Digital Photogrammetric System

PHOTOMOD

Version 8.0

USER MANUAL

Three-dimensional modeling (Windows x64)

RACURS

Table of Contents

1. Purpose of the document

This document contains detailed information about features and functions provided by the *3D-Mod* module. The document provides general information about 3D modelling, description of import and export operations of vector objects, about generating and editing of 3D-objects, using light sources and camera, assigning texture to objects, and about work with 3D-scene.

2. 3D-Mod module

The *3D-Mod module* is intended for 3D objects generation, for applying textures to 3D-objects and then to export them to different data formats and further using in third-party software.

Generation of terrain 3D model is called *3D modelling*.

3D model of terrain is a surface, created considering terrain relief. The surface is overlapped by image of vector or raster map along with 3D-objects, that correspond to objects of 2D map.

In order to start *3D-Mod module* perform one of the following actions:

- choose the **Start › Programs › PHOTOMOD 8 x64 › PHOTOMOD 3D-Mod**
- choose **Terrain › 3D-Mod › Start** or click the button of the main system toolbar;
- choose **3D-Mod** in the context menu of *System Monitor module* (the icon in *Windows* system tray).

The module allows to import vector objects from file or open vector objects layer directly from the system.

To generate 3D terrain model, perform the following actions:

1. Load vector objects using one of the following ways:
   - open layer with vector objects in the main system's window and choose **Vectors › Open vectors in 3D-Mod**. The *3D-Mod module starts* and the **Parameters of import and building** window opens.
   - export vector objects to ASCII-A format file (see the chapter "*Vector objects export*" of the "Vectorization" User Manual). Start the *3D-Mod* module.
2. Perform 3D-objects import and generation from ASCII-A format file.
3. Edit 3D-objects.

4. Assign textures to 3D-objects.

5. Create lighting of the scene using light sources.

The following operations are available for generated terrain 3D model:

- export to `*.dxf`, `*.txt`, `*.tx3`, `*.dae`, `*.3ds`, `*.shp` formats;
- scene animation;
- create video file of the scene in AVI or MPEG-4 format.

3. Interface and its elements

3.1. Working windows interface

The *3D-Mod* interface contains the following child windows (sections), grouped within the main **3D-Mod** window:

- Main 3D-scene viewport (always displayed);
- The **Log** window (**Windows › Log**) displays system messages. Located at the bottom of the **3D-Mod** window, hidden by default, displayed automatically if error messages occur;
- The **Track** window (**Windows › Track**) is designed to control the playback of a 3D scene. Located at the bottom of the **3D-Mod** window, displayed by default, and overlaps the relevant toolbar (see below);
- The **Properties** window (**Windows › Properties**) displays toolbars used to control 3D objects and display their properties (see below). Located on the right side (side column) of the **3D-Mod** window, displayed by default;
- The **Script** window (**Windows › Script**) is for creating, loading, editing, and saving so-called *scripts* (scenarios), `*.js` files, containing a program code describing a set of sequential actions that the system must perform. Located on the right side of the **3D-Mod** window, hidden by default.

  The use of *scripts* provides automated execution of a sequence of operations that, in a generic case, are manually launched by the user using the appropriate menu items and toolbar buttons.

  This function is intended for advanced users who know programming languages.

  The **Script** window toolbar contains the following buttons:

  ○ – to create a new script;

- – to load existed script from `*.js` file;
- – to save changes in script and re-write current file;
- – to save new script or changes in current script in the new `*.js` file;
- – to run the script.

To control the visibility of windows, use the **Windows** menu.

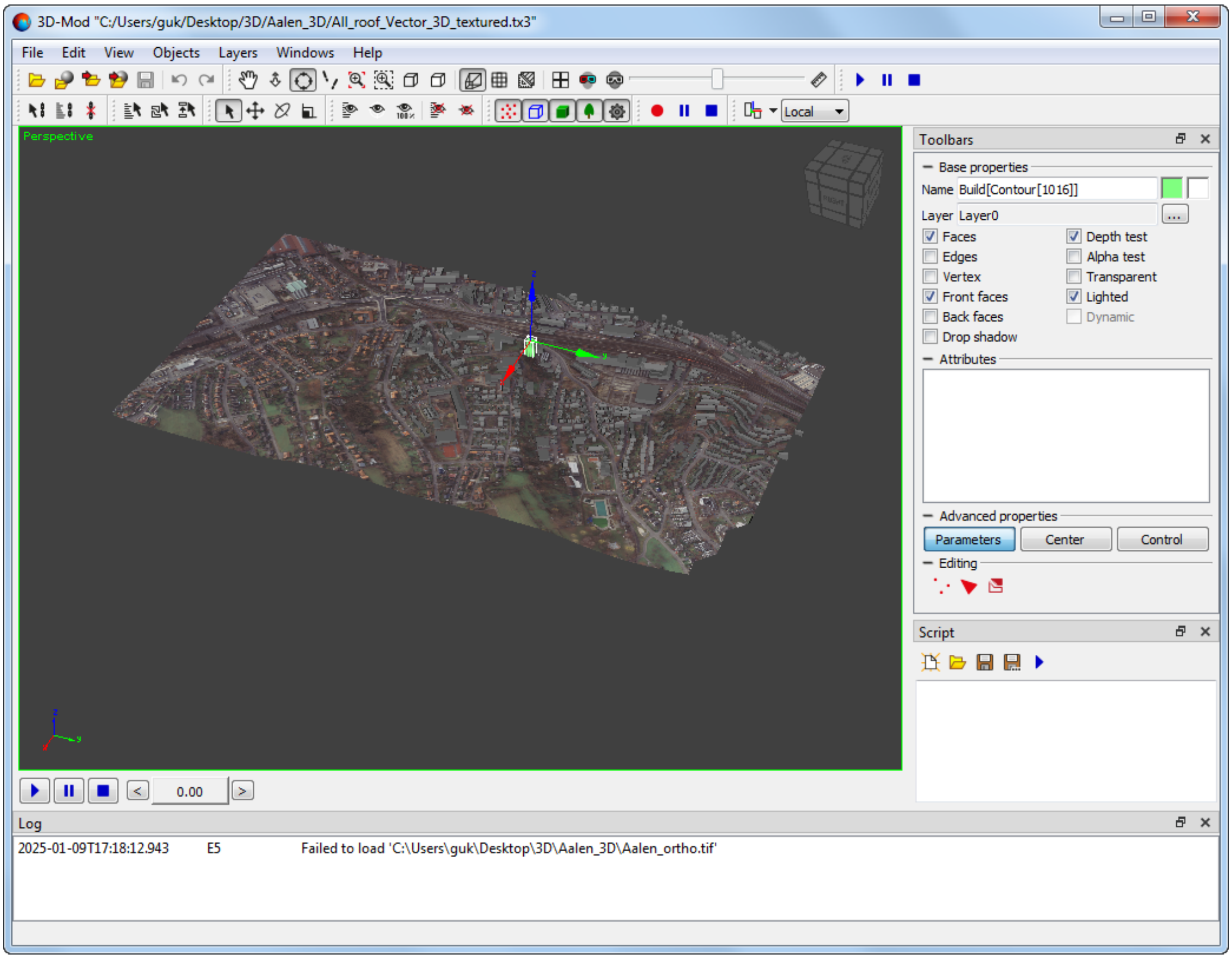


Fig. 1. 3D-Mod module (with all sections displayed)

User interface of the *3D-Mod* module contains the following elements:

- the window title bar, used to display the name of the uploaded file;
- menus *(A)*;
- toolbars *(B, C)*;

The system interface is flexible for customizing the locations of toolbars according to the user's needs. Toolbars can either be fixed in designated sections of the work area (top or bottom, right or left) or undocked by the user and placed in any place in the window.

Depending on the user-set interface configuration, docked toolbars can be partly minimized (some buttons will be hidden). Docked (optionally minimized) toolbars are displayed as one line, vertical or horizontal, depending on their location.

By default, toolbars are docked at the top of the workspace. Toolbars are marked with a special icon located on the left or top (depending on the location) edge of the panel. To maximize the toolbar, click » (︾) on the right (at the bottom).

Undocked toolbars are always displayed horizontally, in one line, in a fully maximized form. To undock a toolbar (or pinpoint it in any place), move the cursor over the icon and, holding down the **left mouse button**, drag the toolbar to the area of its targeted location (the cursor's shape changes ( ) when it is possible to capture the toolbar).

- object properties bars and toolbars *(D)*;
- projective cube *(E)*;
- local coordinate system axes *(K)*;
- 3D-objects *(F)*;
- scene replay toolbar (G);
- global coordinate system axes *(H)*;
- orthomosaic sheet *(L)*;
- bounding box *(M)*;
- name of current projection *(N)*.

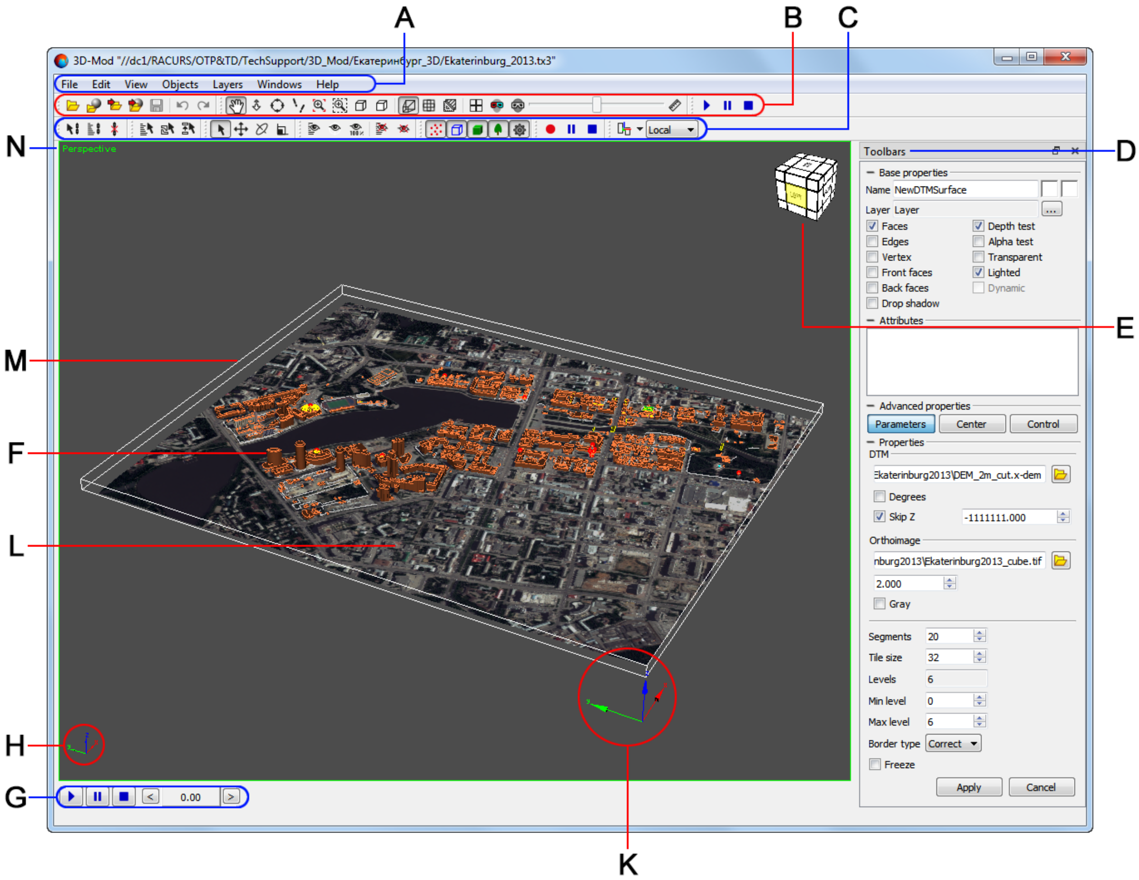


Fig. 2. 3D-Mod module (default configuration)

3.2. Brief description of module menu

The main module menu contains menu items used to import / export objects, to work with objects, to manage view area and set of displayed objects, and to setup different parameters.

Table 1. Main module menu

Menu	Function
File	to open, save 3D-scene, import objects to 3D-scene or to export objects
Edit	to select scene objects using different ways, assign textures to 3D-objects
View	to manage 3D-scene displaying
Objects	to manage 3D-scene content displaying
Layers	to manage 3D-scene layers
Windows	to manage *3D-Mod* sub-windows visibility
Help	to open **User Manual**

3.3. Toolbars

Table 2. Description of toolbar for saving and loading 3D-scene

Buttons	Function
	to open 3D-scene from `*.tx3` file
	to open 3D-scene from active profile resources (`*.json`)
	to import objects to 3D-scene from `*.txt`, `*.tx3`, `*.3ds`, `*.obj`, `*.glb`, `*.gltf`, `*.b3dm` or `*.json` files
	to import objects to 3D-scene from active profile resources (`*.json`, `*.b3dm`)
	to save 3D-scene changes
	to cancel the last operation
	to repeat the last cancelled operation

Table 3. Description of toolbar for managing of 3D-scene displaying

Buttons	Function
	to move view area of 3D-scene in any direction
	to move view area of 3D-scene perpendicular to the screen plane
	to rotate 3D-scene view area
	to move view area of 3D-scene, with imitation of the scene observation from camera.
	to zoom in/zoom out view area
	to zoom in of 3D-scene view area selected by rectangle
	to implement a comprehensive display of all objects of 3D-scene
	to display an area only with selected objects of 3D-scene
	to turn the perspective mode on, i.e. to display 3D space in 2D plane
	to show coordinate grid
	to show scale bar
	to display 3D-scene in four types of projections
	to turn on anaglyph stereo mode
	to turn on page-flipping stereo mode
	to turn on measurements mode

Table 4. Description of toolbar for 3D-scene playback management

Buttons	Function
	to start 3D-scene playback
	to temporarily stop 3D-scene playback
	to pause 3D-scene playback

Table 5. Description of toolbar for objects attaching mode management

Buttons	Function
	to turn objects attaching mode on to move objects simultaneously

Buttons	Function
	to select objects from the list to attach objects and simultaneously move them during scene playback
	to turn objects attaching mode off for selected objects

Table 6. Description of toolbar for objects attaching mode management

Buttons	Function
	to select objects from the list in view area using their names
	to highlight scene elements, that were not used for objects generation
	to highlight both the whole object, and all elements used for objects generation

Table 7. Description of toolbar for objects editing

Buttons	Function
	to turn on objects selection mode in view area
	to turn on moving of selected objects in view area
	to turn on rotating of selected objects
	to turn on zoom of selected objects

Table 8. Description of toolbar for objects visibility management

Buttons	Function
	to display in view area previously hidden objects using their names in the list
	to display only selected objects in view area;
	to display all layer objects in view area;
	to hide only selected objects in view area;
	to hide in view area objects using their names in the list

Table 9. Description of toolbar for managing of objects displaying

Buttons	Function
	to turn on/of selected point objects display
	to turn on/of display of outlines of objects external faces
	to turn on/of buildings display
	to turn on/of standard library objects display
	to turn on/of display of auxiliary objects (for example, dummy object, light source)

Table 10. Description of toolbar for 3D-scene recording

Buttons	Function
	to record and save 3D-scene in AVI or MPEG-4 format
	to pause recording of 3D-scene
	to stop recording of 3D-scene

Table 11. Description of toolbar for coordinate systems management

Buttons	Function
	to display in view area coordinate system axis for each selected object
	to display in view area the same coordinate system axis for all selected objects

4. Objects import and export

4.1. The “File” menu

Table 12. Brief description of the File menu

Menu items	Function
Open	to open 3D-scene from `*.tx3` file
Open from resources	to open 3D-scene from active profile resources (`*.json`)
Previous	to open one of recent 3D-scenes
Save	to save opened 3D-scene to `*.tx3` file
Save as	to save opened 3D-scene to file with another name and `*.tx3` extension
Save scene image	to save 3D-scene image to BMP format
Import...	to import objects to 3D-scene from `*.txt`, `*.tx3`, `*.3ds`, `*.dae`, `*.obj`, `*.glb`, `*.gltf`, `*.b3dm` or `*.json` files
Import from resources	to import objects to 3D-scene from active profile resources (`*.json`, `*.b3dm`)
Export...	to export objects from 3D-scene to `*.dxf`, `*.txt`, `*.tx3`, `*.dae`, `*.3ds`, `*.shp`, `*.obj`, `*.gltf`, `*.b3dm` or `*.json` file
Export selected...	to export only selected objects from 3D-scene to `*.dxf`, `*.txt`, `*.tx3`, `*.dae`, `*.3ds`, `*.shp`, `*.obj`, `*.gltf`, `*.b3dm` or `*.json` file
3D-models batch conversion	for batch export from *3D-Mod*-supported files or resources (`*.json`, `*.obj`) into a single `*.obj`-file
Settings	to open **Settings** window
Close	to close 3D-scene
Exit	to close the module*3D-Mod*

4.2. Import

4.2.1. Import from PHOTOMOD

In order to import vector objects from *PHOTOMOD* software perform the following actions:

1. Open at least one layer with vector objects in *PHOTOMOD* system and select **Vectors › Open vectors in 3D-Mod**. The *3D-Mod* module and the **Parameters of import and building** window opens:

The **Additional parameters** button allows to set additional parameters of objects import in **Texturing** tab.

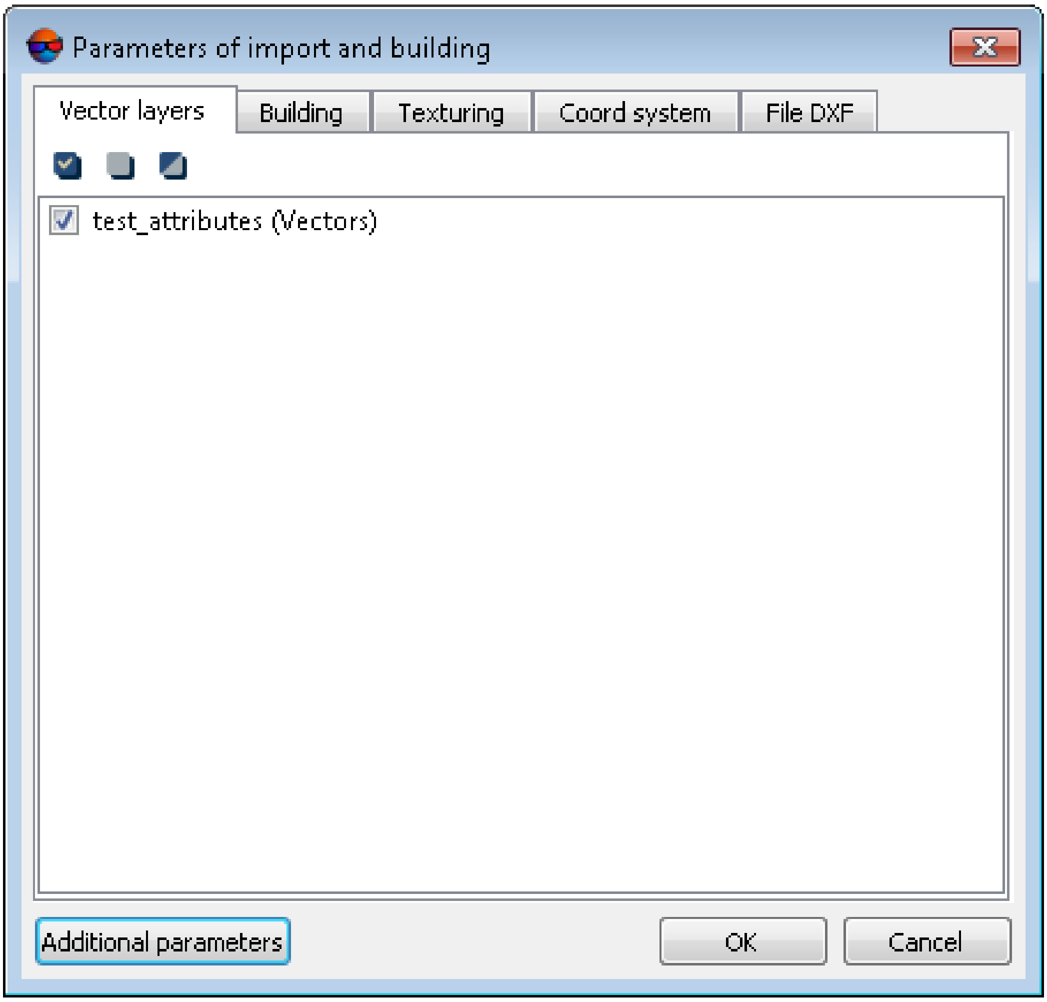


Fig. 3. The Parameters of import and building window

2. To select the **vector layers** to be imported, set or clear the appropriate checkboxes.

   The **Vector layers** tab contains the following buttons:

   - – allows to select all items in the list;
   - – allows to deselect all items in the list;
   - – allows to invert items selection.

3. Choose the **Building** tab. To build 3D-objects by default the **Make 3D building** checkbox is set on. Otherwise the system performs import of 2D-objects.

   For correct 3D-objects generating set the following checkboxes on: **Use objects without assignment**, **Build objects from closed lines** and **Include points to 3D modeling**.

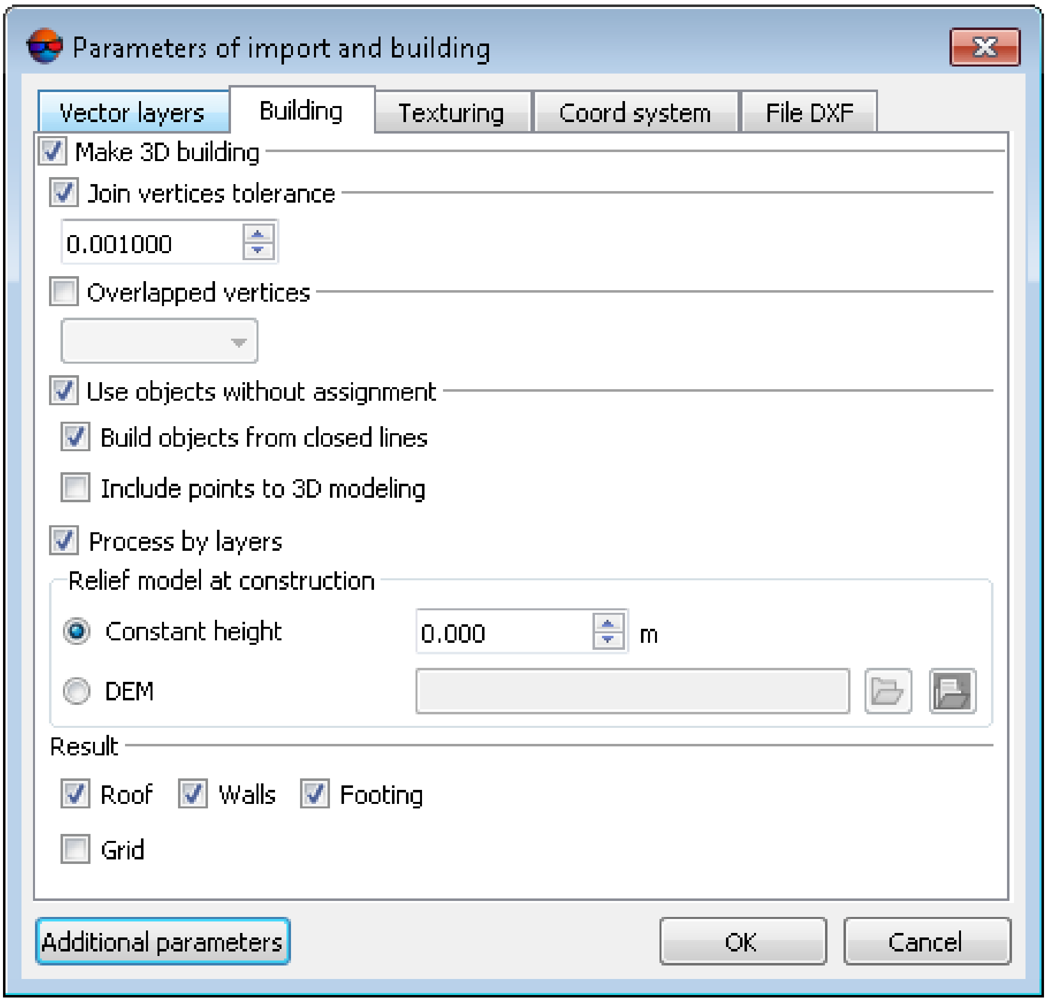


Fig. 4. The Building tab

3D building parameters depend not only on the settings specified in the **Building** tab, but also on the mode of construction of vector objects themselves in the *PHOTOMOD* (in particular, on the topological connectivity of elements of complex objects - see the “Roofs creation” section of the “Vectorization” User Manual).

4. To merge vertices, the distance between which is less than specified, the **Join vertices tolerance** checkbox is set on by default.

5. [optional] When importing vertices with the same X,Y-coordinates, set the **Overlapped vertices** checkbox on and select option of coordinates use from the drop-down list.

6. In order to use objects without attributes during 3D-building the **Use objects without assignment** and **Build objects from closed lines** checkboxes are set on by default.

7. [optional] In order to use points without attributes during 3D-building set the **Include points to 3D modelling** checkbox on.

8. To process vector objects separately in each layer the **Process by layers** checkbox is on by default.

   To accelerate 3D-building operation, and for correct work with layers it is highly recommended to set the **Process by layers** checkbox on.

9. Select the **relief model in construction**:

   • [optional] in the **Constant height** field specify an elevation level – the lower boundary of 3D-objects construction;

   • [optional] click the button and select a file with **source DEM**, which defines the lower boundary of 3D-objects construction.

     Click the button to open the **Layer selection** window and select the **source DEM** from the list of DEMs uploaded to the project.

10. To include to 3D-modelling roofs, walls, and footings of buildings, the **Roof**, **Walls** and **Footing** checkboxes are on by default in the **Result** section.

11. [optional] To convert object into a grid set the **Mesh** checkbox on.

    Set the **Mesh** checkbox if the **texturing** of imported objects is intended (see below).

12. [optional] In the **Texturing** tab, set the **Build textures** checkbox to import a textured objects:

    Texturing of the imported objects is carried out using images of the loaded project.

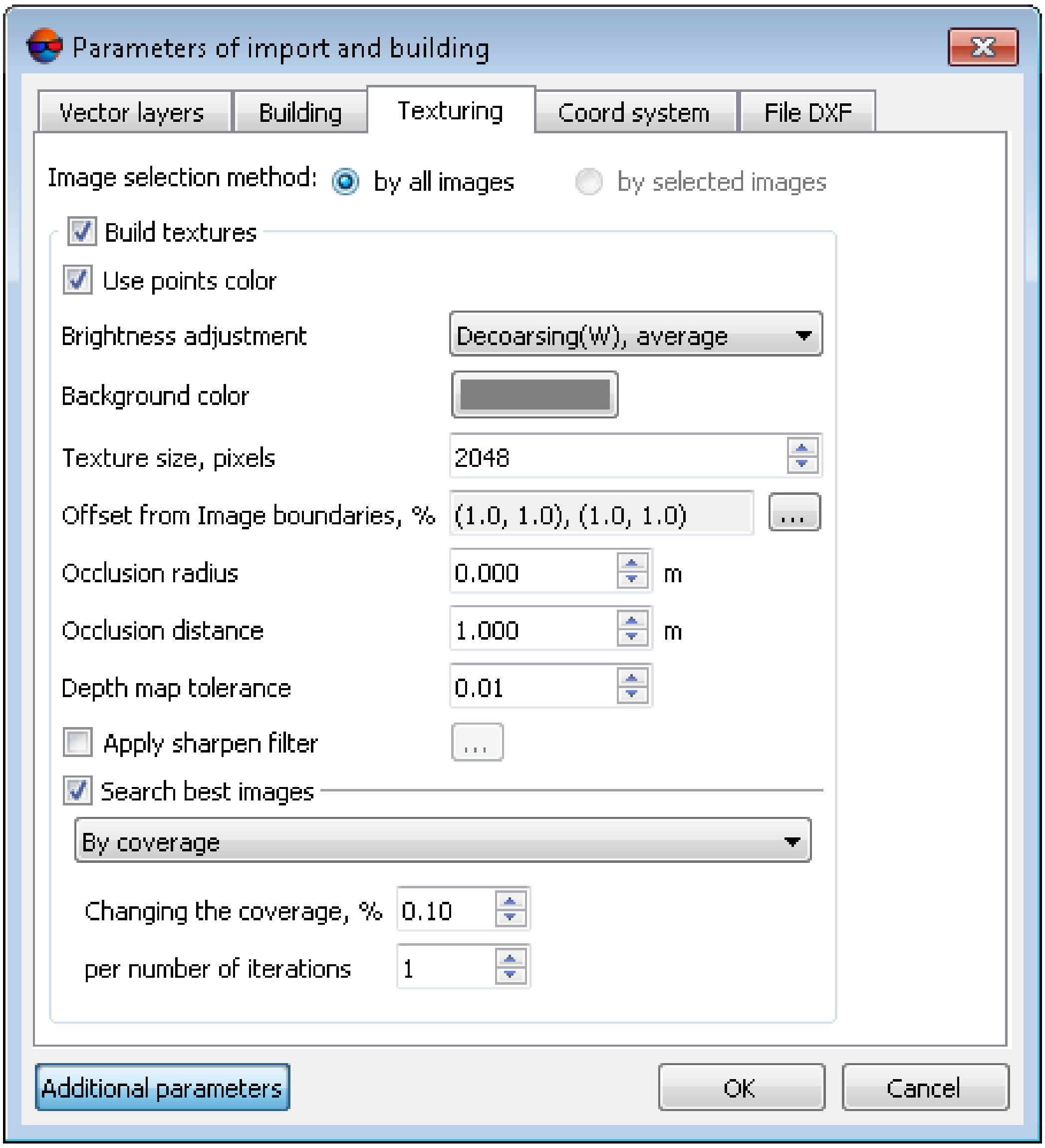


Fig. 5. The Texturing tab

Set the main parameters of the textures creation:

- Choose the **brightness adjustment** method for equalizing brightness between textures:
  - **Best**;
  - **Average**;
  - **Decoarsing, best**;
  - **Decoarsing, average**;
  - **Decoarsing, nearest**;

- ○ **Decoarsing (W), best**;
- ○ **Decoarsing (W), average**;
- ○ **Decoarsing (W), nearest**.

All images covering a object fragment under processing are involved in the color calculation. **Brightness adjustment** allows a user to create a visually unified and continuous object by smoothing out differences between the brightness and contrast characteristics of its individual fragments.

The proposed techniques for calculating the color of the final pixel of a object generally come down to either using the average brightness and contrast characteristics of the relevant pixels of all images involved or to using the color of a pixel of a specific image that best satisfies certain conditions, i.e., maximum proximity to the projection center and the smallest off-nadir angle at a given point on the object.

Averaging the characteristics of all involved images usually leads to the creation of visually continuous 3D model textures devoid of sharp transitions between areas with different color, brightness, and contrast characteristics. A disadvantage of such a technique is the possible blurring that may occur in certain circumstances in some areas of object textures.

The use of brightness characteristics of individual images recognized as the most suitable when calculating a specific pixel, in turn, leads to the greatest reliability when creating textures for individual fragments, negatively affecting, in certain cases, the quality of brightness adjustment across the entire object as a whole.

Automatic filtering allows users to pre-exclude from processing those images in which the brightness and contrast characteristics of the area of interest differ significantly from the majority of images covering the given area (for example, if a particular image was created under changed lighting conditions).

The user also has the option to preliminarily select images intended for creating textures, manually rejecting unsuitable images (see below).

- Select the **background color** used when texturing fragments of the object that are not displayed in any of the project images used (being in so-called “occluded zones”);
- Specify the **image selection method**:
  - ○ **by all images**;
  - ○ **by selected images**.

The **image selection method** can have a significant impact on the **brightness adjustment** between the textures of object fragments (see above), especially if images with noticeably different spectral and brightness characteristics (for example, taken with a significant time interval, e.g., in different seasons, under different lighting conditions, etc.) are used for project processing.

- Set the **Texture size**, in pixels;

It is recommended to set the **Texture size** exceeding the **Tile size** (see above) at least twice (or more). Increasing of this parameter results in increased texture resolution and increased time of building:

  ○ If the **Tile size** is 64, the recommended **Texture size** is 256.

  ○ If the **Tile size** is 32, the recommended **Texture size** is 128.

If the *Remote Desktop Protocol* (*RDP*) is used for the access to the workstation with *PHOTOMOD* installed, then to ensure correct visual assessment of texturing results, it is strongly recommended to set the **Texture size** not exceeding 1024 pixels and divisible by powers of 2 (2, 4, 8, 16, 32, 64, 128, 256, 512, 1024).

Otherwise, due to the peculiarities of the *Remote Desktop Protocol*, correct display of object textures on the screen of a computer remotely connected to a workstation with *PHOTOMOD* installed is not ensured.

RDP is the *Remote Desktop Protocol* supported by *Microsoft* used to work remotely with another computer. This technology allows for controlling a remote computer at a distance, from the user's workstation, using an Internet connection.

- In order not to use boundary regions of imagery while texturing, set the **Offset from image boundaries, %** by clicking the ... button. The **Image margin** window opens. Set image margins in percent which are not to be involved in texturing;

It may be necessary so that only useful part of an image was textured (e.g. while processing projects with analog imagery as source data).

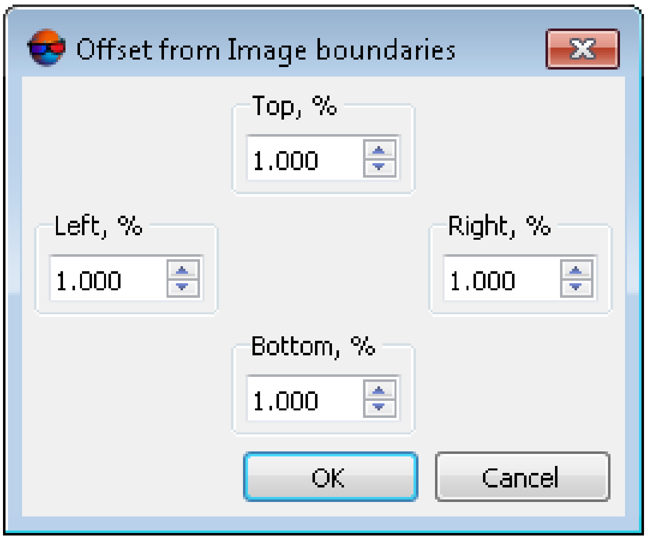


Fig. 6. The Image margin window

Fig. 7. Offset from image boundaries, %

- Set the **Occlusion radius** in pixels when texturing overlapping objects;

> Recommended **Occlusion radius** is several pixels. If this parameter is set to zero, invisible areas will not be checked what may result in incorrect texturing of overlapping objects (especially when processing projects with “oblique” survey data as source data).

- Set the **Occlusion distance** – minimum distance to invisible areas in the project units (i.e. minimum distance between overlapping objects). Invisible areas will be verified when this distance is exceeded.

> Invisible area check will not be performed if the **Occlusion radius** (see above) is equal to zero.

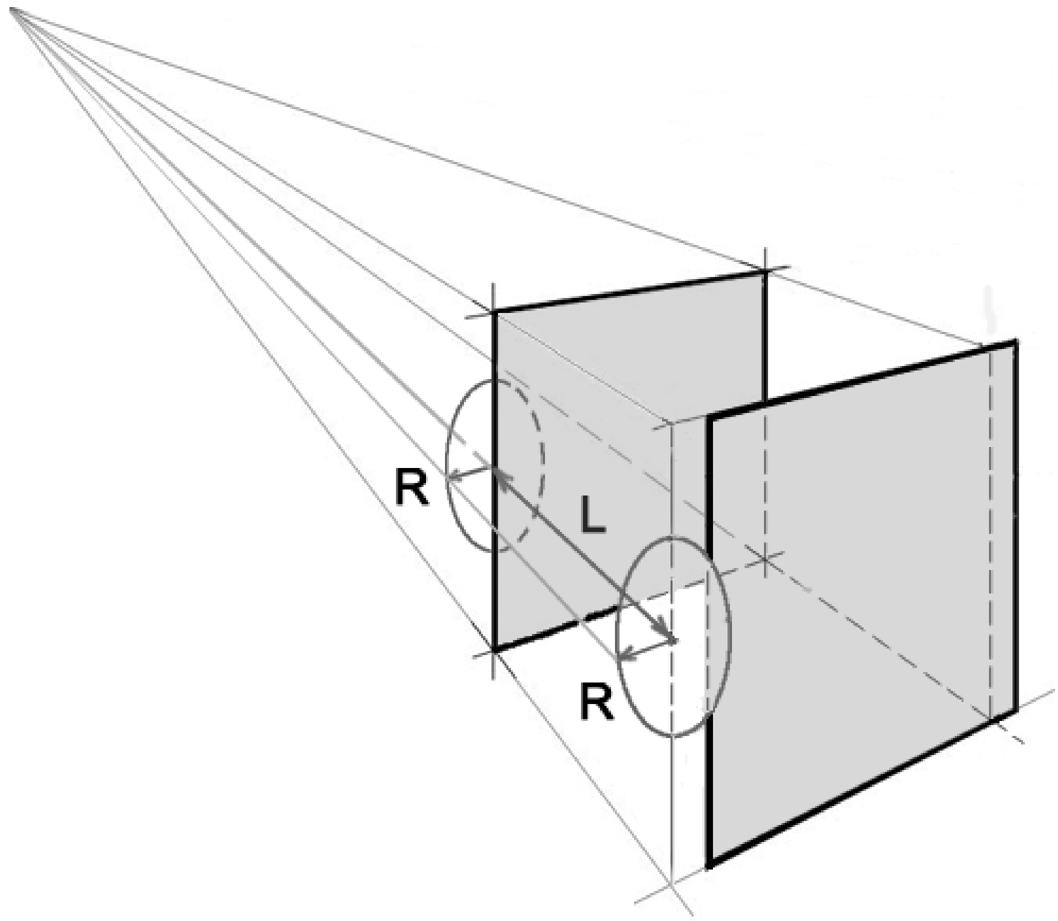


Fig. 8. Invisible areas when texturing overlapping objects (hatched), where R is the **Occlusion radius** and L is the **Occlusion distance**

[optional] to set the **Additional parameters** of textures creation click the appropriate button:

- Set the **Depth map tolerance** in the project units. The **Occlusion distance** is calculated on the base of the depth map;
- [optional] set the **Apply sharpen filter** checkbox and click the ... button to open the **Filter parameters** window:

The sharpen filter allows to highlight and intensify differences between image's individual details (image sharpness). See the "Radiometric correction" chapter of the "General information" User Manual.

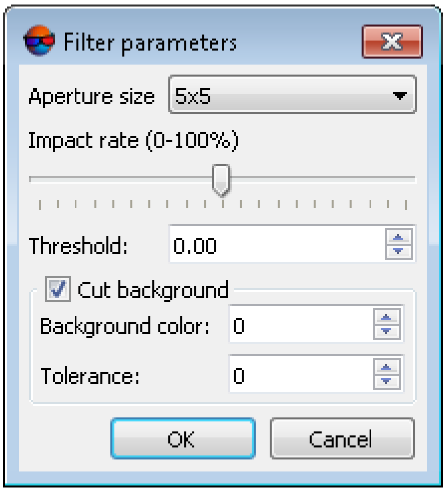


Fig. 9. Filter parameters

Set the following parameters:

○ In the **Aperture size** list define the matrix size from 3x3 pixels to 21x21 pixels.

○ Move slider to define **Filtering level** in percent.

○ Set the **Threshold**.

Each single image element is filtered only if the brightness difference between adjacent elements exceed the given filtering **Threshold**. This helps to avoid errors looking as spots in the areas of an image with originally uniform hues.

○ [optional] Be default the **Cut background** checkbox is set on for removing background on image edges. To remove background set the following parameters:

■ **Background color** – value of background color for cutting;

If the 0 value is set in the **Background color** field, background does not consider during correction.

■ **Tolerance** – deviation from background color value for cutting.

○ Click OK to close the window.

• [optional] The system allows the user to speed up the process of 3D-TIN texturing by limiting the number of images used. To do this, set the **Search the best images** checkbox and select the criterion for terminating the selection process:

○ **By coverage**;

- Set minimum coverage change (in percent) for a certain number of iterations;

- **By iterations**.
  - Set maximum **number of iterations**;

For each object fragment, the selection of the best images is performed. If after the texturing process completion there are areas unfilled with textures, the selection of the best images (from among the unused ones) is repeated, either until the maximum user-defined number of iterations specified is reached, or until the process loses its efficiency, according to the criteria specified by the user (minimum texture coverage change for the specified number of iterations).

13. [optional] In order to swap coordinate system, set the **Swap X and Y** checkbox on in **Coord system** tab.

If the **Swap X and Y** checkbox is off, the initial data will be imported in the right coordinate system. Otherwise, in the left one.

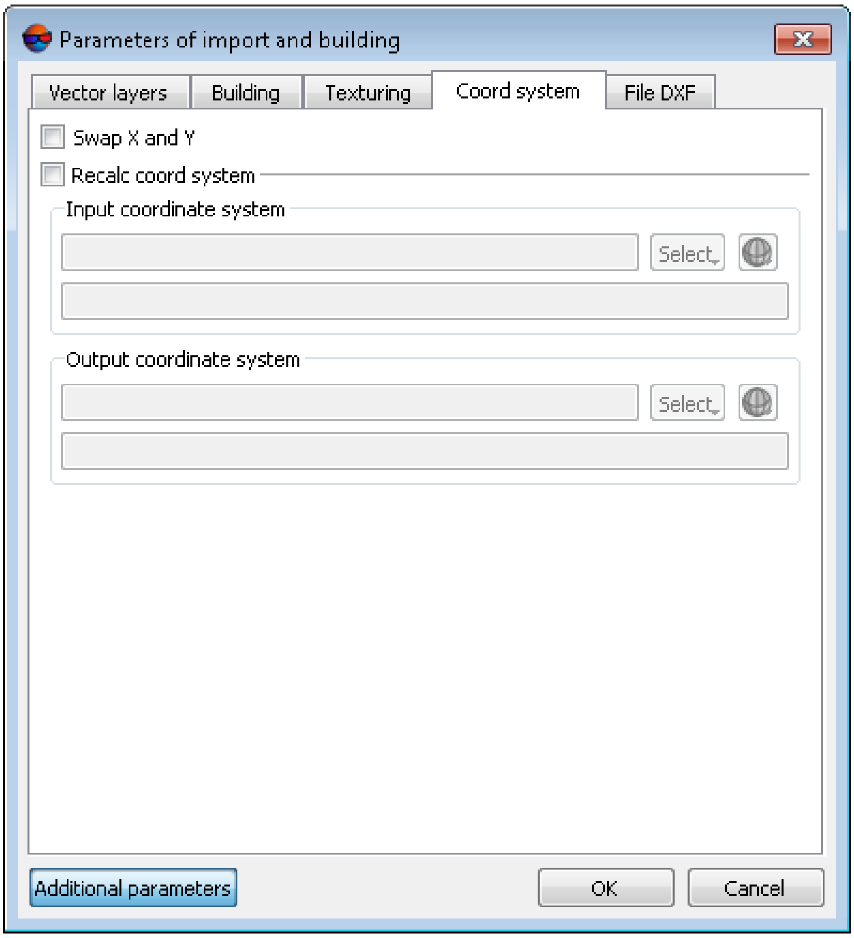


Fig. 10. The Coordinate system tab

14. [optional] To define standard parameters set the **Recalc coord system** checkbox on.

15. [optional] To clarify geometry of point objects, open the **File DXF** tab. Click the button and select `*.tx3` file with description of point objects.

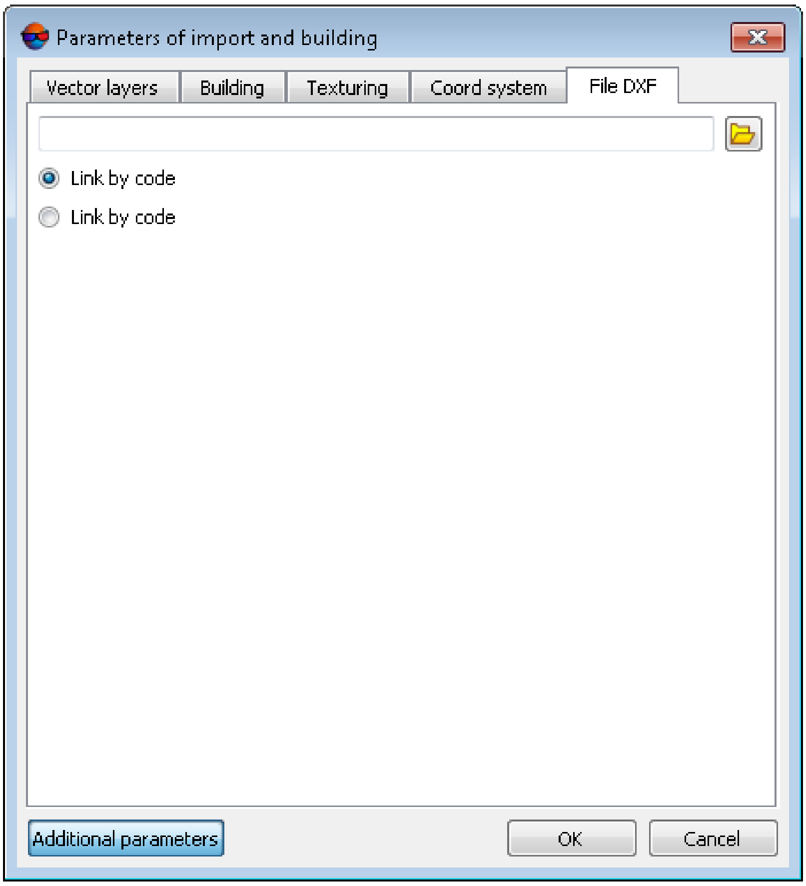


Fig. 11. Parameters of DXF-file import

Select the attributes associated with the classifier entry that allow one to correlate point objects and 3D objects in the reference file:

- [optional] **Link by code** – allows to match point objects with description of point objects provided in DXF-file, using object code;
- [optional] **Link by codename** – allows to match point objects with description of point objects provided in DXF-file, using object codename.

16. Click OK to complete the import operation.

After import points are displayed in the module with the color similar to layer color in the system.

4.2.2. Import from ASCII-A and 3D-building

The module provides possibility to import vector objects from ASCII-A format. ASCII-A format contains information about coordinates of vector objects vertices, and about object type, layer number, attributes name and value.

Files of this format have the `*.txt` extension. In contrast with ASCII format, in ASCII-A format the object description is supplemented by starting lines, containing description of object type and attributes.

An example of ASCII-A file format:

```
L 101 1 13 4

OBJECT_NAME=Highway

OBJECT_COLOR=3

OBJECT_SYMBOL=R

OBJECT_SIZE=5.5

545566.505,473671.817,77.850

545715.103,473656.072,78.310

545782.001,473567.393,78.156

545860.428,473463.139,77.974

545847.506,473339.305,77.380

545795.032,473249.288,76.795

545517.126,473365.500,76.318

545269.605,473463.426,75.869

*
```

The first line of an object description has the following structure:

`Type Code Layer N1 N2`, where:

- Type - the symbol describing an object type:
  - L – polyline;

  - `P` – point;
  - `C` – polygon.

- Code - the code of an object;
- Layer - the layer number;
- N1 - the total number of lines of an object description;
- N2 - the number of lines describing object attributes.

Then there are lines with descriptions of attributes like follows:

```
Name=Value
```

Then follow the lines with the object points coordinates. The sequence of records is delimited by the `*` symbol.

In order to import vector objects from ASCII-A format perform the following actions:

1. Choose **File › Import** or click the  button. Select the ASCII-A file.The **Parameters of import and building** window opens on the **Sources** tab.

   The **Additional parameters** button allows to set additional parameters of objects import in **Texturing** tab.

   Texturing of the imported objects is carried out using images of the loaded project (available in case of the vector objects import from *PHOTOMOD* software, see the previous chapter).

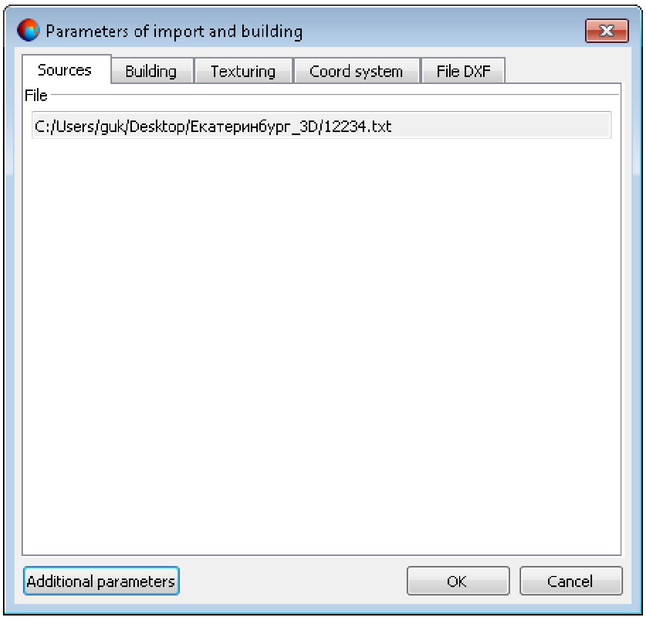


Fig. 12. The Parameters of import and building window

2. Choose the **Building** tab. To build 3D-objects by default the **Make 3D building** checkbox is set on. Otherwise the system performs import of 2D-objects.

For correct 3D-objects generating set the following checkboxes on: **Use objects without assignment**, **Build objects from closed lines** and **Include points to 3D modeling**.

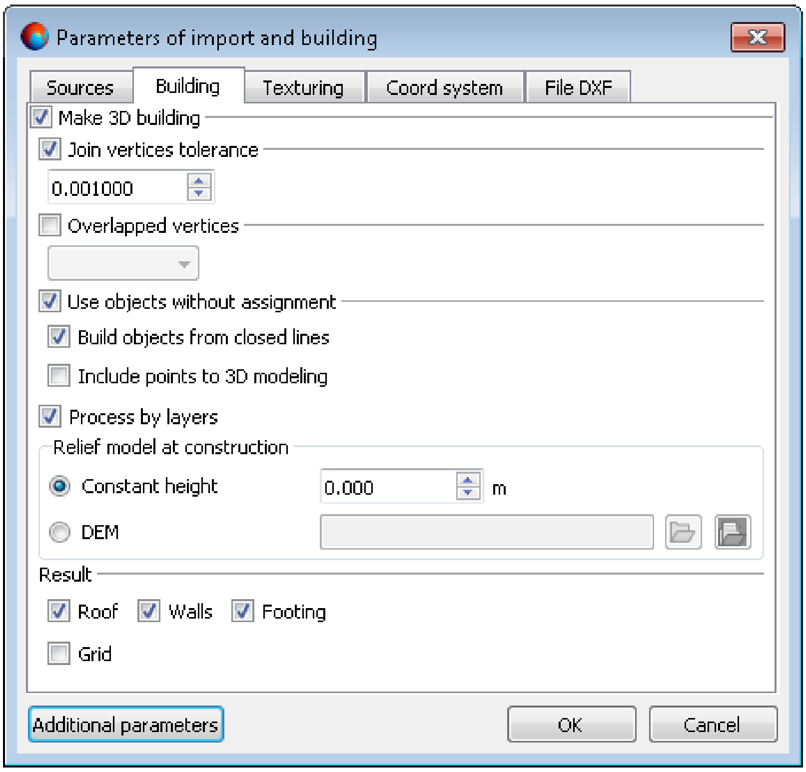


Fig. 13. Parameters of 2D-objects import

3. To merge vertices, the distance between which is less than specified, the **Join vertices tolerance** checkbox is set on by default.

4. [optional] When importing vertices with the same X,Y-coordinates, set the **Overlapped vertices** checkbox on and select option of coordinates use from the drop-down list.

5. In order to use objects without attributes during 3D-building the **Use objects without assignment** and **Build objects from closed lines** checkboxes are set on by default.

6. [optional] In order to use points without attributes during 3D-building set the **Include points to 3D modelling** checkbox on.

7. To process vector objects separately in each layer the **Process by layers** checkbox is on by default.

To accelerate 3D-building operation, and for correct work with layers it is highly recommended to set the **Process by layers** checkbox on.

8. Select the **relief model in construction**:

   • [optional] in the **Constant height** field specify an elevation level – the lower boundary of 3D-objects construction;

   • [optional] click the button and select a file with **source DEM**, which defines the lower boundary of 3D-objects construction.

   Click the button to open the **Layer selection** window and select the **source DEM** from the list of DEMs uploaded to the project.

9. To include to 3D-modelling roofs, walls, and footings of buildings, the **Roof**, **Walls** and **Footing** checkboxes are on by default in the **Result** section.

10. [optional] To convert object into a grid set the **Mesh** checkbox on.

11. [optional] In order to swap coordinate system, set the **Swap X and Y** checkbox on in **Coord system** tab.

    If the **Swap X and Y** checkbox is off, the initial data will be imported in the right coordinate system. Otherwise, in the left one.

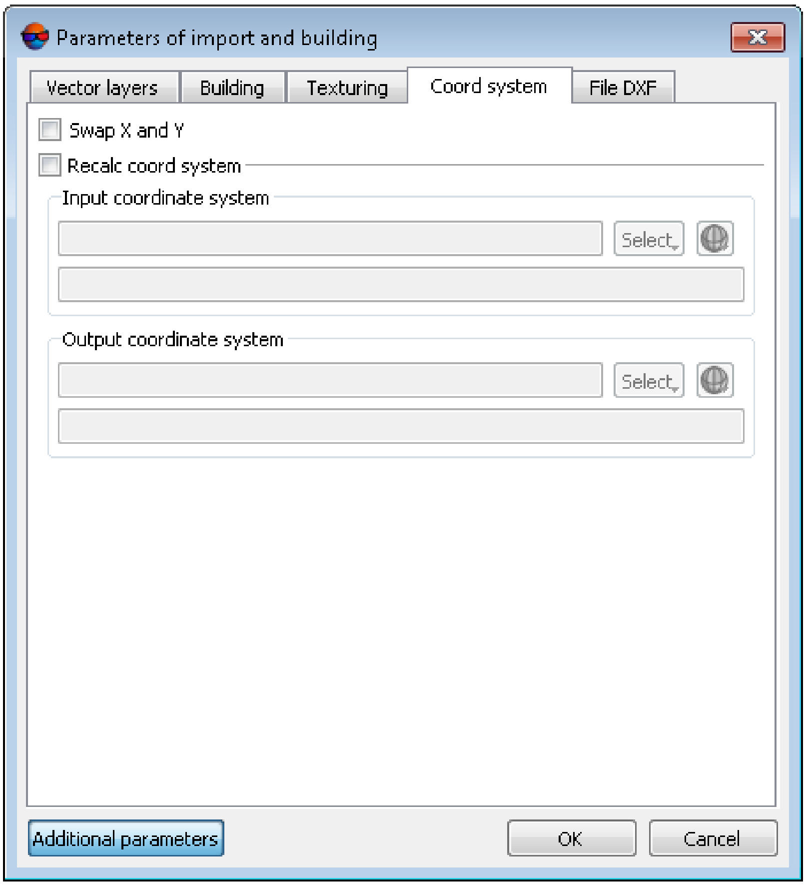


Fig. 14. The Coord system tab

12. [optional] To define standard parameters set the **Recalc coord system** checkbox on.

13. [optional] To clarify geometry of point objects, open the **File DXF** tab. Click the button and select `*.tx3` file with description of point objects.

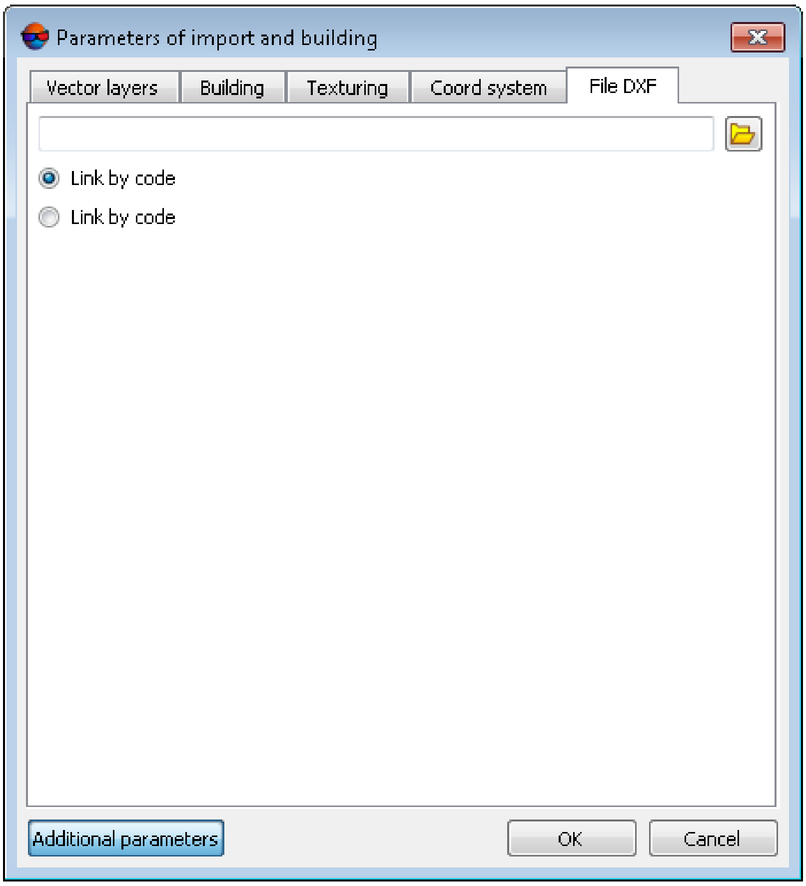


Fig. 15. Parameters of DXF-file import

Select the attributes associated with the classifier entry that allow one to correlate point objects and 3D objects in the reference file:

- [optional] **Link by code** – allows to match point objects with description of point objects provided in DXF-file, using object code;
- [optional] **Link by codename** – allows to match point objects with description of point objects provided in DXF-file, using object codename.

14. Click OK to complete the import operation.

After import points are displayed in the module with the color similar to layer color in the system.

4.2.3. Import from ASCII3D, COLLADA, OBJ, GLB, GLTF, B3DM and JSON

The module provides possibility to import 3D-scene from ASCII3D, COLLADA, OBJ, GLTF, B3DM and JSON formats:

- To import 3D-scene from ASCII3D format select **File › Import**. The **Import** window opens. In the **File type** list select **ASCII3D (*.tx3)**, then select desired file by mouse click and click the **Open** button;
- To import 3D-scene from COLLADA format select **File › Import**. The **Import** window opens. In the **File type** list select **COLLADA (*.dae)**, then select desired file by mouse click and click the **Open** button;
- To import 3D-scene from OBJ format select **File › Import**. The **Import** window opens. In the **File type** list select **OBJ (*.obj)**, then select desired file by mouse click and click the **Open** button;
- To import 3D-scene from GLB format select **File › Import**. The **Import** window opens. In the **File type** list select **GLB (*.glb)**, then select desired file by mouse click and click the **Open** button;
- To import 3D-scene from GLTF format select **File › Import**. The **Import** window opens. In the **File type** list select **GLTF (*.gltf)**, then select desired file by mouse click and click the **Open** button;
- To import 3D-scene from B3DM format select **File › Import**. The **Import** window opens. In the **File type** list select **B3DM (*.b3dm)**, then select desired file by mouse click and click the **Open** button.
- To import 3D-scene from JSON format select **File › Import**. The **Import** window opens. In the **File type** list select **Multilevel model (*.json)**, then select desired file by mouse click and click the **Open** button.

4.2.4. Import from 3DS

The module provides possibility to import 3D-scene from 3DS format. 3DS format file contains data about grid, object attributes, 3D-objects animation and so on. Files of this format have the `*.3ds` extension.

