

**Job No:** 05**Duration:** 16H**Job Title:** Create Compound Objects**Objective:**

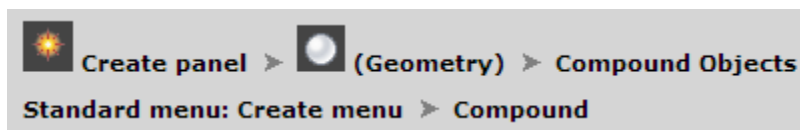
Combine two or more existing objects, 2D or 3D using compound objects to edit the form of one or the other into a new single object.

Students should be able to combine two or more existing objects into a single object using compound objects



- Boolean
- ProBoolean

**Introduction:**

Compound Objects in 3ds Max tools, not physical objects in the sense of a Standard primitive. It provide editing tools with options that are not readily available in other 3ds Max tools by using 2D or 3D geometry as part of the tool itself. Because compound objects in 3ds Max are in some way combining 3D surfaces, the resulting object can be complex and memory intensive to keep track of the original objects being used. There is also a moderate chance that the tool will fail because 3ds Max works only with surface information and not volume information.

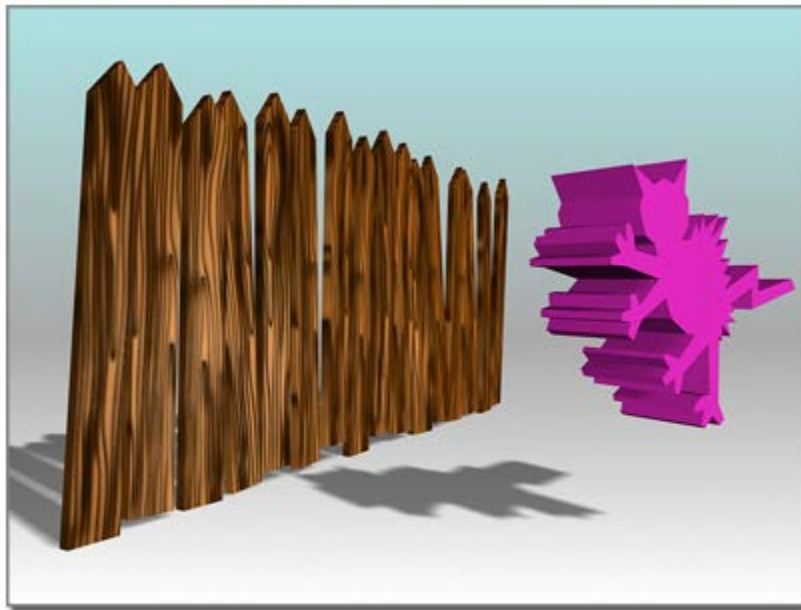


**Boolean:**

Select an object. >  Create panel >  (Geometry) > Compound Objects > Object Type rollout > Boolean  
Standard menu: 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)**

**Union**

The Boolean object contains the volumes of both original objects. The intersecting or overlapping portion of the geometry is removed.

**Intersection**

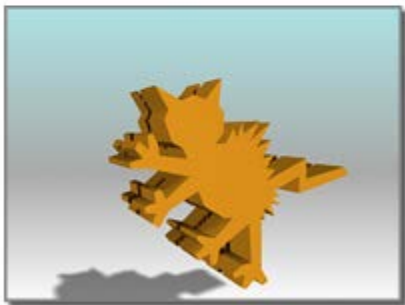
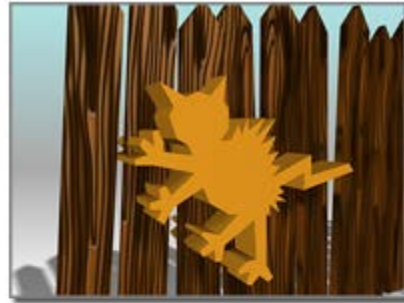
The Boolean object contains only the volume common to both original objects (in other words, where they overlapped).

**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)**

### To create a Boolean object:

1.  Select an object. This object becomes operand A.
2. Click Boolean. The name of operand A appears in the Operands list on the Parameters rollout.
3. 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.)
4. 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.
5. On the Pick Boolean rollout, click Pick Operand B.
6. Click in a viewport to select operand B. 3ds Max performs the Boolean operation.

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.

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

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:


1. 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.

2. Deselect the Boolean object. Build the cylinder if it does not already exist.



3. Select the Boolean object; and under Compound Objects, click Boolean again.

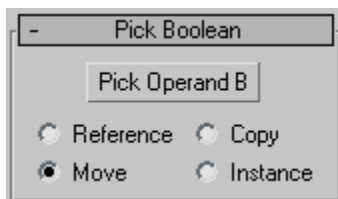
4. Click Pick Operand B and click the cylinder in the viewport. It is converted to operand B.

5. 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.

If you want to animate the Cylinder or the Cylinder's parameters you can now access them in the modifier stack display.

