5.8.4.3 Modeling - Modifiers - Generate - Boolean Modifier
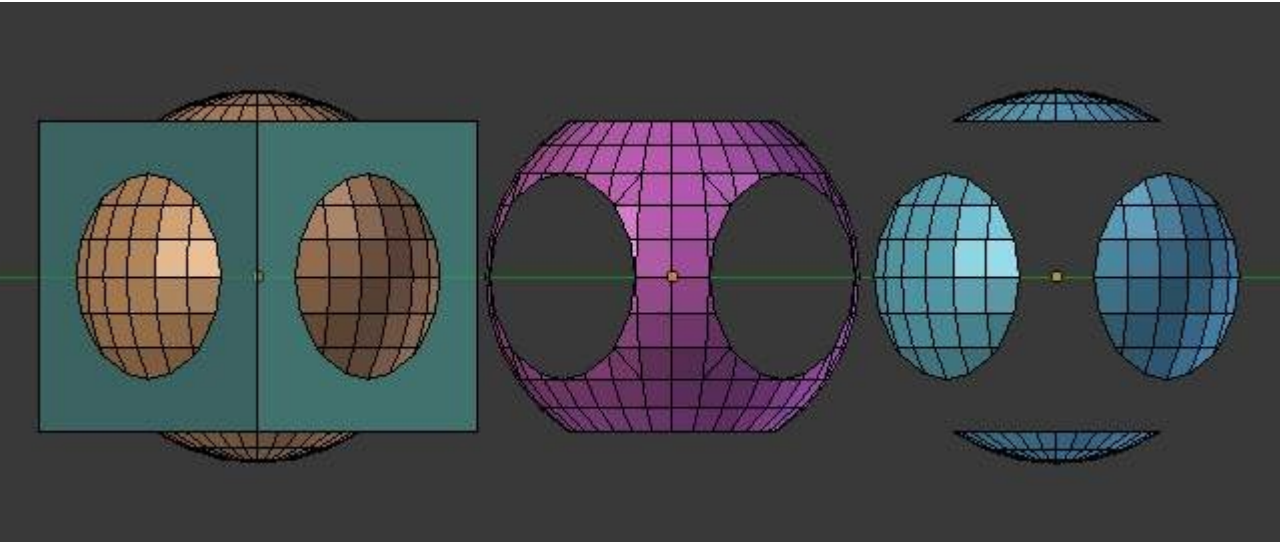
Boolean Modifier

Introduction

The Boolean modifier performs operations on meshes that are otherwise too complex to achieve with as few steps by editing meshes manually, meaning you can achieve results with little effort to make mesh operations like Unions, Differences and Intersections.

The Boolean modifier uses one of three Boolean operations (*Difference* (negation), *Union* (conjunction), and *Intersect* (disjunction)) to create a single compound object out of two mesh objects.

The Union, Intersection and Difference between a Cube and a UV Sphere, with the modifier applied to the Sphere and using the cube as target.

Description

The Boolean modifier can only be used on mesh objects.

It performs one of the three Boolean Operations for the faces of open or closed volumes that creates a complete topology in the faces it's being used. This means that this modifier will only work properly for the intersection of faces of the two meshes that will result in another closed loop of edges (filled with faces), creating a new resulting face topology.

The Boolean modifier is non-destructive for the target; it uses the topology of the target to make the calculations, but you will still have the target in the scene. In normal conditions, using face normals pointed outside, when you apply the Boolean modifier operation, the modified mesh will receive changes in topology, and you will have to move or hide the target to see the resulting mesh. The only exception is when you are using inverted normals; in this case, depending on the calculations, you will also change the topology of the target. You can see one example of a target being modified in the Materials section in this page.

The results of the mesh operation will only be shown in Object Mode of the 3D View.

Note

- The Boolean modifier works with open and closed volumes.
- The Boolean modifier doesn't work on edges without faces.
- The target topology determines the new topology of the modified mesh.
- The face normals are taken into account for the calculations.
- Whether faces are marked for smooth or flat for shading doesn't affect the calculations of this modifier.
- The line at which this modifier is calculated is delimited by the first tangential contact between faces of the modified mesh and target.

Tip

This is a dynamic real-time modifier!

