

SIMULATION WITH BOOLEAN SUBTRACTION

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Abstract

Boolean subtraction operations are the most widely used in modeling. Most often, they are used to create rounds and grooves on the first of the original objects, as well as grooves and through holes in it, and therefore the second object can be conventionally considered a kind of chisel or cutter that creates a groove on the first object or selects some part of it. A wide variety of objects can be used as "cutting tools", in particular objects obtained from curved splines by lofting or rotating.

Keywords:

Modeling, conventionally, objects, cutting tools.

Introduction

In the first step, we will use a Boolean subtraction operation to form a cylindrical hole inside the ball. Create initial objects in the form of a ball and a cylinder (the radius of the section of the cylinder must be less than the radius of the ball, and its length must be greater than the radius of the ball) and align them in relation to each other along the X, Y and Z axes, applying the **Align** operation(Align) (fig. 9). Render and immediately adjust the parameters of the objects so that they are sufficiently smooth, especially in the area of intersection; if this is not done, then the created Boolean object will also not have the proper smoothness. In this case, it can be seen (Fig. 10) that the degree of smoothness needs to be increased - this is achieved by increasing the density of objects: increasing the number of segments and sides of segments and decreasing the size of the segments (Fig. 11). At the same time, when working with complex models, to speed up the modeling process,

in some cases it is better to increase the density of objects used as operands, not before creating a Boolean operation, but after - during the editing of operands at the object level.

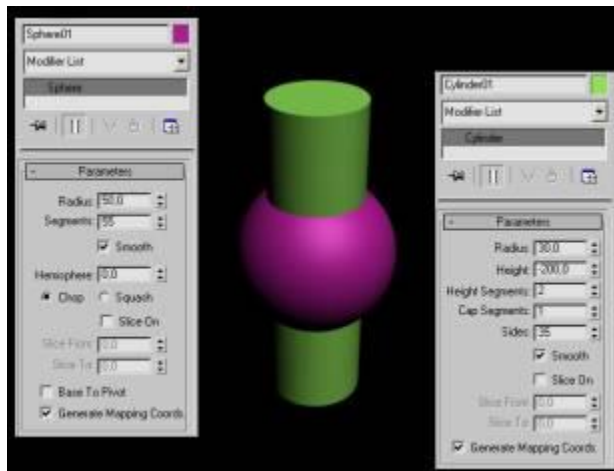
Rice. 9. Ball and cylinder



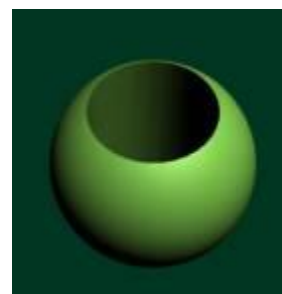
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Rice. 10. Rendering original objects

*Highlight cylinder, set the mode to create Boolean objects, set operation **Subtraction (BA)** (Subtract BA), to specify the operand **B**, click **Pick Operand, B** (Select operand **B**) and specify the scope. This will remove the inner part of the sphere exactly the size of the original cylinder so that a through hole appears in the sphere (Fig. 12).*



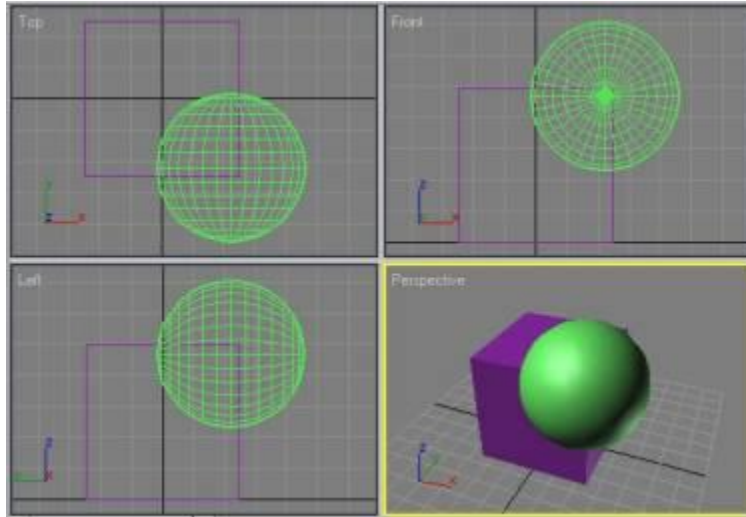
Rice. 11. Rendering objects and their parameters after smoothness adjustment