In order to import 3D-scene from 3DS format perform the following actions:

1. Select **File › Import**. The **Import** window opens. In the **File type** list select `3DS (*.3ds)`, then select desired file by mouse click and click the **Open** button. The **Import 3DS** window opens.

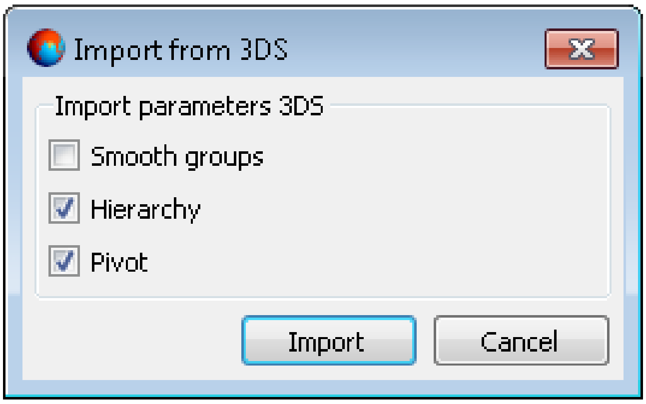


Fig. 16. Parameters of import from 3DS format

2. [optional] In order to import object faces with c smoothing groups, set the **Smoothing groups** checkbox on (more details about smoothing groups see in Section 6.5.6).

3. To import relations established between scene's objects the **Hierarchy** checkbox is set on by default.

4. To import coordinates of 3D-scene center the **Origin** checkbox is set on by default.

5. Click the **Import** button to complete the import.

4.2.5. Import from 3D-TIN

The system allows to create textured 3D-TIN surfaces (see the "Creation of textured TIN 3D surface" chapter of the "DTM Generation" User Manual). The output format of textured 3D-TIN surfaces is `*.json`. 3D-TIN fragments (tiles, with `*.b3dm` extension) are saved in the separate directory (with the same name) in the folder chosen for output 3D-TIN saving, in the active profile's resources.

The 3D-Mod module provides possibility to import 3D-TIN from active profile resources.

To import 3D-TIN from active profile resources select **File › Import from resources** or click the of the main toolbar. In the **File type** list select **3D-Mod files**, then select desired file with `*.json` extension by mouse click and click the **Open** button.

To import separate 3D-TIN fragment (tile) from active profile resources select **File › Import from resources** or click the of the main toolbar. In the **File type** list select **3D-Mod files**, then select desired file with `*.b3dm` extension by mouse click (in the separate directory of the folder chosen for output 3D-TIN saving) and click the **Open** button.

4.3. Export 3D-Mod data

The system provides possibility of data export to the following formats:

- **DXF** – exchange format with `*.dxf` extension, that is used in *AutoCAD software*;
- **ASCII-A** – exchange text format with `*.txt` extension, which is supported by major applications in different industries;

  Export to this format is provided only for polylines/polygons and points (see the “Vectorization” User Manual).

- **ASCII3D** – exchange format with `*.tx3` extension;
- **COLLADA** – exchange format with `*.dae` extension, which is supported by major applications in different industries;
- **3DS** – format with `*.3ds` extension, that is used in *Autodesk 3ds Max* (*3D Studio MAX*);
- **Shape** – exchange format with `*.shp` extension, that is used in *ArcInfo software*;
- *Cesium* formats (`*.obj`, `*.gltf`, `*.b3dm` or `*.json`).

For example, to export data to `*.dxf` (`*.tx3`, `*.shp`, `*.obj`, `*.gltf`, `*.b3dm`, `*.json`) format select **File › Export**. The **Export** window opens. Choose a folder to place a file in *Windows* file system. Specify a file name in the **File name** input field. Set a file extension in the **File type** drop-down list. Click the **Save** button to complete the export.

The system provides possibility to change objects coordinate system during export to *Cesium* formats (`*.obj`, `*.gltf`, `*.b3dm` and `*.json`).

When exporting an object representing a **surface** to `*.json` format, the system provides for advanced customization of visual display of exported data in various software programs designed for viewing and editing 3D objects.

To export just selected objects, select **File › Export selected**. Specify desired format in the **File type** list. Specify desired parameters and click the **Save** button to complete the export.

4.3.1. Export data to COLLADA

The system provides possibility of data export to COLLADA format. COLLADA format is an exchange format with `*.dae` extension, that is used to exchange data between 3D software packages

In order to export data to COLLADA format perform the following actions:

1. Select **File › Export**. The **Export** window opens.

2. Choose a folder to place a file in *Windows* file system.

3. Click the **Save** button. The **Export parameters** window opens.

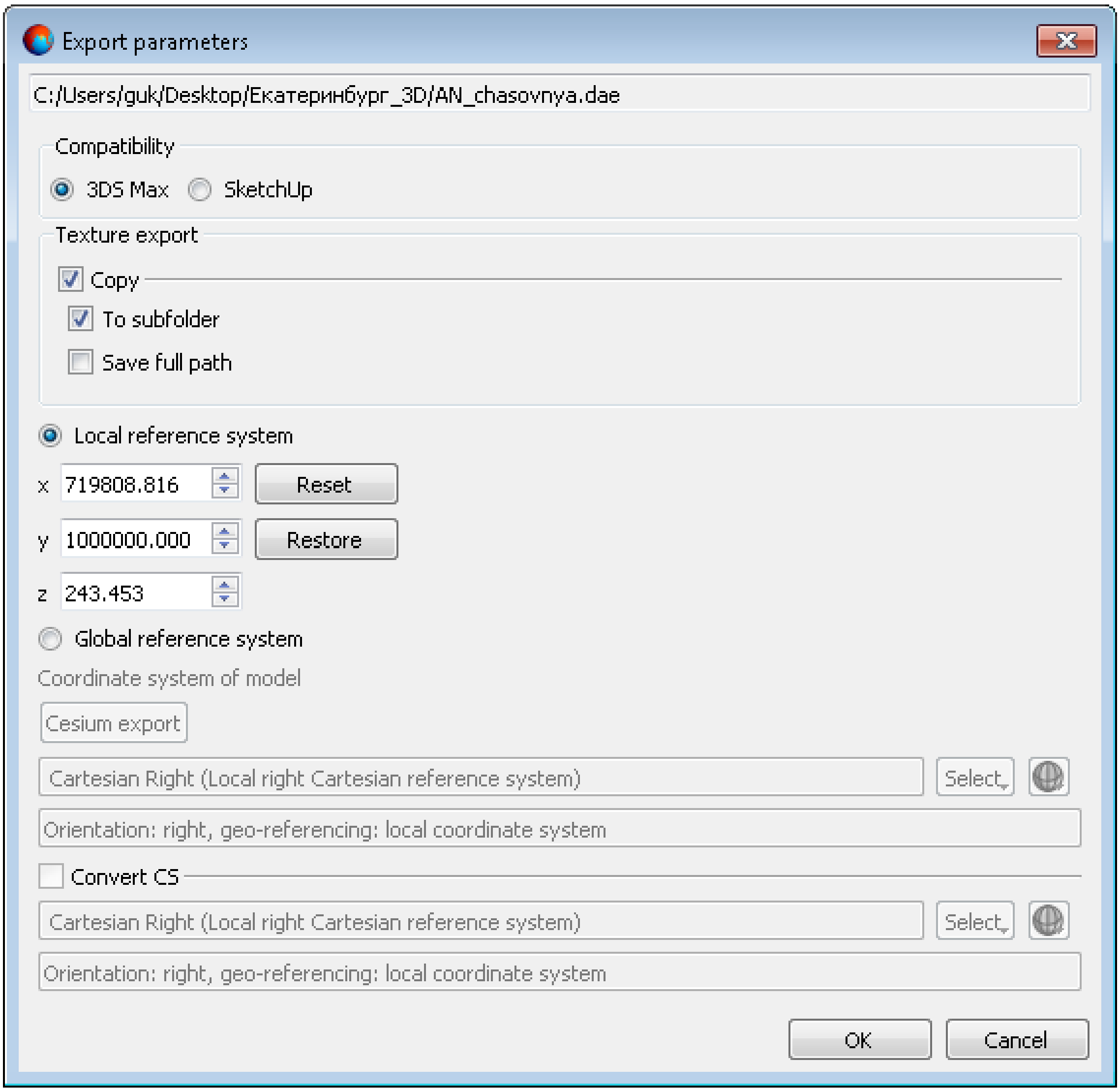


Fig. 17. Parameters of export to COLLADA format

4. In the **Compatibility** section select one of the following compatible programs:

   • **3DS Max** – is used to develop scenes, containing three-dimensional geometric models, available for animation;

   • **SketchUp** – is used to model relatively simple three-dimensional objects – buildings, furniture, interior.

5. In the **Textures** section the **Copy** and **To subfolder** checkboxes are set on by default to save object textures to a separate folder.
   - [optional] When **3DS Max** option is selected, it is recommended to set the **Save full path** checkbox on for correct work in that program.
6. Select a coordinate system of the objects to be exported;
   - [optional] **Local CS**;
     - [optional] Configure additional exported data viewing options.

       PHOTOMOD 3D-Mod allows users to work with objects created including in *PHOTOMOD* system. *PHOTOMOD* uses global coordinate systems for data processing (see the "Coordinate systems" chapter in the "Creating project" User Manual). Hence, the values of coordinates of objects that were exported from *PHOTOMOD* and imported for viewing in *PHOTOMOD 3D-Mod*, can be quite large.

       When further exporting data from *PHOTOMOD 3D-Mod*, for viewing in third-party software, large values of object coordinates may be a certain inconvenience (depending on the features of a particular program). For example, when loading a 3D-scene in the third-party software for the first time, such objects may be outside the area displayed on the screen, due to their significant distance from the origin of the local coordinate system.

       COLLADA (`*.dae`) interchange file format allows for recording information about the offset of the center of the 3D scene viewport, along the **X**, **Y**, and **Z** axes. Such information can be read by some programs when importing data from the COLLADA format. To display the relevant data in the **X**, **Y**, and **Z** input fields of the **Export parameters** window, directly before exporting, perform the following:

       1. Select **File › Settings**. The **Settings** window opens (see details in Section 11);
       2. To place a 3D-scene's center on the point that is central relative to all 3D-scene objects, click the **All** button in the **Origin** section, **Scene** tab, **Settings** window. The 3D-scene's center offset parameters along the three axes are displayed in the fields in the right part of the **Settings** window;
       3. Click OK to close the **Settings** window and go to data export.

       When opening the **Export parameters** window, the 3D-scene viewport center offset parameters set in the **Settings** window will be displayed in the **X**, **Y**, and **Z** fields. To **reset** these parameters, click the appropriate button. To **restore** data loaded at the moment of opening the **Export parameters** window, click the appropriate button.

- [optional] **Global CS** (see the “Coordinate Systems” chapter of the “Creating project” User Manual);
  - [optional] To recalculate all the objects to be exported from one coordinate system to another perform the following actions:
    1. Set the **Convert CS** checkbox;
    2. [optional] Click the **Select...** button to specify initial **model cs**, if needed.

       Coordinate system is specified using one of the following ways:

       - **From DB** – from international or Russian coordinate system database (see “Coordinate systems databases” in the Project creation” User Manual);
       - **From file** – allows to select coordinate system from `*.x-ref-system` files, located *out* of active profile resources;
       - **From resource** – from files with `*.x-ref-system` extension, located in active profile resources. It is used for example, to choose coordinate system from another active profile project.
       - **From GeoCalculator** – from the list of *GeoCalculator* program database (see the “Coordinate Systems” chapter in “The GeoCalculator program” User manual).

         The *GeoCalculator* program allows to edit coordinate systems, to create new ones, to perform import and export of coordinate systems (see the “The GeoCalculator program” User Manual).

       The system also allows to select coordinate system from a list of recently used coordinate systems.

       When choosing coordinate system from database the **Coordinate system database** opens, which contains the list of coordinate systems. To perform fast search for coordinate system, input the whole coordinate system name or its part to the **Find** input filed.

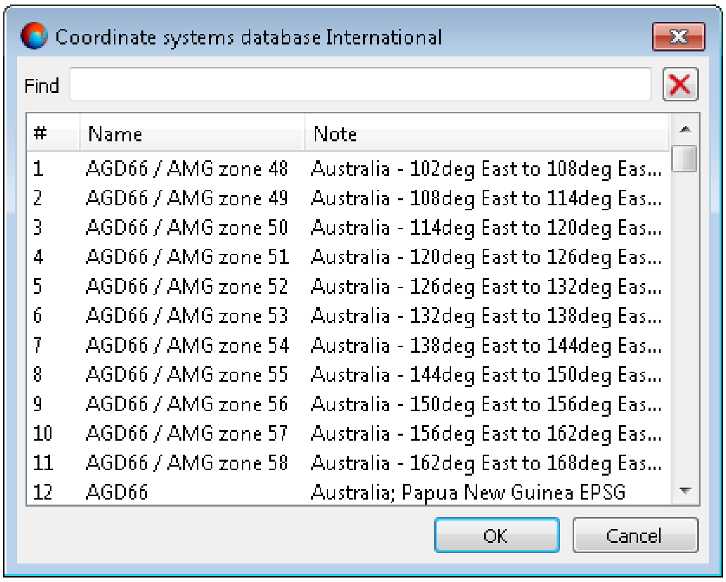


Fig. 18. Coordinate systems database window

[optional] To choose geoid click the button. Select proper type of geoid usage:

- **No geoid**;
- **EGM 96**.

The system also allows to use the **EGM2008** geoid. See installation instructions in the "EGM2008 Geoid installation" User Manual. After installation the geoid is displayed in the list.

PHOTOMOD GeoCalculator provides for creating a user height system (geoid) with preset parameters. *PHOTOMOD* system allows to use previously created custom vertical datum (geoid). See instructions in the "Creating custom height system" chapter of "The GeoCalculator program" User Manual.

3. Define the target coordinate system in which it is necessary to convert the objects. To do this perform the actions described above once more or click the **Export to Cesium** button to select the appropriate coordinate system.

For CESIUM 1.38 version, the coordinate system does not matches the geocentric reference one. It is rotated by -90 degrees around the X axis. CESIUM 1.70 coordinate system matches the classic geocentric reference system with WGS84 ellipsoid and orientation.

7. Click the **Export** button to complete the export.

4.3.2. Export data to 3DS

The system provides possibility of data export to 3DS format. 3DS format file contains data about grid, object attributes, 3D-objects animation and so on. Files of this format have the `*.3ds` extension.

In order to export data to 3DS format perform the following actions:

1. Select **File › Export**. The **Export** window opens.
2. Choose a folder to place a file in *Windows* file system.
3. Click the **Save** button. The **Export 3DS** window opens.

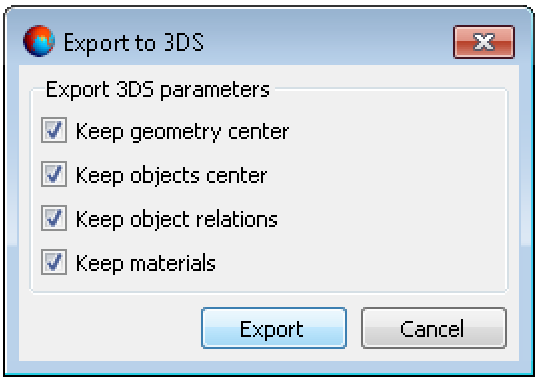


Fig. 19. Parameters of export to 3DS format

4. To save 3D-scene center coordinates, links between objects, and object textures to 3DS format file, the **Pivot**, **Origin**, **Hierarchy**, **Materials** checkboxes are set on by default.
5. Click the **Export** button to complete the export.

4.3.3. Exporting surfaces to JSON

Data export to `*.json` format is carried out in a standard way, in the same way as to `*.dxf`, `*.tx3`, `*.shp`, `*.obj`, `*.gltf` and `*.b3dm` formats. When exporting to *Cesium* formats (`*.obj`, `*.gltf`, `*.b3dm` and `*.json`) it is also possible to change objects' coordinate system.

However, when exporting an object representing a **surface** to `*.json`, format, the system provides for advanced customization of visual display of exported data in various software programs designed for viewing and editing 3D objects.

To export the object representing a surface to `*.json`, perform the following:

1. Do one of the two following:

   • [optional] If one object representing a surface is open in the 3D scene, select **File › Export**;

   • [optional] If several objects are open in the 3D scene, select the object being a surface and choose **File › Export selected**.

2. The **Export** window opens. Select **Multilevel model (*.json)** file type, enter the export file name and select the folder to place the file in the *Windows* file system;

3. Click **Save**. The **Export parameters** window opens:

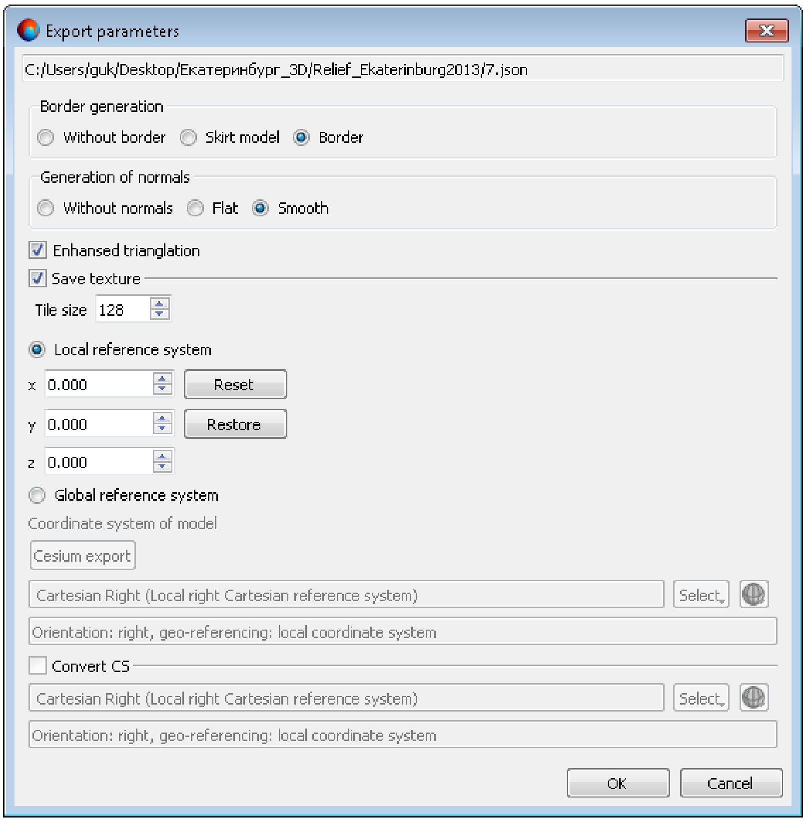


Fig. 20. The Export parameters window

4. An object saved in `*.json` format is a model divided in tiles, and, in addition, having several levels of detail. Data having such a structure often have certain display features that are noticeable when viewed in specialized software designed to work with 3D models.

   For example, it is conceivable that during scaling, tiles with different levels of detail can be displayed within one 3D scene. In such cases, the boundaries between such tiles can be quite noticeable and affect the overall quality of the visual display of the model.

Note, that data display quality depends on many factors, including on the features of the exported model (and its export parameters) and on the software used for its displaying (as well as current software settings).

To optimize the quality of the display of a multilevel surface model divided in tiles, the so called border generation is often used, i.e the construction of areas on the boundaries of tiles, ensuring their correct display when visualizing the entire model.

The system provide for the following **generating borders** options:

• [optional] **Without borders**;

• [optional] tiles having a **border**, i.e. actually extending a little beyond their boundaries, thereby providing a slight overlap with neighboring tiles (similar to the overlap of images in the strip);

• [optional] tiles having a border of the **skirt** type – the border is built along the boundaries of the tile, in the shape of a vertical “wall” directed downwards.

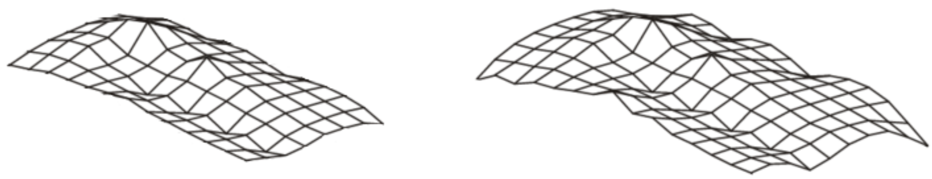


Fig. 21. A borderless tile (left) and a tile with a border (right)

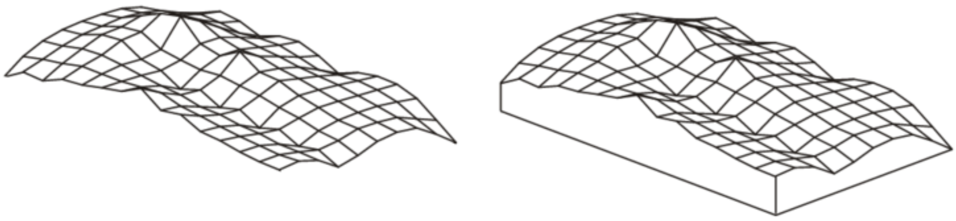


Fig. 22. A borderless tile (left) and a “skirt” border tile (right)

5. [optional] If the exported surface describes very rough terrain, there may be a loss in the quality of visualization of model sections where the tile boundary passes through an area with a significant elevation difference. When exporting such objects to `*.json`, set the **improved triangulation** checkbox.

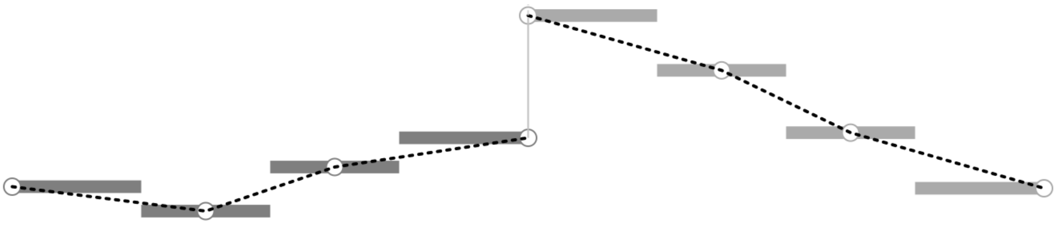


Fig. 23. The 3D model divided in tiles. The tile boundary passes through very rough terrain (at the center)

6. When viewing a 3D model in specialized software (depending on the features of a particular software), the interaction of a 3D model with light sources can be provided. To ensure the correct interaction of the model with light sources, normals to the faces of exported surface can be generated, for further recording of these data in the exported file.

   The system provide for the following **generating normals** options:

   • [optional] **Without normals**;

- [optional] **Flat** – provides more clear visualization of the surface when interacting with a light source;
- [optional] **Smooth** – provides more “natural” surface visualization when interacting with a light source.

7. [optional] To **save texture** when exporting, set the appropriate box and set the texture **tile size** in pixels;

8. Select a coordinate system of the objects to be exported;

   - [optional] **Local CS**;

     ○ [optional] Configure additional exported data viewing options.

     PHOTOMOD 3D-Mod allows users to work with objects created including in *PHOTOMOD* system. *PHOTOMOD* uses global coordinate systems for data processing (see the “Coordinate systems” chapter in the “Creating project” User Manual). Hence, the values of coordinates of objects that were exported from *PHOTOMOD* and imported for viewing in *PHOTOMOD 3D-Mod*, can be quite large.

     When further exporting data from *PHOTOMOD 3D-Mod*, for viewing in third-party software, large values of object coordinates may be a certain inconvenience (depending on the features of a particular program). For example, when loading a 3D-scene in the third-party software for the first time, such objects may be outside the area displayed on the screen, due to their significant distance from the origin of the local coordinate system.

     `*.json` interchange file format allows for recording information about the offset of the center of the 3D scene viewport, along the **X**, **Y**, and **Z** axes. Such information can be read by some programs when importing data from the `*.json` format. To display the relevant data in the **X**, **Y**, and **Z** input fields of the **Export parameters** window, directly before exporting, perform the following:

     1. Select **File › Settings**. The **Settings** window opens (see details in Section 11);
     2. To place a 3D-scene’s center on the point that is central relative to all 3D-scene objects, click the **All** button in the **Origin** section, **Scene** tab, **Settings** window. The 3D-scene’s center offset parameters along the three axes are displayed in the fields in the right part of the **Settings** window;
     3. Click OK to close the **Settings** window and go to data export.

     When opening the **Export parameters** window, the 3D-scene viewport center offset parameters set in the **Settings** window will be displayed in the **X**, **Y**, and

Z fields. To **reset** these parameters, click the appropriate button. To **restore** data loaded at the moment of opening the **Export parameters** window, click the appropriate button.

- [optional] **Global CS** (see the “Coordinate Systems” chapter of the “Creating project” User Manual);
  - [optional] To recalculate all the objects to be exported from one coordinate system to another perform the following actions:
    1. Set the **Convert CS** checkbox;
    2. [optional] Click the **Select...** button to specify initial **model cs**, if needed.

       Coordinate system is specified using one of the following ways:

       - **From DB** – from international or Russian coordinate system database (see “Coordinate systems databases” in the Project creation” User Manual);
       - **From file** – allows to select coordinate system from `*.x-ref-system` files, located *out* of active profile resources;
       - **From resource** – from files with `*.x-ref-system` extension, located in active profile resources. It is used for example, to choose coordinate system from another active profile project.
       - **From GeoCalculator** – from the list of *GeoCalculator* program database (see the “Coordinate Systems” chapter in “The GeoCalculator program” User manual).

         The *GeoCalculator* program allows to edit coordinate systems, to create new ones, to perform import and export of coordinate systems (see the “The GeoCalculator program” User Manual).

       The system also allows to select coordinate system from a list of recently used coordinate systems.

       When choosing coordinate system from database the **Coordinate system database** opens, which contains the list of coordinate systems. To perform fast search for coordinate system, input the whole coordinate system name or its part to the **Find** input filed.

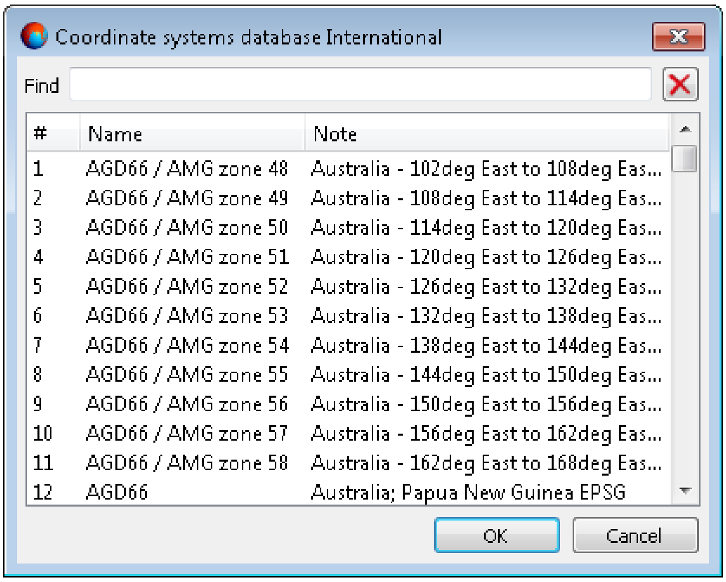


Fig. 24. Coordinate systems database window

[optional] To choose geoid click the button. Select proper type of geoid usage:

- **No geoid**;
- **EGM 96**.

The system also allows to use the **EGM2008** geoid. See installation instructions in the "EGM2008 Geoid installation" User Manual. After installation the geoid is displayed in the list.

PHOTOMOD GeoCalculator provides for creating a user height system (geoid) with preset parameters. *PHOTOMOD* system allows to use previously created custom vertical datum (geoid). See instructions in the "Creating custom height system" chapter of "The GeoCalculator program" User Manual.

3. Define the target coordinate system in which it is necessary to convert the objects. To do this perform the actions described above once more or click the **Export to Cesium** button to select the appropriate coordinate system.

For CESIUM 1.38 version, the coordinate system does not matches the geocentric reference one. It is rotated by -90 degrees around the X axis. CESIUM 1.70 coordinate system matches the classic geocentric reference system with WGS84 ellipsoid and orientation.

9. Click OK to complete exporting.

4.3.4. Batch export

The system allows for batch export from *3D-Mod*-supported files or resources (`*.json`, `*.obj`) into a single `*.obj`-file.

For this, perform the following:

1. Choose **File › Batch 3D-models transform**. The **3D-model batch export** window opens:

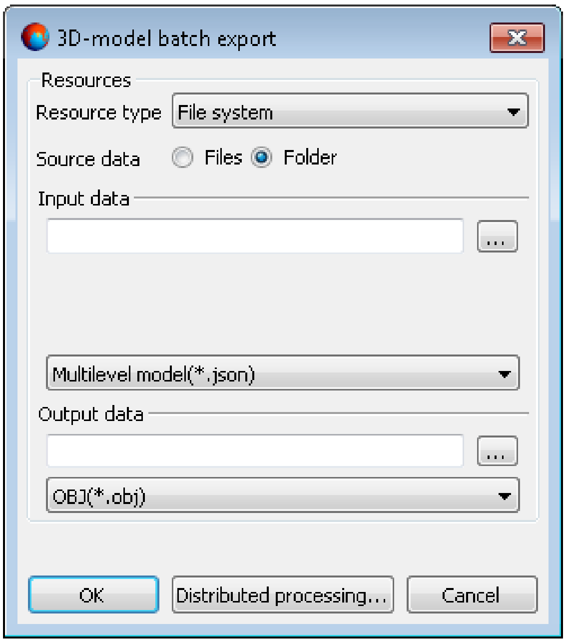


Fig. 25. The 3D-model batch export window

2. Choose the **Resource type** for batch export:

   - *Windows* **file system**;
   - *PHOTOMOD* **resource system**.

3. Choose **Data source**:

   - **Files**;
   - **Folder**.

4. Click ... to specify **source data** (`*.json`, `*.obj`) in the *Windows* file system or in the *PHOTOMOD* resource system;

5. Click ... to specify the location where **output data** (`*.obj`) will be saved (the *Windows* file system or the *PHOTOMOD* resource system);

6. Click OK.

   For batch export using distributed processing, perform the following:

   1. Configure and run the distributed processing server/client (see the “Distributed processing” chapter in the “General information“User Manual);

   2. Click the **Distributed processing** button.

4.4. Change objects coordinate system

To recalculate all vertices of current layer from one coordinate system to another perform the following actions:

1. Set the **Recalc coord system** checkbox on in the window of vector objects import.

2. Click the **Select...** button to specify initial coordinate system.

   Coordinate system is specified using one of the following ways:

   - **From DB** – from international or Russian coordinate system database (see “Coordinate systems databases” in the Project creation” User Manual);

   - **From file** – allows to select coordinate system from `*.x-ref-system` files, located *out* of active profile resources;

   - **From resource** – from files with `*.x-ref-system` extension, located in active profile resources. It is used for example, to choose coordinate system from another active profile project.

   - **From GeoCalculator** – from the list of *GeoCalculator* program database (see the “Coordinate Systems” chapter in “The GeoCalculator program” User manual).

     The *GeoCalculator* program allows to edit coordinate systems, to create new ones, to perform import and export of coordinate systems (see the “The GeoCalculator program” User Manual).

   The system also allows to select coordinate system from a list of recently used coordinate systems.

   When choosing coordinate system from database the **Coordinate system database** opens, which contains the list of coordinate systems. To perform fast search for coordinate system, input the whole coordinate system name or its part to the **Find** input filed.

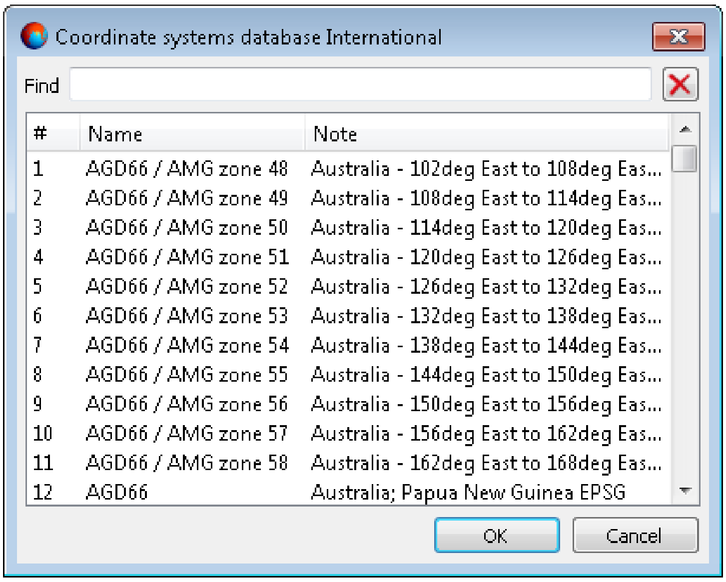


Fig. 26. Coordinate systems database window

[optional] To choose geoid click the button. Select proper type of geoid usage:

- **No geoid**;
- **EGM 96**.

The system also allows to use the **EGM2008** geoid. See installation instructions in the "EGM2008 Geoid installation" User Manual. After installation the geoid is displayed in the list.

PHOTOMOD GeoCalculator provides for creating a user height system (geoid) with preset parameters. *PHOTOMOD* system allows to use previously created custom vertical datum (geoid). See instructions in the "Creating custom height system" chapter of "The GeoCalculator program" User Manual.

3. Output coordinate system is specified in the same way.

4.5. Loading a standard library objects layer

The system provides for loading a layer with standard library objects.

This tool allows to create a layer containing standard objects of the *same* type. The system also provides the functionality of loading a layer with objects from the reference file, which allows for importing standard objects of several types at once (see Section 4.6).

For this, perform the following:

1. Choose **Layers › Create points layer**. The **New points layer** window opens:

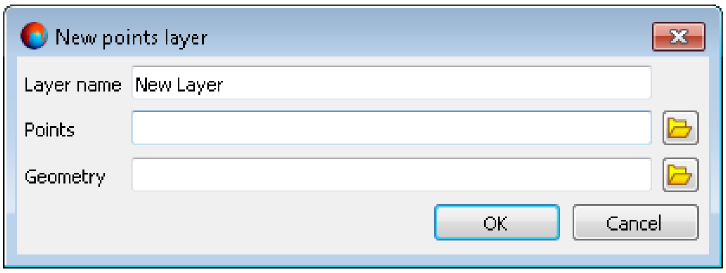


Fig. 27. The New points layer window

2. Enter the **Layer name**;

3. To specify the objects location, click the button near the **points** field, and select a file containing data on object coordinates in the ASCII-A format;

   ASCII-A – exchange text format with `*.txt` extension, which is supported by major applications in different industries.

4. To specify the objects type, click the button near the **geometry** field, and select a file containing *one* library object in ASCII3D format;

   ASCII3D – exchange format with `*.tx3` extension.

   The file must contain one object.

5. Click OK.

To check the correctness of loading a layer of point objects, perform the following:

1. Click the button of the main toolbar. The **Select objects** window opens;

2. In the opened window, select loaded objects and click **Select** button;

3. Click the button of the main toolbar.

4.5.1. Points file

The *PHOTOMOD* system provides possibility of vector objects import from ASCII-A format (see the “Export to ASCII-A” chapter of the “Vectorization” User Manual). ASCII-A format contains information about coordinates of vector objects vertices, as well as information about object type, layer number, attributes name and value.

Files of this format has the `*.txt` extension. Unlike ASCII, in ASCII-A format object description contains first lines that describe object type and attributes.

Example of ASCII-A file content (with point objects):

```
P "None" 0 6 4

OBJECT_NAME=

OBJECT_COLOR=65535

OBJECT_SYMBOL=

OBJECT_SIZE=1

545566.505,473671.817,77.850

*
```

The first line of each section has the following structure:

`Type, code, layer, N1, N2`, where:

- Type - the symbol describing an object type:
  - `L` – polyline;
  - `P` – point;
  - `C` – polygon.
- Code is an object code;
- Layer is a number of layer;
- N1 – the total number of lines where there is a description of the object in the file;
- N2 – the number of lines where there is a description of the object attributes in the file;

This is followed by lines with attributes description that have the following form:

`Name=Value`

Then there are lines with the object vertices coordinates. The sequence of records is delimited by `*` symbol.

4.6. Loading a layer containing objects from a reference file

The system also provides for loading a layer with objects from a reference file. This tool allows one to import standard 3D objects of several types at once.

☞ The system provides simplified functionality that allows one to create a layer from library objects of the same type (see Section 4.5).

To perform this operation, user need to prepare two files in advance:

- ASCII-A point file containing data on objects' coordinates;

  ☞ ASCII-A – exchange text format with `*.txt` extension, which is supported by major applications in different industries.

- ASCII3D reference file that allows one to specify the types of imported objects. This file may contain more than one object.

  ☞ **ASCII3D** – exchange format with `*.tx3` extension.

To load 3D objects from the reference file instead of point vector objects when importing data from a point file, use **File DXF** tab tools of the **Parameters of import and building** window.

4.6.1. Preparing a point file

The point file containing data about the coordinates of objects used to load objects from the reference file must (in addition to the standard requirements for ASCII-A files) comply with the following parameters:

- Contain point vector objects created in the vector layer with a classifier (see the "Classifier" section in the "Vectorization" User Manual). Point objects must have the following attributes:
  - Attributes referred to the classifier entry (see "Vector objects attributes" in the "Vectorization" User Manual):
    - [optional] **Code** – associates point objects with their descriptions in the reference file by object code;
    - [optional] **Code name** – associates point objects with their descriptions in the reference file by object code name.
  - An additional attribute having `type` name and `library` value (see "Using attributes when building 3D-objects" in the "Vectorization" User Manual).

To prepare a correct point file, perform the following:

1. Run *3D-Mod*;
2. Import `*.tx3` reference file;

3. Select the required 3D object;

4. Copy the object's **Name** from the appropriate field in the **Base properties** section;

5. Without closing *3D-Mod*, launch *PHOTOMOD*;

6. Create a vector layer with a classifier (see "Vector layer creation" in the "Vectorization");

7. Ensure that the **Classifier** window is open (see "Classifier" in the "Vectorization");

8. To create attributes referred to the classifier entry allowing one to match up point objects in the point file and 3D objects in the reference file, create a new classifier code (see "Classifier creation" in the "Vectorization");

   For this, perform the following:

   - Click in the **Classifier** window, to enable the classifier editing mode;
   - Click on the **Classifier** window main toolbar, to create a new code in the classifier. The **Add code** window opens;
   - Set **Code** – **Name** of object from the reference file (see paragraph **4** above);
   - Set **Code name** – **Name** of object from the reference file (see paragraph **4** above);
   - Select object **Type** – **P** (point object);
   - Click OK.

9. [optional] Repeat the steps described in paragraphs **4** and **8** (in *PHOTOMOD* system, in the layer with the classifier, create classifier codes corresponding to 3D objects from the reference file open in *3D-Mod*);

10. Ensure that the generated point objects have an additional attribute `type` name and `library` value (see "Using attributes when building 3D objects" in the "Vectorization").

    For this, perform the following:

    - Open the **3D-Mod** toolbar (**Windows › Toolbar › 3D-Mod**);
    - Click on the **3D-Mod** toolbar to enable the value input mode for the `type` attribute;
    - Select `library` value of the `type` attribute clicking Lib;

11. Select the required classifier code in the **Classifier** window, **Codes** tab (see paragraphs **8** and **9**);

12. Create one or more point vector objects

    To check the values of attributes referred to classifier codes (as well as additional attributes), select a vector object and choose **Windows › Object attributes** or click the button on the additional **Vectors** toolbar. The **Object attributes** window opens.

13. [optional] repeat the steps from paragraph **11** and **12**;

14. Click the button on the **3D-Mod** toolbar to disable the value input mode for the `type` attribute;

15. [optional] Add other vector objects to this layer, if required;

16. Save the layer containing the point vector features described above as an ASCII-A file (see “Export to ASCII-A” in the “Vectorization” User Manual).

17. Go back to the open *3D-Mod* window. Choose **File › Close** дto close the 3D scene with objects of the reference file.

The prepared point file can be used to import data into the *3D-Mod* together with the reference file.

5. 3D-objects creation

The module provides possibility to create 3D-objects using outlines of objects external faces.

This operation could be also applicable, if during vector objects import the **Make 3D-building** checkbox was off.

To generate 3D-objects using 2D-objects, perform the following actions:

1. Select **Edit › Create › Polyline** and create outlines of the upper edges of objects (roofs) as polygons.

    To create polygons set the **Loop** checkbox on in the **Polyline** section.

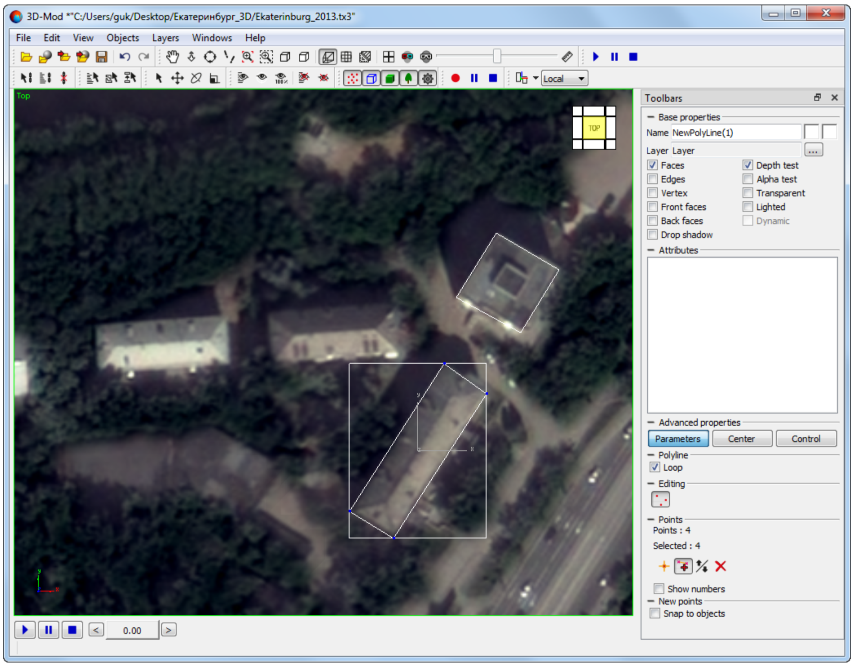


Fig. 28. Polygons creation

2. Select 2D-objects to be used for 3D-objects creation.

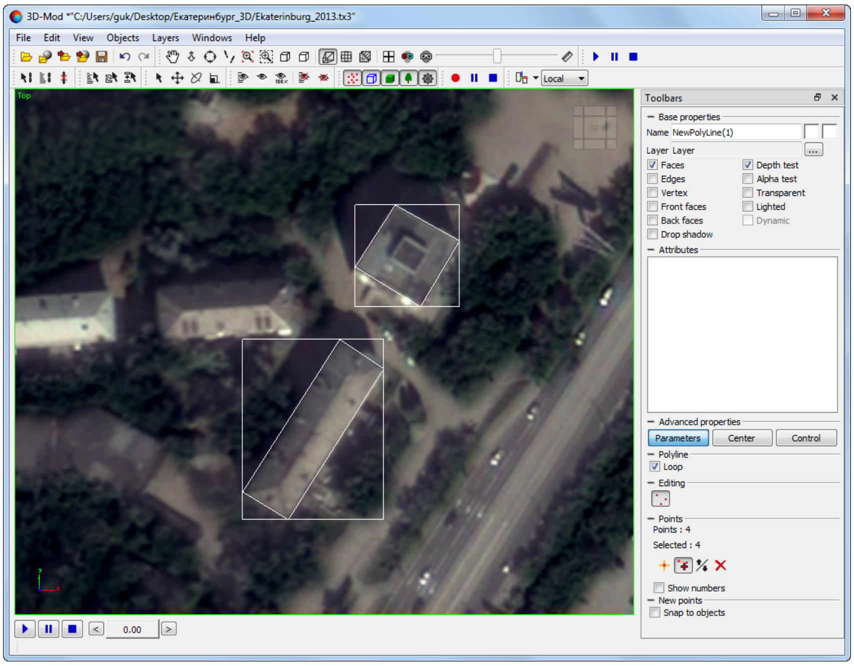


Fig. 29. Polygons creation

3. Choose the **Objects › Build**. The **Parameters of building** window opens.

The **Additional parameters** button allows to set additional parameters of objects import in **Texturing** tab.

Texturing of the imported objects is carried out using images of the loaded project (available in case of the vector objects import from *PHOTOMOD* software, see the previous chapter).

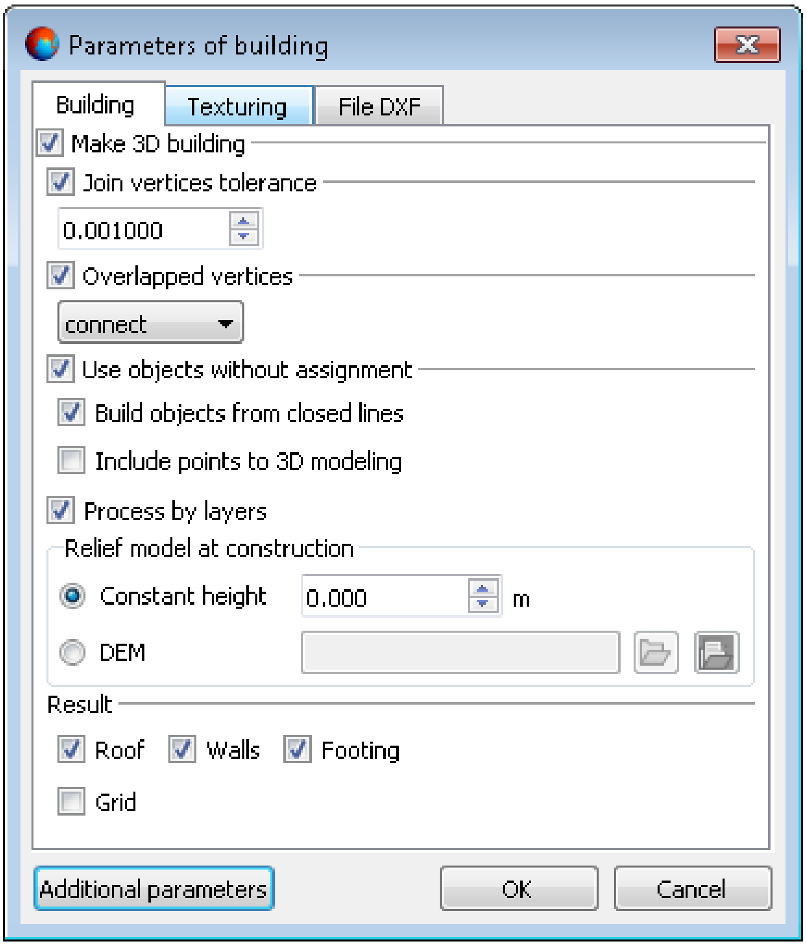


Fig. 30. Parameters of 3D-objects creation

4. Define the following parameters of the operation:

   - **Join vertices tolerance** – allows to merge vertices, the distance between which is less than specified;
   - **Overlapped vertices** – for vertices with the same coordinates (X,Y) allows to select one of the following options:
     - **connect**;
     - **use top**;
     - **use bottom**;

   ○ **use average**;

   ○ **use first**;

   ○ **use last**.

- **Use objects without assignment** – allows to select an action to be applied to vector objects without attributes:

   ○ **Build objects from closed lines**;

   ○ **Include points to 3D modeling**.

- **Process by layers** – allows to process vector objects separately in each layer;

   To accelerate 3D-building operation, and for correct work with layers it is highly recommended to set the **Process by layers** checkbox on.

- Select one of the following options of relief model use:

   ○ if DEM file is available, click the button and select the file that determines the lower boundary of 3D-objects construction;

   ○ otherwise, specify constant relief elevation in the **Constant height** field.

- The **Result** section allows to select buildings elements to be created: **Roof**, **Walls** and **Footing**. The **Mesh** checkbox allows to convert object elements to a grid.

5. [optional] For more accurate geometry of vector objects it is possible to use `*.dxf` file containing description of polygons geometric centers. To do this, on the **File DXF** tab click the button, select `*.dxf` file and choose one of the following options:

   - **Link by code** – allows to match point objects with description of point objects geometry provided in `*.dxf` file, using object code (see detailed description of object attributes in the “Vectorization” User Manual);

   - **Link by codename** – allows to match point objects with description of point objects geometry provided in `*.dxf` file, using object codename (see detailed description of object attributes in the “Vectorization” User Manual);

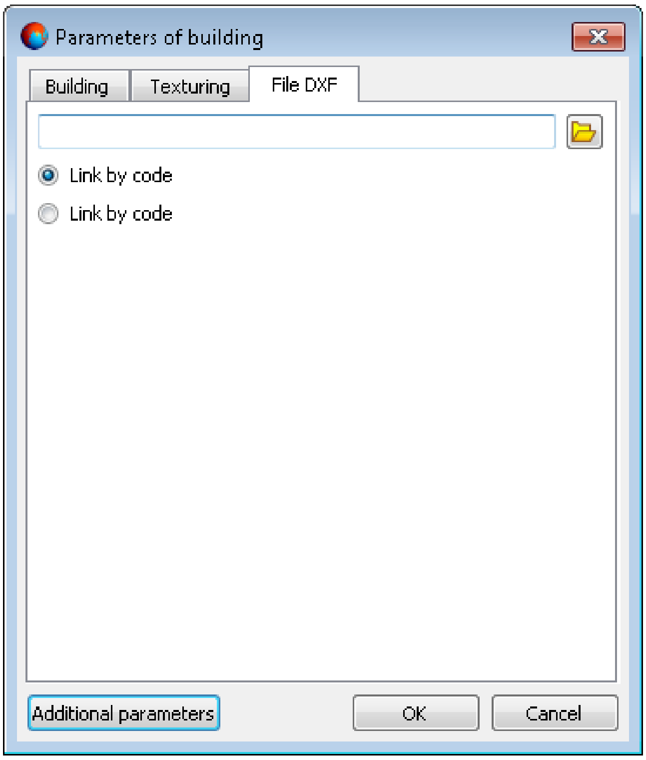


Fig. 31. Parameters of reference DXF-file

6. Click OK. After that 3D-objects with specified parameters are created.

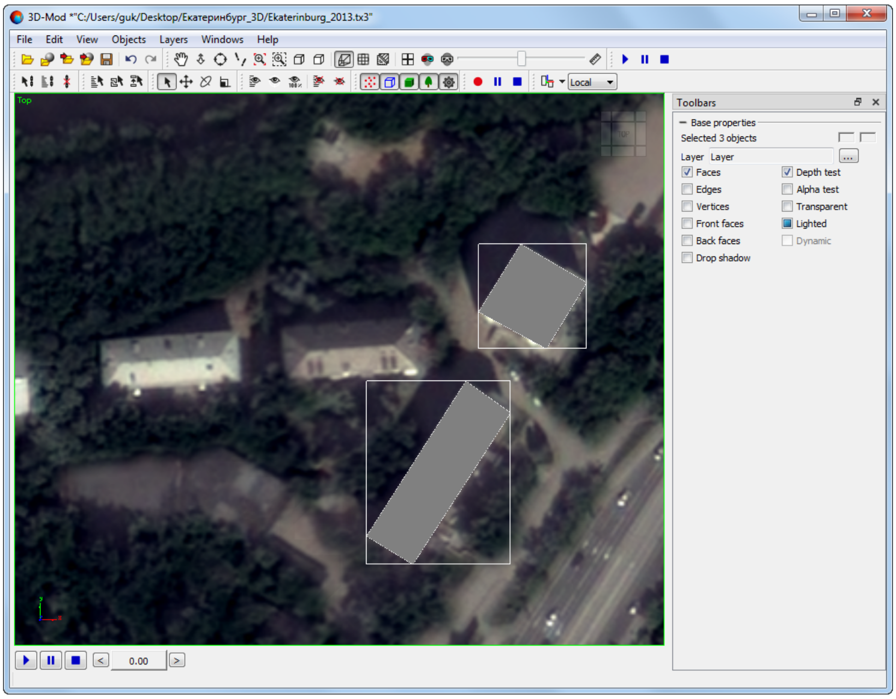


Fig. 32. Created 3D-objects - view from above

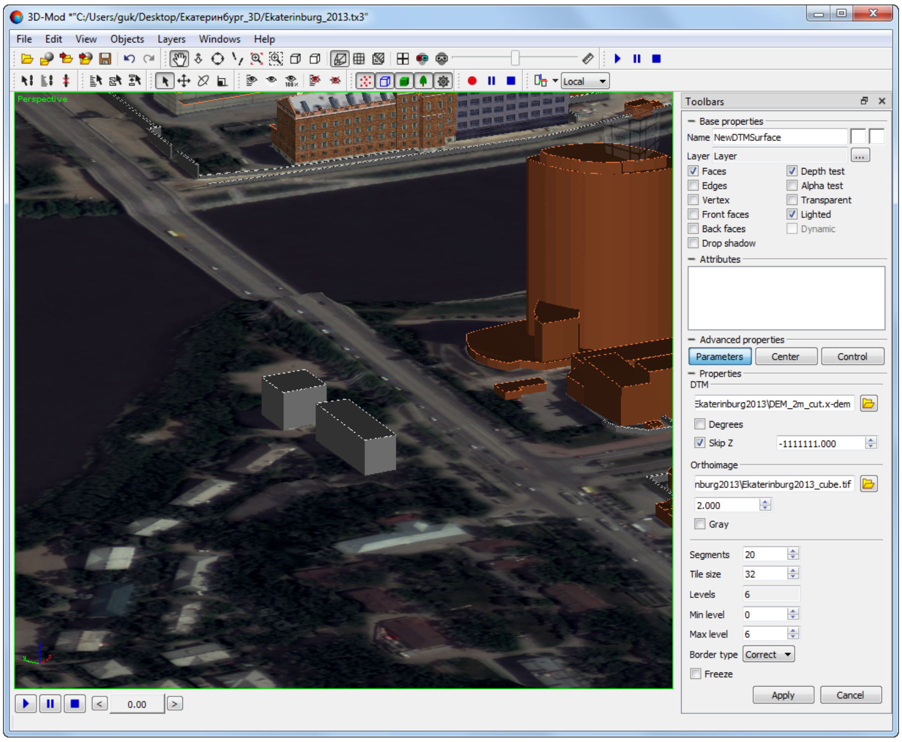


Fig. 33. Created 3D-objects - perspective view

6. Objects Editing

6.1. Menu “Edit”

Table 13. Brief description of the Edit menu

Menu items	Function
Cancel	to cancel the last operation
Redo	to repeat the last cancelled operation
Create	contains menu items to create 3D-objects
Select	to turn on objects selection mode in view area
Select by name...	to select objects from the list in view area using their names
Select unassigned	to select elements (outlines, breaklines) not used for 3D-creation
Select dependent	to select both the whole object, and all elements (outlines, breaklines) used for 3D-creation
Select all	to select all objects
Move	to turn on moving of selected objects in view area
Rotate	to turn on rotating of selected objects
Scale	to turn on scaling of selected objects in XY and Z planes

Menu items	Function
Convert to	to convert 3D-objects to a grid
Attach	to turn on objects attaching mode and to connect objects to each other to move them simultaneously
Detach	to unlink objects
Edit texture coordinates	to turn on editing mode of texture coordinates of 3D-object
Map georeferenced image	to load raster map with texture for upper faces of 3D-objects
Delete	to delete an object (duplicates the **Delete** hotkey)
Copy	to copy an object (duplicates the **Ctrl+C** hotkeys)
Paste	to paste an object (duplicates the **Ctrl+V** hotkeys)

Use the appropriate mode ( ) to move the copied object.

6.2. 3D-objects creation

6.2.1. General information

The module allows to create the following objects:

- **Dummy** – auxiliary object that appears in the form of a cube frame. This object is not displayed when viewing 3D-scene;

  It is used as a guide object when moving a link of connected objects.

- **Surface** – flat body in the form of a DEM or orthophoto. The system also allows to load triangulated irregular network (TIN);
- **Polyline** – a broken line or a curve, containing a set of vertices, joined by straight or curve line pieces called segments; The system also allows to create a polygon (closed polyline);
- **Curve Bezier** – Bezier vector line containing points, connecting line segments and check points (in green colour), used to adjust curvature of the segments. The system also allows to create closed Bezier curve, when start and end points coincide;
- **Camera** – is an object imitating surveying camera, through which lens 3D-scene animation occurs;
- **Box** – is a three-dimensional body displayed in the form of a cube;
- **Sphere** – is a three-dimensional body with the frame in a form of a regular convex polygon. Faces of a sphere have a triangular shape;

If a number of faces is sufficiently large, a sphere takes shape of a ball.

- **Cone** – is a three-dimensional body, displayed as a cone with a round base and a sharp end. It is also possible to create a pyramid;
- **Cylinder** – is a three-dimensional body displayed in the form of a cylinder;
- **Tube** – is a three-dimensional body displayed as a part of tube;
- **Plane** – is a flat rectangular body with limited size;
- **Light source** – is an auxiliary object, that imitates an effect of real 3D-scene lighting.

The objects consist of standard set of elements: vertices, edges and normals. Refer to Operations with 3D-objects for detailed description of editing of objects elements.

6.2.2. Dummy

In order to create a dummy object select **Edit › Create › Dummy**. The system creates an object with default size of 1.

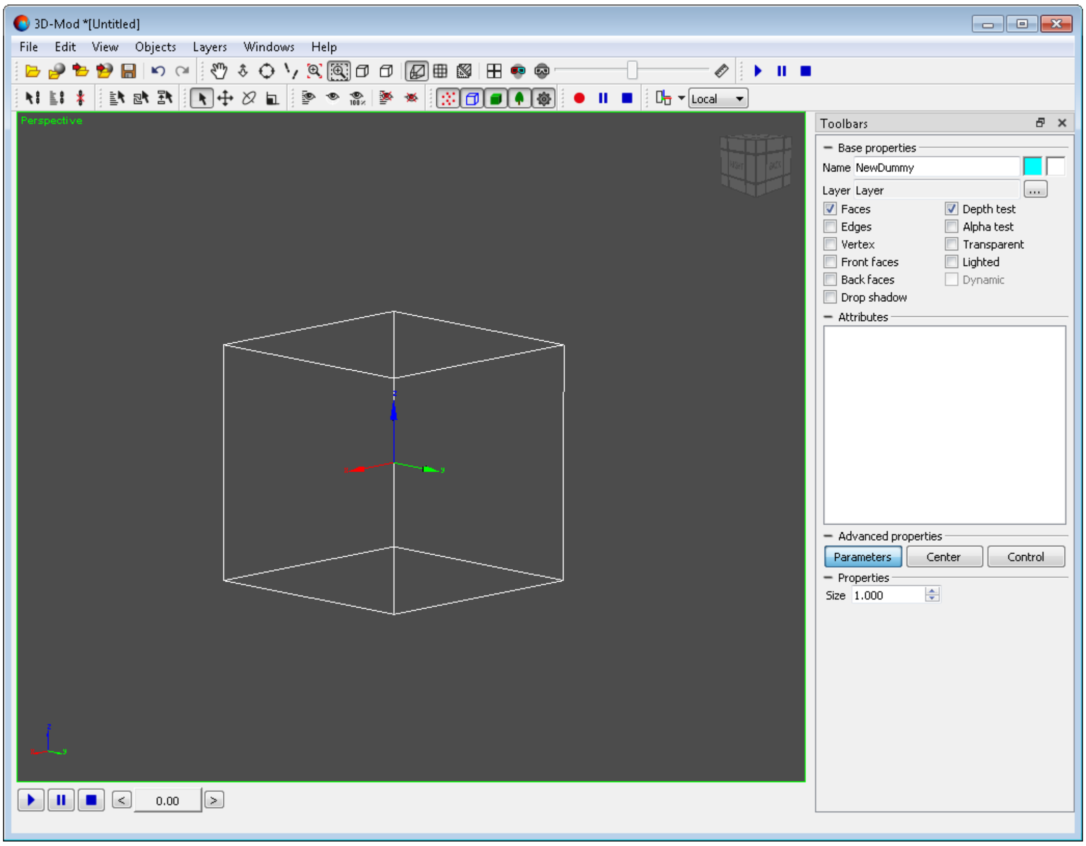


Fig. 34. Dummy object

6.2.3. Surface

In order to create a surface perform the following actions:

1. Select **Edit › Create › Surface**. The **Surface** window opens.

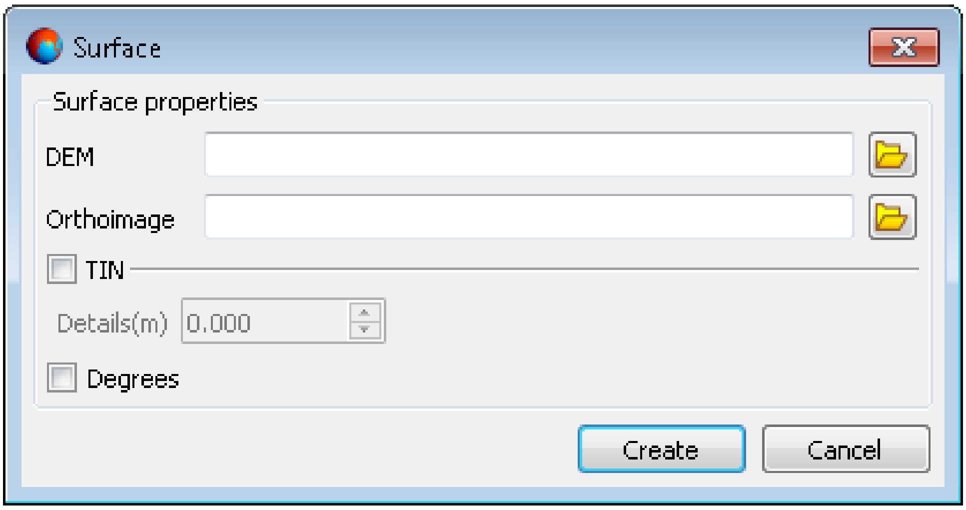


Fig. 35. Surface properties

2. To load a DEM that is not in active profile resources click the button and choose a file.

3. To load an orthophoto or terrain map that is not in active profile resources click the button and choose a file.

4. In the **Details** field specify DEM cell size in meters.

   The DEM cell size should be commensurable with the average distance between pickets of base layer. Smaller cell size increases surface creation time, and 3D-scene editing time.

