Compound Objects

Compound objects typically combine two or more existing objects into a single object.

- **Create panel > (Geometry) > Compound Objects**
- **Standard menu: Create menu > Compound**
- **Enhanced menu: Objects menu > Compound Objects**

- **Morph Compound Object** - Morphing is an animation technique similar to tweening in 2D animation. A Morph object combines two or more objects by interpolating the vertices of the first object to match the vertex positions of another object. When this interpolation occurs over time, a morphing animation results.

- **Scatter Compound Object** - Scatter is a form of compound object that randomly scatters the selected source object either as an array, or over the surface of a distribution object.

- **Conform Compound Object** - Conform is a compound object created by projecting the vertices of one object, called the Wrapper, onto the surface of another object, called the Wrap-To. There is also a space-warp version of this function.

- **Connect Compound Object** - The Connect compound object lets you connect two or more objects between "holes" in their surfaces. To do this, you delete faces in each object to create one or more holes in their surfaces, position them so that the holes face one another, and then apply Connect.

- **BlobMesh Compound Object** - The BlobMesh compound object creates a set of spheres from geometry or particles, and connects the spheres together as if they were made of a soft, liquid substance. When the spheres move within a certain distance of one another, they connect together. When they move apart, they take on a spherical form again.

- **ShapeMerge Compound Object** - ShapeMerge creates a compound object consisting of a mesh object and one or more shapes. The shapes are either embedded in the mesh, altering the edge and face patterns, or subtracted from the mesh.

- **Boolean Compound Object** - A Boolean object combines two other objects by performing a Boolean operation on them.

- **Terrain Compound Object** - The Terrain compound object creates planet surfaces from contour-line data.

- **Loft Compound Object** - Loft objects are two-dimensional shapes extruded along a third axis. You create loft objects from two or more existing spline objects. One of these splines serves as the path. The remaining splines serve as cross sections, or shapes, of the loft object. As you arrange shapes along the path, 3ds Max generates a surface between the shapes.

- **Mesher Compound Object** - The Mesher compound object converts procedural objects to mesh objects on a per-frame basis so that you can apply modifiers such as Bend or UVW Map. It can be used with any type of object, but is designed primarily to work with particle systems. Mesher is also useful for low-overhead instancing of objects with complex modifier stacks.

- **ProBoolean/ProCutter Compound Objects** - The ProBoolean and ProCutter compound objects provide you with modeling tools for combining 2D and 3D shapes in ways that would be difficult or impossible otherwise.

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**Boolean Compound Object**

- Select an object. ➤ Create panel ➤ (Geometry) ➤ Compound Objects ➤ Object Type rollout ➤ Boolean
- Select an object. ➤ Create menu ➤ Compound ➤ Boolean

A Boolean object combines two other objects by performing a Boolean operation on them. **Tip** ProBoolean is an improved, up-to-date, and more-complete implementation of the Boolean compound object. In general, it is recommended that you use ProBoolean rather than Boolean for combining 3D objects.

Operand A (left); Operand B (right)
These are the Boolean operations for geometry:

- **Union** - The Boolean object contains the volumes of both original objects. The intersecting or overlapping portion of the geometry is removed.
- **Intersection** - The Boolean object contains only the volume common to both original objects (in other words, where they overlapped).
- **Subtraction (or difference)** - The Boolean object contains the volume of one original object with the intersecting volume removed.

The two original objects are designated operands A and B.

You can layer Booleans in the stack display, so that a single object can incorporate many Booleans. By navigating through the stack display, it's possible to revisit the components of each Boolean and make changes to them.

Subtraction: A-B (above); B-A (below)  Union (above); Intersection (below)

### Booleans with Objects That Have Materials Assigned to Them

Most primitives use several material IDs on their surfaces. For example, a box uses material IDs 1–6 on its sides. If you assign a Multi/Sub-Object material with six sub-materials, 3ds Max automatically assigns one to each side. If you assign a Multi/Sub-Object material with two sub-materials, 3ds Max assigns the first material to sides 1, 3, and 5, and the second to sides 2, 4, and 6.

When you create a Boolean from objects that have materials assigned to them, 3ds Max combines the materials in the following way:

- If operand A doesn't have a material, it inherits operand B's material.
- If operand B doesn't have a material, it inherits operand A's material.
- If both operands have materials, the resulting material is a Multi/Sub-Object material that combines the materials from both operands.

### Solutions When Working with Booleans

The Boolean algorithm caused unpredictable behavior in earlier releases. The solutions are discussed here.

**Surface Topology** - Boolean requires that operands' surface topology be intact: This means no missing or overlapping faces and no unwelded vertices. The surface should be one continuous closed surface. The Boolean corrects operands that fail to meet this requirement. However, the automatic correction may not be exactly what you want, so in some cases it might be safer to correct the surfaces manually.

- To check for holes in the geometry, use the **STL-Check modifier** or the **Measure utility**.
- To fill holes, use the **Cap Holes modifier**.

**Face Normals** - Booleans require that the face normals of the surface be consistent. Flipped normals can produce unexpected results. Surfaces where some faces are facing one way and adjacent faces are flipped are also problematic, and are commonly found in geometry imported from CAD programs. The Boolean fixes these faces as best it can. Again, it might make more sense to correct these manually.
Use shaded viewports to look for normal problems, watching for objects that appear inside-out or look otherwise incorrect. You can also turn on Show in the Editable Mesh (Face) ➤ Surface Properties rollout ➤ Normals group. Fix normals here, or with a Normal modifier.

**Overlapping Elements**—Because Boolean operations depend on a clear understanding of what is inside and what is outside a mesh, meshes that overlap themselves can produce invalid results. For instance, if you use the **Collapse utility** with two overlapping objects without turning on the Boolean feature, the resulting object will not make a good Boolean operand. This is also a problem for the **Teapot primitive** (with all parts turned on), which overlaps itself.

If you need to use such an object as a Boolean operand, you might reconstruct it as a single non-overlapping mesh by separating the components and combining them with Boolean.

**Working with Inverted Meshes**—Boolean doesn't always produce the ideal result on "inverted meshes" (meshes that have been turned inside-out by having their normals flipped). The problem is that the area inside the flipped mesh is correctly seen as "outside," but the area outside it may also be seen as "outside." To remedy this, instead of inverting the mesh, make a very large box or other primitive centered on (but not touching) the mesh and subtract the mesh from it using Boolean. Then convert it to an editable mesh, and delete the box faces. This produces a correctly inverted mesh that works correctly with Boolean.

**Alignment**—If two Boolean operands are perfectly aligned without actually intersecting, the Boolean operation might produce the wrong result. Although this is rare, if it does occur, you can eliminate it by making the operands overlap slightly.

**Relative Complexity Between Operands**—Boolean works best when the two operands are of similar complexity. If you wish to subtract text (a complex object made of many faces and vertices) from a box without any segments, the result is many long, skinny faces that are prone to rendering errors. Increasing the number of box segments produces better results. Try to maintain a similar complexity between operands.

**Coplanar Faces/Colinear Edges**—Previously, Boolean required that objects overlap. If two objects did not overlap but merely touched an edge to an edge, or a face to a face, the Boolean would fail. Boolean allows for non-overlapping objects. Coincident faces/edges and vertices are no longer a problem. You can use objects completely encased within another object, where no edges intersect, to create Booleans.