Rice. 12. Sphere with a hole

Holes formed using Boolean subtraction can have very different shapes, and the result depends not only on the size and shape of objects, but also on their position in relation to each other, as well as on which of the objects was specified first. Take a cube and a ball as initial objects and place them as shown in fig. 13 way. Select the cube, set the **Subtraction (AB)** operation in the mode of creating boolean objects and specify the sphere as the **B** operand - the result will be the appearance of the corresponding indentation in it (Fig. 14), and then save the result (we will need it later). Cancel the created Boolean operation and apply Boolean **Subtraction (AB)** to the original objects, but specify a sphere as the first

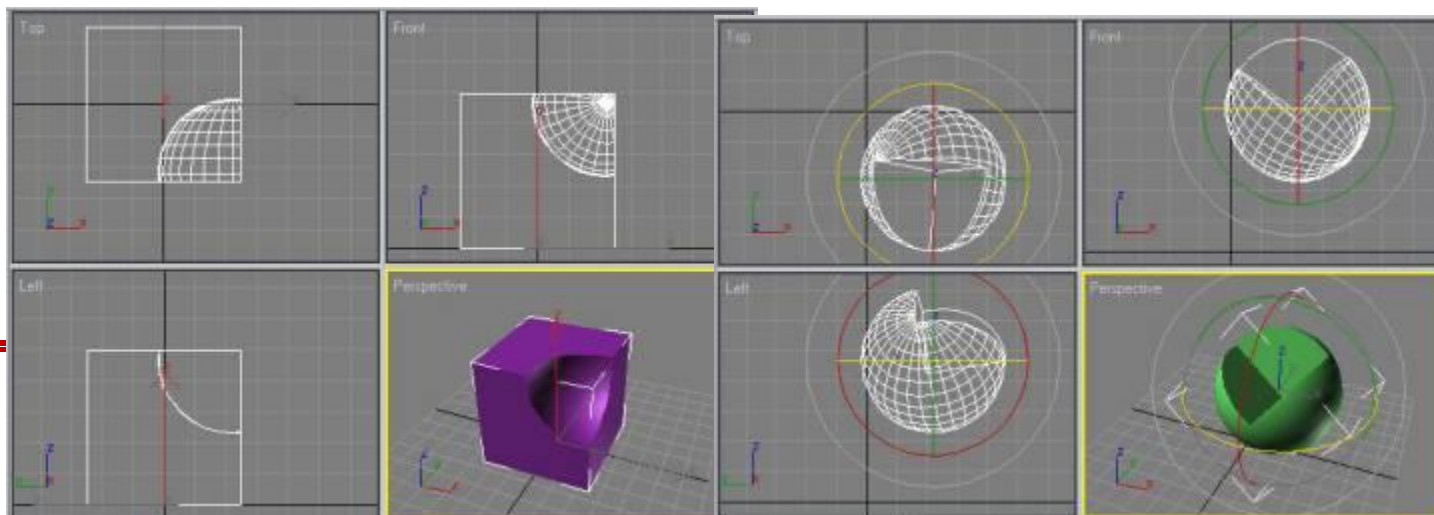
operand - and instead of a cube with a deepening, the result of the operation will be a ball, in which one of its quarters is cut out, as it were (Fig. 15). It is worth noting that to obtain the same result it was not at all necessary to swap the operands: with the same success it was possible to choose the **Subtraction (BA)** operation instead of the **Subtraction (AB)** operation . A similar



The interchange of the **Subtraction (AB)** and **Subtraction (BA)** operations is very convenient, since if the operand **A** is selected incorrectly, it is not necessary to cancel the operation, but it is enough just to switch from one subtraction operation to another.