6. If you want to modify the sphere's parameters, choose the box in the Operands list.
7. Now there are two entries labeled Boolean in the stack display. Choose the lower entry. The Sphere is displayed in the Operands list.
8. Choose the Sphere from the Operands list. The sphere's parameters are available by clicking the sphere's name in the modifier stack display.
9. 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.

**Booleans Interface Setting:****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.

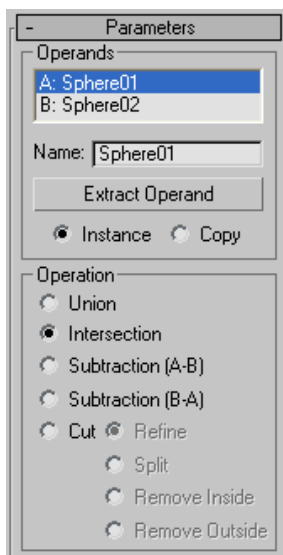
### Reference/Copy/Move/Instance

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



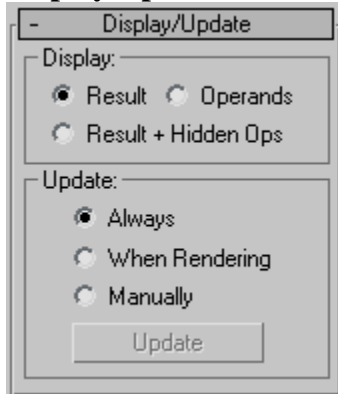
**Operation group:**

- **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 Outside to delete specific areas from your geometry.

**Display group:**  
**Display/Update rollout:**



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.

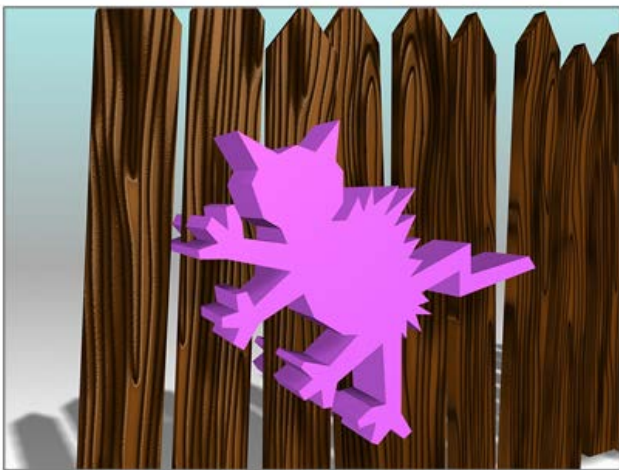
The display controls have no effect until you've created the Boolean.

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

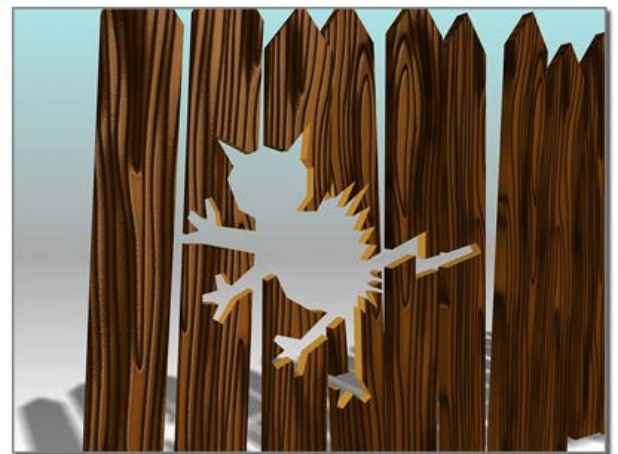
**Tip:** When operands are difficult to see in a viewport, you can use the Operand list to select one or the other. Click the name of the A or B operand to select it.

- **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.