### Procedures

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Select an object. This object becomes operand A.</td>
</tr>
<tr>
<td>2.</td>
<td>Click Boolean. The name of operand A appears in the Operands list on the Parameters rollout.</td>
</tr>
<tr>
<td>3.</td>
<td>On the Pick Boolean rollout, choose the copy method for operand B: Reference, Move, Copy, or Instance. (These methods are described in the Pick Boolean rollout section, later in this topic.)</td>
</tr>
<tr>
<td>4.</td>
<td>On the Parameters rollout, choose the Boolean operation to perform: Union, Intersection, Subtraction (A-B), or Subtraction (B-A). You can also choose one of the Cut operations, described later in the Operation group section.</td>
</tr>
<tr>
<td>5.</td>
<td>On the Pick Boolean rollout, click Pick Operand B.</td>
</tr>
<tr>
<td>6.</td>
<td>Click in a viewport to select operand B. 3ds Max performs the Boolean operation.</td>
</tr>
<tr>
<td>7.</td>
<td>The operand objects remain as sub-objects of the Boolean object. By modifying the creation parameters of the Boolean's operand sub-objects, you can later change operand geometry in order to change or animate the Boolean result.</td>
</tr>
</tbody>
</table>

**Example: To create and modify a single object that contains multiple Booleans:**

1. Suppose you want to create a box with two holes in it. One hole is to be cut by a sphere, and the second by a cylinder. If you want to make changes to the sphere or the cylinder later, you can do so by following these steps:
2. Create a Boolean following the steps in the previous sections. The original object (the box) is converted to a Boolean, and is designated operand A. The second object (the sphere) is converted to operand B.
3. Deselect the Boolean object. Build the cylinder if it does not already exist.
4. Select the Boolean object; and under Compound Objects, click Boolean again.
5. Click Pick Operand B and click the cylinder in the viewport. It is converted to operand B.
6. On the Modify panel, choose Operand B from the Parameters rollout ➤ Operands list. If you want to see operand B, choose Display/Update rollout ➤ Display group ➤ Operands or Result + Hidden Ops.
7. If you want to animate the Cylinder or the Cylinder’s parameters you can now access them in the modifier stack display.
8. If you want to modify the sphere’s parameters, choose the box in the Operands list.
9. Now there are two entries labeled Boolean in the stack display. Choose the lower entry. The Sphere is displayed in the Operands list.
10. Choose the Sphere from the Operands list. The sphere’s parameters are available by clicking the sphere’s name in the modifier stack display.
11. Use this technique to change parameters or animate any of the operands within the multiple Boolean.

You can also navigate multiple Booleans through Track View. Clicking the operand in Track View gives you direct access to its entry in the modifier stack display. In complex objects with many Booleans, this is an easier method than the one outlined above.

Interface

Pick Boolean rollout

When you select operand B, you designate it as a Reference, Move (the object itself), Copy, or Instance, according to your choice in the Pick Boolean rollout for Boolean objects. Base your selection on how you want to use the scene geometry after you create the Boolean.

Because you usually create Boolean objects from overlapping objects, if the B object isn’t removed (if you don’t use the default Move option), it often obstructs your view of the completed Boolean. You can move the Boolean or the B object to better see the result.

Pick Operand B

Use this button to select the second object to use to complete the Boolean operation.

Reference/Copy/Move/Instance

- Lets you specify how operand B is transferred to the Boolean object. It can be transferred either as a **reference**, a copy, an **instance**, or moved.
- Use Reference to synchronize modifier-induced changes to the original object with operand B, but not vice-versa.
- Use Copy when you want to reuse the operand B geometry for other purposes in the scene.
- Use Instance to synchronize animation of the Boolean object with animated changes to the original B object, and vice-versa.
- Use Move (the default) if you’ve created the operand B geometry only to create a Boolean, and have no other use for it.
- Object B geometry becomes part of the Boolean object regardless of which copy method you use.

Parameters rollout Operands group

[list of operands]

Displays the current operands.

**Name**-Edit this field to change the name of the operands. Choose an operand in the Operands list and it will also appear in the Name box.

**Extract Operand**-Extracts a copy or an instance of the selected operand. Choose one of the operands in the list window to enable this button.

**Note**This button is available only on the Modify panel. You can’t extract an operand while the Create panel is active.

**Instance/Copy**-Lets you specify how the operand is extracted: as either an **instance** or a copy.
**Operation group**

- **Union** The Boolean object contains the volume of both original objects. The intersecting or overlapping portion of the geometry is removed.
- **Intersection** The Boolean object contains only the volume that was common to both original objects (in other words, where they overlapped).
- **Subtraction (A-B)** Subtracts the intersection volume of operand B from operand A. The Boolean object contains the volume of operand A with the intersection volume subtracted from it.
- **Subtraction (B-A)** Subtracts the intersection volume of operand A from operand B. The Boolean object contains the volume of operand B with the intersection volume subtracted from it.
- **Cut** Cuts operand A with operand B, but doesn't add anything to the mesh from operand B. This works like the Slice modifier, but instead of using a planar gizmo, Cut uses the shape of operand B as the cutting plane. Cut treats the geometry of the Boolean object as volumes rather than closed solids. Cut does not add geometry from operand B to operand A. Operand B intersections define cut areas for altering geometry in operand A.

There are four types of Cut:

- **Refine** Adds new vertices and edges to operand A where operand B intersects the faces of operand A. 3ds Max refines the resulting geometry of operand A with additional faces inside the intersected area of operand B. Faces cut by the intersection are subdivided into new faces. You might use this option to refine a box with text so that you can assign a separate material ID to the object.
- **Split** Works like Refine but also adds a second or double set of vertices and edges along the boundary where operand B cuts operand A. Split produces two elements belonging to the same mesh. Use Split to break an object into two parts along the bounds of another object.
- **Remove Inside** Deletes all operand A faces inside operand B. This option modifies and deletes faces of operand A inside the area intersected by operand B. It works like the subtraction options, except that 3ds Max adds no faces from operand B. Use Remove Inside to delete specific areas from your geometry.
- **Remove Outside** Deletes all operand A faces outside operand B. This option modifies and deletes faces of operand A outside the area intersected by operand B. It works like the Intersection option, except that 3ds Max adds no faces from operand B. Use Remove to delete specific areas from your geometry.

**Display/Update rollout**

**Display group**

Visualizing the result of a Boolean can be tricky, especially if you want to modify or animate it. The Display options on the Boolean Parameters rollout help you visualize how the Boolean is constructed.

The display controls have no effect until you've created the Boolean.

- **Result** Displays the result of the Boolean operation; that is, the Boolean object itself.
- **Operands** Displays the operands instead of the Boolean result.

**Tip** When operands are difficult to see in a viewport, you can use the Operand list to select one or the other. Click the name of the A or B operand to select it.

- **Results + Hidden Ops** Displays the "hidden" operands as wireframe.

Operand geometry remains part of the compound Boolean object, although it isn't visible or renderable. The operand geometry is displayed as wireframes in all viewports.
Displaying the operands
Displaying the hidden operand after A-B
Displaying the result (A-B)

Displaying the hidden operand after B-A

Update group
By default, Booleans are updated whenever you change operands. A scene that contains one or more complicated, animated Booleans can impede performance. The update options provide alternate methods to improve performance.

- **Always** Updates Booleans immediately when you change an operand, including the original object of an instanced or referenced B operand. This is the default behavior.
- **When Rendering** Updates Booleans only when you render the scene or click Update. With this option, viewports don’t always show current geometry, but you can force an update when necessary.
- **Manually** Updates Booleans only when you click Update. With this option, the viewports and the render output don’t always show current geometry, but you can force an update when necessary.

**Update** - Updates the Boolean. The Update button is not available when Always is selected.

**ProBoolean/ProCutter Compound Objects**
The ProBoolean and ProCutter compound objects provide you with modeling tools for combining 2D and 3D shapes in ways that would be difficult or impossible otherwise.

The **ProBoolean compound object** takes a 3ds Max mesh and adds extra intelligence to it prior to performing Boolean operations. First it combines the topologies, then it determines coplanar triangles and removes incident edges. The Booleans are then performed not on triangles but N-sided polygons. Once the Boolean operations are completed, the result is retriangulated and sent back into 3ds Max with coplanar edges hidden. The result of this extra work is twofold: The reliability of the Boolean object is extremely high, and the resulting output is much cleaner in terms of having fewer small edges and triangles.

**Objects combined by using ProBoolean**

Advantages of ProBoolean over the legacy 3ds Max Boolean compound object include:

- **Better quality mesh**: fewer small edges, fewer narrow triangles.
- **Smaller mesh**: fewer vertices and faces.
- **Easier and faster to use**: unlimited objects per Boolean operation.
- **Cleaner-looking mesh**: coplanar edges remain hidden.
Integrated decimation and quad meshing

In addition, ProCutter is an excellent tool for exploding, breaking apart, assembling, sectioning, or fitting together objects such as a 3D puzzle. See the following illustration for an example of a goblet shattering.

