Modifiers

Modifiers provide a way for you to sculpt and edit objects. They can change the geometry of an object, and its properties.

**Example: effects of the Twist modifier on an object**
The modifiers you apply to an object are stored in a stack. By navigating up and down the stack, you can change the effect of the modifier, or remove it from the object. Or you can choose to “collapse” the stack and make your changes permanent.

There are other general things to know about using modifiers:
- You can apply an unlimited number of modifiers to an object or part of an object.
- When you delete a modifier, all its changes to the object disappear.

- You can move and copy modifiers to other objects using controls in the modifier stack display.
- The order or sequence in which you add modifiers is important. Each modifier affects those that come after it. For instance, adding a Bend modifier before a Taper can give you distinctly different results than if you first added the Taper followed by the Bend.

**How Modifiers Differ from Transforms**
Modifiers and transforms differ in how they affect an object and the order in which they are applied to an object.

**Transforms**
The transform is the most basic of 3D manipulations. Unlike most modifiers, transforms are independent of an object’s internal structure, and they always act in world space. An object can carry any number of modifiers, but it always has only a single set of transforms.

**world space**

*Note Most of this information applies to transforming objects at the object level. You can also transform a sub-object selection, in which case only part of the object is affected.*

The transforms of an object are expressed as a matrix of values that contain the following information:
- Position of the object center in world space
- Rotation of the object in world space
- Scale of the object along its local axes

The matrix is called the *transformation matrix*, and its information relates directly to the transforms Move, Rotate, and Scale. Applying one of these transforms alters the values in the transformation matrix.

**Transforms have the following properties. They are:**
- Applied to the entire object.
- Independent of their order of application. No matter how many times you transform an object, the results are stored as one set of values in the matrix.
- Applied after all object-space modifiers have been evaluated, but before the world-space modifiers. See *Using the Modifier Stack*.

Most transforms produce equal displacement along one or more axes of an object, or part of an object. For Move, Rotate, and Uniform Scale transforms, the displacement is equal along all three axes. When you rotate a box, all sides remain parallel. In general, all vertices keep the same relative position to one another. The exceptions are Squash and Non-Uniform Scale, which displace axes by different amounts.

**Tip** Use the Xform modifier if you want to transform an object at a specific location in the stack (that is, after some object-space modifiers but before others), or if you want to transform a sub-object selection. See *Working at the Sub-Object Level*.
Most modifiers allow you to perform operations on the internal structure of an object in object space. For example, when you apply a modifier such as Twist to a mesh object, the position of each vertex of the object is changed in object space to produce the twisting effect. Modifiers can operate at the sub-object level, and are dependent on the internal structure of the object when the modifier is applied.

Modifiers have the following properties. They are:

- Applied to all of an object or part of an object (using a sub-object selection).
- Dependent on the order of application. Applying a Bend followed by a Twist produces a result different from applying a Twist followed by a Bend.
- Displayed as individual entries in the modifier stack, where you can turn them on or off, and change the order in which they're applied.

Some modifiers operate in world space. These use world-space coordinates, and are applied to the object after all object-space modifiers and transforms have been applied. Otherwise, they have the same overall properties as object-space modifiers.

**Modifier Stack Controls**

The modifier stack controls appear near the top of the Modify panel, just below the Modifier List. The modifier stack ("stack" for short) contains the accumulated history of an object, including its creation parameters and the modifiers applied to it. At the bottom of the stack is the original object. Above the object are the modifiers, in order from bottom to top. This is the order in which modifiers are applied to the object’s geometry.

**Instances and References in the Modifier Stack Display**

In the modifier stack display, objects and modifiers appear in normal type unless they are an instance or a reference. Here is how instances and references appear in the stack display:

- The name of an instanced object appears in boldface.
- The name of a modifier appears in boldface if it is part of an instanced pipeline.

**Make a selection. Modify panel**

Object with two modifiers applied to it in the stack

Plain object displayed in plain text

Object instance displayed in boldface

Pipeline displayed in plain text

Pipeline instance displayed in boldface
• If a modifier is applied to two or more pipelines, it is called an instanced modifier. Its name appears in italic.

• If a modifier is instanced and part of an instanced pipeline, its name appears in boldface and italic.

Left: Instanced modifier displayed in italic (modifier applied to two objects)
Right: Instanced modifier in an instanced pipeline displayed in italic and boldface

• A referenced object appears with a dark bar above it. Modifiers below the bar are part of the current pipeline. Modifiers above the bar are unique to the reference object.

Note: You can also create instances of a reference. In this case, the modifier above the reference bar apply to the reference and to its instances.

• A modifier above the reference object bar can itself be an instance and appear in other pipelines, in which case its name would be italic (either plain or boldface).

Left: Object reference shows a bar in the pipe
Right: Modifier applied to reference is not bold, as it is unique to this reference

The Make Unique button makes a pipeline or a modifier instance unique. When you highlight the base object and then click Make Unique, the whole pipeline becomes unique. When you highlight a bold modifier and then click Make Unique, this also makes the pipeline unique. If the modifier is an instanced modifier that belongs to an instanced pipeline (it appears in boldface and italic), clicking Make Unique makes the modifier unique but not the entire pipeline (the modifier’s name is no longer italic, but it is still bold).

Procedures

To adjust an object’s creation parameters:
1. Choose the object by clicking its name in the stack.
2. Primitive objects have a Parameters rollout. Other kinds of objects (such as meshes and NURBS) have a variety of rollouts.
3. Use the rollout controls to adjust the object.

To apply a modifier to an object:
1. Select the object.
2. Do one of the following:
   Choose a modifier from the Modifier List. This is a drop-down list near the top of the Modify panel.
   Tip: In many cases, multiple modifiers’ names start with the same letter. You can go directly to a particular modifier if you type the first few letters (enough for a unique combination) in the desired modifier’s name quickly. For example, say you want to assign the Mirror modifier to an object. Pressing M goes to Mesh Select, which isn’t anywhere near Mirror in the Modifier list, but typing MI goes directly to Mirror.
   • Choose a modifier from the Modifiers menu. This menu is organized into sets by functionality.
   • Not all modifiers appear on the Modifiers menu.
   • If the modifier buttons are visible on the Modify panel and the modifier you want is one of them, click the button.

   If the buttons are not visible but you want to use them, click (Configure Modifier Sets, below the modifier stack display) and choose Show Buttons. A set of buttons with the names of modifiers appears between the modifier list and the stack display. Click Configure Modifier Sets again, choose the set of modifiers you want to use (for example, Free-Form Deformations), and then click the button for the modifier you want to apply.
1. Rollouts are now displayed below the modifier stack display, showing settings for the modifier. As you change these settings, the object updates in viewports.

To remove a modifier, do one of the following:
- Choose the modifier by clicking its name in the stack, and then click (Remove Modifier From The Stack). This button is one of the tools beneath the display of the modifier stack.
- Right-click the modifier's name in the stack and then choose Delete.

To turn the effect of a modifier off, do one of the following:
- Click the light-bulb icon to the left of the modifier's name in the stack.
- When you apply a modifier, the light-bulb icon is on by default.
- Right-click the modifier in the stack display, and choose Off.

To turn the effect of a modifier back on, do one of the following:
- Click the light-bulb icon to the left of the modifier's name in the stack.
- Right-click the modifier in the stack display, and choose On.

To change the size of the modifier stack display:
1. Position the cursor over the shaded bar below the tool buttons beneath the stack list.
2. The cursor changes to an up-and-down resize arrow (as it does on the horizontal edges of a resizable window).
3. Drag the bar up or down to change the size of the stack display in the Modify panel.

To change a modifier's position in the stack, do one of the following:

Note The original object is always at the bottom of the stack, and world-space modifiers are always at the top. Drag the modifier to a different location in the stack.

Use Cut and Paste:
1. Right-click the modifier's name in the stack, and choose Cut.
2. Right-click the name of the modifier you want the modifier to appear before (that is, above), and choose Paste.

To use the modifier buttons:
- Click (Configure Modifier Sets), and choose Show Buttons.
- This menu item is a toggle. It is either on or off. When you turn on Show Buttons, the current button set appears between the drop-down modifier list and the stack display.
- See Configure Modifier Sets Dialog for more information.

To convert the modified object to an editable mesh, do one of the following:
- Right-click the modifier stack, and choose Collapse All.
- A dialog opens, warning you that the collapse operation cannot be undone, and gives you the option of performing aHold before converting the object.
- Right-click the object in a viewport, and choose Convert To ➤ Convert to Editable Mesh from the quad menu.

Tip You can also convert a modified object to an editable patch or editable polygon surface. Use the quad menu to do this.

To adjust a modifier's component such as its gizmo or center point:
1. Expand the modifier's hierarchy by clicking the plus-sign icon.
2. Click the component you want to adjust, such as the Gizmo.
3. The component highlights to show it is active.
4. Adjust the component.
5. For example, you might use transforms to move a gizmo or a center point.
6. When done, you can hide the hierarchy display by clicking the minus-sign icon. The modifier itself is highlighted again.

Tip You can also view the entire hierarchy by right-clicking the stack and choosing Show All Subtrees, and view only objects and modifiers with Hide All Subtrees.

To go to a sub-object level for complex objects:

1. Click the plus-sign icon to display the object’s hierarchy.
2. Choose the sub-object level you want to adjust.
   The sub-object level highlights to show it is active.
   Keyboard shortcut: Insert cycles through the different sub-object levels.
3. Adjust sub-objects.
   When you add a new sub-object type, the modifier stack updates to show the new sub-object levels. For example, when you add a point curve sub-object to a NURBS surface, the Point and Curve sub-object levels appear in the stack.
4. To leave the sub-object level, click to select the name of the top-level object or a different top-level object.

Tip You can also view the entire hierarchy by right-clicking the stack and choosing Show All Subtrees, and view only objects and modifiers with Hide All Subtrees.

Interface

The Modifier Stack

Modifier List

The Modifier List lets you choose a modifier to add to the stack. When you choose an object-space modifier from this list, it appears above the object, or above the modifier currently highlighted in the stack. When you choose a world-space modifier from this list, it appears at the top of the stack.

Use Pivot Points

The first item in the Modifier List is the Use Pivot Points toggle. It is available only when multiple objects are selected.
When Use Pivot Points is on, 3ds Max uses the pivot point of each object as the center of a modifier’s operation. For example, if you bend a line of trees around the Z axis, they all bend along their trunks.
When Use Pivot Points is off, 3ds Max calculates a central pivot point for the entire selection set and modifies the selection as a whole. For example, if you bend a line of trees around the Z axis, trees at the end of the line deform more than those at the center where the pivot is located.

The Use Pivot Points setting persists, so that applying modifiers to different sets of objects during the current session always uses the same setting.
**Note** Be sure to set Use Pivot Points to the desired value before you apply the modifier to multiple objects. You can't change the setting afterward, although you can delete the modifier and start over without deselecting the selection set.

**Modifier Buttons**

Between the Modifier List and the stack display, you can optionally display up to 32 buttons. The buttons are a shortcut way to add modifiers to the stack.

![Modifier Buttons](image)

To display the modifier buttons, click Configure Modifier Sets (below the stack display) and choose Show Buttons.

To customize the button set, click Configure Modifier Sets (below the stack display) and choose Configure Modifier Sets.

When a modifier's button is visible, clicking the button adds the modifier to the stack. Object-space modifiers are applied immediately above the currently selected object or modifier. World-space modifiers are applied at the top of the stack.

