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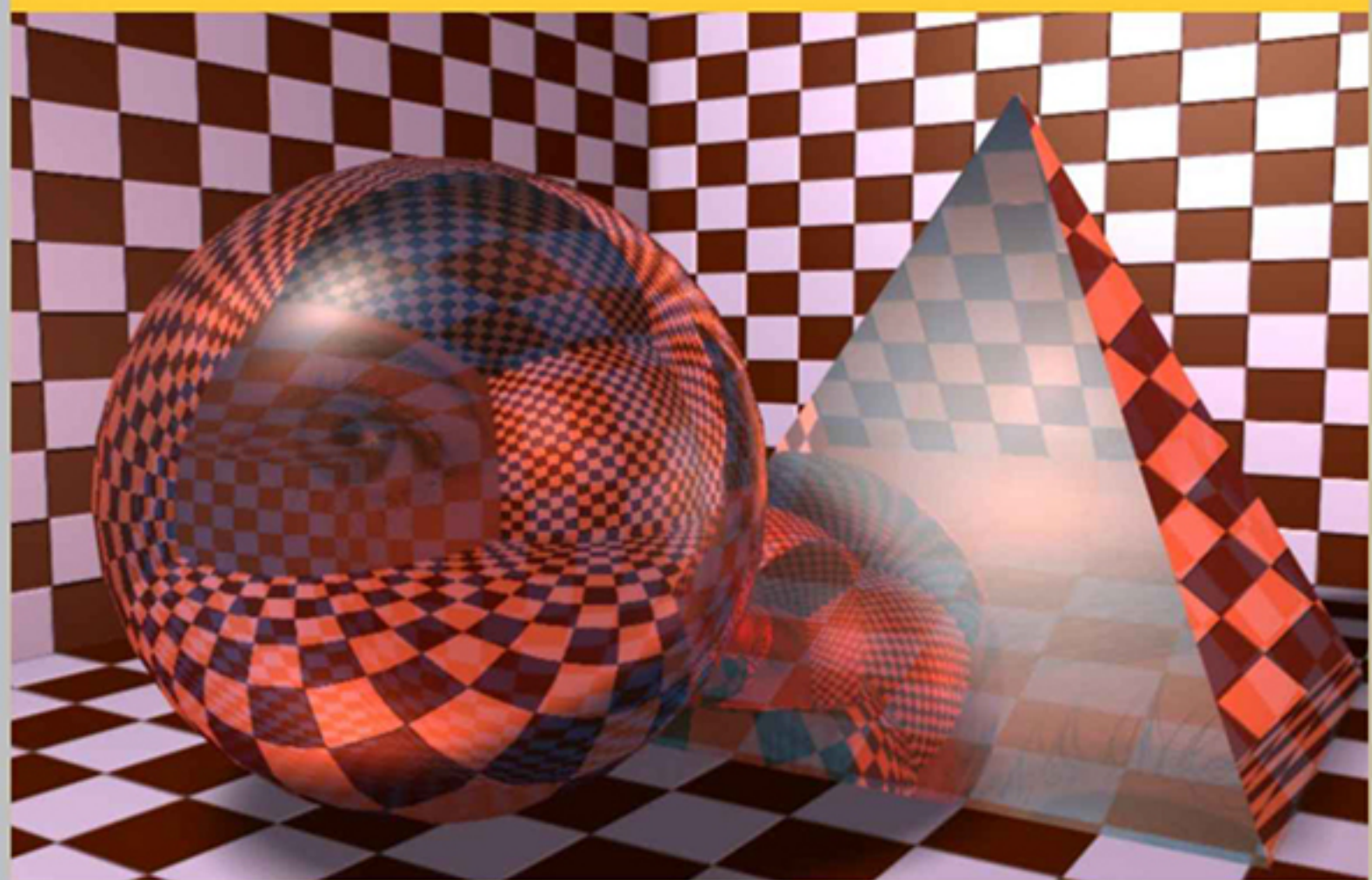
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# A Fascinating Journey into the World of 3D Graphics with 3ds Max

**IFTIKHAR ABBASOV**



# **A Fascinating Journey into the World of 3D Graphics with 3ds Max**

**Iftikhar B. Abbasov**

*Training Manual*

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## INTRODUCTION

Today it is difficult to imagine the development of three-dimensional scenes, interactive games, and realistic effects in the film industry without the use of modern computer simulation technologies. The designer work, which should not only create realistic scenes but also pay attention its artistic qualities, becomes indispensable. This book covers learning of modeling tool for three-dimensional computer scenes.

3ds Max graphic system is developed by Autodesk Company (USA) and is designed for modeling of three-dimensional scenes and animation. The first versions of this program emerged about twenty five years ago and the program has become almost the most popular modeling tool for both beginners and professional designers since that time.

3ds Max 2018 recent version, described in the manual, is the result of its evolutionary development. 64-bit operating system Windows 8 Professional x64 and higher with a multi-core Intel or AMD processor, at least 4 GB of RAM, a video card with at least 512 MB of memory, and a disk space of about 6 GB are recommended to install 3ds Max 2018 graphics system.

This manual is a revised and enlarged edition of the publication [1,2]. The manual uses the author's long-term experience as a teacher of computer-graphic disciplines. The teaching and methodological material presented in the manual has been successfully tested for 15 years at the Engineering Technological Academy of the Southern Federal University in Taganrog.

This manual is based on the step-by-step acquisition method from the creation of flat forms for further modeling and assignment of materials and installation of lighting to realistic rendering. The learning of commands and tools is carried out with specific exercises with objects of a single scene are modeling in stages. The interior of the bar room is used as a modeling scene. Creative tasks on three-dimensional objects modeling are presented for self-study. The manual also includes control questions and a list of educational and methodological literature.

Following themes are addressed in the training manual:

- Description of the main elements of the 3ds Max 2018 editor window;
- Basics of two-dimensional forms modeling;
- Basic methods of 3D modeling;
- Modeling based on 3D primitives;
- Assigning of materials and textures to 3D objects;
- Lighting sources installation and adjustment;
- Cameras installation and setup.

# 1. INTERFACE OF THE GRAPHIC EDITOR 3DS MAX 2018

After the first start of the graphic editor 3ds Max 2018, the Welcome Screen appears on the screen. With it, you can open recent files and view the training videos that come with 3 ds Max. To disable the display of this window at startup, you must clear the Show this Welcome Screen at startup check box and click the Close button.

The window of the graphical editor (user interface) of the 3ds Max 2018 is shown in Figure 1.1 at the first start.

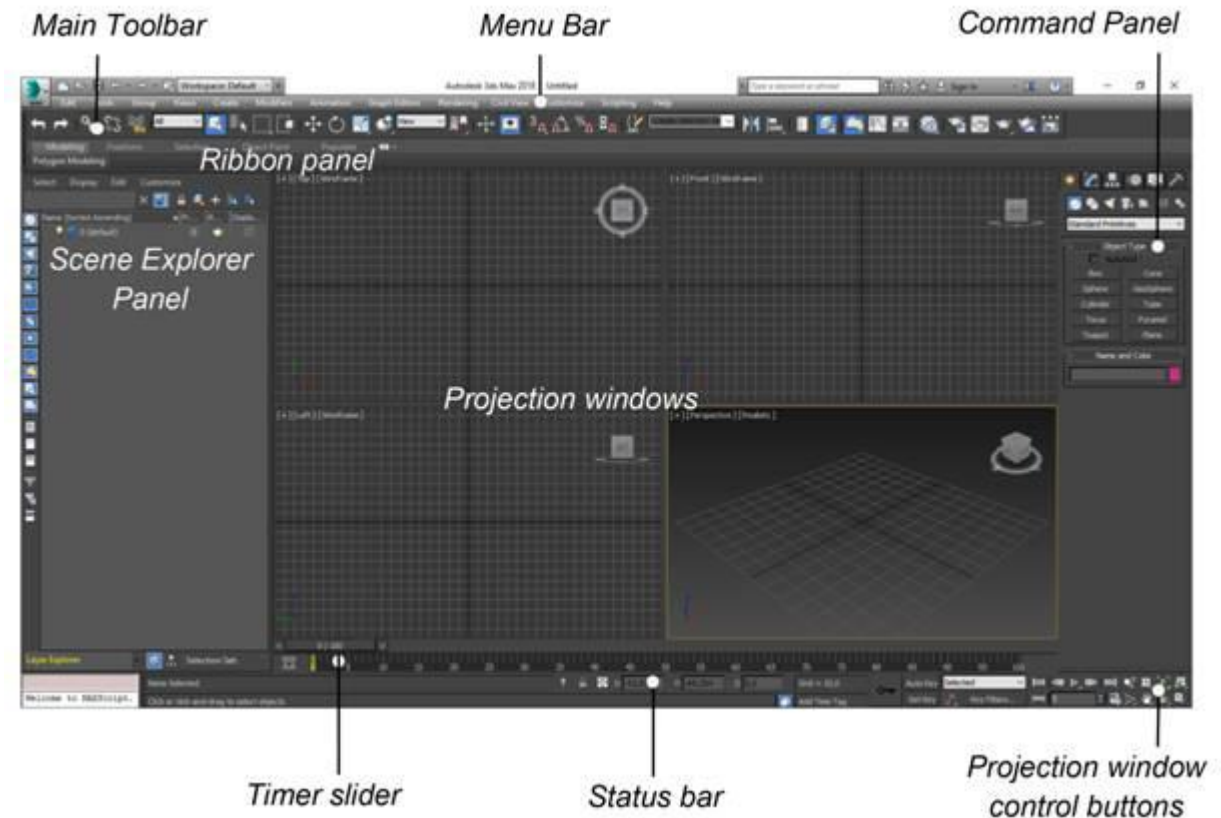


Fig.1.1. Interface of the graphic editor 3ds Max 2018

Below the line with the name of the editor is the menu bar. To select the appropriate menu, click on its name with the left mouse button. The menu contains the majority of commands that provide access to numerous functions of 3ds Max 2018. These submenus will drop down corresponding submenus. Below the menu bar is the Main Toolbar, designed to implement the main functions of the program.

Next is the Ribbon panel for quick access to the necessary commands. On the left side of the main screen is the Scene Explorer panel with the current scene objects. Expanding and hiding these panels is done with the corresponding buttons Toggle Ribbon and Toggle Scene Explorer toolbar.

In the center of the editor window are four projection windows (three of them orthogonal) - Top, Front, Left and Perspective, displaying the kinds of scene.

To the right of the projected windows is the command panel. At the top of the panel are six tabs. Each tab contains expandable panels whose settings and settings depend on the tab type and the selected object.

Under of the projection windows of the slider animation timer and track bar, as well as the status bar with the value of the current coordinates. In the lower right corner of the window are the buttons for controlling the projection windows and navigation.

In the upper right corner of the projection windows is a special View Cube manipulator system (Fig.1.1). Clicking on the face of the cube converts the view to match the view on the selected face, on the edge and the top of the cube changes the view from the side of the selected element, changes the corresponding orientation on the compass symbols. Clicking the icon in the form of a home leads to the default view.

The Views menu has a special Steering Wheel graphical tool that provides quick access to various navigation tools in the projection windows. Calling and hiding the View Cube manipulators and the Steering Wheel graphic menu is carried out by the same commands from the Views menu.

### 1.1. The main elements of the interface

To call and delete the corresponding interface element of the 3ds Max editor, you can use the Customize/Show UI/Show ... command (Fig.1.2, left). If the process seems long, then you can use one more method: move the mouse pointer to the border of the command panel and the toolbar, when the icon appears as a white double rectangle, click the right mouse button and you will get a menu access to the main interface panels (Fig. 1.2, on right).

The menu bar includes the following drop-down menus: File, Edit, Tools, Group, Views, Create, Modifiers, Animation, Graph Editors, Rendering, Lighting Analysis, Customize, MAXScript, Help and Tentacles.

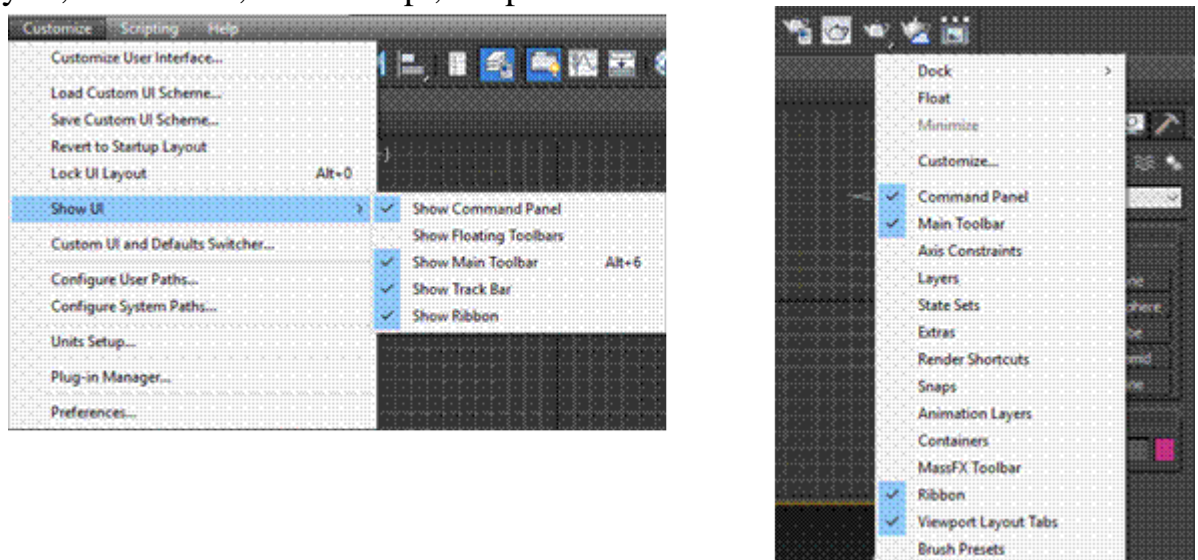


Fig.1.2. Calling the interface panels

The main toolbar provides one of the easiest ways to execute 3ds Max commands, because you only need to click on the corresponding button of the

6. In the modifier stack (in the Modify tab), expand the list of subobjects of the Line object by clicking on the (+) icon and select the sub-object Vertex.
7. The line in the projection window will be represented as two vertices and the segment that connects them. After selecting the Select and Move button on the toolbar, select the second vertex.
8. Next, click on the right mouse button, and then a quadruple menu appears, giving access to the vertex editing commands. The form of the quadruple menu is shown in Fig.1.13. Closing the menu by right clicking again, you can move each vertex of a straight line in any direction.

### **Exercise 1.4. Metamorphoses of the cylinder**

1. Before proceeding to a direct study of the basics of 3D modeling, let's look at a small creative example to illustrate the "modest" opportunities of the 3ds Max graphics system.
2. Let's choose a cylinder for our example as a three-dimensional primitive. The Cylinder button is located in the Geometry section of the Create tab of the command panel. Let's see what you can create from such a three-dimensional primitive.
3. Construct a cylinder with proportions, as in Fig.1.14, on the left. To convert a cylinder into a sleeve it is necessary to apply the Taper modifier from the list of the Modify tab of the command panel (Fig.1.14, right).

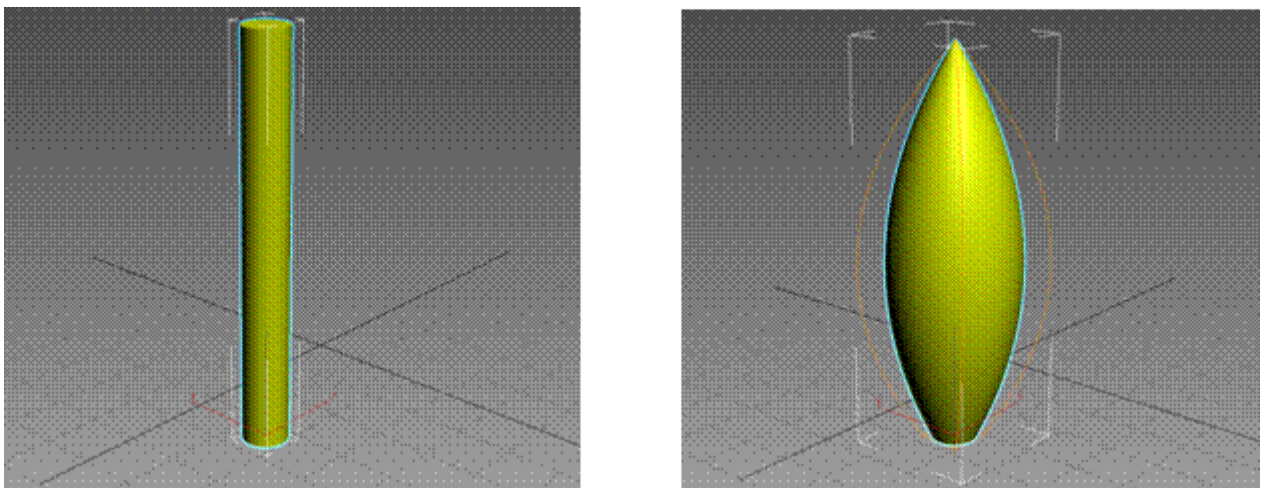


Fig.1.14. Building a cylinder and using the Taper command

4. To convert the cylinder to the objects shown in Figure 1.15, you must use the Bend modifier. Here two variants of bending with the same parameters are given, but on different axes - Z and X. Having the skills of three-dimensional shaping, it is not difficult to create one or another object, it is enough to change the axis or plane of transformation and you will get a completely new object.