5. [optional] For correct reading coordinate values from DEM file in degrees, set the **Degrees** checkbox on.

6. [optional] In order to create a surface, that is displayed as a TIN layer, set the **TIN** checkbox on.

7. Click the **Create** button to load an orthophoto.

6.2.4. Polyline

In order to create a polyline/polygon perform the following actions:

1. Select **Edit › Create › Polyline**. The coordinate system of object to be created is displayed.

2. Place mouse cursor to selected point in 3D-window and click the mouse button. The first polyline/polygon vertex is created.

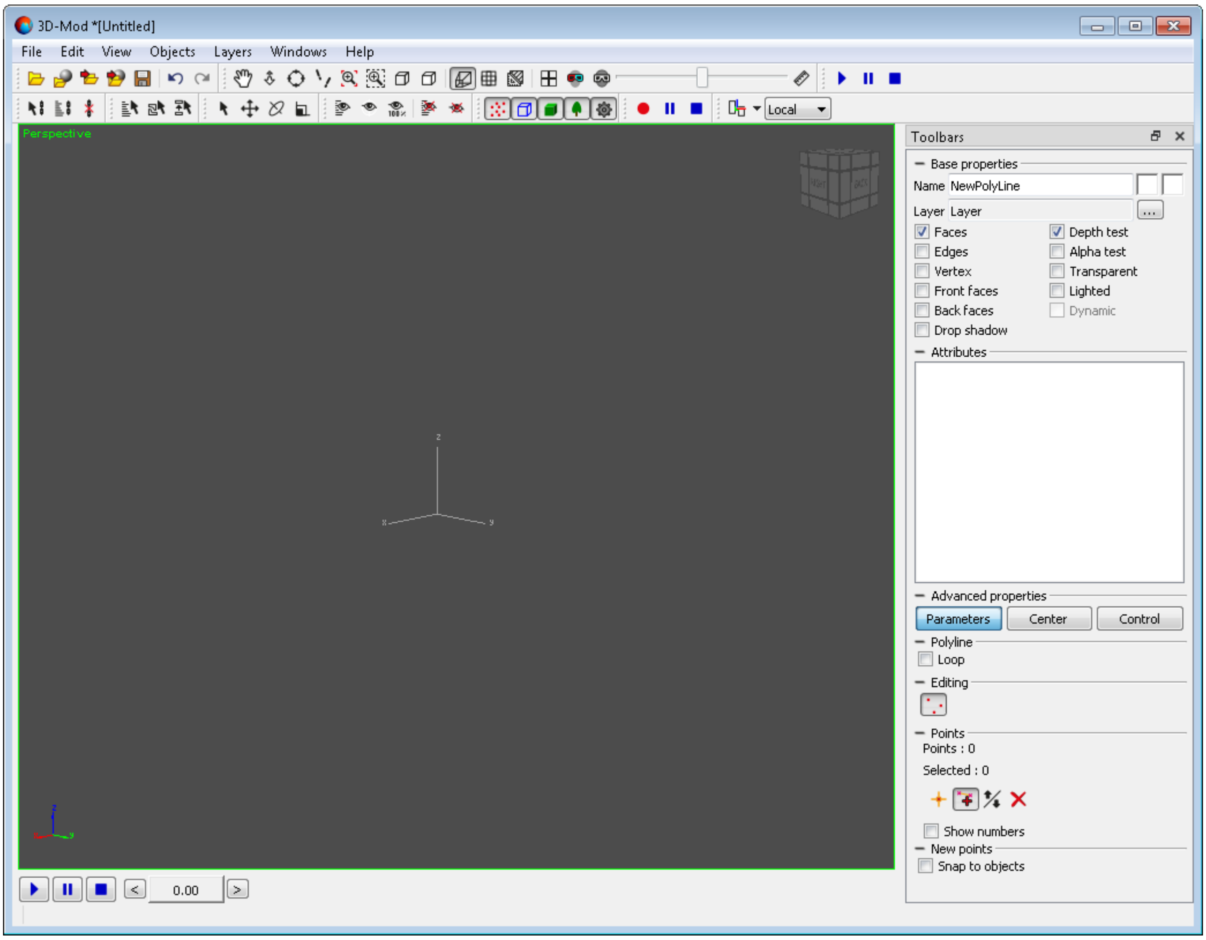


Fig. 36. First polyline vertex

3. Continue creating new vertices of the polyline/polygon.

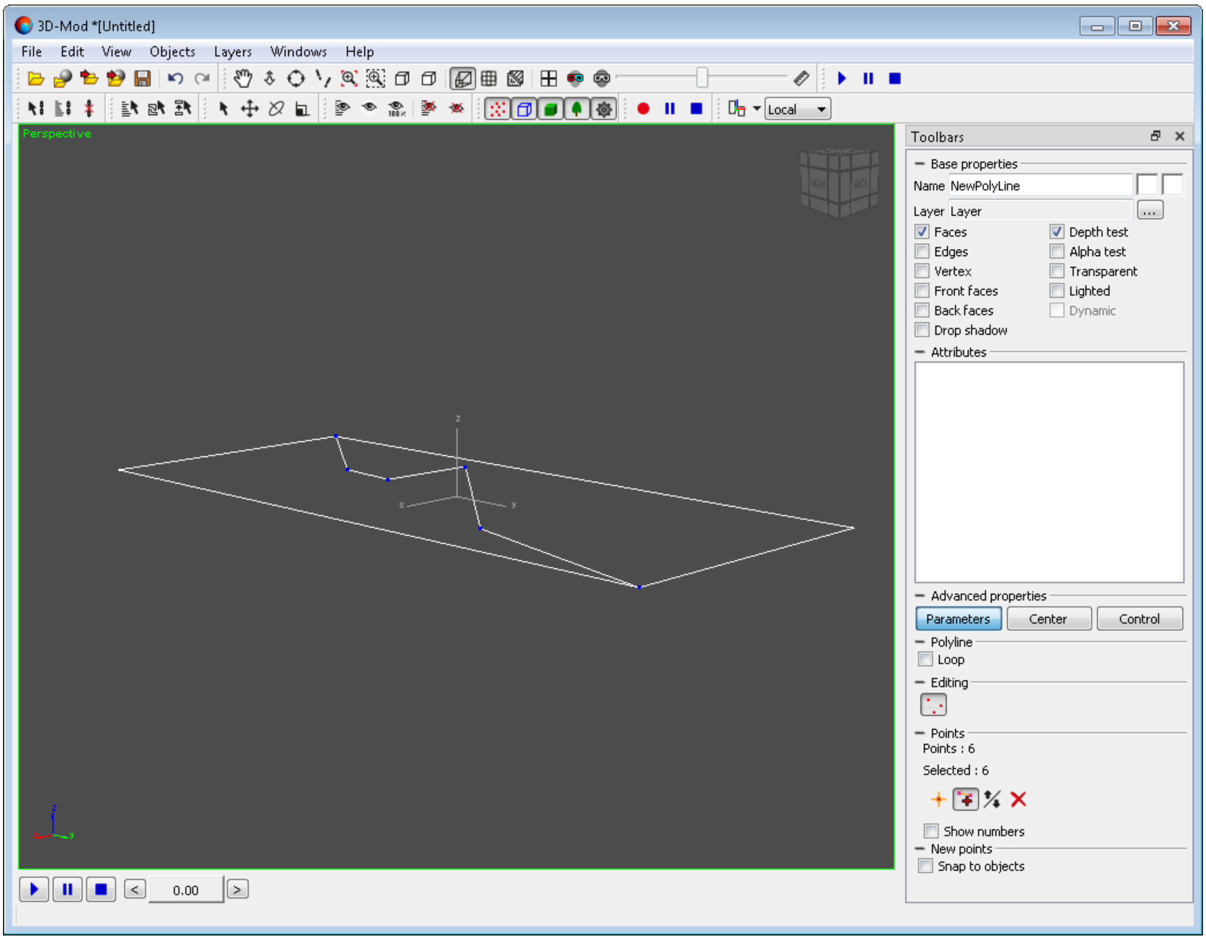


Fig. 37. Polyline object

4. [optional] In order to link a polyline to selected objects set the **Snap to objects** checkbox on.

5. [optional] In order to create a polygon, set the **Loop** checkbox on in the **Polyline** section.

6. Press the **Esc** key to complete polyline/polygon creation.

6.2.5. Bezier curve

In order to create a Bezier curve perform the following actions:

1. Select **Edit › Create › Bezier curve**. The coordinate system of object to be created is displayed.

2. Place mouse cursor to selected point in 3D-window and click the mouse button. The first Bezier curve point is created.

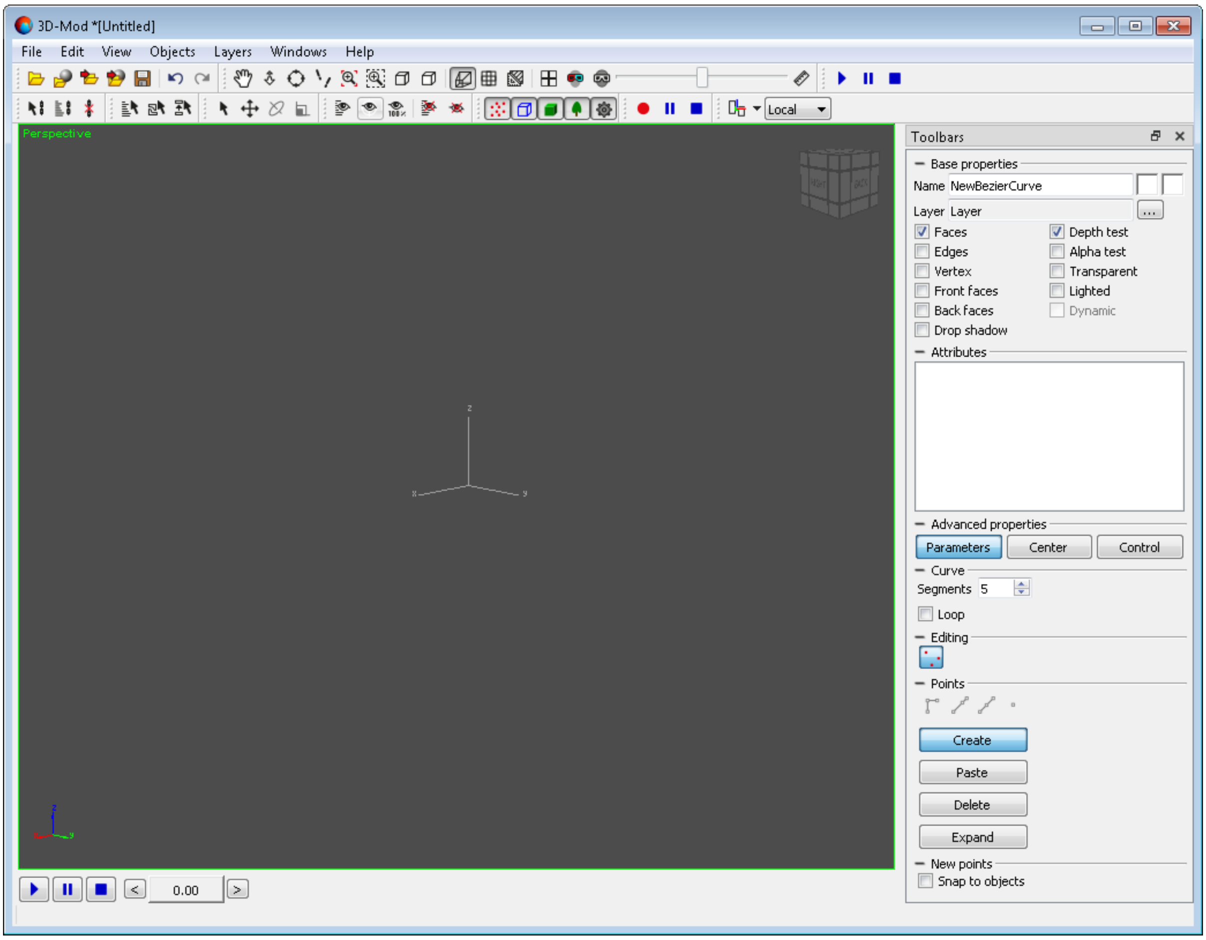


Fig. 38. The first Bezier curve point

3. Continue creating new points of the Bezier curve.

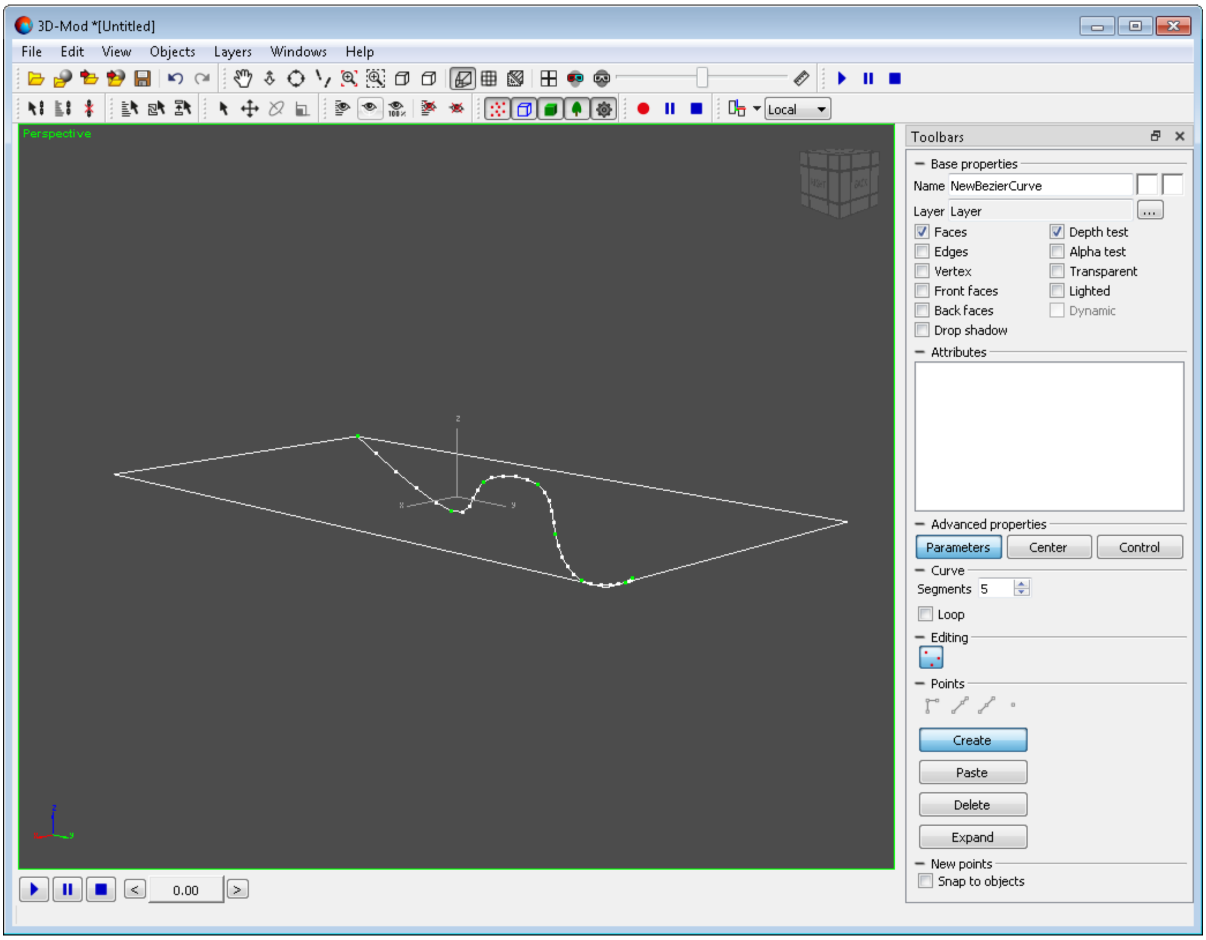


Fig. 39. Bezier curve object

4. [optional] In order to change a number of segments, specify necessary segments number in the field and press **Enter**.

5. [optional] In order to link a polyline to selected objects set the **Snap to objects** checkbox on.

6. [optional] In order to create closed Bezier curve, set the **Loop** checkbox on in the **Curve** section.

7. Press the **Esc** key to complete Bezier curve creation.

8. [optional] Edit Bezier curve points.

6.2.6. Camera

Camera – is special object imitating surveying camera, through which lens 3D-scene animation occurs;

The module allows to create an object, that imitates surveying camera to generate and save different types of final scene image.

In order to create a camera perform the following actions:

1. Select **Edit › Create › Camera**. The system creates a camera object.

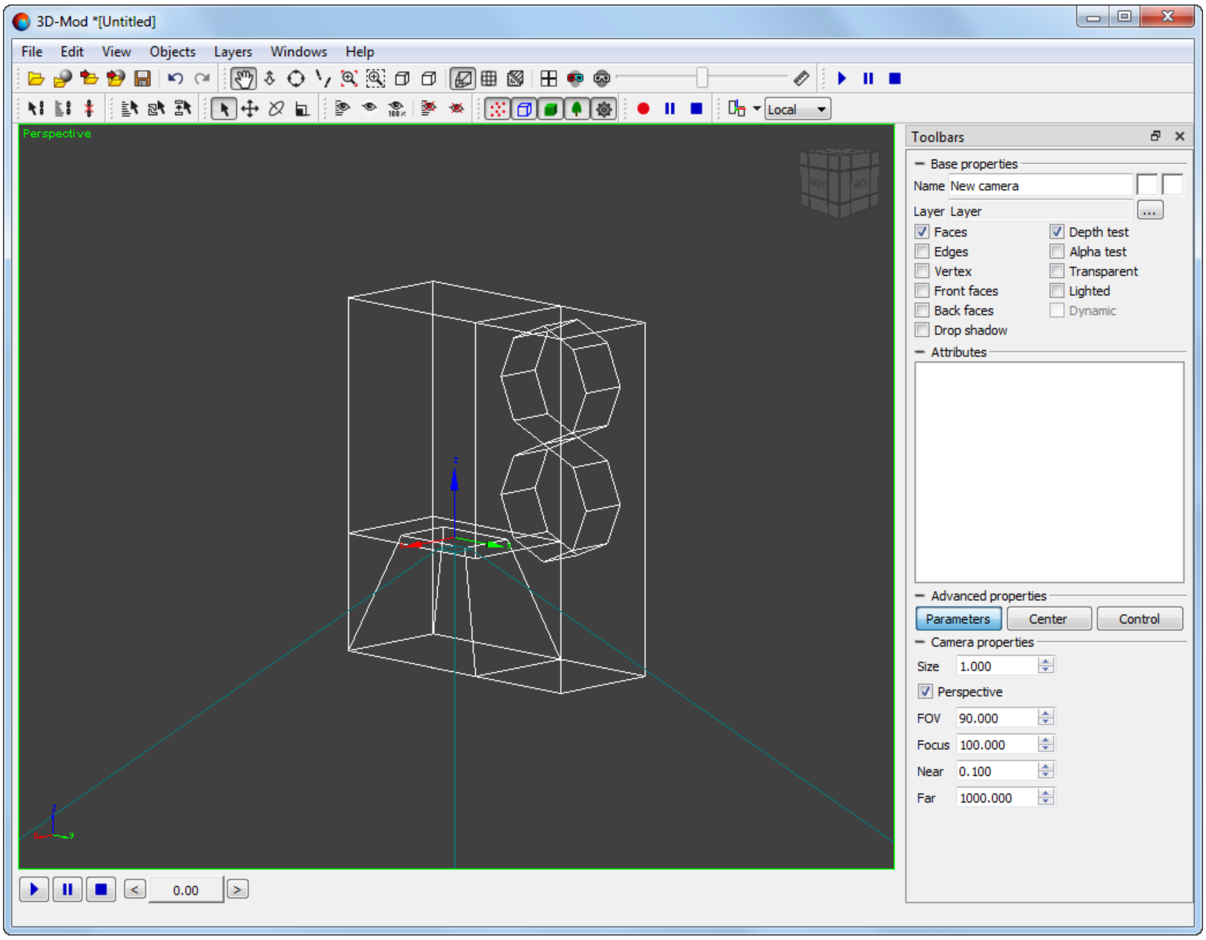


Fig. 40. Camera object

2. Setup the following camera parameters:

   - **Size** – a size of a camera;
   - **Perspective** – display mode of the scene through the camera in perspective (area of camera projection – viewing pyramid). If the checkbox is off, display mode of the scene through the camera with parallel projection (area of camera projection – parallelepiped);
   - **FOV** (field of vision, perspective) – an angle between extreme light rays which pass into the camera. Field of vision defines the scope of 3D-scene;

- **Width** (parallel projection) – width of parallelepiped;
- **Focus** – focal length of camera objective in millimetres;
- **Near** – clipping plane nearest to the camera (objects located closer than this plane are not displayed in the projection window of this camera);
- **Far** – far clipping plane (objects that are farther of the plane are not displayed in the projection window of this camera).

The field of view boundary displayed in the form of a regular pyramid with a rectangular base, is called *viewing pyramid*.

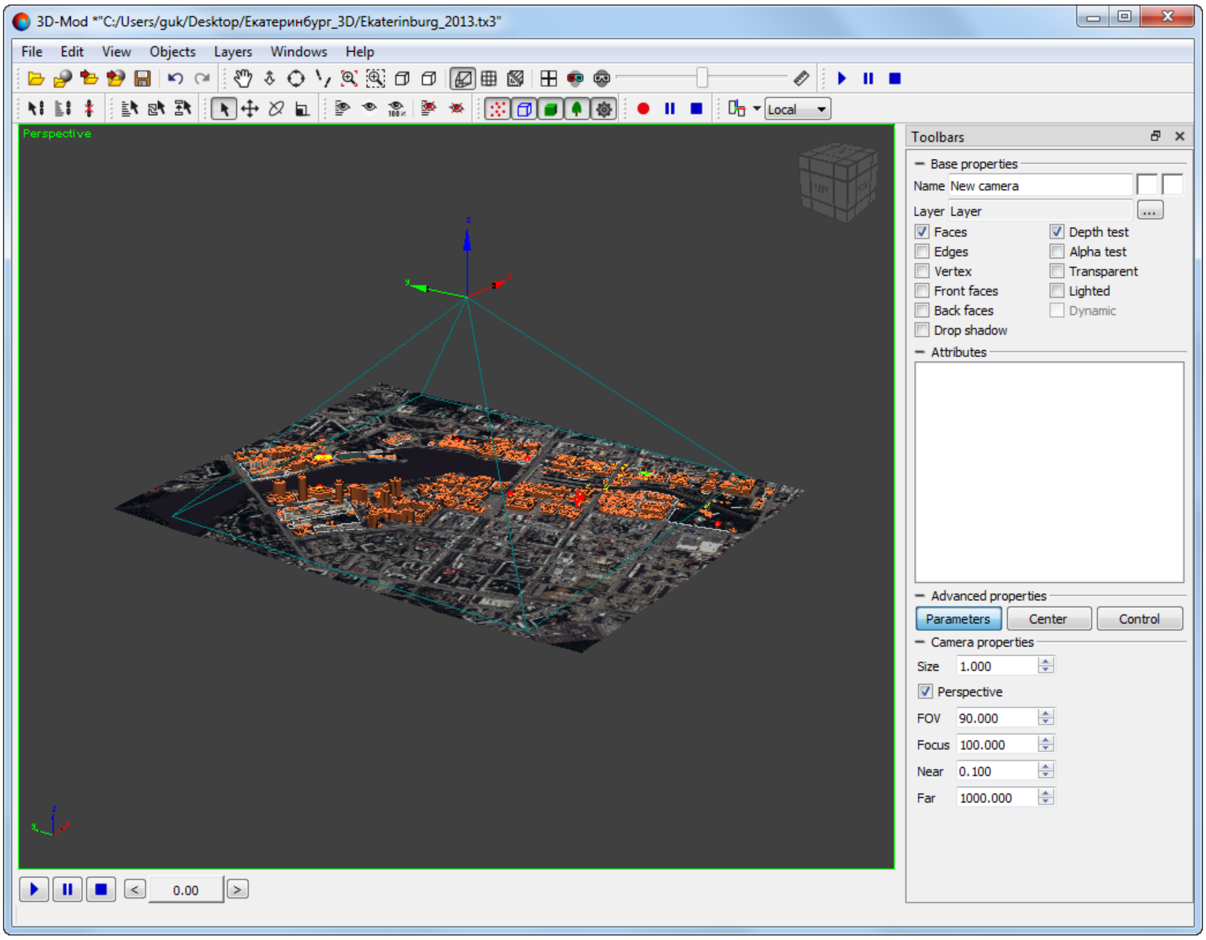


Fig. 41. Camera viewing pyramid

Camera lens is located on the top of viewing pyramid. Rectangular base of the pyramid is a projection area of the camera, which dimensions are similar to the field of view of the window of the camera projection(**View › Camera › Projection**).

6.2.7. Box

In order to create a box select **Edit › Create › Box**. The system creates an object with length, width and height equal to 1.

The system allows to create a box. To do this turn on zoom mode, place mouse cursor to one of the box axes and move the cursor to the necessary direction.

To rename a box input its name to the **Name** field in the **Base properties** section.

In order to change color of a box, select color in the window opened after double click on the rectangle in the **Base properties** section.

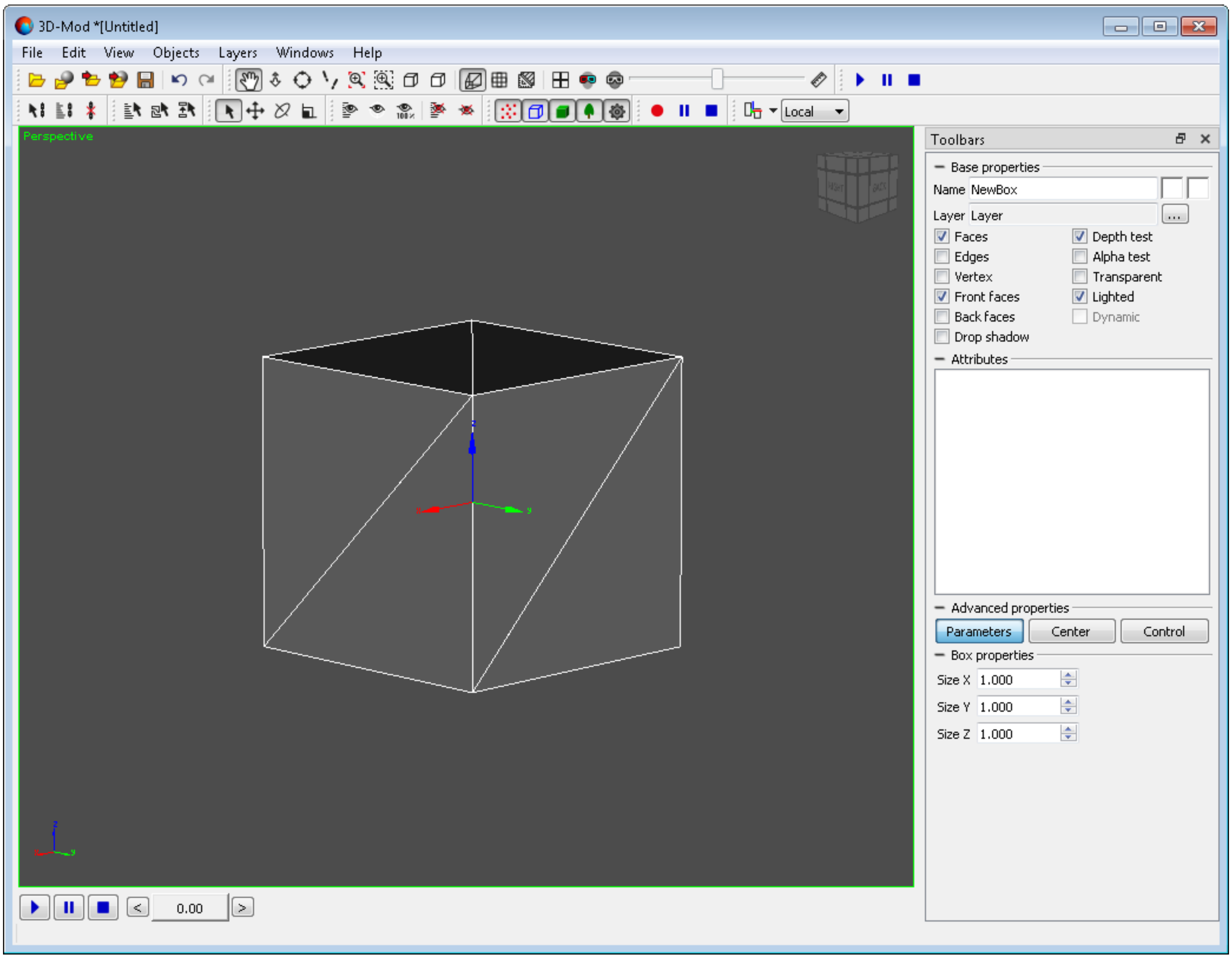


Fig. 42. Box object

6.2.8. Sphere

In order to create a sphere perform the following actions:

1. Select **Edit › Create › Sphere**. The system creates a sphere object.

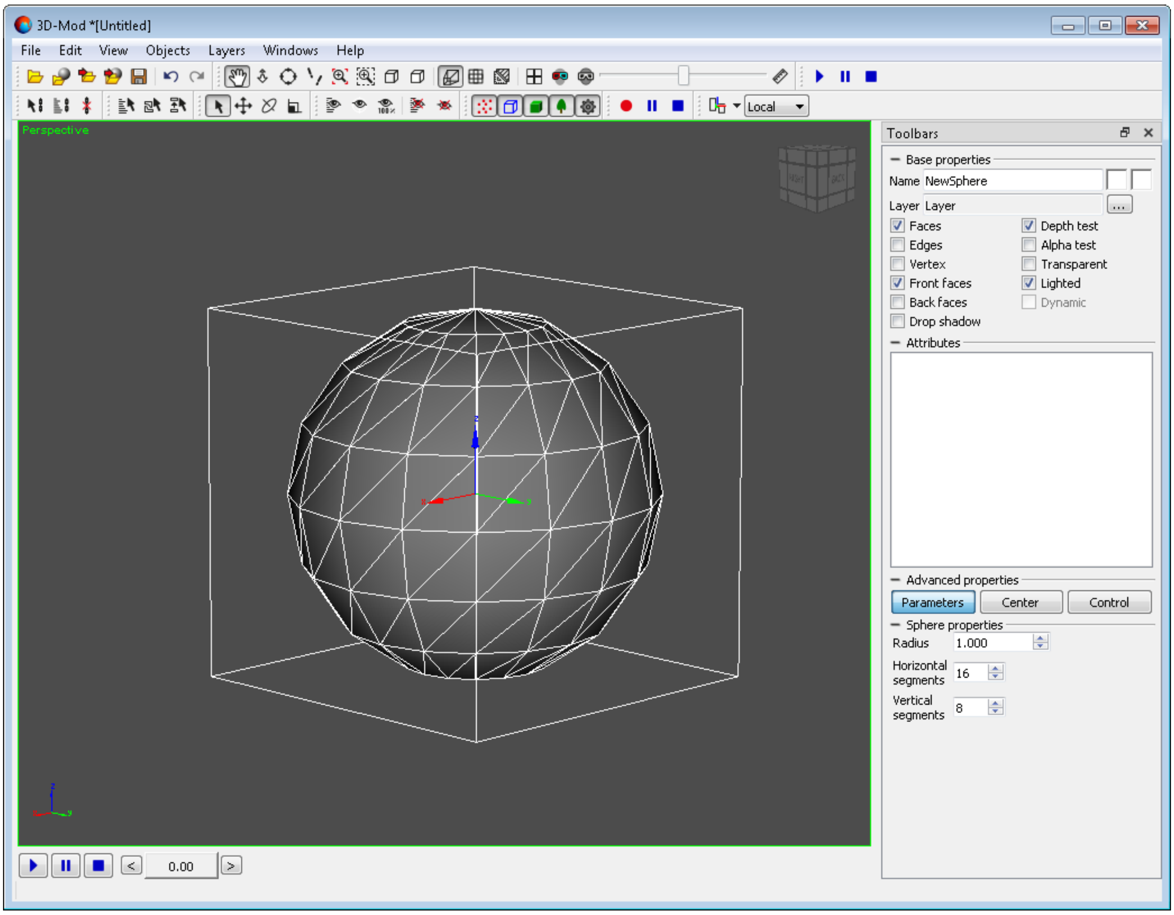


Fig. 43. Sphere object

2. Setup the following sphere parameters:

   - **Radius** – a radius of a sphere;
   - **Horizontal segments** – number of horizontal segments;

     In order to change a number of segments, specify necessary segments number in the field and press **Enter**.

   - **Vertical segments** – number of vertical segments;

     In order to change a number of segments, specify necessary segments number in the field and press **Enter**.

3. [optional] To rename a sphere input its name to the **Name** field in the **Base properties** section.

4. [optional] In order to change color of a sphere, select color in the window opened after double click on the rectangle in the **Base properties** section.

6.2.9. Cone

In order to create a cone perform the following actions:

1. Select **Edit › Create › Cone**. The system creates a cone object.

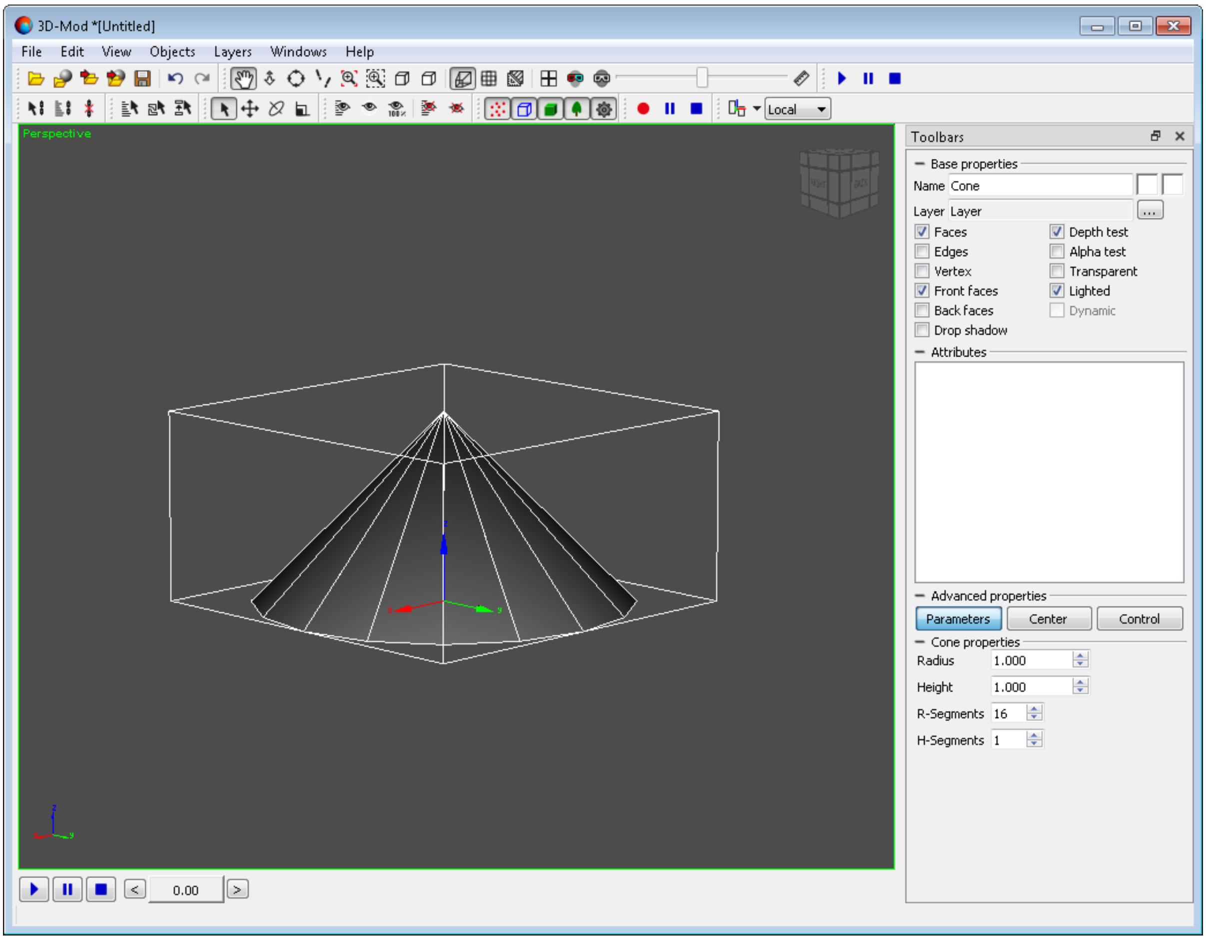


Fig. 44. Cone object

2. Setup the following cone parameters:

   - **Radius** – cone base radius;
   - **Height** – cone height;
   - **R-segments** – number of segments in cone radius;

In order to change a number of segments, specify necessary segments number in the field and press **Enter**.

- **H-segments** – number of segments in cone height;

  In order to change a number of segments, specify necessary segments number in the field and press **Enter**.

3. [optional] To rename a cone input its name to the **Name** field in the **Base properties** section.
4. [optional] In order to change color of a cone, select color in the window opened after double click on the rectangle in the **Base properties** section.

The system allows to create a pyramid. To do this input number of segments that equals 4 to the **R-segments** field.

6.2.10. Cylinder

In order to create a cylinder perform the following actions:

1. Select **Edit › Create › Cylinder**. The system creates a cylinder object.

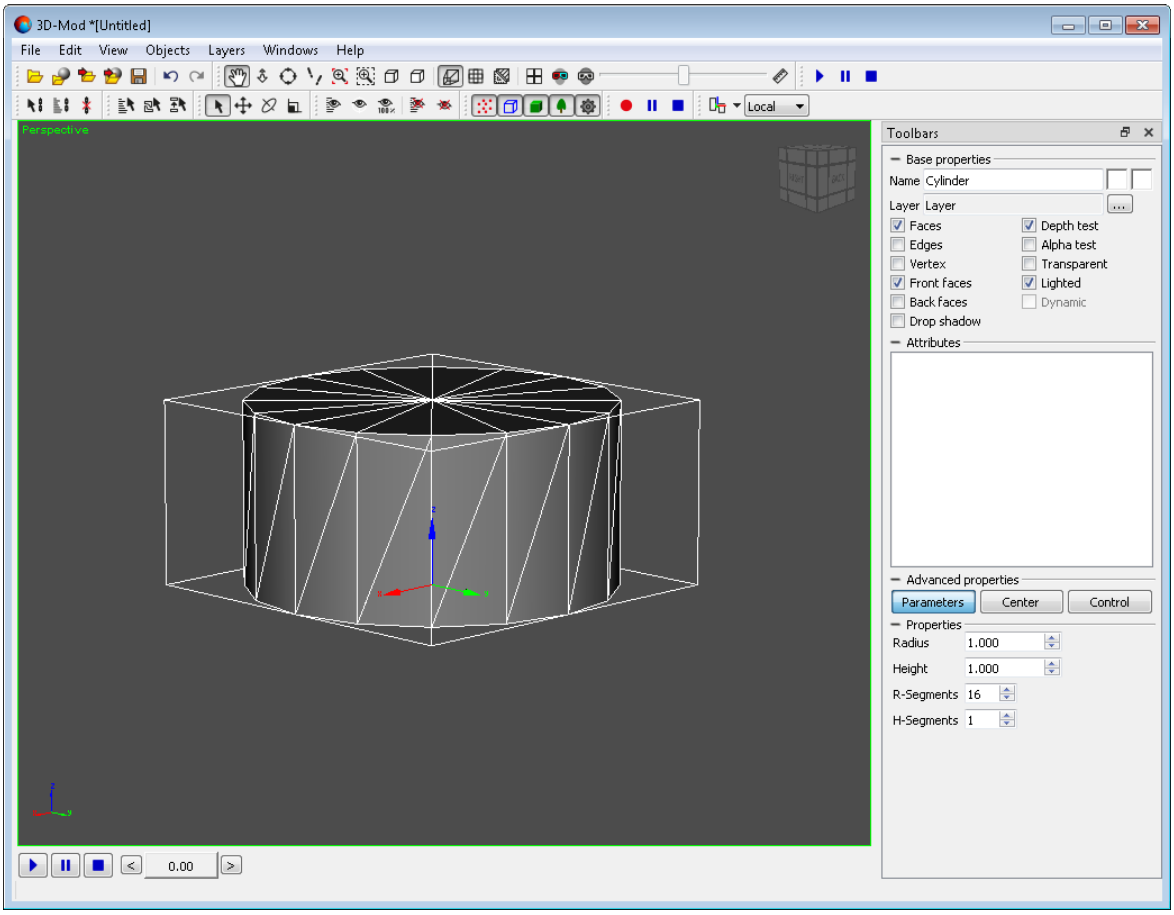


Fig. 45. Cylinder object

2. Setup the following cylinder parameters:

   - **Radius** – cylinder base radius;
   - **Height** – cylinder height;
   - **R-segments** – number of segments in cylinder radius;

     In order to change a number of segments, specify necessary segments number in the field and press **Enter**.

   - **H-segments** – number of segments in cylinder height;

     In order to change a number of segments, specify necessary segments number in the field and press **Enter**.

3. [optional] To rename a cylinder input its name to the **Name** field in the **Base properties** section.

4. [optional] In order to change color of a cylinder, select color in the window opened after double click on the rectangle in the **Base properties** section.

6.2.11. Tube

In order to create a tube perform the following actions:

1. Select **Edit › Create › Tube**. The system creates a tube object.

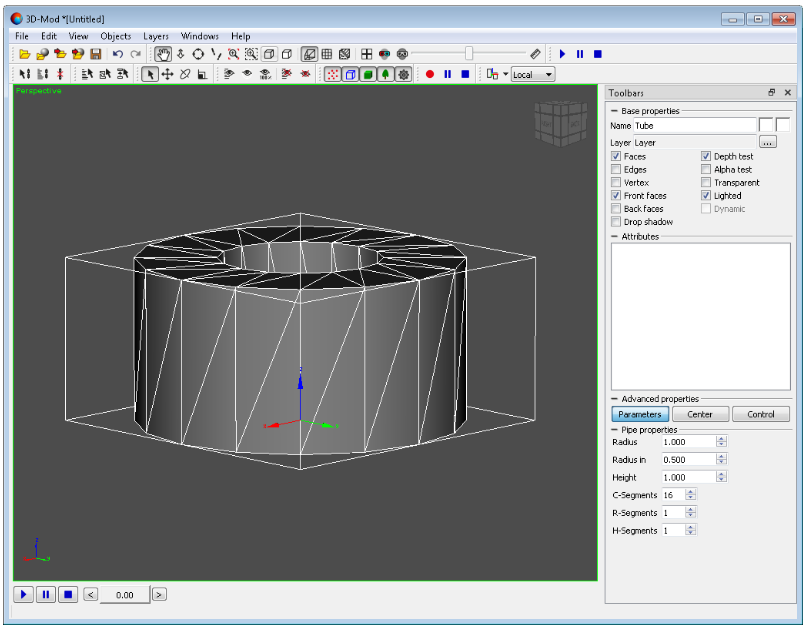


Fig. 46. Tube object

2. Setup the following tube parameters:
   - **Radius** – the external radius of the tube;
   - **Radius in.** – the internal radius of the tube;
   - **Height** – tube height;
   - **R-segments** – number of segments across the thickness of the tube;

     In order to change a number of segments, specify necessary segments number in the field and press **Enter**.

   - **H-segments** – number of segments along the tube height;

     In order to change a number of segments, specify necessary segments number in the field and press **Enter**.

3. [optional] To rename a tube input its name to the **Name** field in the **Base properties** section.
4. [optional] In order to change color of a tube, select color in the window opened after double click on the rectangle in the **Base properties** section.

6.2.12. Plane

In order to create a plane perform the following actions:

1. Select **Edit › Create › Plane**. The system creates a plane.

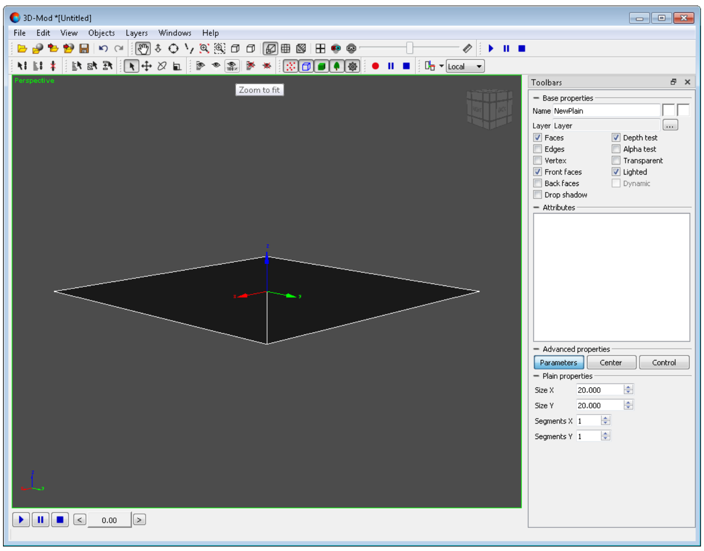


Fig. 47. Plane object

2. Setup the following plane parameters:

   * **Size X** and **Size Y** – a plane length and width;
   * **Segments X** and **Segments Y** – number of segments in length and width.

   In order to change a number of segments, specify necessary segments number in the field and press **Enter**.

3. [optional] To rename a plane input its name to the **Name** field in the **Base properties** section.

4. [optional] In order to change color of a plane, select color in the window opened after double click on the rectangle in the **Base properties** section.

6.2.13. Light source

The system provides the use of light sources for 3D-scene lighting. Built-in light sources are used by default. When creating a new light source (**Edit › Create › Light source**) built-in light sources are disabled.

Perform the following actions for creating a light source:

1. Select **Edit › Create › Light source**. The system creates an object that imitates action of real light source.

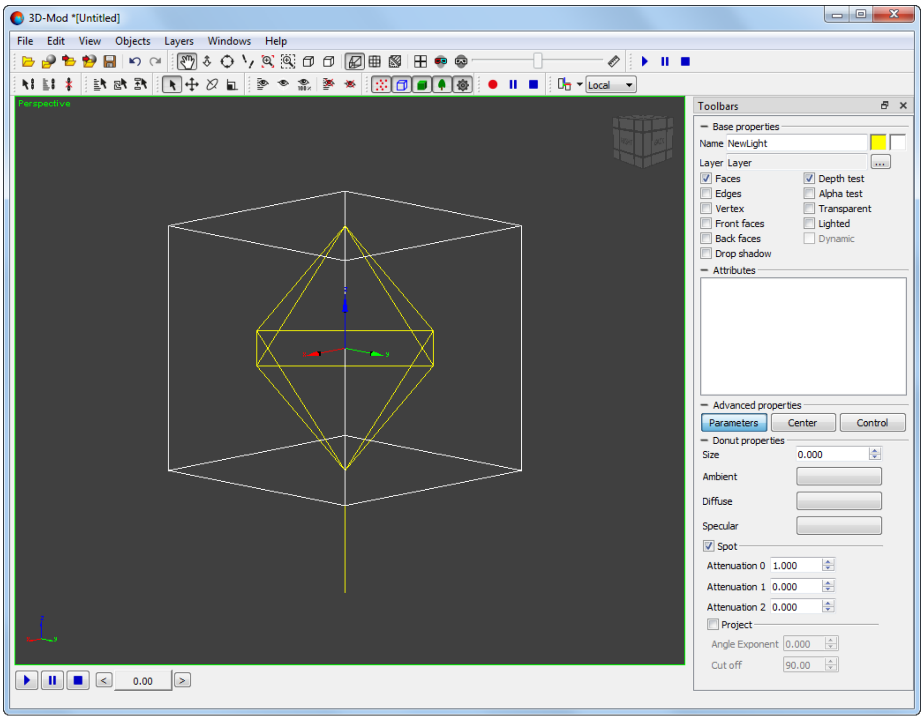


Fig. 48. Light source object

2. Setup the following parameters of light source:

   - **Size** – a size of light source;
   - **Ambient** – a colour of the ambient light rays emitted by the source;
   - **Diffuse** – a colour of the direct light rays emitted by the source;
   - **Specular** – a colour of a flare emitted by the source;
   - **Spoot** – a point source emitting rays of light in all directions;
   - **Attenuation 0**, **Attenuation 1**, **Attenuation 2** – allows to change point light source intencity, i.e. it allows to set light attenuation depending on the distance to the object. The light intensity value, which does not depend on the distance to the object, is set by default (k_0=1, k_1=0, k_2=0), that means that there is no light attenuation.

     The light intensity coefficients are calculated by the following formula:

     $I = \frac{1}{k_0 + k_1 \cdot d + k_2 \cdot d^2}$, where k_0, k_1, k_2 – coefficients, which correspond to the parameters **Attenuation 0**, **Attenuation 1**, **Attenuation 2**. d – a distance between the object and the light source.

   - **Project** – a source of the spotlight type, which emits a divergent beam of light directed at an angle to the object;
   - **Cutoff** – a coefficient that allows to change the spotlight intencity;
   - **Angle Exponent** – the angle of inner area of the spotlight directionality.

In order to increase natural lighting of 3D-scene, it is recommended to use at least two light sources.

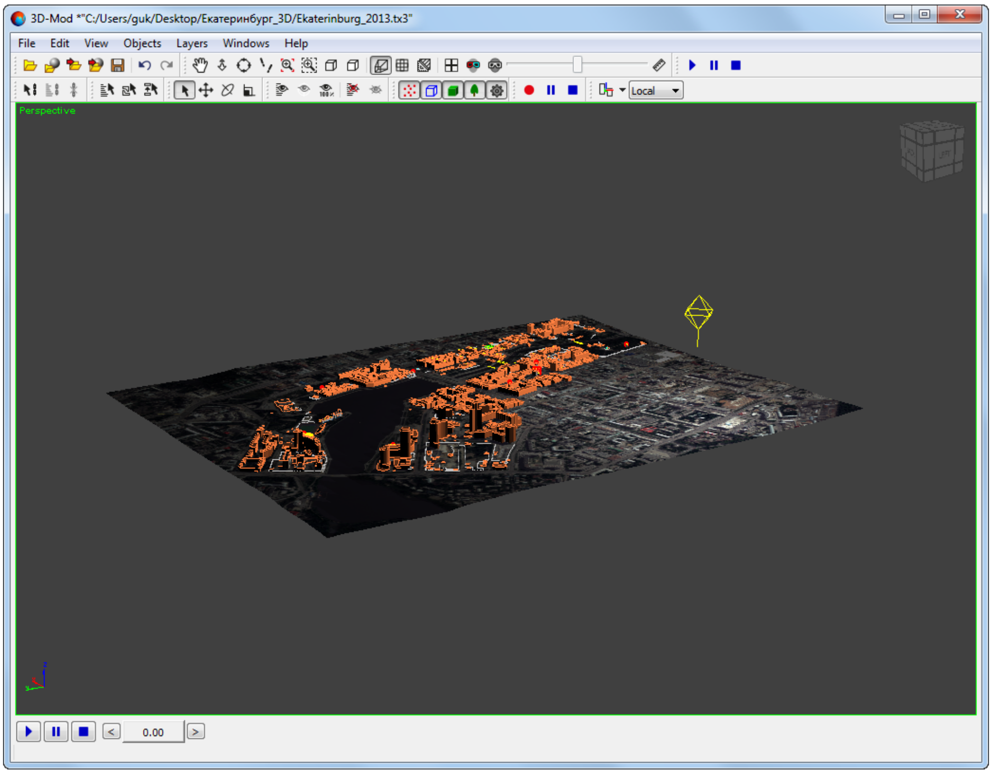


Fig. 49. One light source

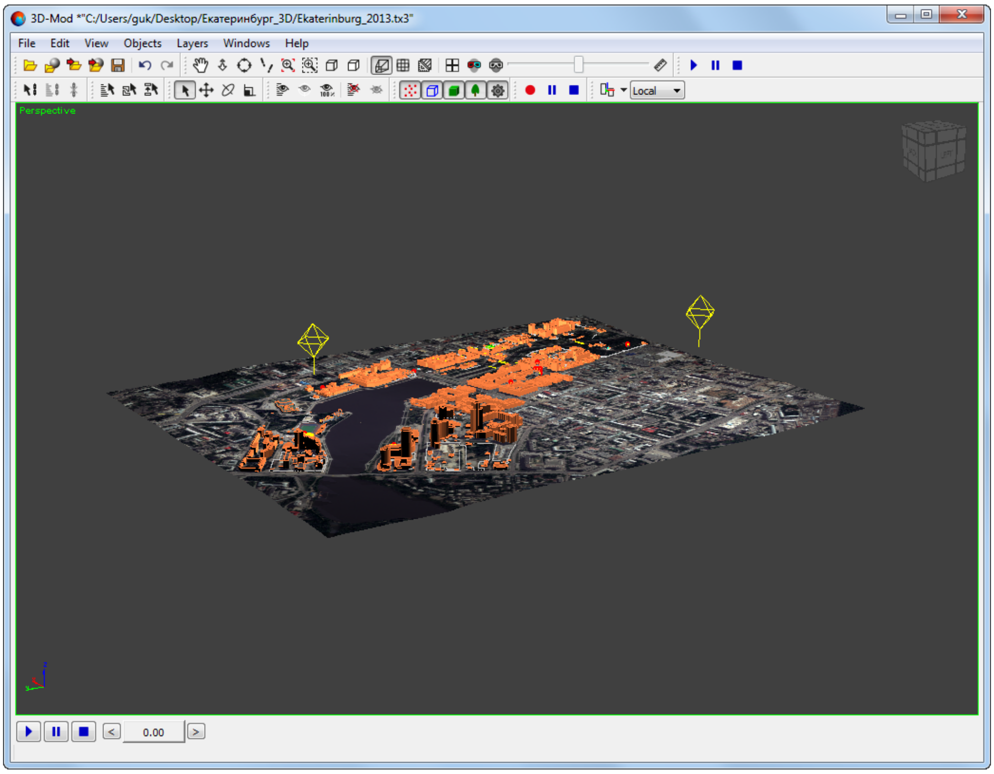


Fig. 50. Two light sources

6.3. Geometric center of the object

Each 3D-scene object contains geometric center and coordinate axes, originating from the center. Geometric center of the object allows to scale, rotate and move the object relative to the object's center.

During creation a new object in 3D-scene or during objects import the geometric center is created for each object automatically. When you select a scene object in the preview area coordinate axes, originating from the geometric center of the object, are displayed.

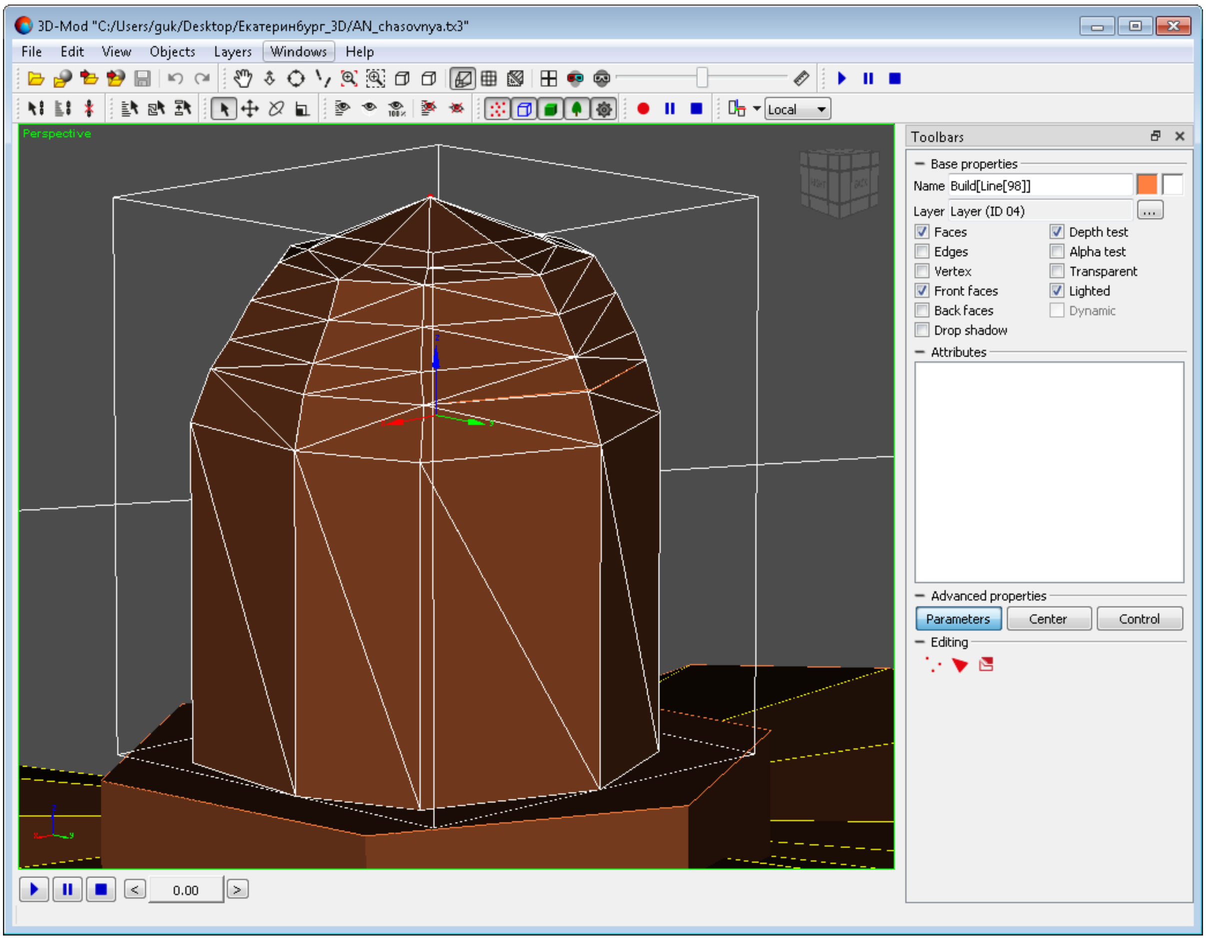


Fig. 51. Geometric center of the object

The system allows to change object geometric center position, for example, to move the object on some distance relative to another object or to rotate the object relative to an arbitrary point in space.