**Stack Display**

The modifier stack is organized as follows:

- At the bottom of the stack, the first entry always lists the object type. Click this entry to display the object's creation parameters so you can adjust them.

  When you click to choose an entry in the modifier stack, its background highlights to show that the entry is current, and that the object's or modifier's parameters are available for adjusting, in rollouts that appear beneath the stack display.

- Above the object itself are entries for object-space modifiers. Click a modifier entry to display the modifier's parameters so you can adjust them.

  This section lets you go back to any modifier you've applied and adjust its effect on the object. You can also delete the modifier from the stack, canceling its effect.

**Note** 3ds Max applies transforms after it applies object-space modifiers but before it applies space warps or world-space modifiers.

- The top of the stack shows which space warps and world-space modifiers the object uses. For example, if the object were bound to a Ripple space warp, an entry in the top section would read Ripple Binding.

  To the left of each modifier in the stack is a light-bulb icon. When the bulb appears white, the modifier is applied to the stack below it. When the bulb appears gray, the modifier is turned off. Click to toggle the on/off state of the modifier.

**Note** You can also turn off the effect of modifiers in viewports but not in renderings, or vice versa. The light-bulb icon changes to show these states as well. See Modifier Stack Right-Click Menu.

![Opening a modifier's hierarchy to access sub-controls](image)

If the modifier has sub-controls such as a center or a gizmo, the stack also shows a small plus/minus icon. Click this icon to open or close the hierarchy.
When the hierarchy is open, you can select a sub-control, such as a gizmo, and then adjust it. The available sub-controls vary from modifier to modifier. Objects that have a sub-object hierarchy, such as editable meshes and NURBS, also show a collapsible hierarchy in the modifier stack.

To work at a sub-object level, click to open the hierarchy, then click to select the sub-object level. Controls for that particular level or type of sub-object appear in rollouts below the stack display.

(Certain types of sub-objects display an icon at the right of the stack, to help you see which sub-object type you are adjusting.)

Opening an object's hierarchy to access sub-object levels

Tool Buttons-Below the stack display is a row of buttons for managing the stack.

Pin Stack-Locks the stack to the currently selected object so it remains with that object regardless of subsequent changes in selection. The entire Modify panel is locked to the current object as well.

Pin Stack is useful for transforming another object while keeping your place in the modified object's stack.

Show End Result-Show the selected object as it will appear after all modifications in the stack have taken place, regardless of your current position in the stack. When this toggle is turned off, the object appears as modified up to the current modifier in the stack.

Make Unique-Converts an instanced modifier to a copy that's unique to the current object. See Make Unique.

Remove Modifier-Deletes the current modifier or unbinds the current space warp.

Configure Modifier Sets-Click to display the pop-up Modifier Sets menu.

Bend Modifier

- Modify panel > Make a selection. > Modifier List > Object-Space Modifiers > Bend

Make a selection. > Modifiers menu > Parametric Deformers > Bend

Tab panel > Modifiers tab > Bend modifier

Bend applied to a streetlight model

The Bend modifier lets you bend the current selection up to 360 degrees about a single axis, producing a uniform bend in
an object’s geometry. You can control the angle and direction of the bend on any of three axes. You can also limit the bend to a section of the geometry.

Procedures

To bend an object:
- Select an object and apply the Bend modifier.
- On the Parameters rollout, set the axis of the bend to X, Y, or Z. This is the axis of the Bend gizmo, not the axis of the selected object.
- You can switch between axes at any time, but the modifier carries only one axis setting.
- Set the angle of the bend along the chosen axis.
- The object bends to this angle.
- Set the direction of the bend.
- The object swivels around the axis.
- You can reverse angle and direction by changing a positive value to a negative value.

To limit the bend:
- Turn on Limit Effect in the Limits group.
- Set values for the upper and lower limits. These are distances in current units above and below the modifier’s center, which is at zero on the gizmo’s Z axis by default. You can make the upper limit zero or positive, and the lower limit zero or negative. If the limits are equal, the result is the same as turning off Limit Effect.
- The bend is applied between these limits. The surrounding geometry, while unaffected by the bend itself, rotates to keep the object intact. This is analogous to bending a pipe, where the unbent sections rotate but remain straight.
- At the sub-object level, you can select and move the modifier’s center.
- The Limit settings remain on either side of the center as you move it. This lets you relocate the bend area to another part of the object.

Interface

Modifier Stack

Gizmo sub-object—You can transform and animate the gizmo like any other object at this sub-object level, altering the effect of the Bend modifier. Translating the gizmo translates its center an equal distance. Rotating and scaling the gizmo takes place with respect to its center.

Center sub-object—You can translate and animate the center at this sub-object level, altering the Bend gizmo's shape, and thus the shape of the bent object.

For more information on the stack display, see Modifier Stack.

Parameters rollout

Bend group

Angle—Sets the angle to bend from the vertical plane. Range=-999,999.0 to 999,999.0.

Direction—Sets the direction of the bend relative to the horizontal plane. Range=-999,999.0 to 999,999.0.

Bend Axis group

X/Y/Z—Specifies the axis to be bent. Note that this axis is local to the Bend gizmo and not related to the selected entity. Default=Z.

Limits group

Limit Effect—Applies limit constraints to the bend effect. Default=off.

Upper Limit—Sets the upper boundary in world units from the bend center point beyond which the bend no longer affects geometry. Default=0. Range=0 to 999,999.0.

Lower Limit—Sets the lower boundary in world units from the bend center point beyond which the bend no longer affects geometry. Default=0. Range=-999,999.0 to 0.
Taper Modifier
Modify panel > Make a selection. > Modifier List > Object-Space Modifiers > Taper

Make a selection. > Modifiers menu > Parametric Deformers > Taper

Tab panels > Modifiers tab > Taper modifier
The Taper modifier produces a tapered contour by scaling both ends of an object’s geometry; one end is scaled up, and the other is scaled down. You can control the amount and curve of the taper on two sets of axes. You can also limit the taper to a section of the geometry.

Examples of default tapers
Interface
Modifier Stack

Gizmo—At this sub-object level, you can transform and animate the gizmo like any other object, altering the effect of the Taper modifier. Translating the gizmo translates its center an equal distance. Rotating and scaling the gizmo takes place with respect to its center.

Center—At this sub-object level, you can translate and animate the center, altering the Taper gizmo’s shape, and thus the shape of the tapered object.
For more information on the stack display, see Modifier Stack.

Moving the modifier’s center changes the gizmo shape.
Parameters rollout

The Taper modifier provides two sets of axes and a symmetry setting in the Taper Axis group.

box of the Parameters rollout. As with other modifiers, these axes refer to the Taper gizmo, not the object itself.

Taper group

Amount—The extent to which the ends are scaled. Amount is a relative value with a maximum of 10.

Curve—Applies a curvature to the sides of the Taper gizmo, thus affecting the shape of the tapered object. Positive values produce an outward curve along the tapered sides, negative values an inward curve. At 0, the sides are unchanged. Default=0.

Taper Axis group

Primary—The central axis or spine of the taper: X, Y, or Z. Default=Z.

Effect—The axis, or pair of axes, indicating the direction of the taper from the primary axis. The available choices are determined by the choice of primary axis. The effect axis can be either of the two remaining axes, or their combination. If the primary axis is X, the effect axis can be Y, Z, or YZ. Default=XY.

Symmetry—Produces a symmetrical taper around the primary axis. A taper is always symmetrical around the effect axis. Default=off.
Changing the effect axis changes the effects of the modifier.

Limits group
The taper offset is applied between the upper and lower limits. The surrounding geometry, while unaffected by the taper itself, is moved to keep the object intact.

Limit Effect—Enables upper and lower limits for the taper effect.

Upper Limit—Sets the upper limit boundaries in world units from the taper center point, beyond which the taper no longer affects the geometry.

Lower Limit—Sets the lower limit boundaries in world units from the taper center point, beyond which the taper no longer affects the geometry.

Left: Limiting the effect of the taper.
Right: Using symmetry.

Twist Modifier
- Modify panel > Make a selection > Modifier List > Object-Space Modifiers > Twist

Make a selection > Modifiers menu > Parametric Deformers > Twist

Tab panels > Modifiers tab > Twist modifier

Left: Original model
Middle: A moderate twist
Right: An extreme twist

The Twist modifier produces a twirling effect (like wringing out a wet rag) in an object’s geometry. You can control the angle of the twist on any of three axes, and set a bias that compresses the twist effect relative to the pivot point. You can also limit the twist to a section of the geometry.

Note: When you apply the Twist modifier, the Twist gizmo’s center is placed at the object’s pivot point, and the gizmo lines up with the object’s local axis.

Procedures

To twist an object:
1. Select an object and apply Twist.
2. On the Parameters rollout, set Twist Axis to X, Y, or Z. This refers to the axis of the Twist gizmo, not the axis of the selected object.
3. You can switch between axes at any time, but only one axis setting is carried with the modifier.
4. Set the angle of the twist. Positive values produce a clockwise twist, negative values a counterclockwise twist. An angle of 360 produces a complete revolution.
5. The object twists to this amount beginning at the lower limit (by default, the location of the modifier's center).
6. Set the bias of the twist.
7. A positive value compresses the twist at the end away from the pivot point, a negative value toward the pivot point.

To limit the twist:
1. Turn on Limits group > Limit Effect.
2. Set values for the upper and lower limits. These are distances in current units above and below the modifier's center, which is at zero on the gizmo's Z axis. The upper limit can be zero or positive, the lower limit zero or negative. If the limits are equal, the result is the same as turning off Limit Effect.

3. The twist offset is applied between these limits. The surrounding geometry, while unaffected by the twist itself, is moved to keep the object intact.

4. At the sub-object level, you can select and move the modifier’s center.

5. The limit settings remain on either side of the center as you move it. This lets you relocate the twist area to another part of the object.

**Interface**

**Modifier Stack**

**Gizmo**—You can transform and animate the gizmo like any other object at this sub-object level, altering the effect of the Twist modifier. Translating the gizmo translates its center an equal distance. Rotating and scaling the gizmo takes place with respect to its center.

**Center**—You can translate and animate the center at this sub-object level, altering the Twist gizmo's shape, and thus the shape of the twisted object.

For more information on the stack display, see **Modifier Stack**.

**Twist Parameters rollout**

**Twist group**

**Angle**—Determines the amount of twist around the vertical axis. Default=0.0.

**Bias**—Causes the twist rotation to bunch up at either end of the object. When the parameter is negative, the object twists closer to the gizmo center. When the value is positive, the object twists more away from the gizmo center. When the parameter is 0, the twisting is uniform. Range=100 to -100. Default=0.0.

**Twist Axis group**

**X/Y/Z**—Specify the axis along which the twist will occur. This is the local axis of the Twist gizmo. Default=Z.

**Limits group**

Applies the twist effect only to vertices that lie between the lower and upper limits. The two spinners represent distance along the gizmo’s Z axis (Z=0 is at the gizmo's center). When they are equal, it is the same as disabling the twist effect.

**Limit Effect**—Applies limit constraints to the Twist modifier.

**Upper Limit**—Sets the upper limit for the twist effect. Default=0.

**Lower Limit**—Sets the lower limit for the twist effect. Default=0.

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**Stretch Modifier**

- Select an object. > Modify panel > Modifiers List > Object–Space Modifiers > Stretch

Select an object. > Modifiers menu > Parametric Deformers > Stretch

Tab panels > Modifiers tab > Stretch Modifier

The Stretch modifier simulates the traditional animation effect of "squash-and-stretch." Stretch applies a scale effect along a specified stretch axis and an opposite scale along the two remaining minor axes.

