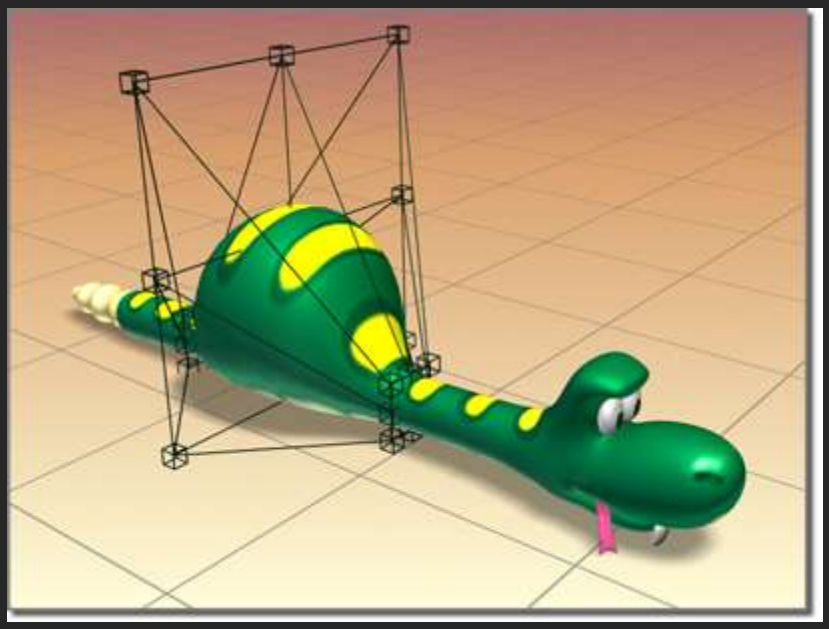
FFD (Box/Cylinder) Modifiers

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 sculptures.

-  **Modify panel > Make a selection. > Modifier List > Object-Space Modifiers > FFD(box) or FFD(cyl)**
- **Make a selection. > Modifiers menu > Free Form Deformers > FFD Box or FFD Cylinder**

The FFD modifier surrounds the selected geometry with a lattice box. By adjusting the control points of the lattice, you deform the enclosed geometry. With the Auto Key button turned on, you can animate the lattice points, and thus the deformation of the geometry.



FFD deformation creates a bulge in the snake.

With the FFD(box) and FFD(cyl) modifiers you can create box-shaped and cylinder-shaped lattice free-form deformation objects. Both are available as object modifiers and as space warps.

The source lattice of an FFD modifier is fitted to the geometry it's assigned in the stack. This can be a whole object, or a sub-object selection of faces or vertices.

Interface

Modifier Stack

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 lie inside the volume makes it possible to apply a localized deformation.

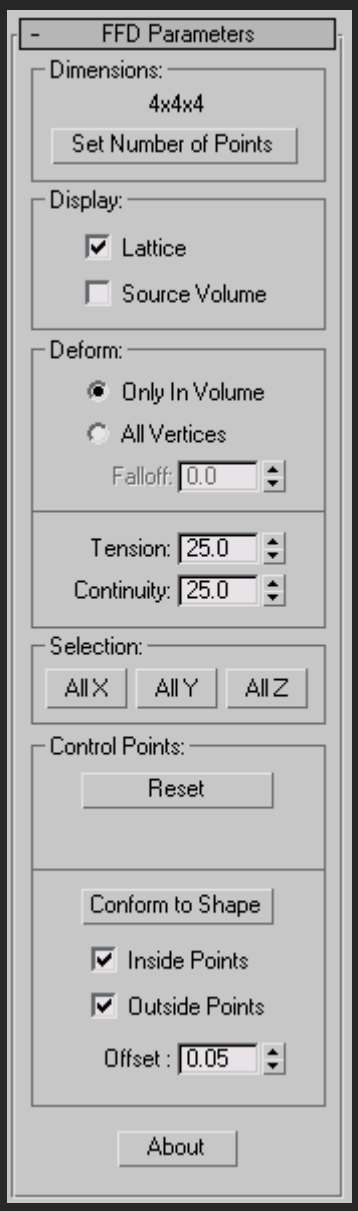
Set Volume

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 a control point is already animated or the Animate button is turned on, then Set Volume 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



Dimensions group

Adjusts the unit dimensions of the source volume and specifies the number of control points in the lattice. Note that the point dimensions also show up beside the modifier name in the stack list.