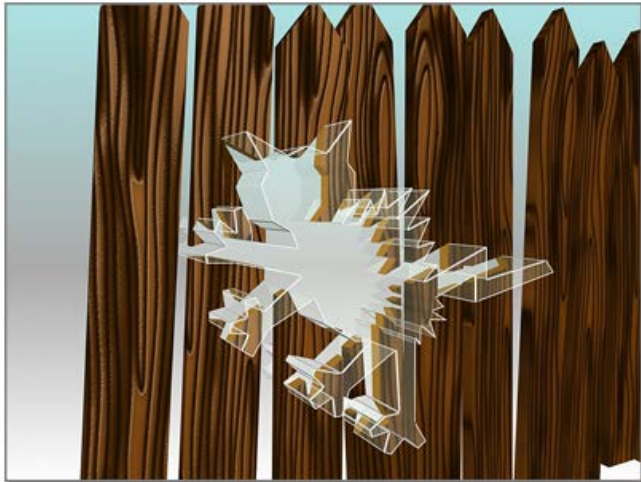


Displaying the operands

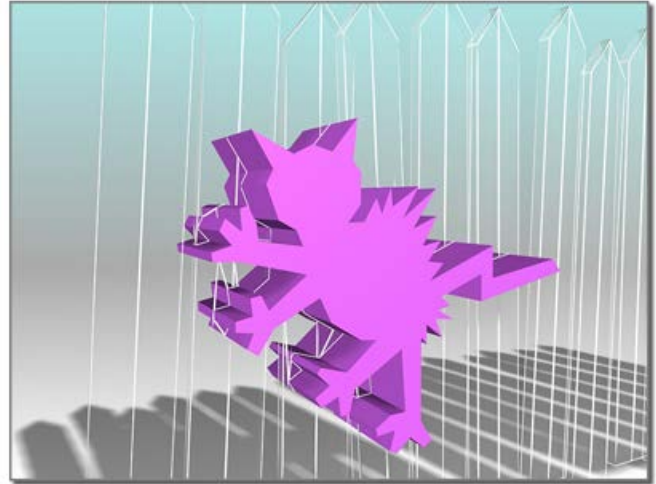


Displaying the result (A-B)





Displaying the hidden operand after A-B



Displaying the hidden operand after B-A

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

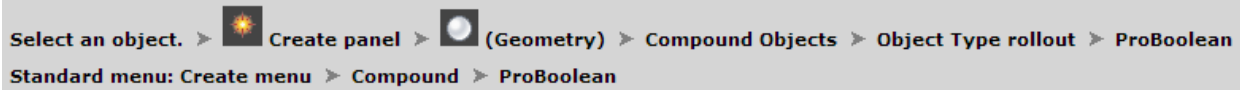
- **Always** Updates Booleans immediately when you change an operand, including the original object of an instanced or referenced B operand. This is the default behavior.
- **When Rendering** Updates Booleans only when you render the scene or click Update. With this option, viewports don't always show 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:



A Boolean object combines two or more other objects by performing a Boolean operation or operations on them. ProBoolean adds a range of functionality to the traditional 3ds Max Boolean object, such as the ability to combine multiple objects at once, each using a different Boolean operation.

### Supported Boolean Operations:

ProBoolean supports Union, Intersection, Subtraction, Merge, Attach, and Insert. The first three operations work similarly to their counterparts in the standard Boolean compound object. The Merge operation intersects and combines two meshes without removing any of the original polygons. This can be useful for cases in which you need to selectively remove parts of the mesh.

The Attach operation combines multiple objects into one without affecting their topology; they remain essentially separate elements of the compound object. And the Insert operation subtracts the bounding shape of operand A from operand B, and then replaces the cut-out part with operand A.



Also supported are two variants of the Boolean operations: Imprint and Cookie Cutter. The Imprint option inserts (imprints) the intersection edges between the operands and the original mesh without removing or adding faces. Imprint only splits faces and adds new edges to the mesh of the base object (original selected object). Cookie Cutter performs the specified Boolean operation but does not add the faces from the operands into the original mesh. It can be used to cut a hole in a mesh or to get the portion of a mesh inside of another object.

### Editing the Boolean Object:

When you access a ProBoolean or ProCutter object from the Modify panel, you can add operands to the existing set. You can also remove and transform (move, rotate, or scale) operands.

### To create a ProBoolean compound object:

1. Set up objects for the Boolean operation. For example, to subtract spherical shapes from a box, create the box and spheres and arrange the spheres so that their volumes intersect the box where the subtractions should take place.
2. Select the base object. In the example in step 1, you would select the box.

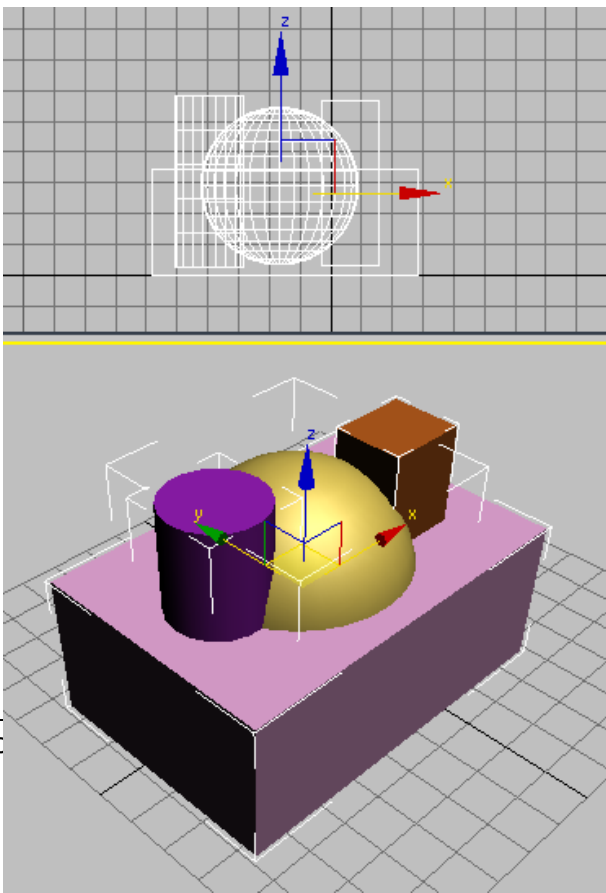
3. On the  Create panel, with  (Geometry) active, choose Compound Objects from the drop-down list. On the Object Type rollout, turn on ProBoolean.
4. On the Parameters rollout, choose the type of Boolean operation you want to use: Union, Intersection, Subtraction, and so on. Also choose how 3ds Max will transfer the next operand you pick into the Boolean object: Reference, Copy, Move, or Instance. You can also choose to retain the original material, or keep the default Apply Material choice: Apply Operand Material.
5. Click the Start Picking button.
6. Pick one or more objects to participate in the Boolean operation.
7. As you pick objects, you can also change, for each newly picked object, the Boolean operation (Merge, and so on) and options (Cookie or Imprint), as well as how the next operand is transferred to the Boolean (Reference, Copy, and so on) and the Apply Material choice. You can continue picking operands as long as the Start Picking button stays pressed in. Each of the objects you pick is added to the Boolean operation.