If you have marked your Objects to show the Edges (in Properties Window, Object context, Display panel, enable *Wire*), you will see the Edge creation process while you're moving your Objects. Depending on your mesh topology, you can also enable X-Ray and Transparency and see the topology being created in real time.


Usage

Using the default Blender install, with the desired mesh Object selected, go to the *Properties Window* which is located at the right of your Blender Screen, below the Outliner. Click on the Modifiers Context, which is represented by a wrench - The Boolean modifier. Then, click on the *Add Modifier* Button and Blender will show you a list of all of the available Modifiers. The Boolean modifier is located on the third row in the *Generate* Column.

You can also click on the *Add Modifier* Button and use N to add the Boolean modifier, or use Blender search with the shortcut Spacebar and type "Add Modifier", click on *Add Modifier* and press N.

When you add the Boolean modifier for an Object, Blender will need a second Object to perform the operation. You can use open or closed Meshes, as long as they have faces for calculations.

You can add one or more modifiers of this type for an Object but you can only apply one operation for the Boolean modifier at a time.

Options
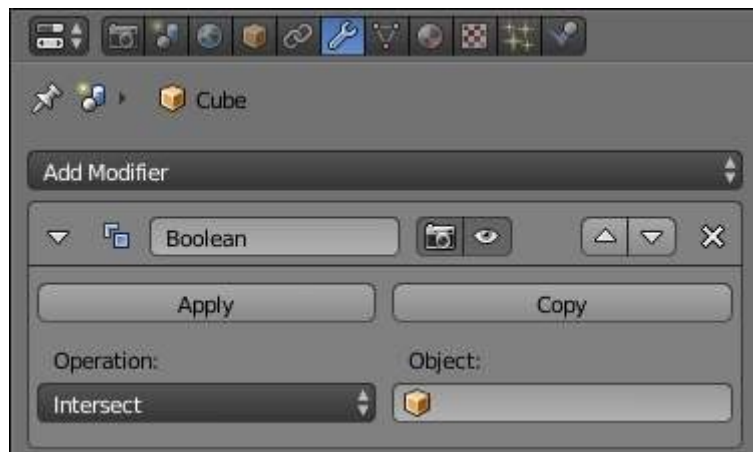
Boolean Modifier Options

Operations

Operation

Which boolean operation will be used.

Difference

The modified mesh is subtracted from the target mesh.

- If the target Mesh has inverted normals, Blender will Intersect the modified mesh.
- If the modified Mesh has inverted normals, Blender will add both meshes (Union).
- If both Meshes use inverted normals, Blender will Intersect the target Mesh.

Union

The target mesh is added to the modified mesh.

- If the target Mesh has inverted normals, Blender will Intersect the target Mesh.
- If the modified Mesh has inverted normals, Blender will subtract the target Mesh.
- If both Meshes use inverted normals, Blender will Intersect the modified Mesh.

Intersect

The target mesh is subtracted from the modified mesh.

- If the target Mesh has inverted normals, Blender will subtract the target Mesh.
- If the modified Mesh has inverted normals, Blender will intersect the target Mesh.
- If both Meshes use inverted normals, Blender will add both meshes (Union).
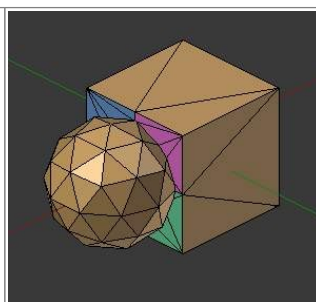
Object

The name of the target mesh object.