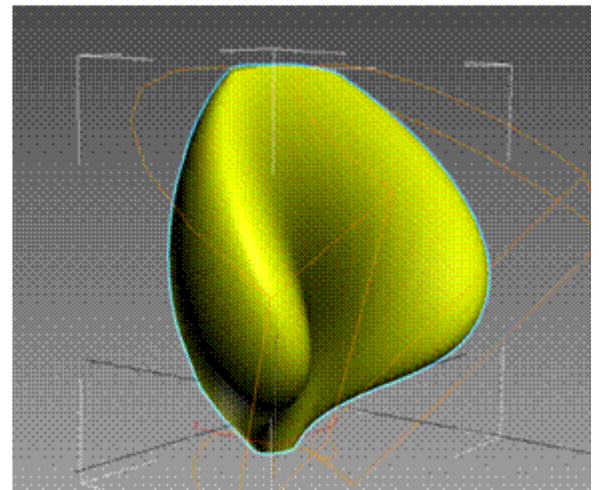
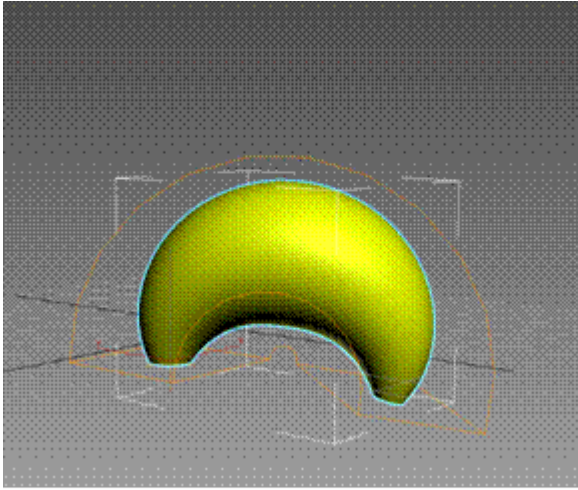


Fig.1.15. Using the Bend modifier

5. The three-dimensional objects shown in Figure 1.16 were created by the sequential application of the same modifiers: Taper & Bend. To confirm the origin of the final sculptural composition presented in Fig.1.17, a tooltip with the name of the object is shown; i.e., this object was once a cylinder.

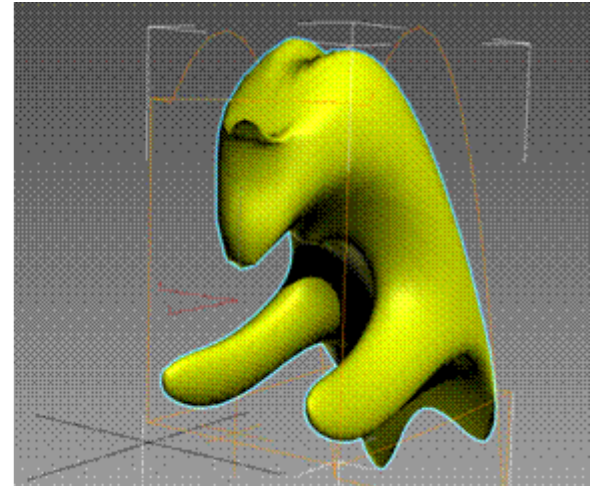
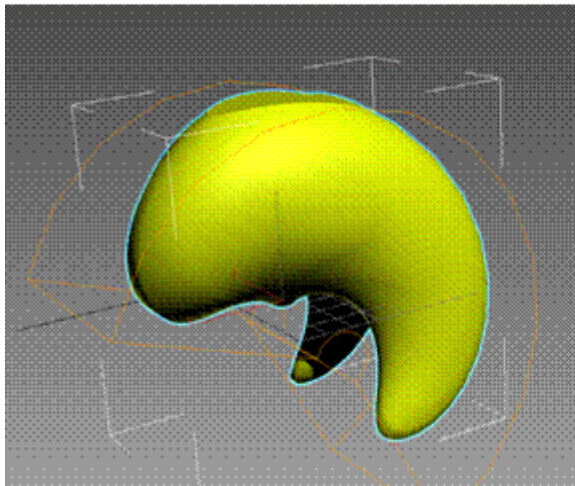


Fig.1.16. Transformations of the cylinder

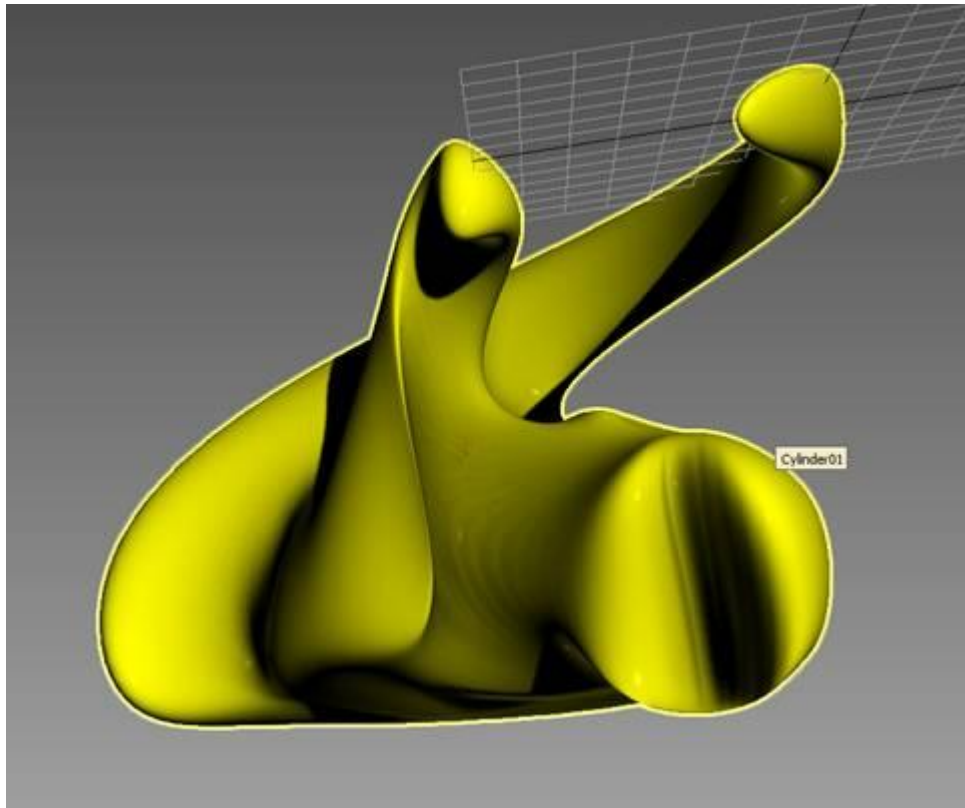


Fig.1.17. Sculptural composition "Metamorphoses of a cylinder"

6. Figure 1.18 shows the renderings of completed scenes with the three-dimensional figure created. If you have not succeeded for the first time, then try to create your metamorphosis again after reading the last page of this manual.





Fig.1.18. Different foreshortenings of the scene "Metamorphoses of the cylinder"

## 2. FUNDAMENTALS OF TWO-DIMENSIONAL MODELING

This chapter will introduce methods of creating flat forms in 3ds Max from two-dimensional primitives to multicomponent curves. It should be pointed out that the word “shapes” is collective for all 2D objects in 3ds Max. Forms consist of vertices, splines and segments. Hereafter we will use these two-dimensional forms for scene modeling in the bar room interior form [4]. However, in order to include rendering for the last scene, you will need to arm yourself with patience, since the modeling process will not be a simple set of specific commands, but it will be full creation.

### 2.1. Two-dimensional shapes

Before you build the first shape, you need to set the units of measurement. In the next exercise, consider the setting of the units, the step of the grid and the snap mode.

#### Exercise 2.1. Setting the units

12. Run the 3ds Max program. The default unit is one inch. Run the Customize/Units Setup command to open the Units Setup dialog box, shown in Figure 2.1. Here you can set the scale price and the system scale type.
13. Select the metric system in the Display Unit Scale section (Fig. 2.1, left) by setting the unit of measurement - mm. Although you can use other units from the metric scale.
14. Next, set the system unit by pressing the System Unit Setup button.
15. As the system unit, we also set - mm and press the OK button. When setting the units of measurement, it is recommended to select the same screen and system units in order to avoid unforeseen situations.
16. To set the grid spacing and binding objects, select Tools/Grids and Snap Settings (Fig. 2.1, right).
17. In the Snaps tab, bindings to various constituent elements of the scene are set: to Vertex, to Grid Points.
18. Go to the Home Grid tab and set the grid spacing to 10 mm, set the other parameters according to the dialog box in Fig. 2.1. Close the dialog by clicking on the cross in the upper right corner.
19. In order to verify the performed settings, check the grid step in the status bar, next to the counter along the Z axis you will see the inscription Grid = 10.0 mm.
20. If necessary, the entered settings can also be saved in a separate file at startup.

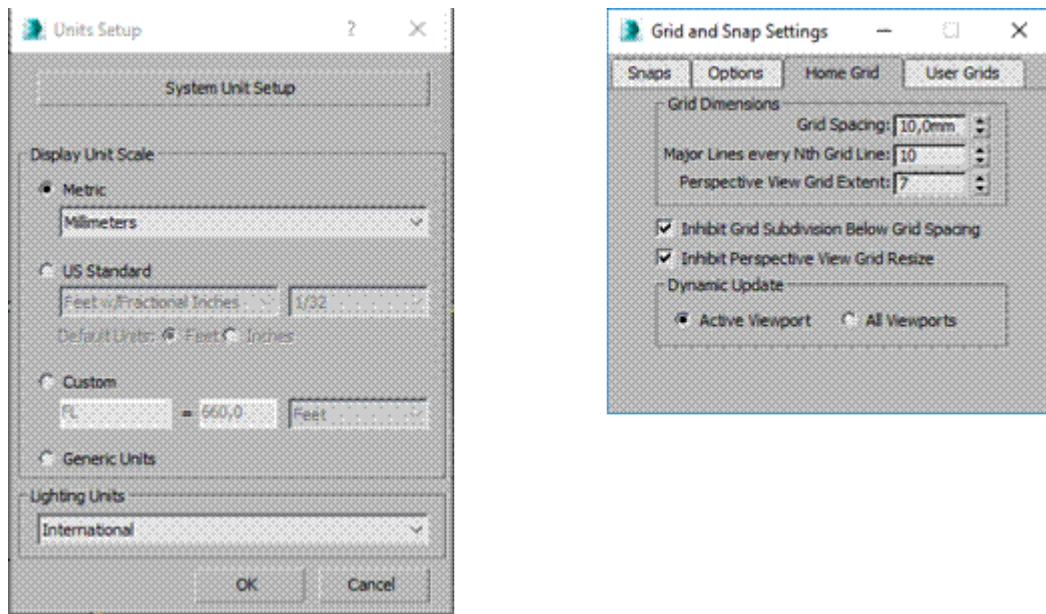


Fig.2.1. Dialog Boxes Units Setup and Grid and Snap Settings

When creating two-dimensional primitives, they are assigned a system name and an individual color in a random way, selected from a certain color palette. By definition, each form contains at least one spline. Complex splines contain various compound shapes. Composite two-dimensional shapes can be created in two ways:

- use the mode Start New Shape;
- using the join operation based on primitives.

In the following exercises, we will create two composite shapes in the form of contours of the front wall and roof using the indicated methods.

### **Exercise 2.2. Creating a outline of the front wall**

1. Continue the construction with the established metric units. In this exercise, we will construct a rectangular outline of the front wall with two window openings.
2. Click on the Front projection window to activate it, and then press the <Alt + W> key combination to expand the window to the full screen.
3. Then click the 3D Snap Toggle button (in the form of a magnet) located on the toolbar to activate the binding mode. The type of Grid Points binding that we need is used by default.
4. To create a rectangle, click the Shapes button located on the command bar in the Create tab, and then on the Rectangle button of the opened Object Type rollout.
5. Click in the left part of the projection window on the bold black line corresponding to the horizontal axis of coordinates, and drag the cursor diagonally to the right and up. When you see that in the rollout of the Rectangle spline parameters (the rectangle) there appeared the values Length = 100 mm and Width = 380 mm, release the mouse button, fixing the values of the parameters (Fig.2.2).

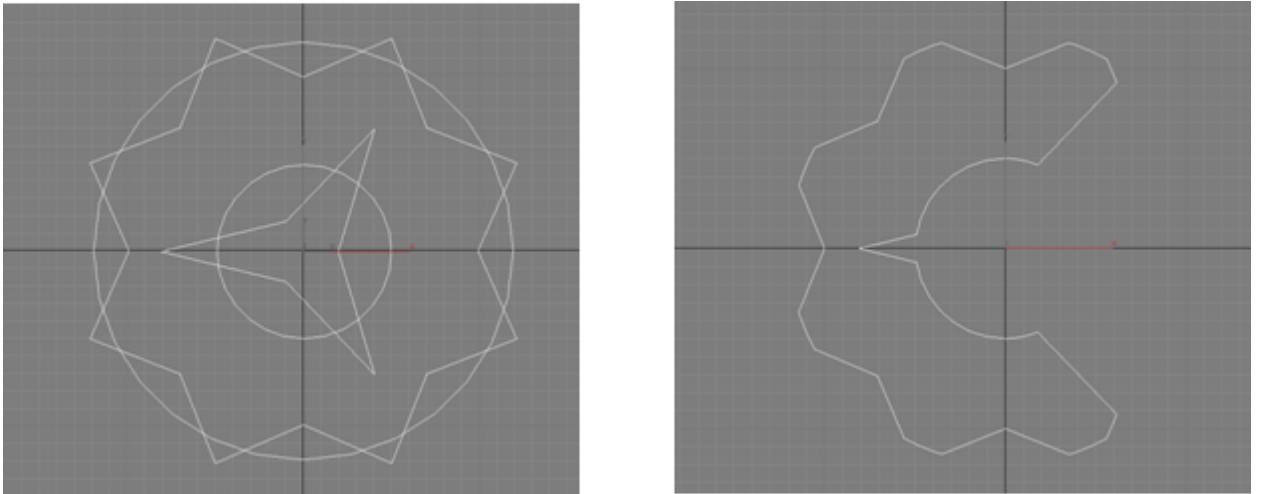


Fig.2.13. Composite shape and its transformation



Fig.2.14. A three-dimensional structure constructed on the basis of a two-dimensional shape

### **2.3. Rendering of two-dimensional shapes**

Sometimes it may be necessary to rendering of scenes containing two-dimensional shapes (rendering of lines). If you enable rendering, you can not find them on the final scene. These objects do not have a third dimension, and by default they are not renderable. In 3ds Max it is possible to make two-dimensional

shapes available for rendering. In the next exercise, we have to create a web, and then rendering it.

### Exercise 2.7. "Invisible" text

1. Execute the File/Reset command. Click on the Top projection window and then use the <Alt+W> key combination to expand the window to full screen.
2. Click the Shapes button on the Create command bar and on the Text button. Click on the free field of the projection window. The window will display MAX Text.
3. To edit it, go to the modifier. In the Text section of the Parameters rollout, you can enter or edit text.
4. Click the Render button on the toolbar or press the F9 key. If you see a black window of the virtual frame buffer, then do not be surprised, we will soon find this text.
5. To rendering the text (or any other flat shape), open the Rendering roll in the modifier. Select the Enable in Renderer check box, click the F9 button again. I suppose that, you will get the image shown in Fig.2.15. The thickness of the font is adjusted by the value of the Thickness counter.

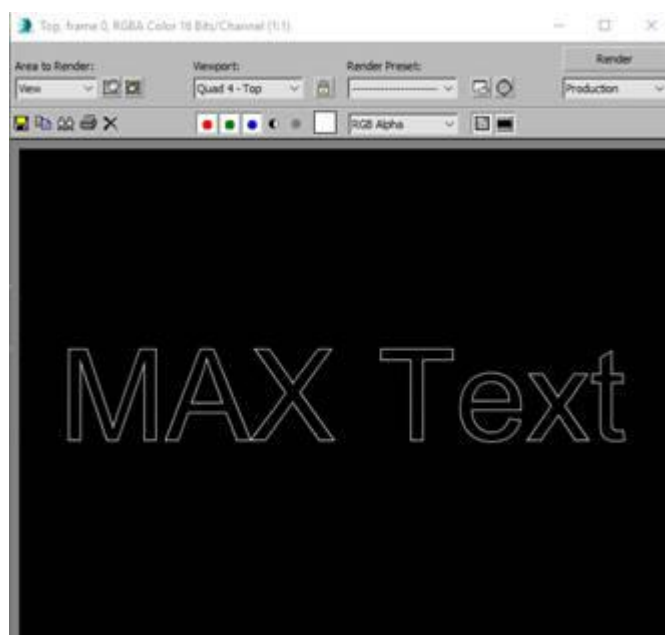


Fig.2.15. Rendering of text inscriptions

### *Individual work*

As a creative task, create a renderable font composition similar to Figure 2-16 (you can also use other flat shapes).



Fig.2.16. Rendering of a font composition

With this exercise, we end the chapter on methods for creating and editing flat shapes in 3ds Max. In this chapter we have become acquainted not only with two-dimensional primitives, but also with compound shapes. We also reviewed the operation of editing these shapes and methods of their rendering.