In order to change coordinates of object's geometric center, perform the following actions:

1. Select an object.

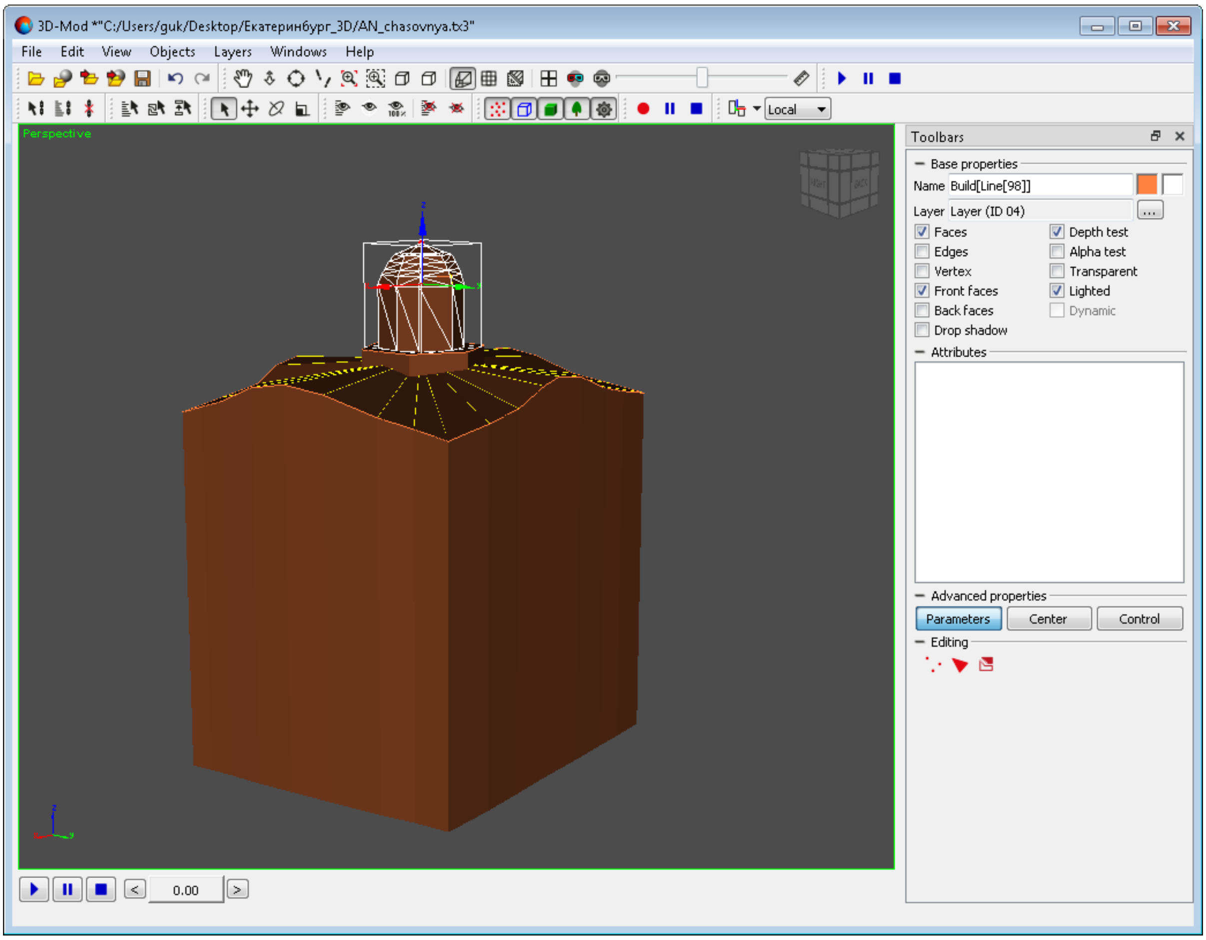


Fig. 52. Selected object

2. In the **Advanced properties** section select the **Origin** tab and click the **Edit pivot** button.
3. Select **Edit › Move** or click the button on the main toolbar. The move mode is on.
4. Move the geometric center of the object to an arbitrary point of scene’s space.

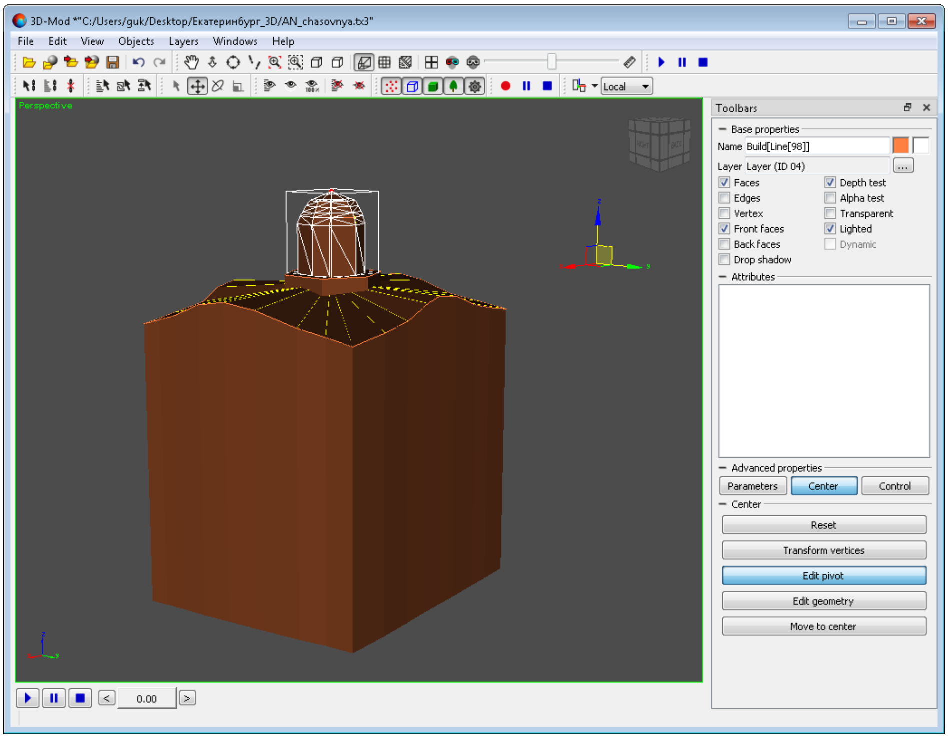


Fig. 53. Moving geometric center in relation to object

5. Click the **Edit center** button.

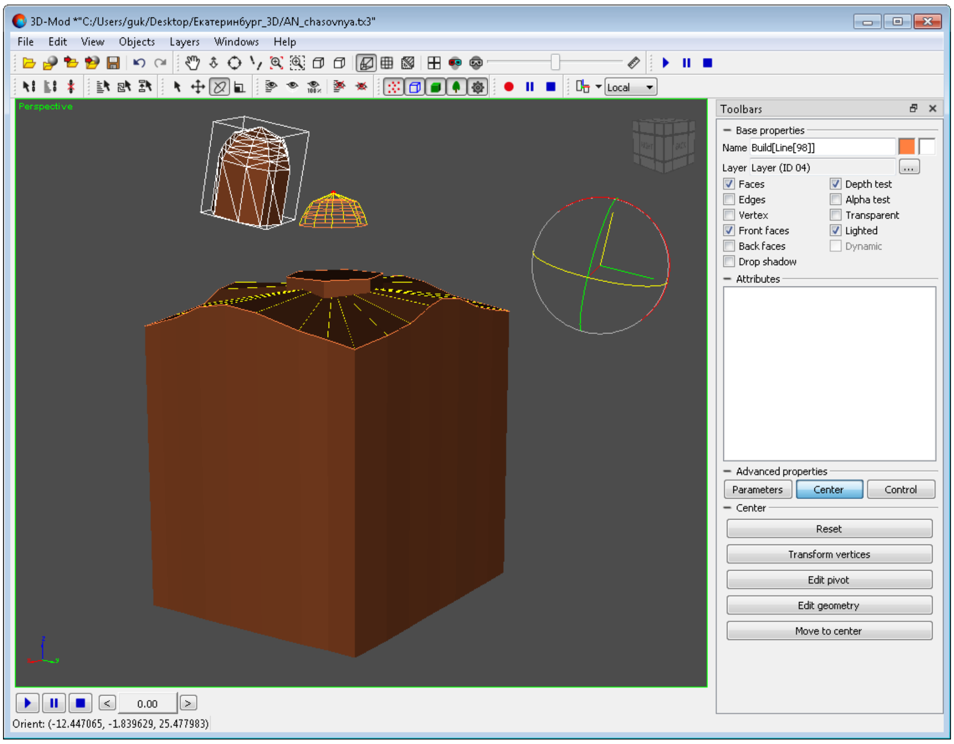


Fig. 54. Rotation of object in relation to geometric center

In order to move an object relatively to geometric center position, perform the following actions:

1. Select an object.

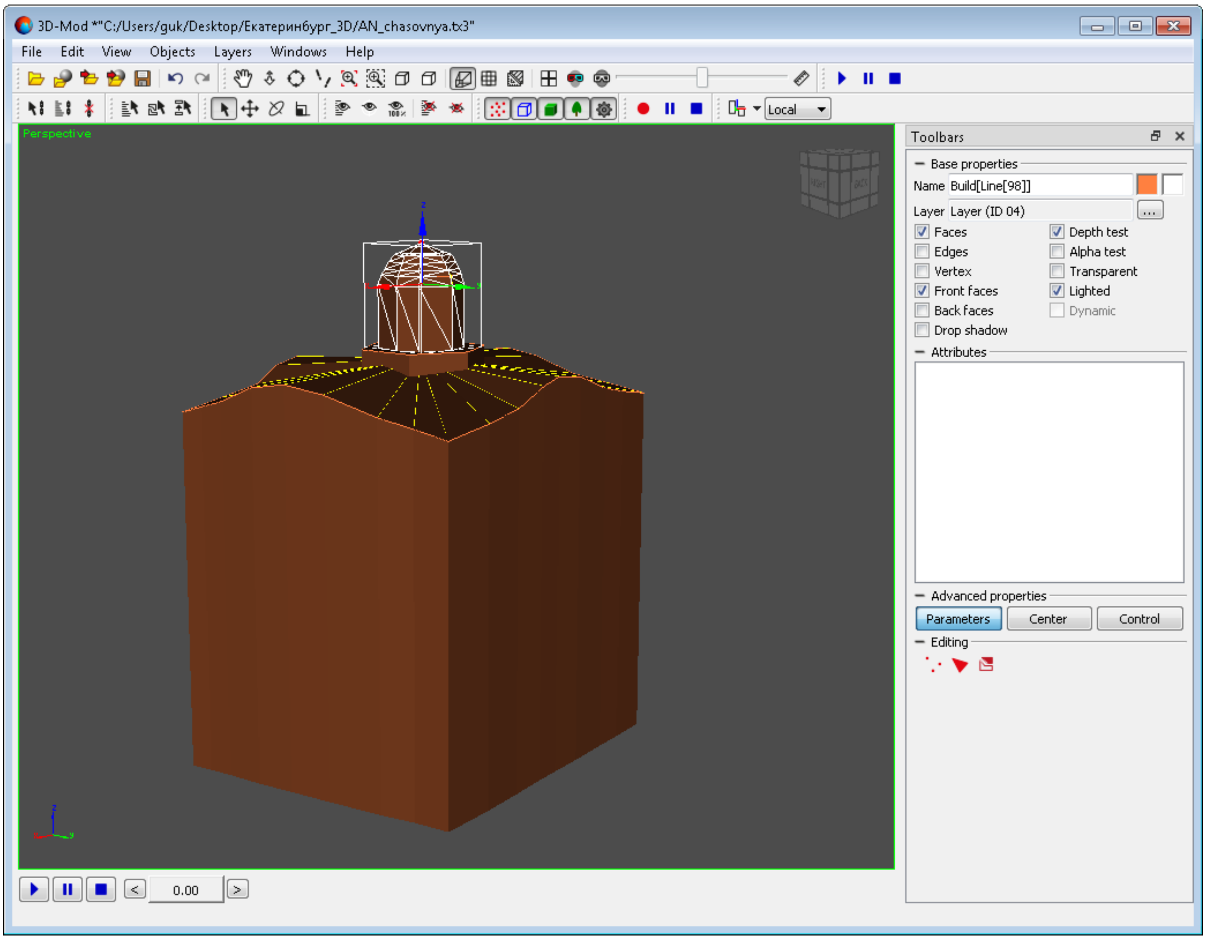


Fig. 55. Selected object with displaced geometric center

2. In the **Advanced properties** section select the **Origin** tab and click the **Edit geometry** button. Selected object changed its position in relation to geometric center.

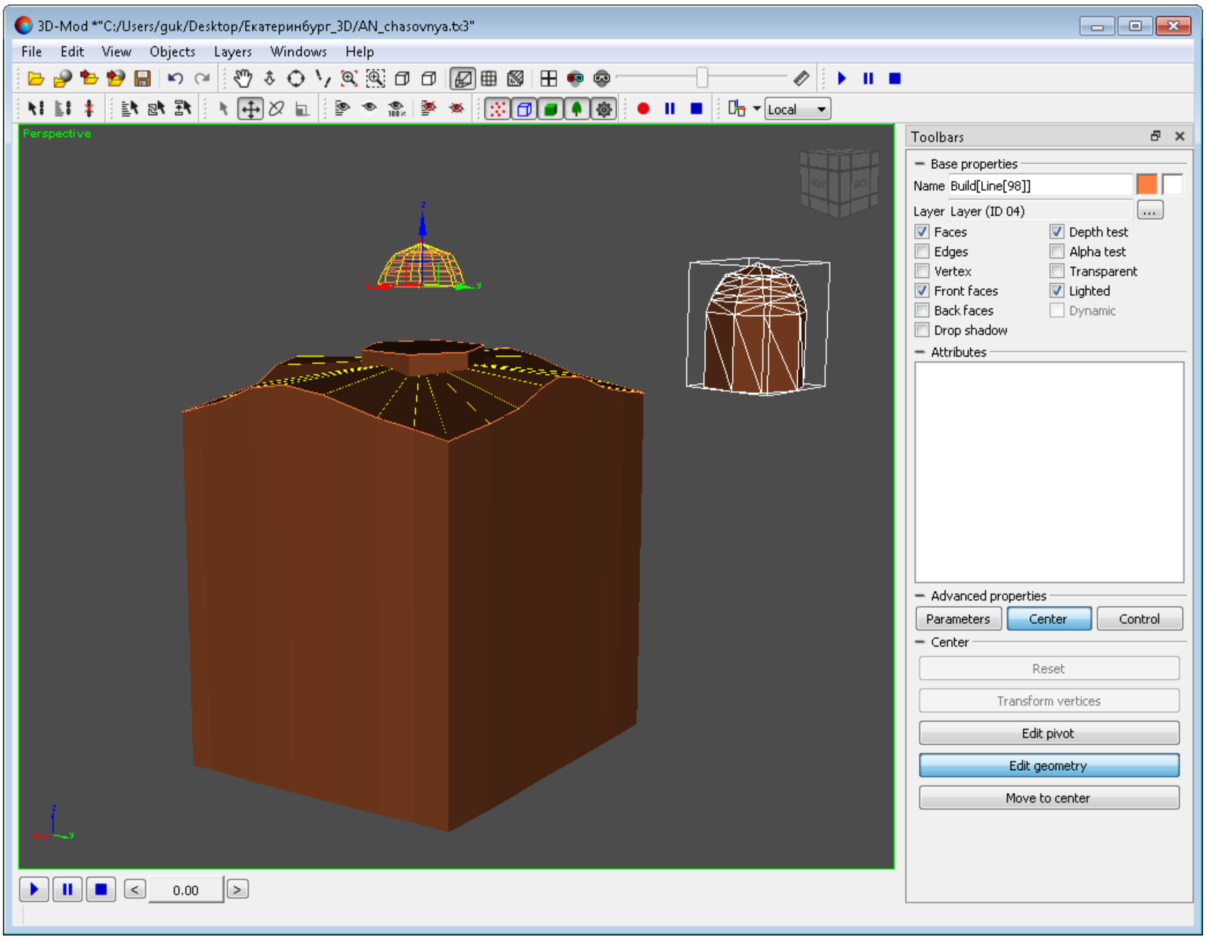


Fig. 56. Moving object in relation to geometric center

6.4. 3D-objects selection

Before you perform any operation with an object (group of objects) you must select the object.

In order to select single objects or objects group in viewing area, choose **Edit › Select** or click the button on the main toolbar. The objects selection mode is on. To select a single object, click in its vicinity. To select a group of objects, press and hold left mouse button and drag a rectangle by the mouse.

To select a group of objects, press and hold the **Shift** key, and click objects sequentially.

If a 3D-scene contains a large number of objects, it is recommended to select them using their names in objects list.

In order to select a single objects or objects group in the list, perform the following actions:

1. Select **Edit › Select by name** or click the button on the main toolbar. The **Select objects** window opens.

   The **Select objects** window contains the following buttons:

   - – allows to select all items in the list;
   - – allows to deselect all items in the list;
   - – allows to invert items selection.

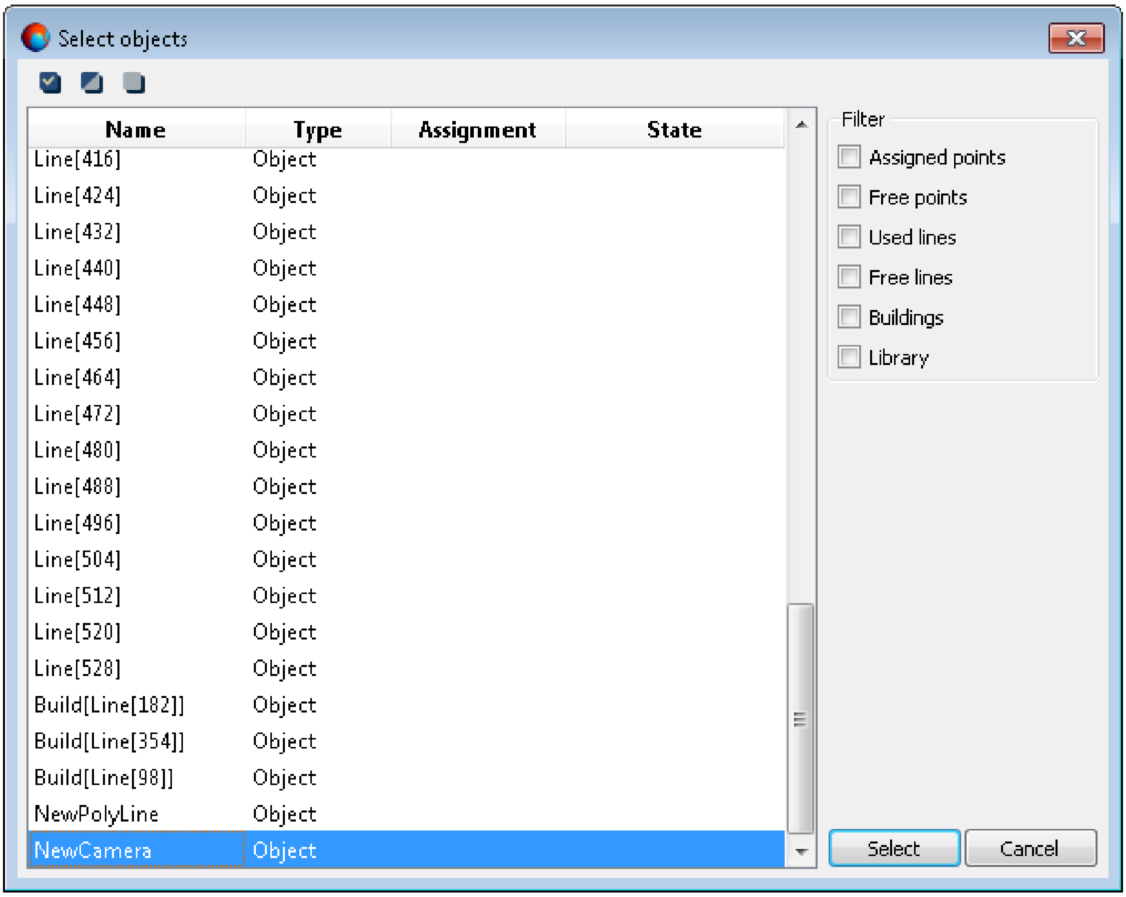


Fig. 57. Select objects from the list window

The list of 3D-objects contains the following columns:

- **Name** – object name;
- **Type** – object type, which is assigned to an object during its creation in the system (Object, Outline, LibPoint, None) (see detailed description of object attributes in the “Vectorization” User Manual);
- **Assignment** – shows object’s assignment;

- **State** – shows objects, used for 3D-creation (Занятый) or not used (Свободный).

2. The **Filter** section allows to select objects type to be shown in the list.

3. [optional] To show 3D-objects in the list, set the **Buildings** checkbox on.

4. [optional] To show in the list point objects, converted to objects during creation from DXF-file library, set the **Library** checkbox on.

5. To manage objects selection in the list, use the following buttons:

   - **Select all** – allows to select all objects in the list;
   - **Inverse** – allows to invert objects selection order;
   - **Clear** – allows to deselect all objects.

6. Select objects by mouse click and click the **Select** button.

   To select a group of objects, press and hold the **Shift** key, and click objects sequentially.

To select objects that *are not* involved in 3D-creation, choose **Edit › Select unassigned** or click the button on the main toolbar.

To select both the whole object, and all elements that are *involved* in 3D-creation, choose **Edit › Select dependent** or click the button on the main toolbar.

6.5. Operations with 3D-objects

6.5.1. Moving object

In order to move an object relatively to geometric center position, perform the following actions:

1. Select **Edit › Move** or click the button on the main toolbar. Move mode of selected objects in the viewing area is on.

2. Click the object. After that the object's coordinate system is displayed.

3. Place mouse cursor close to the coordinate axis or to the plane in which you want to move the object. The coordinate axis or the plane is displayed in yellow.

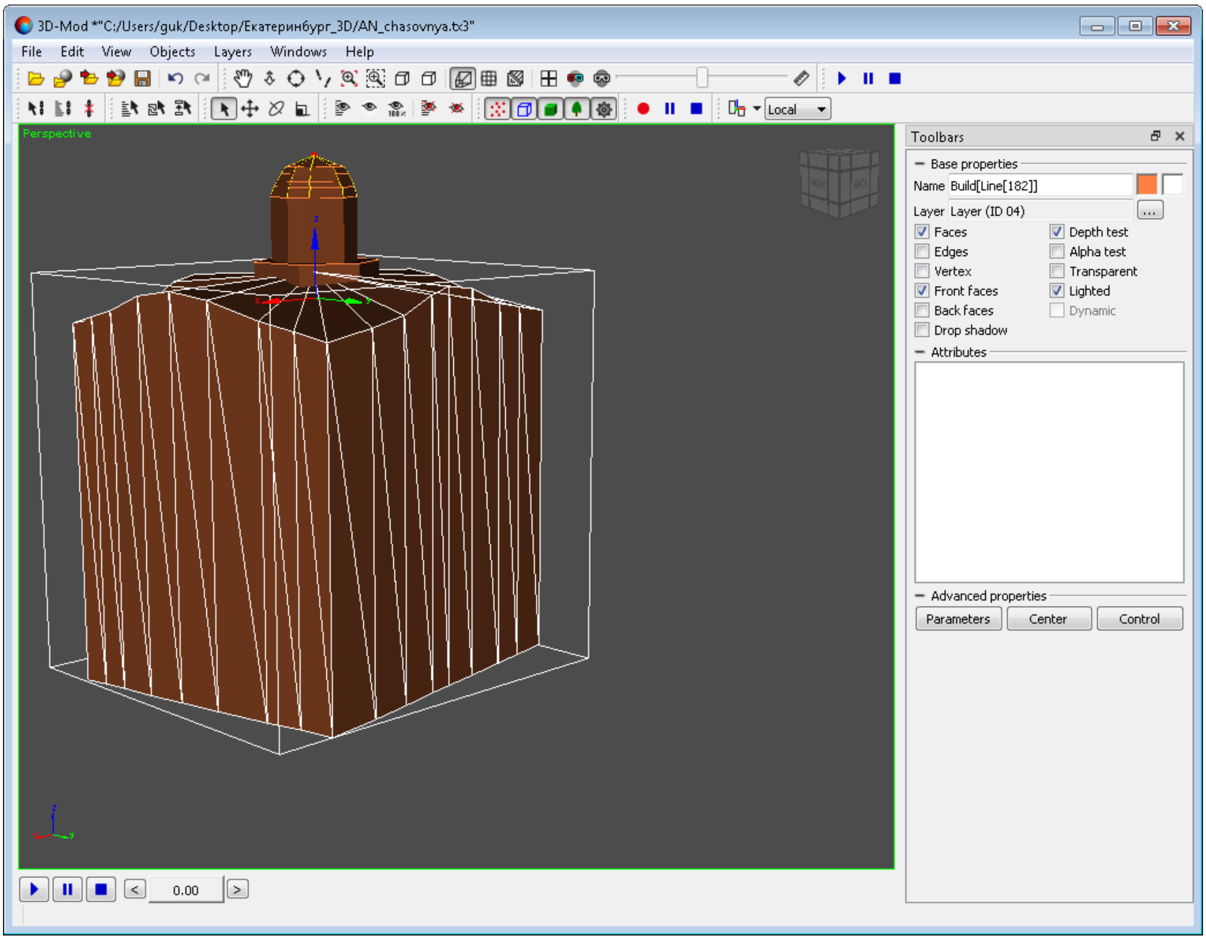


Fig. 58. Selected YZ plane

4. Press and hold mouse button while moving an object to desired place.

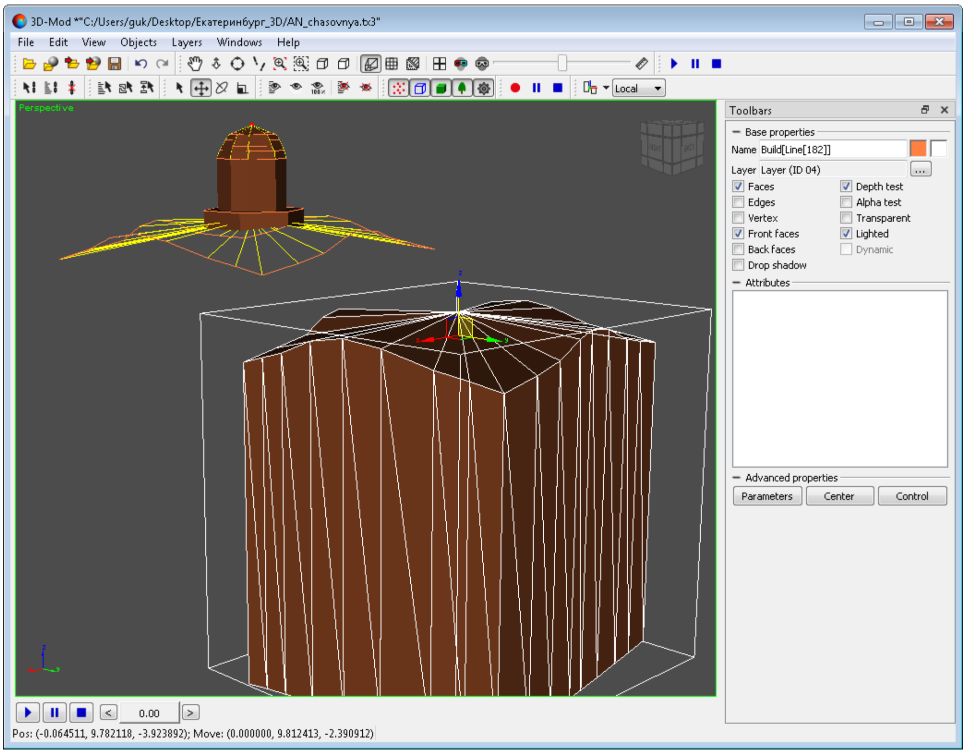


Fig. 59. Moving an object in YZ plane

5. [optional] **Right click** the button of the main toolbar. The **Position** window opens. Specify object moving parameters using one of the two following ways:

   - relative to its current position (in the **Relative** section);
   - relative to current origin (in the **Absolute** section).

   Press **Enter**.

In the **Position** window you can input parameters of object moving with negative values.

After object moving its new position coordinates are displayed in the **Absolute** section.

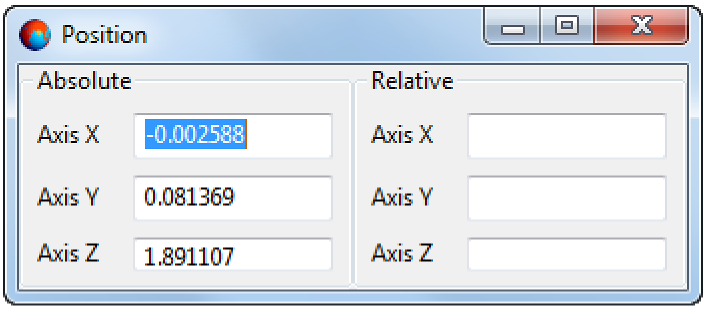


Fig. 60. Object moving parameters

6.5.2. Object rotation

You can rotate the selected scene object in relation to object geometric center.

In order to rotate an object in view area, perform the following actions:

1. Select **Edit › Rotate** or click the  button on the main toolbar. The selected objects rotation mode is on.

2. Click the object. After that the rotation sphere is displayed.

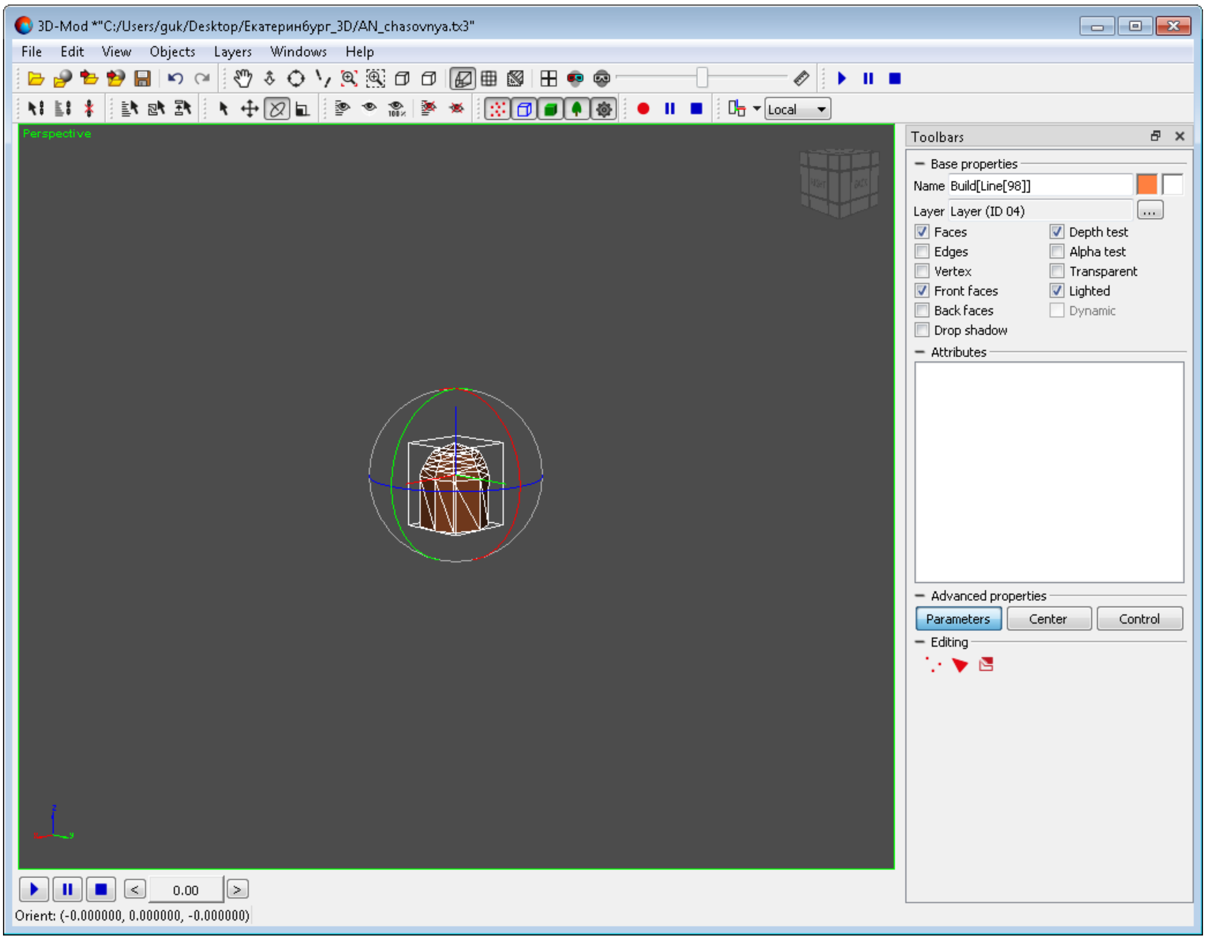


Fig. 61. Rotation sphere of an object

3. Select one of the following object rotation options:

   • to rotate an object along *one* of the rotation sphere planes, place mouse cursor close to the plane. The selected plane is displayed in yellow.

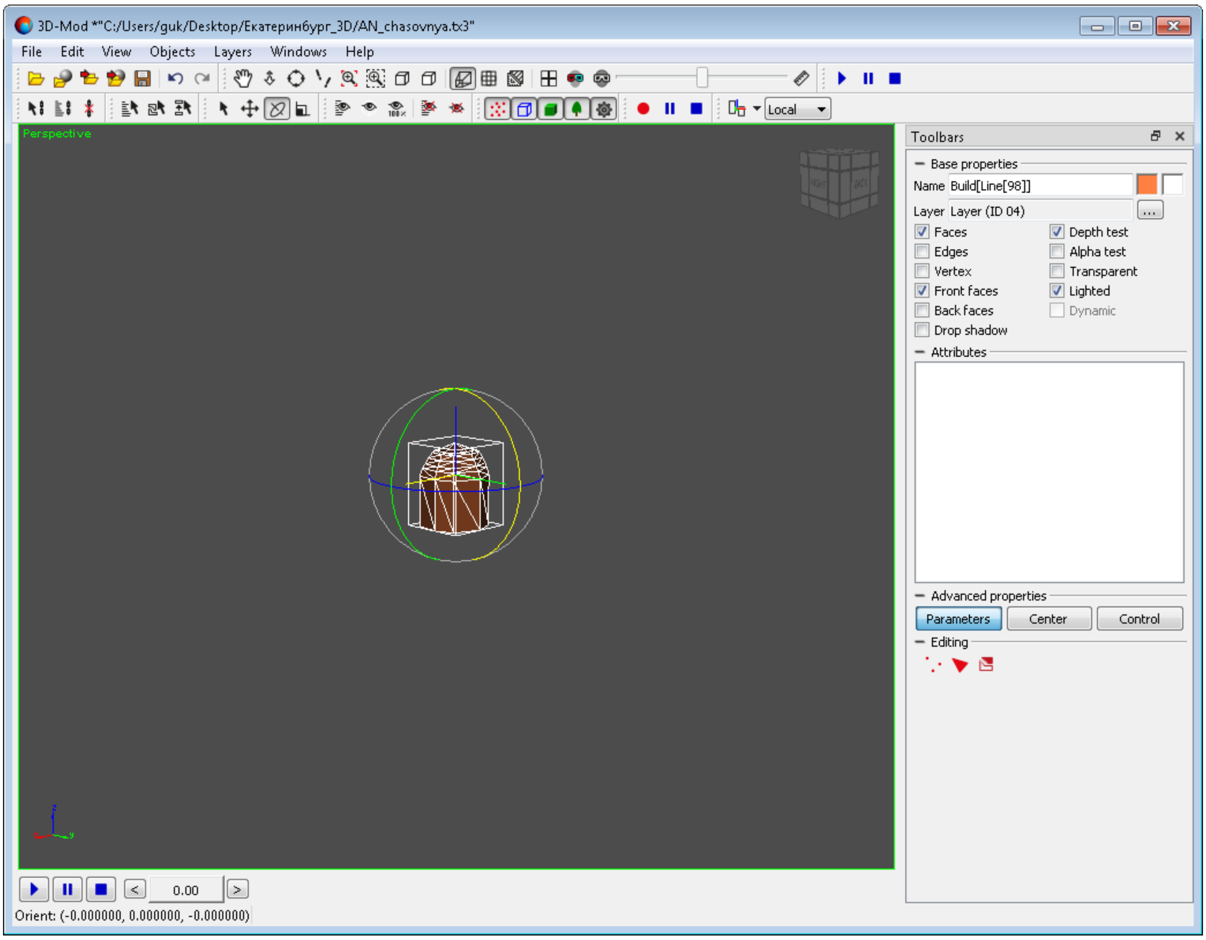


Fig. 62. Object rotation along one of the rotation sphere planes

- to rotate an object in a *free plane*, move the mouse cursor to the rotation sphere center. The rotation sphere is displayed in yellow.

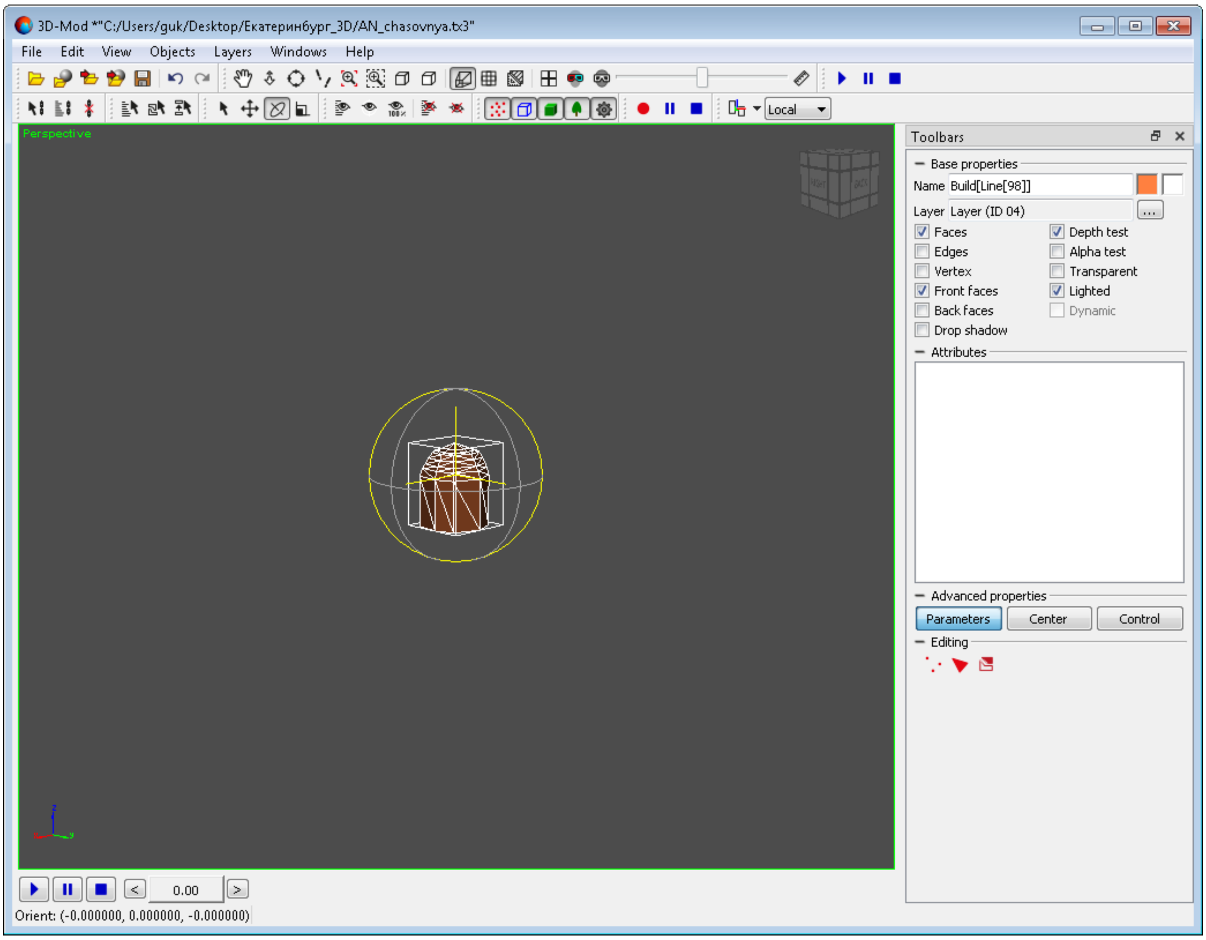


Fig. 63. Selected free plane

4. Press and hold mouse button while rotating an object to desired position.

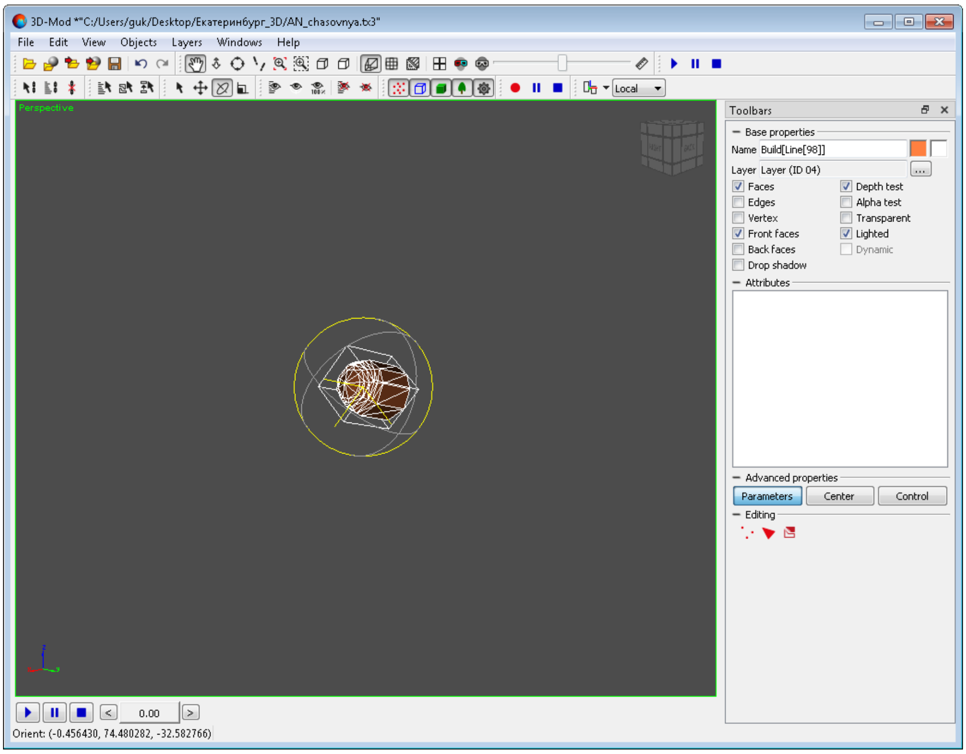


Fig. 64. Object rotation in free plane

5. [optional] **Right click** the button of the main toolbar. The **Rotation** window opens. Specify object rotating parameters using one of the two following ways:

   - relative to its current position (in the **Relative** section);
   - relative to current origin (in the **Absolute** section).

   Press **Enter**.

In the **Rotation** window you can input rotation parameters with negative values.

After object rotating its new position coordinates are displayed in the **Absolute** section.

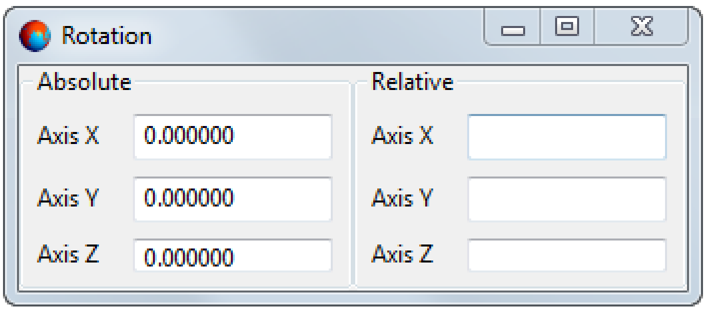


Fig. 65. Object rotating parameters

6.5.3. Object scaling

You can scale the selected scene object in relation to object geometric center.

In order to change object scale along three coordinate axes or along one of them, perform the following actions:

1. Select **Edit › Scale** or click the button on the main toolbar. The selected objects scale mode is on.

2. Click the object. After that the object's coordinate system is displayed.

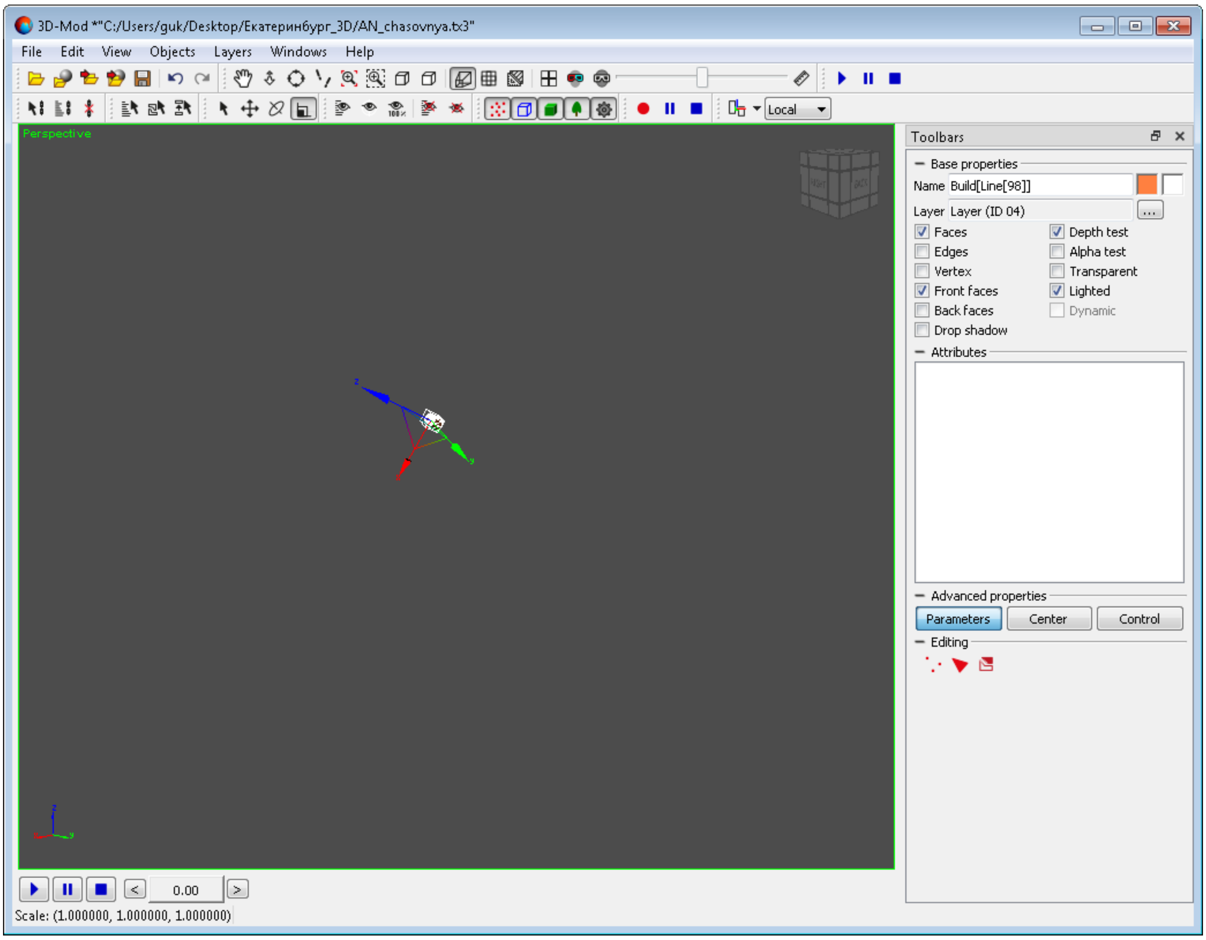


Fig. 66. Object's coordinate system

3. Select coordinate axis along which you want to scale an object:

   - to change object scale along *one* of the axes, move the mouse cursor close to the axis. The coordinate axis is displayed in yellow.

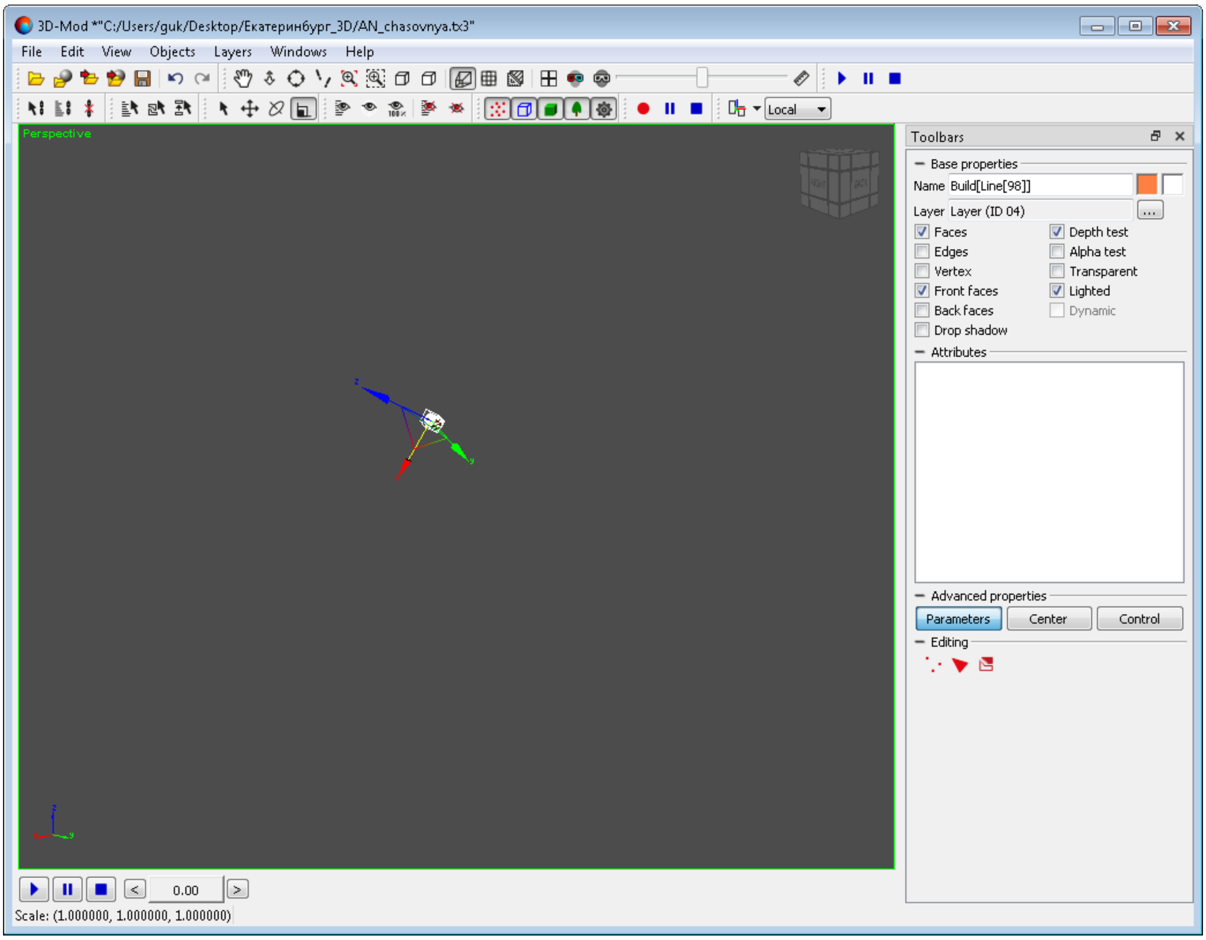


Fig. 67. Selected Z-axis

- to change object scale in a plane of *two* coordinate axes, move the mouse cursor close to the bridge in triangle shape connecting the two axes. The selected plane is displayed in yellow.

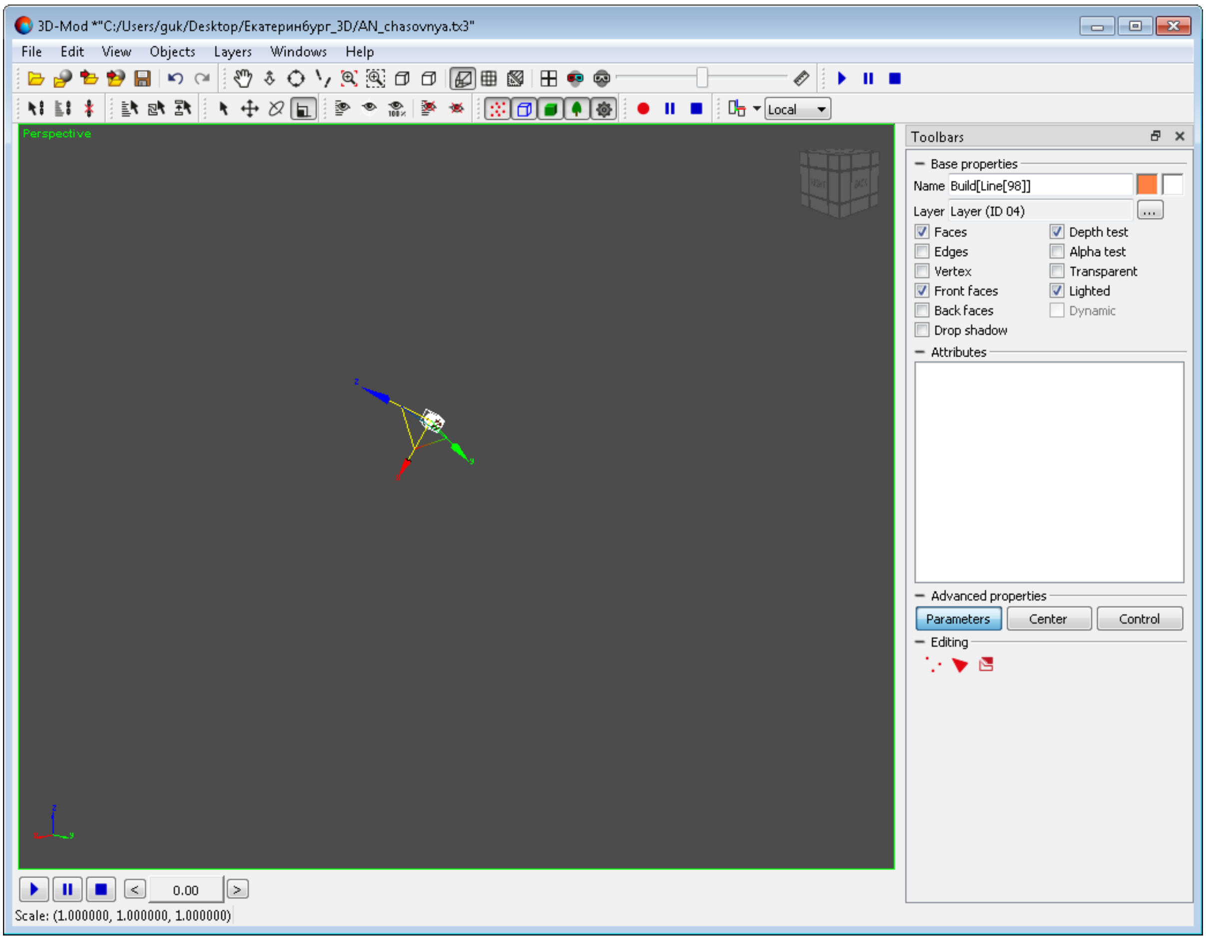


Fig. 68. Selected YZ plane

- to change object scale along *three* coordinate system axes, move the mouse cursor close to the axes origin. Selected area is displayed in triangle shape of yellow color.

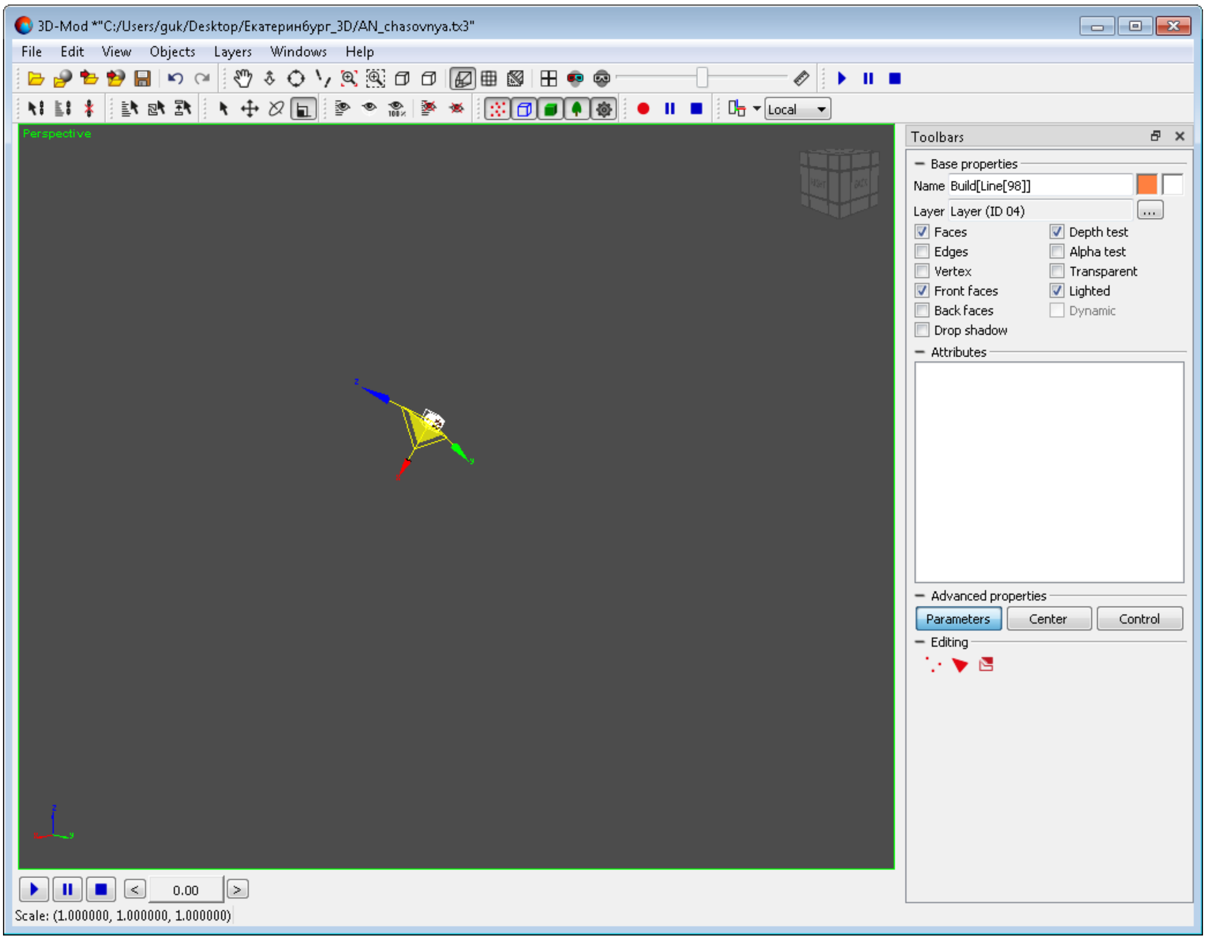


Fig. 69. Selected area along three coordinate system axes

4. Press and hold mouse button while moving the mouse cursor. The object scale is changed along selected coordinate axes.