Lattice dimensions

The text displays the current number of control points in the lattice (for example 3x4x4).

Set Number of Points

Displays a dialog containing three spinners labeled Length, Width, and Height, plus OK/Cancel buttons. Specify the number of control points you want in the lattice, and then click OK to make the change.

Warning: Make changes to the lattice dimensions before you adjust the positions of the lattice control points. When you change the number of control points with this dialog, you lose any adjustments you've already made to the control points. (You can undo this dialog.)

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 extra lines appear, they help to visualize the lattice.

Source Volume

Displays the control points and lattice in their unmodified state. This is an important display when you're adjusting the source volume to affect specific vertices that lie inside or outside it.

Tip: To see which points lie in the source volume (and therefore will be deformed), temporarily deactivate the modifier by clicking to turn off the light bulb icon in the modifier stack display.

Deform group

Provides controls that specify which vertices are affected by the FFD.

- **Only In Volume Deforms vertices that lie inside the source volume. Vertices outside the source volume are not affected.**
- **All Vertices Deforms all vertices regardless of whether they lie inside or outside the source volume depending on the value in the Falloff spinner. The deformation outside the volume is a continuous extrapolation of the deformation inside the volume. Note that the deformation can be extreme for points far away from the source lattice.**

Falloff

Determines the distance from the lattice that the FFD effect will decrease to zero. Available only when you choose All Vertices. When set to 0, it's effectively turned off, and there is no falloff. All vertices are affected regardless of how far they are from the lattice. The units of the Falloff parameter are actually specified relative to the size of the lattice. A falloff of 1 means that the effect will go to 0 for points that are a lattice width/length/height away from the lattice (depending on which side they are).

Tension/Continuity

Adjust the tension and continuity of the deformation splines. Although you can't actually see the splines in an FFD, the lattice and control points represent the structure that controls the splines. As you adjust the control points, you alter the splines (which move through each of the points). The splines, in turn, deform the geometry of the object. By altering the tension and continuity of the splines, you alter their effect on the object.

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

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 you animate a control point, a controller is assigned and it becomes visible in Track View. You can also add and delete keys and perform other key operations. Animate All assigns Point3 controllers to all control points so that they're immediately visible in Track View.

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 for the lattice 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.

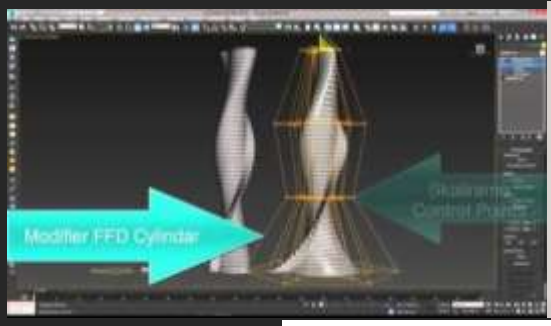
About

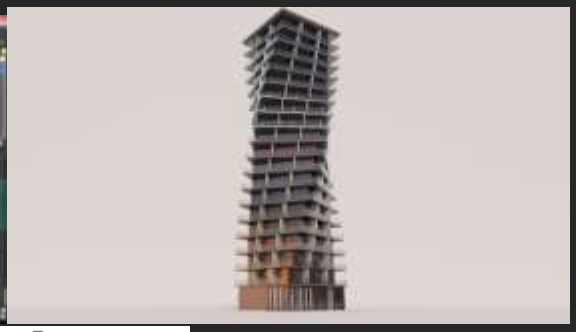
Displays a dialog with copyright and licensing information.