### 3. FUNDAMENTALS OF 3D MODELING

Working with flat forms is quite an important step, but such work does not lead to the direct creation of three-dimensional scenes in 3ds Max. Therefore, in this chapter we have to learn how to create mesh manifolds of three-dimensional objects, sometimes called simply meshes, on the basis of two-dimensional forms. We will consider the basic methods of 3D modeling; the use of other methods requires additional study. But if you study the key techniques considered in this chapter, you will acquire the basic skills that allow you to build frequently used objects often used in the modeling of three-dimensional scenes.

Path forward on building a bar room model will help you to study many methods of 3D modeling. There are no “right” or “wrong” methods of solution. But the more methods of modeling you know, the easier it will be for you to choose the right method subsequently when you implement your own projects.

Some of the methods that you saw in the previous chapter will be considered once again as an illustration of the effectiveness of editing the shape of three-dimensional bodies. In working with two-dimensional shapes and three-dimensional grids, there are many common points [4,5]. For example:

- Conversion to Editable Mesh. This transformation is exactly the same as converting two-dimensional shapes to Editable Spline. With its help you get access to the editing levels of subobjects, of which the three-dimensional grid consists, vertices, edge edges, polygons and elements. However, after you have converted a three-dimensional primitive, such as Box, to an editable view, you can no longer change the basic parameters of this primitive such as length, width, and height;

- you can apply modifiers to selected sub-objects in the same way as when editing a two-dimensional shapes;

- The presence of modifiers working only with three-dimensional objects. Modifier Fillet/Chamfer works only with two-dimensional forms. Similarly, the Mesh Smooth, Mesh Select, or UVW Map modifiers can only be applied to 3D meshes.

In the following sections, you will become acquainted with some modifiers, the application of which leads to the transformation of two-dimensional splines into three-dimensional objects. These modifiers can be applied only to two-dimensional shapes. If you have a grid object selected, you will not even see such modifiers in the list available for use.

In this chapter we will learn how to work with modifiers:

- Extrude;
- Bevel;
- Bevel Profile;
- Lathe.

Separately, we will consider the Loft method, which is based on constructing the surface of a three-dimensional object along basic sections, placed along a given trajectory.

### **3.1. Extrude Modifier**

The Extrude modifier works only with two-dimensional shapes. As a result of its application, the outline of the shape extends along the local Z axis, in the positive or negative direction. In Exercise 3.1, we will use the previously created form of the front wall with window openings, as the basis for applying the Extrude modifier. We will also get acquainted with the method of attaching objects from other scenes to the current scene.

#### **Exercise 3.1. Creating a facade wall**

1. Run the program 3ds Max (or select the command File/Reset if the program is running). To extrude the front wall, create outline of the foundation line based on the rectangle.
2. Go to the Top projection window and expand it to the full screen. Then click on the 3D Snap Toggle button on the toolbar to activate the snap mode. The type of Grid Points snap that we need is used by default.
3. To create a rectangle, click the Shapes button located on the command bar in the Create tab, and then on the Rectangle button of the opened Object Type rollout.
4. Click in the upper-left corner of the projection window and drag the cursor diagonally to the right down. When you see that in the rollout of the Rectangle spline parameters there are values of Length 200 mm and Width of 380 mm, release the mouse button, fixing the values of the parameters. Try to arrange the form symmetrically with respect to the horizontal bold line (the container of transformations should be aligned with the intersection of the bold lines).
5. Go to the Perspective window and execute the File/Merge command. In the Merge File dialog box, select the file "Facade max" from the folder Lesson 1. In the appeared Merge dialog box, select the Facade object and click the OK button. This operation will only attach the selected object to the scene.
6. To extrude the wall, select the "Facade" object, then select Extrude from the modifier list. In the Amount scroll of the Parameters rollout, set the value to 5.0 mm.
7. To set the wall to its place, select the Align tool on the toolbar and point to the outline of the foundation.
8. In the Align Selection dialog box that appears, select the X Position and Y Position check boxes. In the Current Object and Target Object switches to the Minimum position. After this, the front wall will be leveled relative to the foundation as in Fig. 3.1.

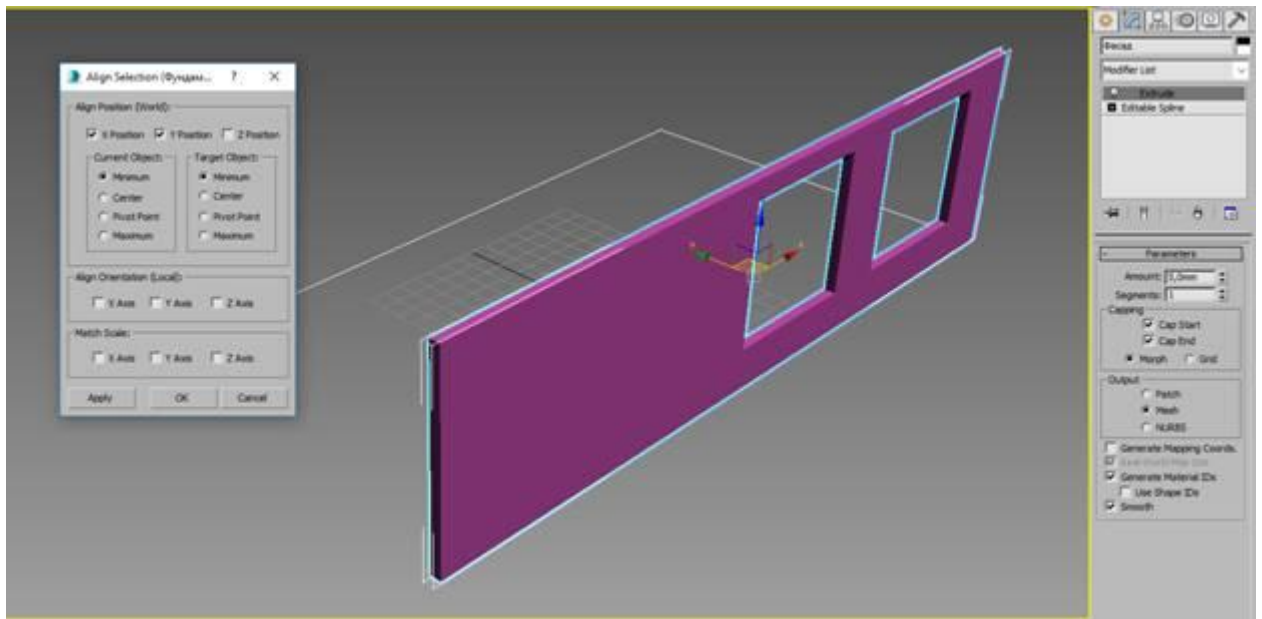


Fig. 3.1. Alignment of the front wall relatively to the foundation

9. In order to finalize the scene, it is necessary to delete the left and bottom segments of the rectangular outline of the foundation in the Top projection window (by location, they will not be useful later).
10. To perform this operation, it is necessary to convert a rectangle using the quadruple menu to an editable spline, and then delete the extra segments with the Del button through the subobject tree. The result is shown in Figure 3.2. The presence of these segments can lead to the appearance of unnecessary walls.
11. For further exercises, save this file in the folder Lesson 2 under the title "Facade wall.max".

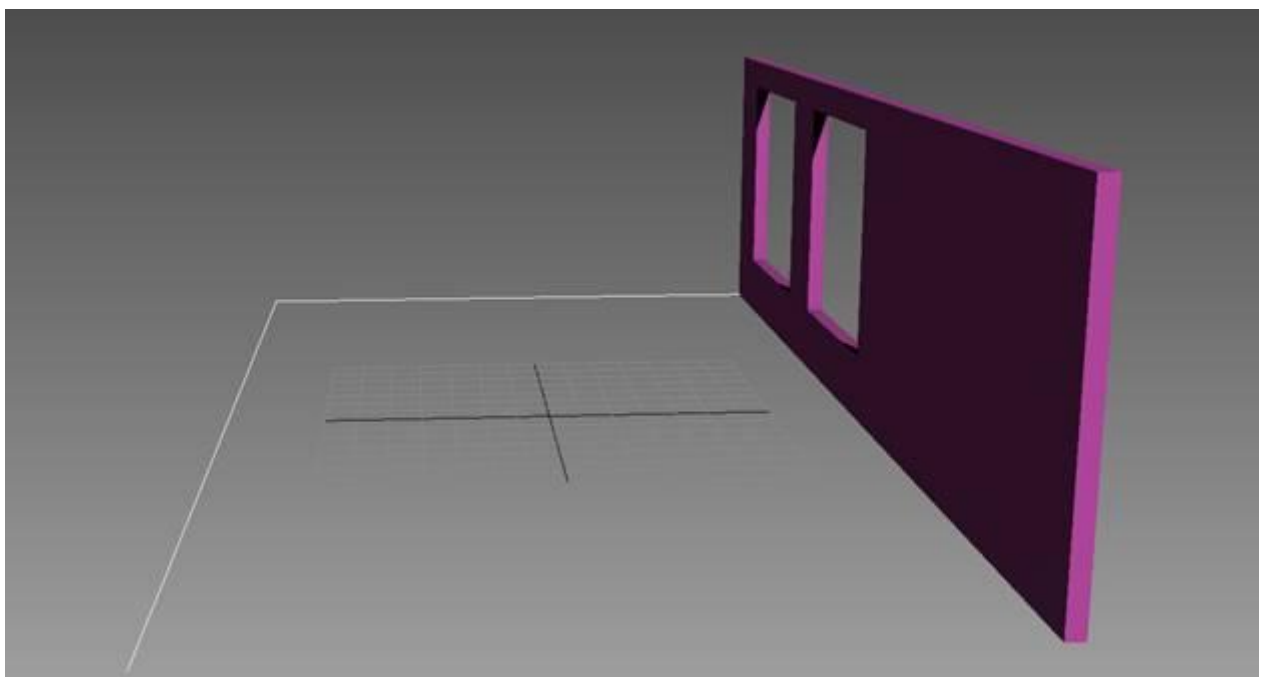


Fig.3.2. Resulting scene with a facade wall

### *Individual work*

As an Individual work, squeeze out the composition from the flat primitives as in Fig.3.3.

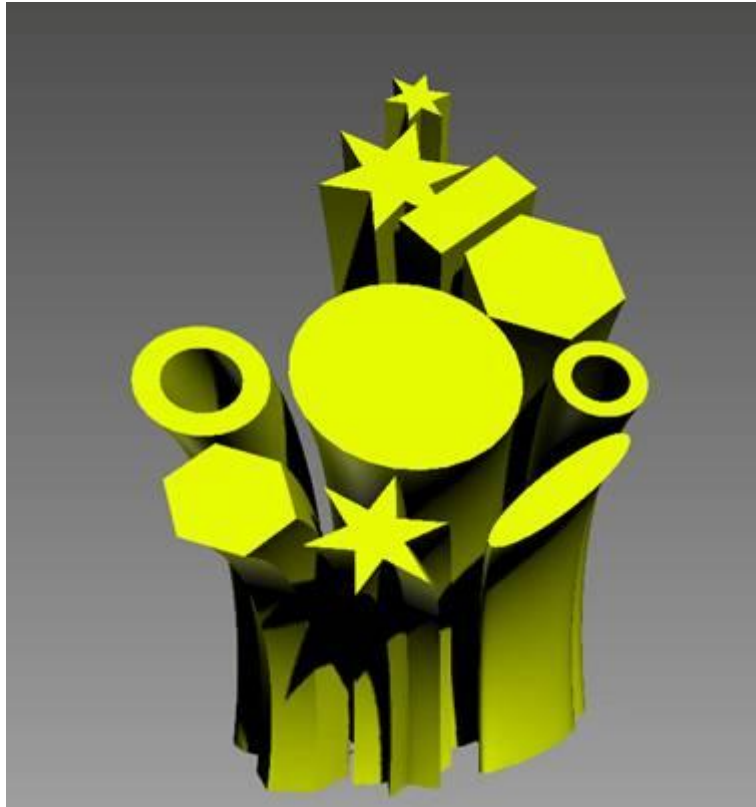


Fig.3.3. Extruded "primitivism"

### **3.2. Bevel modifier**

The Bevel modifier allows you to create three-dimensional bodies by multilayer extrusion. After applying the Bevel modifier, new faces appear, resulting in an increase in the grid density. But in some cases, with the help of additional faces, you can make the scene more effective. These additional faces reflect light, resulting in an underlining of the shape of the object. In Exercise 3.2, we will create a window trimmer and frame.

#### **Exercise 3.2. Creating a frame and trimmer**

1. Execute the File/Reset command.
2. Open the file "Facade wall.max" from the folder Lesson 2. Execute the command File/Merge and in the dialog box Merge File select the file "Facade with the outline of the frame.max" from the folder Lesson 1. In the Merge

constructions or attach the upper and lower parts to each other. Otherwise, the bar stand will consist of two parts.

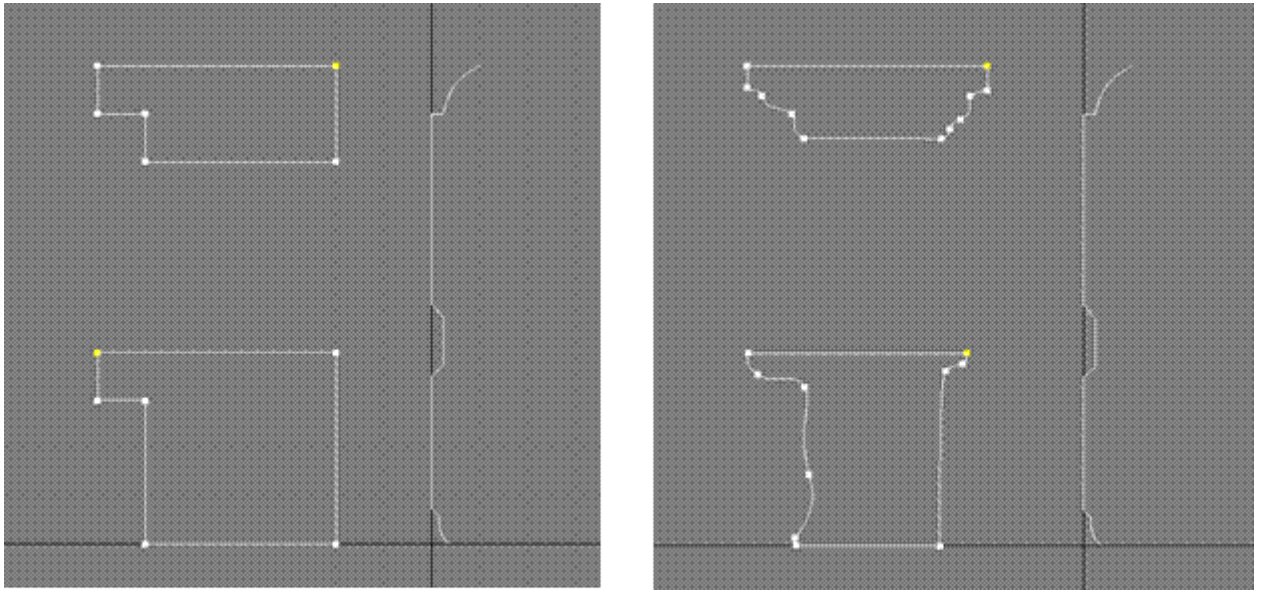


Fig. 3.20. Creating a profile of bar stand

4. To finalize the profile, go to the modifier in the vertex editing mode and convert the original spline to the form shown in Figure 3.20, on the right. You can change the shape of the profile to your liking, taking into account ergonomics.
5. Save the file with the profile of the bar stand in the folder Lesson 2 under the name "Profile of bar stand.max". In the next exercise, we will create a way for the laying and the bar stand itself.

### **Exercise 3.9. Creating a bar stand**

1. Open the file "Walls edited.max" from the folder Lesson 2.
2. Attach to this scene the profile of the bar stand. Execute the command File/Merge. In the Merge File dialog box, select the file "Profile of bar stand.max" from the folder Lesson 2. In the Merge dialog box that appears, select the "Bar stand profile" object and click the OK button.
3. Select the Top projection window and expand it to full screen. Using the Line button, build (from left to right) a spline with a right angle of two segments. When building, keep proportions relative to the wall and the location of the windows.
4. After selecting the corner vertex, apply the rounding operation to it using the Fillet command from the Geometry rollout and display it as in Figure 3.21.