When the Modify panel is active, you can add objects to a selected ProBoolean object by clicking the Start Picking button and then picking the objects to add.




### To change an existing Boolean with sub-object operations:

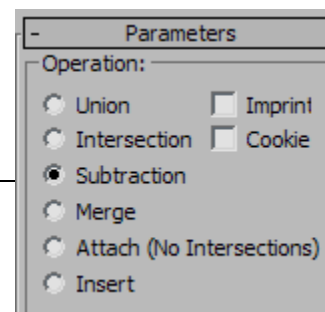
ProBoolean offers a great deal of flexibility in combining various Boolean operations simultaneously, plus the ability to change the way operands combine both as you build the Boolean object and after the fact.

1. Start by adding a box, a sphere, a smaller box, and a cylinder, as shown in the following illustration.



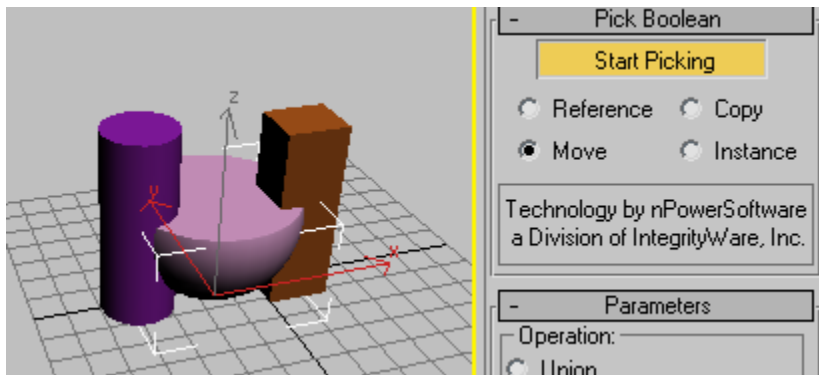
Top: Front viewport; Bottom: Perspective viewport

2.  Select the box.
3. On the  Create panel, with  (Geometry) active, choose Compound Objects from the drop-down list. On the Object Type rollout, turn on ProBoolean.
4. On the Parameters rollout, in the Operation group, choose Intersection.



5. On the Pick Boolean rollout, click Start Picking, and then click the sphere.

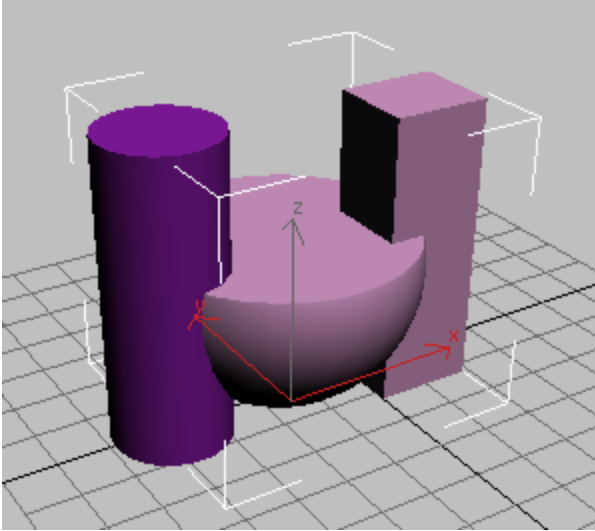
The result is the intersection of the sphere and the box; that is, a single object that represents the *common* volume both objects occupy. In this case, it's the overlap of the sphere and the box. Although neither has a material at this point, the result uses the default color originally assigned by 3ds Max, at random, to the box when it was created.



Note that Start Picking stays active (blue or yellow, depending on the color scheme). This means you can continue picking objects to incorporate into the Boolean object, optionally changing the operation as you go.