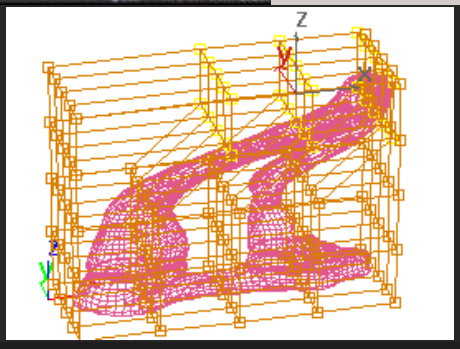
2025-2026

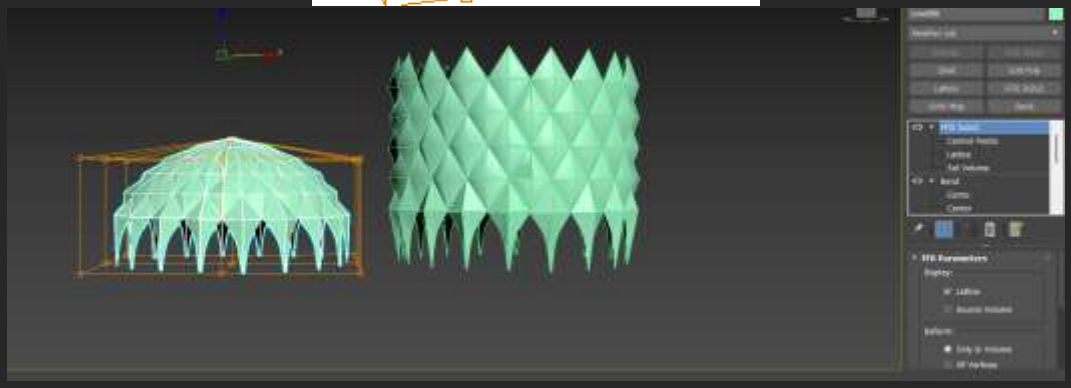
LECTURE 9

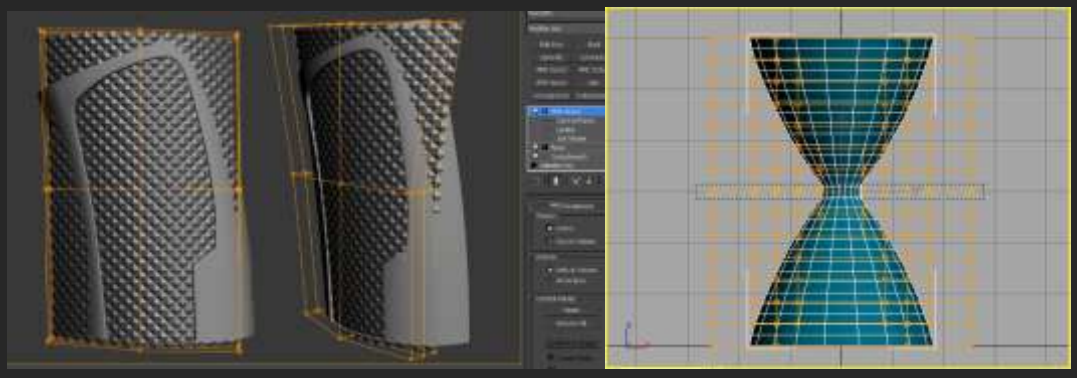
AL-HELLI MARWAH

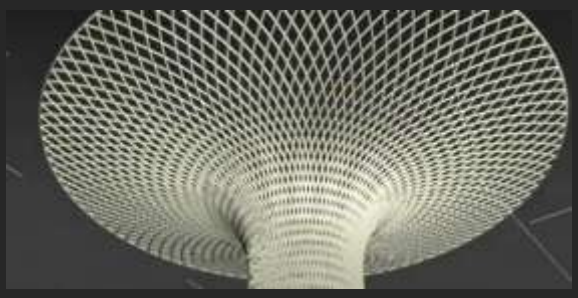












Optimize Modifier

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.