The amount of opposite scaling on the minor axes varies, based on distance from the center of the scale effect. The maximum amount of scaling occurs at the center and falls off toward the ends.
Stretching an organ pipe.

Procedures

To stretch an object:

1. Select an object.
2. Apply Stretch.
3. On the Parameters rollout > Stretch Axis group, choose X, Y, or Z.
4. On the Parameters rollout > Stretch group, enter a value in the Stretch field.
5. Adjust the Parameters rollout > Stretch group > Amplify setting to change the amount of scaling along the minor axes.

To limit a stretch:

1. Apply a Stretch modifier to an object and specify the stretch amounts and stretch axis.
2. On the Parameters rollout > Limits group, turn on Limit Effect.
3. Set values for the Upper and Lower Limits to define the Stretch boundaries on either side of the Stretch center.
4. In the stack display, choose the Center sub-object level, and move the center to locate the limited stretch effect.

Interface

Modifier stack

Gizmo—At this sub-object level, you can transform and animate the gizmo like any other object, altering the effect of the Stretch modifier. Translating the gizmo translates its center an equal distance. Rotating and scaling the gizmo takes place with respect to its center.

Center—At this sub-object level, you can translate and animate the center, altering the Stretch gizmo’s shape, and thus the shape of the stretched object.

Parameters rollout

Use options in the Parameters rollout to set the following:

- Amount of stretch
- Major stretch axis
- Area affected by the stretch

Stretch group

The Stretch group of the Parameters rollout has two fields that control the amount of stretch scaling applied.

Stretch—Sets the base scale factor for all three axes. The scale factor derived from the Stretch value varies according to the sign of the value.

- Positive stretch values define a scale factor equal to Stretch+1. For example, a stretch value of 1.5 yields a scale factor of 1.5+1=2.5, or 250 percent.
- Negative stretch values define a scale factor equal to -1/(Stretch-1). For example, a stretch value of -1.5 yields a scale factor of -1/(-1.5-1)=0.4, or 40 percent.

The calculated scale factor is applied to the selected stretch axis and the inverse scale is applied to the minor axes.
Stretch values of 0.0, 0.5, and -0.5

**Amplify**—Changes the scale factor applied to the minor axes. Amplify generates a multiplier using the same technique as stretch. The multiplier is then applied to the Stretch value before the scale factor for the minor axes is calculated.

Amplify values affect scaling along the minor axes in the following way:
- A value of 0 has no effect. It uses the default scale factor calculated from the Stretch amount.
- Positive values exaggerate the effect.
- Negative values reduce the effect.

Stretched objects with Amplify values of 0.0, 1.0, and -1.0.

**Stretch Axis group**

You select which of the object's local axes is the Stretch Axis using options in the Stretch Axis group of the Parameters rollout.

- The scale factor calculated from the Stretch Amount is applied to the Stretch Axis.
- The inverse scale factor is applied to the remaining minor axes.

**Effects of changing the Stretch axis**

**Limits group**

You can apply the stretch effect to the entire object, or limit it to a portion of the object, using controls in the Limits group of the Parameters rollout. The limits restrict the stretch effect along the positive and negative Stretch Axis as measured from the modifier's center.

**Limit Effect**—Limits the stretch effect. When Limit Effect is turned off, values in the Upper and Lower Limit fields are ignored.

**Upper Limit**—Sets the boundary of the stretch effect along the positive Stretch Axis. The Upper Limit can be 0 or any positive number.

**Lower Limit**—Sets the boundary of the stretch effect along the negative Stretch Axis. The Lower Limit can be 0 or any negative number.

**Limiting the effect of Stretch**

Click Sub-Object and move the modifier's center to change the location of the limited stretch areas. The Upper and Lower Limit boundaries move with the modifier center to maintain their specified distances.

**Effects of moving the Stretch center**

Note: You can also limit the stretch effect by using an Edit or Select modifier, defining a sub-object selection, and then applying Stretch. If the modifier's Sub-Object button is active, only the selected sub-objects will be stretched.
Squeeze Modifier

1. Modify panel > Make a selection. > Modifier List > Object-Space Modifiers > Squeeze

Make a selection. > Modifiers menu > Parametric Deformers > Squeeze

The Squeeze modifier lets you apply a squeezing effect to objects, in which the vertices closest to the object’s pivot point move inward. The squeeze is applied around the Squeeze gizmo’s local Z axis. You can also use Squeeze to create a bulge on the vertical axis, to accentuate the squeeze effect.

Left: Original object
Middle: Squeeze applied along axial axis
Right: Squeeze applied along radial axis.

Interface

Gizmo—At this sub-object level, you can transform and animate the gizmo like any other object, altering the effect of the Squeeze modifier. Translating the gizmo translates its center an equal distance. Rotating and scaling the gizmo takes place with respect to its center.

Center—At this sub-object level, you can translate and animate the center, altering the Squeeze gizmo’s shape, and thus the shape of the squeezed object.

For more information on the stack display, see Modifier Stack.

Parameters rollout

Axial Bulge group
These controls let you apply a bulge effect along the Squeeze gizmo’s local Z axis, which is aligned by default with the object’s local Z axis.

Amount—Controls the magnitude of the bulging effect. Higher values effectively elongate the object and cause the ends to curve outward.

Curve—Sets the degree of curvature on the bulging ends. You can use this to control whether the bulge is smooth or pointy.

Radial Squeeze group
These controls let you apply a squeeze effect around the Squeeze gizmo’s local Z axis, which is aligned by default with the object’s local Z axis.

Amount—Controls the magnitude of the squeezing action. Values larger than zero tend to constrict the “waist” of the object, and values less than zero tend to bulge the waistline out, as if the object had been stepped on.

Curve—Sets the degree of curvature into the squeeze. Low values cause a sharp squeezing effect, while high values create a gradual, less pronounced squeeze.

Limits group
These controls let you limit the squeeze effect’s extents along the local Z axis.

Limit Effect—Limits the extent of the squeeze effect as defined by the Lower and Upper Limit settings.

Lower Limit—Sets the limit in the positive direction along the Z axis.

Upper Limit—Sets the limit in the negative direction along the Z axis.

Effect Balance group

Bias—Changes the relative amounts of bulge and squeeze while retaining a constant object volume.

Volume—Increases or decreases the effects of both Squeeze and Bulge in parallel.

Mirror Modifier

• Modify panel > Make a selection. > Modifier List > Object-Space Modifiers > Mirror

Make a selection. > Modifiers menu > Parametric Deformers > Mirror

Mirroring a bench - The Mirror modifier provides a parametric method of mirroring an object or a sub-object selection. You can apply the Mirror modifier
to any type of geometry, and you can animate the mirror effect by animating the modifier’s gizmo.

Procedure

To apply the mirror modifier to an object:
Apply the Mirror modifier to a selection.
Set the axis or axis pair on which to mirror the object.
To create a mirrored pair, specify an Offset amount and turn on Copy.

Interface

Modifier Stack

Mirror Center—Represents the axis of the mirror effect. You can move, rotate or scale the gizmo to affect the mirroring. You can animate the gizmo transforms, which you can't do with the toolbar Mirror tool.
For more information on the stack display, see Modifier Stack.

Parameters rollout

Mirror Axis group
X, Y, Z, XY, YZ, ZX—Specify the axis or axes about which the mirroring takes place.
You can usually see the effect in the viewport as you select the option.

Options group
Offset—Specifies the offset, in units, from the mirror axis. This is an animatable parameter.
Copy—Copies the geometry rather than simply mirroring it.
Note: The Copy option affects only geometry with triangular meshes.

Skew Modifier

- Modify panel > Make a selection. > Modifier List > Object-Space Modifiers > Skew

Make a selection. > Modifiers menu > Parametric Deformers > Skew

Tab panels > Modifiers tab > Skew modifier
The Skew modifier lets you produce a uniform offset in an object's geometry. You can control the amount and direction of the skew on any of three axes. You can also limit the skew to a section of the geometry.

Skew modifier applied

Procedures

To skew an object:

Select an object, go to the Modify panel, and choose Skew from modifier list.
On the Parameters rollout, set the axis of the skew to X, Y, or Z. This is the axis of the Skew gizmo, not the axis of the selected object.
1. You can change the axis at any time, but only one axis setting is carried with the modifier.
2. Set the amount of the skew. The amount is an offset in current units parallel with the axis.
3. The object skews to this amount beginning at the lower limit, by default the location of the modifier’s center.
4. Set the direction of the skew.
5. The object swivels around the axis.
6. You can reverse the amount and direction by changing a positive value to a negative value.

To limit the skew:
1. Turn on Limits group > Limit Effect.
2. Set values for the upper and lower limits. These are distances in current units above and below the modifier’s center, which is at zero on the gizmo’s Z axis. The upper limit can be zero or positive, the lower limit zero or negative. If the limits are equal, the result is the same as turning off Limit Effect.
3. The skew offset is applied between these limits. The surrounding geometry, while unaffected by the skew itself, is moved to keep the object intact.
4. At the sub-object level, you can select and move the modifier’s center.
5. The limit settings remain on either side of the center as you move it. This lets you relocate the skew area to another part of the object.

Interface
Modifier Stack

Gizmo—At this sub-object level, you can transform and animate the gizmo like any other object, altering the effect of the Skew modifier. Translating the gizmo translates its center an equal distance. Rotating and scaling the gizmo take place with respect to its center.

Center—At this sub-object level, you can translate and animate the center of the Skew effect.

For more information on the stack display, see Modifier Stack.

Parameters rollout

Skew group
Amount—Sets the angle to skew from the vertical plane.
Direction—Sets the direction of the skew relative to the horizontal plane.

Skew Axis group
X/Y/Z—Specify the axis that will be skewed. Note that this axis is local to the Skew gizmo and not related to the selected entity. Default=Z.

Limits group
Upper Limit—Sets the upper limit boundaries in world units from the skew center point, beyond which the skew no longer affects the geometry. Default=0.
Lower Limit—Sets the lower limit boundaries in world units from the skew center point, beyond which the skew no longer affects the geometry. Default=0.

TurboSmooth Modifier

The TurboSmooth modifier, like MeshSmooth, smoothes geometry in your scene.

- Make a selection. > Modify panel > Modifier List > Object-Space Modifiers > TurboSmooth
- Make a selection. > Modifiers menu > Subdivision Surfaces > TurboSmooth

The differences between the two are as follows:

- TurboSmooth is considerably faster and more memory-efficient than MeshSmooth. TurboSmooth also has an option for Explicit Normals, unavailable in MeshSmooth. See Explicit Normals.
- TurboSmooth provides a limited subset of MeshSmooth functionality. In particular, TurboSmooth uses a single smoothing method (NURMS), can be applied only to an entire object, has no sub-object levels, and outputs a triangle-mesh object.
TurboSmooth lets you subdivide the geometry while interpolating the angles of new faces at corners and edges, and apply a single smoothing group to all faces in the object. The effect of TurboSmooth is to round over corners and edges as if they had been filed or planed smooth. Use TurboSmooth parameters to control the size and number of new faces, and how they affect the surface of the object.
Angular model (shown on the right) changed to a smooth model with TurboSmooth

Smoothing an object modeled with extrusions

You use TurboSmooth to produce a Non-Uniform Rational MeshSmooth object (NURMS for short). A NURMS object is similar to a NURBS object in that you can set different weights for each control vertex.

TurboSmooth's effect is most dramatic on sharp corners and least visible on rounded surfaces. Use TurboSmooth on boxes and geometry with crisp angles. Avoid using it on spheres and similar objects.