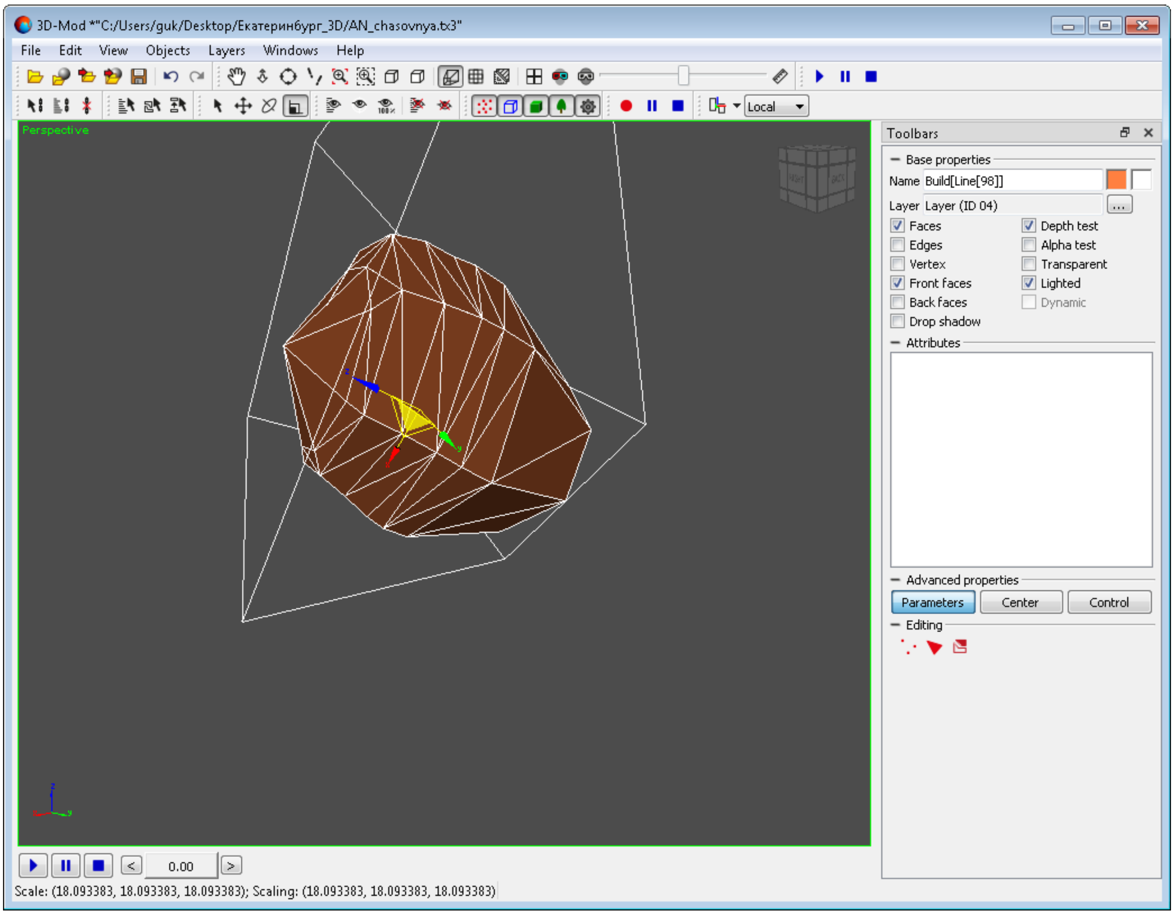


Fig. 70. Object scaling along three coordinate system axes

5. [optional] **Right click** the button of the main toolbar. The **Scale** window opens. Specify scaling parameters in the **Relative** section. Press **Enter**.

In the **Scale** window you can input scaling parameters with negative values.

After object scaling its new position coordinates are displayed in the **Absolute** section.

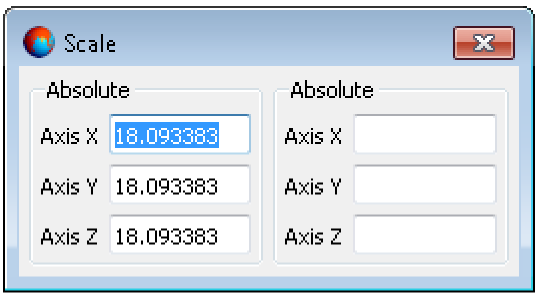


Fig. 71. Object scaling parameters

6.5.4. Converting an object into a grid

The module allows to perform operations with any geometric body.

Geometric body is called 2D or 3D-object, created to be displayed on final 3D-scene.

A base of geometric body is its grid shell (grid).

Grid shell of geometric body has a certain structure and consists of points and faces. Vertices and faces of any created body (**Edit › Create**) are not available for editing, i.e. it is impossible to change the shape of the body in an arbitrary way. To edit a geometric body it is necessary to convert an initial object to grid shell (mesh manifold).

In order to convert an object to a grid perform the following actions:

1. Create object or import it.
2. Select an object.

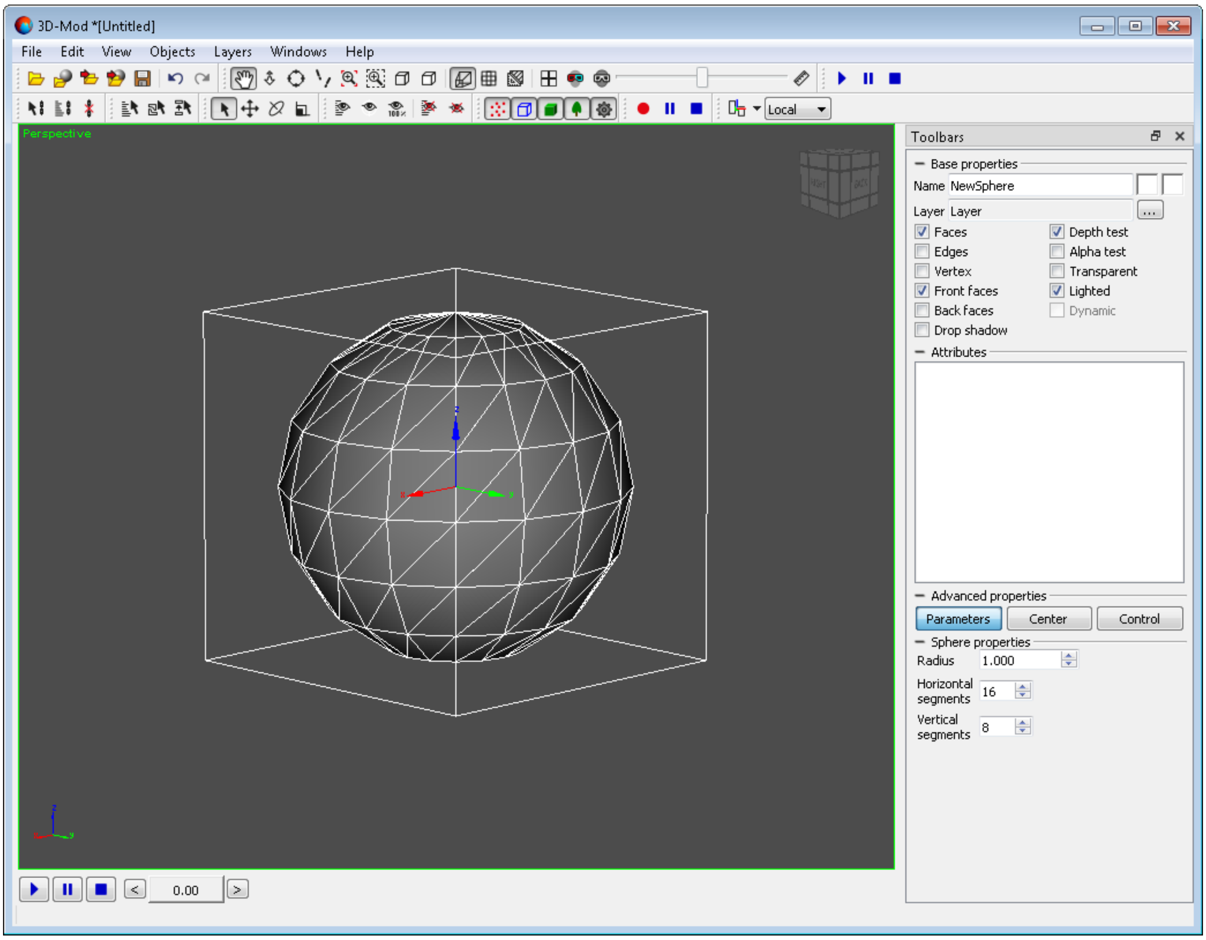


Fig. 72. Selected object - sphere

3. Select **Edit › Convert to › grid**. After that converted object becomes editable.

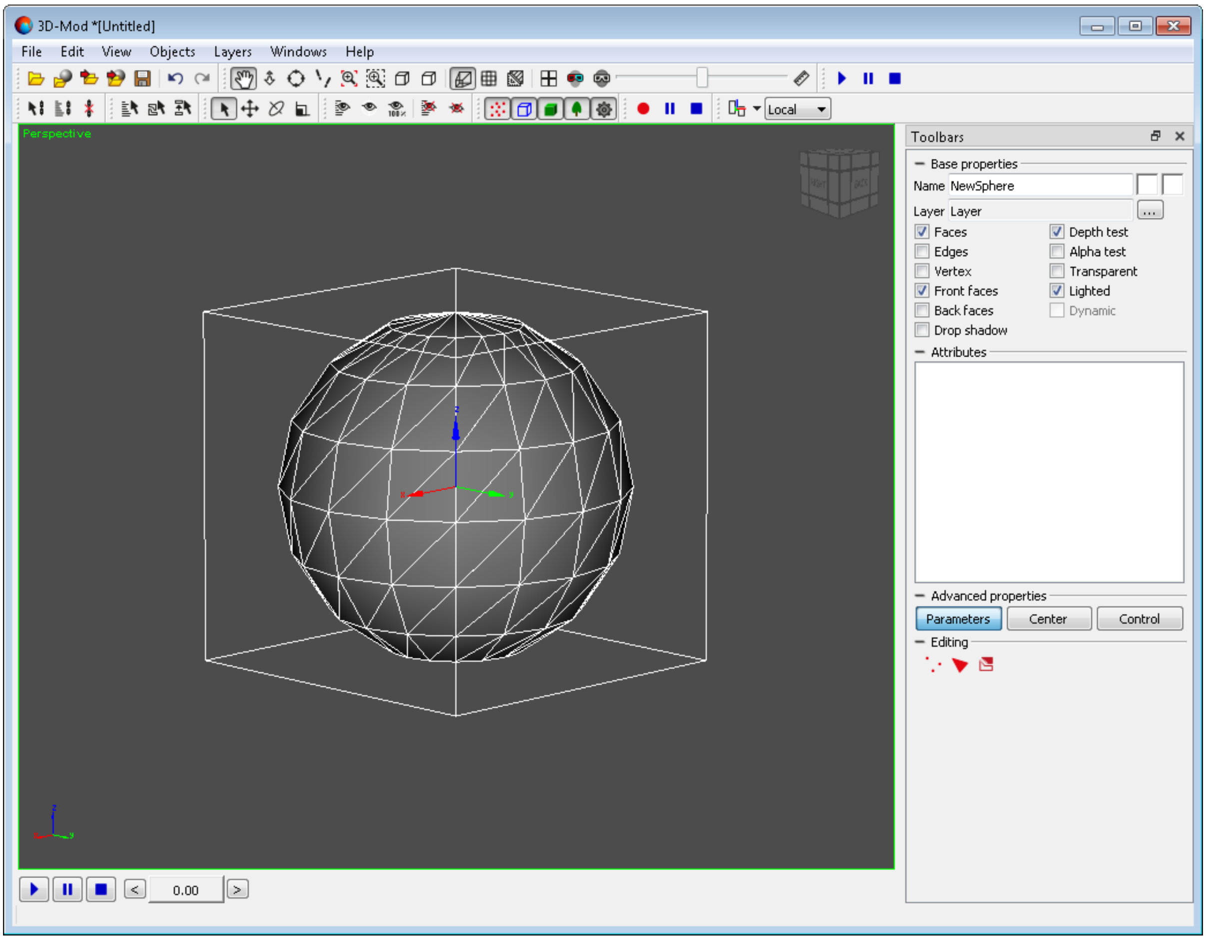


Fig. 73. Selected object converted to a grid

6.5.5. Editing of object's points

Object's point – a point in which grid shell faces converge.

Perform the following actions to edit object's points:

1. Create object or import a vector objects layer.
2. Select an object.
3. [optional] To edit *created* object choose **Edit › Convert to › grid**.
4. In the **Editing** section click the  button. The editing of object's points mode is on.

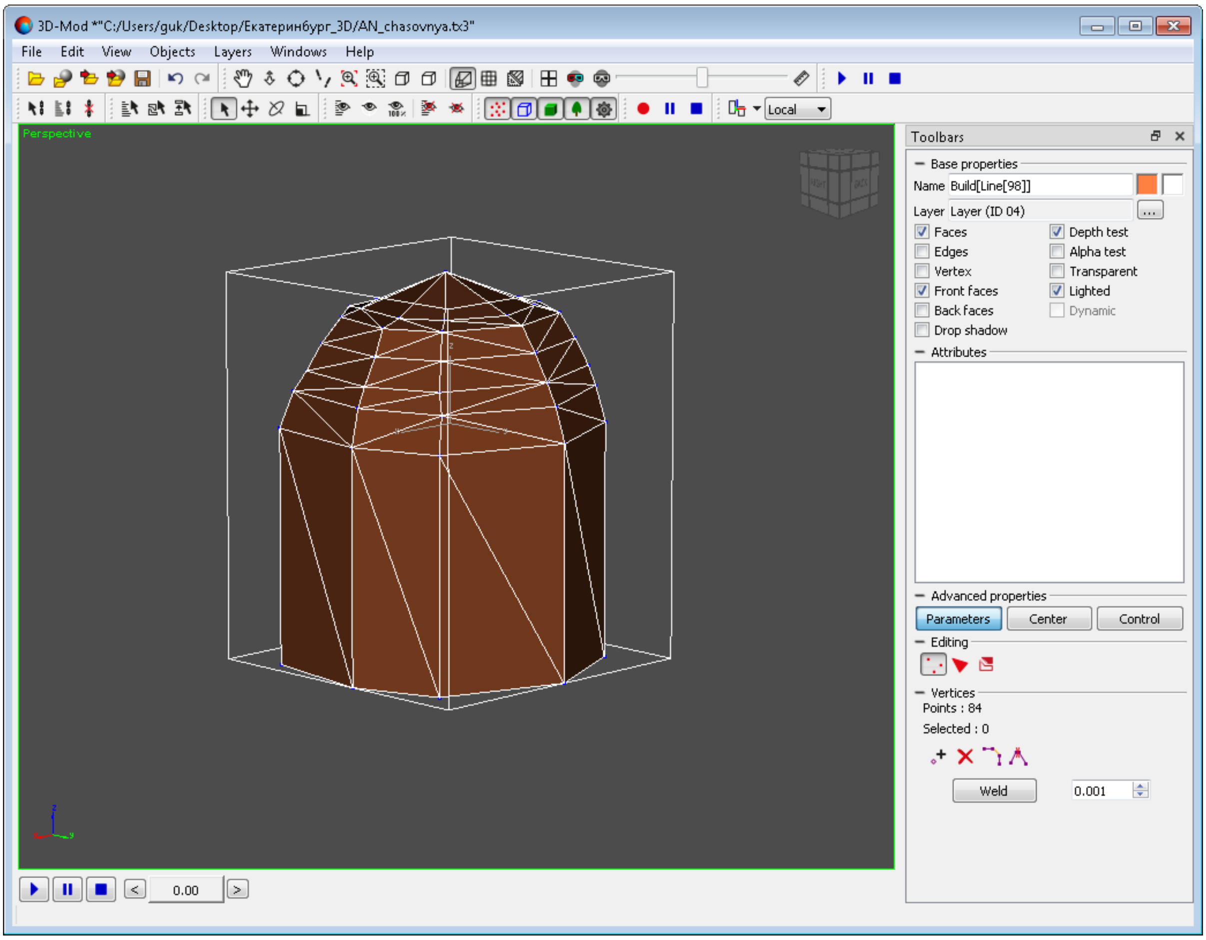


Fig. 74. Editing of object's points mode

5. [optional] In order to remove a point, select it and click the (**Delete**) button.

6. In order to combine multiple points, select two or more points and click the (**Weld**) button.

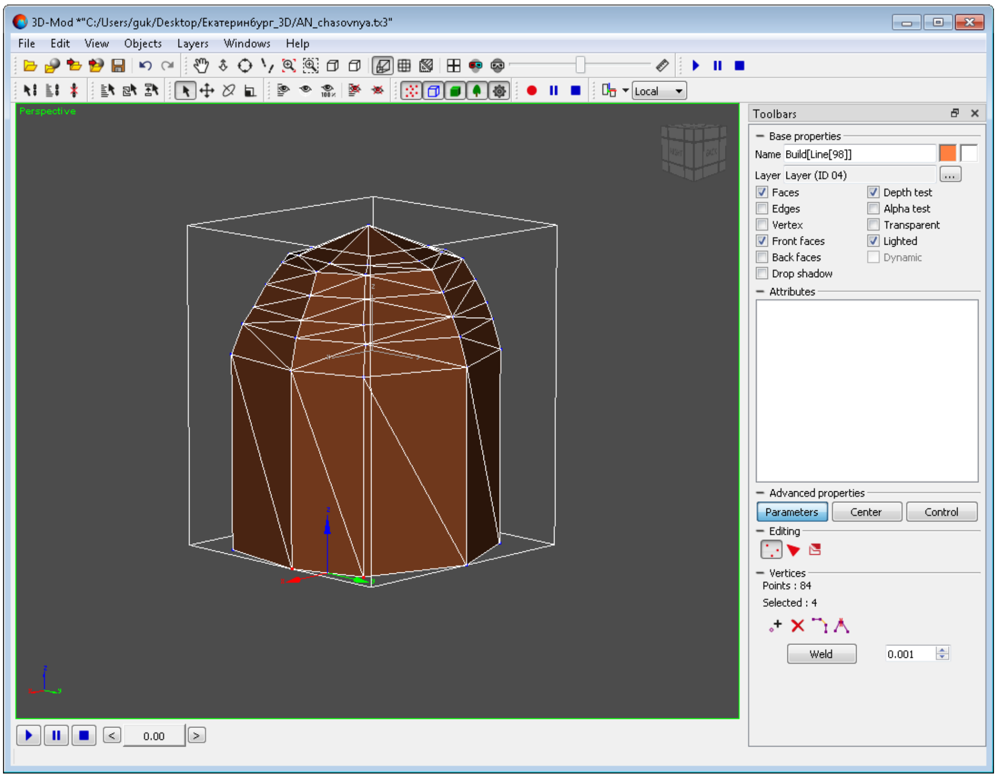


Fig. 75. Two selected points

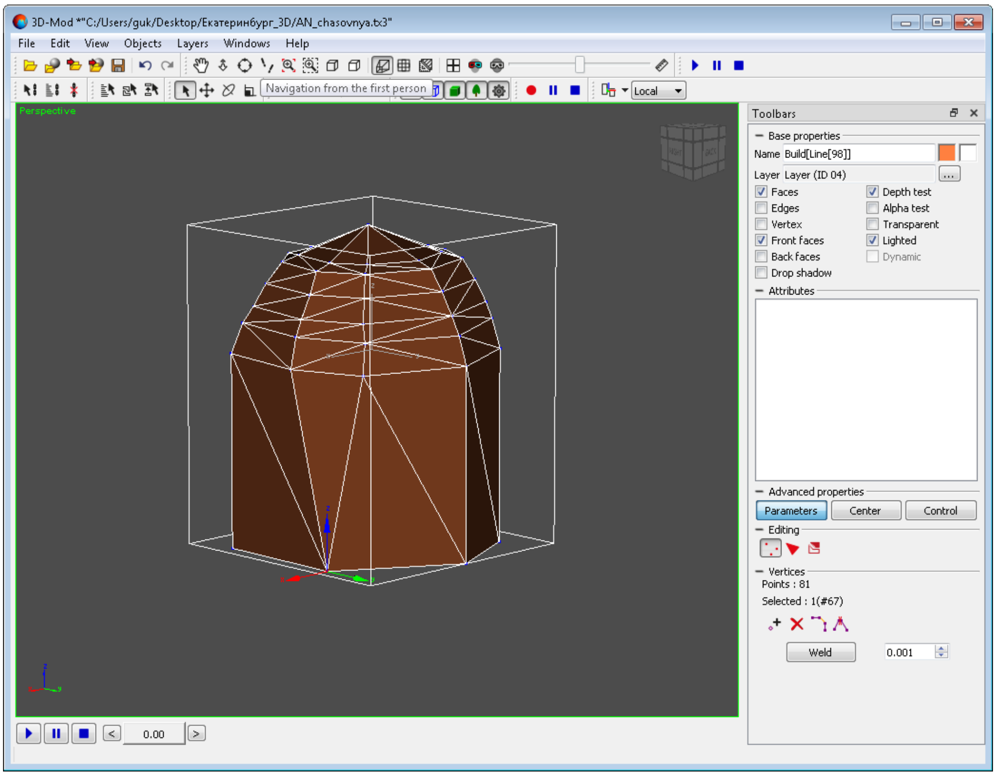


Fig. 76. One point obtained by combining of two points

7. [optional] To combine multiple points, located at a distance less than the specified, input a value into the field and click the (**Weld**) button.

   To create *a smooth model* of object select all its points, input minimal distance value to the field and click the (**Weld**) button.

8. [optional] In order to split previously combined points, select them and click the (**Divide**) button. Turn the move mode of selected objects on and drag split points to the desired distance by mouse button.

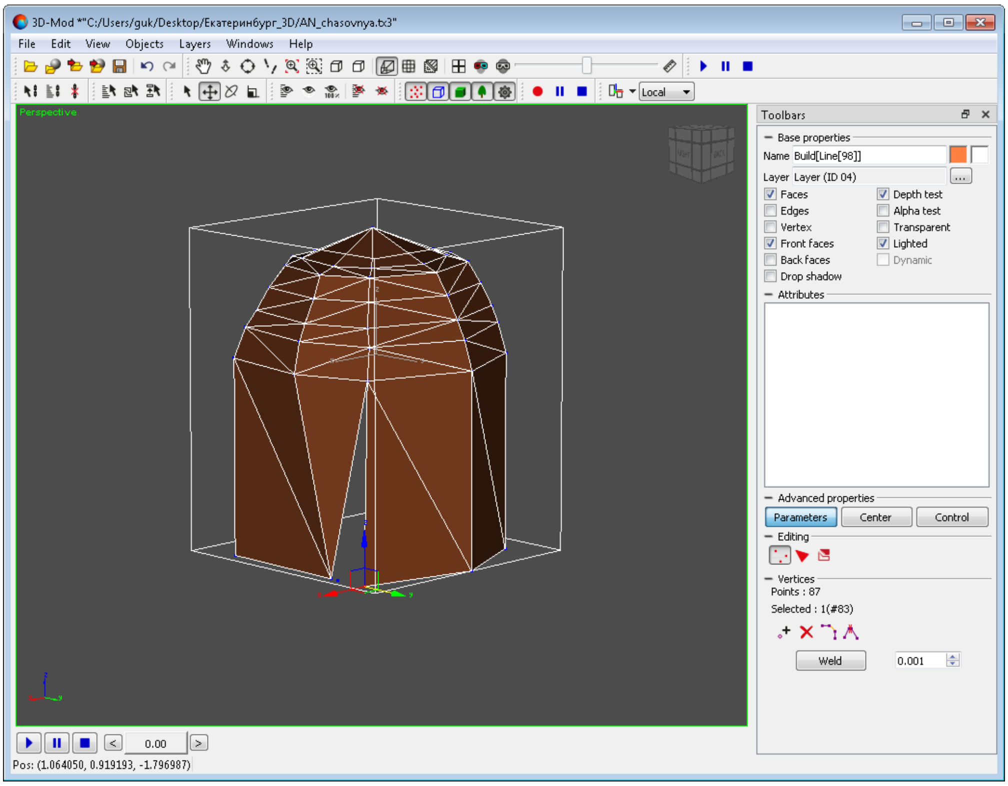


Fig. 77. Moving of one of points by Y

9. In order to turn the object points editing mode off, click the button.

Perform the following actions to create a new object point:

1. Select an object.
2. In the **Editing** section click the button. The editing of object's points mode is on.
3. In the **Points** section click the (**Create**) button. The points creating mode is on.
4. Move a marker into desired place on object.

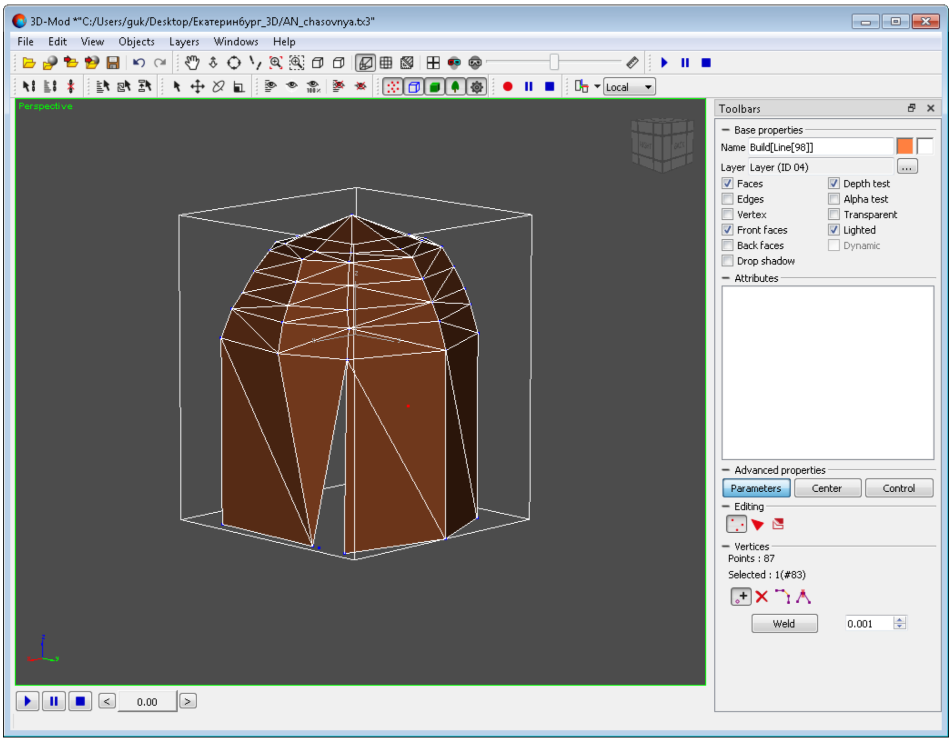


Fig. 78. The marker located in a place of new object point to be created

5. Create a new object point by mouse click.

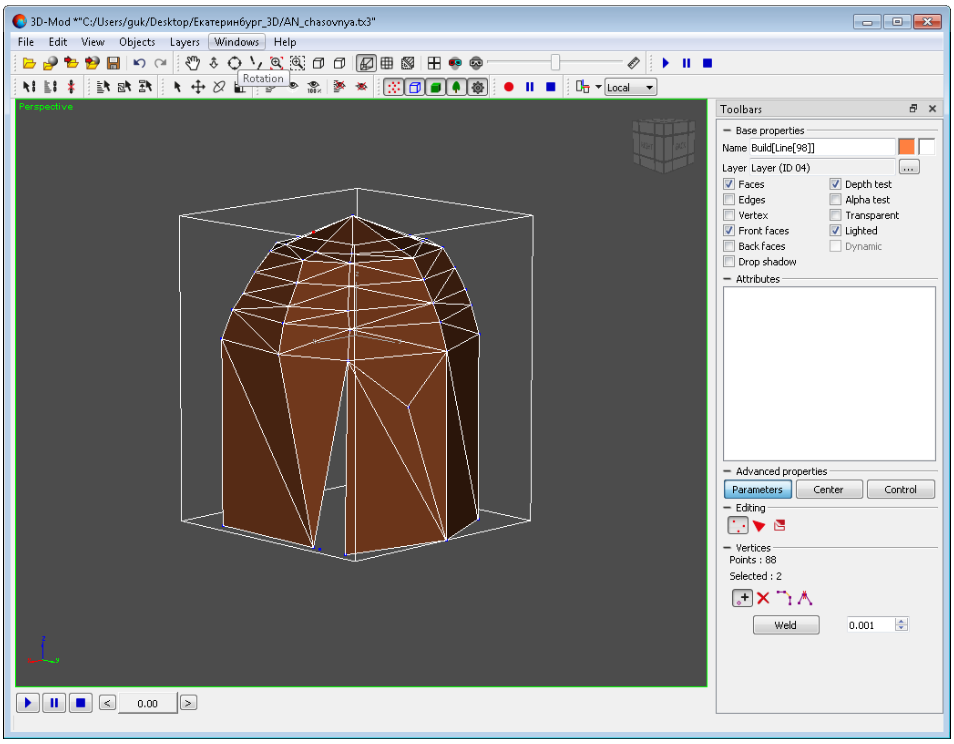


Fig. 79. A new object point creation

6. To turn the points creation mode off, click the (**Create**) button.

6.5.6. Editing of object’s faces

Object face – minimal triangle element of mesh body shell.

Each object face contains a normal. If the normal is directed towards the observer, the object face is displayed. If the normal is directed in the opposite direction from the viewpoint, then the face is not displayed.

Perform the following actions to edit object’s faces:

1. Create object or import a vector objects layer.
2. Select an object.
3. [optional] To edit *created* object choose **Edit › Convert to › grid**.
4. In the **Editing** section click the button. The editing of object’s faces mode is on.

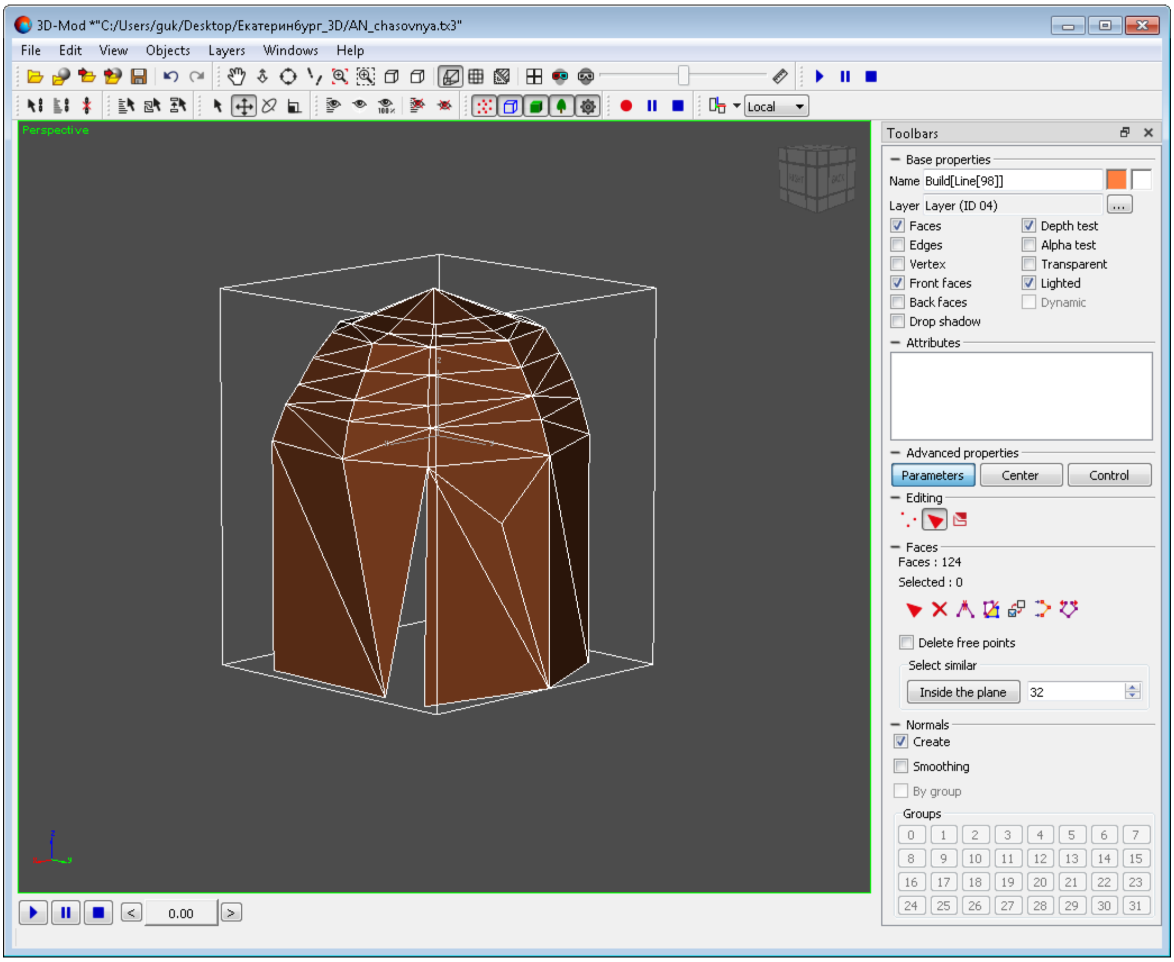


Fig. 80. Editing of object’s faces mode

5. To select faces, perform the following:

   • [optional] select a single face by **left mouse button** click;

   To select several faces, press and hold **Shift**, and click the desired faces one by one.

   To deselect certain faces from the selected group, press and hold **Ctrl**, and click the mouse to deselect the desired faces one by one.

   • [optional] to select a group of adjacent faces, press and hold the **left mouse button** and move the marker to “stretch” the rectangular area where the faces will be selected;

   • [optional] to **select similar** object’s faces, i.e. faces located near the selected one and at the same time lying in the same plane with it (or in planes close to the original one), perform the following:

     1. Enter the maximum acceptable angle of deviation from the plane in which the initially selected face lies in the **Select similar**, section, from 0 to 180 degrees.

     2. Click the **In plane** button.

     Too small values of the deviation angle will lead to extra strict check of the similarity of the faces, too large ones - to the selection of all faces of the object, regardless of their location. Entering reasonable angle values allows one to quickly select uniform areas of objects, which can be useful, for example, when texturizing.

     In this case, the number of detected similar faces and the range of their detection are potentially unlimited, however, as a result of the operation, only those similar faces that are in direct proximity to each other will be selected. In this case, the selection does not involve isolated areas, as well as faces located in parallel planes.

6. [optional] In order to remove a face, select it and click the (**Delete**) button.

   To remove vertices of selected faces set the **Delete free points** checkbox on and then click the (**Delete**) button.

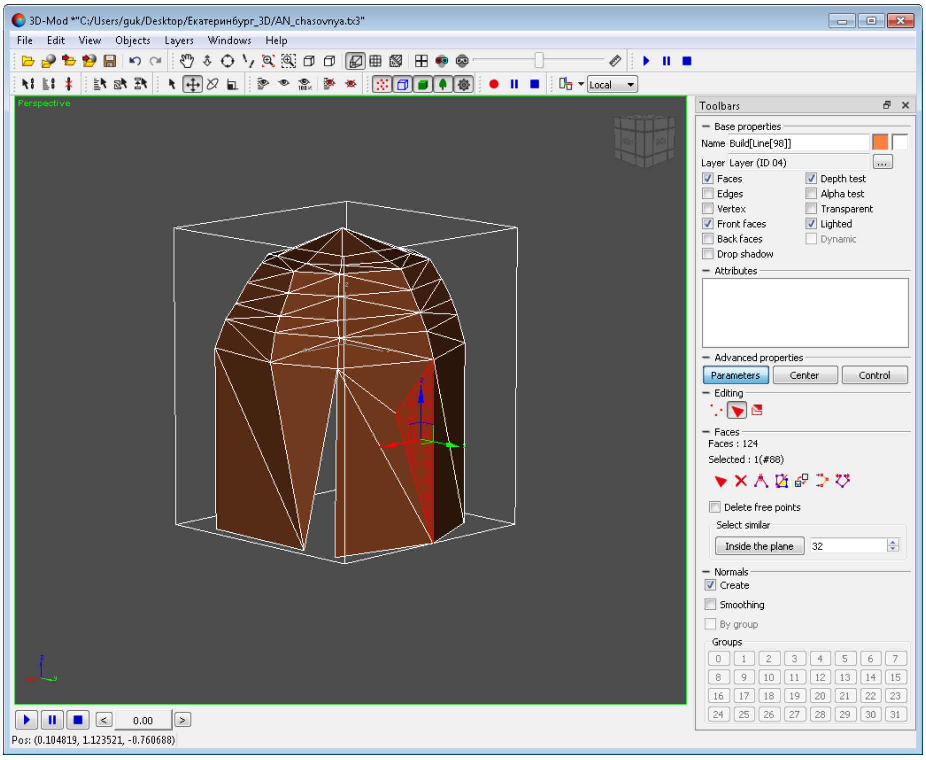


Fig. 81. Selected object's face to be deleted

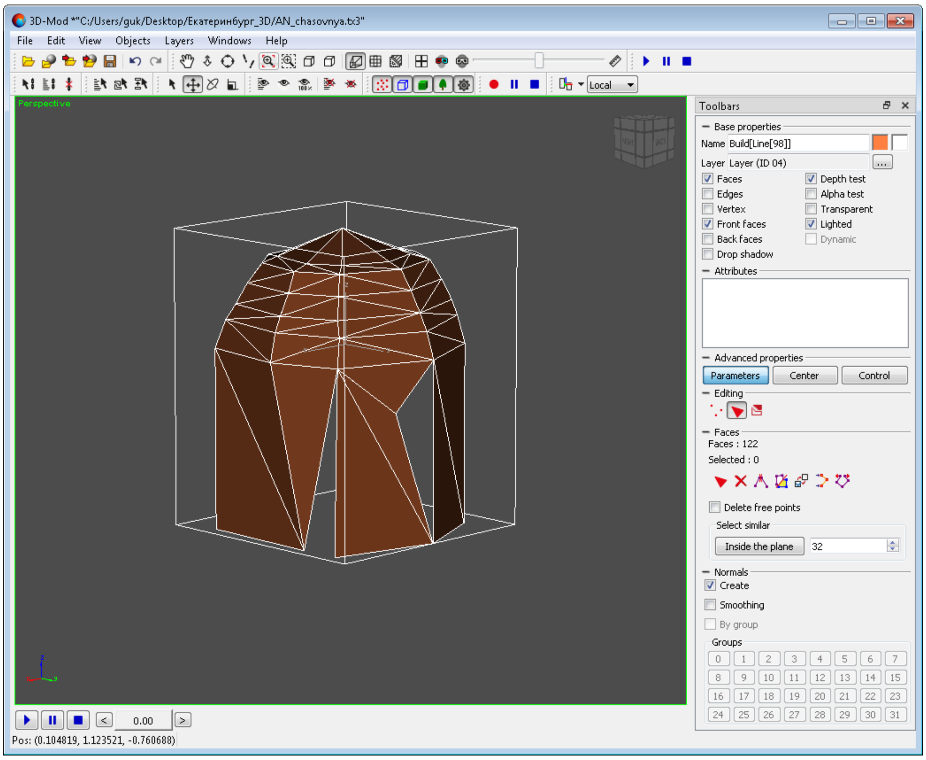


Fig. 82. Deleting of selected face

7. [optional] In order to separate a face from the object, select the face and click the (**Separate**) button. Turn the objects moving mode on and move the separated face. After that a face remains in the object's grid shell.

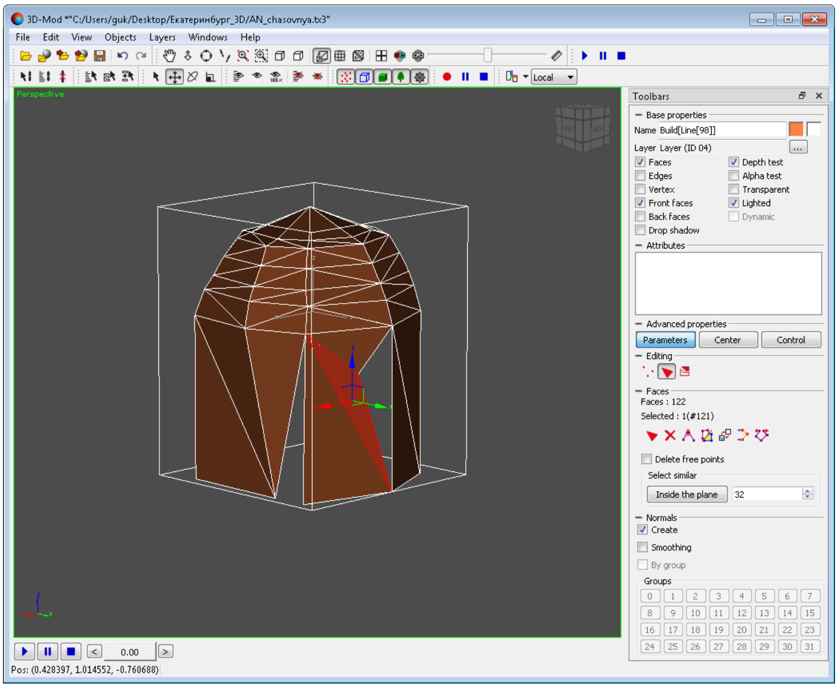


Fig. 83. Selected object's face to be separated

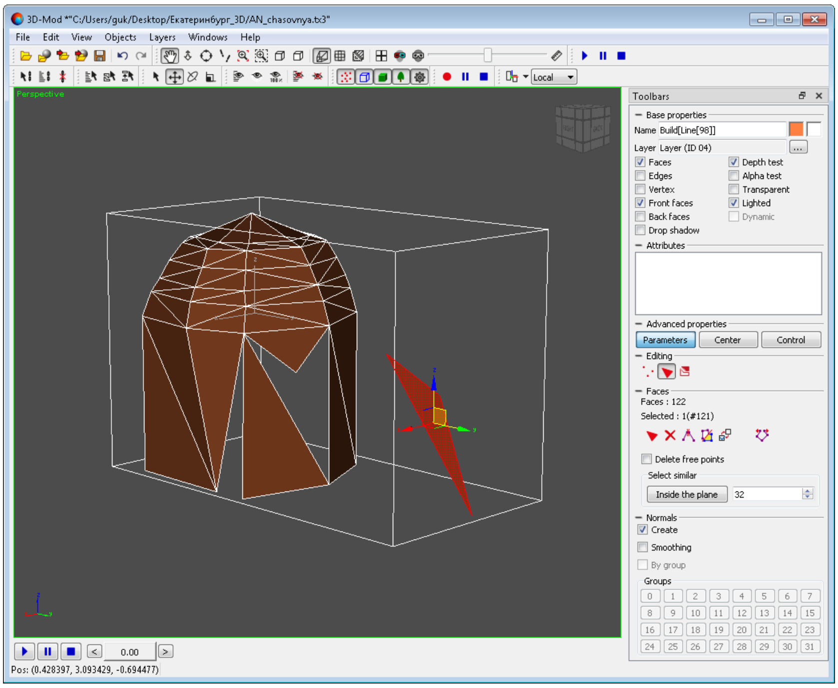


Fig. 84. Separated face

8. [optional] In order to divide a face into several pieces, click the (**Divide**) button and use the mouse to mark boundaries of new faces as follows: drag lines between existing vertices or edges of the face you wish to divide into several smaller faces.

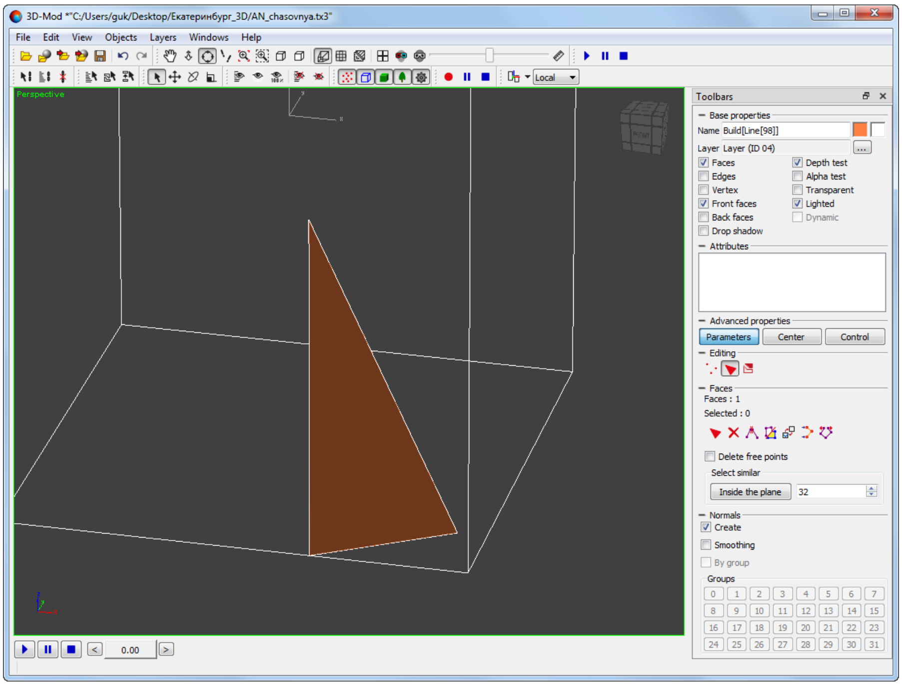


Fig. 85. The separate object's face (other elements were deleted for the example's clarity)

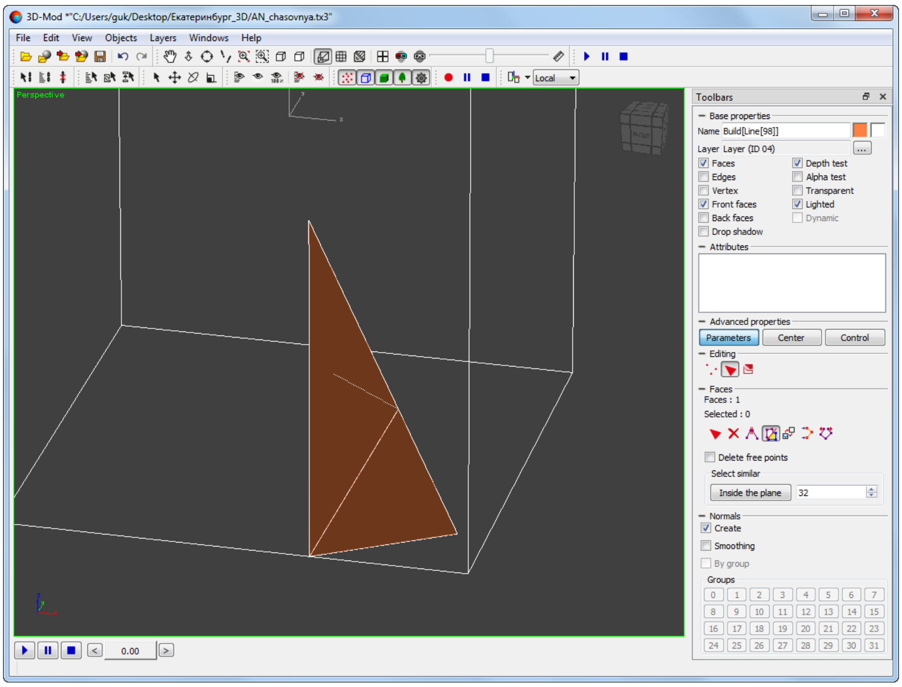


Fig. 86. One face divided in two.

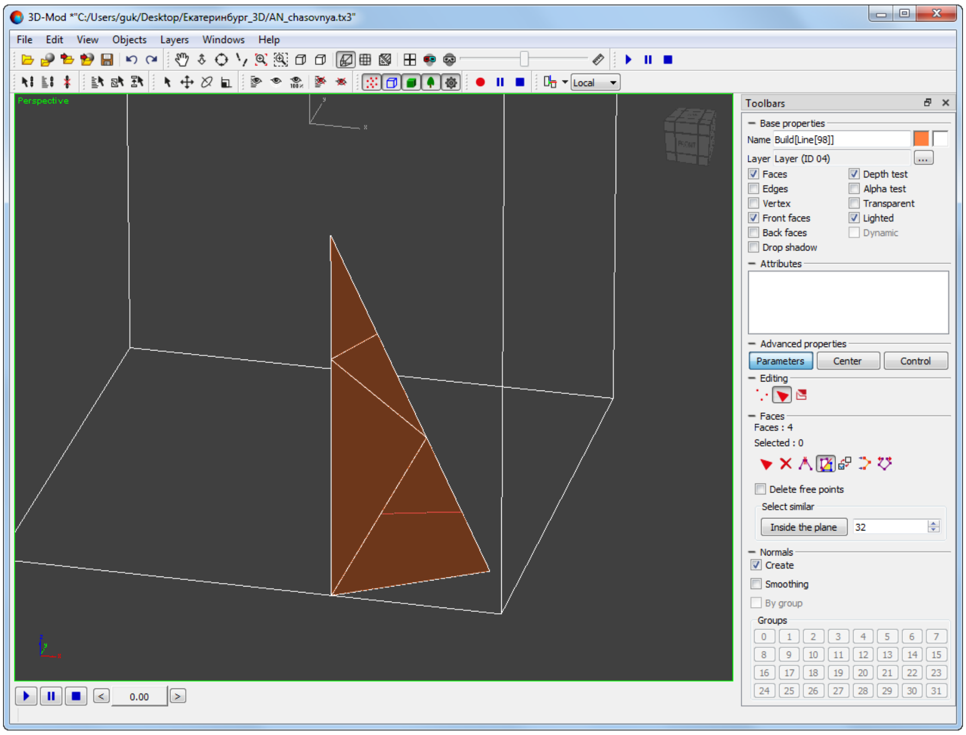


Fig. 87. User creates the border between two existing edges (marked in red)

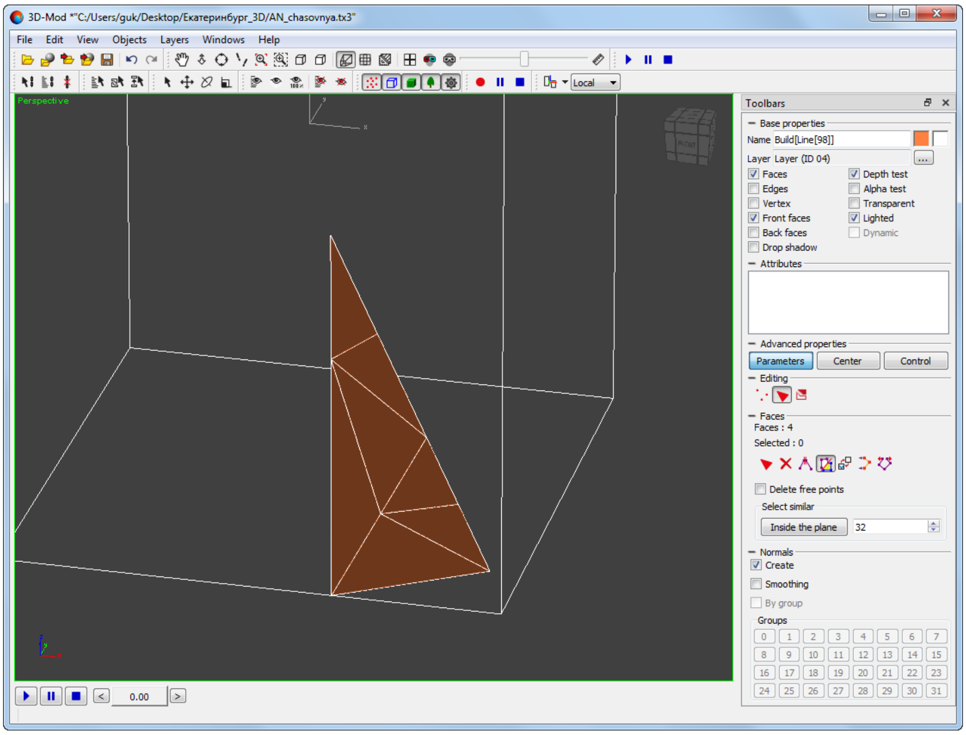


Fig. 88. The needed triangular faces are to be created in automatic mode

To quit faces dividing mode, click the (**Divide**) button once more.

9. [optional] In order to separate a face, select it and click the (**Detach**) button. The dialog box opens.

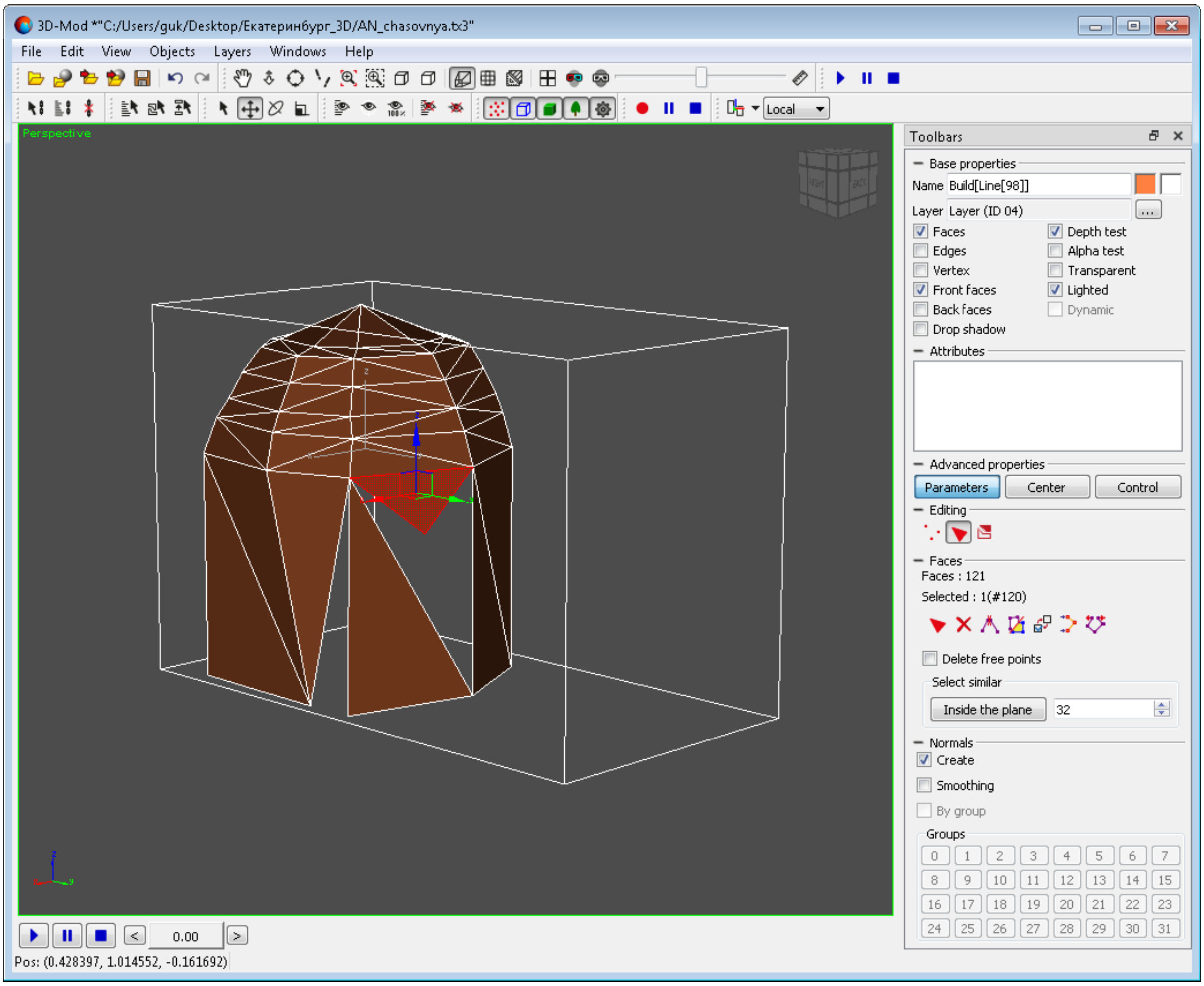


Fig. 89. Selected object's face to be split and separated

10. Turn the objects moving mode on and move the face. Split and separated face is excluded from object's frame and is a separate object.

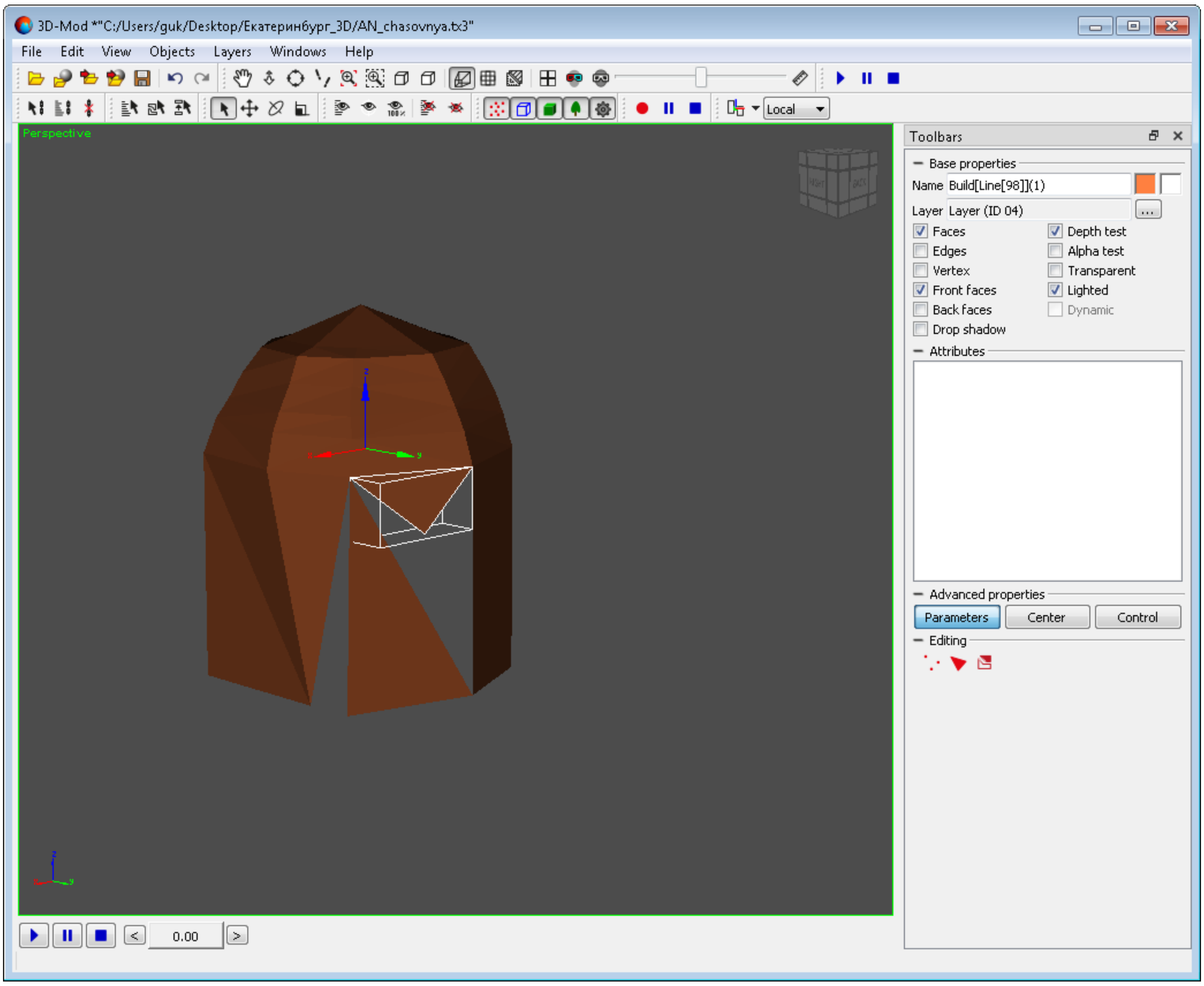


Fig. 90. Split and separated face

11. To move a face in normal direction, that means to swap front and back face, click the  (**Redirect**) button.

Each face of an object contains a normal. If a face normal is directed towards the observer, then the face is displayed in the view panel and is called *front face*. Otherwise, the face is not displayed and is called *back face*.