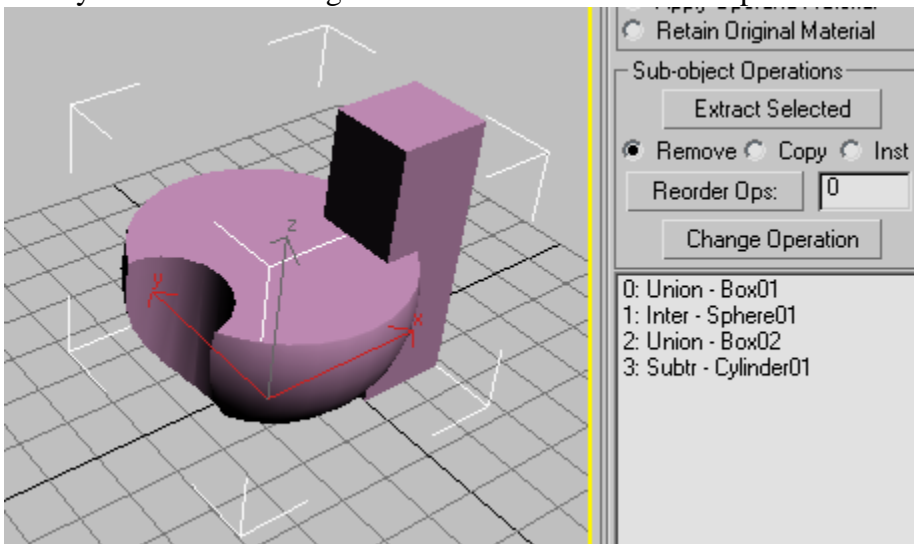
6. Set Operation to Union, and then click the small box.

The result is the union (adding) of the small box with the intersection of the sphere and larger box. Again, the original object's color is assigned to the result.



- Set Operation to Subtraction, and then click the cylinder.

The cylinder's intersecting volume is subtracted from the previous Boolean result.



Note that the entire history of operands and operations used to build the Boolean object is listed in the hierarchy view list at the bottom of the Parameters rollout. Box01 starts the Boolean with Union, Sphere01 is then incorporated with Intersection, Box02 is incorporated with Union, and finally Cylinder01 is incorporated with Subtraction.

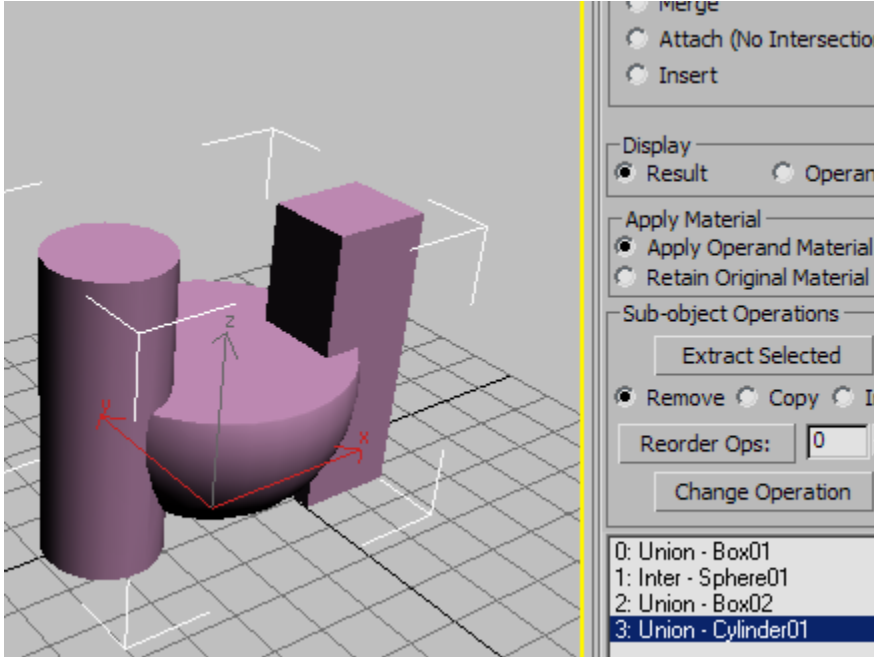
**Note:** The operation for the first object in the list has no effect on the Boolean object, but if you move it to another position in the list it does. You'll see an example of this at the end of this exercise.

You can use the list and the other controls in the Sub-object Operations group to change the results.

- In the list, highlight the Subtr - Cylinder01 entry, and then set Operation to Union.

9. In the Sub-object Operations group, click the Change Operation button.

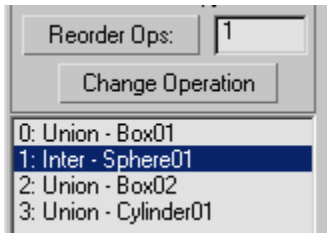
As a result of the change of operation, the cylinder appears in the Boolean object as an additive volume instead of a subtractive one. Also, its entry in the list changes to “Union - Cylinder01”, showing that the Boolean operation for the cylinder is now Union.



You can also change the order of the operations, which can affect the results.