Tip: To better understand TurboSmooth, create a sphere and a cube and apply TurboSmooth to both. The cube's sharp corners become rounded, while the sphere's geometry becomes more complex without changing shape significantly.

Procedures

To apply TurboSmooth to an object:

1. Select an angular object.
2. Apply the TurboSmooth modifier.
3. Set TurboSmooth parameters.

Example: To compare the speeds of TurboSmooth and MeshSmooth:

1. Create a Box primitive with Length/Width/Height Segs=3. Convert the box to editable poly format.
2. Apply MeshSmooth.
3. Set Iterations=5.
   This creates a heavily subdivided mesh.
4. Go to the Editable Poly ➤ Vertex sub-object level, and turn on (Show End Result On/Off Toggle).
5. Move one of the corner vertices outward.
6. There is a significant delay before you see the result of the Move operation.
7. Perform a few more Move operations on vertices, observe the delays, and then undo (Ctrl + Z) repeatedly until the MeshSmooth modifier goes away.
8. Apply TurboSmooth.
9. Set Iterations=5.
   This creates a heavily subdivided mesh.
1. Go to the Editable Poly ➔ Vertex sub-object level, and turn on (Show End Result On/Off Toggle).

2. Move one of the corner vertices outward. The response is much faster.

Interface

Main group

Lets you set the basic parameters for TurboSmooth.

Iterations

Sets the number of times the mesh is subdivided. When you increase this value, each new iteration subdivides the mesh by creating smoothly interpolated vertices for every vertex, edge, and face from the iteration before. The modifier then subdivides the faces to use these new vertices. Default=1. Range=0 to 10.

From right to left, effect of increasing the number of iterations

Note: Be cautious when increasing the number of iterations. The number of vertices and faces in an object (and thus the calculation time) can increase as much as four times for each iteration. Applying four iterations to even a moderately complex object can take a long time to calculate.

Render Iter[ation]s

Lets you choose a different number of smoothing iterations to be applied to the object at render time. Turn on Render Iters, and then use the field to its right to set the number of render iterations.

Isoline Display

When on, 3ds Max displays only isolines: the object's original edges, before smoothing. The benefit of using this option is a less cluttered display. When off, 3ds Max displays all faces added by TurboSmooth; thus, higher iterations values result in a greater number of lines. Default=off.

Warning: If you're going to collapse the model or apply further modifiers after the TurboSmooth, you should first turn off Isoline Display. Unlike in MeshSmooth, isoline display is achieved by making all the edges "invisible," joining large groups of faces together in single "polygons." This can be especially problematic if you apply a PolyObject-based modifier afterwards, because all vertices in the interior of these "polygons" will be lost.

Explicit Normals

Lets the TurboSmooth modifier compute normals for its output, which is faster than the standard method 3ds Max uses to compute normals from the mesh object's smoothing groups. Default=off.

Consequently, if the TurboSmooth result is used directly for display or rendering, it will generally be faster with this option turned on. Also, the quality of the normals will be slightly higher. However, if you apply
any topology-affecting modifiers, such as Edit Mesh, above the TurboSmooth modifier, these normals will be lost and new ones computed, potentially affecting performance adversely. So it’s important to remember to turn on Explicit Normals only if no modifiers change the object topology after TurboSmooth takes effect.

Surface Parameters group-Lets you apply smoothing groups to the object and restrict the smoothing effect by surface properties.

Smooth Result-Applies the same smoothing group to all faces.

Separate by Materials-Prevents the creation of new faces for edges between faces that do not share Material IDs.

Separate by Smoothing Groups-Prevents the creation of new faces at edges between faces that don’t share at least one smoothing group.

Update Options group- Sets manual or render-time update options, for situations where the complexity of the smoothed object is too high for automatic updates. Note that you can also set a greater degree of smoothing to be applied only at render time, in the Main group.

- Always Updates the object automatically whenever you change any TurboSmooth settings.
- When Rendering Updates the viewport display of the object only at render time.
- Manually Updates the object only when you click Update.

Update
Updates the object in the viewport to match the current TurboSmooth settings. Works only when you choose When Rendering or Manually.

Symmetry Modifier

- Modify panel > Make a selection. > Modifier List > Symmetry

Make a selection. > Modifiers menu > Mesh Editing > Symmetry

The Symmetry modifier is unique in that it allows you to perform three common modeling tasks:

- Mirror a mesh about an X, Y, or Z plane.
- Slice a mesh, removing parts if necessary.
- Automatically weld vertices along a common seam.

Examples of using Symmetry with different mirror axes or by moving the mirror gizmo

You can apply the Symmetry modifier to any geometry, and you can animate the mirror or slicing effect by animating the modifier’s gizmo.

When the Symmetry modifier is applied to a mesh, any edits made to the original half of the mesh will appear interactively to the other half.

The Symmetry modifier is especially useful when modeling characters or building ships and aircraft.

Note: The Symmetry modifier converts Editable Mesh, Editable Patch, and NURBS objects to Editable Meshes in the modifier stack; however, Editable Poly objects remain as polys.

Procedure

Example: To apply the symmetry modifier to an object:

1. Create a teapot in the perspective viewport.
2. Apply the Symmetry modifier.
   The teapot will look like it has two spouts.
3. In the modifier stack, click the + button to see the Mirror gizmo, and then select Mirror. The mirror gizmo acts as a slice plane when it is within the boundaries of the object.

4. With the Mirror Axis set to X, click and drag the mirror gizmo along the X axis. Dragging right slices more of the teapot until there is nothing visible. Dragging left causes a second teapot to appear. When the mirror gizmo is moved beyond the boundaries of the original mesh, it acts as a mirror plane showing you two complete teapots.

Interface

Modifier Stack

**Mirror**—The placement of the mirror gizmo delegates how the object will be affected by symmetry. You can move or rotate, as well as animate the gizmo.

For more information on the stack display, see **Modifier Stack**.

**Parameters rollout**

**Mirror Axis group**

X, Y, Z—Specify the axis about which the symmetry takes place. You can see the effect in the viewport as you select the axis.

Flip—Turn on Flip if you want to flip the direction of the symmetry effect. Default=off.

**Slice Along Mirror**—Turning on Slice Along Mirror causes the mirror gizmo to act as a slice plane when it is located inside the boundaries of a mesh. When the gizmo is outside the boundaries of a mesh, the symmetrical reflection is still treated as part of the originating mesh. If Slice Along Mirror is turned off, the symmetrical reflection is treated as a separate element of the originating mesh. Default=on.

**Weld Seam**—Turning on Weld Seam assures that the vertices along the mirror axis will be automatically welded if they are within the Threshold. Default=on.

**Threshold**—The value of the Threshold setting delegates how close vertices can be before being automatically welded together. Default=0.1.

Note: Setting the Threshold value too high may result in some distortion of the mesh, especially when the mirror gizmo is outside the boundaries of the originating mesh.

Mesh optimization

Optimize Modifier

- Select an object. ➔ **Modifier List ➔ Optimize**
- Select an object. ➔ **Modifiers menu ➔ Mesh Editing ➔ Optimize**

The Optimize modifier lets you reduce the number of faces and vertices in an object. This simplifies the geometry and speeds up rendering while maintaining an acceptable image. A Before/After readout gives you exact feedback on the reduction as you make each change.

**Optimize simplifies a smooth model with a high number of faces without greatly changing the model’s appearance.**

**Tip** Because Optimize makes decisions based on angles between faces, it’s sometimes best to apply it to selected
face sub-objects rather than to an entire object. Avoid applying Optimize to areas where you want to preserve geometric detail.

**Applying Optimize**

When you first apply Optimize, you might not see any change in the viewports. Adjust the Face Threshold setting to obtain the best optimization. In the Last Optimize Status group, you can see how the object or faces were optimized. Watch these values while you adjust the Optimize parameters, until you have the best possible result.

**Setting Level of Detail**

Optimize lets you maintain two levels of optimization detail. You might set a lower optimization level, with fewer faces, to speed up your viewport work, and a higher level for final output in the renderer. However, you can render at either level. You can also switch to the higher level in a viewport to get an idea of what the rendered image will look like.

**Procedures**

**To optimize manually:**
1. Set up two viewports: one wireframe, one smooth shaded.
2. Select an object and apply the Optimize modifier.
3. The Parameters rollout for this modifier appears.
4. Turn off Manual Update and then adjust the Face Thresh value. Observe the result in the viewports.
5. You can also choose to view the results of the Optimize operation manually by leaving the Manual Update checkbox turned on and clicking the Update button every time you wish to view a result.
6. In the Parameters rollout ➤ Last Optimize Status group, notice the Before/After count for vertices and faces.
7. In the Optimize group, vary parameters to continue reducing geometry.
8. Compare the result in the two viewports against the Before/After count.

**To set the level of detail:**
1. In the Parameters rollout ➤ Level of Detail group, choose Viewports L1.
2. Adjust parameters in the Optimize and Preserve groups.
3. This sets the L1 level of optimization for both the viewport and the renderer.
4. Repeat steps 1 and 2 for Viewports L2, adjusting parameters for a different optimization.

**To use level of detail:**
1. Switch between L1 and L2 for either Viewports or Renderer.
2. You see the effect immediately in a smooth shaded viewport. Do a test rendering to see the effect on the renderer.

The following parameters are stored for each level: Face Threshold, Edge Threshold, Bias, Max Edge Len, Material Boundaries, and Smooth Boundaries.

**Interface**

**Level of Detail group**

**Renderer L1, L2**-Set the level of display for the default scanline renderer. Use Viewports L1 and L2 to change the stored optimization level. Default=L1.

**Viewports L1, L2**-Set the optimization level for both viewport and renderer. Also toggles the level of display for the viewport. Default=L1.

**Optimize group**

Adjusts the degree of optimization.
**Face Thresh**—Sets the threshold angle used to determine which faces are collapsed. Low values produce less optimization but better approximations of the original shape. Higher values improve optimization, but are more likely to result in faces that render poorly (see Bias). Default=4.0.

**Edge Thresh**—Sets a different threshold angle for open edges (those that bound only one face). A low value preserves open edges. At the same time you can apply a high face threshold to get good optimization. Default=1.0.

**Bias**—Helps eliminate the skinny or degenerate triangles that occur during optimization, which can cause rendering artifacts. Higher values keeps triangles from becoming degenerate. The default of 0.1 is enough to eliminate the skinniest triangles. Range=0.0 to 1.0 (a 0 value turns Bias off).

**Max Edge Length**—Specifies the maximum length, beyond which an edge cannot be stretched when optimized. When Max Edge Len is 0, it has no effect. Any value greater than 0 specifies the maximum length of the edges. Default=0.0.

Along with Bias, this control helps you avoid creating long skinny faces while optimizing.

**Auto Edge**—Turns edges on and off following optimization. Turns on any open edges. Turns off any edges between faces whose normals are within the face threshold; such edges beyond the threshold are not turned on. Default=off.

**Preserve group**—Maintains clean separation at the face level between material and smoothness boundaries.

**Material Boundaries**—Prevents face collapse across material boundaries. Default=off.

**Smooth Boundaries**—Optimizes an object and maintain its smoothing. When turned on, allows only faces that share at least one smoothing group to collapse. Default=off.

**Update group**

**Update**—Updates the viewports with the current optimization settings. Available only when Manual Update is turned on.

**Manual Update**—Enables the Update button. When turned off, Optimize works as it does by default, updating the viewport display dynamically.