Materials

The Boolean modifier preserves the Materials of the participant Meshes, including their basic textures and mappings, and the modified mesh will receive its first active material index assigned to its new topology (the first active material).
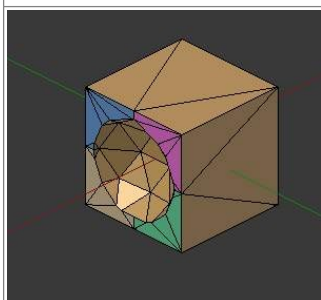
Below, some examples are shown to exemplify how materials work with the Boolean modifier; we took the cube as the modified mesh, and the icosphere as the target with one material (white). We added four different indexes to one of the faces of the cube, leaving another basic material in the other faces. The top left image shows how the Boolean modifier interacts with the materials. The other three images show the three different Boolean operations applied to the modified mesh. In all the images the meshes have normals pointed outwards with the Icosphere as the target, and the Cube being the modified mesh.
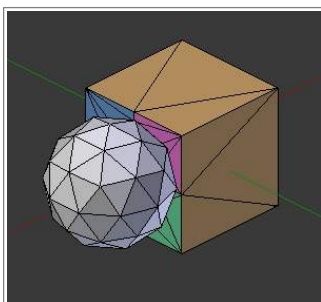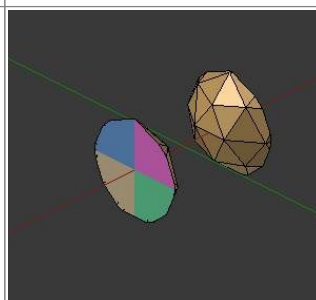
|	
Cube with Multi-Materials and Icosphere with basic Material	Union: The first active Material of the Cube is added to the new topology
Difference: The Icosphere was subtracted from the Cube	Intersect: The resulting Mesh was copied and rotated 180

The only exception is the difference operation when the normals of the target and modified mesh are inverted. In this case, Blender will project the textures in an inverted direction over the target using the center contact of the meshes as a pivot and the resulting mesh will have the modified mesh subtracted from the target. For complex target meshes in some particular cases, you may have to reassign materials to faces because Blender will use the possible projection, and this may result in a sub-optimal texture assignment. You can see this in the last example below.
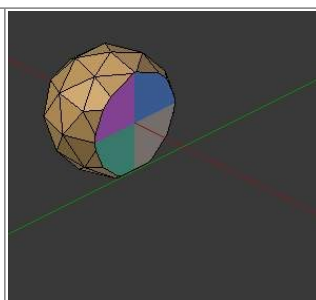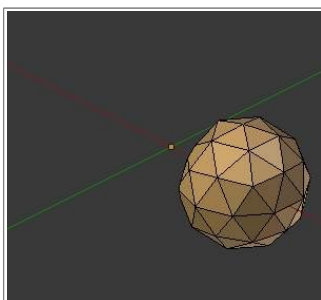
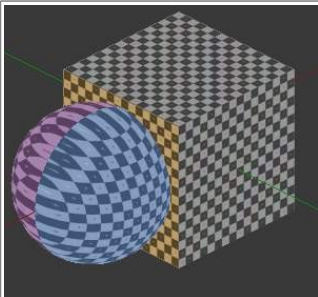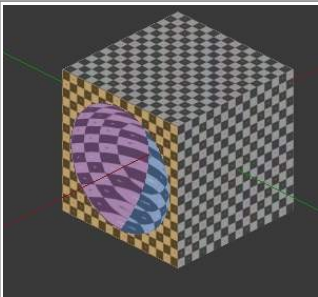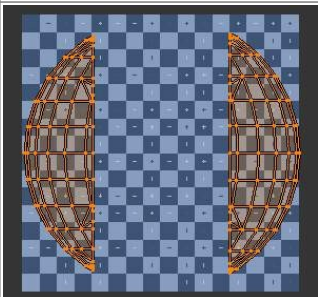| Front of the target with the modified mesh materials	Back of the target with the modified mesh materials

UV Mappings

When you map UV Images to your target, Blender will add a map for each of the faces of the target. When you apply the Boolean modifier, Blender will follow the UV maps already assigned to the faces of the target topology that will be the result of the operation on the modified mesh. Blender will also use the same image mapped to the target faces in the modified mesh.

<table>
<tr><td style="background-color:#F5A623">Warning</td></tr>
<tr><td>Depending on the way you have assigned textures to the faces during the UV unwrap, and the complexity of your meshes, the boolean operation may generate imperfect UVs for the new faces.</td></tr>
</table>

Below we have four Images, a UV sphere mapped with a test grid tinted blue and the other face tinted in purple, one face of the cube tinted in a light orange and the other faces using the normal test grid. The firat image shows the operation at the start (difference), and on to the right of that shows the resulting mesh. And in the bottom row we show the unwrap in the Blender UV/Image Editor Window.