Shattering a glass by use of the ProCutter object

Spline boolean

Editable Spline (Spline)

- Select an editable spline > Modify panel > Expand the editable spline in the stack display > Spline sub-object level

Select an editable spline > Modify panel > Selection rollout > Spline button

Select an editable spline > Right-click the spline > Tools 1 (upper-left) quadrant of the quad menu > Sub-objects > Spline

While at the Editable Spline (Spline) level, you can select single and multiple splines within a single spline object and move, rotate, and scale them using standard methods.

Procedure

To change spline properties:

- You change the properties of a spline from Line to Curve by right-clicking and choosing Line or Curve from the Tools 1 (upper-left) quadrant of the quad menu.
- Changing the spline property also changes the property of all vertices in the spline:
  - Choosing Line converts vertices to Corners.
  - Choosing Curve converts vertices to Beziers.

Interface

Rendering, Interpolation and Selection rollouts

- See Editable Spline for information on the Rendering, Interpolation and Selection rollout settings.
- Soft Selection rollout
- See Soft Selection Rollout for information on the Soft Selection rollout settings.

Geometry rollout

Create Line—Adds more splines to the selected spline. These lines are separate spline sub-objects; create them in the same way as the line spline. To exit line creation, right-click or click to turn off Create Line.

Attach—Attaches another spline in the scene to the selected spline. Click the object you want to attach to the currently selected spline object. The object you're attaching to must also be a spline.

For further details, see Attach.

Reorient—Reorients the attached spline so that its creation local coordinate system is aligned with the creation local coordinate system of the selected spline.

Attach Mult.—Click this button to display the Attach Multiple dialog, which contains a list of all other shapes in the scene. Select the shapes you want to attach to the current editable spline, then click OK.

End Point Auto-Welding—

Automatic Welding—When Automatic Welding is turned on, an end point vertex that is placed or moved within the threshold distance of another end point of the same spline is automatically welded. This feature is available at the object and all sub-object levels.
Threshold Dist.—The threshold distance spinner is a proximity setting that controls how close vertices can be to one another before they are automatically welded. Default=6.0.

Insert—Inserts one or more vertices, creating additional segments. Click anywhere in a segment to insert a vertex and attach the mouse to the spline. Then optionally move the mouse and click to place the new vertex. Continue moving the mouse and clicking to add vertices. A single click inserts a corner vertex, while a drag creates a Bezier (smooth) vertex. Right-click to complete the operation and release the mouse. At this point, you’re still in Insert mode, and can begin inserting vertices in a different segment. Otherwise, right-click again or click Insert to exit Insert mode.

Reverse—Reverses the direction of the selected spline. If the spline is open, the first vertex will be switched to the opposite end of the spline. Reversing the direction of a spline is usually done in order to reverse the effect of using the Insert tool at vertex selection level.

Outline—Makes a copy of the spline, offset on all sides to the distance specified by the Outline Width spinner (to the right of the Outline button). Select one or more splines and then adjust the outline position dynamically with the spinner, or click Outline and then drag a spline. If the spline is open, the resulting spline and its outline will make a single closed spline.

Note: Normally, if using the spinner, you must first select a spline before using Outline. If, however, the spline object contains only one spline, it is automatically selected for the outlining process.

Center—When off (default), the original spline remains stationary and the outline is offset on one side only to the distance specified by Outline Width. When Center is on, the original spline and the outline move away from an invisible center line to the distance specified by Outline Width.

Boolean—Combines two closed polygons by performing a 2D Boolean operation that alters the first spline you select, and deletes the second one. Select the first spline, then click the Boolean button and the desired operation, and then select the second spline. Note: 2D Booleans only work on 2D splines that are in the same plane.

There are three Boolean operations:
- Union—Combines two overlapping splines into a single spline, in which the overlapping portion is removed, leaving non-overlapping portions of the two splines as a single spline.
- Subtraction—Subtracts the overlapping portion of the second spline from the first spline, and deletes the remainder of the second spline.
- Intersection—Leaves only the overlapping portions of the two splines, deleting the non-overlapping portion of both.

Original splines (left), Boolean Union, Boolean Subtraction, and Boolean Intersection, respectively

Mirror—Mirrors splines along the length, width, or diagonally. Click the direction you want to mirror first so it is active, then click Mirror.

Copy—When selected, copies rather than moves the spline as it is mirrored.

About Pivot—When on, mirrors the spline about the spline object’s pivot point (see Pivot). When off, mirrors the spline about its geometric center.

Mirrored splines
**Trim**—Use Trim to clean up overlapping segments in a shape so that ends meet at a single point. To trim, you need intersecting splines. Click the portion of the spline you want to remove. The spline is searched in both directions along its length until it hits an intersecting spline, and deleted up to the intersection. If the section intersects at two points, 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, or if the spline is closed and only one intersection is found, nothing happens.

**Extend**—Use Extend to clean up open segments in a shape so that ends meet at a single point. 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.

**Infinite Bounds**—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.

**Hide**—Hides selected splines. Select one or more splines, and then click Hide.

**Unhide All**—Displays any hidden sub-objects.

**Delete**—Deletes the selected spline.

**Close**—Closes the selected spline by joining its end vertices with a new segment.

**Detach**—Copies selected spline(s) to a new spline object, and deletes them from the currently selected spline if Copy is clear.

**Copy**—When selected, copies rather than moves the spline as it is detached.

**Reorient**—The spline being detached is moved and rotated so that its creation local coordinate system is aligned with the creation local coordinate system of the selected spline.

**Explode**—Breaks up any selected splines by converting each segment to a separate spline or object. This is a time-saving equivalent of using Detach on each segment in the spline in succession. You can choose to explode to splines or objects. If you choose Object, you're prompted for a name; each successive new spline object uses that name appended with an incremented two-digit number.

### Surface Properties rollout

**Material group**

You can apply different material IDs (see material ID) to splines in shapes containing multiple splines. You can then assign a multi/sub-object material to such shapes, which appears when the spline is renderable, or when used for lathing or extrusion.

**ID**—Lets you assign a particular material ID number to selected splines for use with multi/sub-object materials and other applications. Use the spinner or enter the number from the keyboard. The total number of available IDs is 65,535.

**Select by ID**—Displays a dialog for you to enter a material ID number. Clicking OK selects the segments assigned that material ID. If Clear Selection is on, any previously selected splines are first deselected. If Clear Selection is off, the new selection is added to any previous selection set.

### Morphing objects

- **Morph**
  - Select an object. > Create panel > Geometry > Compound Objects > Object Type rollout > Morph
  - Select an object. > Tab panels > Compounds tab > Morph Compound Object

**The resulting animation**

Morphing is an animation technique similar to tweening in 2D animation. A Morph object combines two or more objects by interpolating the vertices of the first object to match the vertex positions of another object. When this interpolation occurs over time, a morphing animation results.
The original object is known as the *seed* or *base* object. The object into which the seed object morphs is known as the *target* object.

You can morph one seed into multiple targets; the seed object's form changes successively to match the forms of the target objects as the animation plays.

Before you can create a morph, the seed and target objects must meet these conditions:

- Both objects must be mesh, patch, or poly objects.
- Both objects must have an equal number of vertices.

If these conditions don't apply, the Morph button is unavailable.

You can use any kind of object as a morph target, including an animated object or another morph object, as long as the target is a mesh that has the same number of vertices as the seed object.

Creating a morph involves the following steps:

- Model the base object and target objects.
- Select the base object.
- Click Create panel > Geometry > Compound Objects > Morph.
- Add the target objects.
- Animate.

### Setting Up the Morph Geometry

Make sure that the objects you want to use as the seed and targets have the same number of vertices.

Tip: When you create Loft objects that you want to use as morph seeds and targets, make sure that Morph Capping is on and Adaptive Path Steps and Optimize are turned off. All shapes in the Loft object must have the same number of vertices.

Tip: You should also turn off Adaptive and Optimize for other shape-based objects that you want to use with Morph, such as those with Extrude or Lathe modifiers.

Warning: The selected object is permanently converted to a morph object as soon as you click Morph, whether or not you proceed to select a target object. The only way to restore the original object is to undo the Morph click.

### Morph Object and Morpher Modifier

There are two ways to set up morphing animations: the Morph compound object and the Morpher modifier.