**Note:** When using Manual Update, if you make any changes that cause the reevaluation of the stack, the existing optimization display disappears. Click the Update button again to restore it.

The Renderer ignores the optimization display in the viewport, using the Optimize settings, regardless of the state of the Manual Update.

**Last Optimize Status group**

Displays numerical results of optimization with exact before-and-after counts for vertices and faces.

**Spline based modifiers**

The Spline Select modifier passes a sub-object selection of shapes up the stack to subsequent modifiers. It provides much of the same set of selection functions available in the **Edit Spline modifier**. You can select vertices, segments, or splines, and you can change the selection from sub-object level to object level.

- Select a shape. > [Modify panel] > Modifier List > Object Space Modifiers > Spline Select
- Select a shape. > [Modifiers menu] > Selection > Spline Select

This modifier is similar to the **Mesh Select** and **Poly Select modifiers**, except for the type of sub-object components.

**Procedures**

To use the Spline Select modifier:

1. Create a multi-spline shape.
2. Apply a Spline Select modifier.
3. By default, the Vertex sub-object level is active.
4. If you wish to work at a different sub-object level, use the modifier stack display to choose it.
5. In the viewports, select vertices, segments, or splines.
   Tip: You can transform the selection using an XForm modifier or Linked XForm modifier.

Interface

Modifier Stack

The sub-object level you choose for the spline select modifier determines which rollout appears. (There are no parameters at the top, object level.)

**Vertex**-Creates a sub-object selection of vertices.

**Segment**-Creates a sub-object selection of segments.

**Spline**-Creates a sub-object selection of splines.

For more information on the stack display, see Modifier Stack.

Select Vertex rollout

**Get Segment Selection, Get Spline Selection**

Select vertices based on the last Segment or Spline selection. This selection is added to the current selection. Available only when Vertex is not the current sub-object level.

Select Segment rollout

**Get Vertex Selection, Get Spline Selection**

Select segments based on the last vertex or spline selection. The selection is added to the current selection. Available only when Segment is not the current sub-object level.

Select Spline rollout

**Get Vertex Selection, Get Segment Selection**

Select splines based on the last vertex or segment selection. The selection is added to the current selection. Available only when Spline is not the current sub-object level.

**Copy/Paste Selection controls (all rollouts)**

**Copy**-Places a named selection into the copy buffer.

**Paste**-Pastes a named selection from the copy buffer.

You can copy a named selection from one object to another or one modifier to another. You must copy and paste in the same sub-object level.

Trim/Extend Modifier

- Select a shape. > Modify panel > Modifier List > Trim/Extend

Select a shape. > Modifiers menu > Patch/Spline Editing > Trim/Extend

The Trim/Extend modifier is used primarily to clean up overlapping or open splines in a multi-spline shape so that lines meet at a single point. As with the Fillet/Chamfer modifier, this modifier operates on the splines at the sub-object level in the shape. When applied to a selection of multiple splines, Trim/Extend works as it does on a single spline.
To trim, you need intersecting splines. Click the portion of the spline you want to remove. The spline is searched along its length until it hits an intersecting spline, and deleted up to the intersection. If the section intersects at both ends, the entire section is deleted up to the two intersections. If the section is open on one end and intersects at the other, the entire section is deleted up to the intersection and the open end. If the section is not intersected, nothing happens.

To extend, you need an open spline. The end of the spline nearest the picked point is extended until it reaches an intersecting spline. If there is no intersecting spline, nothing happens. Curved splines extend in a direction tangent to the end of the spline. If the end of a spline lies directly on a boundary (an intersecting spline), then it looks for an intersection further along.

Note: As of version 3 of 3ds max, Edit/Editable Spline includes interactive trim/extend functions. The only reason to use this modifier is to apply it at a specific location on the stack.

**Procedure**

**To trim a shape using the Trim/Extend modifier:**
1. Create an open Line shape in the form of roughly concentric overlapping circles.
2. Apply the Trim/Extend modifier.
3. Click Pick Locations.
4. Click the inner spline sections of the concentric shape to trim them away, or click the open spline segment to extend the spline.

**Interface**

Pick Locations—Click to turn on Pick mode. While in this mode, the mouse cursor changes in appearance when over part of the spline that can be affected by the Trim/Extend modifier. Click to either trim or extend the spline, based on the settings below. Default=Auto.

Operation group
Specifies the type of operation that's performed on the selected spline.
Auto—When this is chosen, a Trim is first looked for and, if not found, an Extend is attempted. In most cases, a Trim will occur when Auto is chosen. An Extend can occur, however, in cases where an open spline exists without intersecting other splines.

Trim Only—Performs only trims. Turn on Pick Locations, and then click the spline section you want to trim.

Extend Only—Performs only extends. Click Pick Locations, and then select the open spline section you want to extend.

Infinite Boundaries—For the purposes of calculating intersections, turn this on to treat open splines as infinite in length. For example, this lets you trim one linear spline against the extended length of another line that it doesn’t actually intersect.

Note: As the number of open splines in the shape increases, the chance of finding an intersection, when using Infinite Boundaries, increases as well. This can produce results you might not have expected because of projected spline intersections you hadn't considered, particularly if you're in Auto mode. For predictable results, avoid using Auto mode when using Infinite Boundaries.

Intersection Projection group

These options specify how the Trim and Extend functions determine a valid intersection.

View—Projects the lines onto the active viewport, and judges the intersections accordingly. These are the intersections as you see them in the active viewport.

Construction Plane—Projects the lines onto the current construction plane.

None (3D)—Considers only true intersections as the splines exist in 3D space. They must physically intersect to be considered.

Lathe Modifier
Select a shape. > Modify panel > Modifier List > Lathe

Select a shape. > Modifiers menu > Patch/Spline Editing > Lathe

Tab panels > Modeling tab > Lathe modifier

Lathe creates a 3D object by rotating a shape or NURBS curve about an axis.

Object resulting from 360-degree lathe

Interface

Modifier Stack

Axis—At this sub-object level, you can transform and animate the axis of revolution.

Parameters rollout

Degrees—Determines the number of degrees that the object is spun around the axis of revolution (0 to 360, default=360). You can set keyframes for Degrees to animate the circular growth of a lathed object. The Lathe axis auto-sizes itself to the height of the shape being lathed.

Object resulting from 270-degree lathe

Weld Core—Simplifies the mesh by welding together vertices that lie on the axis of revolution. Keep it
turned off if you intend to create morph targets.

Flip Normals—Depending on the direction of the vertices on your shape, and the direction of rotation, the lathed object might be inside out. Toggle the Flip Normals check box to fix this.

Segments—Determines how many interpolated segments are created in the surface between the start and endpoint. This parameter is also animatable. Default=16

Capping group

Controls whether or not caps are created for the interior of the lathed object if Degrees is set to less than 360.

Cap Start—Caps the start of the lathed object with Degrees set to less than 360 and a closed shape.

Cap End—Caps the end of the lathed object with Degrees set to less than 360 and a closed shape.

Morph—Arranges cap faces in a predictable, repeatable pattern necessary for creating morph targets. Morph capping can generate long, thin faces that don't render or deform as well as grid capping. Use morph capping primarily if you are lathing multiple morph targets.

Grid—Arranges cap faces in a square grid trimmed at the shape boundaries. This method produces a surface of evenly sized faces that can easily be deformed by other modifiers.

Direction group

Sets up the direction of the axis of revolution, relative to the pivot point of the object.

X/Y/Z—Set the direction of the axis of revolution relative to the pivot point of the object.

Align group

Min/Center/Max—Align the axis of revolution to the minimum, center, or maximum extents of the shape.

Output group

Patch—Produces an object that you can collapse to a patch object (see the Edit Modifier Stack section in Modifier Stack).

Mesh—Produces an object that you can collapse to a mesh object (see the Edit Modifier Stack section in Modifier Stack).

NURBS—Produces an object that can be collapsed to a NURBS surface (see the Edit Modifier Stack section in Modifier Stack).

Generate Mapping Coordinates—Applies mapping coordinates to the lathed object. When Degrees is less than 360, and Generate Mapping Coordinates is turned on, additional mapping coordinates are applied to the end caps, placing a 1 x 1 tile on each cap.

Generate Material IDs—Assigns different material IDs to the sides and the caps of the lathed object. Specifically, the sides receive ID 3, and the caps (when Degrees is less than 360 and the lathed shape is closed) receive IDs 1 and 2. Default=on.

Use Shape IDs—Uses the material ID values assigned to segments in the spline you lathed, or curve sub-objects in the NURBS curve you lathed. Use Shape IDs is available only when Generate Material IDs is turned on.

Smooth—Applies smoothing to the lathed shape.

Fillet/Chamfer Modifier

- Select a shape. > Modify panel > Modifier List > Fillet/Chamfer

Select a shape. > Modifiers menu > Patch/Spline editing > Fillet/Chamfer

The Fillet/Chamfer modifier lets you fillet or chamfer the corners between linear segments in Shape objects. Fillet rounds corners where segments meet, adding new control vertices. Chamfer bevels corners, adding another vertex and line segment. Note that this modifier works on the splines at the sub-object level in the shape. It does not work between two or more independent shape objects.

When you apply Fillet/Chamfer, you're placed in a Vertex sub-object selection level. You can select (and move) any vertex, but only Corner vertices and Bezier Corner vertices are valid for fillet and chamfer functions. In addition, both segments connected by a Bezier Corner vertex must be linear rather than curved.

There are two methods for applying either fillets or chamfers:

- Select one or more valid corner vertices, and then adjust either the Radius spinner to fillet the selected corners, or the Distance spinner to chamfer the corners.

You can preset the Radius or Distance values, and then select one or more valid corner vertices, and click one of the Apply buttons to apply the specified value to the selected vertices.

Note: As of version 3 of 3ds max, Edit/Editable Spline includes interactive fillet/chamfer functions. The only reason to use this modifier is to apply it at a specific location on the stack.
Procedure

Example: To fillet/chamfer a star:
1. Create a Star shape.
2. Apply a Fillet/Chamfer modifier.
3. Select one or more of the star's vertices.
4. Adjust the parameters to achieve different effects.

Interface

<table>
<thead>
<tr>
<th>Fillet group</th>
<th>Chamfer group</th>
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<tbody>
<tr>
<td><strong>Radius</strong></td>
<td><strong>Distance</strong></td>
</tr>
<tr>
<td><strong>Apply</strong></td>
<td><strong>Apply</strong></td>
</tr>
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</table>

Fillet group
- **Radius**—Specifies the radius of the filleted corner.
- **Apply**—Applies the value specified in the Radius spinner to selected vertices. For example, before selecting any vertices, set the Radius to the desired value, then select your vertices and click Apply to fillet the selection with the specified radius.

Chamfer group
- **Distance**—Specifies the distance of the new vertices from the original corner vertex.
- **Apply**—Applies the value specified in the Distance spinner to selected vertices. For example, before selecting any vertices, set Distance to the desired value, then select your vertices and click Apply to chamfer the corners.

Edit Spline Modifier

- **Create or select a spline > Modify panel > Object-Space Modifiers > Edit Spline**

- **Create or select a spline > Modifiers menu > Patch/Spline Editing > Edit Spline**

Tab panels > Modifiers tab > Edit Spline Modifier
The Edit Spline modifier provides explicit editing tools for different levels of the selected shape: vertex, segment, or spline. The Edit Spline modifier matches all the capabilities of the base Editable Spline object, with the exceptions noted below. See Editable Spline for a complete parameter reference.