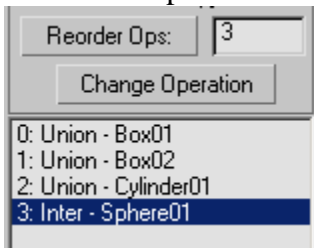
10. In the list, click the Union - Cylinder01 entry to remove the highlighting, and then highlight the entry 1: Inter - Sphere01.

Note that its position in the list, 1, appears in the editable field next to the Reorder Ops button.

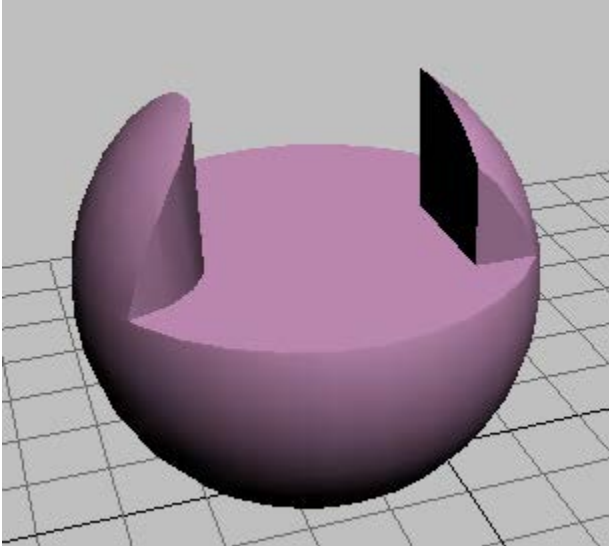


11. Change the value in the field from 1 to 3, and then click the Reorder Ops button.

The Inter - Sphere01 item jumps to the end of the list.



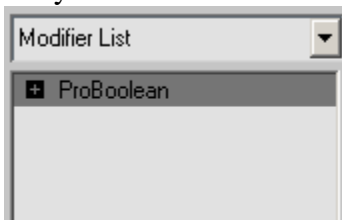
The Boolean object changes significantly. The new order in the list tells you how this shape was achieved: The two boxes and the cylinder were all combined with Union, adding their volumes together, and then the sphere was incorporated into that result with Intersection, leaving only the volume shared by all four objects.



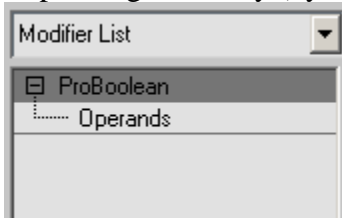
### ProBoolean Interface Setting

#### Modifier stack:

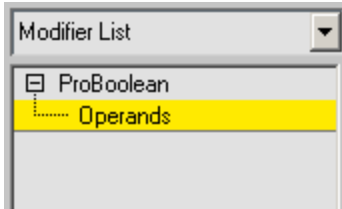
With an unmodified ProBoolean object selected, the modifier stack shows a single, expandable entry: ProBoolean.



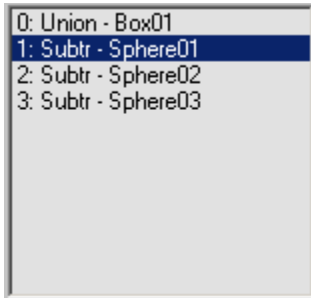
Expanding this entry (by clicking the + icon) reveals a single subsidiary branch: Operands.



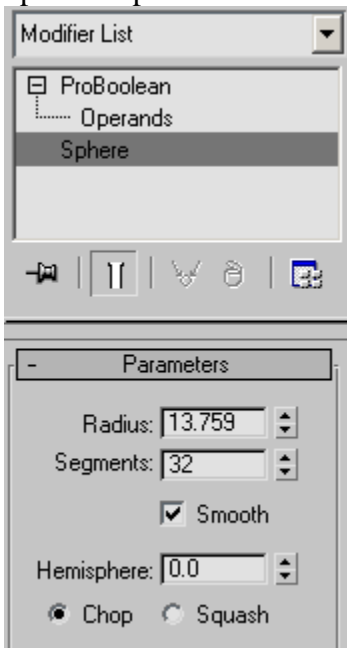
To transform operands in the ProBoolean object independent of the entire object, click the Operands branch to highlight it.



You can then select one or more operands, either by using standard selection methods in the viewport, or by highlighting their names in the hierarchy view list at the bottom of the Parameters rollout.

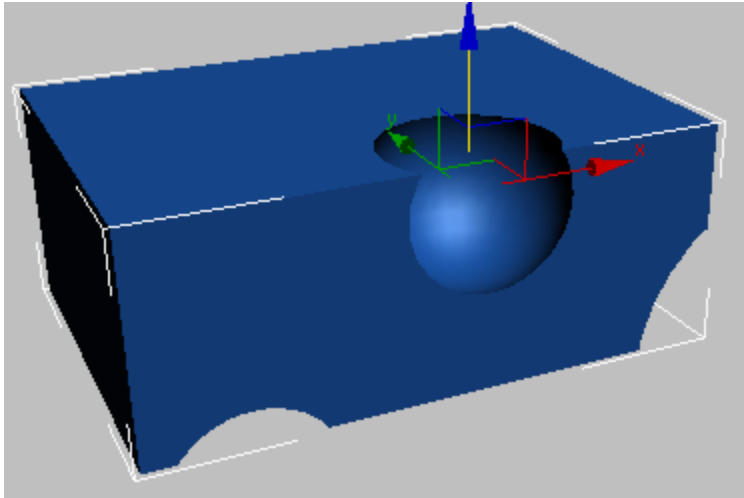


When one, and only one, operand is selected, the object type (not its name) appears as a separate stack entry below the ProBoolean entry. Clicking this entry provides direct access to the operand's parameters on the Modify panel.