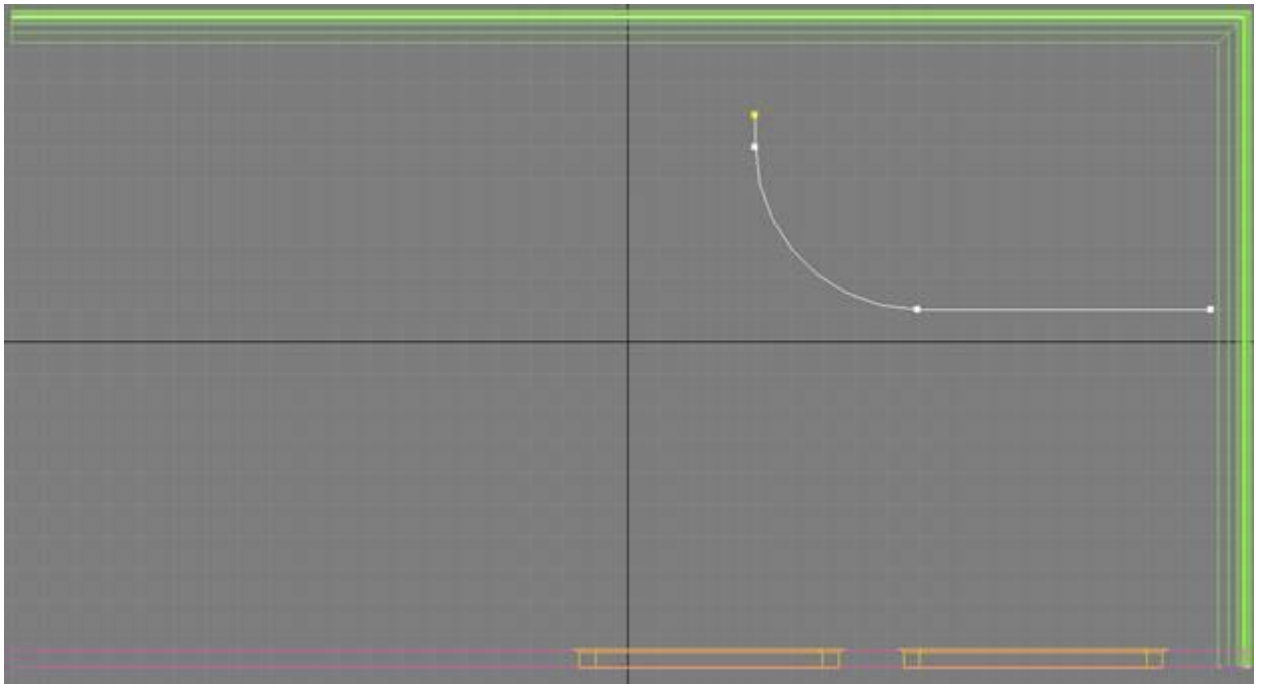


Fig. 3.21. Shapes of the way to create a bar stand

5. Exit the vertex editing mode and go back to the Perspective viewport, then expand the entire screen.
6. Select the created path shape and to apply the lofting, select the Compound Objects option in the drop-down list of the varieties of the Create panel objects.
7. Click the Loft button, in the Creation Method rollout, click the Get Shape button, then press the H key, and in the Pick Object dialog box, select the "Profile of bar stand" object.
8. A stand will be created along the middle line, so align it with the walls in height using the Align tool.
9. Do not be surprised if you find that the angle of the stand is not rounded, contrary to expectations, as the original form of the path. This misunderstanding was due to exercise 3.7, where we set the Skins Parameters rollout to the value of zero in the Steps counter.
10. So go to the modifier, and check the number of steps. To round the corner, you can increase the number of steps in the counters to 5.
11. This will lead to the compaction of the grid, so you can use the optimal path with the angular segment splitting. To do this, you can use the Divide command from the Geometry rollout in the modifier stack at the Segment level.

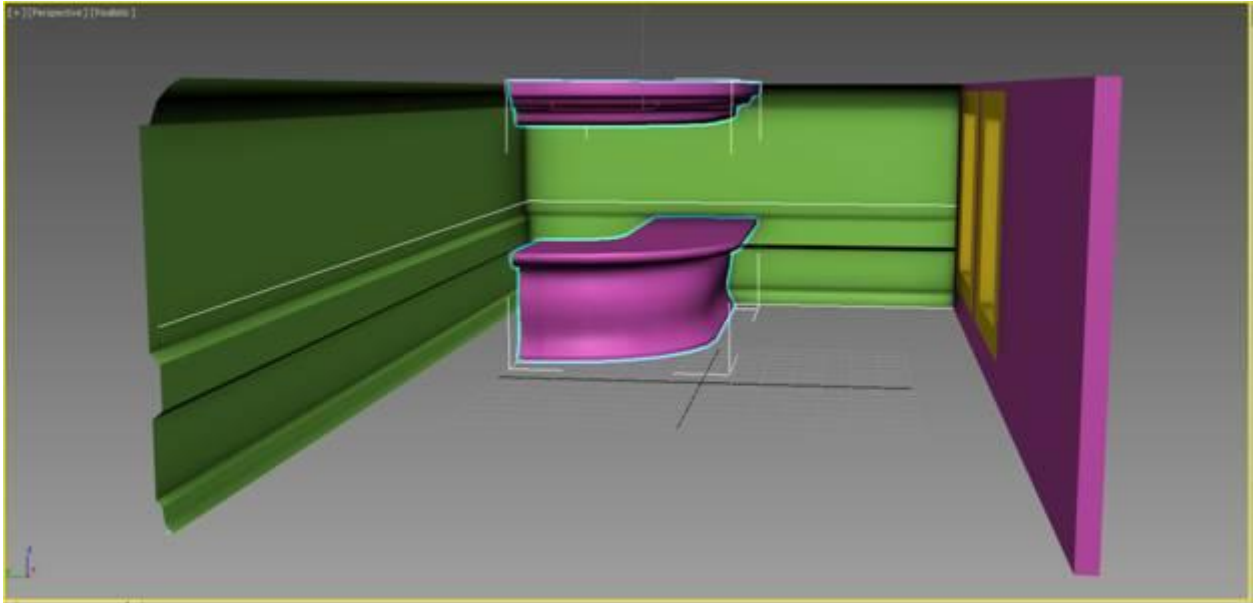


Fig. 3.22. The final view of bar stand with the walls

12. In the final form, the bar counter is shown in Fig. 3.22. The profiles of the loft wall and the column can be taken out of the room for better visibility, but not removed, since they are still useful.
13. Save the constructions in the folder Lesson 2 under the title "Walls with stand.max".

### 3.6. Lofting based on several basic cross-section

We have already examined how it is possible to create a simple two-dimensional shape-section, extrude it along some spline path, also editing the original two-dimensional shapes, and change the appearance of the resulting three-dimensional grid. In the next exercise, we'll look at the additional features of the loft method:

- selection of waypoints for placing sections;
- use of more than one section;
- deformation of the reference sections.

We have to create a set of objects for the design of the bar stand: a bottle and a wineglass. At the base of the bottle there is a section in the form of a circle, but along the height it passes into an eight-pointed star, and on the top of the bottle back to the circle in the form of a cylindrical bottle cork. In this case, the star will rise along the helix. You can not create a similar object using the Extrude, Bevel Profile, or Lathe modifiers.

When creating a bottle, we will use the tools for deforming the loft bodies located in the Deformations rollout of the Modify command panel.

#### Exercise 3.10. Creating a Bottle

1. Run the command File/Reset.

2. Expand the Perspective viewport to the full screen. Construct a circle with a radius of 20 mm, an eight-pointed star with an outer radius of 40, an inner radius of 30 mm, set the rounding radius of the outer vertices of 4 mm.
3. Also, in the snap mode, construct a vertical line in the front view with a length of 250 mm (the centerline of the bottle, the construction of the cells), the results of the constructions are shown in Fig. 3.23, on the left.
4. Select the vertical line to be constructed, to apply the lofting, select the Compound Objects option from the drop-down list of the varieties of the Create panel objects. Click the Loft button, in the Creation Method rollout, click the Get Shape button, point to the circle (you can also use the list of objects). As a result, get a cylinder.
5. Increase the cursor in the Path count of the Path Parameters rollout of the Modify command panel. The distance from the start of the spline to the point of specifying the new section to 10.
6. Note the yellow cross at the lower end of the spline path, which moves when the counter is pressed. This is the active waypoint. You will also notice a circle that was used as the starting section. After setting a new value, the yellow cross will move 10% up along the track line.

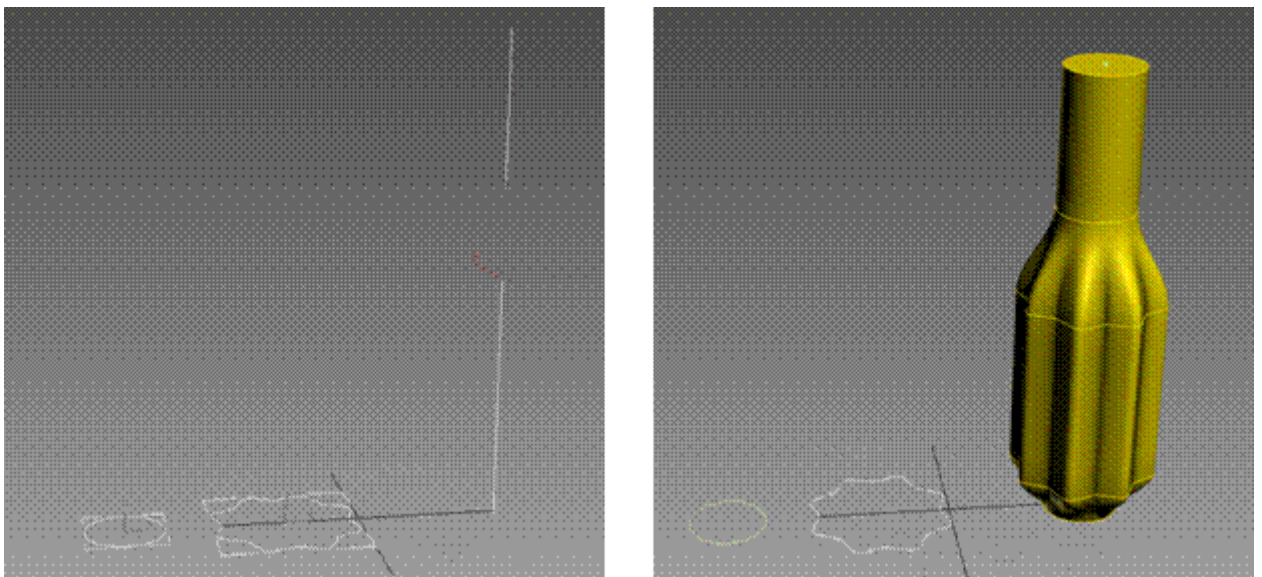


Fig.3.23. Two-dimensional shapes for creating bottles and construction billet

7. Click the Get Shape button in the Creation Method rollout and click on the shape of the eight-pointed star. As a result, the cylinder goes into a multifaceted prism.
8. Set the next height for the section, increase the value in the Path counter to 50 and re-point to the eight-pointed star. At heights of 70 and 100, point to the original circle. As a result, we get the workpiece for further transformations as in Fig. 3.23, on the right.
9. In the Deformations rollout of the Modify command bar, click the Scale button. A window opens dialogue Scale Deformation (X).

10. In the Scale Deformation (X) dialog window, the view of which is shown in Fig. 3.24, there is a red line with black markers at the ends. The red line shows the magnitude of the deformation of the scale of the loft body sections as a function of the path length, and the black markers represent the vertex control points. Vertical dotted lines show the position of each section.
11. To adjust the deformation of the section scale, you need to place additional control points on the deformation curve. Click the Insert Corner Point button and click in the six places of the deformation curve shown in Figure 3.24.
12. Click the Move Control Point button. Move the points and bring the curve to the view, as in Fig. 3.24. Right-clicking they can also be converted to a Bezier type for a smooth transition. You can apply your variations to create a bottle.

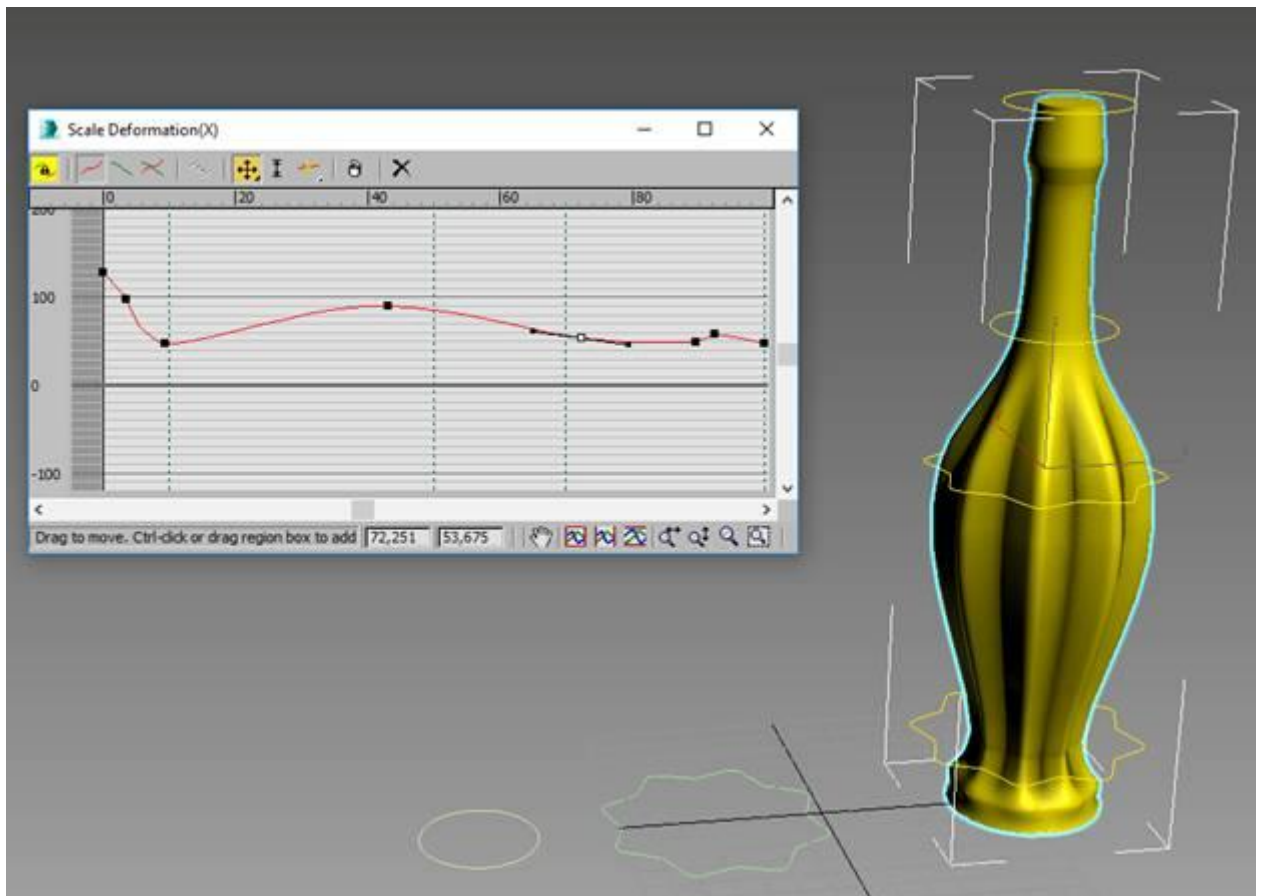


Fig.3.24. Change in the shape of the strain curve

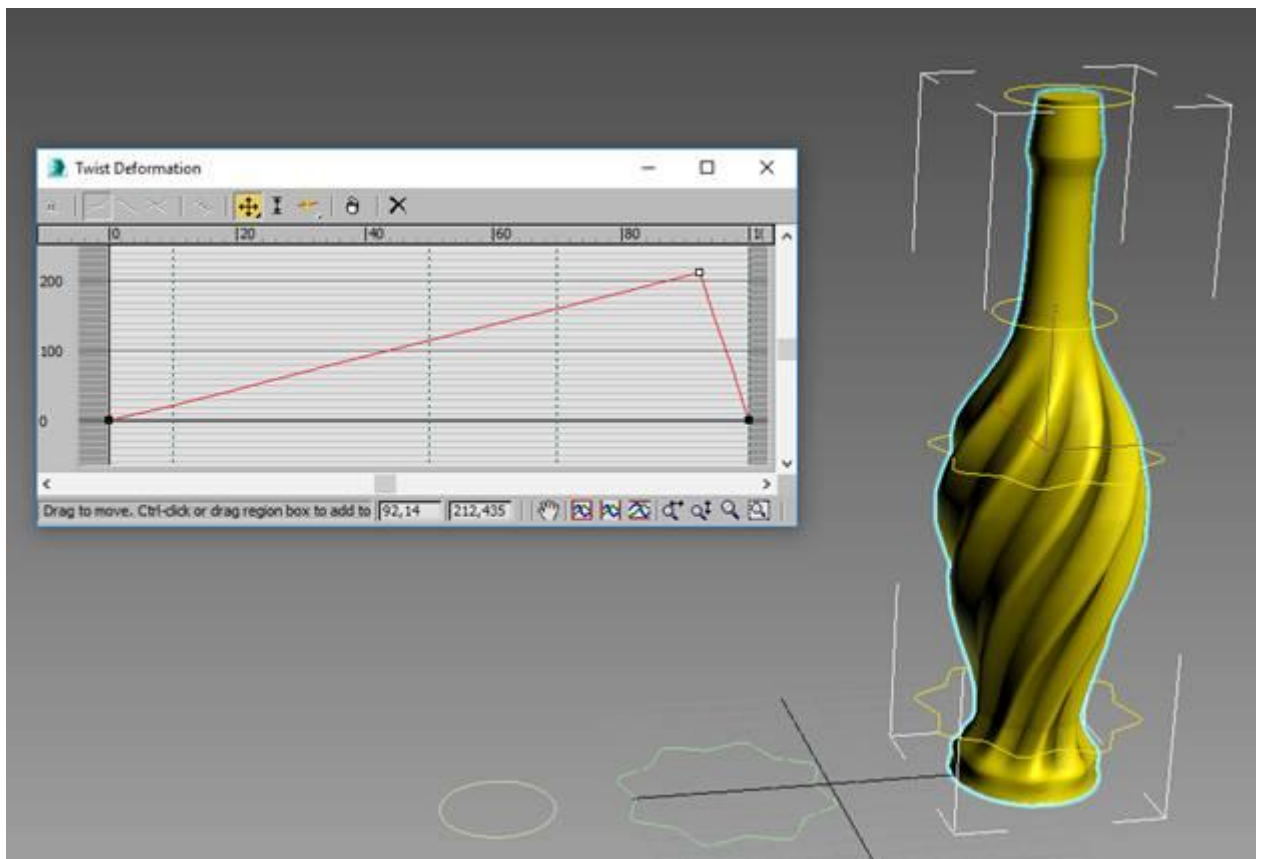


Fig.3.25. Twisting the bottle faces

13. To create a screw thread, click the Twist button of the Deformations rollout of the Modify command panel. Add one or more points to the control line in red. Move it to the upper right corner in two divisions, as in Figure 3.25, to create a thread on the surface of the bottle.
14. You can set the rounding of the inner vertices of the eight-pointed star (or enlarge existing ones) to smooth out the contours of the thread. In the final form, the bottle is shown in Fig. 3.26, on the left.
15. To complement the bottle, you can also choose a wineglass, which is created by the same sections and is shown in Fig. 3.26, on the right. To create an internal volume, you can apply the Shell modifier to the wineglass.