The **Morpher modifier** is more flexible because you can add it multiple times at any place in an object's modifier stack display. This flexibility lets you animate the base object or the morph targets before reaching the Morpher modifier, for example with a noise modifier. The Morpher modifier works hand in hand with the Morpher material. The Morpher modifier is the ideal way to morph characters. The Barycentric Morph controller can be simpler to use in Track View. The Track View display for Compound Morph has only one animation track regardless of the number of targets. Each key on the track represents a morph result based on a percentage of all the targets. For basic morphing needs, Compound Morph may be preferable to the Morpher modifier.

Lastly, you can add the Morpher modifier to the stack of a Compound Morph object.

### Procedures

**Example: To create a basic morph:**

1. On the Create panel > Geometry > Patch Grids > Object Type rollout, click Quad Patch.
2. In the Top viewport, click and drag to create a patch on the left side of the viewport.
3. Right-click the modifier stack display in the Modify panel and select Convert To Editable Patch from the pop-up menu.
4. Right-click the patch, and then click Move in the Transform quadrant of the quad menu.
5. In the Top viewport, hold SHIFT and drag with the patch to create a copy on the right side of the viewport.
6. On the Modify panel > Selection rollout, go to the Vertex sub-object level.
7. In the Front viewport, select and move vertices on the selected patch to alter its shape.
8. On the Modify panel, in the stack display, click Editable Patch again to return to the top level.
9. Select the original patch in the viewports.
10. On the Create panel > Geometry > Compound Objects > Objects Type rollout, click Morph.
11. On the Pick Targets rollout, click Pick Target.
12. In the viewports, click the second patch object.
13. Both patch objects are listed in the Morph Targets list.
14. Click Modify panel.
15. Morph displays above the Editable Patch in the modifier stack.
16. Move the time slider to frame 10.
17. In the Morph Targets list, click M_QuadPatch01.
18. On the Current Targets rollout, click Create Morph Key.
19. On the track bar, a key is displayed at frame 10.
20. On the track bar, right-click the key at frame 10 and click QuadPatch01:Morph in the menu.
22. On the Key Info dialog, select M_QuadPatch01 from the list.
23. On the Key Info dialog, drag the percentage spinner.
24. The base object changes shape.
25. Close the Key Info dialog and drag the time slider back and forth. The patch morphs its shape.

To select the targets for a morph:
1. Select the seed object.
2. On the Create panel > Geometry > Compound Objects, click Morph.
3. The name of the seed object is displayed at the top of the Morph Targets list on the Current Targets rollout.
4. On the Pick Targets rollout, choose the method for creating targets: Reference, Move, Copy, or Instance.
5. Click Pick Target.
6. Select one or more target objects in the viewports.
7. As you select each target, its name is added to the Morph Targets list. If an object can't be a target (for example, if it has a different number of vertices than the morph seed), you can't select it.
8. If you select a target object while you are not at frame 0, creating the target also creates a morph key. You can create additional morph keys from targets you've already selected, as described in the following procedure.

To create morph keys from existing targets:
1. Drag the time slider to the frame where you want to place the morph key.
2. Note: The Auto Key button does not need to be on to set morph keys.
3. Highlight the name of a target object on the Morph Targets list.
4. The Create Morph Key button is available only when a target object name is selected.
5. Click Create Morph Key.
6. The software places a morph key at the active frame.
7. To preview the effect of the morph, drag the time slider back and forth. You can view and edit the morph keys in Track View, which also lets you view the morph's target object parameters.

Interface

Pick Targets rollout

When you pick target objects, you designate each target as a Reference, Move (the object itself), Copy, or Instance. Base your selection on how you want to use the scene geometry after you create the morph.

Pick Target—Use this button to designate the target object or objects.
Reference/Copy/Move/Instance—Lets you specify how the target is transferred to the compound object. It can be transferred either as a reference, a copy, an instance, or it can be moved, in which case the original shape is not left behind.
- Use Copy when you want to reuse the target geometry for other purposes in the scene.
- Use Instance to synchronize morphing with animated changes to the original target object.
- Use Move if you've created the target geometry to be only a morph target, and have no other use for it.
- You can use an animated object or another morph as the target of a morph.

Current Targets rollout

Morph Targets—Displays a list of the current morph targets.
Morph Target Name—Use this field to change the name of the selected morph target in the Morph Targets list.
Create Morph Key—Adds a morph key for the selected target at the current frame.
Delete Morph Target—Deletes the currently highlighted morph target. If morph keys reference the deleted target, then those keys are deleted as well.

Conform object Conform
- Select an object. > Create panel> Geometry > Compound Objects > Object Type rollout > Conform
Conform fits the road to the surface of the hills.
Conform is a compound object created by projecting the vertices of one object, called the Wrapper, onto the surface of another object, called the Wrap-To. There is also a space-war c version of this function; see Conform space warp.
Because the space-war c version is somewhat easier to use, it's a good idea to read that topic first, try the example, and then return here. This topic provides additional methods of projecting the wrapper vertices.
Note: This tool gives you the ability to morph between any two objects, regardless of the number of vertices in each object.

Procedure
To create a Conform object:
1. Position two objects, one of which will be the Wrapper, and the other the Wrap-To. (For this example, create a box as the Wrap-To object, and then create a larger sphere that completely surrounds it. The sphere will be the Wrapper.)
2. Select the Wrapper object (the sphere), and click Create panel > Geometry > Compound Objects > Object Type rollout > Conform button.
3. Note: Both objects used in Conform must be either mesh objects or objects that can be converted to mesh objects. If the selected Wrapper object is invalid, the Conform button is unavailable.
4. Specify the method of vertex projection in the Vertex Projection Direction group. (Use Along Vertex Normals for this example.)
5. Note: If you were to choose Use Active Viewport, you would next activate whichever viewport looks in the direction that you want to project the vertices. For example, if the Wrapper hovered over a Wrap-To terrain on the home plane, you'd activate the Top viewport.
6. Choose Reference, Copy, Move, or Instance to specify the type of cloning to perform on the Wrap-To object. (Choose Instance for this example.)
7. Click Pick Wrap-To Object, and then click the object onto which to project the vertices. (You can press the H key and use the Select By Name dialog to select the box.)
8. The list windows display the two objects, and the compound object is created with the Wrapper object conforming to the Wrap-To object. (In the example, the sphere is wrapped into the shape of the box.)
9. Use the various parameters and settings to alter the vertex projection direction, or adjust the vertices that are being projected.

Interface
Pick Wrap-To Object rollout

Object—Displays the name of the selected Wrap-To object.
Pick Wrap-To Object—Click this button, and then select the object to which you want the current object to wrap.
Reference/Copy/Move/Instance—This option lets you specify how the Wrap-To object is transferred to the Conform object. It can be transferred either as a reference, a copy, an instance, or it can be moved, in which case the original is not left behind.
Parameters rollout
Contains all parameters for the Conform object.

Objects group
Provides a list window and two edit fields that let you navigate the compound object and rename its components.
List Window—Lists the Wrapper and the Wrap-To objects. Click to select an object in the window so that you can access it in the Modifier stack.
Wrapper Name—Lets you rename the wrapper object within the compound Conform object.
Wrap-To Object Name—Lets you rename the Wrap-To object.
Vertex Projection Direction group
Choose one of these seven options to determine the projection of the vertices.
We provide GNDU question papers, PTU question papers, PU question papers, LPU question papers, GNA university question papers, PSEB question papers, HPSEB question papers, ICSE question papers and CBSE question papers.

Use Active Viewport—The vertices are projected away (inward) from the active viewport.
Recalculate Projection—Recalculates the projection direction for the currently active viewport. Because the direction is initially assigned when you pick the Wrap-To object, if you want to change viewports after assignment, click this button to recalculate the direction based on the new active viewport.

Use Any Object’s Z Axis—Lets you use the local Z axis of any object in the scene as a direction. Once an object is assigned, you can alter the direction of vertex projection by rotating the direction object.
Pick Z-Axis Object—Click this button, and then click the object you want to use to indicate the direction of the projection source.

Object—Displays the name of the direction object.

Along Vertex Normals—Projects the vertices of the Wrapper object inward along the reverse direction of its vertex normals. A vertex normal is a vector produced by averaging the normals of all faces attached to that vertex. If the Wrapper object encloses the Wrap-To object, the Surface takes on the form of the Wrap-To object.
Towards Wrapper Center—Projects the vertices toward the bounding center of the Wrapper object.
Towards Wrapper Pivot—Projects the vertices toward the original pivot center of the Wrapper object.
Towards Wrap-To Center—Projects the vertices toward the bounding center of the Wrap-To object.
Towards the Wrap-To Pivot—Projects the vertices toward the pivot center of the Wrap-To object.