A UV Sphere and a Cube with different UV Maps	Difference operation applied
Faces of the modified mesh mapped	New topology mapped and UV faces assigned

Other Modifiers

The Boolean modifier calculation is performed using the target modified mesh topology and dimensions. Other modifiers added to the modified mesh are bypassed. It means that if a target is using another modifier, like subsurf, the resulting topology for the modified mesh will take into account the subsurf of the target; but for the modified mesh, the basic topology is used anyway (see examples).

If you add subsurf to the modified mesh with a Boolean modifier, Blender will visually add the subsurf for the modified mesh, but not for its calculations; it will only take into account its basic mesh topology. If you want to have a subsurf added to the modified mesh, you have to apply the subsurf to the Boolean modified mesh before

applying the Boolean operation.

The Boolean modifier can be added together with other modifiers in the modified mesh, but depending on the modifier, the calculations can't be done and/or the modifier cannot execute. When the modifier cannot execute, it will show the message `"Cannot execute boolean operation"`, and when the modifier cannot be applied to the mesh, Blender will show the message `"Modifier is disabled, Skipping Apply."`. In this case, you either have to remove some modifiers or apply the necessary ones.


Boolean Modifier with error message

The most common case is when you add or copy a Boolean modifier to use the modified mesh in conjunction with another target later; Blender will place the warning in the subsequent Boolean modifiers in the stack depending on the operation, because you may be creating concurrent Boolean operations for the same modified mesh, which in most cases is impossible to execute depending on the chosen target. In this case, you can apply the first Boolean modifier of the stack for the target and then use the other Boolean modifier(s) in the stack for subsequent operations.

Also, if some other modifiers are placed above this modifier and you click on Apply, Blender will warn you with the message `"Applied Modifier was not first, results may not be as expected"`. The best usage scenario for this modifier is to prepare your modified mesh and target to work with the Boolean modifier.

When the Boolean modifier is the first of the stack and is applied, the other Modifiers will act over the resulting meshes using the resulting topology and will remain in the modifiers stack.

Below are two images: one with the subsurf added to the target, and another with the resulting topology.
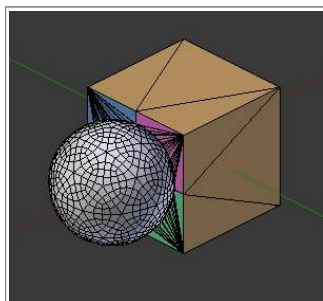
Modifier with Subsurf Target
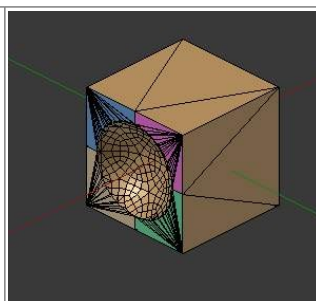
The Resulting Topology

As you can see, the added (not applied) subsurf to the target was taken into consideration. The topology of the Icosphere with subsurf (Level 2) was completely transferred to the modified mesh.

Tip

The target topology determines the resulting topology

The target topology determines the results of the Boolean modifier operation. It means that any modifier added to the target which modifies its topology will affect the resulting mesh of the operation.

Concurrent Operations

For the modified meshes, you can only apply one operation at a time, but you can use the same target for other modified meshes and use modified meshes as a target for other meshes as well. Also, you can copy or add the same modifier to the modifiers stack as many times as you wish to suit the number of operations you need, but be aware that if you choose concurrent targets which are, at the same time, modified meshes pointing to each other, you can cause Blender to crash with closed loops!

Hints

Be aware that other modifiers and their stack position could cause this modifier to fail in certain circumstances.

| Tip |
| --- |
| The best way to work with this modifier when you need to make lots of sequential operations of the same modifier is to define the target at the time you need to apply the changes to the topology. |

Face Normals

When using the Boolean modifier, Blender will use the face normal directions to calculate the three Boolean operations. The direction of the normals will define the result of the three available operations. When one of the participants has inverted normals, you're in fact multiplying the operation by -1 and inverting the calculation order. You can, at any time, select your modified mesh, enter Edit Mode and flip the normals to change the behavior of the Boolean modifier. See *Tips for Fixing Mixed Normals* below.

Blender also cannot perform any optimal Boolean operation when one or more of the mesh Normals of the participants that are touching has outwards/inwards normals mixed.