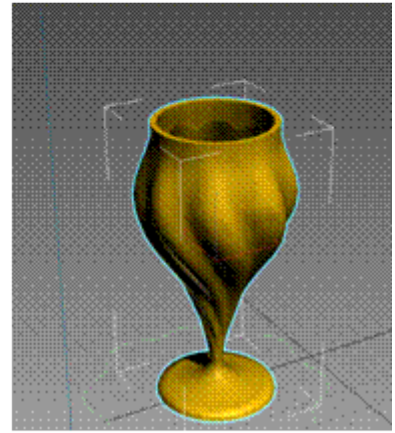
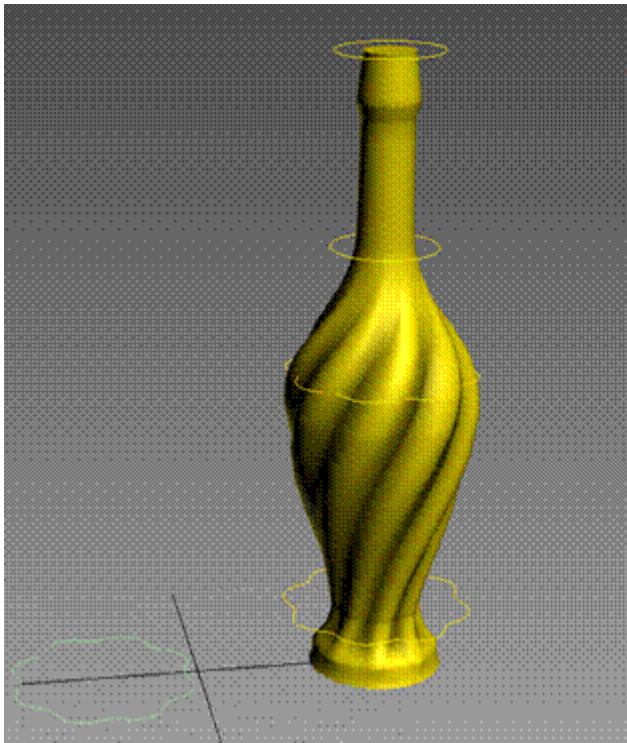


Fig. 3.26. Bottle and a wineglass, created by the method of lofting

16. Create and save the set from the bottle with the wine glasses (Fig. 3.27) in the "Set.max" file in the folder Lesson 2.



Fig.3.27. A set of bottles with wineglasses "Flame"

*Individual work*

As a creative task, you can try to create a snake, as a shape of the path used three-dimensional spline and the shapes of sections are the circle and the ellipse (Fig. 3.28). Also try to simulate a flower vase based on a circle and a seven-pointed star (Figure 3.29).



Fig.3.28. Dialogue with the "lofting" snake



Fig. 3.29. Flower vase

### **Exercise 3.11. Creating a fixture**

1. Open the file "Plafon.max" from the folder Lesson 2.
2. Build a line on the Front view in the form of a curved plafond holder. Using the method of lofting, build on its base the holder, as in Fig. 30, on the left.
3. Next, we will create the basis for fixing the plafond to the holder. Construct an eight-pointed rounded star on the top view, aligning it in the center with the plafond.
4. Then use the Extrude modifier to transform the star into a thin plate - the base of the plafond.
5. To mount to the wall, create a two-dimensional shape of the slab in the Left view as an ellipse. Convert it to an editable spline and move the top vertex down to give it a heart-shaped shape, as in Figure 3.30, on the right.
6. Using the Bevel modifier, create a fixture holder on the basis of a two-dimensional shape. It is also desirable to simulate a flat stand for a plafond, when creating objects you can use your own variations.

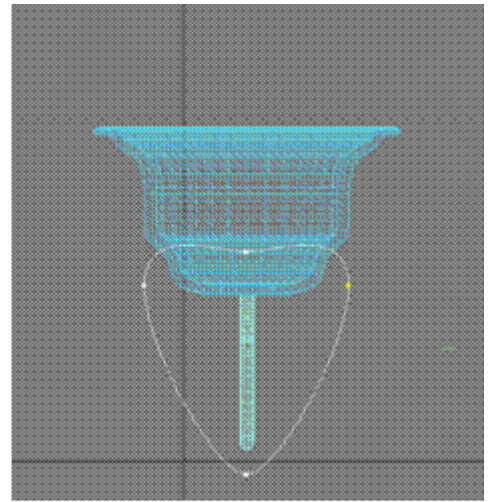
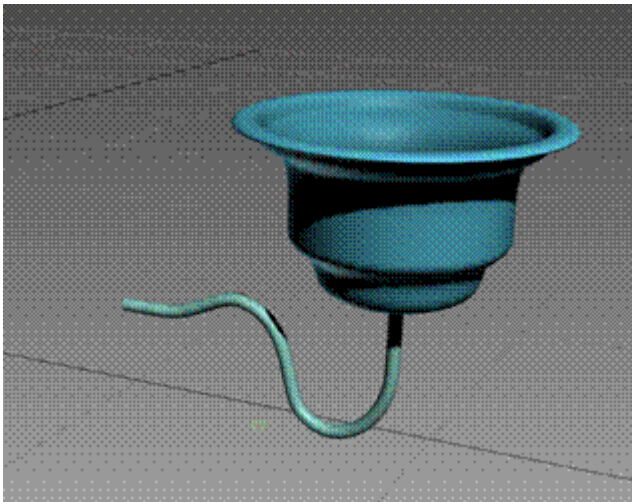


Fig.3.30. Creating holders for the plafond

7. For further operations, it is necessary to combine the component parts of the fixture into one group with the help of the Group / Group command and give the name to the group "Fixture". In the same menu is the command for ungrouping.
8. The result of the assembly is shown in Fig.3.31. Save the file with the fixture in the file "Fixture.max" in the folder Lesson 2.

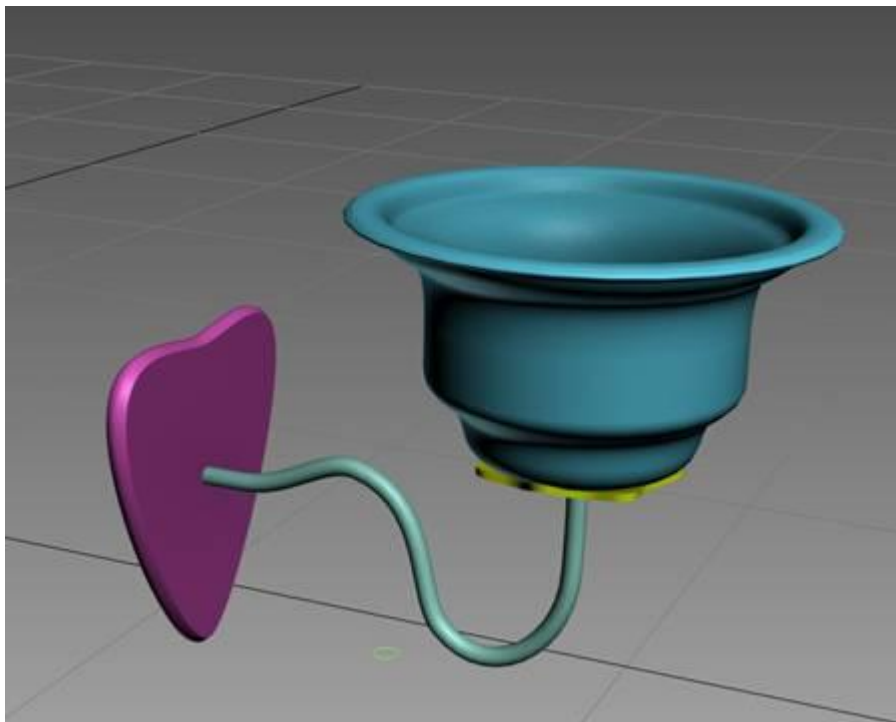


Fig.3.31. Fixture assembly

## 5. ASSIGNING MATERIALS AND TEXTURES

Creating of lighting and assignment of materials are very important when making photorealistic scenes. This stage sometimes seems to be more labor-intensive than the primary 3D modeling of scene objects. A beautiful model or an unfortunate picture can be made from the same scene depending on the purpose of materials and selection of lighting.

We will study foundations of creating materials that will be subsequently applied in a variety of combinations in this chapter. Therefore, we have to create the original components for modeling complex color structures, shadows and textures. A special Material Editor Dialog box is used to create and edit materials in 3ds Max, it can remain open while you are working with other objects

The ability to simulate small details on the surface of a geometric model is very important when working with materials. As you already know, the process of modeling and rendering can be accelerated if you leave the minimum number of faces and edges necessary to convincingly reproduce an object. Sometimes you can refuse from the creation of small details, making the illusion of their availability with the help of the material.

Let us consider the main terms with which we shall meet later [4,5,6]:

- **Materials** - the set of characteristics assigned to geometric surface model to impart resemblance to the real object surface;
- **Maps** – these are images assigned to materials as a characteristic pattern, or texture. In 3ds Max, there are several types of texture maps: bitmap (BMP file format is, JPG, etc.); procedural maps (for example, Checker (Chess field); composite maps of textures;
- **Diffuse color** – color of light rays scattered by the object in arbitrary directions;
- **Ambient Color** – the color of the object in the shaded area;
- **Specular Color** – color of light rays mirrored by the surface of the object;
- **Specular Level** – brightness of specular highlight on the surface;
- **Glossiness** – size of specular highlights on surface;
- **Shader** – algorithm for smoothing edges between faces and displaying specular highlights;
- **Opacity** – the ability of a material to hold back light, a property opposite to transparency;
- **Self-Illumination** – creation of the illusion of glow an object by replacing shadows on its surface with the color of diffuse scattering;
- **Material Libraries** – recorded files on the hard disk, used to store materials and maps;
- **Bump Maps** – a texture map whose pixel brightness variation controls the creation of an illusion of troughs and bumps on the surface of an object without changing its geometry;
- **Opacity Maps** – a texture map whose pixel brightness variation controls the transparency property or the opacity of the surface;
- **Tiling** – method of repeatedly repeating the image of a sample of a texture to cover a surface area exceeding the sample by size;

- **Smoothing** – the effect of the disappearance of edges between faces when rendering;
- **Face Normal** – the vector that determines its orientation is perpendicular to the face. If the normal of the face is directed towards the viewer, then the face is visible.

It should also be noted that you can create a completely correct material, but its realism will depend on the curvature of the assigned surface and its illumination.

## 5.1. Material Editor

The process of creating materials is quite laborious, as it will often have to move between it and the projection windows, adding new textures, making adjustments to parameters and test rendering.

There are many types of materials and texture maps that can be used in the process of work. The most widely used material type is Standard, which appears in the default material preview window. To open the Material Editor dialog box, select the appropriate tool on the toolbar or press the M button, Figure 5.1 shows this window.

The editor has two display options: Slate Material Editor and Compact Material Editor. The Slate Material Editor window contains sections for viewing materials and textures, the type of the sample itself, the navigator and parameters for editing materials. The display option is set in the menu bar of the Modes editor itself, taking into account the convenience and clarity, we will choose the classic version of the Compact Material Editor (Fig.5.2).

It should be noted that if you have activated the rendering mode Mental Ray or V-Ray, then the form of the editor will be different, because there will appear special materials for this mode. For the render Mental Ray materials like Arch & Design are recommended that correctly mimic construction and architectural materials based on the reflection and refraction of light rays. The V-Ray render is supported by its own set of materials.

To return to the original settings, you must run the Customize/Customize UI and Default Switcher command. In the Choose initial setting for tool options and UI layout dialog, select the line Max [4,8,9] in the Initial settings for tool options list. After that, restart the program.

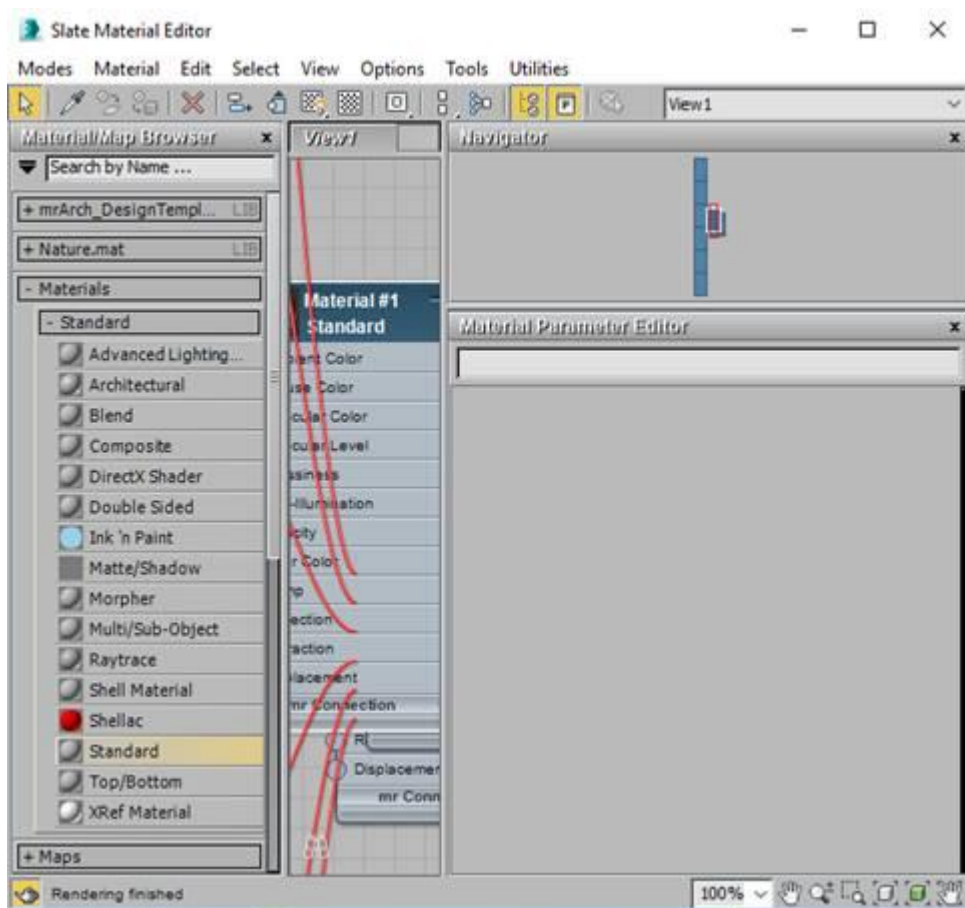


Fig.5.1. Slate Material Editor window

In the Material Editor, you see 15 sample cells by default, although the number can be increased or decreased by a total of 24. You can change the number by right-clicking on the sample cell, you can select the display mode for sample material cells from the context menu. Here you can also rotate the sample itself and examine the sample separately in an enlarged version (the Magnify command).

To load a sample material from the scene object into the cell, use the Pick Material from Object button. It is located to the left of the drop-down list of material names and is marked with a pipette icon.

Materials are stored in a special file called the material library. Clicking on the Get Material button, located on the toolbar under the set of cells with samples of materials, brings up the Material/Map Browser dialog box (Fig.5.3, left). It is intended for viewing the list of materials and texture maps available in the scene, in material libraries or on selected objects.