Note: Towards Wrapper Pivot and Towards the Wrap-To Pivot operate on the position of the original pivot point of the object before the Conform object is created. Once you create the Conform object, it’s a new compound object with a single pivot point.

Tip: You can animate the conforming effect by morphing between the compound object and a previously made copy of the original wrapper object. To do this, however, you must turn on Hide Wrap-To Object in the Update group so that the original object and the compound object have the same number of vertices. Using this technique, you can effectively morph between two objects with a different number of vertices.

Wrapper Parameters group

Provides controls that determine how far the vertices are projected.

Default Projection Distance—The distance a vertex in the Wrapper object will move from its original location if it does not intersect the Wrap-To object.

Standoff Distance—The distance maintained between the vertex of the Wrapper object and the surface of the Wrap-To object. For example, if you set Standoff Distance to 5, the vertices can be pushed no closer than 5 units from the surface of the Wrap-To object.

Use Selected Vertices—When turned on, only the selected vertex sub-objects of the Wrapper object are pushed. When turned off, all vertices in the object are pushed, regardless of the Modifier stack selection. To access the Modifier stack of the Wrapper object, select the Wrapper object in the list window, open the Modifier stack, and select the base object name. At this point you can apply a Mesh Select modifier, for example, and select the vertices you want to affect.

Update group

The items in this group determine when the projection for the compound object is recalculated. Because complex compound objects can slow performance, you can use these options to avoid constant calculation.

Always—The object is updated constantly.

When Rendering—The object is recalculated only when the scene is rendered.

Manually—Activates the Update button for manual recalculation.

Update—Recalculates the projection.

Hide Wrap-To Object—Hides the Wrap-To object.

Display group

Determines whether the shape operands are displayed.

Result—Displays the result of the operation.

Operands—Displays the operands.

ShapeMerge

- Select an object. > Create panel > Geometry > Compound Objects > Object Type rollout > ShapeMerge

- Select an object. > Tab panels > Compounds tab > ShapeMerge Compound Object
Select an object. > Create menu > Compounds > ShapeMerge

ShapeMerge combines the lettering, a text shape, with the mesh that models the cake.
ShapeMerge creates a compound object consisting of a mesh object and one or more shapes. The shapes are either embedded in the mesh, altering the edge and face patterns, or subtracted from the mesh.

Procedure
To create a ShapeMerge object:
- Create a mesh object and one or more shapes
- Align the shapes in the viewport so they can be projected toward the surface of the mesh object.
- Select the mesh object, and click the ShapeMerge button.
- Click Pick Shape, and then select the shape.

The geometry of the surface of the mesh object is altered to embed a pattern matching that of the selected shape.

Interface
Pick Operand rollout

**Pick Shape**—Click this button, and then click the shape you want to embed in the mesh object. The shape is projected onto the mesh object in the direction of the shape's local negative Z axis. For example, if you create a box, and then create a shape in the Top viewport, the shape is projected onto the top of the box. You can repeat this process to add shapes, and the shapes can be projected in different directions. Simply click Pick Shape again, and then pick another shape.

**Reference/Copy/Move/Instance**—Lets you specify how the shape is transferred to the compound object. It can be transferred either as a reference, a copy, an instance, or moved, in which case the original shape is not left behind.

Parameters rollout

Operands group

**Operands list**—Lists all operands in the compound object. The first operand is the mesh object, and any number of shape-based operands can follow.

**Delete Shape**—Remove selected shapes from the compound object.

**Extract Operand**—Extracts a copy or an instance of the selected operand. Choose an operand in the list window to enable this button.

**Instance/Copy**—Lets you specify how the operand is extracted. It can be extracted either as an instance or a copy.

Operation group

These options determine how the shape is applied to the mesh.

**Cookie Cutter**—Cuts the shape out of the mesh object's surface.

**Merge**—Merges the shape with the surface of the mesh object.

**Invert**—Reverses the effect of Cookie Cutter or Merge. With the Cookie Cutter option, the effect is obvious. When Invert is off, the shape is a hole in the mesh object. When Invert is on, the shape is solid and the mesh is missing. When you're using Merge, Invert reverses the sub-object mesh selection. As an example, if you merge a circle shape and apply a Face Extrude, the circular area is extruded when Invert is off, and all but the circular area is extruded when Invert is on.

Output Sub-Mesh Selection group

Provides options that let you specify what selection level is passed up the Stack. The ShapeMerge object stores all selection levels; that is, it stores the vertices, faces, and edges of the merged shape with the object. (If you apply a Mesh Select modifier and go to the various sub-object levels, you'll see that the merged shape is selected.) Thus, if you follow the ShapeMerge with a modifier that acts on a specific level, such as Face Extrude, that modifier will work properly.

If you apply a modifier that can work on any selection level, such as Volume Select or Xform, the options will specify which selection level is passed to that modifier. Although you can use a Mesh Select modifier to specify a selection level, the Mesh Select modifier considers the selection only at frame 0. If
you've animated the shape operand, that animation will be passed up the Stack for all frames only by using the Output Sub-Mesh Selection options.

**None**—Outputs the full object.
**Face**—Outputs the faces within the merged shape.
**Edge**—Outputs the edge of the merged shape.
**Vertex**—Outputs the vertices defined by the spline of the shape.

Display/Update rollout

Display group
Determines whether the shape operands are displayed.
**Result**—Displays the result of the operation.
**Operands**—Displays the operands.

Update group
These options specify when the display is updated. Typically, you use them when you've animated the merged shape operands and the viewport display is slow.
**Always**—Updates the display at all times.
**When Rendering**—Updates the display only when the scene is rendered.
**Manually**—Updates the display only when you click the Update button.
**Update**—Updates the display when any option except Always is chosen.

**Terrain object**

- Select spline contours. > Create panel > Geometry > Compound Objects > Object Type rollout > Terrain
- Select spline contours. > Tab panels > Compounds tab > Terrain Compound Object
- Select spline contours. > Create menu > Compounds > Terrain

The Terrain button lets you produce terrain objects. The software generates these objects from contour line data. You select editable splines representing elevation contours and create a mesh surface over the contours. You can also create a "terraced" representation of the terrain object so that each level of contour data is a step, resembling traditional study models of land forms.

Using contours to build a terrain

**Upper left: The contours**

**Upper right: The terrain object**

**Lower left: Terrain object used as the basis of a landscape**

If you import an AutoCAD drawing file to use as contour data, the software names each object based on the AutoCAD object's layer, color, or object type. A number is appended to each name. For example, an AutoCAD object on the layer BASE becomes an object named BASE.01.

After you import or create the contour data, select the objects, and click the Terrain button, the software creates a new triangulated mesh object based on the contour data. The name of the first selected spline becomes the name of the terrain object. Other splines in the selection are treated according to the previously set Reference, Move, Copy, or Instance selection in the Pick Operand rollout, described below.

Keep in mind that the Terrain object can use any spline objects as operands, whether they are horizontal splines or not. Though the most common scenario is when sets of elevational contours are used to create terrain forms, it is possible to append or refine Terrain objects by using non-horizontal splines.

**Note:** To ensure that the software imports polylines as splines, when you import an AutoCAD drawing file, turn off Import AutoCAD DWG File dialog > Geometry Options group > Cap Closed Entities.

**Procedure**

Following are examples of uses of the Terrain feature:
- Visualizing the effects of grading plans in 3D.
- Maximizing views or sunlight by studying topographical undulation of land forms.
- Analyzing elevation changes by using color on the data.
Adding buildings, landscaping, and roads to a terrain model to create virtual cities or communities.

Viewing corridors and completing ridge analyses from particular locations on a site by adding cameras to the scene.

To analyze elevation changes:
1. Import or create contour data.
2. Select the contour data, and click the Terrain button.
3. On the Color By Elevation rollout, enter elevation zone values between the maximum and minimum elevations in the Base Elev box. Click Add Zone after entering the value.
4. The software displays the zones in the list under the Create Defaults button.
5. Click the Base Color swatch to change the color of each elevation zone. For example, you could use a deep blue for low elevations, a light blue for intermediate elevations, and perhaps greens for higher elevations.
6. Click Solid To Top of Zone to see the elevation changes in a striped effect.
7. Click Blend To Color Above to see the elevation changes blended.
8. Interface

Name and Color rollout
Displays the name of the terrain object. The software uses the name of one of the selected objects to name the terrain object.