This means you can use the normals of the meshes pointed completely towards the inside or outside of your participants in the operation, but you cannot mix normals pointed inwards and outwards for the faces of the topology used for calculations. In this case, Blender will enable the modifier and you may apply the modifier, but with bad to no effects. We made some examples with a cube and an icosphere showing the results.

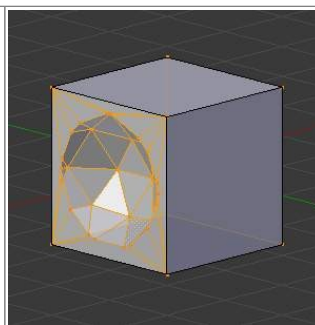In the images below, all face normals are pointing outwards (Normal meshes).
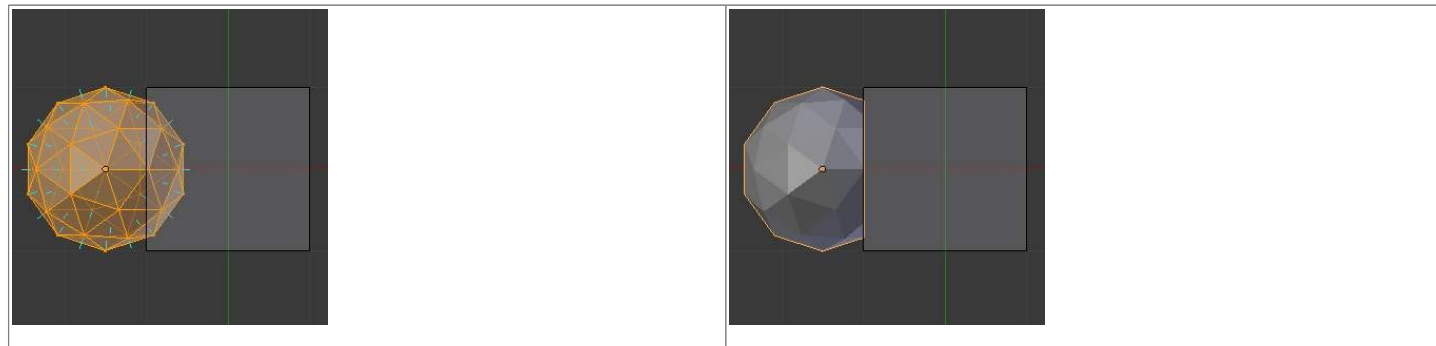
Faces with normals pointing outwards	Normal Boolean modifier operation (Difference operation)

In the images below, all face normals are inverted and using the intersection operation
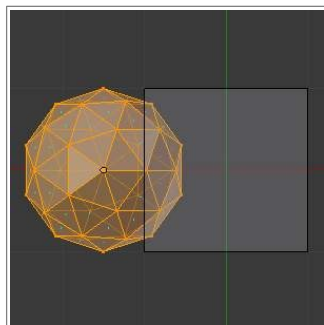
|	
Boolean Operation with inverted normals	Normal Boolean modifier operation

Now, let's see what happens when the normal directions are mixed for one of the participants in the Boolean modifier operation. The images below show face normals mixed, pointed to different directions and the resulting operation, you can see that the modifier has bad effects when applied, leaving faces opened:
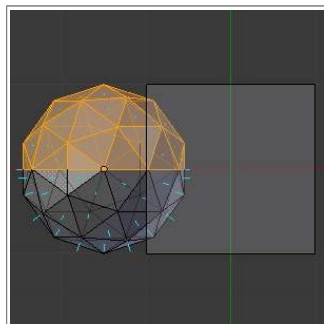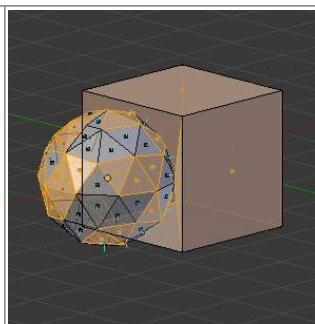
Face normals mixed, pointed to different directions	Resulting operation leaves faces opened

As you can see, the normal directions can be pointing to any of the Mesh sides, but can't be mixed in opposite directions for the faces of the participants. The Library can't determine properly what's positive and negative for the operation, so the results will be bad or you will have no effect when using the Boolean modifier operation.