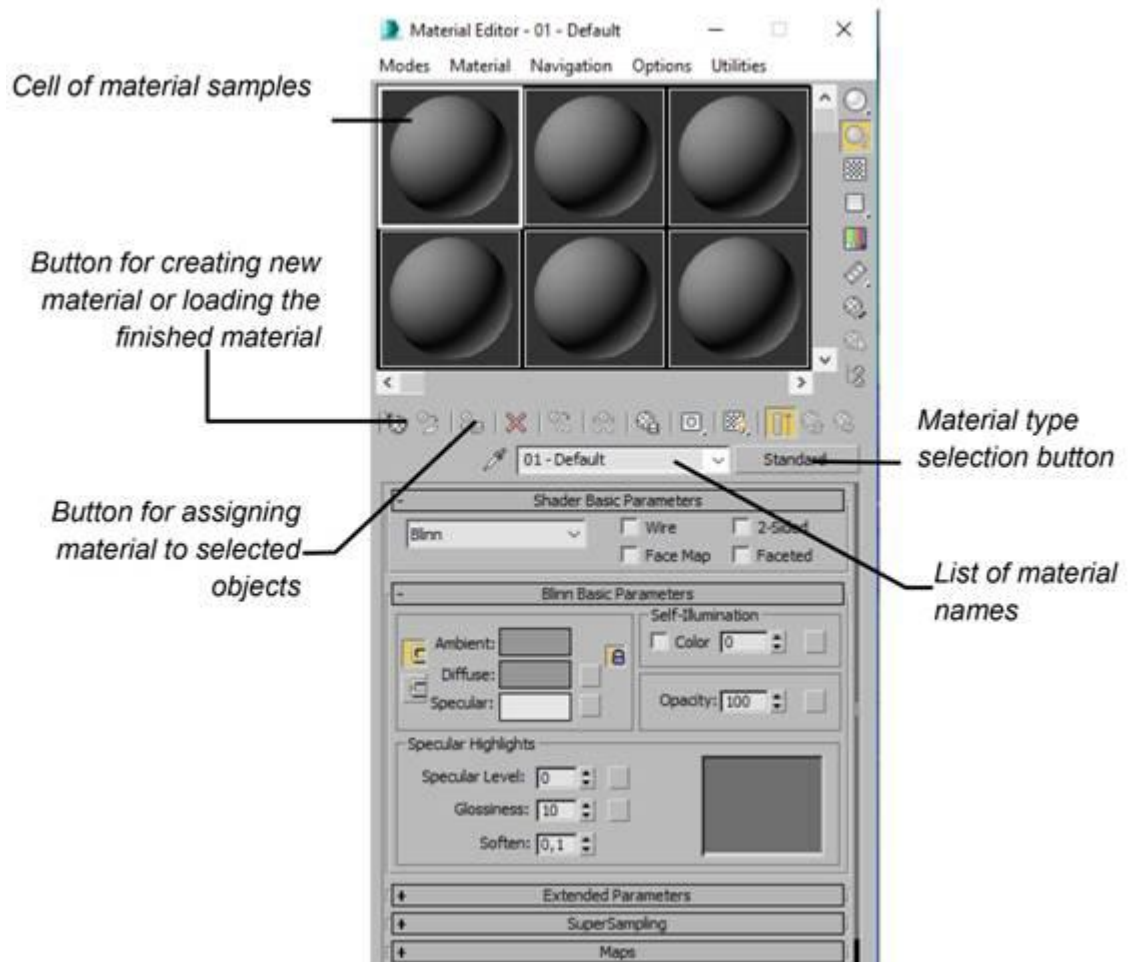


Fig.5.2. Dialog box Material Editor

Perhaps this window will most likely be empty. In 3ds Max, there is a set of libraries that are loaded as needed. To load the standard library, select the Open Material Library line in the menu (left upper corner) of the Material/Map Browser window, open the file from the folder with Autodesk/3ds Max 2018/materiallibraries/3dsmax.mat installed.

In the same folder are the remaining libraries of materials (for example, mrArch\_DesignTemplates.mat, Nature.mat), if necessary they can be downloaded to the startup folder of the program on the desktop. Fig. 5.3 shows the Materials and Maps scrolls with a set of materials.

In the lower left part of the Material/Map Browser dialog box, you can set the display mode of the texture map list. The types of texture maps available in 3ds Max:

- 2D maps – create the effect of a painted or projected surface of a painting;
- 3D maps – they originate in the center of a three-dimensional object and, as it were, fill its entire volume. Due to this, deleting part of the grid does not affect the correct positioning of the drawing on the surface of the object;
- Compositor maps – designed to combine different colors and textures into one common texture. Using cards of this kind, for example, you can overlap part of one texture with another texture;
- Color Modifier maps – change the color of the pixels of maps or materials. You can use color modifier cards to correct bitmap colors;
- Other maps – This category includes maps designed to simulate the effects of reflection and refraction.

It should be noted that the name of the card does not limit its use. For example, the Tiles map is often used to simulate brickwork, while using this map, a relief was created on the skin of the snake, which was shown in Figure 3.28.

In Exercise 5.4, we have to create a floor for our bar room, imitating a tiled masonry. As you understand, for a correct rendering of such a floor it is necessary to take into account a lot of factors, so have the patience for the next exercise. In this exercise, we will use a texture map to control the color of the material. When replacing the color of diffuse scattering with a texture map, the Amount counter readings in the Maps rollout are set to 100 by default. This means that the diffuse scattering color is completely replaced by a texture map. Similarly, by default the map is assigned to the color of the ambient light simultaneously.

#### **Exercise 5.4. Folding the floor of tiles**

1. Open the "Materials 3.max" file from the Lesson 3 folder.
2. Select the "Floor" object. Open the Material Editor window and activate the fourth from the top free cell with the sample material. In the drop-down list of material names, assign this material the name "Floor". Click the Assign Material to Selection button. Your plane will turn gray.
3. Now, instead of clicking on the Diffuse color sample and setting its parameters in the Color Selector dialog box, we will assign a texture map to the color component. Click on the (embossed) button for applying texture maps to the right of the Diffuse color sample. In the Material/Map Browser dialog box, double-click on the name of the Tiles texture map.
4. You will see that the material is assigned only to the sphere in the sample cell, and the view of the floor surface has not changed. Click the Show Map in Viewport button in the materials editor window (the icon with the chess pattern).
5. After that, you will see huge bricks on the floor, we will fit them in size a little later, and now we will work on their color and form of masonry.

6. In the Standard Controls rollout, expand the Preset Type list and select the Stack Bond brickwork type.
7. In the Material Editor dialog box, set the scroll Advanced Controls (Figure 5.11, left). In the Tiles Setup section, you will see a sample of the color of bricks and Horiz. Count & Vert. Count, which serve to specify the number of bricks within the sample.

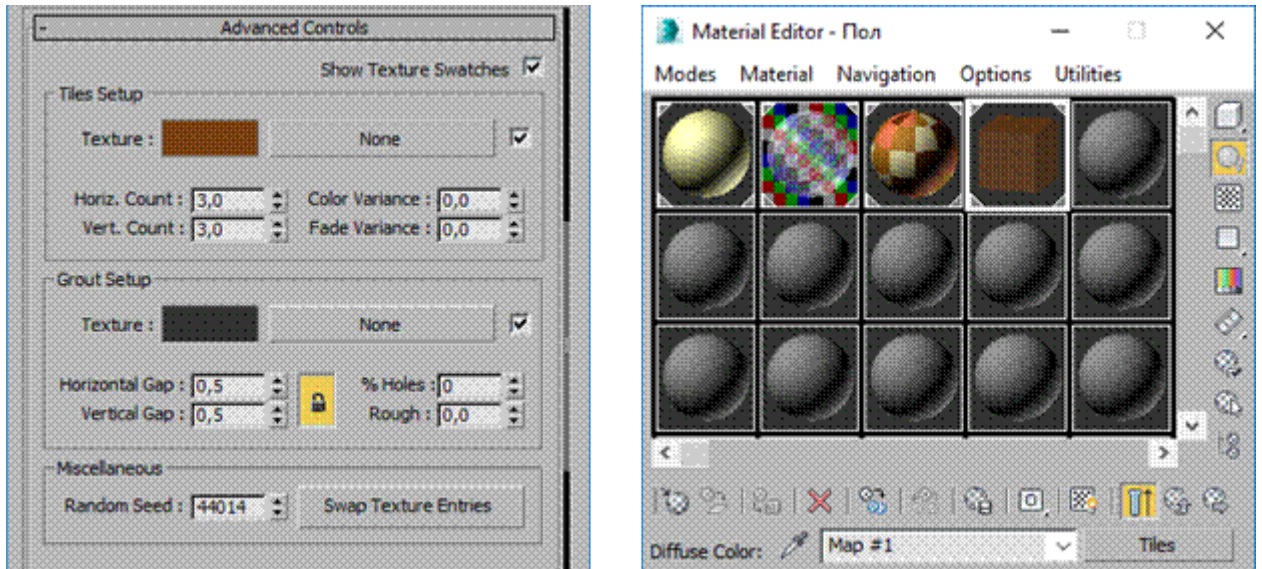


Fig.5.11. Assigning and editing a Tiles texture map

8. In the Advanced Controls rollout in the Tiles Setup section, set the value of 3 in the counters vertically and horizontally.
9. For further settings, we need to change the size of the sample of the material assigned to the floor (increase the density of the masonry of the tiles). For the correct projection of the texture map on the surface of the object, we need to equip this object with the projection coordinate system.
10. Go to the modifier for the "Floor" object. Select the UVW Map command from the modifier list. In the Parameters rollout, enter 7.0 in the U Tile V Tile counters (although you can specify a different masonry density). In this mode, the Real-World Map Size checkbox should be absent by default.
11. Let's return to the materials editor. On the color sample in the Advanced Controls section, set the color of the tiles in shades of red-brown color. To ensure that the bricks do not differ in hue and color saturation, set the Color Variance and Fade Variance counters to 0. Set the remaining parameters according to Fig.5.11, on the left. Now all the bricks will have the same shade.
12. For clarity, you can change the demonstration object in the sample cell by clicking on the Sample Type button (top right) of the material editor by selecting any of the options - sphere, cylinder or cube - on the drop-down toolbar of this tool. Select the cube for the correct image of the floor texture (Fig.5.11, right).
13. So, we replaced the color of diffuse map diffraction by the texture, and since this color is locked with the ambient light color, this texture map replaced the

ambient light color too. Next, we need to create the impression that the floor is bumpy and the bricks protrude slightly above the floor surface. Instead of creating additional faces of the floor grid to form the protrusions of each tile, we will use the properties of the material, creating the illusion of the additional detail of the geometric model.

14. This time we will use the Tiles map to simulate the bump. The apparent relief appears due to the alternation of the brightness of the pixels of the texture map. White pixels mimic protuberances above the surface, while black pixels seem to squeeze into it, forming an impression of cavities. White pixels imitate bumps above the surface, while black pixels seem to squeeze into it, forming an impression of dents.
15. To exit the editing mode of the texture map in the list next to the eyedropper, select the "Floor" level. Next, in the Maps rollout of the Material Editor dialog box, click on the button labeled Map # 1 Tiles and, without releasing the mouse button, drag the cursor to the button labeled None located to the right of the material characteristic name Bump.
16. This will bring up the Copy Map dialog box. Leave the Method switch in the Copy position and click OK. In the Amount counter, set the value to 10. Reset the check box next to the Diffuse material component to temporarily cancel the texture map action in this material channel.
17. In the cell of the sample material (after increasing the size), you can clearly see the illusion that the grouted joints between the bricks seem to have fallen below the level of the bricks themselves due to the use of a texture map in the Bump channel of the material. To achieve this effect, you did not need to enter additional faces and vertices of the grid representing the surface. Changing the colors in the map Tiles, placed in the channel Bump, you will amplify this effect.
18. Click on the Map # 1 button (Map # 1 (Tiles)) of the Bump line to go to the editing level of this texture map as part of the material. In the Tiles Setup section of the Advanced Controls rollout, click on the color sample field (it is still in shades of red-brown color) and set the counters Red, Green, Blue to the same value of 255 to get a pure white color. In the Grout Setup section, click on the color sample field and set the counters Red, Green, Blue to the same value 0 to get a pure black color.
19. While in the central projection window, click on the Render button to see how much the floor has become bumpy. Return to the materials editor, select the flag in the Maps rollout to the left of the component name of the Diffuse material to activate the action of the texture map in this material channel.
20. In the central projection window, use the Zoom, Arc Rotate, and Pan buttons to properly view the scene. Click the Render button.
21. To finalize the floor, we need to set the tiles reflectivity. We will perform this operation similar to the window panes, and apply the Raytrace reflection map.
22. Select the Maps rollout, click the None button on the Reflection line. From the Material / Map Browser dialog that appears, select the Raytrace texture map.

23. After that, the texture name appears under the original button. Set the reflectivity in the Reflection counter to 15 (the value of 100 will delight the lovers of the mirrored floor). Also set some value in the Specular Level and Glossiness counters of the Blinn Basic Parameters rollout.
24. Click the Render button to check the assigned material. The result is shown in Fig. 5.12. If you succeed, you will see reflections from the scene objects on the floor.



Fig.5.12. Final rendering of a scene with a tiles floor

25. In this difficult exercise, we created a material for the floor in the form of tiles with imitation of its real physical characteristics. Therefore, rendering the result can not fail to please you.
26. Save the file with the assigned material in a folder Lesson 3, entitled "Materials 4.max».

#### *Individual work*

Try to simulate the objects "Jug" and "Tail of the snake", presented in Figure 5.13, create and assign them materials with a relief texture. As a relief map, we used images of leaves and cellular structure.

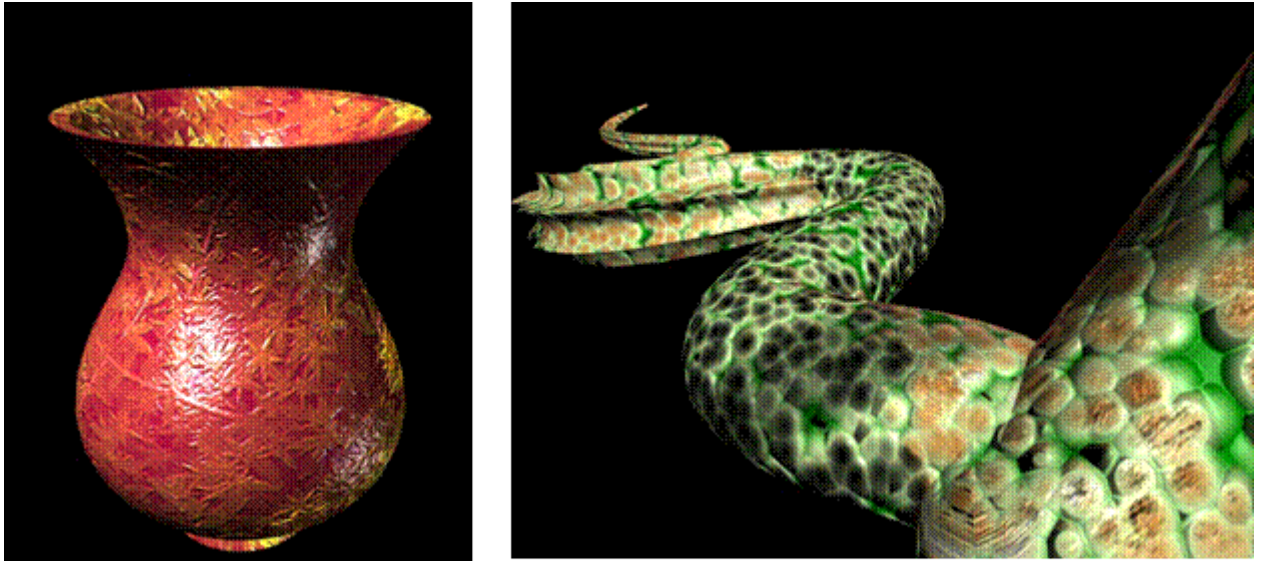


Fig.5.13. Objects with a relief texture surface

#### 5.4. Mirror reflection. Raytrace type material

In Exercise 5.4, we created the material for the floor, simultaneously applying the Tiles map as a diffuse color and bump. Real floor tiles (if they are, of course, not too old) reflect the light that falls on them. The methods for creating a light reflection effect in 3ds Max are based on the use of various texture maps as an optical characteristic of the Reflection material, including:

- **Bitmap** - when working with this map, bitmaps with images of any objects or landscapes are used as a mirror reflection texture. Projection coordinates in this case are assigned automatically to correctly reproduce the curvature of the surface. Use this map makes sense when simulating blurry reflections on small objects;
- **Reflect/Refract** - The action of this map is based on the rendering of six different projections (front, back, left, right, top and bottom) of the surrounding objects of the scene from the center of the object. This process results in a more accurate imitation of reflection than the use of a Bitmap. Use this card is only possible to simulate the reflection of surrounding objects in a mirror material or the refraction of light by transparent materials;
- **Flat Mirror** - the difference between this map and the Reflect/Refract map is that it is designed to simulate the mirror properties of flat surfaces or surfaces consisting of parallel faces;
- **Raytrace** - the use of this map leads to the most accurate simulation of the reflection effect, but a fairly large amount of time is required for mathematical calculations of the tracing of light rays.

In the next exercise we will learn the basics of using Raytrace material type. A result similar to the application of this material can be obtained by other methods, for example, using a Raytrace map as a mirror reflection texture when working with a material of the Standard. However, material of the Raytrace type

has its own peculiarities. We will use the tracer material to create a stainless steel bar stand.

### Exercise 5.5. Stainless steel bar stand

1. Open the file "Materials 4.max» from the folder Lesson 3.
2. Select the object "Bar stand". Open the Material Editor window (or press the M key) and activate the next empty cell with the sample material. In the drop-down list of material names, assign this material the name "Bar stand". Click the Assign Material to Selection button. The bar stand will turn gray.
3. Click the Standard button to the right of the drop-down list of material names. In the Material/Map Browser dialog box, double-click the name of the Raytrace material (Fig. 5.3).