Pick Operand rollout

Pick Operand—Adds splines to the terrain object. You might do this if you didn’t select all the objects before generating the terrain object, or if some objects in the imported data weren’t included in the terrain object. You can also use this option to add existing splines in the current scene to the terrain object.
When you click Pick Operand, the copy method you designate determines how the operands are used. When Move is the method, the original contour data is moved from the scene and into the operands of the new terrain object. Copy, Reference, and Instance retain the original contour data in the scene and create copies, references or instances of the contour data as operands in the terrain object. This is similar to the copy method for Boolean.

Override—Allows you to select closed curves that override any other operand data within their interior. Within the area an Override operand encloses (as seen in plan), other curves and points of the mesh are disregarded and the elevation of the Override operand supersedes them. An Override operand is indicated in the operands list by a # after its name. Override is only effective on closed curves. If multiple override operands overlap, later overrides (higher operand numbers) take preference.

Parameters rollout

Operands group
Operands—Displays the current operands. Each operand is listed as "Op" followed by a number and the name of the object that is being used as the operand. The operand name comprises layer, color, or object type name plus a numeric suffix.
Delete Operand—Deletes a selected operand from the Operands list.
Form group
Graded Surface—Creates a graded surface of the mesh over the contours.
Terrain created as a graded surface
Graded Solid—Creates a graded surface with skirts around the sides and a bottom surface. This represents a solid that is visible from every direction.

Layered Solid—Creates a "wedding cake" or laminated solid similar to cardboard architectural models.

Terrain created as a "layered solid" surface, with levels

Stitch Border—When on, suppresses the creation of new triangles around the edges of terrain objects when edge conditions are defined by splines that are not closed. Most terrain forms display more reasonably when this is turned off.

Retriangulate—The basic Terrain algorithm tends to flatten or notch contours when they turn sharply upon themselves. A typical situation in which this may happen is when a narrow creek bed is described with contours; the resulting form may look more like a series of cascades at each elevational contour, rather than a smoothly descending ravine. When Retriangulate is checked, a somewhat slower algorithm is used that follows contour lines more closely. This may be particularly evident in the Layered Solid display mode. For additional precision, try using Retriangulate in conjunction with horizontal interpolation.

Display group
Terrain—Displays only the triangulated mesh over the contour line data.

Contours—Displays only the contour line data of the terrain object.

Both—Displays both the triangulated mesh and the contour line data of the terrain object. You can select the terrain object by clicking its surface, but not by clicking a contour line. When Both is selected, contour lines may not be apparent in Wireframe display modes or when Edged Faces are displayed.

Update group
The items in this group box determine when the software recalculates the projection for the terrain object. Because complex terrain objects can slow performance, you can use these options to avoid constant calculation.

- Simplification
  - Horizontal
    - No Simplification
    - Use 1/2 of Points
    - Use 1/4 of Points
    - Interpolate Points * 2
    - Interpolate Points * 4
  - Vertical
    - No Simplification
    - Use 1/2 of Lines
    - Use 1/4 of Lines

Always—Updates the terrain object immediately when you change an operand, including the original object of an instanced or referenced operand.

When Rendering—Updates the terrain object when you render the scene or when you click Update. With this option, viewports won’t show current geometry unless you click Update.

Manually—Updates the terrain object when you click Update.

Update—Updates the terrain object. This button is not enabled only when Always is the active option.

Simplification rollout

Horizontal group
No Simplification—Uses all the operands’ vertices to create a complex mesh. This results in greater detail and a larger file size than the two fractional options.

Use 1/2 of Points—Uses half the set of vertices in the operands to create a less complex mesh. This results in less detail and a smaller file size than using No Simplification.

Use 1/4 of Points—Uses a quarter of the of vertices in the operands to create a less complex mesh. This results in the least detail and smallest file size of these options.

Interpolate Points * 2—Doubles the set of vertices in the operands to create a more refined but more complex mesh. This is most effective in terrain forms that use constructive curves such as circles and ellipses. This results in more detail and a larger file size than using No Simplification.

Interpolate Points * 4—Quadruples the set of vertices in the operands to create a more refined but more complex mesh. This is most effective in terrain forms that use constructive curves such as circles and ellipses. This results in more detail and a larger file size than using No Simplification.

Vertical group
No Simplification—Uses all the spline operands’ vertices of the terrain object to create a complex mesh. This results in greater detail and a larger file size than the other two options.

Use 1/2 of Lines—Uses half the set of spline operands of the terrain object to create a less complex mesh. This results in less detail and a smaller file size than using No Simplification.
Use 1/4 of Lines—Uses a quarter of the spline operands of the terrain object to create a less complex mesh. This results in the least detail and smallest file size of the three options.

Color by Elevation rollout

**Maximum Elev.**—Displays the maximum elevation in the Z axis of the terrain object. The software derives this data from the contour data.

**Minimum Elev.**—Displays the minimum elevation in the Z axis of the terrain object. The software derives this data from the contour data.

**Reference Elev.**—This is the reference elevation, or datum, that the software uses as a guide for assigning colors to zones of elevation. After entering a reference elevation, click the Create Defaults button. The software treats elevations above the reference elevation as solid land and those below the reference elevation as water. If you enter a value no greater than the minimum elevation in the object, the software divides the range between the reference and minimum elevations into five color zones: dark green, light green, yellow, purple, and light gray.

If you enter a value between the minimum and maximum elevations, the software creates six color zones. Two zones (dark blue and light blue) are used for elevations below the reference elevation. These are considered to be under water. One zone (dark yellow) is used for a narrow range around the reference elevation. Three zones (dark green, light green, light yellow) are used for elevations above the reference elevation.

If you enter a value at or above the maximum elevation, the software divides the range between the minimum and reference elevations into three zones (dark blue, medium blue, light blue).

Zones by Base Elevation group

**Create Defaults**—Creates elevation zones. The software lists the elevation at the bottom of each zone, referenced to the datum (the reference elevation). The software applies the color of the zone at the base elevation. Whether the colors blend between zones depends on your choice of the Blend to Color Above or Solid to Top of Zone option.

**Color Zone group**
The items in this group box assign colors to elevation zones. For example, you might want to change levels of blue to indicate the depth for water. Your changes in the Color Zone area don't affect the terrain object until you click the Modify Zone or Add Zone button.

**Base Elev**—This is the base elevation of a zone to which you assign color. After entering a value, click Add Zone to display the elevation in the list under Create Defaults.

**Base Color**—Click the color swatch to change the color of the zone.

**Blend to Color Above**—Blends the color of the current zone to the color of the zone above it.

**Solid to Top of Zone**—Makes a solid color at the top of the zone without blending to the color of the zone above it.

**Modify Zone**—Modifies selected options of a zone.

**Add Zone**—Adds values and selected options for a new zone.

**Delete Zone**—Deletes a selected zone.

Loft object

- **Select a path or shape.** > Create panel > Geometry > Compound Objects > Object Type rollout > Loft

  **Select an object.** > Create menu > Compound Objects > Loft

  **Select an object.** > Tab panels > Compounds tab > Loft Compound Object

  **Select an object.** > Tab panels > Modeling tab > Loft Compound Object
Roadway created as a lofted shape

Loft objects are two-dimensional shapes extruded along a third axis. You create loft objects from two or more existing spline objects. One of these splines serves the path. The remaining splines serve as cross-sections, or shapes, of the loft object. As you arrange shapes along the path, the software generates a surface between the shapes. You create shape objects to serve as a path for any number of cross-section shapes. The path becomes the framework that holds the cross sections forming your object. If you designate only one shape on the path, the software assumes an identical shape is located at each end of the path. The surface is then generated between the shapes.

The software places few restrictions on how you create a loft object. You can create curved, three-dimensional paths and even three-dimensional cross sections.

When using Get Shape, as you move the cursor over an invalid shape, the reason the shape is invalid is displayed in the prompt line.