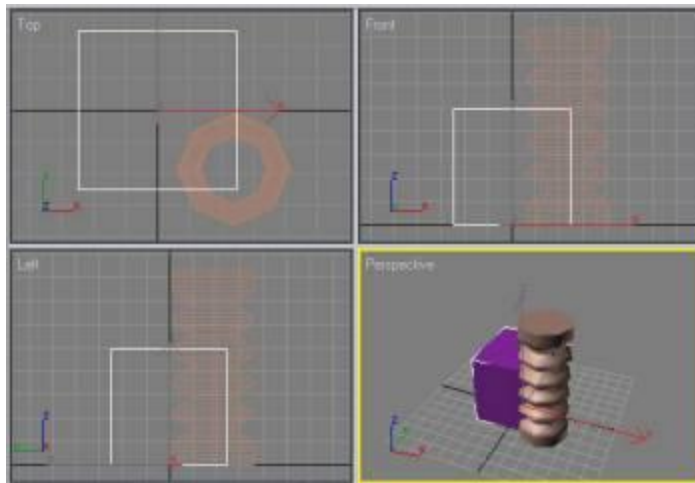
Rice. 13. Cube and ball

Rice. 14. Deepening in a cube

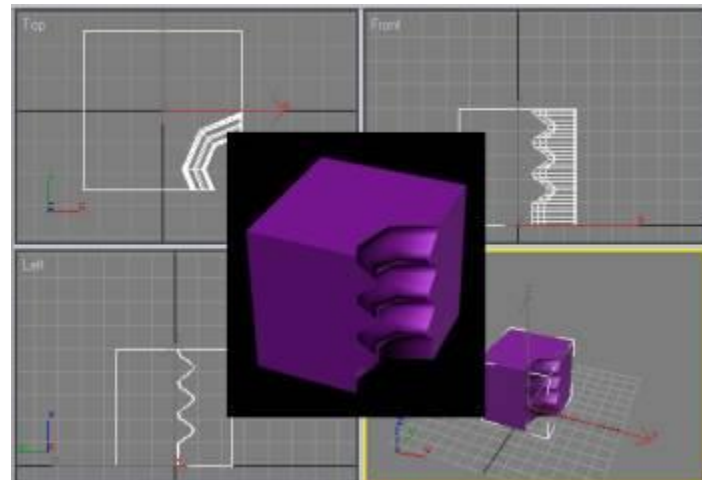


Rice. 15. Removing a fragment of the ball

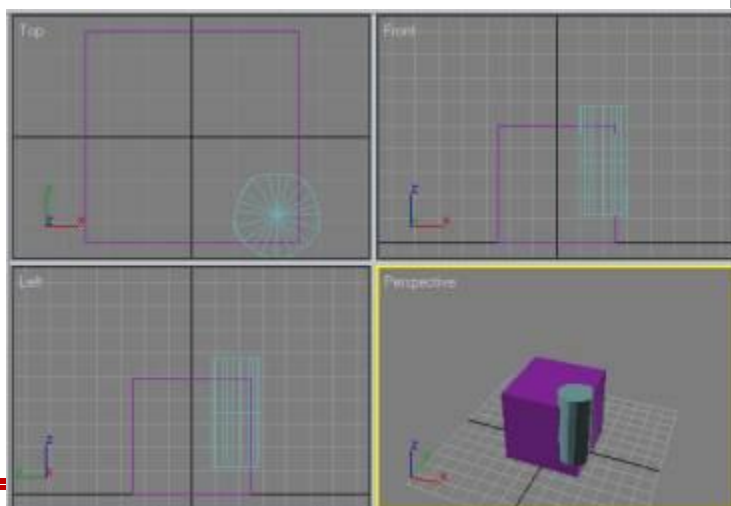
As noted, the shape of the resulting cut is determined by the second operand. Try creating notches and depressions with other objects instead of a ball. For example, using the **Hose** object (Figure 16) can create a threaded recess (Figure 17). If we take as an operand **B** faceted prism **Gengon** (. Figure 18), the recess would be multifaceted (Fig. 19), while using the spindle **Spindle** - bevelled (Figure 20 and 21.), Etc.