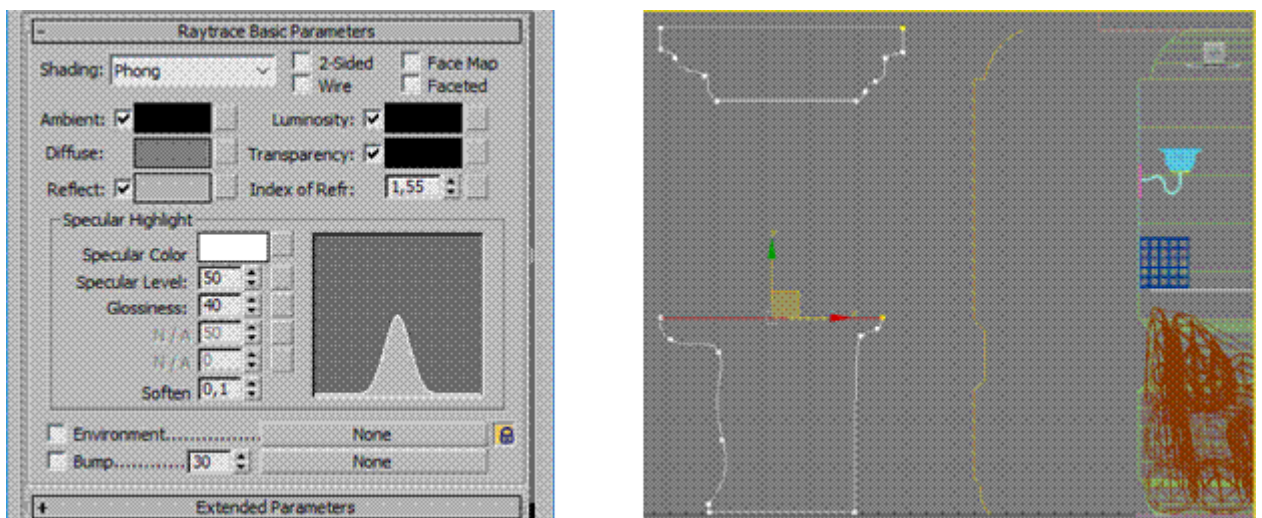


Fig. 5.14. Raytrace Basic Parameters scroll and identification of countertops

4. The Raytrace Basic Parameters rollout shown in Figure 5.14, on the left, differs significantly from the Blinn Basic Parameters rollout, which is used to customize the parameters of the standard material. Now, instead of assigning the Raytrace map to the Reflection parameter, as you would do when working with standard material, you will adjust the brightness of the Reflect parameter.
5. The black color does not have the ability to reflect light, while the pure white color of the Reflect parameter ensures a complete specularity of the material. In the Raytrace Basic Parameters rollout, click the Reflect color sample field and in the Color Selector dialog box, set the value to 180 in the Value counter to get a gray tint.
6. If you want to make sure that you tried not in vain, press the F9 key (Render) and wait a bit. In the virtual frame buffer, you will see the rendering shown in Figure 5-15.
7. For the sake of practicality, it would be nice to replace the stainless steel on the dark red matt plate. To do this, we have to change the material of the countertop by editing a shape that depicts the profile of the section of this stand

(changing the material identifier at the level of segment editing). Then we convert the material assigned to the stack to the Multi/Sub-Object type.



Fig.5.15. Rendering of a bar stand from stainless steel

8. Go to the Left projection and expand it to full screen. Press the H key and in the Select Objects dialog box that appears, select the shape "Profile of bar stand". Increase the table profile view window to the required sizes, as in Fig. 5.14, on the right.
9. In the modifier stack, go to the Segment sub-object editing level, select the segment of countertop. In the Surface Properties rollout of the Modify command panel, set the value to 2 in the ID counter. The faces of the grid obtained by lofting these segments will be assigned the second component of a multicomponent material. Exit segment editing mode.
10. Go to the central projection window and select the "Bar stand" object. Go to the modifier stack, in the Surface Parameters rollout, select the Use Shape ID check box.
11. Press the M key to open the Material Editor. Select the sample of the material "Bar stand". Click the Raytrace button to the right of the material name drop-down list, and in the Material/Map Browser dialog box that appears, double-click the Multi/Sub-Object material name. This will bring up the Replace

Material dialog box. Click OK, leaving the switch in the Keep old material as sub-material?



Fig.5.16. Final rendering of the scene with a bar stand

12. In the Multi/Sub-Object Basic Parameters rollout, leave two samples with the Set Number 2 sphere. Click on the second material component selection button and in the Blinn Basic Parameters rollout, a dark red diffuse color. Set the value to 50 in the Specular Level counter and the value 0 in the Glossiness counter to give the material a matte finish.
13. Go to the central projection window and press the F9 key to rendering. The upper part hanging from the ceiling and the bottom of the stand are now covered with stainless steel, while the countertop is made of red matte plate. The result of the rendering is shown in Fig.5.16.
14. Save the file with the stainless steel bar stand in the folder Lesson 3 under the name "Materials 5.max". In the next exercise, we will create chrome chairs with a soft red seat.

#### *Individual work*

Try to model scenes "Mirror symphony" and "Barrier", with the assigned materials, which are presented in Fig. 5.17. As a reflection map, we used tracer

materials assigned to 3D primitives, for the second scene we used a standard material with a lacquered surface.

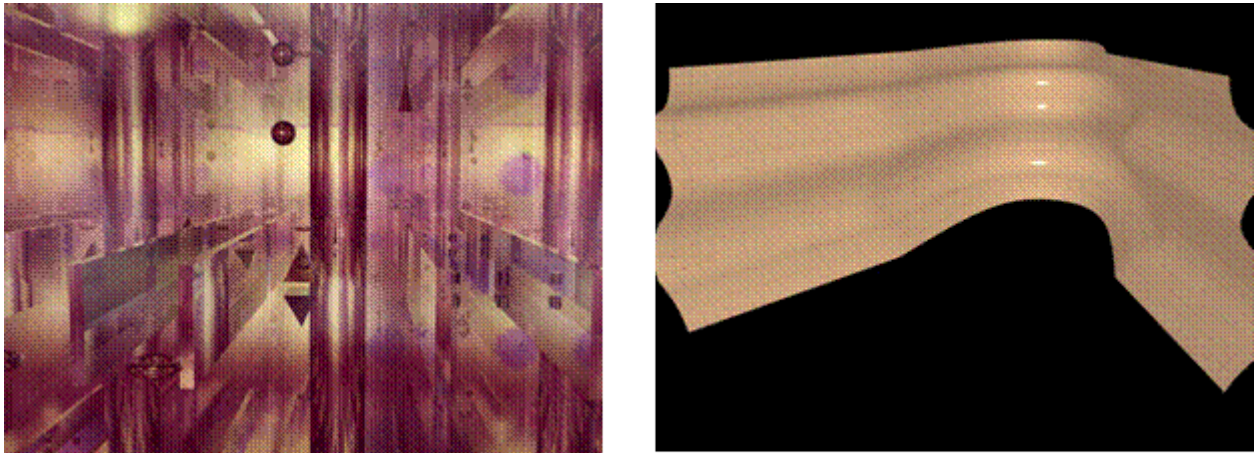


Fig. 5.17. Scenes "Mirror symphony" and "Barrier"

### **Exercise 5.6. Chrome plating chairs**

1. Open the file "Materials 5.max" from the folder Lesson 3.
2. Select the group "Chair" of objects. Open the Material Editor window and activate the next empty cell with the sample material. Click the Assign Material to Selection button. All chairs should turn gray, as they are dependent copies.
3. For the Standard material in the Shader Basic Parameters rollout, select the Metal shading type and in the Maps rollout, set the Reflection option to the Raytrace texture map. You can also set the Specular Level counter to 40. Check the rendering of chrome plating chairs. They are completely metal, they will not be very comfortable to sit on, so we need to replace the seat with a softer material.
4. Click the Standard button and in the Material/Map Browser dialog box that appears, double-click the Multi/Sub-Object material name. At the request leave the old material.
5. In the Multi/Sub-Object Basic Parameters rollout, click the Set Number button and set the number of components to 3. Click the Material/Map Navigator button to display the same name and select the second component. This material will depict a soft red chair seat.
6. In the Blinn Basic Parameters rollout, click the Diffuse color sample field and select a red color. Color Ambient choose darker. Set the value to 40 in the Specular Level counter and the value 0 in the Glossiness counter. Close all dialog windows.
7. Click the Select toolbar button and in the Front projection window click on the group of "Chair" objects, ungroup it, and select the "Chair" object to access the modifier.

8. Zoom in on the Front view, in the modify list of the Modify command bar, select the Mesh Select modifier you know to select the seat of the chair. Expand the Mesh Select modifier and go to the polygon editing level.
9. Click the Select button and select the faces of the chair seat. All selected faces will become red (Fig. 5.18, left). In the modifier list, select the Material modifier. In the Parameters rollout, set the counter to 2.
10. Render the central projection window, and you will see that the seats of the chairs are painted red, and the rest - in gray. You can ask the question: "where are the chrome plating chairs?" The answer is related to the peculiarity of the Bevel Profile modifier, with which the chair was created.

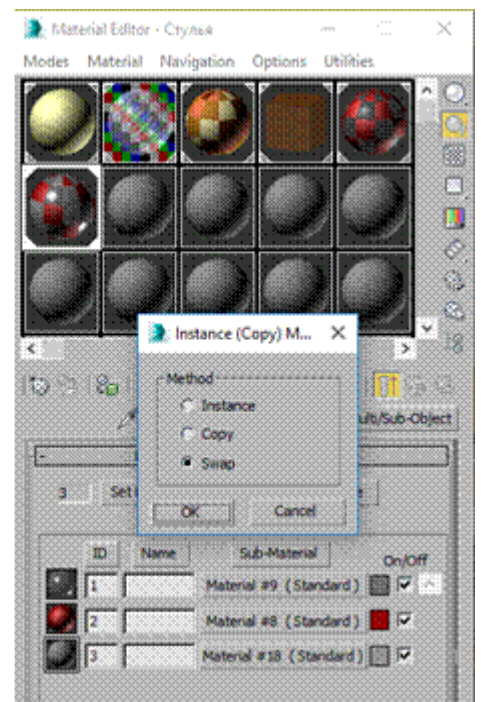
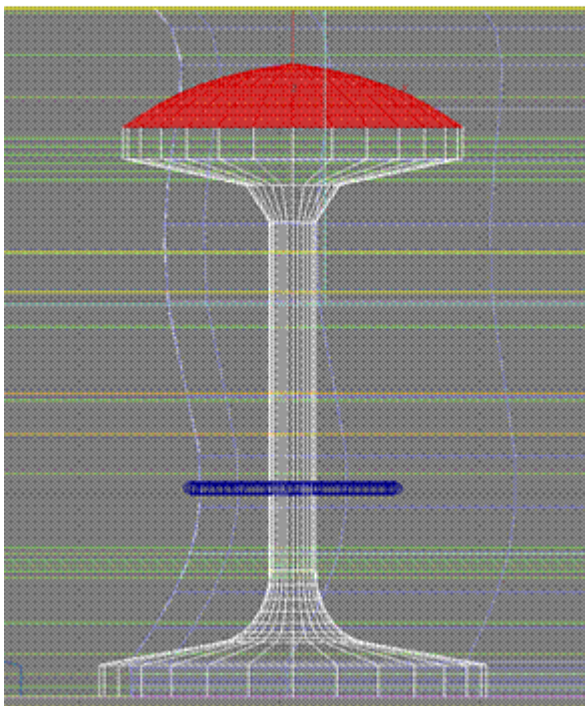


Fig.5.18. Select seat of chair and material assignment

11. In this case, the program automatically assigns the identifier of the material equal to 1 to all faces of the upper base of the formed three-dimensional body, the identifier equal to 2 to the faces of the bottom base, and identifier 3 to the sides of the lateral surface. Therefore, in order that the chairs again acquire chrome shine, the first Standard material should be made the third component of a multicomponent material.
12. Therefore, in the Multi/Sub-Object Basic Parameters rollout, click the Standard button of the first sample and, without releasing the mouse button, drag the cursor to the button of the third material component. When you release the mouse button, the Instance (Copy) Material dialog box appears. Set the Method switch to Swap, as shown in Figure 5.18, to the right and click OK. In the drop-down list of material names, assign this material the name "Chair".
13. Render the scene. On the lower part of the chairs should be chrome plated. The result of the rendering is shown in Fig. 5.19.

14. Save the file with chrome plated chairs in the folder Lesson 3 under the title "Materials 6.max". In the next exercise, we will conduct the final shading of the entire scene.



Рис.5.19. Rendering of scene with chrome plated chairs

### **5.5. Methods for shading objects**

In this subsection I want to draw your attention to the things that we are so used to seeing around ourselves daily, that we consider their presence to be completely natural. However, their study in the creation of computer rendering is very important for giving the stage a realistic look.

As mentioned earlier, the simplest way to determine the type of specular highlights is what material was used to construct the object. If you look around you, you can easily determine what the objects surrounding you are made of: metal, plastic, cardboard, paper, fabric, etc. How do you define this? Basically by the form of a specular highlights, which is usually a spot of white light reflected from the surface. The size, shape and sharpness of the edges of this spot depend on the molecular structure of the light reflecting material. Mirror highlights, appearing on the surface of plastic, which can be very hard, occupy a larger area and have more blurred edges than glare appearing on the surface of chromium.

Also important is the bump of metals, which is highly dependent on the type of metalworking (and this can be casting, rolling and forging), can be layered and resemble the bump of a tree. Sometimes you can observe extended specular highlights on the metal surface. The reason for the appearance of such specular highlights is due to the peculiarities of grinding, which lead to the appearance of specifically oriented microscopic scratches on the surface. Sometimes on the surface of a metal, for example, stainless steel, even two specular highlights located at different angles can be observed [3,4].

The second factor helping to determine what the object consists of is the sharpness of the edges of the specular highlight. On the surface of soft materials, such as rubber, cloth, etc., usually more dull specular highlights with highly eroded edges appear. In 3ds Max you can specify the type of specular highlight of the material, using different variants of shading algorithms and changing the values of the parameters Specular Level and Glossiness,.

You already know how you can adjust the brightness and size of specular highlights using the Specular Level and Glossiness parameters. Plus, you have the opportunity to choose different types of shading in the list of the Shader Basic Parameters rollout editor. There are the following main types of shading:

- **Anisotropic**, anisotropy in this case is called the stretching of the specular highlight, which can be caused by surface scratches or the orientation peculiarities of metal molecules or pressed materials;
- **Blinn**, this type of shading specular highlights of a circular shape that can usually be observed on the surface of objects made of plastic;
- **Metal**, this type of shading gives the effect of shiny metal;
- **Multi-Layer**, here you have two anisotropic specular components. With the help of the first, the parameters of the specular highlights on the smooth metal surface are made, and with the help of the second one, the adjustment of the specular highlights parameters caused by scratches on the surface;
- **Oren-Nayer-Blinn**, this type of shading is designed to produce specular highlight of a round shape, with soft, blurry edges that appear on the surface of materials such as rubber, fabric or human skin;
- **Phong**, this type of shading does not form specular highlights on the surface of objects;
- **Strauss**, when using the Strauss shading, the Color parameter specifies the color of the diffuse scattering of the material. This type of shading is suitable for simulating materials such as gold, bronze or anodized aluminum;
- **Translucent**, this type of shading is used to create translucent materials.

### **Exercise 5.7. Final shading of the scene**

1. Open the file "Materials 6.max" from the folder Lesson 3.
2. Let's start the shading from the ceiling. Open the Material Editor window and activate the next empty cell with the sample material. Select the "Roof" object. Click the Assign Material to Selection button. In the drop-down list of material names, assign this material the name "Ceiling".

3. In the Blinn Basic Parameters rollout, click on the Diffuse color sample field and select a shade of red. Color Ambient select in darker colors of this color. Set the value to 30 in the Specular Level counter and the value 0 in the Glossiness counter. Render the scene, the ceiling will turn red with a matte finish.
4. Activate the next empty cell with the sample material. Select the "Frame" object. Click the Assign Material to Selection button. In the material name drop-down list, name this material "Frame".
5. In the Blinn Basic Parameters rollout, click on the Diffuse color sample field and select a shade of beige, given the color of the front wall. Color Ambient select in darker colors of this color. Set the value to 50 in the Specular Level counter and the value of 30 in the Glossiness counter. Render the scene, the frames must be plastic.
6. Activate the next empty cell with the sample material. Select objects "Armchair", "Armchair 01" and "Sofa". Click the Assign Material to Selection button. In the drop-down list of material names, assign this material the name "Soft furniture".
7. In the Blinn Basic Parameters rollout, click on the Diffuse color sample field and select a shade of red-brown color, given the color of the floor. Select Ambient in darker colors. Set the value to 0 in the Specular Level and Glossiness counters. Render the scene, the chairs and sofa will be matte without gloss.
8. Select the next empty cell with the sample material. Select objects "Shelf" and "Shelf 01". Click the Assign Material to Selection button.
9. Create a simulation of the metal for the Standard sample, in the Shader Basic Parameters rollout, select the Metal shading type and in the Maps rollout set the Reflection option to the Raytrace texture. The levels of specular highlight and glossiness adjust themselves. In the list of material names, assign this material the name "Shelf". Check the rendering of the chrome shelves. The result of the rendering for the current stage of shading is shown in Fig.5.20.

right corner. Switching lighting modes by default is carried out with the command Views/Viewport Configuration, in the Visual Style & Appearance tab in the Lighting and Shadows section you can set one (1 Light) or two (2 Lights) light source. This lighting disappears as soon as a light source is created in the scene.

In 3ds Max, there are three ways to illuminate the scene:

- standard light sources and scanning rendering. This is an old method of "drawing with light," in which the placement of illuminators is not very similar to what can be in the real world. The main advantage of this technique is a rather fast rendering of the scene. Lighting of street scenes in this case is made using the system of Sunlight objects;
- photometric light sources and an algorithm for calculating global illumination using the radiation transfer method (Radiosity). This is a new approach, in which the calculation of illumination is performed taking into account such physical phenomena as attenuation and diffuse scattering of light. The lights are located in the scene in the same place where they would be placed in the real world, and the application calculates the interaction of light with the surfaces of the scene objects;
- Light of the sky and algorithm for calculating global illumination using the Light Tracer method. Light source Skylight is used to simulate the light of the sky. The illumination of each elementary section is calculated as the sum of the illumination by direct rays of light from the sky source and illumination by light reflected from other objects reached by the rays emitted by the firmament. Rendering is faster than using the Radiosity algorithm, which is why the Light Tracer algorithm is preferable for creating animations and street scenes. External scenes calculated by this algorithm can be used both by the Skylight illuminator and the Daylight illuminator system.