The Rendering and Interpolation rollouts found in Editable Spline, which allows manipulation of the spline's creation parameters, are not available in the Edit Spline modifier. (The creation parameters are available in the modifier stack for a spline to which Edit Spline is applied.) In addition, the direct vertex animation capabilities of Editable Spline are not possible in Edit Spline. When possible, it’s far more efficient and reliable to perform explicit editing at the Editable Spline level rather than store those edits within the Edit Spline modifier. The Edit
Spline modifier must copy the geometry passed to it, and this storage can lead to large file sizes. The Edit Spline modifier also establishes a topological dependency that can be adversely effected if earlier operations change the topology being sent to it.

There are, however, situations where Edit Spline is the preferred method.

- You want to edit a parametric shape as a spline, but want to retain the ability to modify its creation parameters after the edit.
- You want to store your edits temporarily within Edit Spline until you are satisfied with the results, before committing them permanently to an editable spline object.
- You need to make edits across several shapes at once, but do not want to convert them to a single editable spline object.
- You have a modifier in the stack that must stay parametric, and the resulting spline must be edited after the modifier is applied.

**Delete Spline Modifier**

- Modify panel > Select a spline sub-object. > Modifier List > Delete Spline
  - Modify panel > Select a spline sub-object. > Modifiers menu > Patch/Spline Editing > Delete Spline

  The Delete Spline modifier provides parametric deletion of spline geometry based on the current sub-object selection level in the stack. The possible selection levels include vertices, segments, and splines. Apply the Delete Spline modifier to delete the geometry specified at that sub-object level.

**Procedure**

**To use the delete spline modifier:**

1. Create a shape that contains multiple splines.
2. Apply a Spline Select modifier and select a section of the spline for deletion.
3. Apply a Delete Spline modifier to delete the section.
4. To undo the deletion, remove the Delete Spline modifier.

**Interface**

This modifier has no parameters.

---

**Surface Modifier**

The Surface modifier generates a patch surface based on the contours of a spline network. A patch is created wherever the segments of the interwoven splines form a three- or four-sided polygon. The Surface modifier and the CrossSection modifier, taken together, are referred to as Surface Tools. They allow you to create complex or organic surfaces, like the fuselage of a plane, or a three-dimensional character.

- Select a spline object. > Modify panel > Modifier List > Object-Space Modifiers > Surface
- Standard menu: Select a spline object. > Modifiers menu > Patch/Spline Editing > Surface
- Enhanced menu: Select a spline object. > Modifiers menu > Spline > Surface

**Procedures Interface**

Applying the **Surface modifier to create a patch surface.**

The CrossSection modifier can be applied before the Surface modifier to connect splines representing cross-sections. Once the basic spline network is created and the Surface modifier is applied, the model can be adjusted by editing the splines using an Edit Spline modifier below the Surface modifier in the modifier stack. Since the Surface modifier creates a Patch surface, further refinements can be made to the patch model by adding an Edit Patch modifier above the Surface modifier.

The bulk of the work in using Surface tools to model lies in creating and editing splines in an Editable Spline or Edit Spline modifier. One of the benefits to modeling using splines and Surface Tools is the ease of editing the model. At almost any stage of modeling, you can add a nostril, ear, limb or body by simply adding splines. This lends itself
to a free-form approach to organic modeling: you have a mental image of what you want, then you create and edit the spline network until you are satisfied.

Note: 3ds Max offers a simplified workflow for this modeling technique, using Edit/Editable Spline and the Edit Patch modifier.

Surface Modifier Basics

1. Create a spline object.
2. Make sure that the Spline vertices form valid three-sided or four-sided, closed regions. Vertices on splines that cross one another should be coincident.
   To make spline vertices coincident, drag vertices over each other with 3D Snap turned on. 3D Snap must have the Vertex or End Point option turned on. With 3D Snap turned on, you can snap to vertices on existing splines as you create new splines. You can also select vertices and use the Fuse option in an Editable Spline to make vertices co-incident.
3. Use the CrossSection modifier to connect spline cross-sections, unless you plan on manually creating the splines that connect the model's cross-sections.
4. Apply the Surface modifier, then adjust the weld threshold to generate a patch object. Ideally all spline vertices that will form a patch surface are coincident; the Threshold parameter allows patch creation even if vertices are not quite coincident.
5. Optionally, add an Edit Patch modifier to edit the patch surface.
   Tip: Make a reference copy of the spline object, then add the Surface modifier to the copy and edit the original. As you edit the original spline object, patches appear on the reference copy as splines form three-or four-sided shapes. This allows you to view a shaded surface as you model.
   You can take this a step further and add a Mirror modifier to the reference copy. As you create splines for one side of a head or body, the reference copy displays an entire model.

Modeling with Surface Tools

There are two primary methods of using the Surface modifier to create patch models.

- Create splines that represent a model's cross sections, add the CrossSection modifier to connect the cross sections, and apply the Surface modifier to create the patch surface. This approach works for models like the body of an airplane.
  Alternatively, use the editable spline Cross Section function to connect the cross sections, and then use the editable patch Spline Surface tools to create the surface.

- Create a network of splines manually, and then apply the Surface modifier or editable patch Spline Surface tools to create the patch surface. This approach works for modeling a face or body of a character.

Modeling Examples

Scooter:
Splines form cross sections of the body
One method of using Surface Tools is to create splines that represent a model's cross sections, then the CrossSection and Surface modifiers are applied to create the patch surface.
Face: Spline network based on front and profile reference images

Two intersecting texture-mapped polygons are used as a reference to create a network of splines manually. Drawing lines on the physical sculpture is used as an added visual aid to position the splines in this case. The CrossSection modifier is not necessary if you create the spline network manually.

As the spline network is edited, the patch surface of the reference copy is updated dynamically. This allows you to view a shaded patch model as you manipulate the spline network, any surface anomalies can be spotted and corrected.

Sequence of images showing the spline network, the patches created by the Surface modifier, and a shaded view of an alien character.

Additional Details

- Splines are initially created using the tools in Create panel ➤ Shapes ➤ Splines ➤ Object Type rollout, such as Line, Circle, Arc, and Section. Splines can also be created using the Create Line command in an Editable Spline or and Edit Spline modifier.
- Splines are edited by applying an Edit Spline modifier to the selected spline object or editing parameters in an Editable Spline. Editing splines changes the patch surface created by the Surface modifier.
- To add splines to a spline object, use the Attach command in the Edit Spline modifier.
- Within a spline object, splines need not be continuous. A spline object may consist of ten splines, for example. As long as the spline vertices are coincident, or close enough for the Threshold parameter in the Surface modifier to weld them together, a surface will be generated.

Procedures

Example: Understanding valid splines:

1. In the Top viewport, use Create panel ➤ Shapes ➤ NGon to create three NGons: a three-sided, four-sided, and five-sided NGon, each about 100 units wide.
2. Make sure that all the splines form one object. Do this by applying an Edit Spline modifier to one of the NGons and using Attach to add the remaining NGon objects.
3. Choose Modifiers menu ➤ Patch/Spline Editing ➤ Surface from the Modifier List. Notice that the three- and four-sided splines formed patches but the five-sided NGon did not. The five-sided spline does not form a three- or
four-sided closed region. To make it a valid spline, a line must bisect the NGon to form a three- and four-sided region.

4. In the modifier stack, highlight the Edit Spline modifier again. On the Geometry rollout, turn on Create Line, then create a line that bisects the five-sided NGon. The start and end points of the line should overlap the vertices on the NGon. Being exact is not critical; the Threshold parameter fuses spline vertices based on their proximity.

5. In the modifier stack, highlight the Surface modifier again. Now the five-sided NGon is a patch object, consisting of a quad patch and a tri patch. Note: If the spline object did not turn into a patch, increase the Surface modifier’s Threshold parameter until the patches appear.

Example continued: Adjusting the shape of the spline:

1. In the modifier stack, expand the Edit Spline modifier’s hierarchy, and highlight the Vertex sub-object level.

2. In the Top viewport, select the top vertex of the five-sided NGon. 3ds Max displays two vector handles. You can move these handles on any axis.

3. On the main toolbar, turn on (Select and Move), then drag the handles around in the Top viewport. The shape of the spline changes.

4. Below the modifier stack display, turn on (Show End Result On/Off Toggle). The patch changes shape to fit the spline.

Interface

Spline Options group

Threshold
Determines the overall distance that is used to weld the vertices of the spline object. All vertices/vectors within the threshold of each other are treated as one. Threshold uses units set in the Units Setup dialog. Note: Spline control handles are also treated as vertices, so setting high Threshold levels can produce unexpected results.

Flip Normals—Flips the normal direction of the patch surface.

Remove Interior Patches—Removes interior faces of an object that you would not normally see. These are the faces created within the caps or other interior patches of the same type of a closed polygon.

Use only selected segs.—Only segments selected in the Edit Spline modifier will be used by the Surface modifier to create patches.

Note: Segment Sub-Object does not have to be left on in the Edit Spline modifier.
**Patch Topology group-Steps**

The steps field spinner determines how many steps are used between each vertex. The higher the step count, the smoother the curve you will get between vertices.

---

**CrossSection Modifier**

- Select a spline object with spline cross sections. > Modify panel > Modifier List > CrossSection

**Make a selection. > Modifiers menu > Patch/Spline Editing > CrossSection**

**Tab panels > Modeling tab > CrossSection Modifier**

CrossSection uses splines to create a model of a boat. The CrossSection modifier creates a "skin" across multiple splines. It works by taking 3D splines and connecting their vertices to form a skin. The resulting object is another spline object that can be used with the Surface modifier to create a patch surface.

CrossSection can build a skin across various shaped splines with different vertex counts and open/closed status. The more different the splines in vertex count and complexity, the more likely the skin will have discontinuity.

Note: The CrossSection and Surface modifiers together are referred to as Surface Tools.

See also **Surface Modifier**

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**Procedures**

**Example: To explore the CrossSection modifier:**

1. On the Create panel, click Shapes, then click Circle.
2. Drag in the Top viewport to create a circle about 100 units in radius.
3. On the Modify panel, choose Edit Spline from the Modifier List.
4. In the modifier stack display, turn on Spline sub-object, then select the circle.
5. In the Front viewport, Shift-Move the spline up to copy it.
6. Shift-Move the copy up to create a third circle.
7. Note: The order that you attach or clone splines is important: this is the order that CrossSection uses to create the skin.
8. On the Modify panel, choose CrossSection from the Modifier List.

CrossSection joins the vertices of the three circles. A basic spline cylinder is displayed.

On the Modify panel, on the Modifiers List, choose Surface to add the Surface modifier.

1. The spline cylinder is transformed into a patch surface by the Surface modifier.
2. To edit the model's surface, change the splines using controls in the Edit Spline modifier. Or, since the output of the Surface modifier is a patch surface, add an Edit Patch.
modifier and use patch edit controls to change the surface.

An Edit Patch modifier above the Surface modifier was used to create the images.

Example: Using the CrossSection modifier to skin several splines with different shapes:

On the Create panel, click Shapes.
On the Object Type rollout, turn on Start New Shape, then click NGon.
In the Top viewport, create two five-sided circular NGons.

Create the vertices left-to-right.

On the main toolbar, click Select And Move, then move the objects in the viewport to order them along the Z axis with the NGons at the bottom and the lines above the NGons.

Select the bottom NGon.

Select the remaining NGon and lines in an ascending order, as numbered in the image.

Note: The order of selection is important. The CrossSection modifier uses the selection order to define the skin.