- **Select an object. >  Modify panel > Modifier List > Optimize**
- **Default menu: Select an object. > Modifiers menu > Mesh Editing > Optimize**
- **Alt menu: Select an object. > Modifiers menu > Geometry (Convert to Mesh) > Optimize**

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.**

The Parameters rollout for this modifier appears.

3. Turn off Manual Update and then adjust the Face Thresh value. Observe the result in the viewports.

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.

4. In the Parameters rollout ➤ Last Optimize Status group, notice the Before/After count for vertices and faces.
5. In the Optimize group, vary parameters to continue reducing geometry.

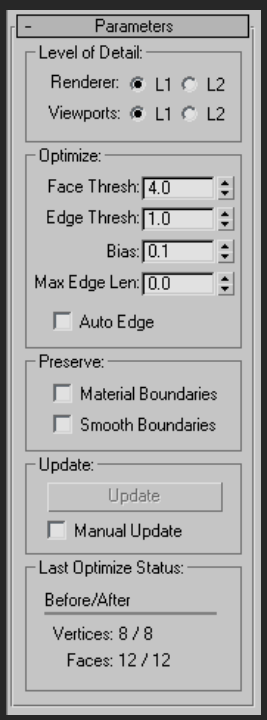
Compare the result in the two viewports against the Before/After count.

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.

This sets the L1 level of optimization for both the viewport and the renderer.

3. Repeat steps 1 and 2 for Viewports L2, adjusting parameters for a different optimization.



To use level of detail:

- Switch between L1 and L2 for either Viewports or Renderer.

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 Len[gth]

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.