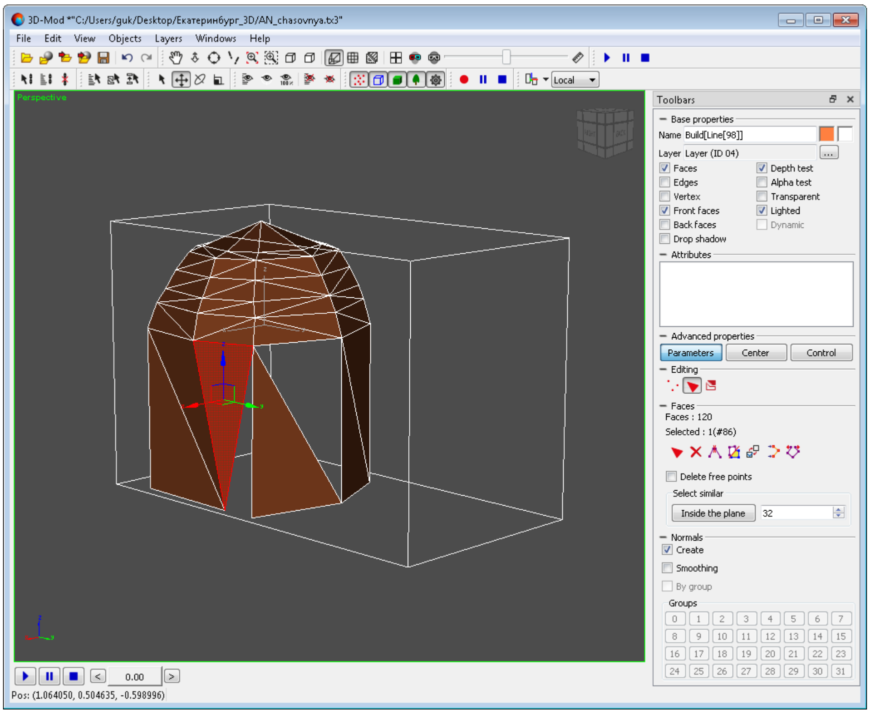


Fig. 91. Selected object’s face, which normal direction to be changed

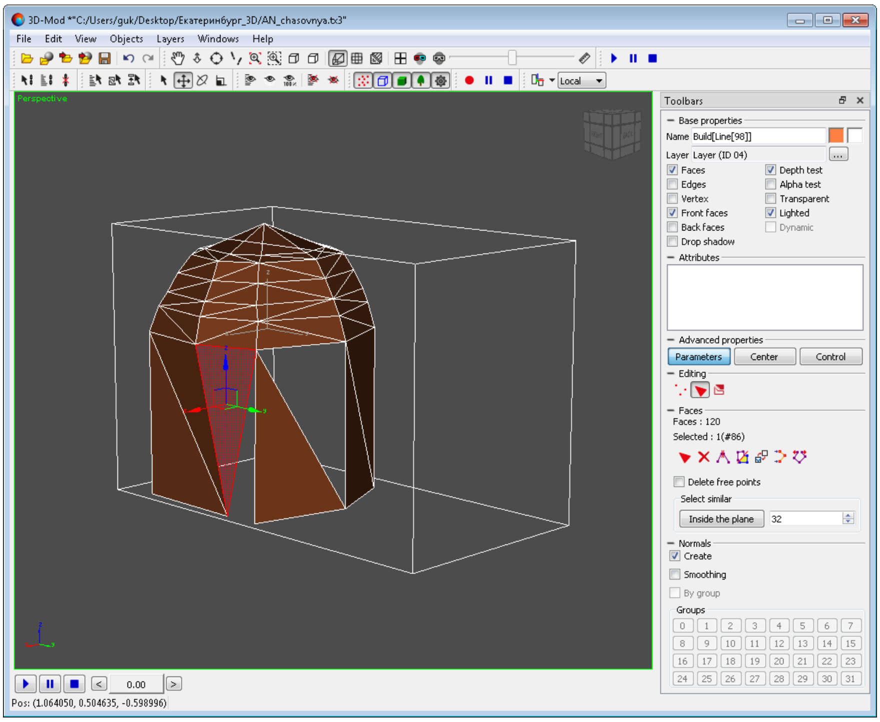


Fig. 92. Back face

12. [optional] To align the normals of selected faces in relation to each other, click the  (**Turn Correct**) button.

In order to change back face into front one, first select the front face. The direction of the normal of the first selected face is the basis for the rest of faces.

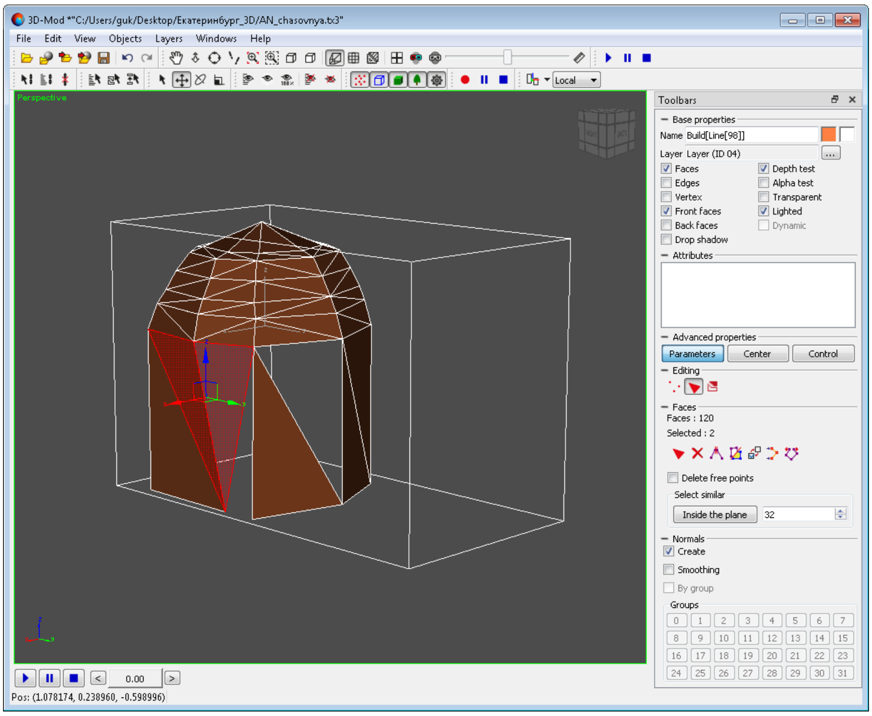


Fig. 93. Selected faces

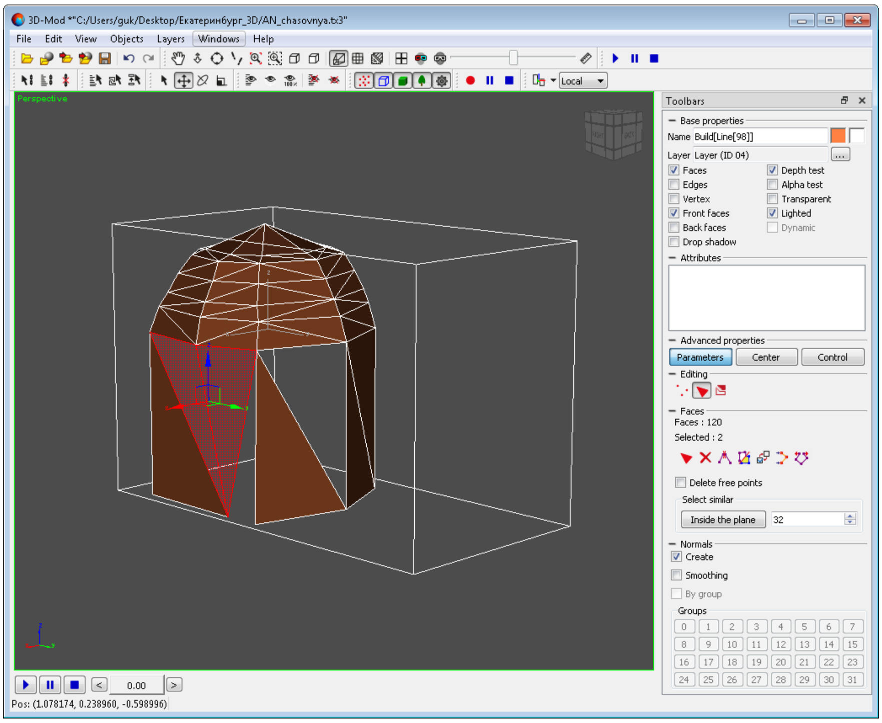


Fig. 94. Back face changed to the front face

13. In order to turn the object faces editing mode off, click the button.

Perform the following actions to create a new object face:

1. Select an object.
2. [optional] To edit *created* object choose **Edit › Convert to › grid**.
3. In the **Editing** section click the button. The editing of object's faces mode is on.
4. In the **Faces** section click the (**Create**) button. The faces creating mode is on.

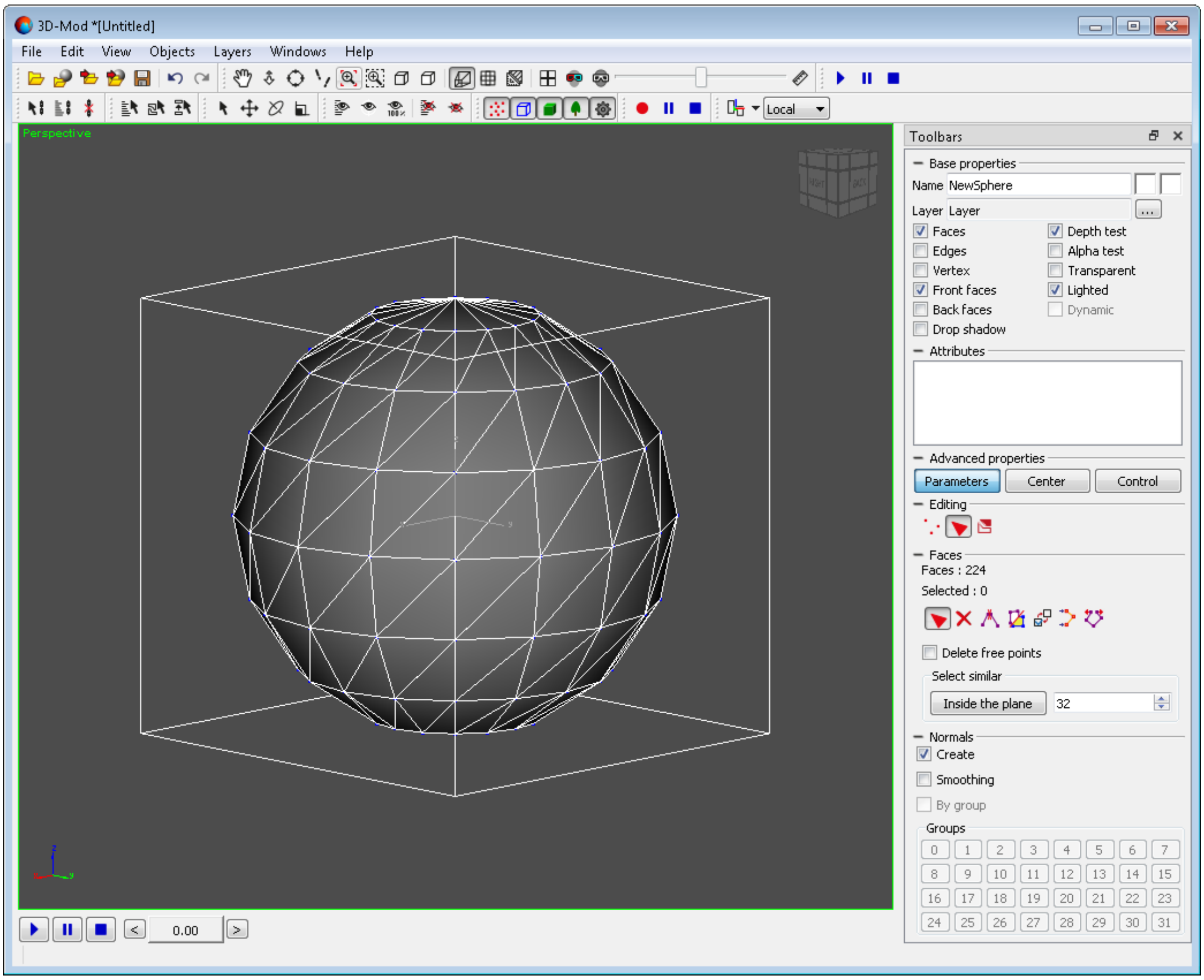


Fig. 95. Faces creating mode

5. [optional] To create a face containing normal the **Create** checkbox is set on by default in the **Normals** section. Otherwise set the **Create** checkbox off.
6. Sequentially select three or more vertices to start the face's creation.

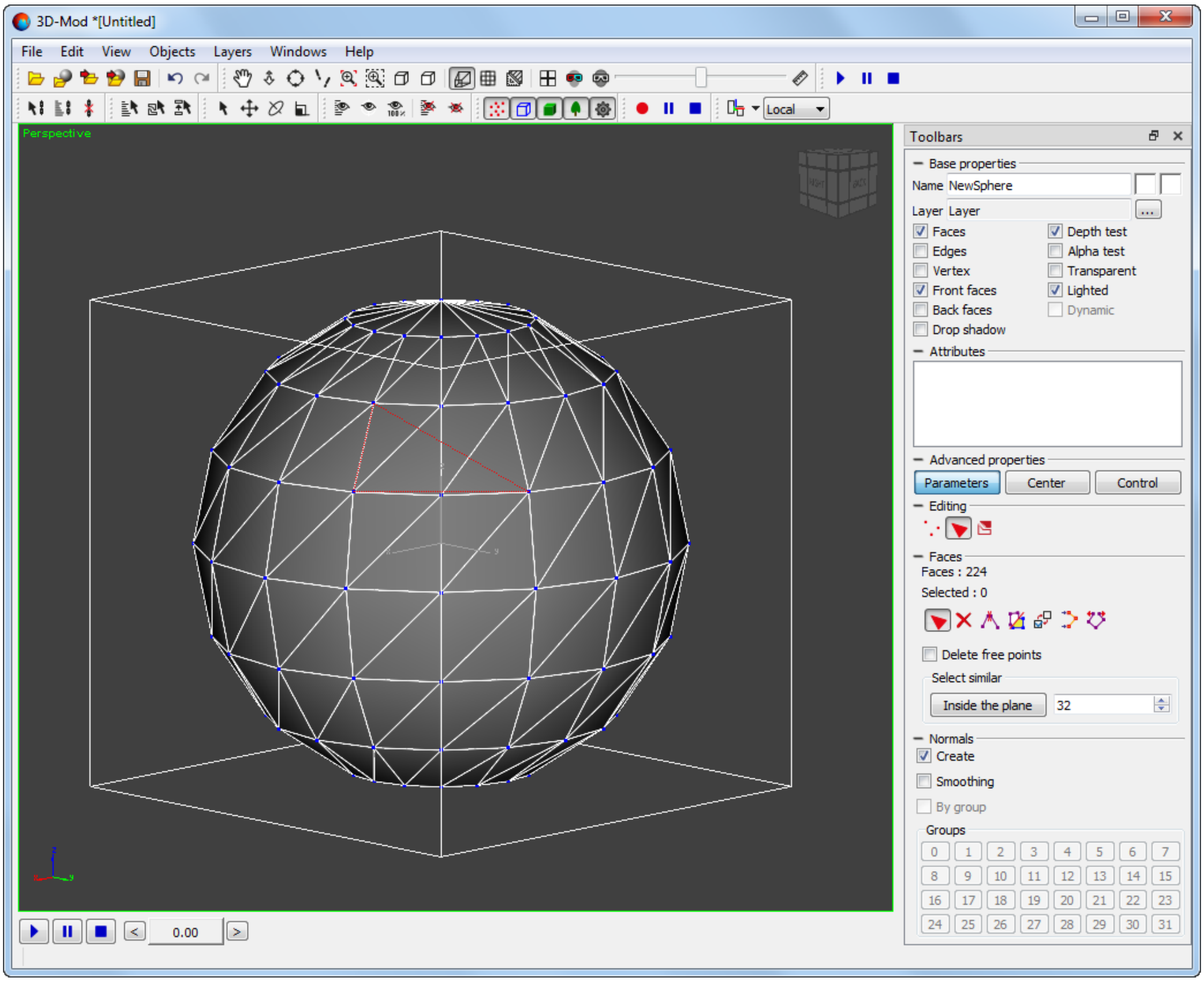


Fig. 96. Two points of a new face

7. Select the first point of face by mouse click one more time. A new object’s face is created.

8. To turn the faces creation mode off, click the (**Create**) button.

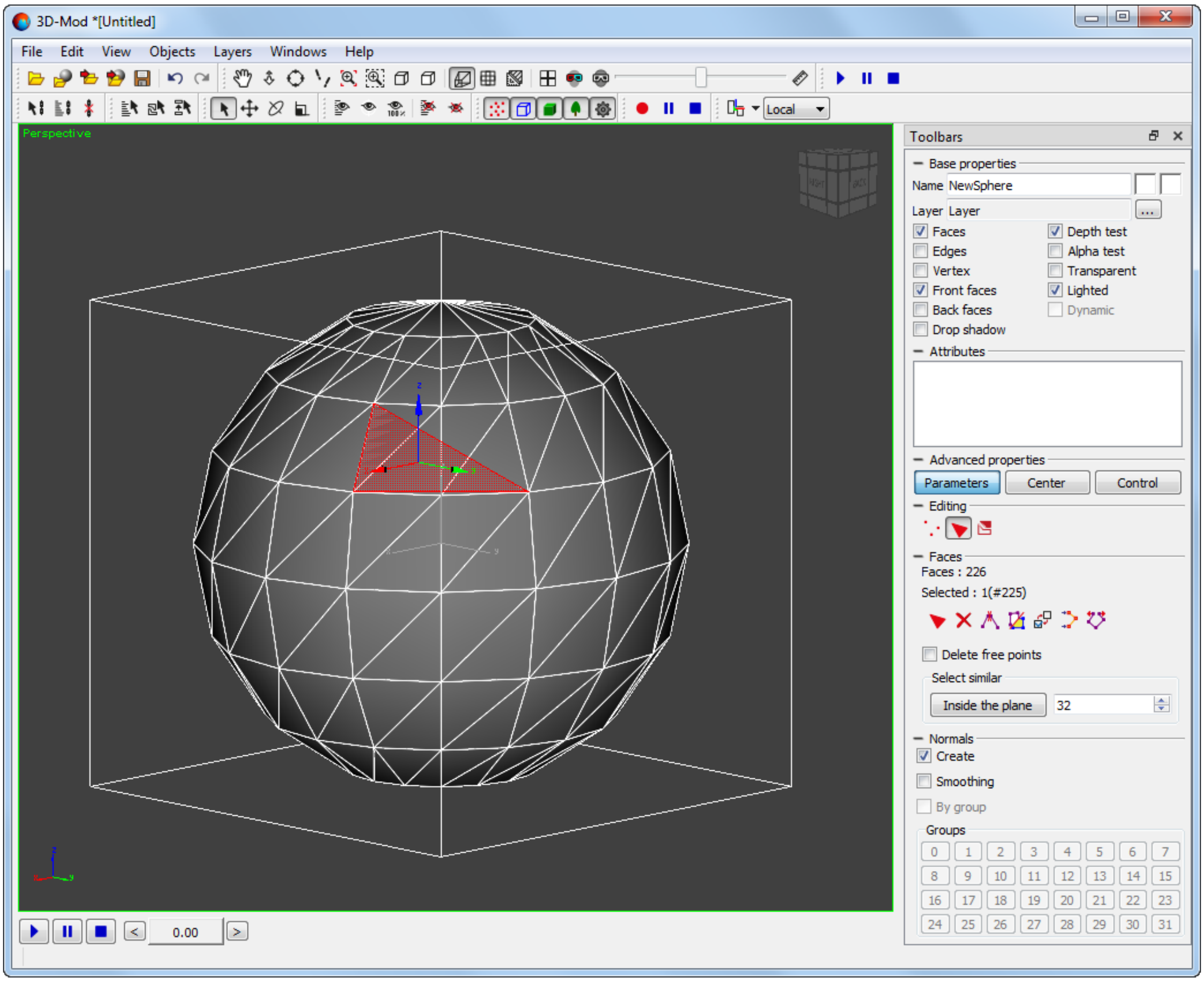


Fig. 97. New object’s face

To specify smoothing groups for selected faces of object, perform the following actions:

1. Select an object.

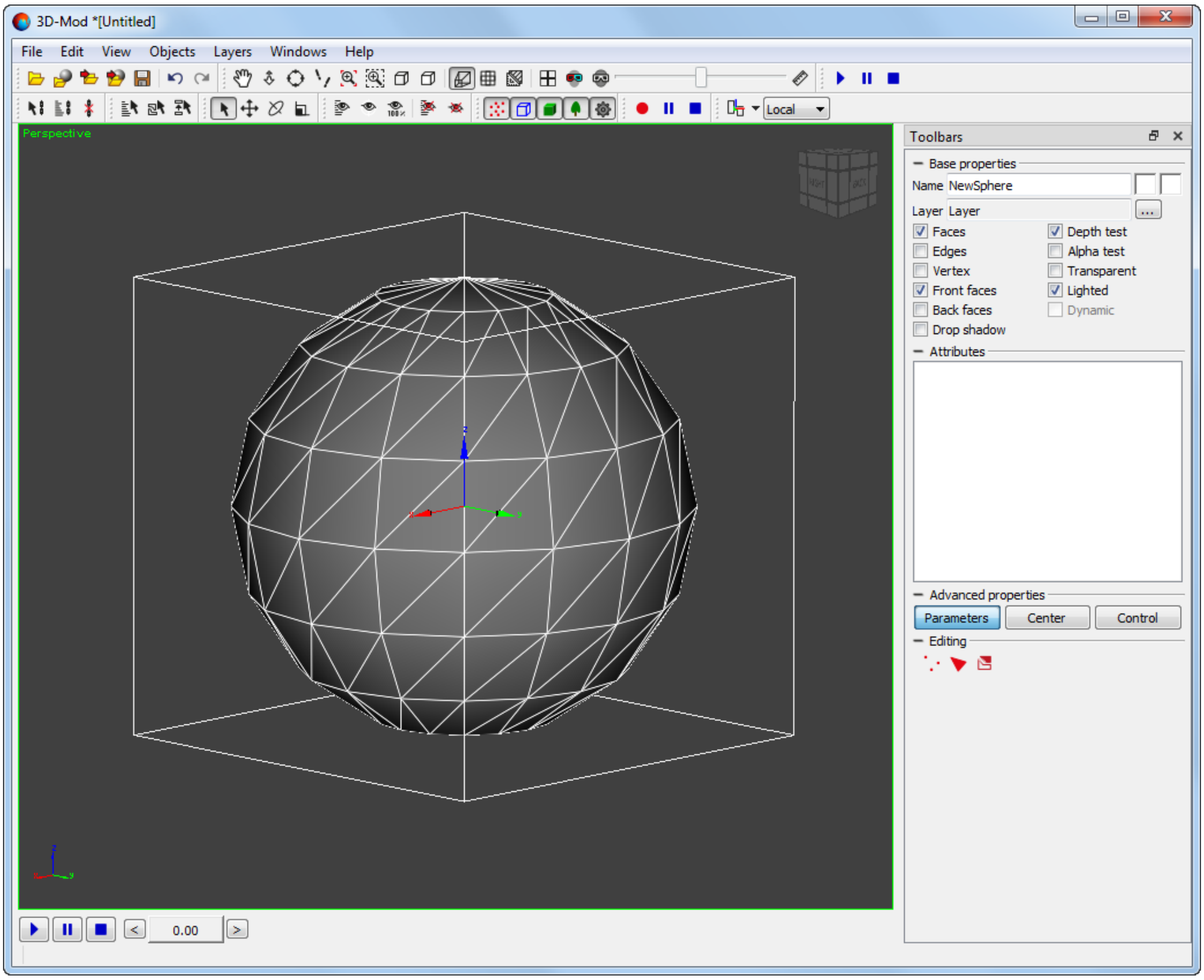


Fig. 98. Selected object

2. In the **Editing** section click the button. The editing of object’s faces mode is on.
3. In the **Normals** section set the **Smoothing** and **By groups** checkboxes on.
4. Select faces and click the **00** button. After that normals of selected faces are directed to the same side. The faces are displayed with the same brightness.

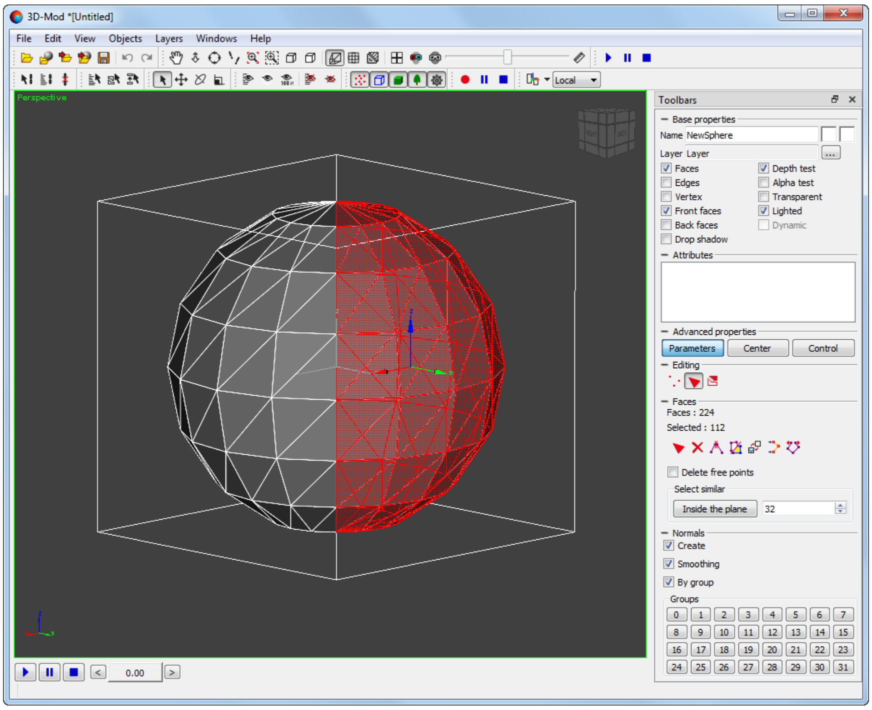


Fig. 99. Selected faces

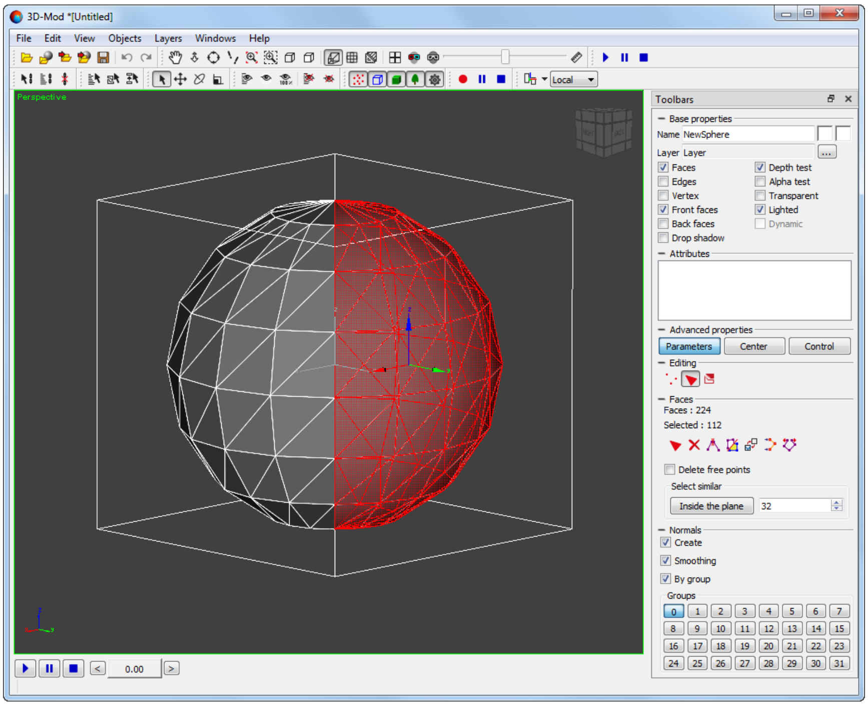


Fig. 100. Specifying smoothing group 00 for selected faces of object

5. Select other faces and click the **01** button. After that normals of these faces are directed to another side.

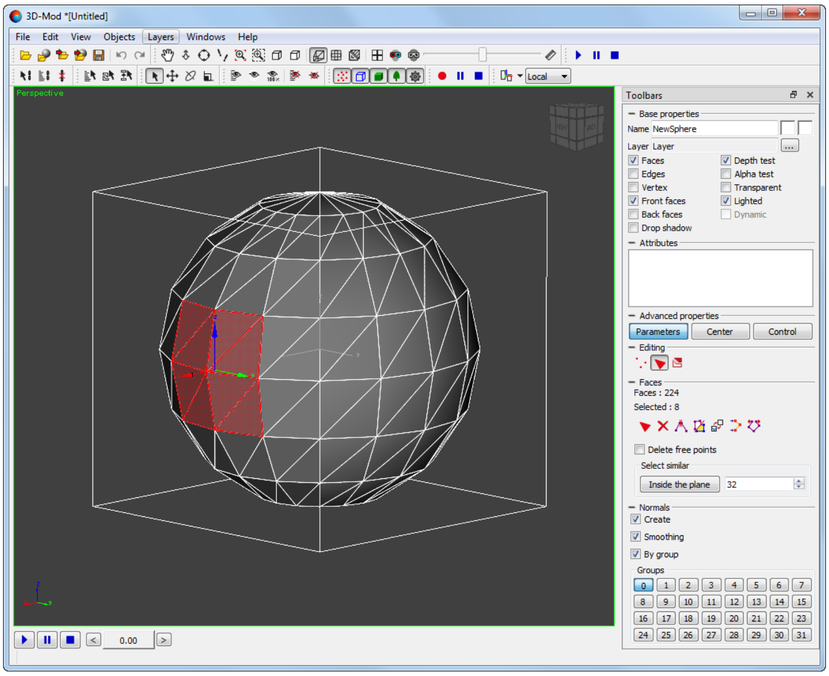


Fig. 101. Selected faces

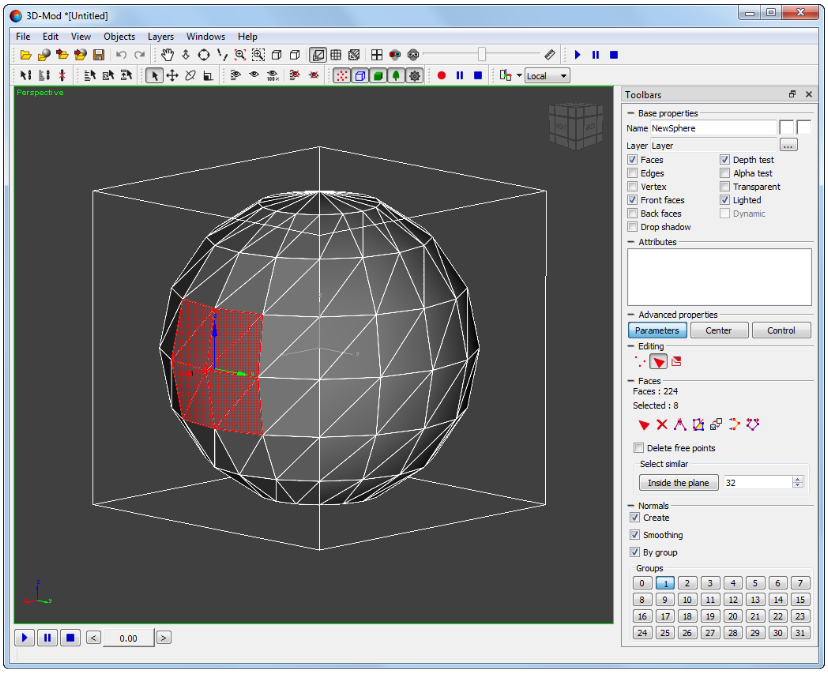


Fig. 102. Specifying smoothing group 01 for selected faces of object

6. Repeat steps 4 and 5 required number of times.
7. Click the to turn off the mode of object’s faces editing.

6.5.7. Composite object creation

The module allows to create a composite object, which consists of several pieces, each of which represents a separate object. Any object could be used as a part.

Composite object – integrated 3D-object, created from two or more objects.

Perform the following actions to create a a composite object:

1. Create initial objects which will be used to form a composite object or import vector objects layer.

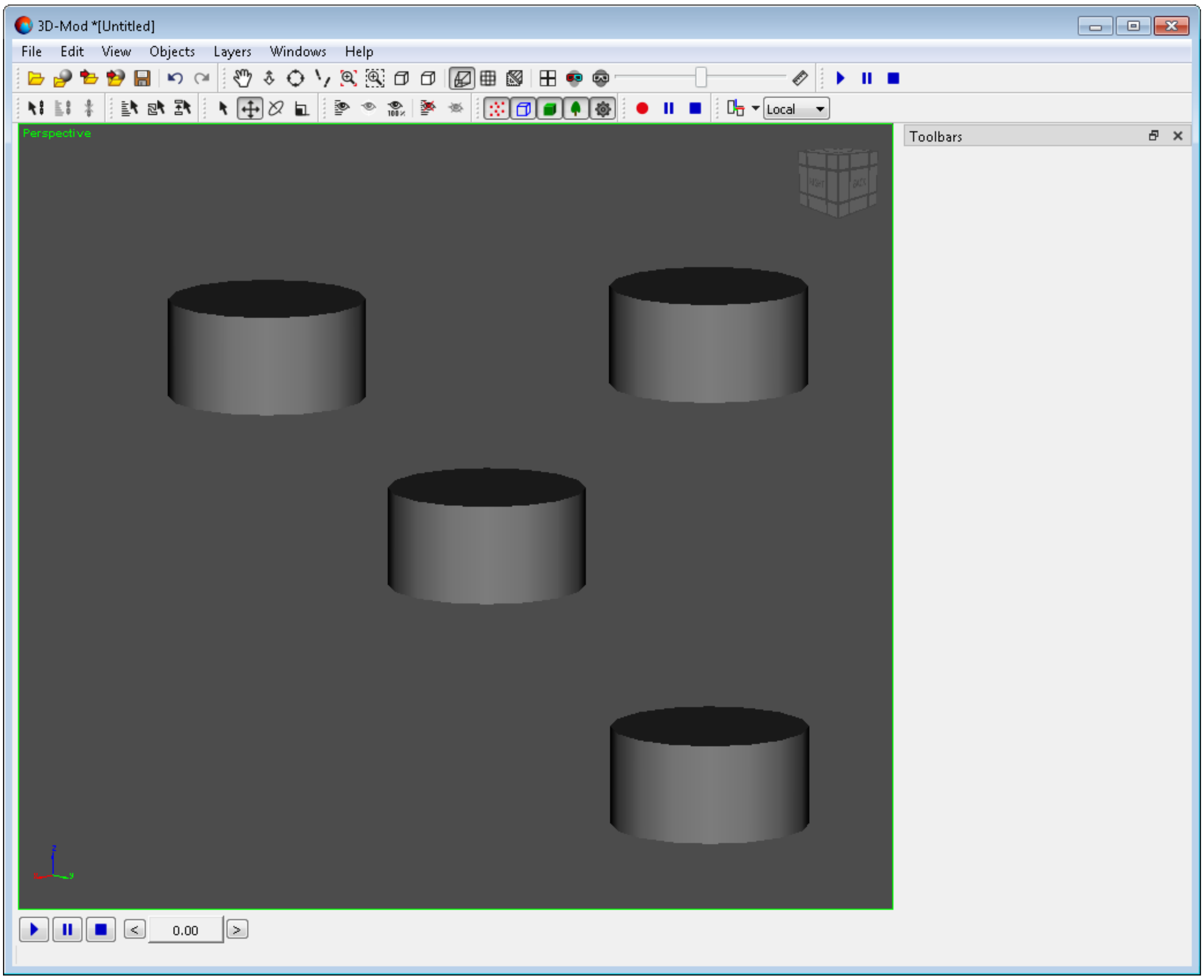


Fig. 103. Initial objects

2. Move the objects in 3D-scene space.

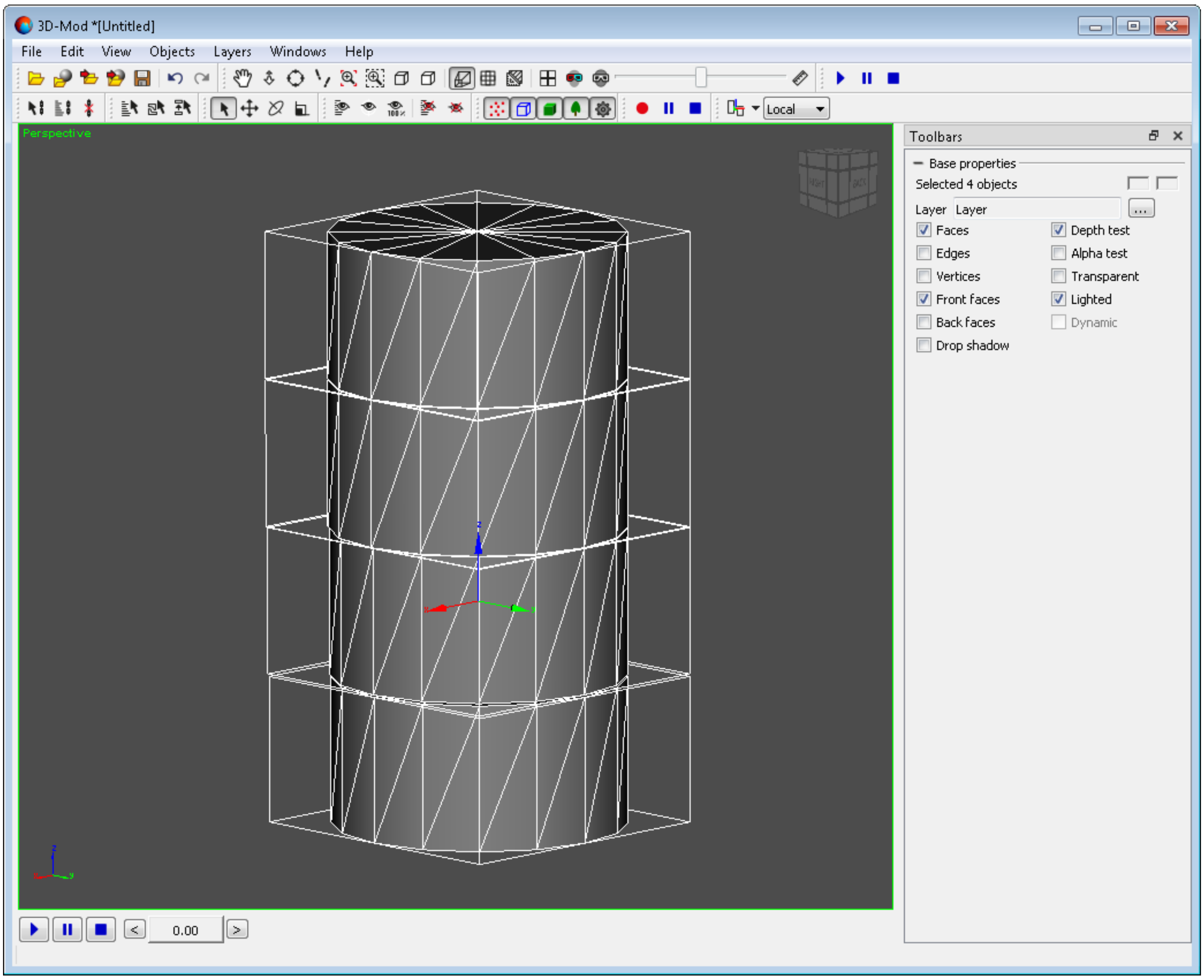


Fig. 104. Objects placement in 3D-scene space

3. Select main object to which other objects are combined in series.

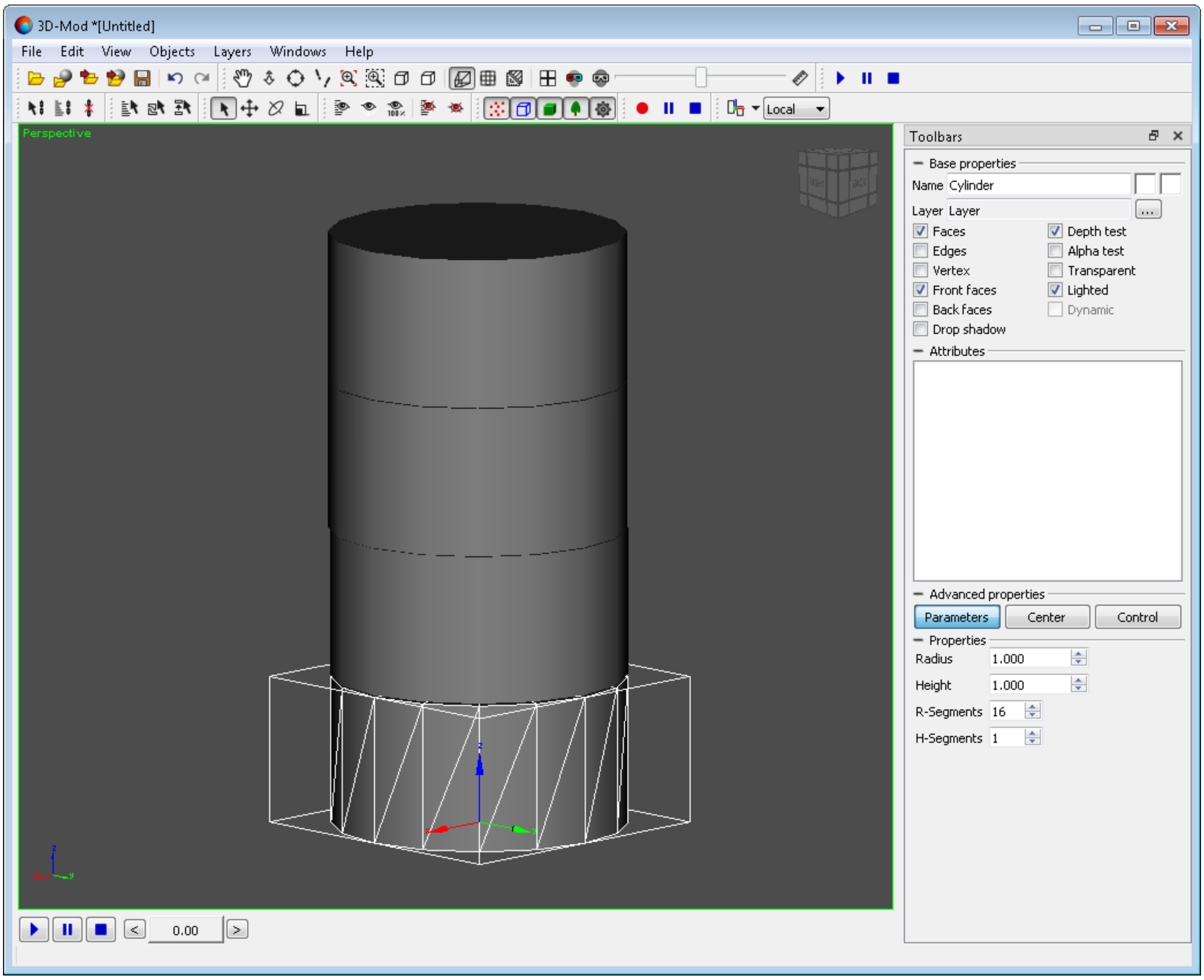


Fig. 105. Main object to which other objects are combined

4. [optional] To edit *created* object choose **Edit › Convert to › grid**.

5. In the **Editing** section click the  button.

6. In the **Parts** section click the **Add** button. The objects adding mode is on.

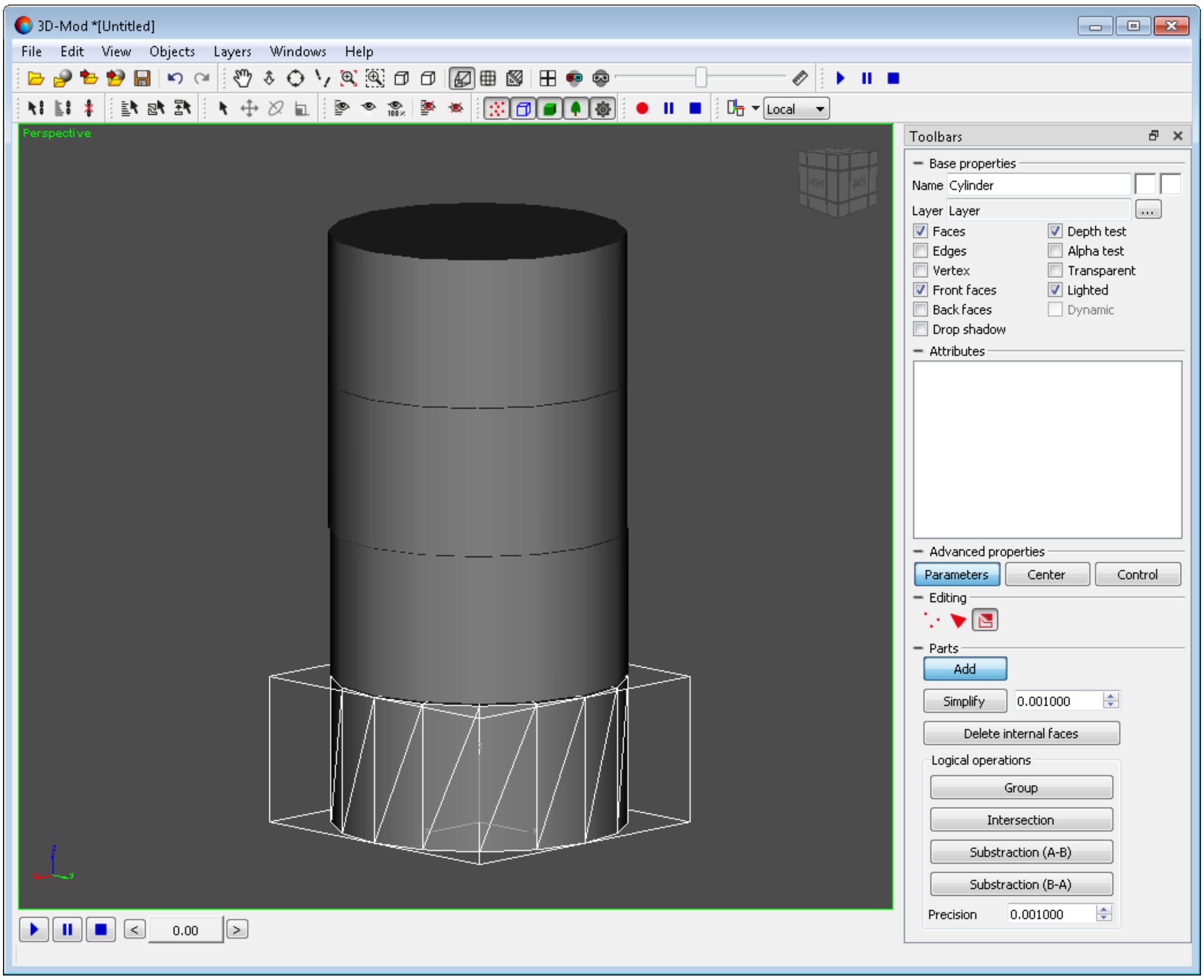


Fig. 106. Objects adding mode

7. Select objects to be combined with the main one by mouse click.

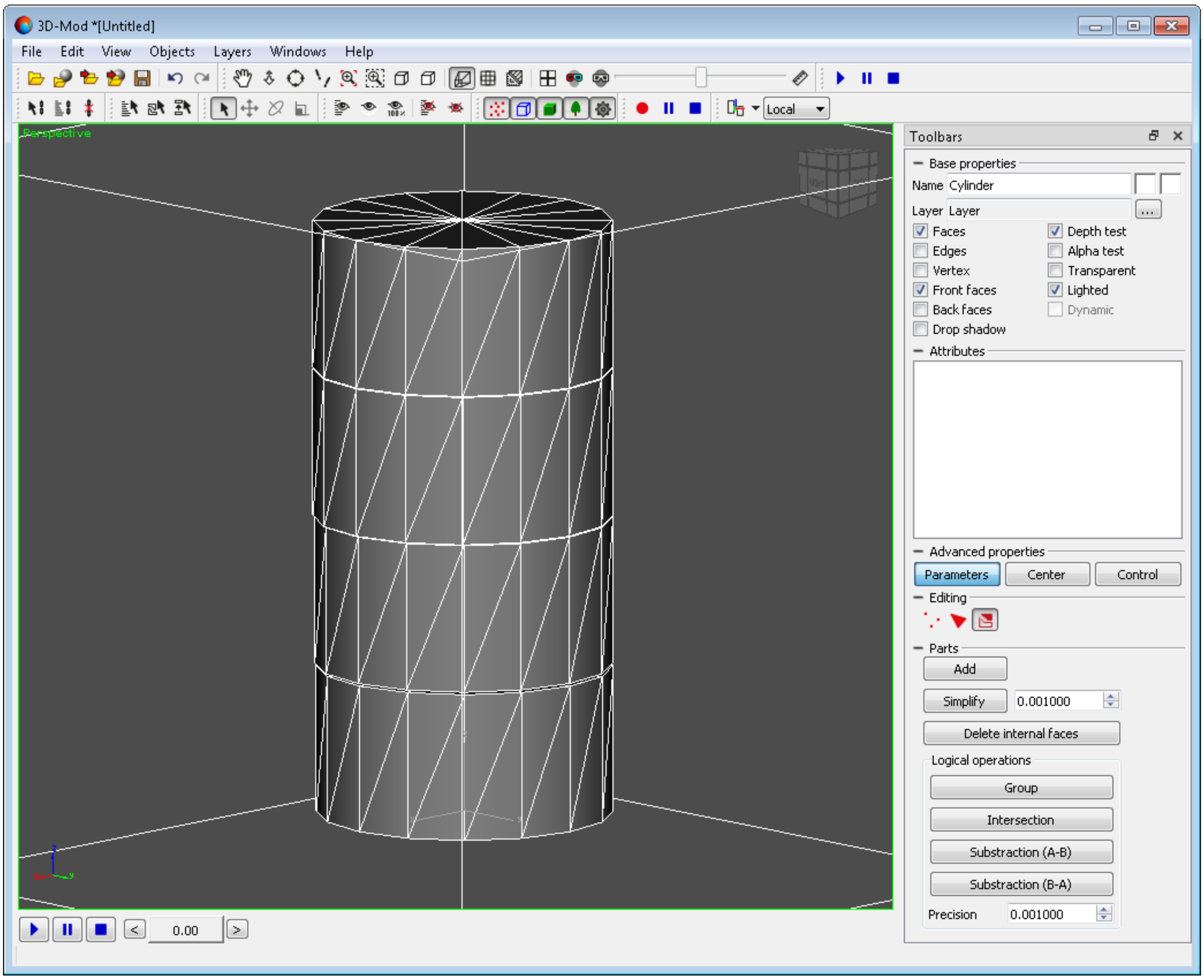


Fig. 107. Combining other object with the main one

8. Click the **Add** button to turn off the objects add mode.

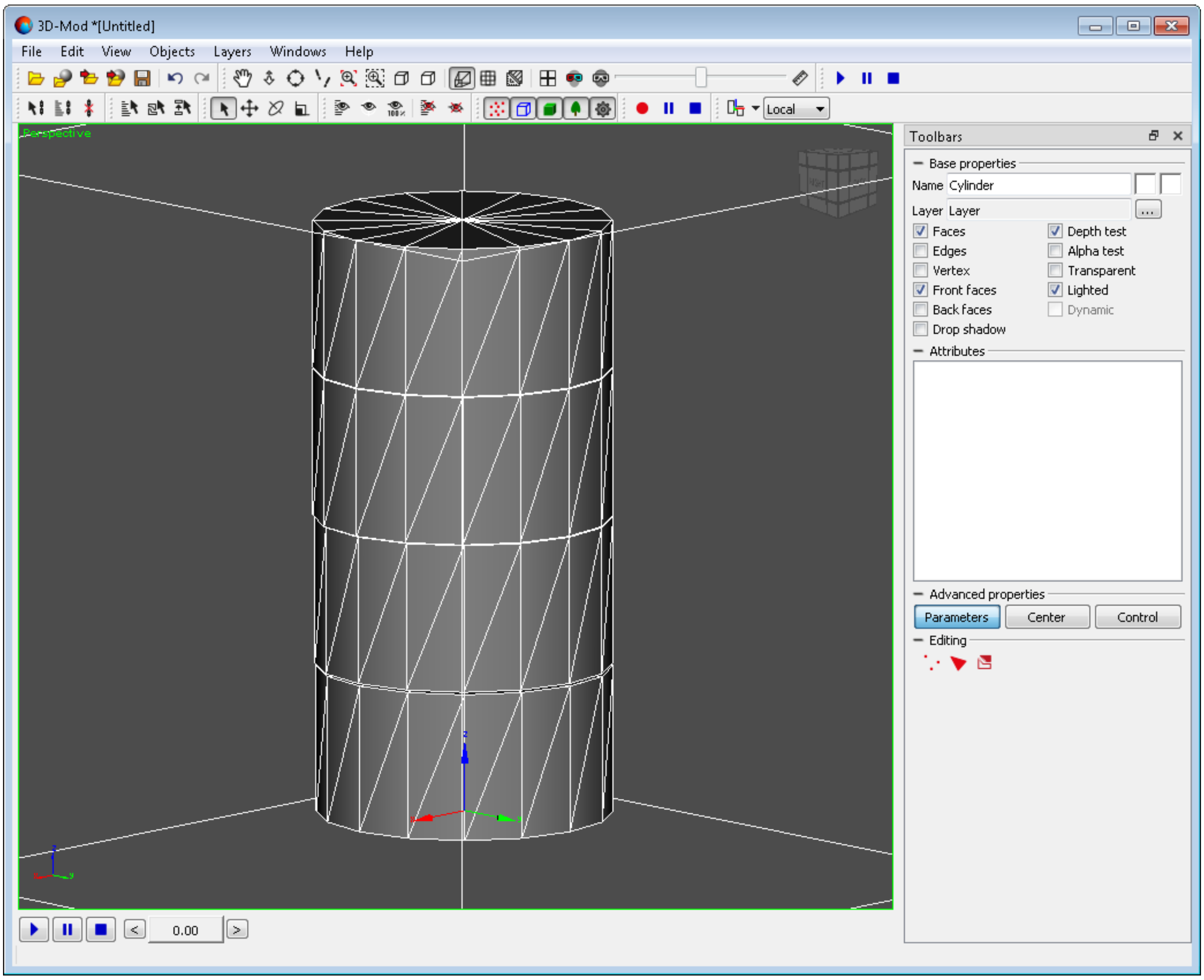


Fig. 108. Composite object

9. Click the button to turn off the mode of parts editing. Separate objects became parts of a composite object.

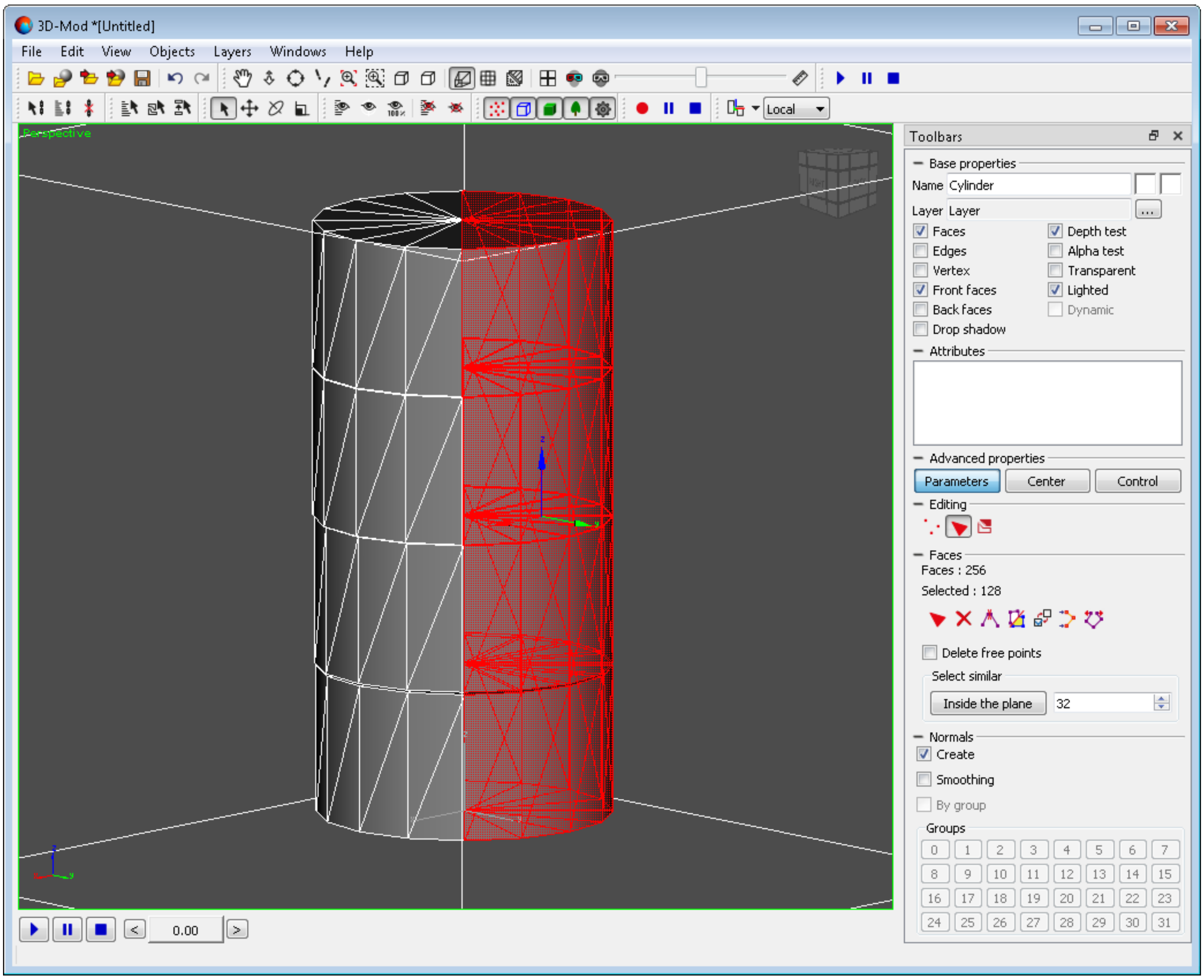


Fig. 109. Selected faces of a composite object

Composite object creation itself does not lead to its automatic re-building, i.e. to the creation of new, continuous, and combined surface that can be described by a set of faces.

The need in such an operation directly depends on the expected result and the way of further object processing (for example, whether texture superposition will be required).