Example continued: Lining up the vertices:

1. On the Modify panel, choose the Vertex sub-object level in the stack display.

2. Lining up the first vertex of each spline is important to prevent the surface from twisting.

3. Use CTRL+click to select the right-most vertex of each line and the bottom-most vertex of each NGon.

4. On the Geometry rollout, click Make First.

Aligning the first vertex is important. This is where the seam forks, going from a closed to an open spline.

Example continued: Using CrossSection and Surface to "skin" the shapes:

1. On the Modify panel, choose CrossSection from the Modifiers List.

2. The CrossSection modifier connects the splines at the vertices.

3. On the Modifiers List, choose Surface.
4. The Surface modifier generates a patch surface based on the splines.
5. In the modifier stack display, choose the CrossSection modifier.
6. On the CrossSection Parameters rollout, toggle between Linear and Smooth. Notice how the splines change.
7. On the Modify panel, toggle the Show End Result On/Off Toggle button to display the final patch surface. The toggle won’t remain on if the CrossSection modifier is current. Drop down to the Editable Patch in the stack and turn on the Show End Result toggle if you like.

Tip: When you use CrossSection, draw splines in a consistent direction. A twisted surface results when lines are created from vertices that are not lined up.

Interface

- Linear/Smooth/Bezier/Bezier Corner—Determines what type of curve will be used through the spline vertices.

FFD (Free Form Deformation) Modifiers
- Modify panel > Make a selection. > Modifier List > Object-Space Modifiers
  > FFD 2x2x2, FFD 3x3x3, or FFD 4x4x4

Make a selection. > Modifiers menu > Free Form Deformers > FFD 2x2x2, FFD 3x3x3, or FFD 4x4x4

FFD stands for Free Form Deformation. Its effect is used in computer animation for things like dancing cars and gas tanks. You can use it as well for modeling rounded shapes such as chairs and sculpture.

The FFD modifier surrounds the selected geometry with a lattice box. By adjusting the control points of the lattice, you deform the enclosed geometry.

FFD deformation creates a bulge in the snake.

There are three FFD modifiers, each providing a different lattice resolution: 2x2, 3x3, and 4x4. The 3x3 modifier, for example, provides a lattice with three control points across each of its dimensions or nine on each side of the lattice.

There are also two FFD-related modifiers that provide supersets of the original modifiers; see FFD (Box/Cyl) Modifier. With the FFD (Box/Cyl) modifiers, you can set any number of points in the lattice, which makes them more powerful than the basic FFD modifier.

Animating FFD Control Points and the Master Point Controller

Turn on the Auto Key button and move the lattice points to animate an FFD and any underlying geometry. When you animate FFD control points, a Master Point Controller is created automatically. In Track View the master controller allows you to move multiple animated control points in time by simply moving one master key (master keys display green in Track View).

Procedure

To use an FFD modifier:
- Select the geometry. This can be the whole object, or you can use a Mesh Select modifier to select a portion of the object's vertices.
- Apply the FFD 2X2, FFD 3X3, or FFD 4X4 modifier, depending on the resolution of the lattice you want.
- An orange lattice gizmo surrounds the geometry.
- In the stack display, choose the Control Points sub-object level, and then move the control points of the lattice to deform the underlying geometry. (Turn on the Auto Key button if you want to animate the deformation.)
- The lattice volume defaults to the bounding box of the selected geometry. However, you can position, rotate, and/or scale the lattice box so that it modifies only a subset of vertices. Choose the Lattice sub-object level, and then use any of the transform tools to adjust the lattice volume relative to the geometry.

Interface

Modifier Stack

- FFD 4x4x4
- Control Points
- Lattice
- SetVolume
- Editable Mesh
Control Points—At this sub-object level, you can select and manipulate control points of the lattice, one at a time or as a group (select multiple points using standard techniques). Manipulating control points affects the shape of the underlying object. You can use standard transformation methods with the control points. If the Auto Key button is turned on when modifying the control points, the points become animated.

Lattice—At this sub-object level, you can position, rotate, or scale the lattice box separately from the geometry. If the Auto Key button is turned on, the lattice becomes animated. When you first apply an FFD, its lattice defaults to a bounding box surrounding the geometry. Moving or scaling the lattice so that only a subset of vertices lies inside the volume makes it possible to apply a localized deformation.

Set Volume—At this sub-object level, the deformation lattice control points turn green, and you can select and manipulate control points without affecting the modified object. This lets you fit the lattice more precisely to irregular-shaped objects, giving you finer control when deforming. Set Volume essentially lets you set the initial state of the lattice. If you use it after you have animated a control point or when the Auto Key button is turned on, then it works the same as at the Control Points sub-object level, deforming the object as you manipulate points.

For more information on the stack display, see Modifier Stack.

FFD Parameters rollout

### Display group
Affects the display of the FFD in the viewports.

- **Lattice**—Draws lines connecting the control points to make a grid. Although the viewports can sometimes become cluttered when these lines are drawn, it helps to visualize the lattice.

### Deform group

- **Only In Volume**—Deforms vertices that lie inside the source volume. Default=on.
- **All Vertices**—Deforms all vertices, regardless of whether they lie inside or outside the source volume.

The deformation outside the volume is a continuous extrapolation of the deformation inside the volume. The deformation can be extreme for points far away from the source lattice.

### Selection group
Provides additional methods of selecting the control points. You can toggle the state of any combination of the three buttons to select in one, two, or three dimensions at once.

- **All X, All Y, All Z**—Selects all control points along the specified local dimension when you select a control point. By turning on two buttons, you can select all control points in two dimensions.

### Control Points group

- **Reset**—Returns all control points to their original positions.
- **Animate All**—Assigns Point3 controllers to all control points so that they're immediately visible in Track View. By default the control points of an FFD lattice don't appear in Track View because they don't have controllers assigned to them. But when a control point is animated, a controller is assigned to it and becomes visible in Track View. With Animate All, you can add and delete keys and perform other key operations.

- **Conform to Shape**—Moves each FFD control point to the intersection of the modified object with a straight line extending between the object's center to the control point's original location, plus an offset distance specified by the Offset spinner.

Note: Conform to Shape works best with regular shapes, such as primitives. It's less effective if the object has degenerate (long, narrow) faces or sharp corners. All the controls are unavailable with shapes, because there are no faces to intersect with.

- **Inside Points**—Only control points inside the object are affected by Conform to Shape.
- **Outside Points**—Only control points outside the object are affected by Conform to Shape.
Offset—The distance by which control points affected by Conform to Shape are offset from the object surface.
About—Displays a dialog with copyright and licensing information.

Extra modifiers

Bevel Profile Modifier
Select a shape. > Modify panel > Modifier List > Bevel Profile

Tab panel > Modeling tab > Bevel Profile modifier
The Bevel Profile modifier extrudes a shape using another shape path as the "beveling profile." It's a variation on the Bevel modifier.

Important: Bevel Profile fails if you delete the original beveling profile. Unlike a loft object, which incorporates the shape, Bevel Profile is simply a modifier.

Note: Although this modifier might seem similar to a loft object with varying scale settings, it's actually different because it uses different outline values as distances between line segments rather than as scale values. This more complex method of resizing a shape results in some levels having either more or less vertices than others, and generally works better with text, for example.

Bevel Profile creates an object using an open spline.
Bevel Profile creates an object using a closed spline, yielding a different result.

Procedure
To use the Bevel Profile modifier:
1. Create the shape you want to bevel (preferably in the Top viewport).
2. In the Front (XZ) viewport, create a shape to use as the beveling profile.
3. Select the first shape and apply the Bevel Profile modifier.
4. Click the Pick Profile button in the Bevel Profile modifier, and then click the profile shape.

Interface

Modifier Stack
Parameters rollout

Bevel Profile group
Pick Profile—Selects a shape or NURBS curve to be used for the profile path.
Generate Mapping Coords—Assigns UV coordinates.
Capping group
Start—Caps the bottom of the extruded shape.
End—Caps the top of the extruded shape.
Cap Type group

Morph—Selects a deterministic method of capping that provides the same number of vertices for morphing between objects.

Grid—Creates gridded caps that are better for cap deformations.

Keep Lines From Crossing—Prevents beveled surfaces from self intersecting. This requires more processor calculation and can be time-consuming in complex geometry.

Separation—Sets the distance that sides should be kept apart to prevent intersections.

Affect Region Modifier

- Modify panel > Make a vertex sub-object selection. > Modifier List > Object-Space Modifiers > Affect Region

Make a vertex sub-object selection. > Modifiers menu > Parametric Deformers > Affect Region

Tab panels > Modeling tab > Affect Region

The Affect Region modifier is a surface modeling tool, primarily used with vertex sub-object selections while surface modeling. With Affect Region, transforming a selection of vertices can also transform vertices in the region that surrounds the selection. This can help you form a bubble or indentation in the surface of an object. The easiest way to see this modifier’s effect is with a shallow, flat box object with plenty of subdivisions. The Affect Region modifier has a two-part, arrow-shaped gizmo plus numeric controls.

When you apply the Affect Region modifier, it assigns an arrow-like gizmo consisting of two points connected by a line. The base of the arrow is the start point. The length and direction of the arrow defines the amount of movement of the vertices. Any vertices within Falloff distance of the base of the arrow are translated in the direction of the arrow.

Because no points on the mesh are directly selected, this modifier doesn’t depend on the topology of the input object. You can apply it to any renderable object. However, you can limit the effect by using a selection modifier like Mesh Select or Volume Select to pass a sub-object selection up the stack.

Note: The Affect Region modifier is ideal for simple animated effects, especially when you need to use interactive parameters. However, for fine-tuned modeling, you’ll probably prefer the expanded capabilities of Soft Selection in Editable Mesh, Editable Poly, Edit Mesh, Mesh Select, Volume Select, the HSDS modifier, and NURBS.

Affect Region modifier applied

Procedure

Example: To form a bubble over the surface of a box:

- Create a box with **15** height, width, and length segments.
- Set the length, width, and height of the box to **50** units.
- Apply the Affect Region modifier.
- In the Parameters group, set Falloff to **50**.
- Adjust the parameters to achieve different effects.

Interface

Note: The parameters of this modifier are similar to those of the Soft Selection function in Editable Mesh.

Modifier Stack

Point sub-object level—At this sub-object level, the base and tip of the gizmo arrow are points that can be selected. You can select, translate, and animate these two points together or individually.

For more information on the stack display, see Modifier Stack.

Parameters rollout
Parameters group

**Falloff**—Sets the radius of affected vertices, in units, from the base of the gizmo arrow. (Spinner value range: float, 0.0 to 999,999.0)

**Ignore Back Facing**—Affects only those vertices whose face normals are in the same general direction as the gizmo arrow. When turned off, all vertices in the Falloff group are affected.

Curve group

**Pinch**—Affects the tangency of the curve where it meets the arrow tip. Positive values produce a pointed tip while negative values produce a dimple. (Spinner value range: float, -999,999.0 to 999,999.0)

**Bubble**—Changes the curvature of the affected vertices. A value of 1.0 produces a half-dome. As you reduce this value, the sides of the dome slope more steeply. Negative values lower the base of the curve below the base of the arrow gizmo. (Spinner value range: float, -999,999.0 to 999,999.0)

**Displace Modifier**

- Modify panel > Make a selection. > Modifier List > Object-Space Modifiers > Displace
- Make a selection. > Modifiers menu > Parametric Deformers > Displace
- Tab panels > Modifiers tab > Displace modifier

Displace used to change the surface in the container

The Displace modifier acts as a force field to push and reshape an object’s geometry. You can apply its variable force directly from the modifier gizmo, or from a bitmapped image. There are two basic ways to use this modifier:

- Apply displacement effects directly by setting Strength and Decay values.
- Apply the grayscale component of a bitmapped image to generate the displacement. Lighter colors in the 2D image push outward more strongly than darker colors, resulting in a 3D displacement of the geometry.