Unlike other compound objects, which are created from the selected object as soon as you click the compound-object button, a Loft object is not created until you click Get Shape or Get Path, and then select a shape or path. Loft is enabled when the scene has one or more shapes. To create a loft object, first create one or more shapes and then click Loft. Click either Get Shape or Get Path and select a shape in the viewports.

Once you create a loft object, you can add and replace cross-section shapes or replace the path. You can also change or animate the parameters of the path and shapes.

You can’t animate the path location of a shape.

You can convert loft objects to NURBS surfaces.

Procedures

To create a loft object:

Creating loft objects is detailed and offers many choices, but the basic process is quite simple.

1. Create a shape to be the loft path.
2. Create one or more shapes to be loft cross sections.
3. Do one of the following:
   a. Select the path shape and use Get Shape to add the cross sections to the loft.
   b. Select a shape and use Get Path to assign a path to the loft. Use Get Shape to add additional shapes.

You can use the loft display settings to view the skin generated by your loft in both wireframe and shaded views.

To create a loft with Get Path:

1. Select a shape as the first cross-section shape.
2. Click Create panel > Geometry > Compound Objects > Loft.
3. On the Creation Method rollout, click Get Path.
4. Choose Move, Copy, or Instance.
5. Click a shape for the path.

The cursor changes to the Get Path cursor as you move it over valid path shapes. If the cursor does not change over a shape, that shape is not a valid path shape and cannot be selected. The first vertex of the selected path is placed at the first shape's pivot and the path tangent is aligned with the shape's local Z axis.

To create a loft with Get Shape:

- Select a valid path shape as the path.
- If the selected shape is not a valid path shape, the Get Shape button is unavailable.
- Click Create panel > Geometry > Compound Objects > Loft.
- On the Creation Method rollout, click Get Shape.
- Choose Move, Copy, or Instance.
- Click a shape.
- The cursor changes to the Get Shape cursor as you move it over potential shapes. The selected shape is placed at the first vertex of the path.
Tip: You can flip the shape along the path by holding down CTRL when using Get Shape. For example, if you select the lowercase letter "b" with a CTRL+click, the loft will look like the letter "d".

Interface

You use the following rollouts for setting loft object parameters:

- Creation Method Rollout
- Surface Parameters Rollout
- Path Parameters Rollout
- Skin Parameters Rollout

Once you've created a loft object, you can also use the Modify panel's Deformations rollout to add complexity.

Scatter

Select an object. > Create panel > Geometry > Compound Objects > Object Type rollout > Scatter

Select an object. > Tab panels > Compounds tab > Scatter Compound Object

Scatter is a form of compound object that randomly scatters the selected source object either as an array, or over the surface of a distribution object.

The plane of the hill is used to scatter the trees and two different sets of rocks.

Procedures

To create a Scatter object:

1. Create an object to be used as a source object.
2. Optionally, create an object to be used as a distribution object.
3. Select the source object, and then click Scatter in the Compound Objects panel.
4. Note: The source object must be either a mesh object or an object that can be converted to a mesh object. If the currently selected object is invalid, the Scatter button is unavailable.
5. Note: You now have two choices. You can either scatter the source object as an array without using a distribution object, or use a distribution object to scatter the object. See the following procedures.

Results of scattering source object with distribution object visible (above) and hidden (below)

To scatter the source object without a distribution object:

1. Choose Use Transforms Only in the Scatter Objects rollout > Distribution group.
2. Set the Duplicates spinner to specify the desired total number of duplicates of the source object.
3. Adjust the spinners on the Transforms rollout to set random transformation offsets of the source object.

To scatter the source object using a distribution object:

1. Make sure the source object is selected.
2. Choose the method by which you want to clone the distribution object (Reference, Copy, Move, or Instance.)
3. Click Pick Distribution Object, and then select the object you want to use as a distribution object.
4. Make sure that Use Distribution Object on the Scatter Object rollout is chosen.
5. Use the Duplicates spinner to specify the number of duplicates. (This is not necessary if you're using the All Vertices, All Edge Midpoints or All Face Centers distribution methods.)

Optionally, adjust the Transform spinners to randomly transform the duplicates.
If the display is too slow, or the meshes too complicated, consider choosing Proxy on the Display rollout or decreasing the percentage of displayed duplicates by reducing the Display percentage. Most of the spinner values are animatable, so you can animate things like the number of duplicates, their transformations, and so on.

**Scatter objects (the grass) with a high number of duplicates**

**Interface**

**Pick Distribution Object rollout**

Contains the options for selecting a distribution object.

**Object**—Displays the name of the distribution object selected with the Pick button.

**Pick Distribution Object**—Click this button, then click an object in the scene to specify it as a distribution object.

**Reference/Copy/Move/Instance**—Lets you specify how the distribution object is transferred to the scatter object. It can be transferred either as a reference, a copy, an instance, or moved, in which case the original shape is not left behind.

**Scatter Objects rollout**

The options on this rollout let you specify how the source object is scattered, and let you access the objects that make up the compound Scatter object.

**Distribution group**

These two options let you choose the basic method of scattering the source object.

**Use Distribution Object**—Scatters the source object based on the geometry of the distribution object.

**Use Transforms Only**—This option doesn’t need a distribution object. Instead, duplicates of the source object are positioned using the offset values on the Transforms rollout. If all of the Transform offsets remain at 0, you won’t see the array because the duplicates occupy the same space.

**Objects group**

Contains a list window showing the objects that make up the scatter object.

**List Window**—Click to select an object in the window so that you can access it in the Stack. For example, if your distribution object is a sphere, you can click Distribution: D_Sphere01, open the Stack list, and select Sphere to access the sphere’s parameters.

**Source Name**—Lets you rename the source object within the compound Scatter object.

**Distribution Name**—Lets you rename the distribution object.

**Extract Operand**—Extract a copy or an instance of the selected operand. Choose an operand in the list window to enable this button.

Note: This button is available only on the Modify panel. You can’t extract an operand while the Create panel is active.

**Instance/Copy**—This option lets you specify how the operand is extracted: as either an instance or a copy.

**Source Object Parameters group**

These options affect the source object locally.

**Duplicates**—Specifies the number of scattered duplicates of the source object. This number is set to 1 by default, but you can set it to 0 if you want to animate the number of duplicates, beginning with none. Note that the Duplicates number is ignored if you’re distributing the duplicates using either Face Centers or Vertices. In these cases, one duplicate is placed at each vertex or face center, depending on your choice.

**Base Scale**—Alters the scale of the source object, affecting each duplicate identically. This scale occurs before any other transforms.
**Vertex Chaos**—Applies a random perturbation to the vertices of the source object.

**Animation Offset**—Lets you specify the number of frames by which each source object duplicate's animation is offset from the previous duplicate. You can use this feature to produce wave-type animation. At the default setting of 0, all duplicates move identically.

**Distribution Object Parameters group**

These options affect how the duplicates of the source object are arranged, relative to the distribution object. These options have an effect only when a distribution object is used.

**Perpendicular**—When on, orients each duplicate object perpendicular to its associate face, vertex, or edge in the distribution object. When off, the duplicates maintain the same orientation as the original source object.

**Use Selected Faces Only**—When on, limits distribution to the selected faces passed up the Stack. Perhaps the easiest way to do this is to use the Instance option when picking the distribution object. You can then apply a Mesh Select modifier to the original object and select only those faces you want to use for the distribution of the duplicates.

**Distribute Using**
The following options let you specify how the geometry of the distribution object determines the distribution of the source object. These options are ignored if you're not using a distribution object.

**Area**—Distributes duplicate objects evenly over the total surface area of the distribution object.

**Objects distributed over a spherical surface with Area turned on**

**Even**—Divides the number of faces in the distribution object by the number of duplicates, and skips the appropriate number of faces in the distribution object when placing duplicates.

**Skip N**—Skips N number of faces when placing duplicates. The editable field specifies how many faces to skip before placing the next duplicate. When set to 0, no faces are skipped. When set to 1, every other face is skipped, and so on.

**Random Faces**—Applies duplicates randomly over the surface of the distribution object.

**Along Edges**—Assigns duplicates randomly to the edges of the distribution object.

**All Vertices**—Places a duplicate object at each vertex in the distribution object. The Duplicates value is ignored.

**All Edge Midpoints**—Places a duplicate at the midpoint of each segment edge.

**All Face Centers**—Places a duplicate object at the center of each triangular face on the distribution object. The Duplicates value is ignored.