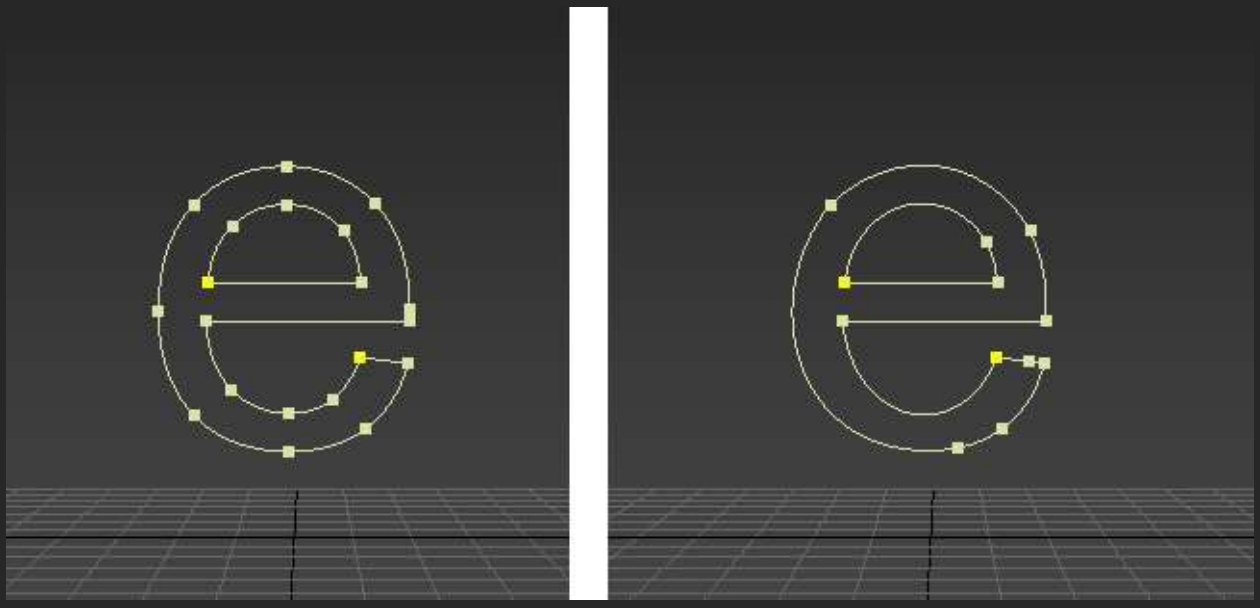
Last Optimize Status group

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

Optimize Spline Modifier

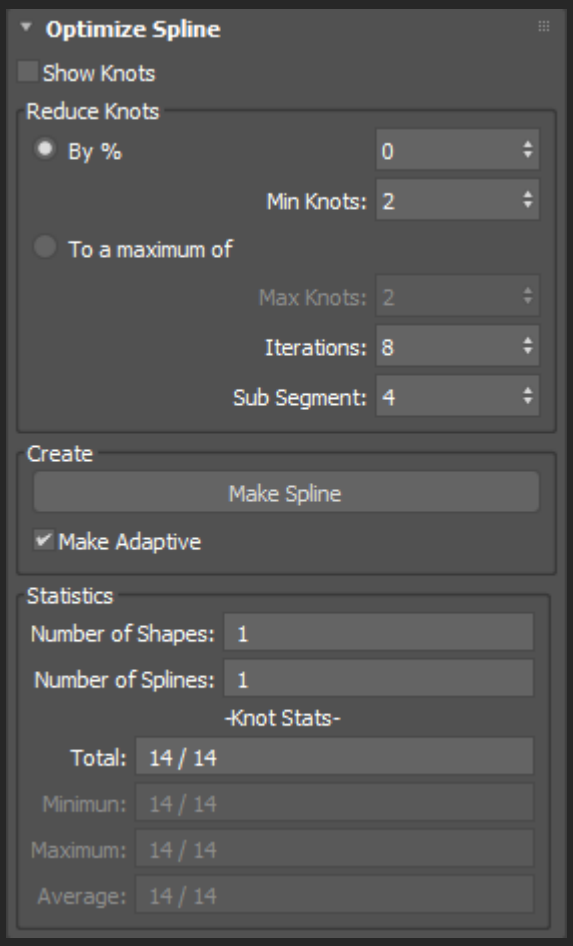
The Optimize Spline modifier reduces the number of knots and adjusts their handles to optimally reproduce the original spline as closely as possible.

- **Select a spline. > Modify panel > Modifier List > Object Space Modifiers > Optimize Spline**



A Text spline before (left) and after an optimization of 40%. Note how the curves remain intact even with fewer knots defining them.

Interface



Optimize Spline rollout

Show Knots

Displays knots on the spline.

Reduce Knots group

Sets how the target number of knots should be determined. If there are multiple splines within the shape, the settings are applied to each spline.

By %

Sets a reduction in knots by a specified percentage. The maximum is 99%.

Min Knots

Sets the minimum number of knots to be retained.

To a maximum of

Uses a maximum number of knots as the reduction target rather than a specific percentage.

Max Knots

Sets the maximum number of knots to be retained after optimization.

Iterations

Sets the number of iterations used to optimize the placement of knots and their tangents. Higher numbers produce better results but take longer to compute.

Sub Segment

Sets the number of knots to add between existing knots during optimization. Higher numbers produce better results but take longer to compute.

Create group

Make Spline button

Creates a duplicate spline with the final result of the calculation to avoid further computation once the desired result is achieved.

Make Adaptive

Enables adaptive interpolation on the created spline.

Statistics group

Number of Shapes

Displays the number of shapes in the current selection.

Number of Splines

Displays the number of splines in the current selection.