The **Displace space warp** has similar features. It’s useful for applying effects to a large number of objects or a particle system.

**Bitmap displacement on a patch and the bitmap used.**

**Terrain effects using Displace**

**Force Distribution**

Displace distributes its force through four different gizmos: Planar, Cylindrical, Spherical, and Shrink Wrap. Gizmos are also used as mapping coordinates for applying bitmaps. Sphere and Shrink Wrap have the same effect when modeling, but differ in the way they map.

The Spherical and Shrink Wrap gizmos begin with a uniform field around them. The Cylinder and Planar gizmos are both directional. Cylinder pushes at right angles to its axis, and Planar pushes at right angles to its surface.

By default, gizmos are centered on the object. However, you can transform any of these shapes and use it directly as a tool to deform the geometry of an object.

**Modeling Options**

Displace is a versatile modifier with many possible applications. Here are some options:

- Produce interior modeling effects by scaling down the gizmo and moving it inside the object. The outward force shapes the geometry from within.
- Animate the modeling process. One result is a roving, magnetic-like field that pushes and pulls on a surface.
- Add additional Displace modifiers to an object, using each one to create a different modeling effect.
- Collapse a finished model into a plain mesh. This reduces the object’s complexity and removes all modifiers, but keeps the modeled surface intact.

**Procedures**

To displace an object:
• Select an object and apply the Displace modifier.
• In the Parameters rollout > Map group, select one of the four gizmo types.
• In the Displacement group, set values for Strength and Decay. Vary these settings to see the effect of the displacement on the object.

Depending on the object and the complexity of the bitmap, you might need to use dense geometry to see the effect clearly. Try a test run and, if necessary, add tessellation in the areas of greatest detail.

To apply a bitmap as a displacement map:
1. In the Parameters rollout > Displacement group, click the Bitmap button (which is labeled "None" until a map has been chosen). Use the file dialog to choose a bitmap.
2. Set the Strength value. Vary the strength of the field to see the effect of the bitmap displacing the object's geometry.

After you get the image you want from bitmapped displacement, you can apply an Optimize modifier to reduce the complexity of the geometry.

To model with the displace modifier:
• Apply Displace to the object you want to model. Choose a gizmo on the Map rollout.
• Increase the Strength setting until you begin to see a change in the object.
• Scale, rotate, and move the gizmo to concentrate the effect. As you do this, adjust the Strength and Decay settings to fine-tune the effect.

Interface

Displacement group

**Decay**—Varies the displacement strength with distance.
By default, Displace has the same strength throughout world space. Increasing Decay causes the displacement strength to diminish as distance increases from the position of the Displace gizmo. This has the effect of concentrating the force field near the gizmo, similar to the field around a magnet repelling its opposite charge. Default=0.0.

**Luminance Center**—Determines which level of gray Displace uses as the zero displacement value.
By default, Displace centers the luminance by using medium (50 percent) gray as the zero displacement value. Gray values greater than 128 displace in the outward direction (away from the Displace gizmo) and gray values less than 128 displace in the inward direction (toward the Displace gizmo). Use the Center spinner to adjust the default. With a Planar projection, the displaced geometry is repositioned above or below the Planar gizmo. Default=0.5. Range=0-1.0.

Image group

Contains mapping parameters for bitmapped displacement. See **UVW Map** control how Displace projects its displacement. The type of location in the scene determine the final effect.

**Cylindrical, Spherical, and Shrink Wrap**
from a single plane.
map as if it were wrapped around the cylinder. Turn on Cap map from the ends of the cylinder.

Displace gizmos: Planar, Planar—Projects the map
Cylindrical—Projects the to project a copy of the

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**Spherical**—Projects the map from a sphere, with singularities at the top and bottom of the sphere where the bitmap edges meet at the sphere's poles.

**Shrink Wrap**—Projects the map from a sphere, as Spherical does, but truncates the corners of the map and joins them all at a single pole, creating only one singularity at the bottom.

**Length, Width, Height**—Specifies the dimensions of the Displace gizmo's bounding box. Height has no effect on Planar mapping.

**U/V/W Tile**—Sets the number of times the bitmap repeats along the specified dimension. The default value of 1.0 maps the bitmap exactly once; a value of 2.0 maps the bitmap twice, and so on. Fractional values map a fractional portion of the bitmap in addition to copies of the whole map. For example, a value of 2.5 maps the bitmap two and a half times.

**Flip**—Reverses the orientation of the map along the corresponding U, V, or W axis.

**Use Existing Mapping**—Has Displace use mapping set earlier in the stack. This has no effect if the object is not mapped.

**Apply Mapping**—Applies the Displace UV mapping to the bound object. This lets you apply material maps to the object using the same mapping coordinates as the modifier.

**Channel group**

Specifies whether to apply the displacement projection to a mapping channel or a vertex color channel, and which channel to use. For more information on these channels, see **UVW Map Modifier**.

**Map Channel**—Choose this to specify a UVW channel to use for the mapping, and use the spinner to its right to set the channel number.

**Vertex Color Channel**—Choose this to use the vertex color channel for the mapping.

**Alignment group**

Contains controls for adjusting the mapping gizmo's size, position, and orientation.

**X, Y, Z**—Flips the alignment of the mapping gizmo along its three axes.

**Fit**—Scales the gizmo to fit the object's bounding box.

**Center**—Centers the gizmo relative to the object's center.

**Bitmap Fit**—Displays a Select Bitmap dialog. The gizmo is scaled to fit the aspect ratio of the bitmap you select.

**Normal Align**—Turns on Pick mode to let you select a surface. The gizmo is aligned to the normal of that surface.

**View Align**—Orients the gizmo in the same direction as the view.

**Region Fit**—Turns on Pick mode to let you drag two points. The gizmo is scaled to fit the specified area.

**Reset**—Returns the gizmo to its defaults.

**Acquire**—Turns on Pick mode to let you choose another object and acquire its Displace gizmo settings.

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**Edit Mesh Modifier**

- Create or select an object > Modify panel > Modifier List > Object–Space Modifiers > Edit Mesh

Create or select an object > Modifiers menu > Mesh Editing > Edit Mesh

Tab panels > Modeling tab > Edit Mesh Modifier

The Edit Mesh modifier provides explicit editing tools for different sub-object levels of the selected object: vertex, edge, and face/polygon/element. The Edit Mesh modifier matches all the capabilities of the base Editable Mesh object, except that you cannot animate sub-objects in Edit Mesh. See **Editable Mesh** for a complete parameter reference.

When possible, it's far more efficient and reliable to perform explicit modeling at the Editable Mesh level rather than store those edits within the Edit Mesh modifier. The Edit Mesh modifier must copy the geometry passed to the object.
it, and this storage can lead to large file sizes. The Edit Mesh modifier also establishes a topological dependency that can be adversely affected if earlier operations change the topology being sent to it.

There are, however, situations where using the Edit Mesh modifier is the preferred method.

- You want to edit a parametric object as a mesh, but want to retain the ability to modify its creation parameters after the edit.
- You want to store your edits temporarily within Edit Mesh until you are satisfied with the results, before committing them permanently to an editable mesh object.
- You need to make edits across several objects at once, but do not want to convert them to a single editable mesh object.
- You have a modifier in the stack that must remain parametric, and the mesh must be edited after the modifier is applied.

### Face Extrude Modifier

**Modifier Stack**
- Modify panel > Select one or more faces of a mesh object. > Modifier List > Face Extrude
- Modify panel > Select one or more faces of a mesh object. > Modifiers menu > Mesh Editing > Face Extrude
- Tab panels > Modeling tab > Face Extrude modifier

**Interface**
- **Parameters rollout**
  - **Amount** — Determines the extent of the extrusion. You can adjust and readjust the Amount spinner as often as you choose. To extrude a second level, apply another Face Extrude modifier.
  - **Scale** — Scales each cluster of selected faces independently about its center. Note: By using multiple extrude modifiers with Scale, you can achieve a bevel effect.

**Modifier Stack**
- can select and move (or animate) only if you turn on Extrude From Center

**Extrude Center** — At this sub-object level, you select and move (or animate) the center point. This affects the geometry Center.

**Parameters rollout**
- **Amount** — Determines the extent of the extrusion. You can adjust and readjust the Amount spinner as often as you choose. To extrude a second level, apply another Face Extrude modifier.
- **Scale** — Scales each cluster of selected faces independently about its center. Note: By using multiple extrude modifiers with Scale, you can achieve a bevel effect.

**Extrude From Center** — Extrudes each vertex radially from the center point.

The direction in which the faces are extruded is slightly different than Face Extrude in the editable mesh. Each vertex is displaced in the direction of the average surface normal of selected faces that share that vertex. So each vertex may move in a slightly different direction. Put another way, each vertex is extruded in the direction of the surface normal at the point on the surface where that vertex lies.

### Melt Modifier

- Modify panel > Make a selection. > Modifier List > Melt

**Modifier Stack**
- Make a selection. > Modifiers menu > Animation Modifiers > Melt
- Tab panels > Modifiers tab > Melt modifier

Increasing the Melt amount progressively melts the cake.
The Melt modifier lets you apply a realistic melting effect to all types of objects, including editable patches and NURBS objects, as well as to sub-object selections passed up the stack. Options include sagging of edges, spreading while melting, and a customizable set of substances ranging from a firm plastic surface to a jelly type that collapses in on itself.

Procedure

Example: To animate a jelly-like melting sphere:
In the Top viewport, create a Sphere primitive with a radius of about 50 units.

- Apply the Melt modifier.
- Turn on the Auto Key button and go to frame 100.
- In the Melt group box, set Amount to 70.
- In the Solidity group box, choose Jelly.
- Drag the time slider to see the sphere melt.

Interface

Modifier Stack

Gizmo—At this sub-object level, you can transform and animate the gizmo like any other object, altering the effect of the Melt modifier. Translating the gizmo translates its center an equal distance. Rotating and scaling the gizmo takes place with respect to its center.

Center—At this sub-object level, you can translate and animate the center, altering the Melt gizmo's shape, and thus the shape of the melted object.

For more information on the stack display, see Modifier Stack.

Parameters rollout

Melt group

Amount—Specifies the extent of the "decay," or melting effect applied to the gizmo, thus affecting the object. Range=0.0 to 1000.0.

Spread group

% of Melt—Specifies how much the object and melt will spread as the Amount value increases. It's basically a "bulge" along a flat plane.

Solidity group

Determines the relative height of the center of the melted object. Less-solid substances like jelly tend to settle more in the center as they melt. This group provides several presets for different types of substances, as well as a Custom spinner for setting your own solidity.

Ice—The default Solidity setting.

Glass—Uses a high Solidity setting to simulate glass.

Jelly—Causes a significant drooping effect in the center.

Plastic—Relatively solid, but droops slightly in the center as it melts.

Custom—Sets any solidity between 0.2 and 30.0.

Axis to Melt group

X/Y/Z—Choose the axis (local to the object) on which the melt will occur. Note that this axis is local to the Melt gizmo and not related to the selected entity. By default, the Melt gizmo's axes are lined up with the object's local coordinates, but you can change this by rotating the gizmo.

Flip Axis—Normally, the melt occurs from the positive direction toward the negative along a given axis. Turn on Flip Axis to reverse this direction.