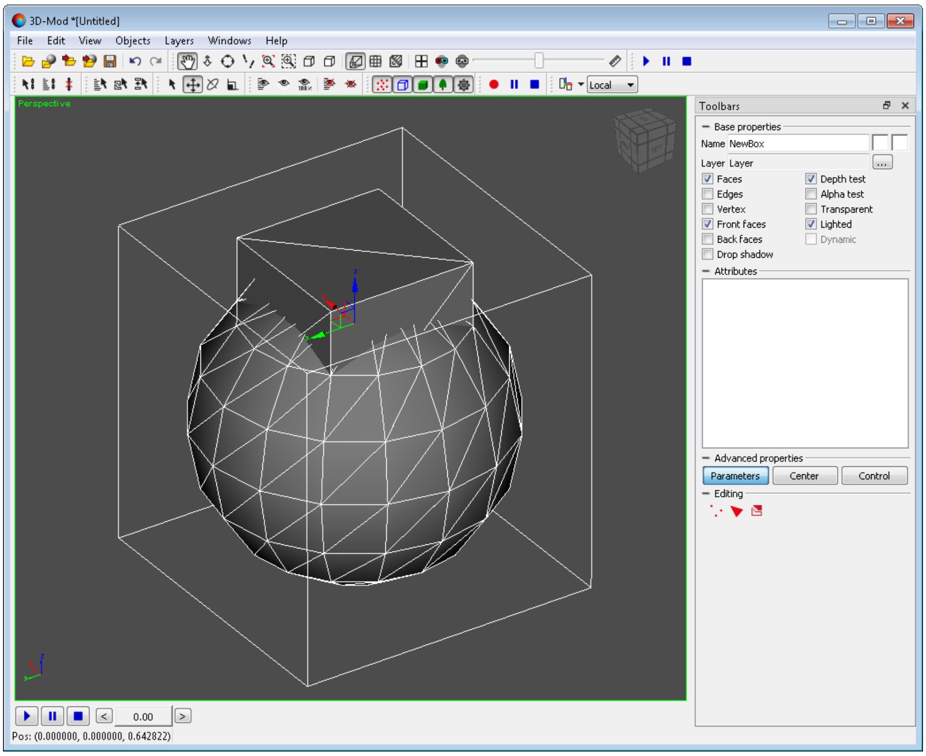


Fig. 110. A composite object of a cube and a sphere, those initially intersected in space

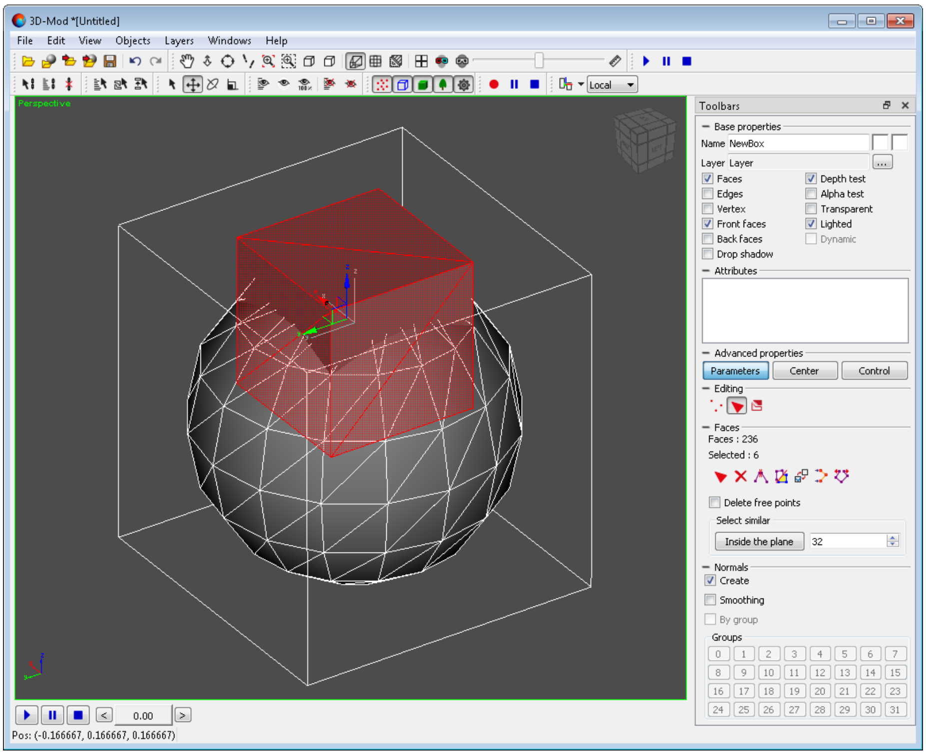


Fig. 111. Highlighted faces of the composite object (including those hidden under its surface)

When necessary, to re-build the surface of a composite object and delete hidden (inner) faces, perform the following:

1. Select the composite object created before;
2. In the **Editing** section, click the button;
3. In the **Parts** section, click the **Delete internal faces** button. The object is being rebuilt;

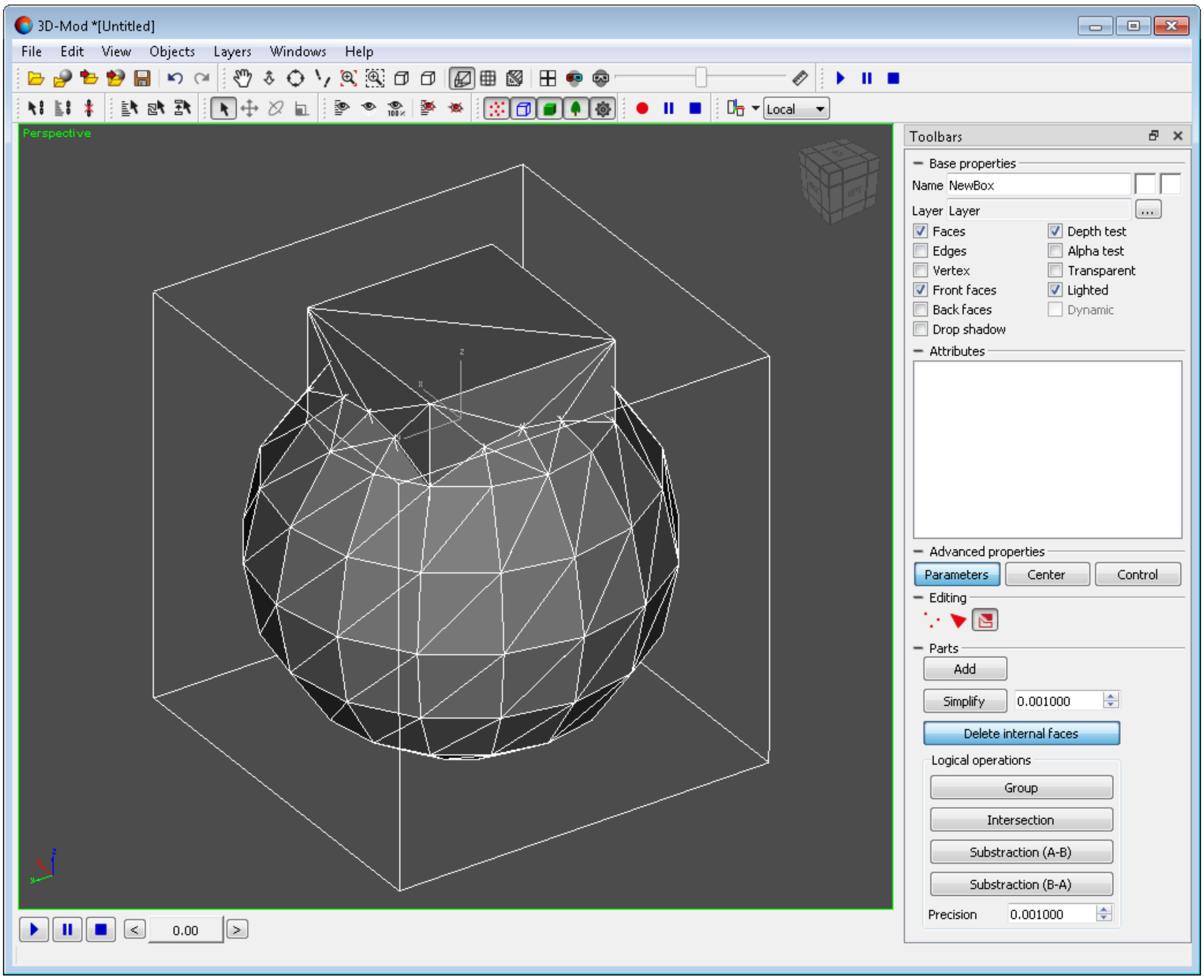


Fig. 112. Reconstructed surface of a composite object

4. Click the button to disable the parts editing mode.

The system also provides for merging objects. When merging objects, operations of inner face removing and the resulting object surface re-building are immediately performed automatically (see below).

6.5.8. Boolean operations on objects

The system provides for logical operations including merging, intersecting, and subtracting the objects (one from another).

For this, perform the following:

1. Create source objects (two or more) or import a vector object layer;

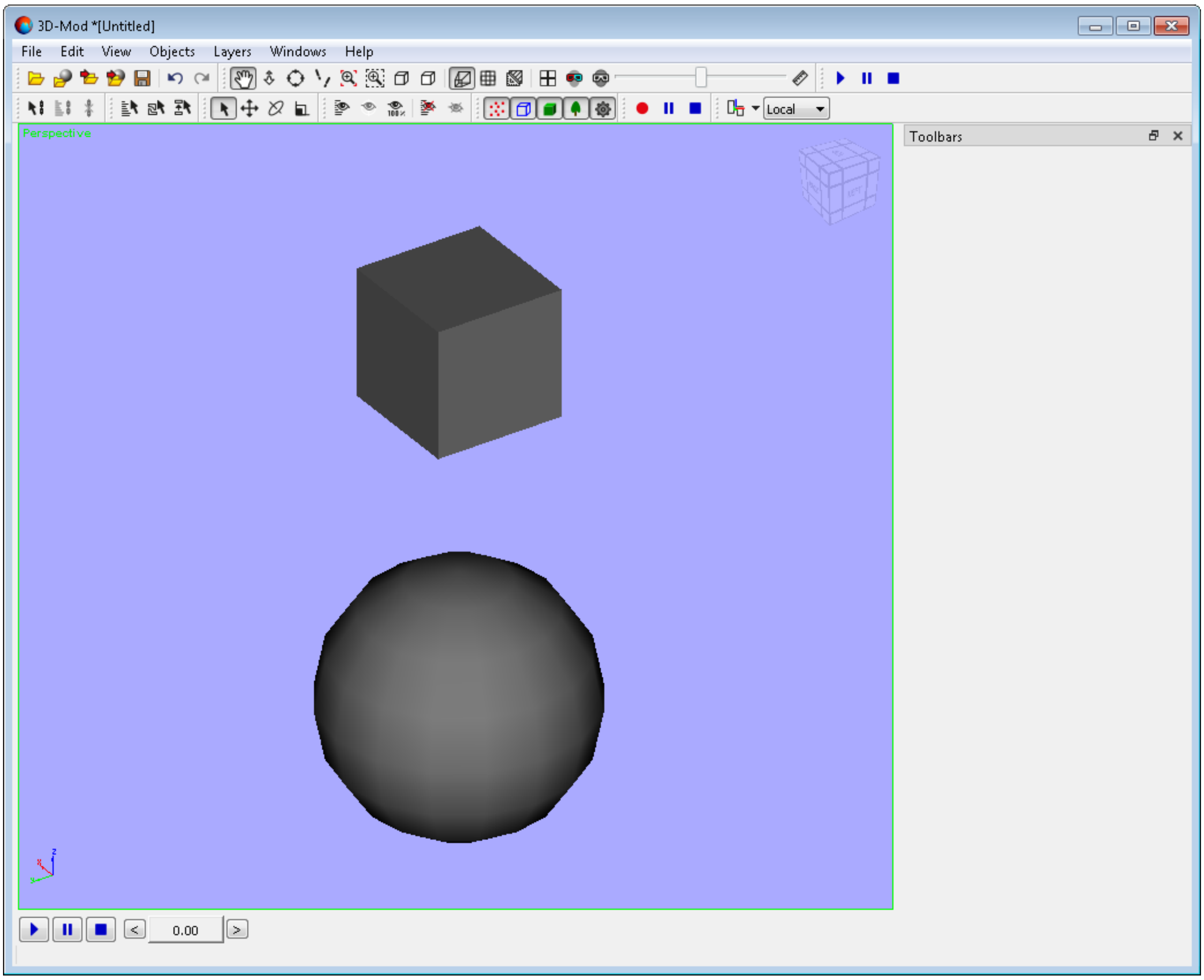


Fig. 113. Source objects

2. Move objects within the 3D-scene;

Spatial intersection of objects is not mandatory for performing the operation (for example, in case of merging objects), but is implied for operations of subtraction and intersection of objects (otherwise, these operations lead to null results).

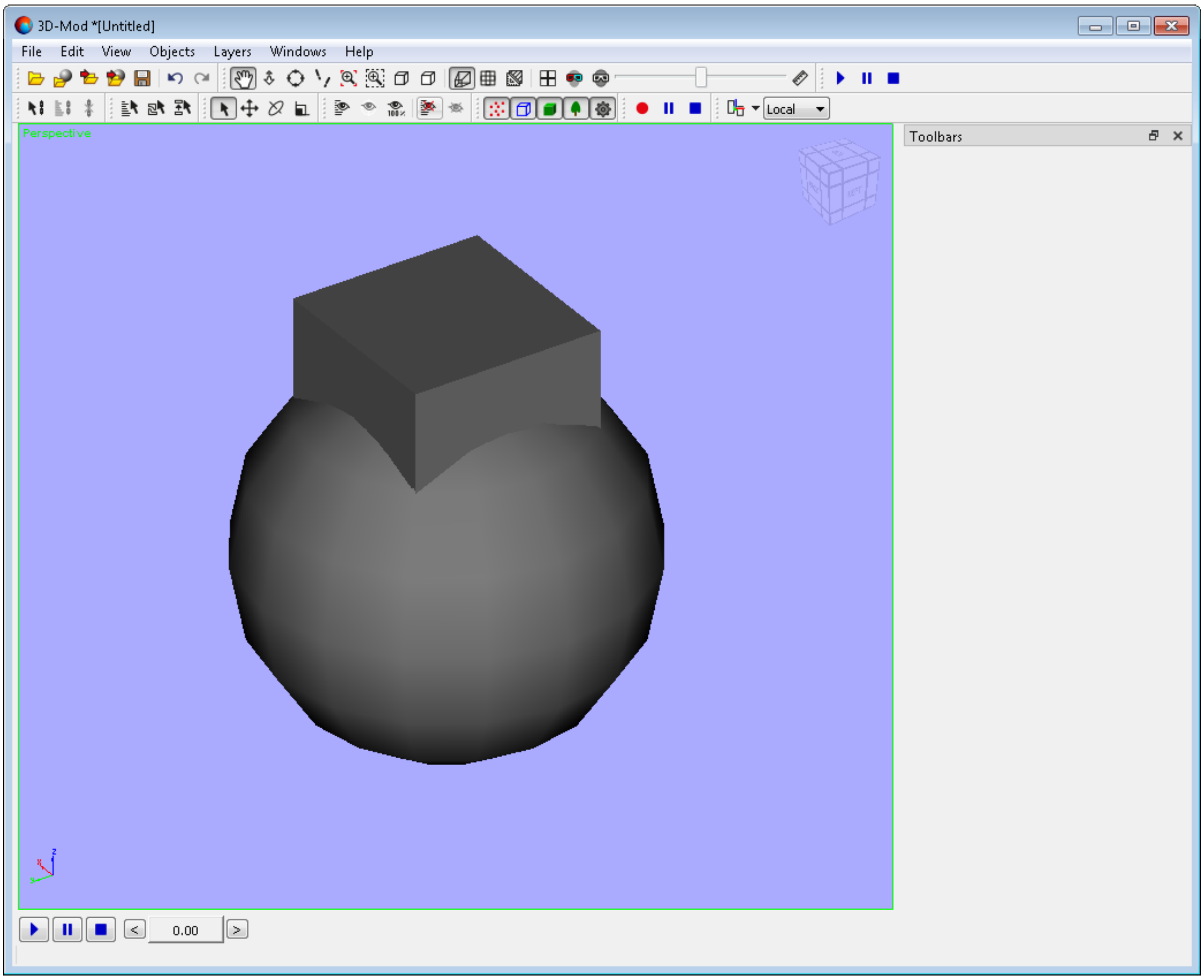


Fig. 114. Location of objects in the 3D scene space

3. Select the main object that will be sequentially subjected to Boolean operations;

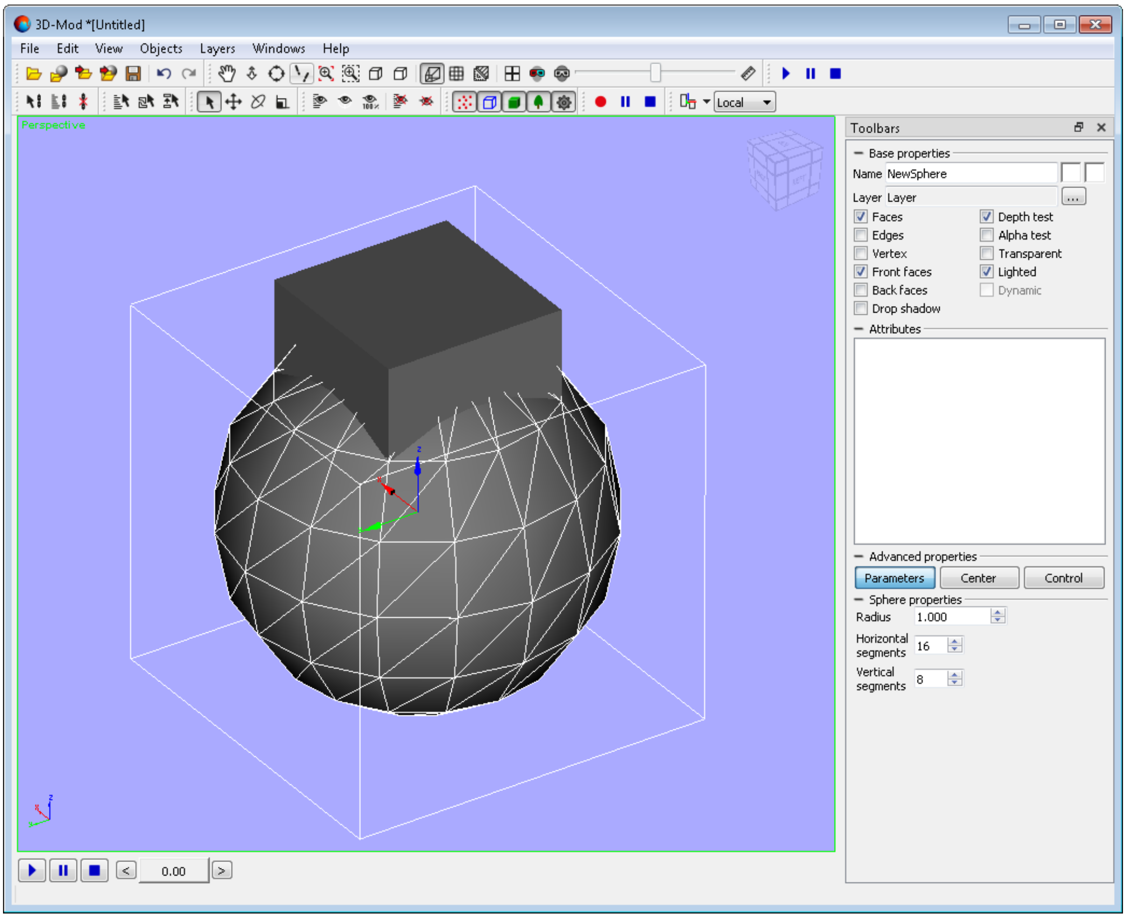


Fig. 115. The main object other objects are merged with

4. [optional] To edit the created object, choose **Edit › Convert to › grid**;
5. Click the button in the **Editing** section;
6. Click one of the buttons in the **Boolean operations** section of the **Parts** section:
   - [optional] **Merge**;
   - [optional] **Intersection**;
   - [optional] **Subtraction (A — B)**;
   - [optional] **Subtraction (B — A)**.

   The mode for performing the appropriate Boolean operation on objects is switched on.

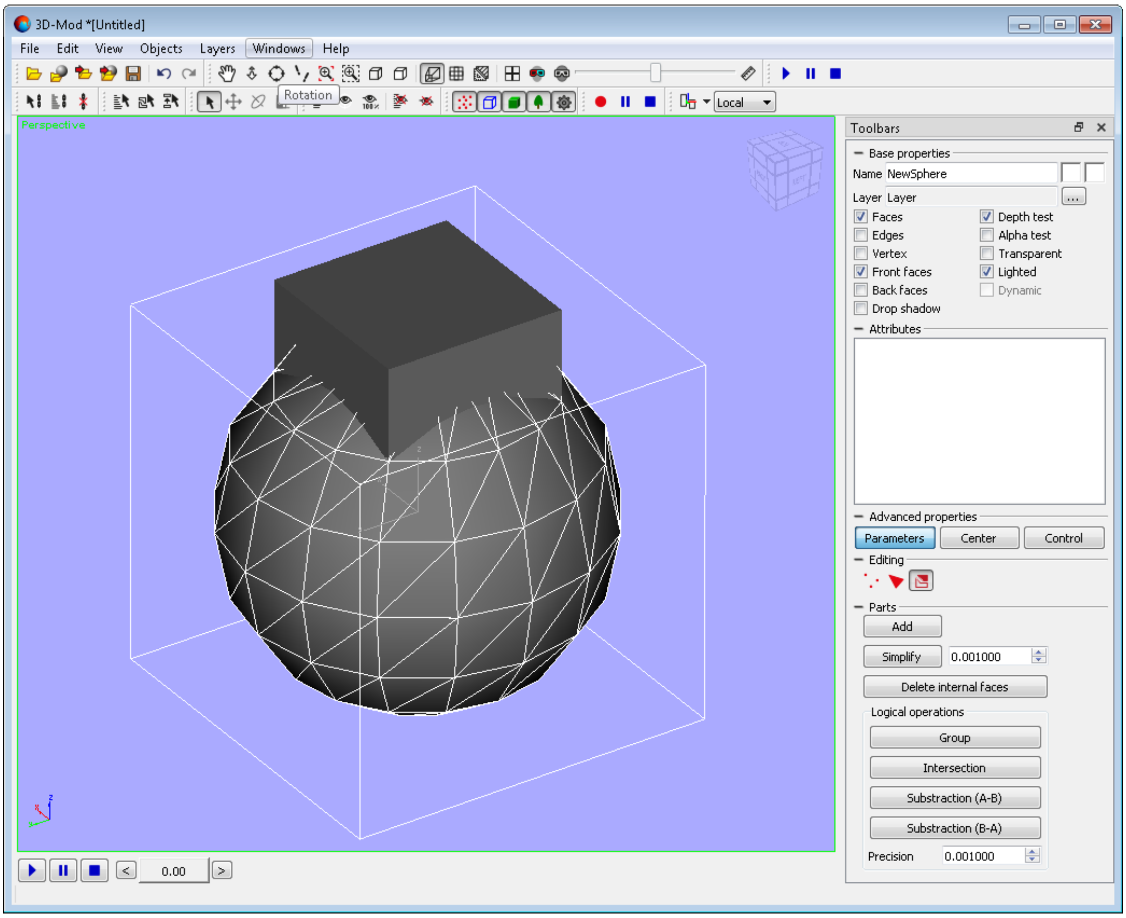


Fig. 116. The Editing, Parts, and Boolean operations sections

7. Configure the **accuracy** of object re-building in the appropriate input field. The increase in the given value causes the worsening of final object’s details. Scale down this value to increase detailing of output objects.

An object re-building **accuracy** required for certain operations may vary depending on the expected results and source data quality (for example, a quality of construction of vector objects created using *PHOTOMOD* or another software). The values of this parameter can play a significant role during the operation of merging objects, which, depending on the circumstances of their construction, can either ideally adjoin each other or be simply quite close.

Thus, it is recommended to perform operations with objects with default accuracy first. In case of unsatisfactory results, the system allows the user to undo the fulfilled operation (the  button of the main toolbar) and repeat it using corrected values of this parameter. Keep in mind that an extra high default value is likely to lead to unsatisfactory results (represented by unintended and significant changes in the original shape of the loaded objects).

8. Clicking the left mouse button, select the object that you want to subject to the operation selected in the previous paragraph together with the main object. A dialog box opens:

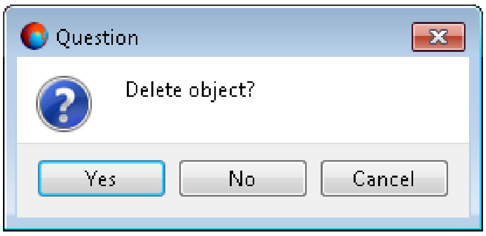


Fig. 117. A dialog box

- [optional] Click **Yes** to delete the selected extra object after the operation is complete;
- [optional] Click **No**, not to delete the selected extra object after the operation is complete.

9. [optional] Sequentially repeat the steps described in the paragraphs above with other objects loaded into the 3D scene space, if necessary;

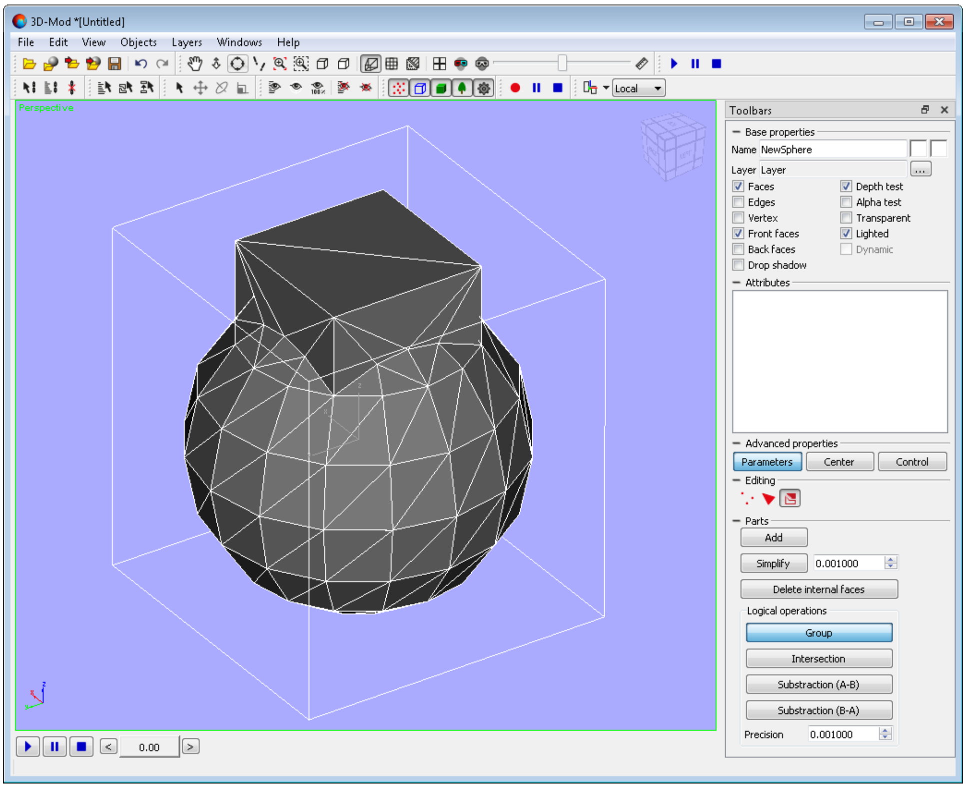


Fig. 118. Two objects merged

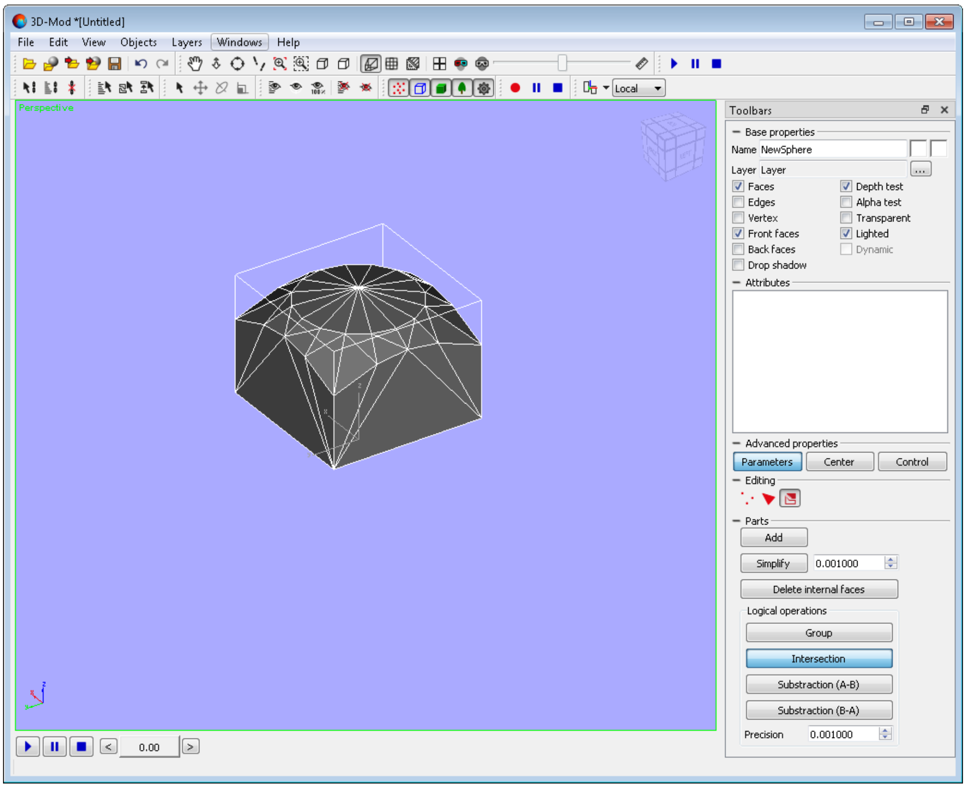


Fig. 119. Two objects intersected

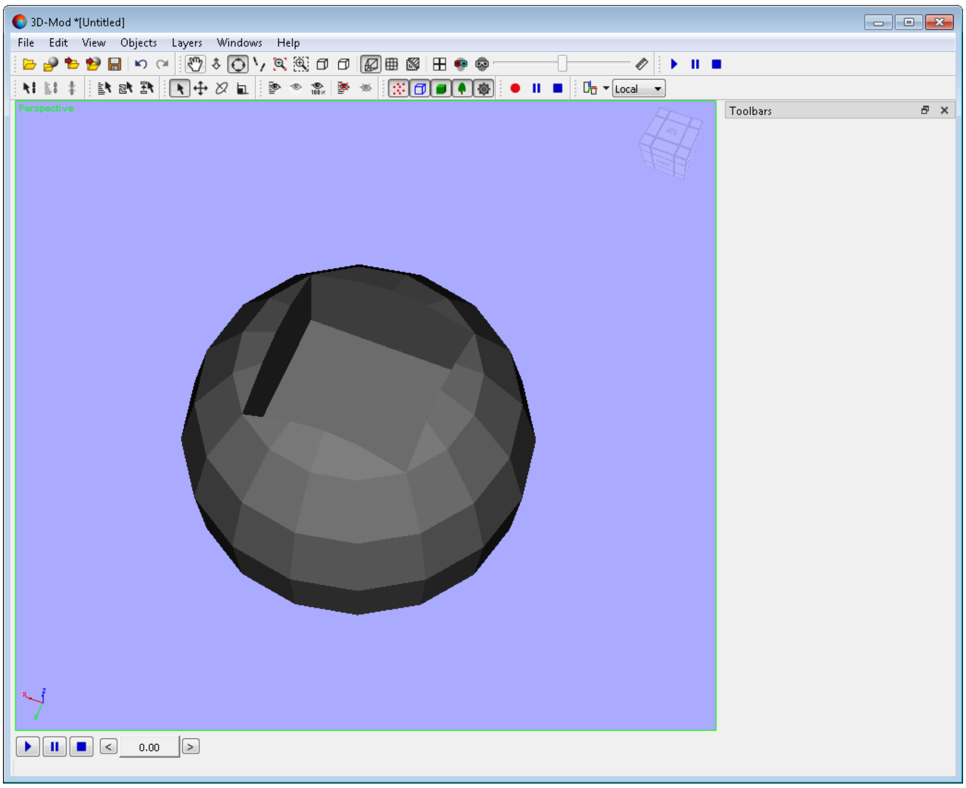


Fig. 120. One object is subtracted from another (Option 1)

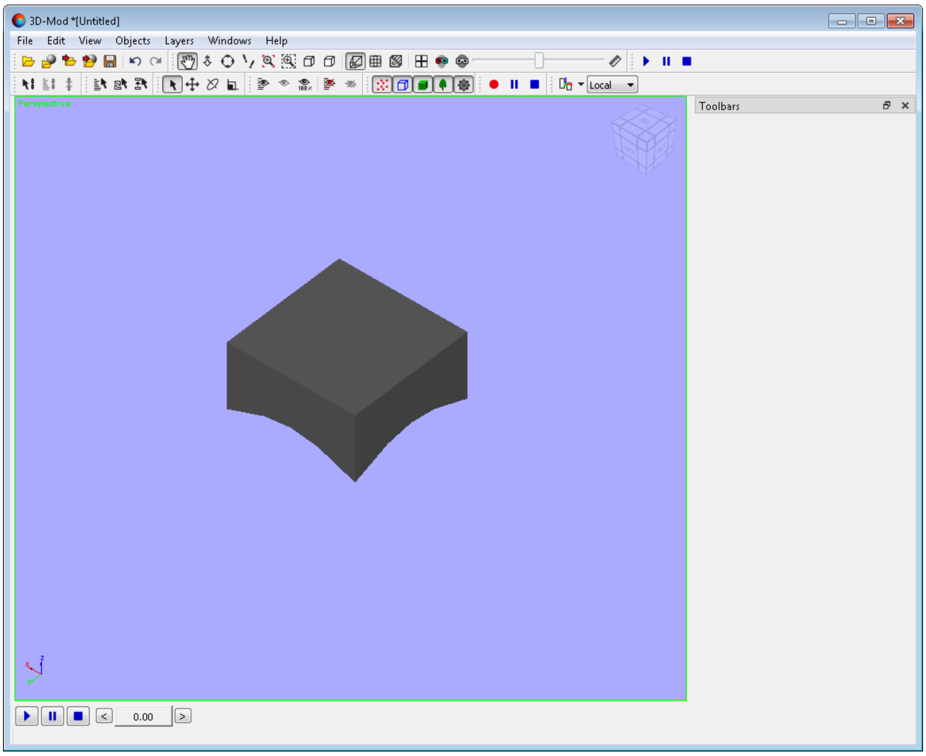


Fig. 121. One object is subtracted from another (Option 2)

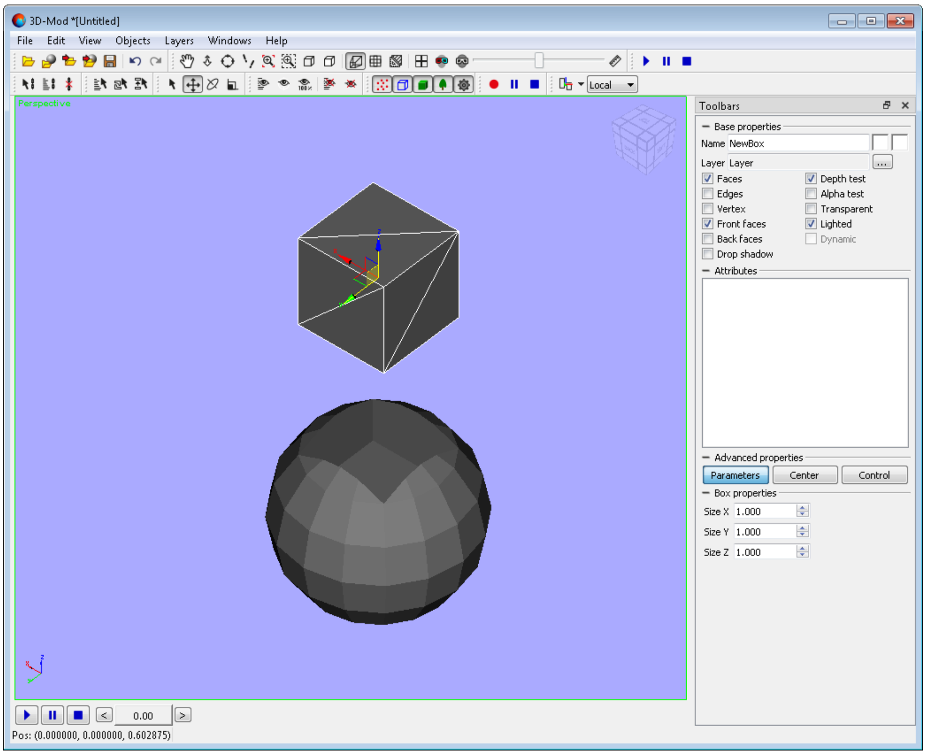


Fig. 122. The result of subtraction of one object from another (Option 1), the additional object was not removed after the operation was performed (and shifted for better visualization)

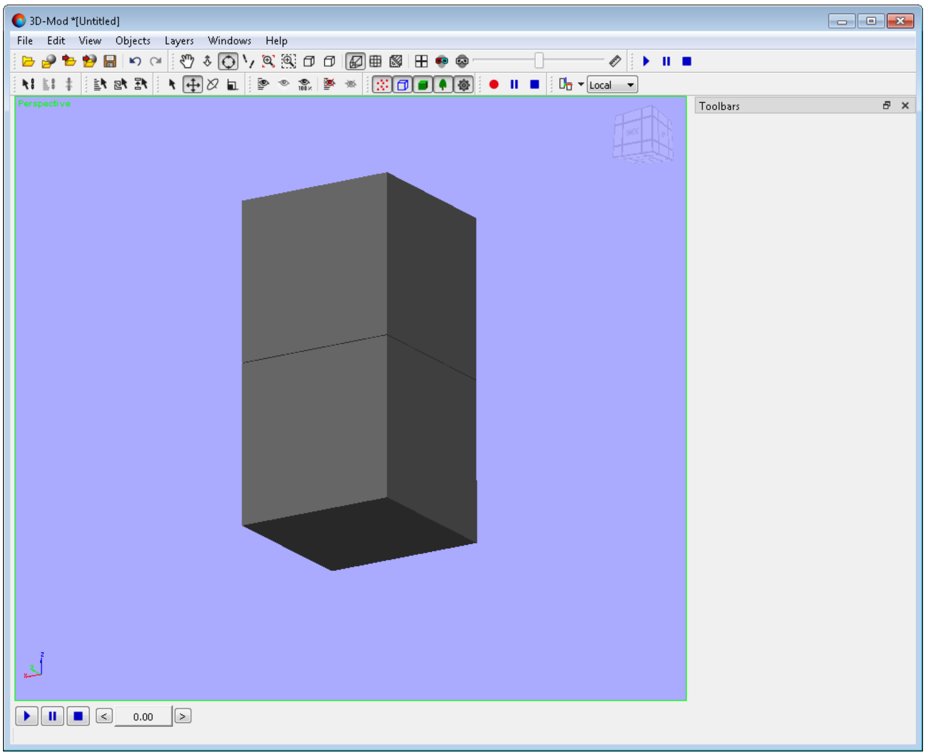


Fig. 123. Adjacent objects

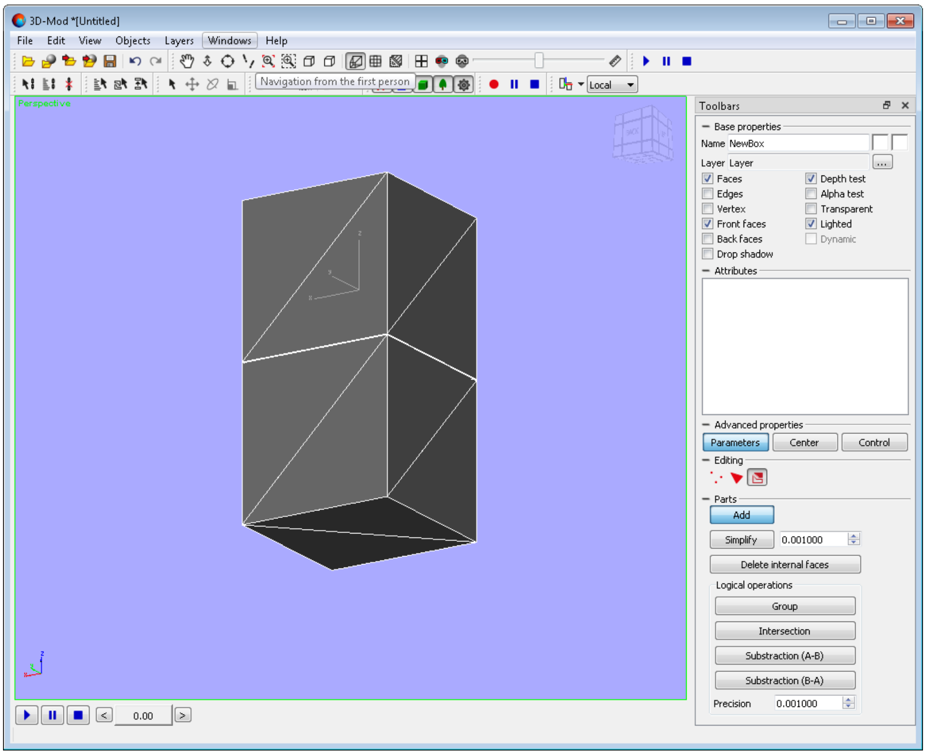


Fig. 124. Adjacent objects merged with high accuracy

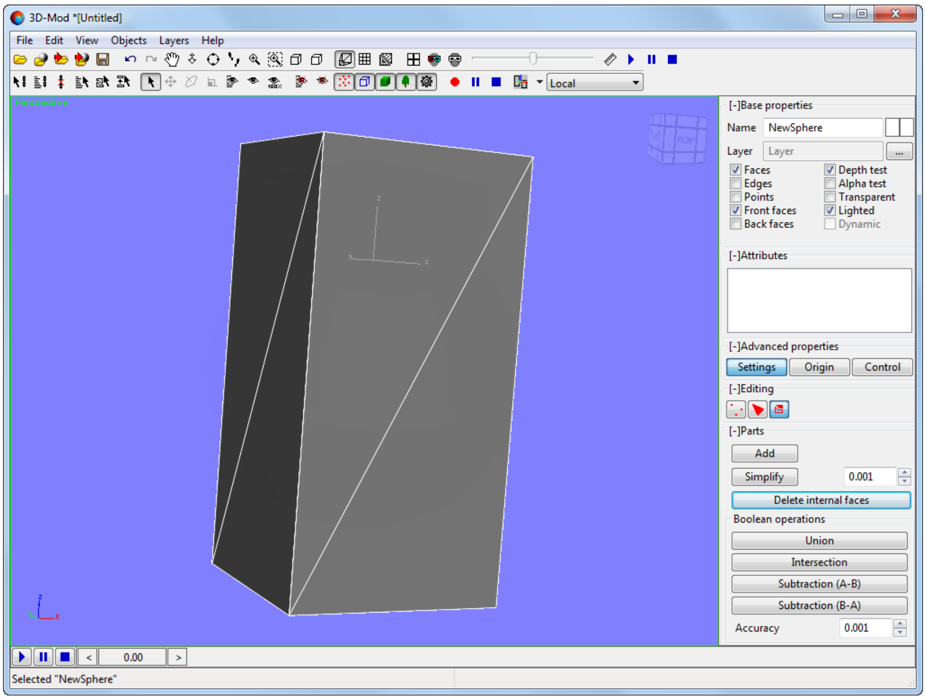


Fig. 125. Adjacent objects merged with low accuracy

10. To disable current mode (intersection, merging, or subtraction), click the appropriate button in the **Boolean operations** section of the **Parts** section;

11. Click the button in the **Editing** section, to disable the parts editing mode.

6.5.9. Optimizing the number of object faces

Imported objects, depending on the conditions of their creation and the tools used for this, may contain an unreasonably large number of faces, in situations when a fragment of an object, which is an ideal plane, can just as well be described by a much smaller number of faces.

To optimize the number of faces describing such parts of an object, perform the following:

1. Select an object;

2. [optional] To edit the created object, choose **Edit › Convert to › grid**;

3. In the **Editing** section, click the button;

4. [optional] Correct the accuracy of object re-building in the input field that corresponds to the **Simplify** button in the **Parts** section.

5. Click the **Simplify** button. If there are redundant faces within “flat” object fragment, their number will be reduced to minimum required.

An object under processing may also contain fragments very close to a plain in their shape, those (if it suits the tasks being solved) would be reasonably interpolated as planes.

By varying the accuracy of object reconstruction, a user can adjust the degree on interpolation. By default, with a low value of this parameter (high accuracy), interpolation is not applied.

To interpolate close-to-a-plane fragments of an object as a plane, it is required (sometimes significantly) to increase the entered value (to reduce the reconstruction accuracy).

6. Click the button in the **Editing** section to disable the parts editing mode.

6.5.10. Editing polyline points

Perform the following actions to edit polyline points:

1. Create a polyline or import a vector objects layer.
2. Select a polyline.
3. In the **Editing** section click the button. The editing of polyline points mode is on.

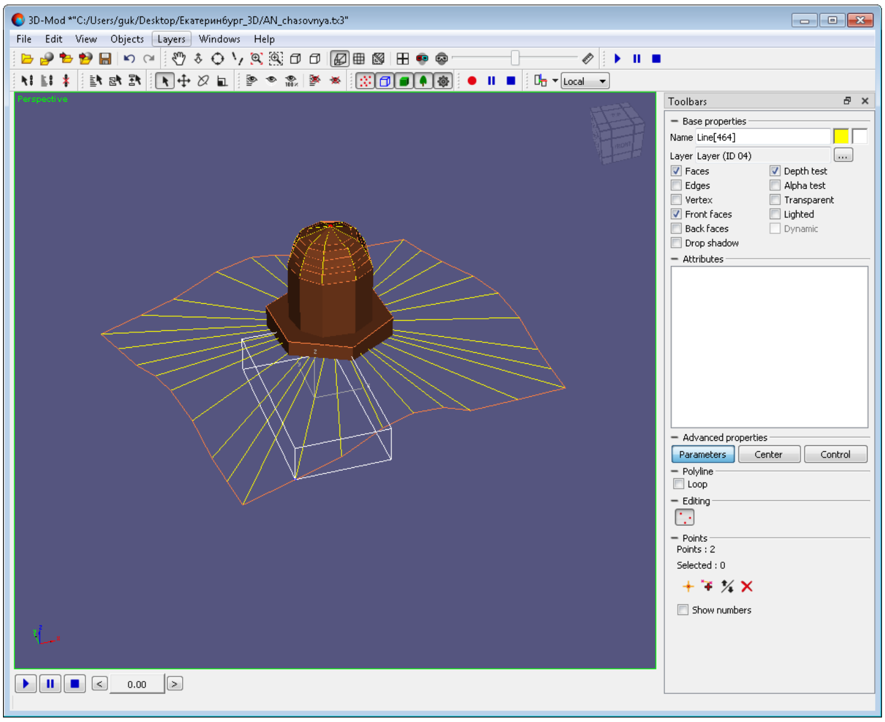


Fig. 126. Editing of polyline points mode

4. In the **Points** section click the (**Create**) button and create a new point by mouse click in view window.

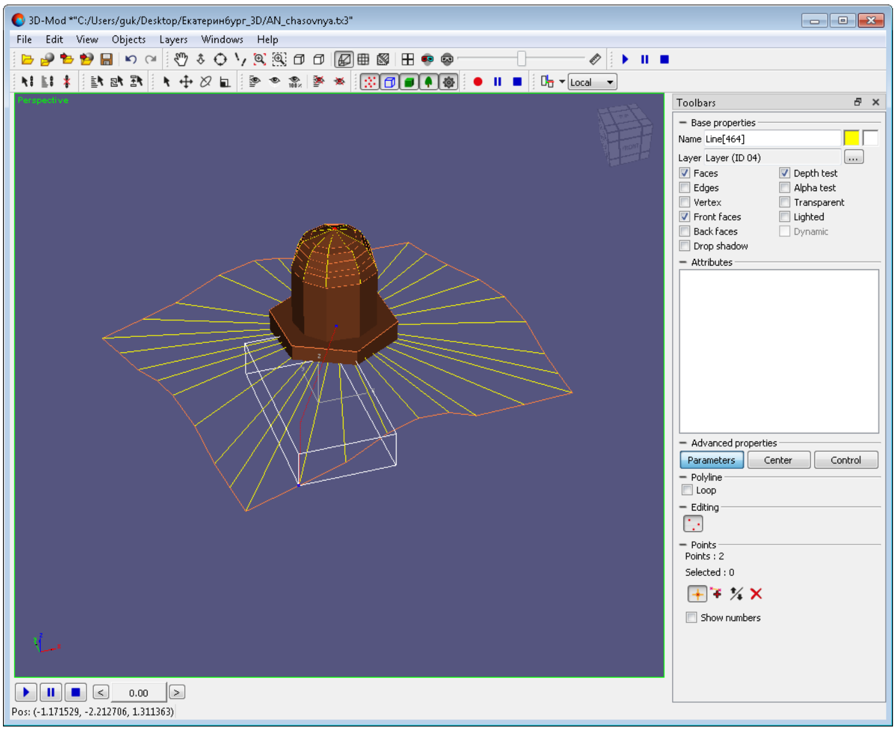


Fig. 127. Creation of a new polyline point

5. [optional] In order to remove a point, select it and click the (**Delete**) button.

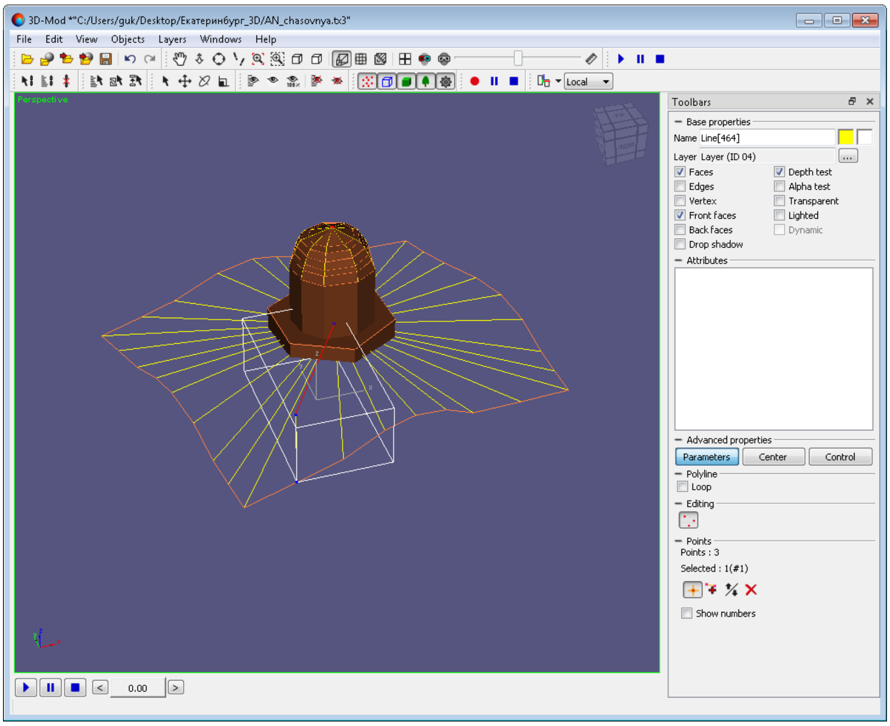


Fig. 128. Selected point to be deleted

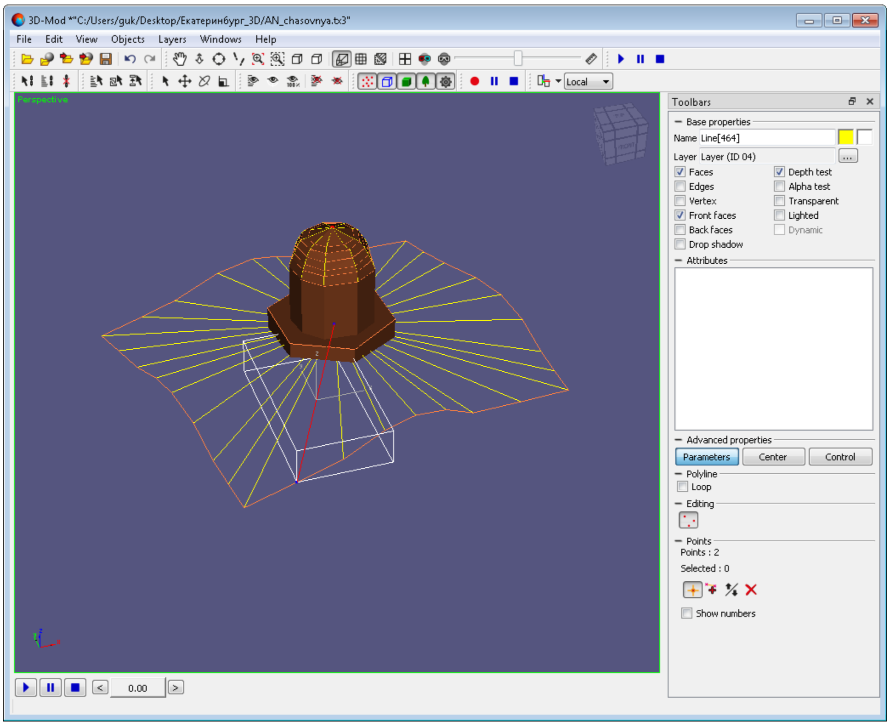


Fig. 129. Deleting of selected point

6. [optional] To change a polyline direction (to swap the first and the last points of a polyline), click the (**Redirect**) button.

7. In order to turn the polyline points editing mode off, click the button.

6.5.11. Editing of Bezier curve

Perform the following actions to edit Bezier curve points:

1. Create Bezier curve or import a vector objects layer.

2. Select Bezier curve.

3. [optional] To change number of segments, in the **Curve** section input number of segments between check points.

4. [optional] To create closed Bezier curve, in the **Curve** section set the **Loop** checkbox on.

5. In the **Editing** section click the button. The editing of Bezier curve points mode is on.

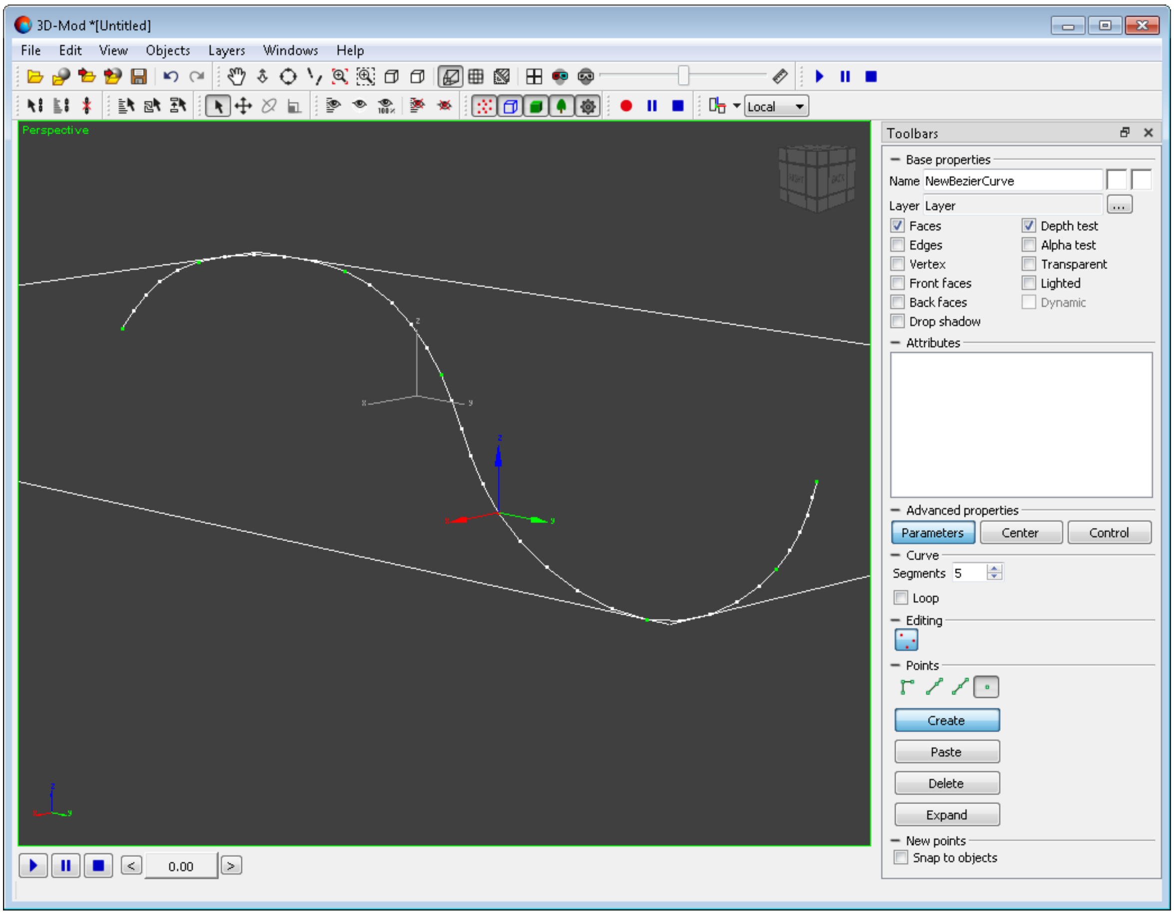


Fig. 130. Editing of Bezier curve points mode

6. In the **Points** section click the **Create** button, and select one of the following types of points:

 - – point with two independent check points, joined by line segments (tangent to the adjacent segments of the curve);

   In order to change the curvature of the curve section, turn on the move mode, set the mouse cursor over the control point (highlighted in green) and move it in any direction.

 - – point with two check points connected to each other, joined by line segments (tangent to the adjacent segments of the curve); when the position of one of the checkpoints is changed, another checkpoint changes symmetrically, but the distance to the main point remains the same;

 - – point with two check points firmly connected to each other, joined by line segments (tangent to the adjacent segments of the curve); when the position of one of the checkpoints is changed, another checkpoint changes symmetrically;

- ▪ – smoothed point (without check points).

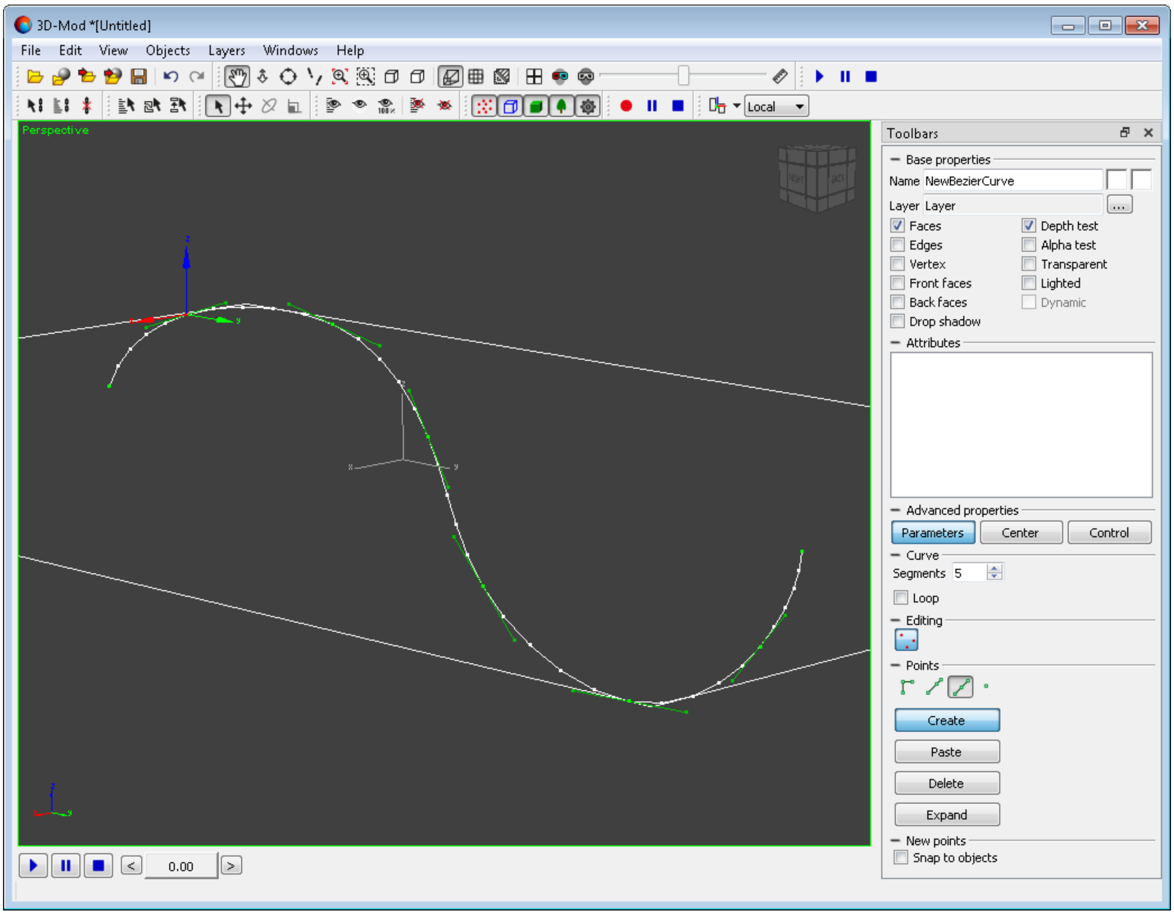


Fig. 131. Point type - point with two check points firmly connected to each other

7. [optional] In order to remove a point, select it and click the ✖ (**Delete**) button.