**Volume**—Scatters objects throughout the distribution object's volume. All other options restrict distribution to the surface. Consider turning on Display rollout > Hide Distribution Object with this option.

**Objects fill a spherical volume with Volume turned on**

**Display group**

**Result/Operands**—Choose whether to display the results of the scatter operation or the operands before the scattering.

**Transforms rollout**

**Rotation**

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**Use Maximum Range**

**Local Translation**

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**Use Maximum Range**

**Translation on Face**

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<tr>
<td>B</td>
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**Scaling**

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<tr>
<td>Z</td>
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</tbody>
</table>

**Use Maximum Range**

**Lock Aspect Ratio**

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The settings in the Transforms rollout let you apply random transform offsets to each duplicate object. The values in the transform fields specify a maximum offset value that’s applied randomly with a positive or negative value to each duplicate. Thus, if you set a rotation angle of 15 degrees, duplicates are rotated randomly from -15 to +15 degrees. For example, one duplicate might be rotated 8 degrees, another -13, another 5, and so on. You can use the Transform settings with or without a distribution object. When there is no distribution object, you must adjust the Transform settings in order to see the duplicates.

Rotation group
Specifies random rotation offsets.

**X, Y, Z deg**—Enter the maximum random rotational offset you want about the local X, Y, or Z axis of each duplicate.

**Use Maximum Range**—When on, forces all three settings to match the maximum value. The other two settings become disabled, and the setting containing the maximum value remains enabled.

Local Translation group
Specifies translation of the duplicates along their local axes.

**X, Y, Z**—Enter the maximum random movement you want along the X, Y, or Z axis of each duplicate.

**Use Maximum Range**—When on, forces all three settings to match the maximum value. The other two settings become disabled, and the setting containing the maximum value remains enabled.

Translation on Face group
Lets you specify the translation of duplicates along barycentric face coordinates of the associate face in the distribution object. These settings have no effect if you’re not using a distribution object.

**A, B, N**—The first two settings specify the barycentric coordinates on the surface of the face, while the N setting sets the offset along the normal of the face.

**Use Maximum Range**—When on, forces all three settings to match the maximum value. The other two settings become disabled, and the setting containing the maximum value remains enabled.

Scaling group
Lets you specify the scaling of duplicates along their local axes.

**X, Y, Z %**—Specifies the percent of random scaling along the X, Y, or Z axis of each duplicate.

**Use Maximum Range**—When on, forces all three settings to match the maximum value. The other two settings become disabled, and the one containing the maximum value remains enabled.

**Lock Aspect Ratio**—When on, maintains the original aspect ratio of the source object. Typically, this provides uniform scaling of duplicates. When Lock Aspect Ratio is off, and any of the X, Y, and Z settings contain values greater than 0, the result is non-uniform scaling of duplicates because the values represent random scaling offsets in both positive and negative directions.

Display rollout

Provides options that affect the display of the Scatter object.

**Display Options group**
These options affect the display of the source and destination objects.

**Proxy**—Displays the source duplicates as simple wedges and speeds up viewport redraws when manipulating a complex Scatter object. This has no effect on the rendered image, which always displays the mesh duplicates.

**Mesh**—Displays the full geometry of the duplicates.

**Display %**—Specifies the percentage of the total duplicate objects that appear in the viewports. This has no effect on the rendered scene.

**Hide Distribution Object**—Hides the distribution object. The hidden object does not appear in the viewport or in the rendered scene.

**Uniqueness group**
Lets you set a seed number upon which the random values are based. Thus, altering this value changes the overall effect of the scattering.

**New**—Generates a new, random seed number.

**Seed**—Use this spinner to set the seed number.

Load/Save Presets rollout

Lets you store preset values to use in other Scatter objects. For example, after setting all of your parameters for a specific Scatter object and saving the settings under a specific name, you can then select another Scatter object and load the preset values into the new object.
**Preset Name**—Lets you define a name for your settings. Click the Save button to save the current settings under the preset name.

**Saved Presets group**
A list window containing saved preset names.

**LOAD**—Loads the preset currently highlighted in the Saved Presets list.

**SAVE**—Saves the current name in the Preset Name field and places it in the Saved Presets window.

**DELETE**—Deletes the selected items in the Save Presets window.

**Mesher**
Select an object. > Create panel > Geometry > Compound Objects > Object Type rollout > Mesher

The Mesher compound object converts procedural objects to mesh objects on a per-frame basis so that you can apply modifiers such as Bend or UVW Map. It can be used with any type of object, but is designed primarily to work with particle systems. Mesher is also useful for low-overhead instancing of objects with complex modifier stacks.

**Procedure**

To use a Mesher object:
1. Add and set up a particle system.
2. Click the Create panel> Geometry > Compound Objects > Object Type rollout > Mesher button.
3. Drag in a viewport to add the Mesher object. The size doesn't matter, but the orientation should be the same as that of the particle system.
4. Go to the Modify panel, click the Pick Object button, and then select the particle system.
5. The Mesher object becomes a clone of the particle system, and shows the particles as mesh objects in the viewports no matter what the particle system’s Viewport Display setting is.
6. Apply a modifier to the Mesher object, and set its parameters. For example, you might apply a Bend modifier and set its Angle parameter to 180.
7. Play the animation.
8. Depending on the original particle system and its settings, as well as any modifiers applied to the Mesher object, you might be getting unexpected results. This typically occurs because the bounding box for the modifier, as applied to the particle system, is recalculated at each frame. For example, with a bent Super Spray particle system set to spread out over time, as the particles stream away and separate, the bounding box becomes longer and thicker, potentially causing unexpected results. To resolve this, you can use another object to specify a static bounding box.
9. To use another object’s bounding box to limit the modified Mesher object, first add and set up the object. Its position, orientation, and size are all used in calculating the bounding box.
10. Select the Mesher object, and go to the Mesher stack level.
11. In the Parameters rollout, turn on Custom Bounding Box, click the Pick Bounding box button, and then select the bounding box object.

The particle stream uses the new, static bounding box.

Tip: You can use any object as a bounding box, so it is often fastest to use the particle system itself. Move to the frame where the particle system is the size you want and pick it.

In the following illustration, you can see a Super Spray particle system (left) and a Mesher object derived from the Super Spray (right). A Bend modifier is applied to the Mesher. In the center is a box object being used as a custom bounding box. The bounding box applied to the Bend modifier is visible as an orange wireframe when the modifier is highlighted in the stack.

**Using a custom bounding box with a bent particle system**

To modify the particles aspect of the Mesher, edit the original particle system.

To modify the custom bounding box, move, rotate, or scale the bounding box object, and then re-apply it using the Mesher object.

At this point, both particle systems will render. The original particle system must exist in order to be able to be used by the Mesher object, so if you want only the Mesher replica to render, you should hide the original system before rendering.

**Interface**
Parameters rollout

Pick Object—Click this button and then select the object to be instanced by the Mesher object. After doing so, the name of the instanced object appears on the button.

Time Offset—The number of frames ahead of or behind the original particle system that the Mesher's particle system will run. Default=0.

Build Only At Render Time—When on, the Mesher systems do not appear in the viewports, but only when you render the scene. Default=off.

Build Only At Render Time—When on, the Mesher particles do not appear in the viewports, but only when you render the scene. Default=off.

Build Only At Render Time—When on, the Mesher systems do not appear in the viewports, but only when you render the scene. Default=off.

Update—After editing the original particle system settings or changing the Mesher Time Offset setting, click this button to see the changes in the Mesher system.

Custom Bounding Box—When on, Mesher replaces the dynamic bounding box derived from the particle system and modifier with a static bounding box of the user's choice.

Pick Bounding Box—When on, Mesher replaces the dynamic bounding box derived from the particle system and modifier with a static bounding box of the user's choice.

Pick Bounding Box—When on, Mesher replaces the dynamic bounding box derived from the particle system and modifier with a static bounding box of the user's choice.

Tip: You can use any object as a bounding box, so it is often fastest to use the particle system itself. Move to the frame where the particle system is the size you want and pick it.

 sede values)—Displays the coordinates of the opposite corners of the custom bounding box.

To specify a custom bounding box object, click this button and then select the object.