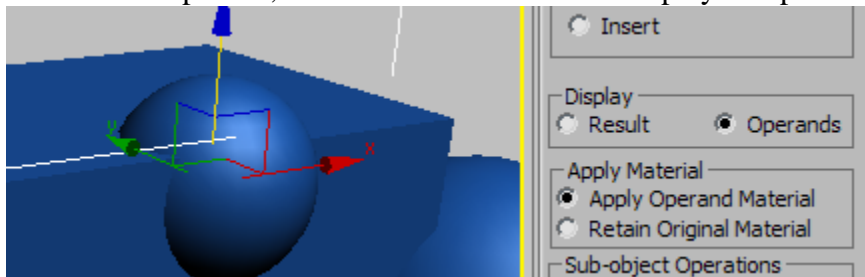


If Parameters rollout ► Display is set to Result, selecting an operand displays the operand's axis tripod or transform gizmo in the viewport, although the operand itself is not visible by default.

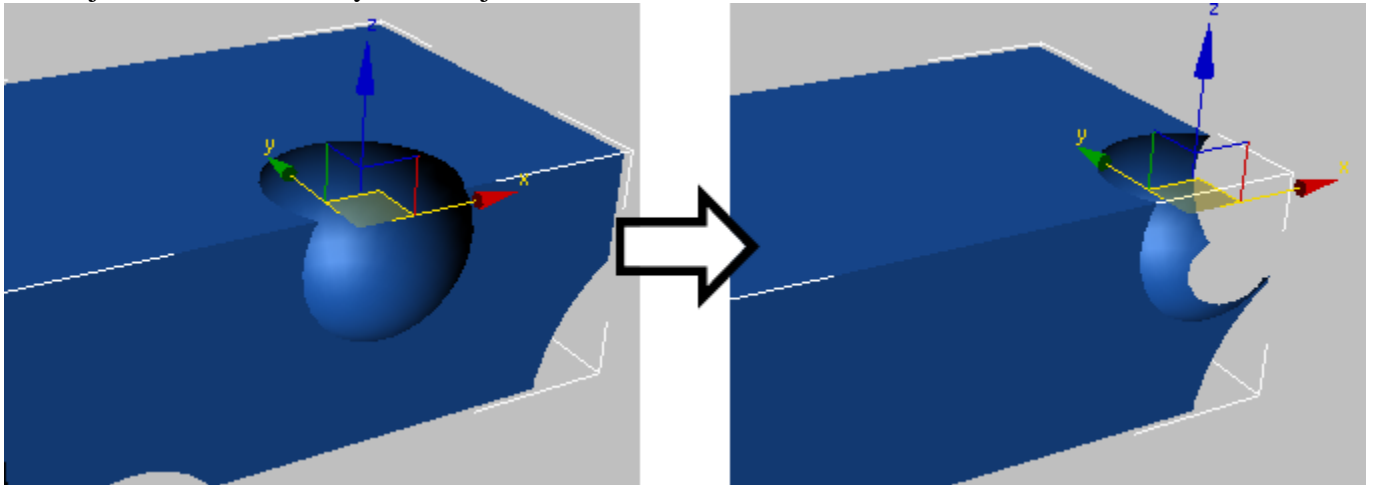




To view the operand, set Parameters rollout > Display to Operands.



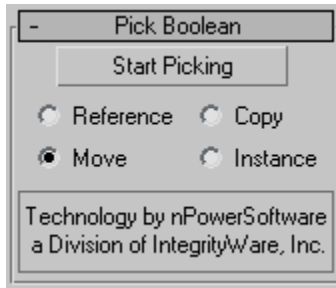
Whether or not the operands are visible, you can transform and animate them at the Operands sub-object level, as with any other object in 3ds Max.



### Changing a ProBoolean object by animating the position of the subtracted operand

You can also transform and animate the base object; that is, the first object in the hierarchy view list.