Knot Stats

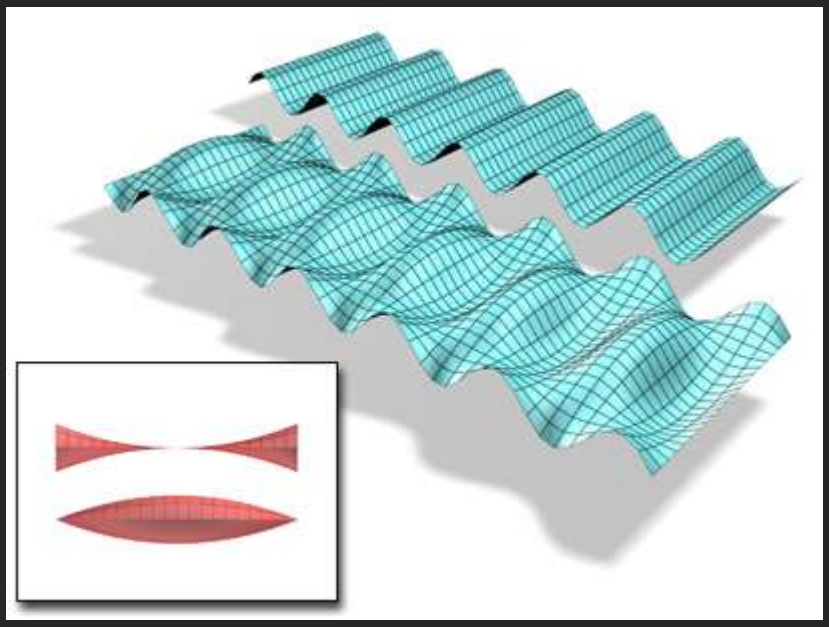
Displays the total, minimum, maximum, and average number of knots.

Wave Modifier

The Wave modifier produces a wave effect in an object's geometry. You can use either of two waves, or combine them. Wave uses a standard gizmo and center, which you can transform to increase the possible wave effects.

-  **Modify panel > Make a selection. > Modifier List > Object-Space Modifiers > Wave**
- **Default menu: Make a selection. > Modifiers menu > Parametric Deformers > Wave**
- **Alt menu: Make a selection. > Modifiers menu > Geometry (Parametric) > Wave**

The Wave space warp has similar features, and is useful for applying effects to a large number of objects.



An object with the Wave modifier applied. Amplitude 1 and 2 can be changed, creating different profiles.

Procedures

To make an object wavey:

1.  **Select an object and apply the Wave modifier.**

Tip: To see the effect clearly, apply Wave to a broad, flat object that has many segments.

2. **Set one or both values for amplitude, or the vertical height of the wave in current units.**

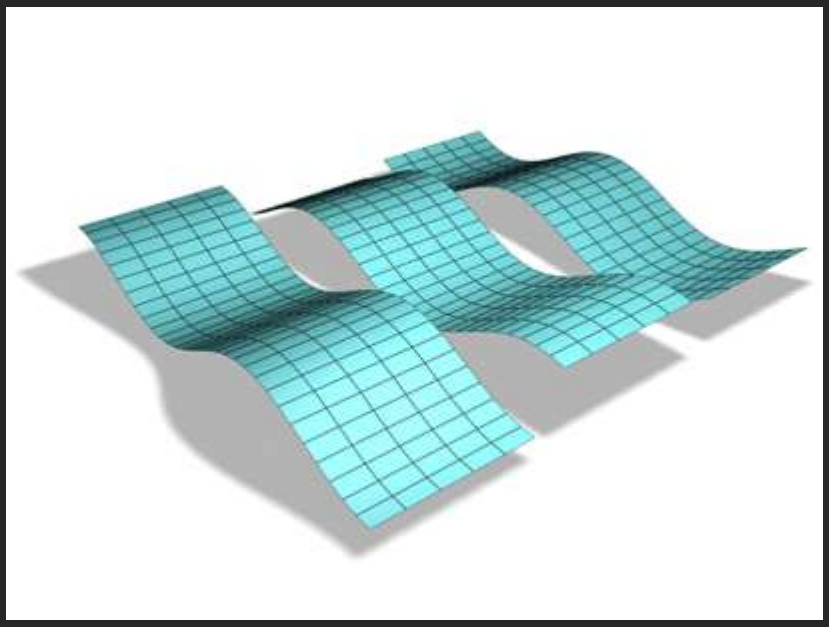
Amplitude 1 produces a sine wave from one edge to the other, while Amplitude 2 creates a wave between the opposite edges. Switching a value from positive to negative reverses the position of peaks and troughs.

3. **Set the length of the wave and the distance in current units between crests of both waves.**

The greater the length, the smoother and more shallow the wave for a given amplitude.