A quick way to fix this is to use Blender's *Recalculate Normals* operation in Edit Mode.

If you still have some ugly black gouges you will have to *Manually Flip the Normals*.
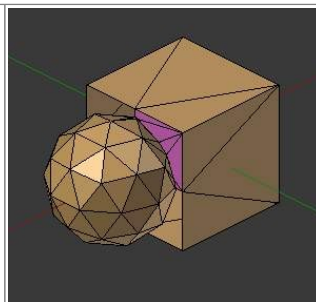
Empty or Duplicated Faces

This modifier doesn't work when the modified and/or the target mesh uses empty faces in the topology used for calculations. If the modifier faces a situation where you have empty faces mixed with normal faces, the modifier will try, as much as possible, to connect the faces and apply the operation. For situations where you have two concurrent faces at the same position, the modifier will operate on the target mesh using both faces, but the resulting normals will get messed. To avoid duplicated faces, you can remove doubles for the vertices before recalculating the normals outside or inside. The button for remove doubles is located in the *Mesh Tools* Panel in the 3D View, while in Edit Mode.

The best usage scenario for this modifier is when you have clean meshes with faces pointing clearly to a direction (inwards/outwards)

Below we show an example of meshes with open faces mixed with normal faces being used to create a new topology. In this example, a difference between the cube and the icosphere is applied, but Blender connected a copy of the icosphere to the Cube mesh, trying to apply what was possible.
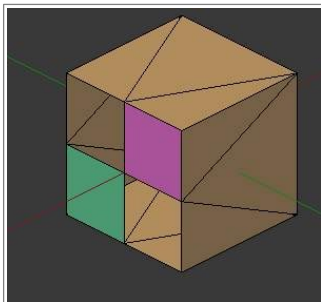
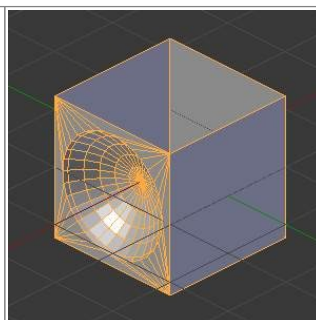| Mesh with two empty faces mixed with normal faces | Result of a difference operation applied |

Open Volumes

The Boolean Modifier permits you to use open meshes or non-closed volumes (not open faces).

When using open meshes or non-closed volumes, the Boolean modifier won't perform any operation in faces that don't create a new topology filled with faces using the faces of the target.

In the images below, is the resulting operation when using two non-closed volumes with faces forming a new topology.
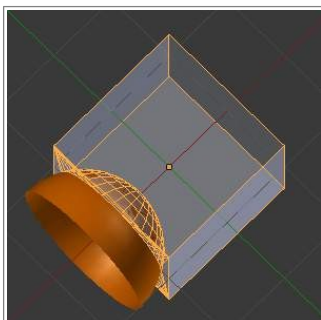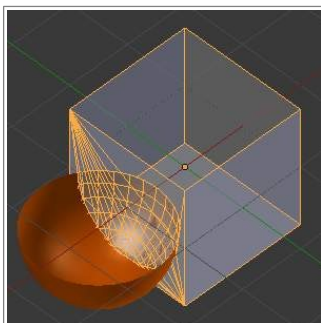

| Non-closed volumes forming a new topology | Resulting operation using two open volumes |

Now, let's see what happens when we use meshes that are partially open, incomplete, or meshes that aren't forming a new topology.

As you can see in the images below the faces of one participant in the Boolean operation gives incomplete information to the modifier. The resulting edges get messy and there is not enough information to create faces for the resulting Mesh. This example uses a smooth shaded UVsphere cut in half. As explained before, the shading (smooth/flat) doesn't affect the calculations of the modifier.

Open volumes that aren't forming a new topology
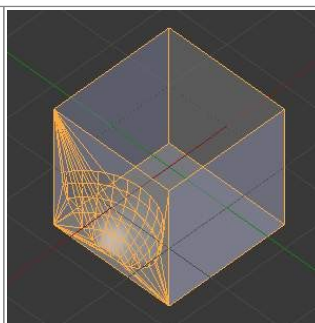
Resulting Operation of image on the left