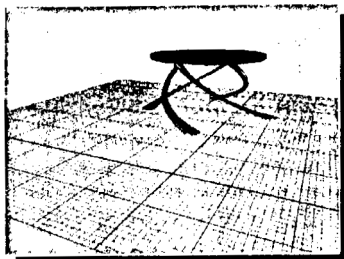
7. Click on any part of the table.

The entire table is selected.

8. In the Perspective viewport, drag the table across the floor toward the back of the ground plane.


9. Play the animation.

The table moves across the floor on twisting legs.



Before you leave this tutorial, remove your custom button set. You won't need it for the remaining tutorials.

#### Remove the custom button set:

1.  Click Configure Button Sets in the Modify command panel.
2. Make sure that Tutorial 6 Modifiers is displayed in the Sets list.
3. Click Delete.
4. Open the Sets list, and choose Default 10.
5. Click OK.

## What's Next?

Create some primitives, and try various combinations of modifier application—both individually, and to selection sets. Experiment with applying modifiers in different order in the Stack.

Explore the various controls in the Modifier Stack rollout. You'll find them described in chapter 15, "Modification Methods," in your *User's Guide*.

Play around with space warps. Try binding more than one object to a space warp—or several space warps to an object.