In 3ds Max, there are the following light sources [2,3]:

- **Omni light** – light source emitting rays in all directions;
- **Spotlight** – a light source emitting a divergent beam of rays within a given cone or pyramid;
- **Direct light** – a light source that emits a beam of parallel rays, like an omnidirectional source at an infinitely large distance;
- **Ambient light** – A set of light rays falling on a given object as a result of reflection from all other objects of the scene. This light does not have a visible source and a certain direction of propagation;
- **Radiosity** – the change in the illumination of an object due to the rays of light reflected from other objects;
- **Sunlight** – Allows you to quickly render the scene. Simulation of clouds can be done by projecting the corresponding figure;
- **Daylight** – Allows to form a coordinated combination of illuminators, imitating the light of the sky and the light of the sun. Lighting in this case is more convincing and has a greater number of settings for the shadows;
- **Skylight** – Differs from other standard sources of illumination in that imaginary rays of light do not emanate from any single point. The standard

Skylight illuminator uses an algorithm to calculate the global illumination of the Light Tracer.

The tools for creating different light sources are in the Object Type scroll of the Lights category and the Systems command panel Create, shown in Figure 6.1.

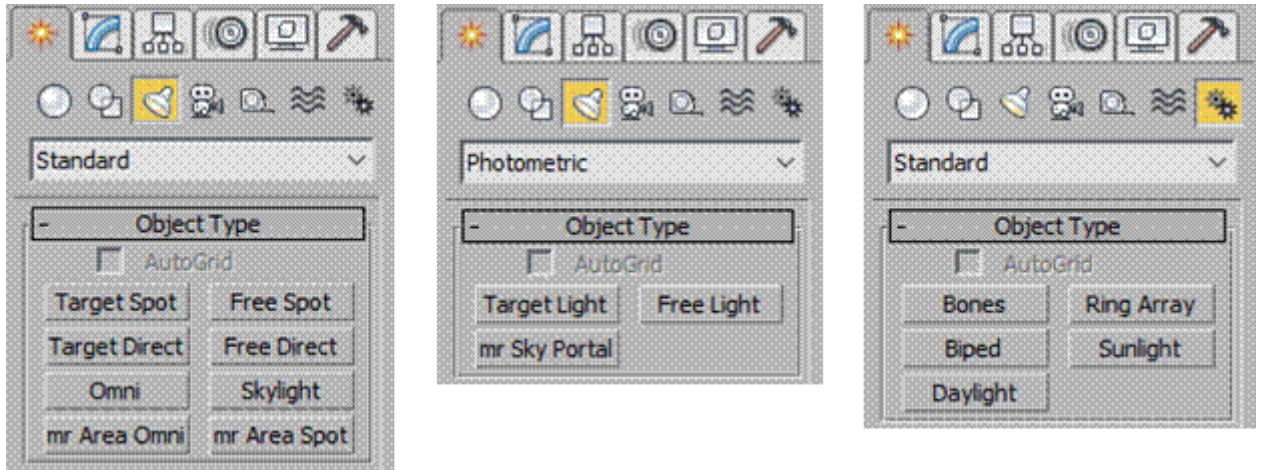


Fig.6.1. Light source panels

The Create panel contains buttons for creating different types of light sources. In this case, there is no button for creating the ambient, because the source of this type of lighting can not be created and placed in the composition of the scene.

Light sources such as Spot and Direct can be targeted or free. They differ only in the way they are used in the scene:

- Target Spot and Target Direct. To create light sources of these types, click in the point of the projection window where it should be located and drag the cursor to the location of its target. The targeted light source is always connected to the target by a straight line, and if the position of the target is changed, the source changes its orientation;

- Free Spot or Free Direct. To create a light source of any of these types, just click on the point of the projection window where it should be located. The direction of the rays of the light source coincides with the negative direction of the Z axis of its local coordinate system.

## 6.2. Ambient light

In the real world, there is no equivalent ambient light. The closest analogy of this type of lighting will be a dim light that you can see under a canopy on a foggy day. It is enough to see surrounding objects, while it does not have a source.

A low ambient light level results in a high contrast in the scene. In Exercise 6.1, we have to adjust the ambient light in our scene and in the system settings. In the latter case, we set the ambient light level, which will be used in subsequent scenes. For better control over the contrast of the scene, it is desirable to set the black color of the ambient light. After that, the ambient light will not have any

effect on the level of illumination of the scene. The increase in the level of illumination is used in night scenes, in scenes with snow and fog.

### Exercise 6.1. Setting the ambient light

15. Open the file "Materials 7.max» from the folder Lesson 3.
16. In this scene, there is an omni-directional light source located in the center of the room, therefore, most of the scene areas are in shadow. The default color of ambient light is black. In other words, the value of the Value parameter of the ambient light color is zero.
17. To change this value, select the Rendering/Environment menu command and click on the Ambient color sample on the right side of the Global Lighting section of the Common Parameters rollout of the Environment and Effects dialog box (Fig.6.2).

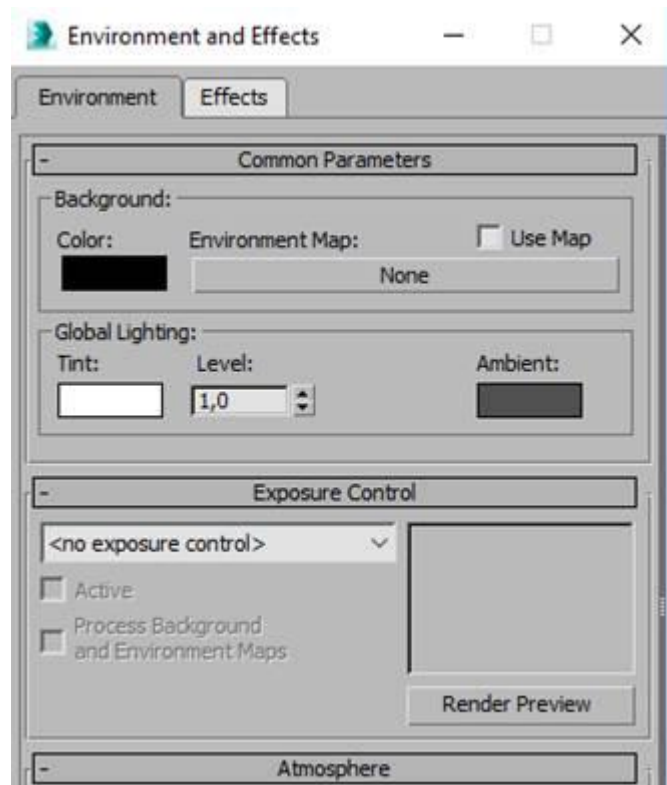


Fig.6.2. Environment Dialog Box

18. Make sure that the central projection window is currently active and click on the Render button to see the current view of the rendered scene. Close the virtual frame buffer.
19. Select the Rendering/Environment command and in the Environment and Effects dialog box, click the Ambient color sample. The Color Selector dialog box appears, in which you will need to move the Value slider to the right to a value of 80. After that, the color of the ambient light will turn gray. Close the Environment dialog box.

20. Click the Render button, you will see a noticeable lightening in the rendering of scene. The image with the gray color of the ambient light is practically devoid of depth, discolored. It looks flat, because it does not have the contrast obtained when comparing the shaded and illuminated areas.
21. Again, open the Environment and Effects dialog box and return the Value slider to a value of 30 (leave a slight lightening). Close the dialog and check the rendering. Save this file as "Light 1.max" in the new folder Lesson 4.

### **6.3. Omnidirectional Illuminator**

Omnidirectional illuminators (Omni) are point sources that emit light in all directions. By default, the lights in 3ds Max do not create shadows, so that the light from the source passes through all objects in the scene. The next exercise is devoted to placing omnidirectional light sources in the scene. So far, we do not face the task of artistic lighting of the stage, we just have to get acquainted with the basic parameters of light sources. An important parameter on which the level of illumination of objects depends is the angle of incidence of light rays. In this exercise, you will see the result of placing the source at different angles to the illuminated objects. You will also learn how to adjust the intensity of the light emitted by the source.

### **6.4. Types of shadows**

In the Shadows section of the General Parameters rollout of the Omni light source, Shadow Map Shadow is selected by default. Shadows are turned on with the On button of the same section. In Shadow Map mode, the program generates raster images of shadows, which are then projected onto the surface of objects. This method of calculation is the fastest and gives shadows with blurred edges. Shadowing is not very realistic, and does not take into account the transparency of objects.

The mode Ray Traced Shadows look realistic, but have sharp edges. Similar type Adv. Ray Traced takes into account the transparency of materials, but gives a more saturated shading and allows blurring of the edges of the shadows.

The Mental Ray Shadow Map mode is used for rendering mode with improved realism Mental Ray.

The color and density of the shadows is adjusted in the Shadow Parameters section with the Color and Density buttons.

### **Exercise 6.2. Setting up the omnidirectional illuminator**

1. Open the file "Light 1.max" from the folder Lesson 4.
2. In this scene, there is already an omni-directional light source Omni 01, which we installed in Exercise 5.1. Go to the central projection window. In order to see the changes in the illumination of the surface depending on the angle of incidence, render the current scene (press the F9 key).

3. Lower the light source to the floor level. Render the central projection window. If you compare the lighting of different objects, then after moving down the most affected floor. It just turned dark, and the ceiling on the contrary became lighter, compare the other objects of the scene. Select Edit\Undo Move to return the light source to its original position.
4. For comparison, you can also use the RAM Player command in the Rendering menu. In this case, it is necessary to load the last visualization one by one in Channel A and Channel B.
5. Let's check the different types of shadows for an omnidirectional source. Enable the drop shadow mode by pressing the On button of the Shadows section. Turn on rendering, check the modes of Shadow Map, Ray Traced Shadows, Adv. Ray Traced, Area Shadows, Mental Ray Shadow Map with subsequent visualization. You can also change the density of shadows in the Shadow Parameters rollout. As you have already noticed, the shadows from this source turn out to be not very beautiful, so turn off the drop shadow mode.
6. Let's consider further the basic parameters of the omnidirectional light source. Select the Omni 01 object. In the Intensity/Color/Attenuation rollout of the Modify command bar, there is a Multiplier counter and a color component window. Click in the color box and try to reduce the intensity of the white light (set the gray light), also choose any color from the color selection window.
7. Changing the color in the window will lead to the creation of an illuminator of the appropriate color, you can check the illumination of the room with various colored lamps. Try what color will the red ceiling with the blue light source?
8. By removing the On checkbox in the Light Type section, you can turn off the illuminator. By the way, try to turn on the rendering after this, while you can count on the appearance in the buffer frames of the "black rectangle of Malevich". But you may not be able to do this, because some of the assigned materials have a self-immolation property, so you will see something.
9. In the Intensity/Color/Attenuation rollout of the Modify command panel, set the Multiplier counter to 2 and render the scene. The brightness of light will increase twice, and the scene will look too light. Now set the counter to 0.5 and re-render. effect of "removing" light from the scene, in the real world such a lamp can be compared to a "black hole".
10. It's a great way to get the viewer's attention to important fragments of the scene. Light with a negative intensity value is usually used to create an attenuation effect, which we will touch on later. In the meantime, duplicate the light source and lower it closer to the floor. Set the amplifier values in the first 3, and in the second (-3) sources.
11. If you combine them with each other, it will be equivalent to the absence of a light source, if you spread them in height you will get an unusual result for virtual scenes, which is shown in Fig. 6.3. The source of black light "black hole" is closer to the floor, the ceiling "illuminates" well and therefore the floor remains light, and the ceiling is almost black.



Fig.7.4. Rendering of the scene through a 24 mm camera

8. From the drop-down list of this group, you can choose either the Depth of Field or Motion Blur effect (Fig.7.2, right). To control the parameters of the selected effect, the corresponding rollout (Depth of Field Parameters).
9. In this rollout, the default focus depth is equal to the depth of the target. The Total Pass field specifies the number of sequential scene renderings required to obtain the desired result. In the Simple Radius field, specify the amount of scene shift for each rendering step.
10. To obtain the final photorealistic image of our scene, specify the number of steps 12 and the value of the original radius of 0.5 mm. The Target Distance field shows the focus distance, this is near the bar stand. Next, run the last rendering in this tutorial, and you can not stop there. The result is shown in Fig. 7.5.
11. You will first see a dark frame buffer window, but gradually with each step there will be an image. In the foreground, the armchair and sofa will be blurred, and the bar stand will be in the center of focus.



Fig.7.5. Rendering a scene with a focus effect

12. I hope you have got some 3D modeling skills and you can either repaint the entire scene or change the lighting yourself after you had made the last point of the last exercise. I wish you success!

## CONCLUSION

This manual reviewed fundamentals of 3D modeling in the 3 ds Max 2018 graphics system. The first chapter described the interface elements: a graphics system viewport, main panels, tools, some system settings, and methods for moving objects in three-dimensional space.

The second chapter presented the fundamentals of two-dimensional modeling, units of measurement setting, creation and editing of flat forms and their rendering.

The third chapter described three-dimensional modeling methods based on two-dimensional forms: extrusion, bevel, rotation, lofting methods.

The fourth chapter described three-dimensional modeling methods based on three-dimensional primitives, editing features of three-dimensional objects at the polygon level, as well as ways of duplicating and collecting objects of the interior taking into account ergonomics.

The fifth chapter reviewed the assignment of materials and textures, the materials editor capabilities, object coloring methods and their application for the scene developed.

The sixth chapter presented methods for creating lighting, illumination types and sources, their installation and configuration.

The seventh chapter described camera installation and configuration, selection of the appropriate camera angles.

Tasks for individual work are given to control the information learnt. The manual also includes questions for assessment, a list of educational and methodical literature.

It should be noted that this manual describes only the foundations of 3D modeling in rather a compact form, were described, but the 3ds Max graphics system capabilities also cover methods for creating landscape objects, environmental effects, improved lighting and rendering methods, and for a wide range of animation tools. With modeling experience, you can independently improve your skill level of this graphic system for your future professional activities. The book can be useful for individuals wishing to learn the basics of three-dimensional computer modeling.

## CONTROL QUESTIONS

1. Describe the graphical interface of the program 3 ds Max 2018. Menu bar. Toolbars. Command panel, modifier. Status bar.
2. How to adjusting project windows? What is the quadruple menu, conversion container. How to move the main panels and dock them?
3. What are the scrolls? How to change the order of the scrolls? How to invoke floating toolbars, and what are they designed for?
4. How to create a new grid? What is the auto-grid mode?
5. How to set up the units of measurement? How do I set the grid spacing? Which snaps to the grid you know?
6. What are shapes? How to create a new shape in the continuation mode for shapes?
7. How is joining to a complex shape? How to convert to an editable spline?
8. How can I align and edit shapes at the level of sub-object? Create a shape for the front wall and windows.
9. How is the editing of the spline vertices done? Create a chair profile.
10. What modifiers of shapes do you know? For what the Fillet/Chamfer modifiers, Trim/Extend?
11. Как осуществляется закругление, фаска, подрезание и наращивание с помощью свитка Geometry?
12. How to create rendered splines? Create a composite form for rendering.
13. What is the Extrude modifier used for? How to extrude a facade wall?
14. How is the Bevel modifier used? How to create a window casing?
15. What is the purpose of the Bevel Profile modifier? How to create a chair?
16. What is the Lathe modifier used for? How to create a plafond?
17. What is the method of lofting? How to create a wall by the method of lofting?
18. How to edit and optimize the density of the wall mesh created by lofting?
19. How to create a bar stand by the method of lofting? How to edit the original shapes for lofting?
20. How to create a bottle by the method of lofting? How does scale deformation and twist of a shape occur?
21. How to create a shelf for dishes from the box using a Lattice modifier?
22. How to create a table of three-dimensional primitives?
23. How to create an armchair from a box, which methods are used?
24. What methods of object duplication exist in 3ds Max? The more different from each other Copy, Instance, Reference?
25. How to attach to the side wall of the shelf and duplicate it?
26. How is duplication and placement of chairs?
27. What types of materials exist in 3ds Max?
28. What is the Material Editor intended for and what parameters does it contain?
29. What are the scrolls for Shader Basic Parameters, Basic Parameters, Maps?
30. How to create a wall and glass material?
31. What is the material of the type Multi/Sub-Object used for? How to assign a material to the loft wall?

32. How to create a material for the floor with tiles? How to create a bump and a reflection?
33. How to assign material to chairs?
34. What is a Raytrace material? How to assign a material to the bar stand?
35. What lighting methods exist in 3ds Max?
36. What types of light sources exist in 3ds Max?
37. How to adjust Ambient brightness?
38. How to install and configure Omni-directional source? What are the basic parameters of the Omni-directional source you know?
39. How to install and configure Target Spot spotlights above the bar stand? How to set the mode of far attenuation of light?
40. How to install spotlights under the ceiling and apply a texture map for them?
41. How to install and configure the light source Free Direct?
42. How to create lighting for wall fixtures? How to exclude shadows for light sources?
43. What are the cameras for in 3ds Max? How is the adjustment of camera parameters?
44. How to install and configure the target camera? How to create focus and blur effects?

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