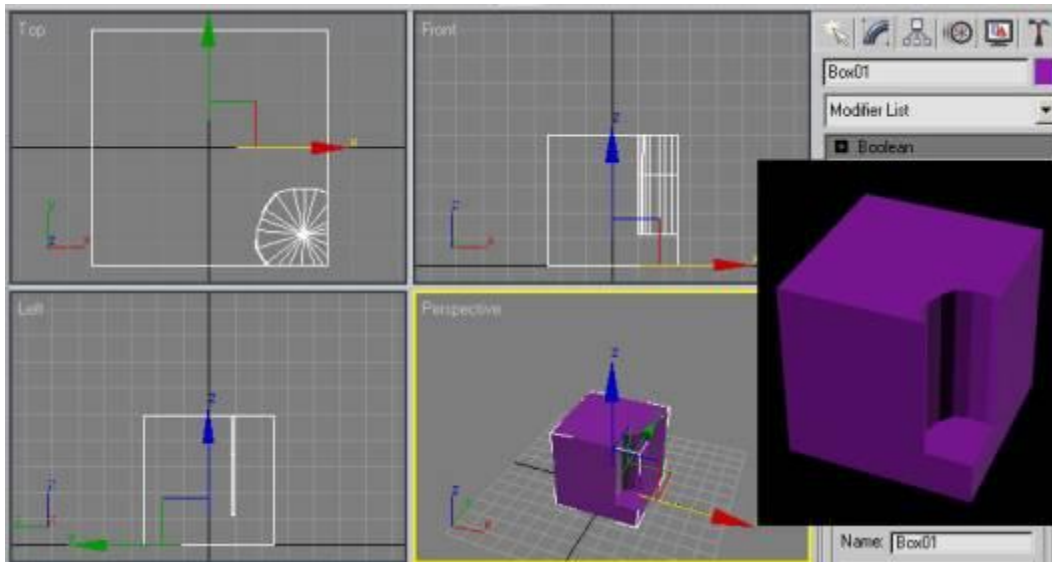
Rice. 16. Original objects



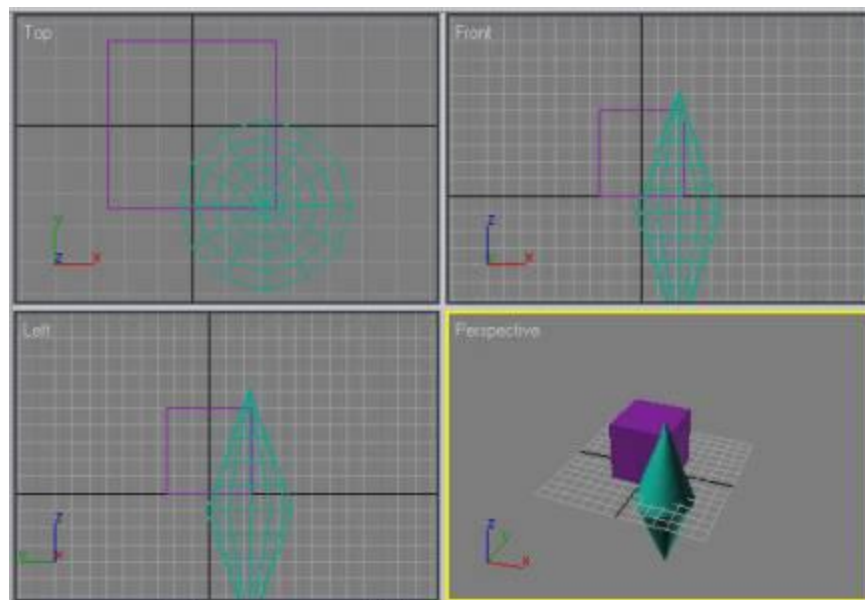
Rice. 17. Cube with a threaded recess



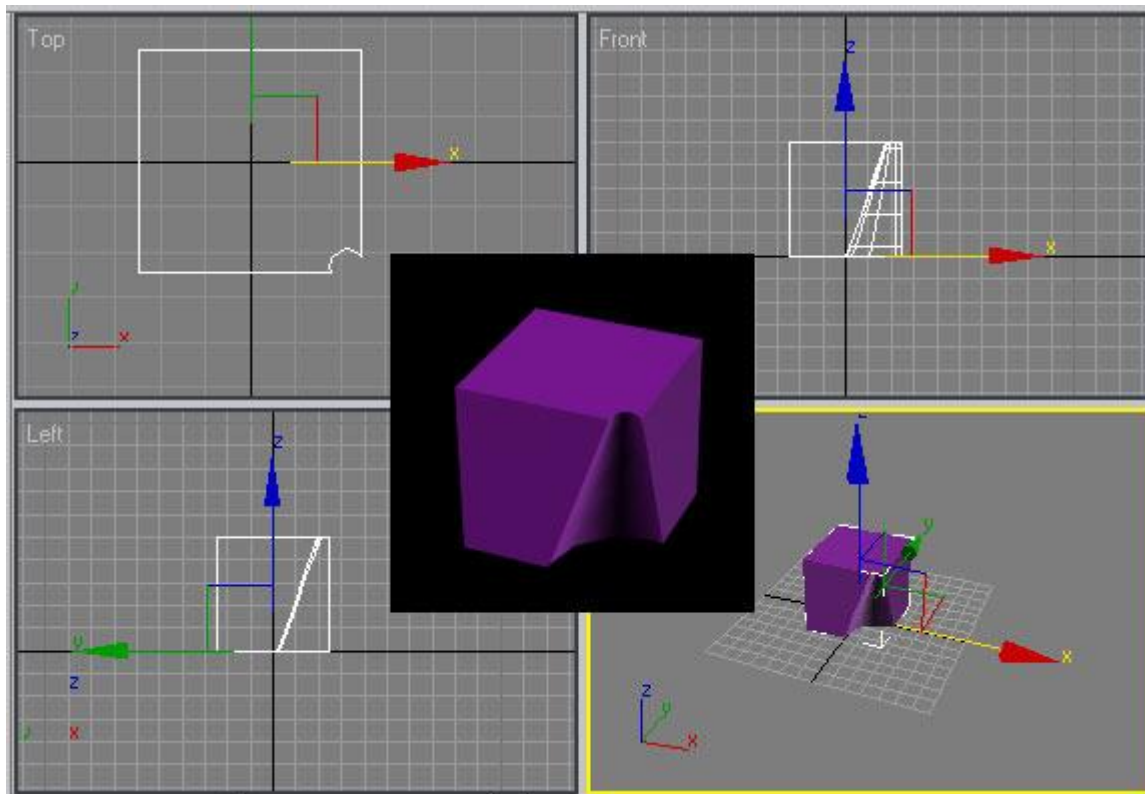
Rice. 18. Cube and hose



Rice. 19. Cube with faceted recess



Rice. 20. Cube and spindle



Rice. 21. Cube with beveled notch

The Boolean operation **Intersection** is the inverse of the Boolean operations **Subtraction (AB)** / **Subtraction (BA)**, since the Boolean objects obtained with it are fragments of the operands A and B, which are removed by a Boolean subtraction if it is performed on the same objects. Take the cube and ball discussed above as the initial ones, select the cube as operand **A**, and then perform the Boolean operation **Intersection** (Intersection) - the result will be a quarter of the ball, which was previously cut out during the **Subtraction (BA)** operation (Fig. 22).

Rice. 22. Initial Objects and Boolean Objects in Intersection and Subtraction Operations (BA)

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