To add a phase effect:

- **Set a phase value to shift the wave pattern over the object. Positive numbers move the pattern in one direction, while negative numbers move them in the other. This effect is especially clear when animated.**



Phase effect on a wave

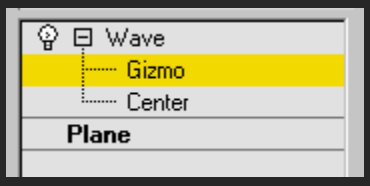
To add a decay effect:

- **Set a decay value to increase or decrease the amplitude.**

A decay value decreases the amplitude as the distance from the center increases. As the Decay value increases, the wave is concentrated at the center and flattens until it disappears (completely decays).

Interface

Modifier Stack



Gizmo

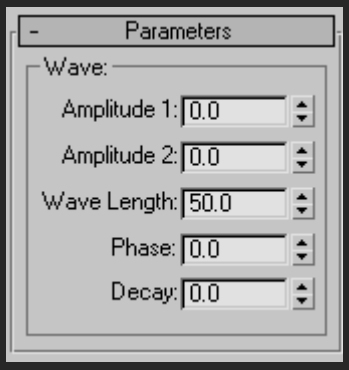
At this sub-object level, you can transform and animate the gizmo like any other object, altering the effect of the Wave modifier. Translating the gizmo translates its center an equal distance. Rotating and scaling the gizmo takes place with respect to its center.

Center

At this sub-object level, you can translate and animate the center, altering the Wave gizmo's shape, and thus the shape of the wavy object.

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

Parameters rollout



Amplitude 1 / Amplitude 2

Amplitude 1 produces a sine wave along the gizmo's Y axis, while Amplitude 2 creates a wave along the X axis (although peaks and troughs appear in the same direction with both). Switching a value from positive to negative reverses the positions of peaks and troughs.

Wave Length

Specifies the distance in current units between the crests of both waves.

Phase

Shifts the wave pattern over the object. Positive numbers move the pattern in one direction, while negative numbers move it in the other. This effect is especially clear when animated.

Decay

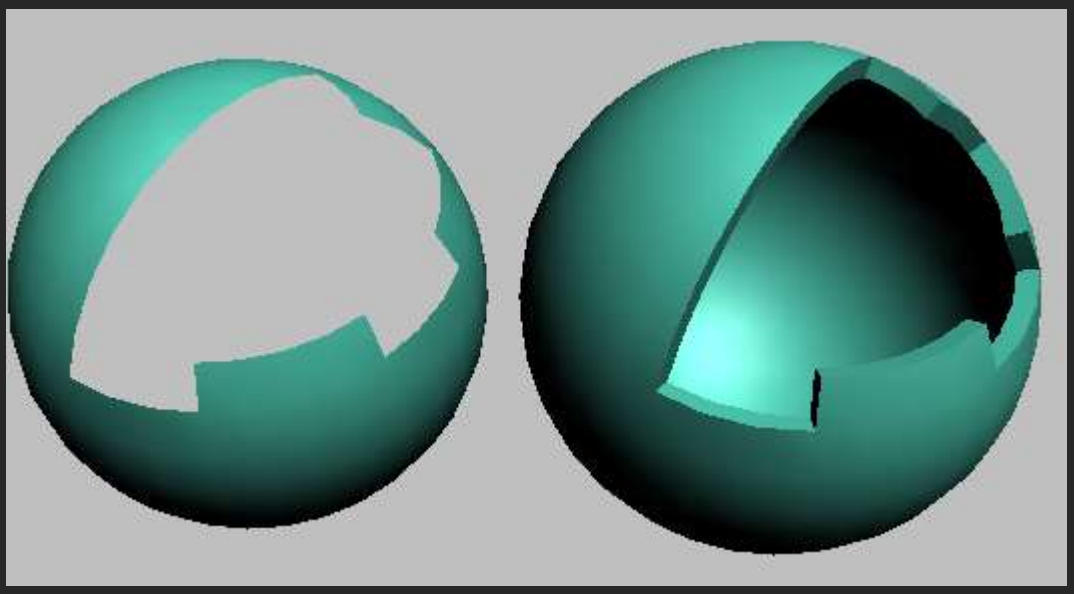
Limits the effect of the wave generated from its origin. A decay value decreases the amplitude at increasing distance from the center. As this value increases, the wave is concentrated at the center and flattened until it disappears (completely decays).