## Pick Boolean rollout



### Start Picking

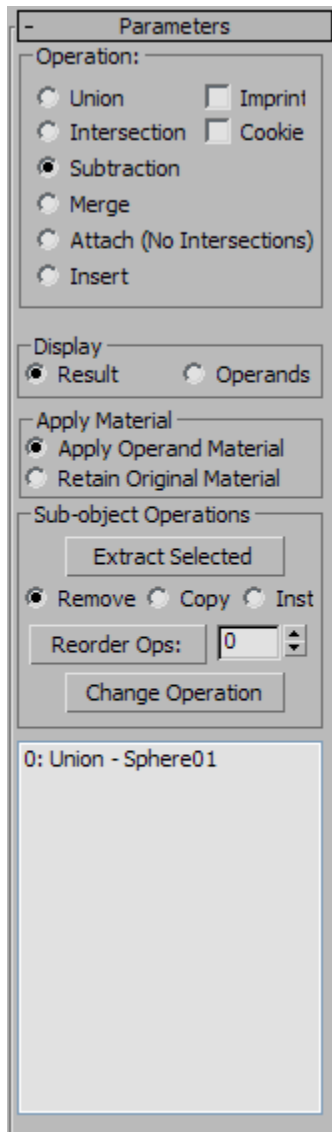
Click this and then click each operand to transfer to the Boolean object in turn. Before picking each operand, you can change the Reference/Copy/Move/Instance choice, the Operation options, and the Apply Material choice.

**Tip** When you're adding many operands to a Boolean object using the default settings, calculating the result each time you pick an object can slow down the process. To maintain optimum feedback, set Parameters rollout ► Display to Operands. Then, when you're finished, set it back to Result. Alternatively, on the Advanced Options rollout set Update to Manually, and then click the Update button to view the results after performing the Boolean operations.

Choose a radio button to specify how the next operand you pick is transferred to the Boolean object:

- **Reference** The Boolean operation uses a reference to the picked operand, so the object remains after being incorporated into the Boolean object. Future modifications to the originally picked object will also modify the Boolean operation. Use Reference to synchronize modifier-induced changes to the original operand with the new operand, but not vice-versa.
- **Copy** The Boolean operation uses a copy of the picked operand. The selected object is unaffected by the Boolean operation, but a copy of it participates in the Boolean operation.
- **Move** The picked operand becomes part of the Boolean operation and is no longer available as a separate object in the scene. This is the default choice.
- **Instance** The Boolean operation makes an instance of the selected object. Future modifications of the selected object will also modify the instanced object participating in the Boolean operation and vice-versa.

## Parameters rollout



### Operation group:

These settings determine how the Boolean operands interact physically.

### Union

Combines two or more separate entities into a single Boolean object.

### Intersection

Creates a "new" object from the physical intersection between the original objects; the non-intersecting volumes are removed.

### Subtraction

Removes the volume of a selected object from the original object.

### Merge

Combines objects into a single object without removing any geometry. New edges are created where the objects intersect.

### Update group:

These options determine when updates are performed on the Boolean object after you make changes. Choose one of the following:

- **Always** Updates occur as soon as you make changes to the Boolean object.
- **Manually** Updates occur only when you click the Update button.
- **When Selected** Updates occur whenever the Boolean object is selected.
- **When Rendering** Updates are applied to the Boolean object only at render time, or when you click Update.

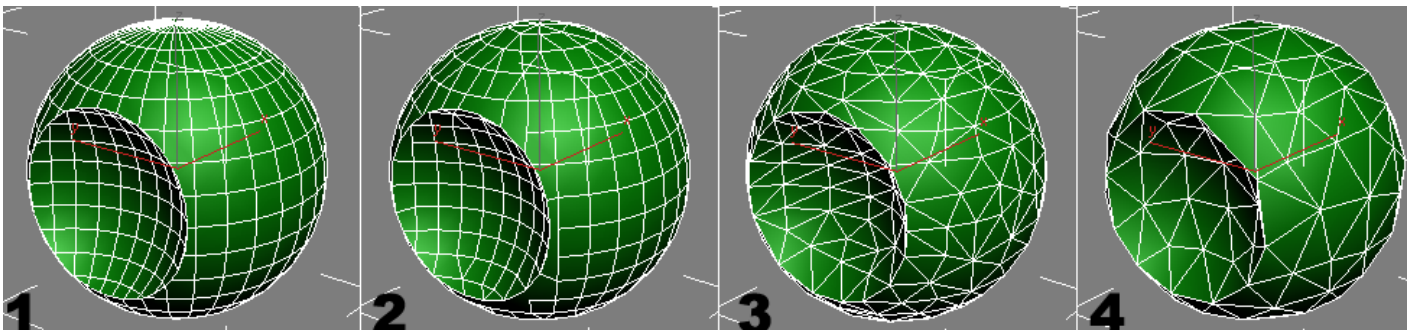
### Update

Applies changes to the Boolean object. Available with all options except Always.

**Note** When you first create a ProBoolean object with Manually or When Rendering active, no operands, including the base object, are visible until you update at least once. Thereafter, the base object is visible, but no subsequently picked operands are until you update again.

### Decimation %

The percentage of edges to remove from the polygons in the Boolean object, thus reducing the number of polygons. For example, a Decimation % setting of 20.0 removes 20 percent of the polygon edges.



1. Decimation %=0.0

2. Decimation %=30.0

3. Decimation %=60.0

4. Decimation %=80.0