Shell Modifier

The Shell modifier "solidifies" or gives thickness to an object by adding an extra set of faces facing the opposite direction of existing faces, plus edges connecting the inner and outer surfaces wherever faces are missing in the original object. You can specify offset distances for the inner and outer surfaces, characteristics for edges, material IDs, and mapping types for the edges.

-  **Modify panel > Make a selection. > Modifier List > Object-Space Modifiers > Shell**
- **Default menu: Make a selection. > Modifiers menu > Parametric Deformers > Shell**
- **Alt menu: Make a selection. > Modifiers menu > Geometry (Parametric) > Shell**

Also, because the Shell modifier doesn't have sub-objects, you can use the Select options to specify a face selection for passing up the stack to other modifiers. Please note that the Shell modifier doesn't recognize existing sub-object selections, nor does it pass such selections up the stack.



Left: Sphere with part of surface removed

Right: Sphere with Shell applied

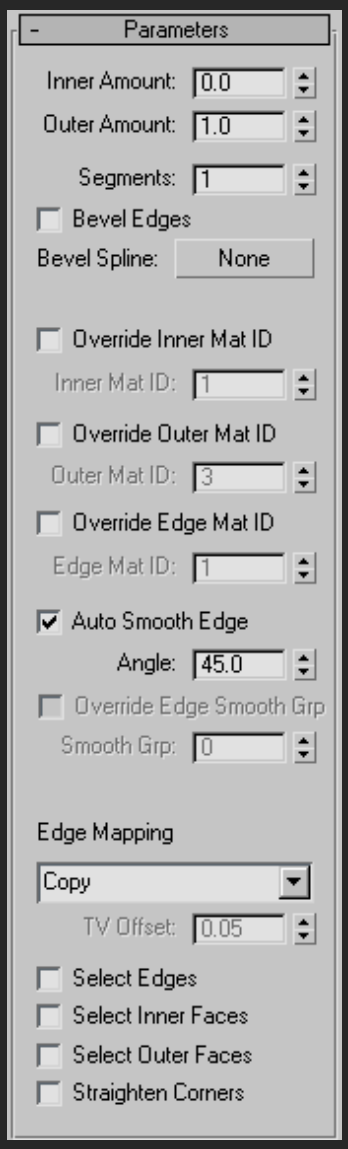
You'd typically use Shell on an object with part of its surface removed, such as a sphere with several deleted vertices or faces, as illustrated above. For best results, the original polygons should face outward. If an object has no faces with at least one free edge, Shell will not create any edges.

Examples of Shell Usage

Following are some examples of modeling tasks for which the Shell modifier would be appropriate:

Inner/Outer Amount

Distance in 3ds Max generic units by which the inner surface is moved inward and the outer surface is moved outward from their original positions. Defaults=0.0 / 1.0.



The sum of the two Amount settings determines the thickness of the object's shell, as well as the default width of the edges. If you set both to 0, the resultant shell has no thickness, and resembles an object set to display as 2-sided.

Segments

The number of subdivisions across each edge. Default=1.

Change this setting if you need greater resolution on the edge for use by subsequent modeling or modifiers.

Note: When you use a Bevel Spline, the spline's properties override this setting.

Bevel Edges

When on, and you specify a Bevel Spline, 3ds Max uses the spline to define the edges' profile and resolution. Default=off.

After you define a Bevel Spline, use Bevel Edges to switch between a flat edge whose resolution is defined by the Segments setting and a custom profile defined by the Bevel Spline.

Bevel Spline

Click this button and then select an *open* spline to define the edge shape and resolution. Closed shapes such as Circle or Star will not work.

The original spline is instanced to the Bevel Spline, so changing the spline's shape and properties are reflected in the Bevel Spline. With non-corner vertices, you can change the edge resolution with the spline's Interpolation