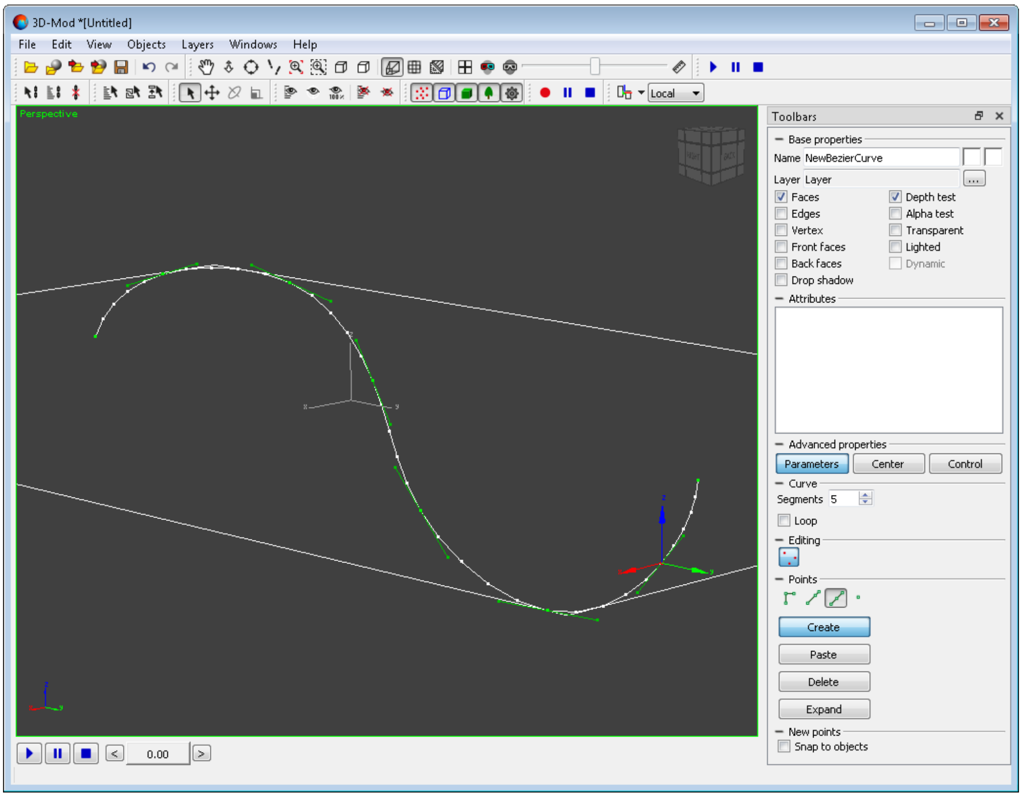


Fig. 132. Selected point to be deleted

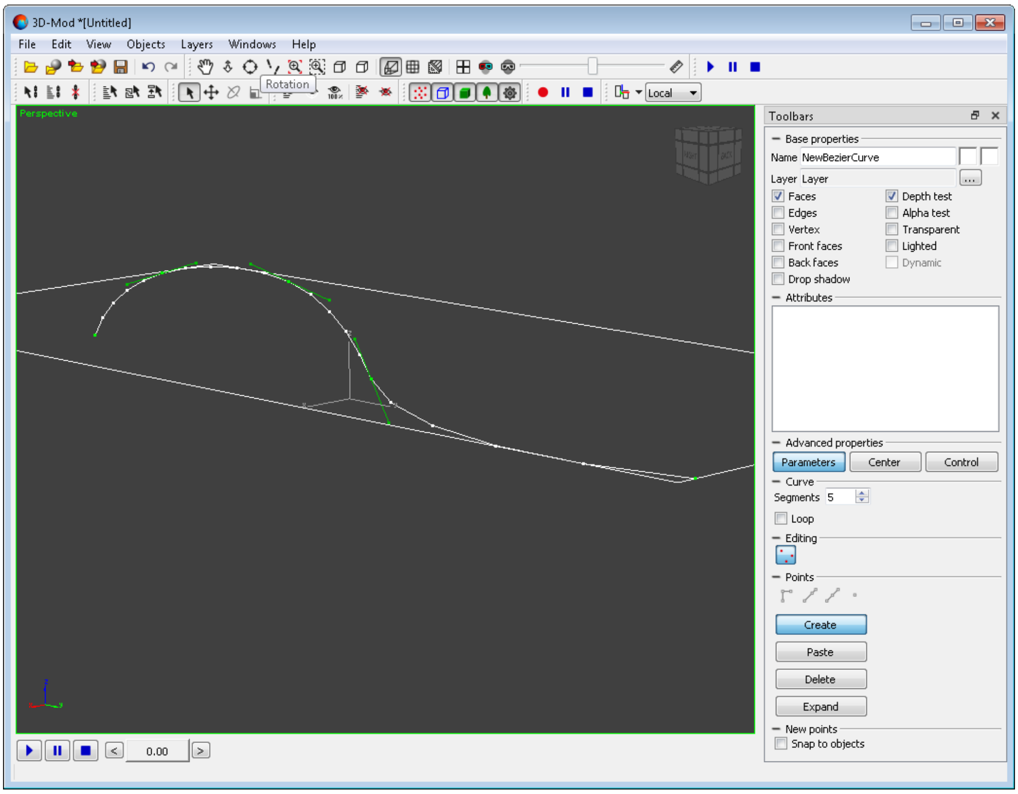


Fig. 133. Deleting of selected point

8. [optional] To change a Bezier curve direction (to swap the first and the last points of a polyline), click the **Redirect** button.

9. [optional] To rename a Bezier curve input its name to the **Name** field in the **Base properties** section.

10. [optional] In order to change color of a Bezier curve points, select color in the window opened after double click on the rectangle in the **Base properties** section.

11. In order to turn the Bezier curve points editing mode off, click the  button.

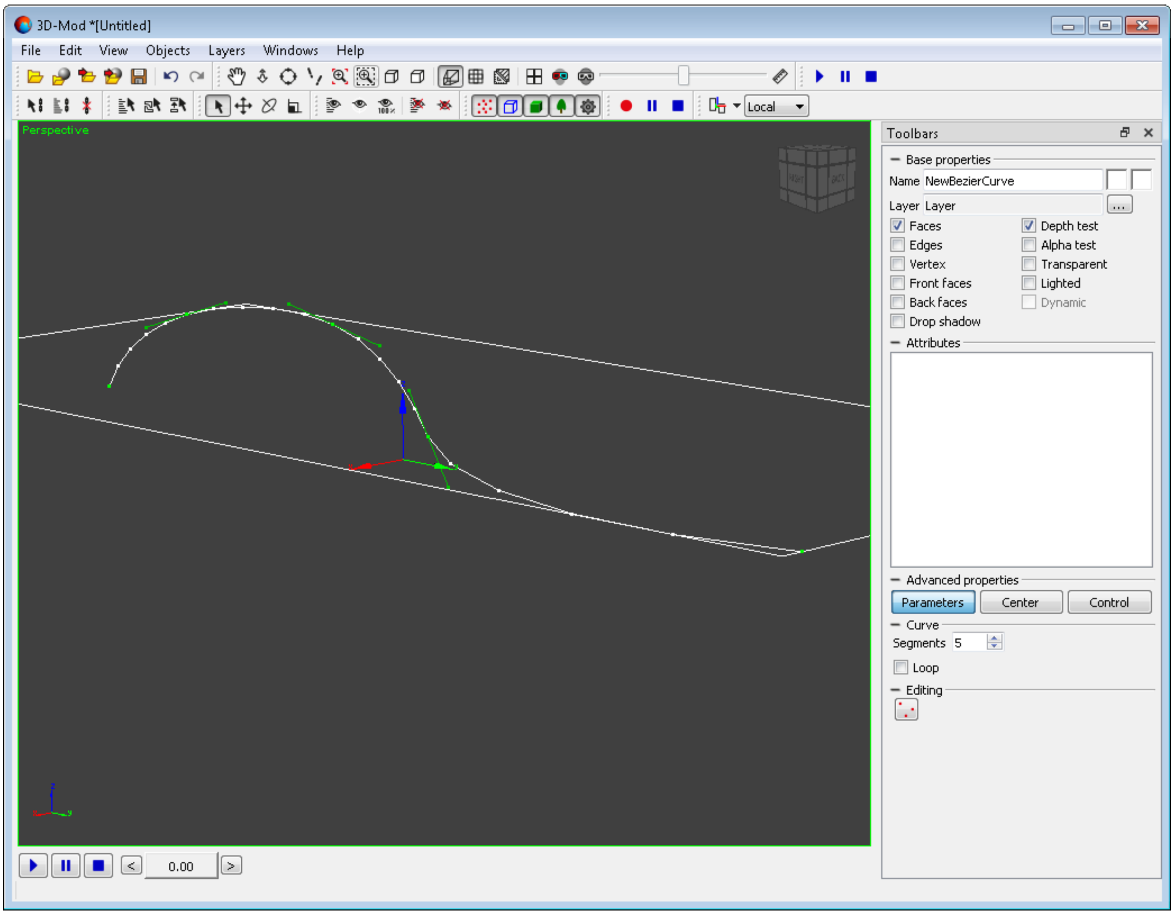


Fig. 134. Turn off the editing of Bezier curve points mode

7. Objects attaching mode

7.1. General information

Objects attaching – establishing hierarchic relation between objects in order to move them simultaneously (zoom, rotate) in scene 3D-space.

The module allows to work both with individual objects located independently from each other, and with object groups, containing hierarchical relationship like “parent object - child object”.

Child object – an object, that when moving, rotating, or scaling the associated parent object is synchronously moved, rotated or scaled.

Parent object – an object that is attached to child object.

There is a possibility to attach multiple objects. Such attaching in a group should be done in ascending order, i.e. the object, which is the youngest child should be selected as the *first*.

7.2. Objects attaching

In order to attach objects, perform the following actions:

1. Select **Edit › Attach** or click the button on the main toolbar. The objects attaching mode is on.

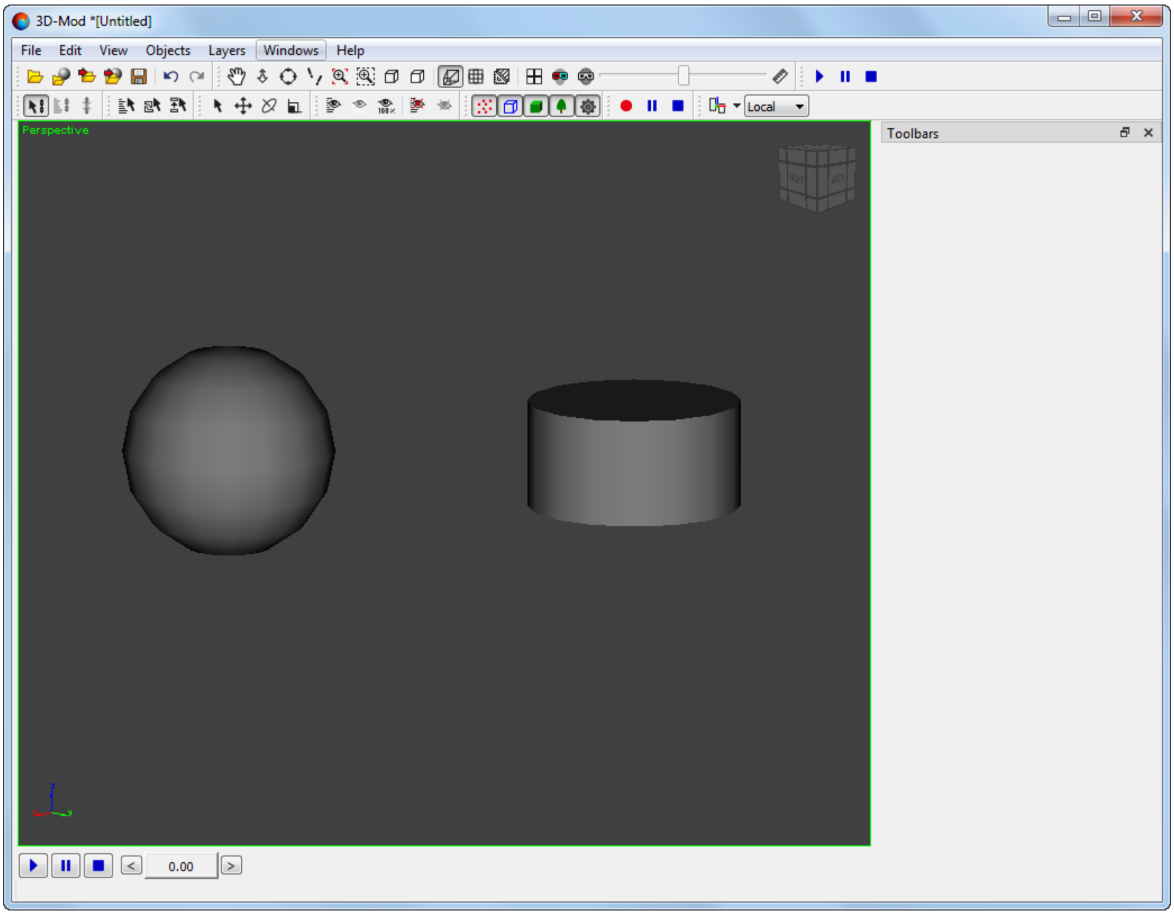


Fig. 135. Objects attaching mode

2. Select child object by mouse click.

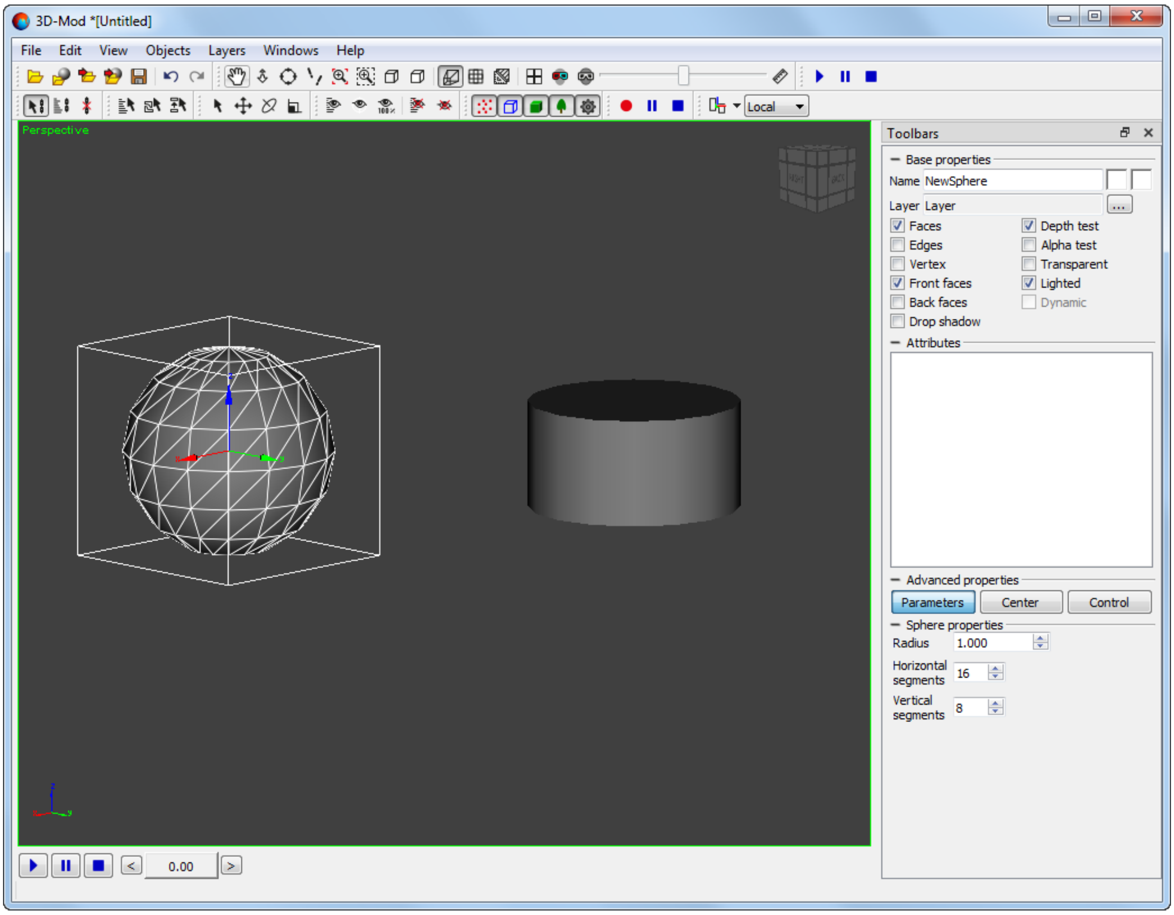


Fig. 136. Child object

3. Press and hold mouse button and draw the cursor on another object.

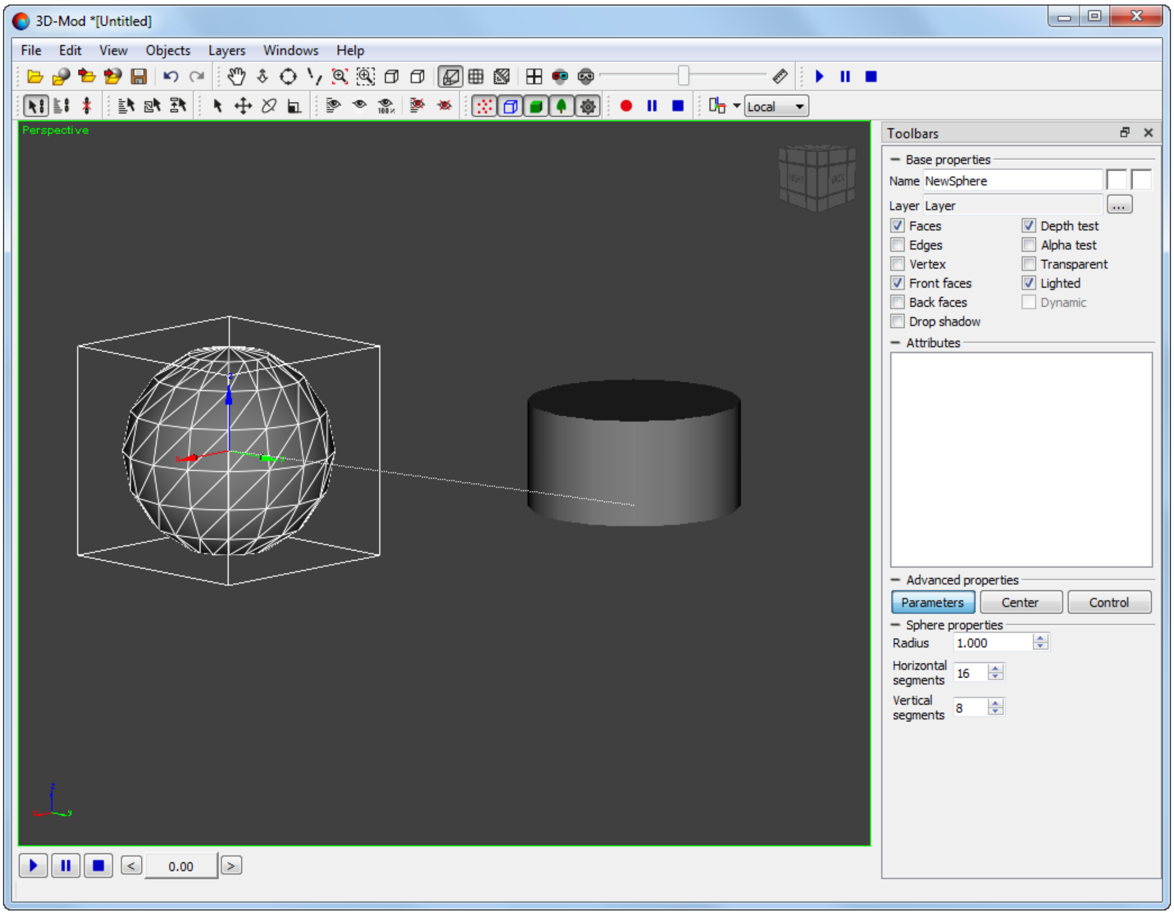


Fig. 137. Attaching child object (sphere) to the parent one (cylinder)

4. Release mouse button. Attachment line between the object is highlighted several times, so the system performs objects attaching.

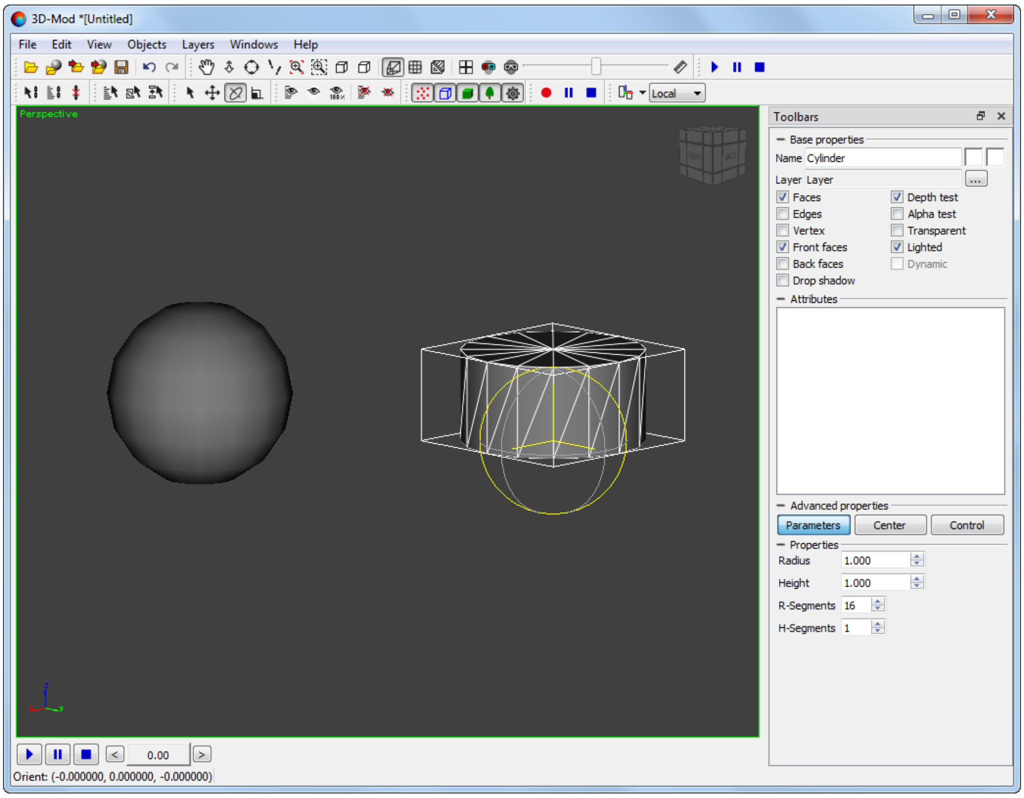


Fig. 138. Sphere rotation along with a cylinder

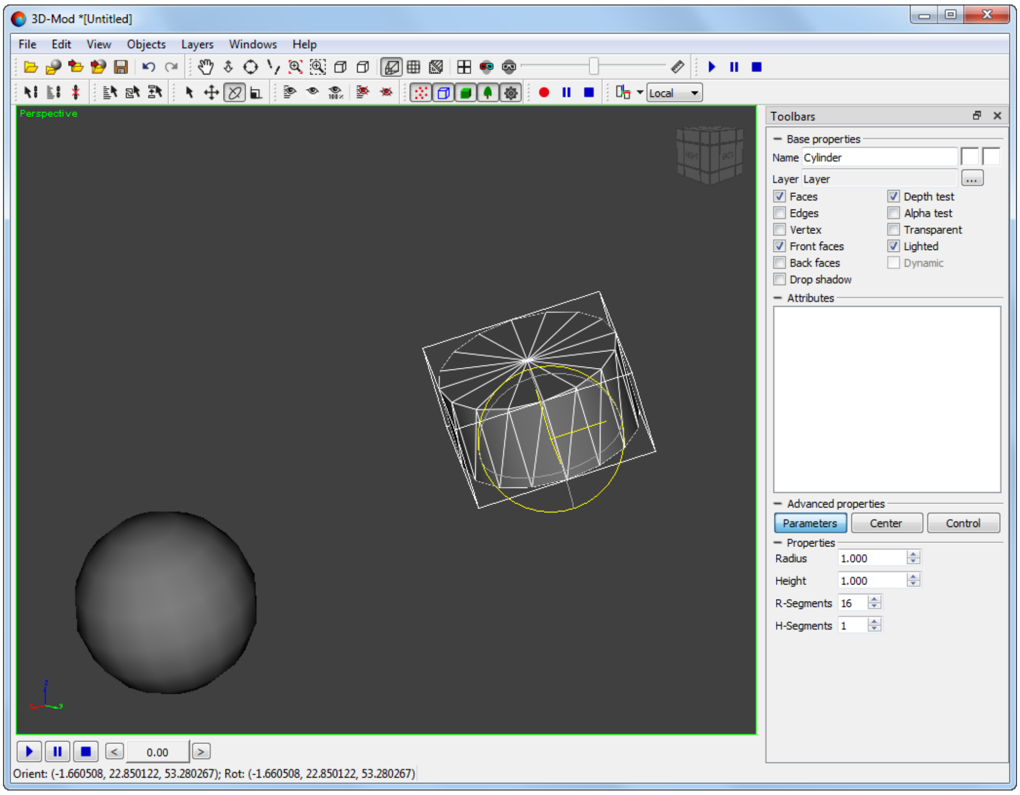


Fig. 139. Sphere rotation along with a cylinder

5. In order to turn the objects attaching mode off, click the button.

In order to attach objects using their names list, perform the following actions:

1. Select child object, i.e. the object to be synchronized to repeat the actions of another object.

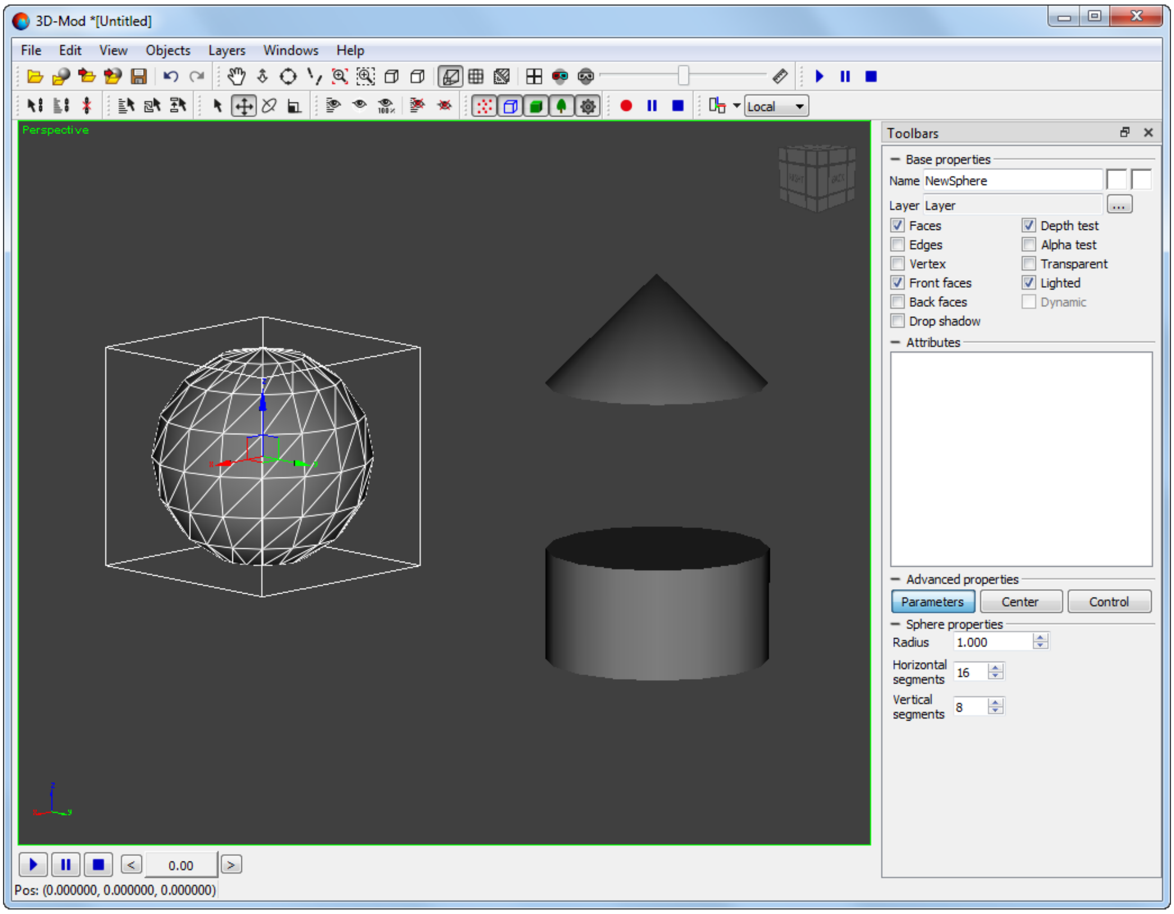


Fig. 140. Child object

2. Click the button on the main toolbar. The **Select objects** window opens.

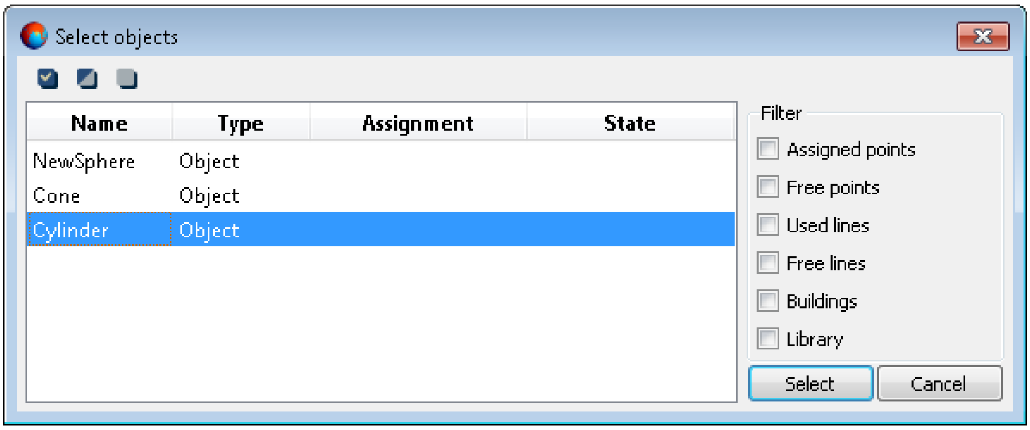


Fig. 141. Select objects from the list window

3. Select in the list parent object, i.e the object to which the selected object will be attached.

4. Click the **Select** button. After that the system performs objects attaching.

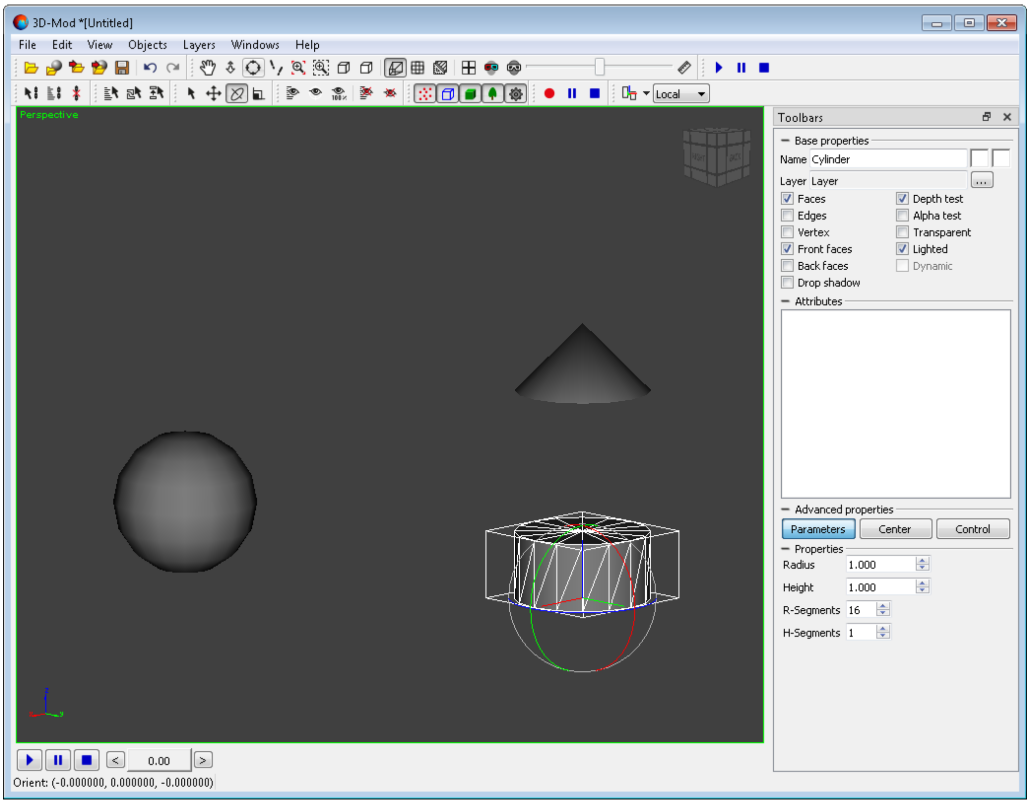


Fig. 142. Sphere rotation along with a cylinder

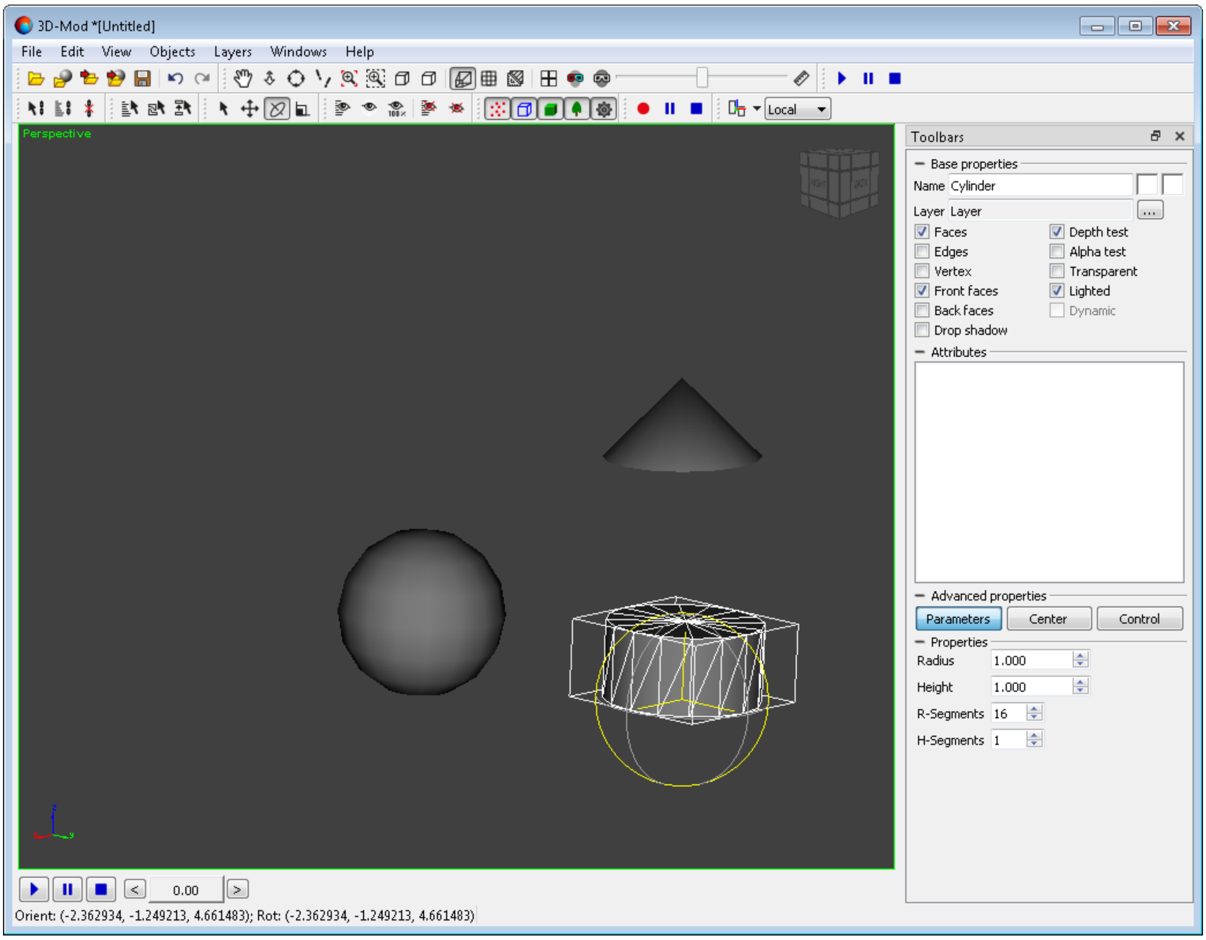


Fig. 143. Sphere rotation along with a cylinder

5. In order to turn the objects attaching mode off, click the button.

7.3. Cancelling objects attaching

The module allows to cancel previously established relationships between objects.

Consider the operation of detaching using the example of three attached objects. In this example the younger child object is *cone*, the older child object is *cylinder*, the parent object is *tube*. Operation of these objects attaching was performed in the following order:

1. The cone was attached to cylinder.

2. The cylinder was attached to the tube. As a result, during rotation of the tube its two child objects rotate synchronously.

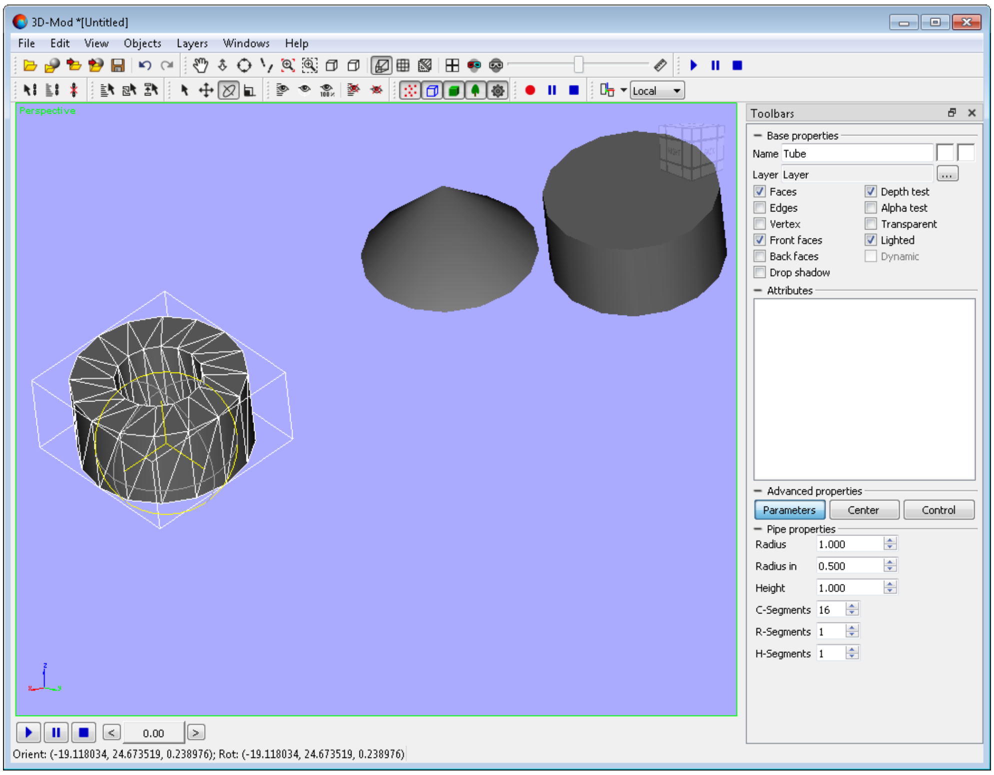


Fig. 144. Tube rotation along with a cylinder and cone

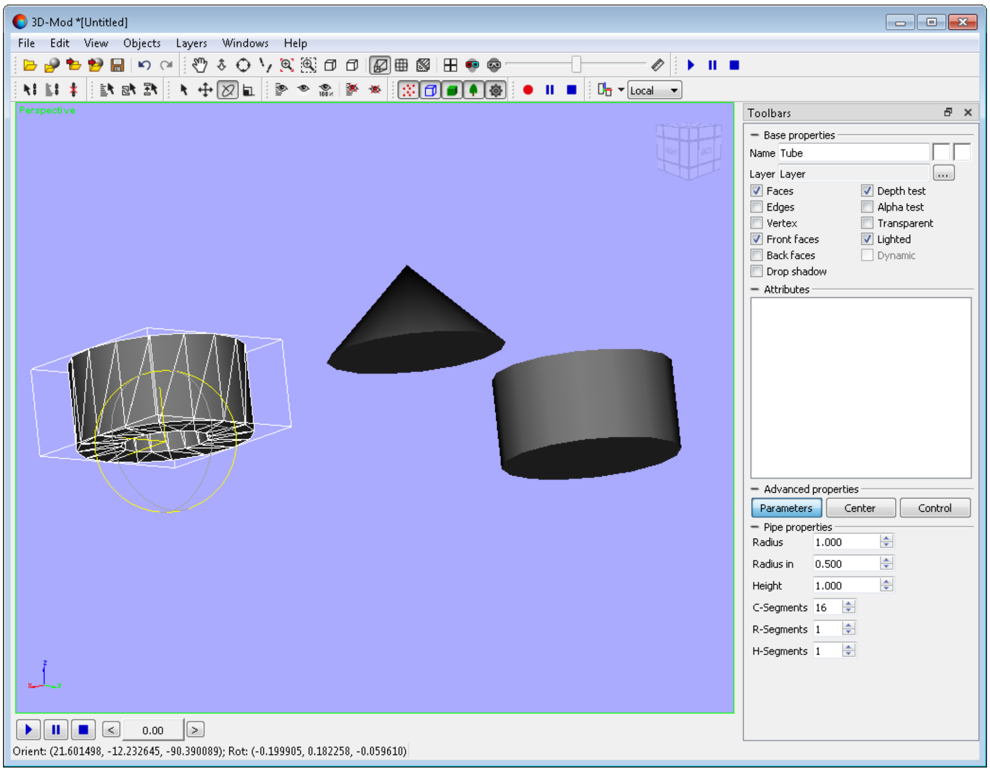


Fig. 145. Tube rotation along with a cylinder and cone

To cancel attachment between objects, perform the following actions:

1. Select the object which you want to unlink from the parent object.

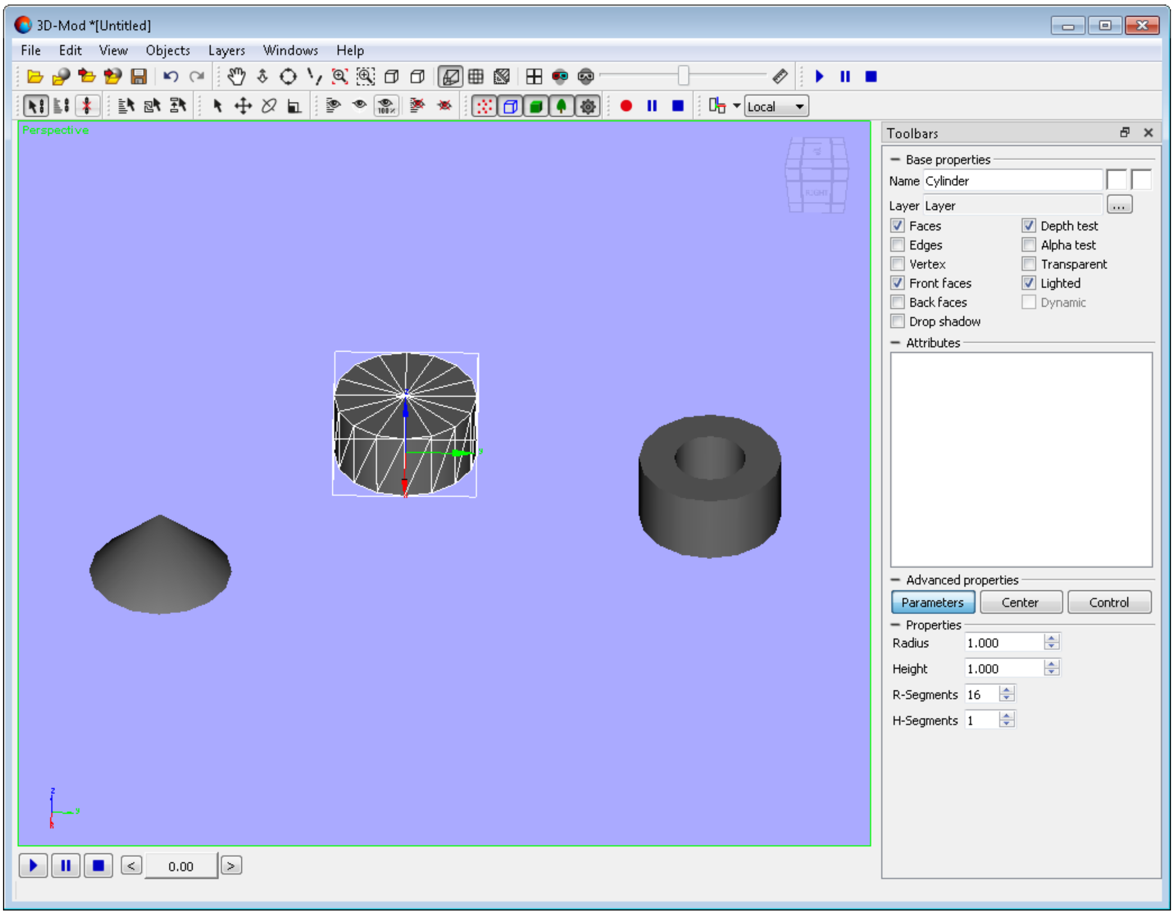


Fig. 146. Selecting child object

2. Select **Edit › Detach** or click the  button on the main toolbar. As a result, the attachment between selected object and the parent one will break, but the connection with another object will remain.

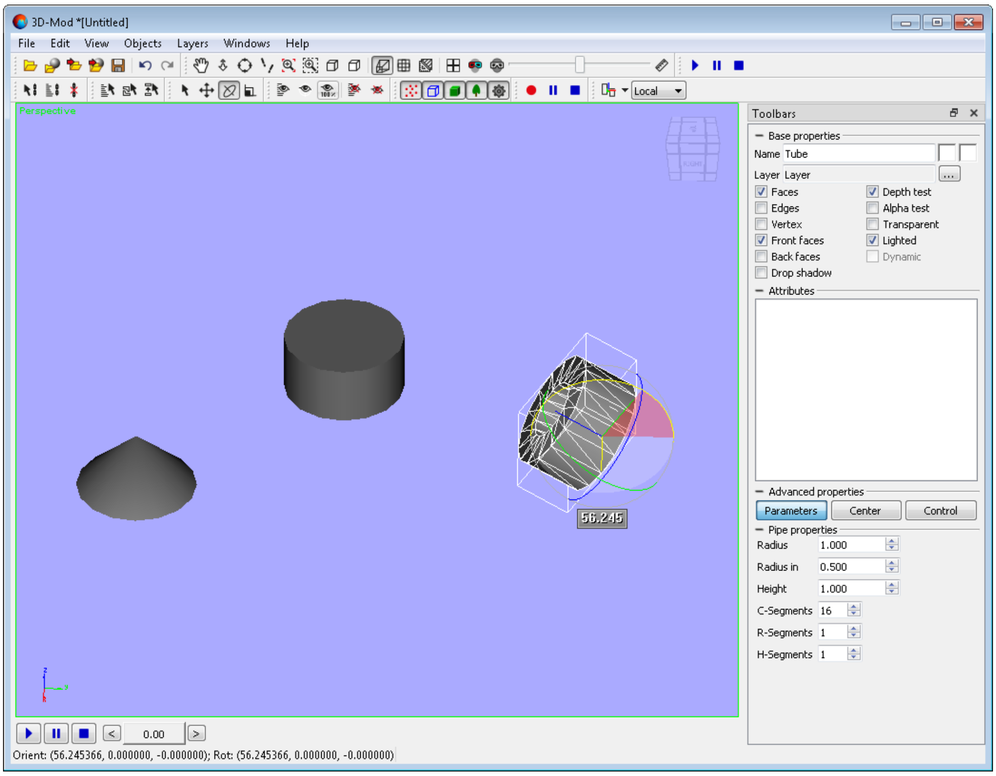


Fig. 147. Tube rotation

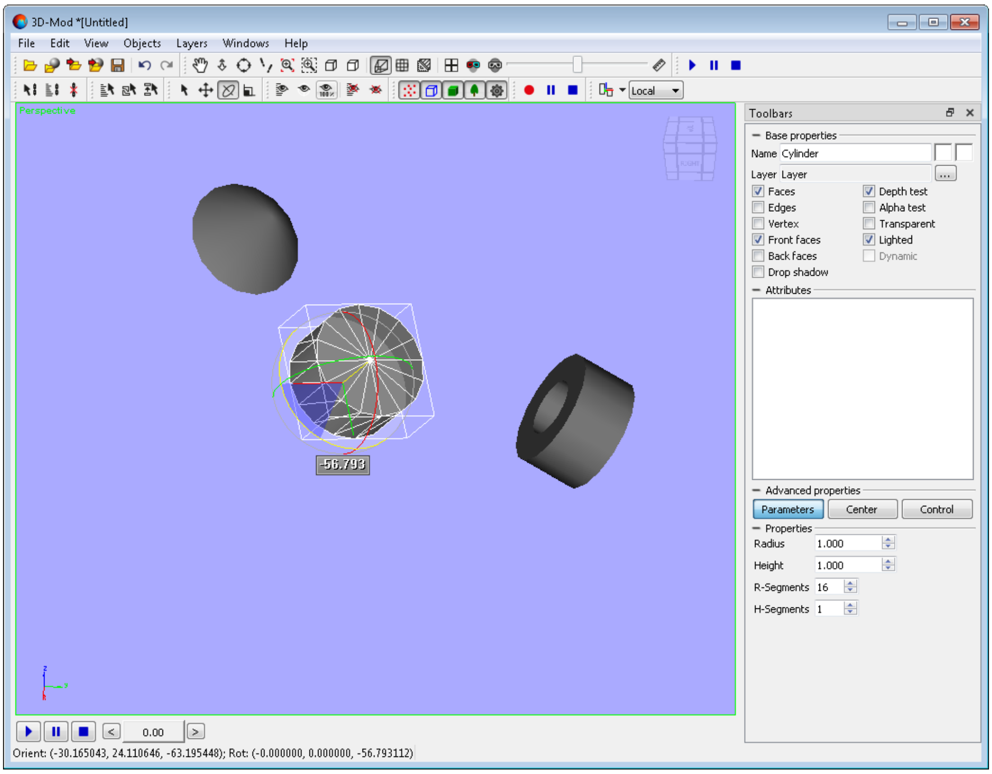


Fig. 148. Cylinder rotation along with a cone

8. Texture assignment

8.1. Texture assignment to 3D-objects

The module allows to assign texture to 3D-objects, that helps to give the form of real objects to geometric bodies.

Texture is an image, which you can assign to 3D-object to simulate real-world materials of natural or synthetic origin.

The images of the following formats could be used to assign texture to 3D-objects:

- Tag Image File Format (TIFF) – TIFF и GeoTiff format, included tags for saving of georeference information;
- Windows Bitmap File (BMP);
- JPEG (JPEG);
- PNG (PNG);
- JPEG2000 (JP2); – raster format with jpeg compression and georeference in the heading developed.

  The limitation on output file size of JPEG2000 format – no greater then 500 Mb.

To assign texture to 3D-objects it is necessary not just load the texture into object, but also edit texture coordinates, i.e. to specify location, change image scale on the object surface.

To assign texture to 3D-object perform the following actions:

1. Create object or import a vector objects layer.
2. Select an object.

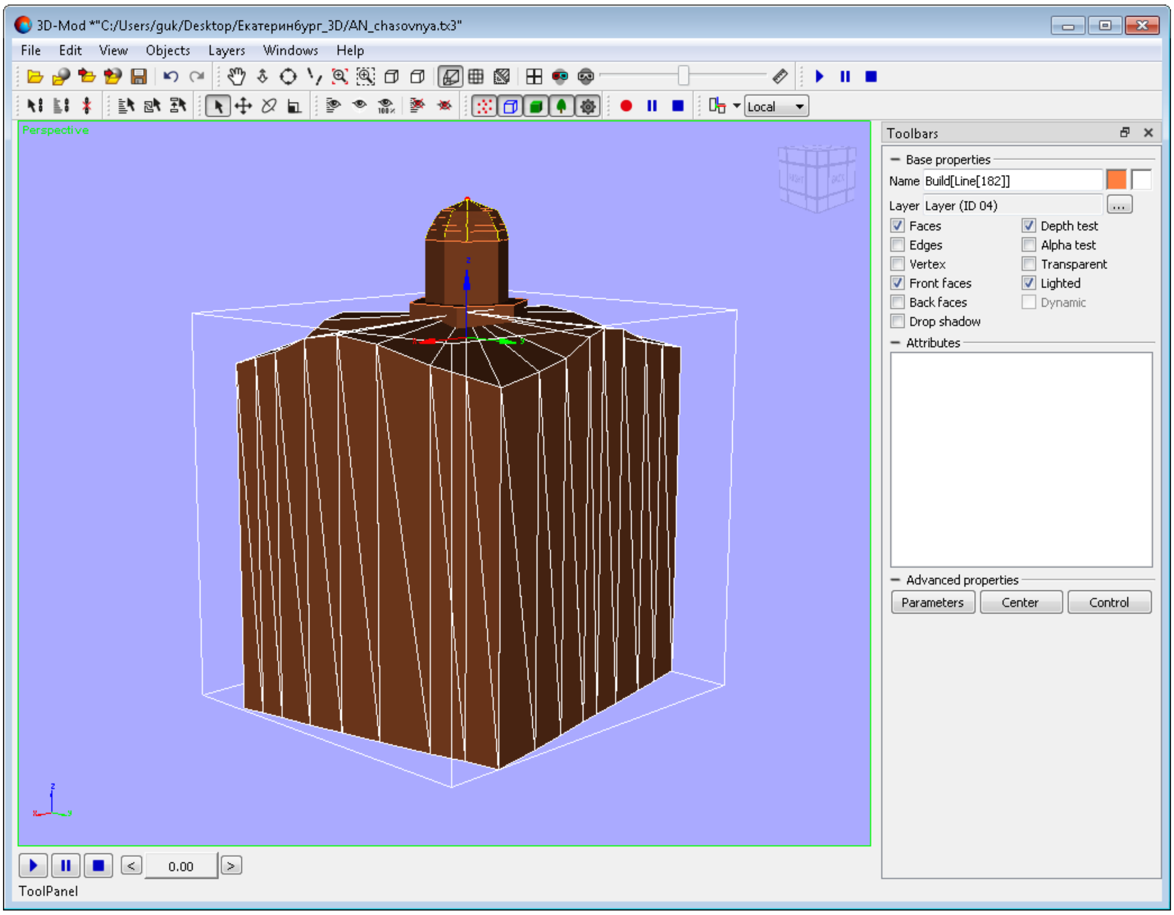


Fig. 149. Selected object

3. Select **Edit › Edit texture coordinates** (**Ctrl+T**). The texturing mode is on.

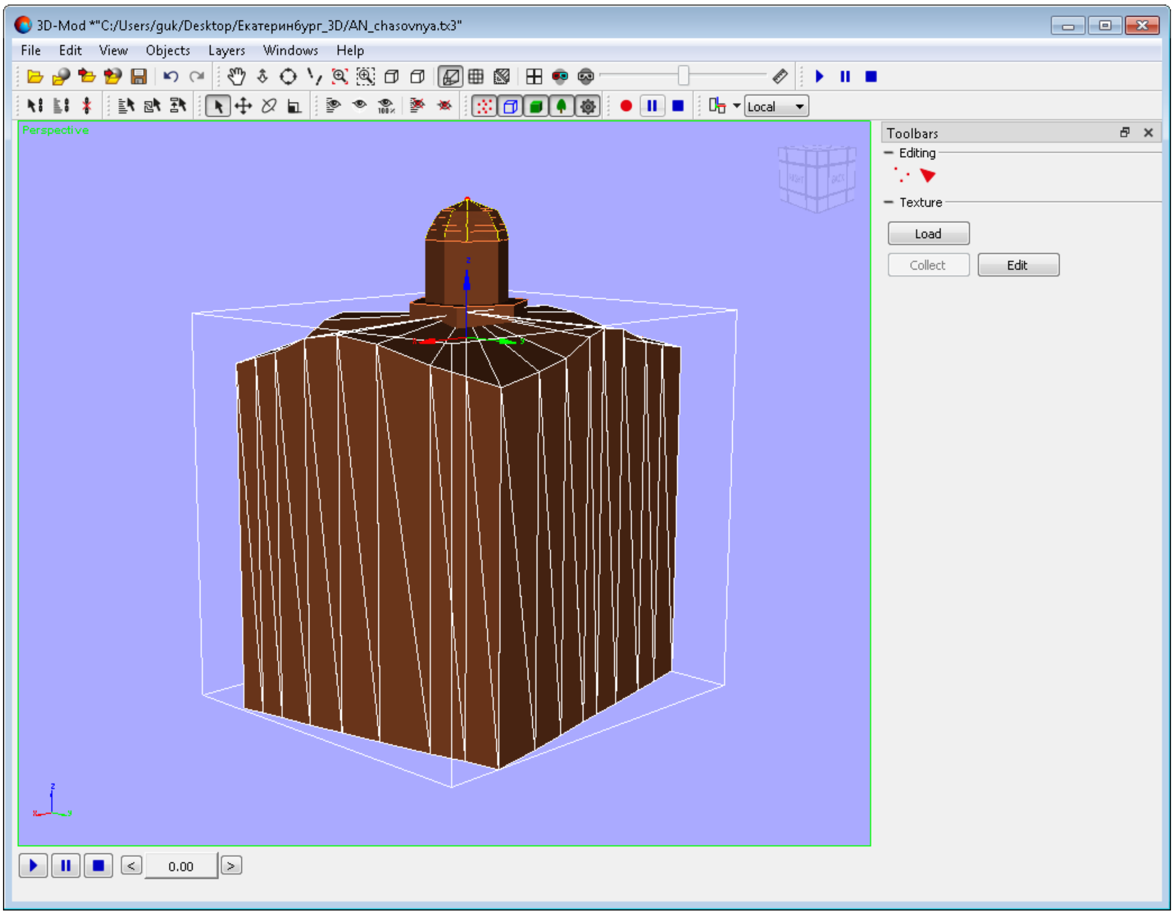


Fig. 150. Texturing mode

4. In the **Texture** section click the **Load** button. The **Load texture** window opens. Select texture file by mouse click and click the **Open** button. The system loads the texture to selected object.

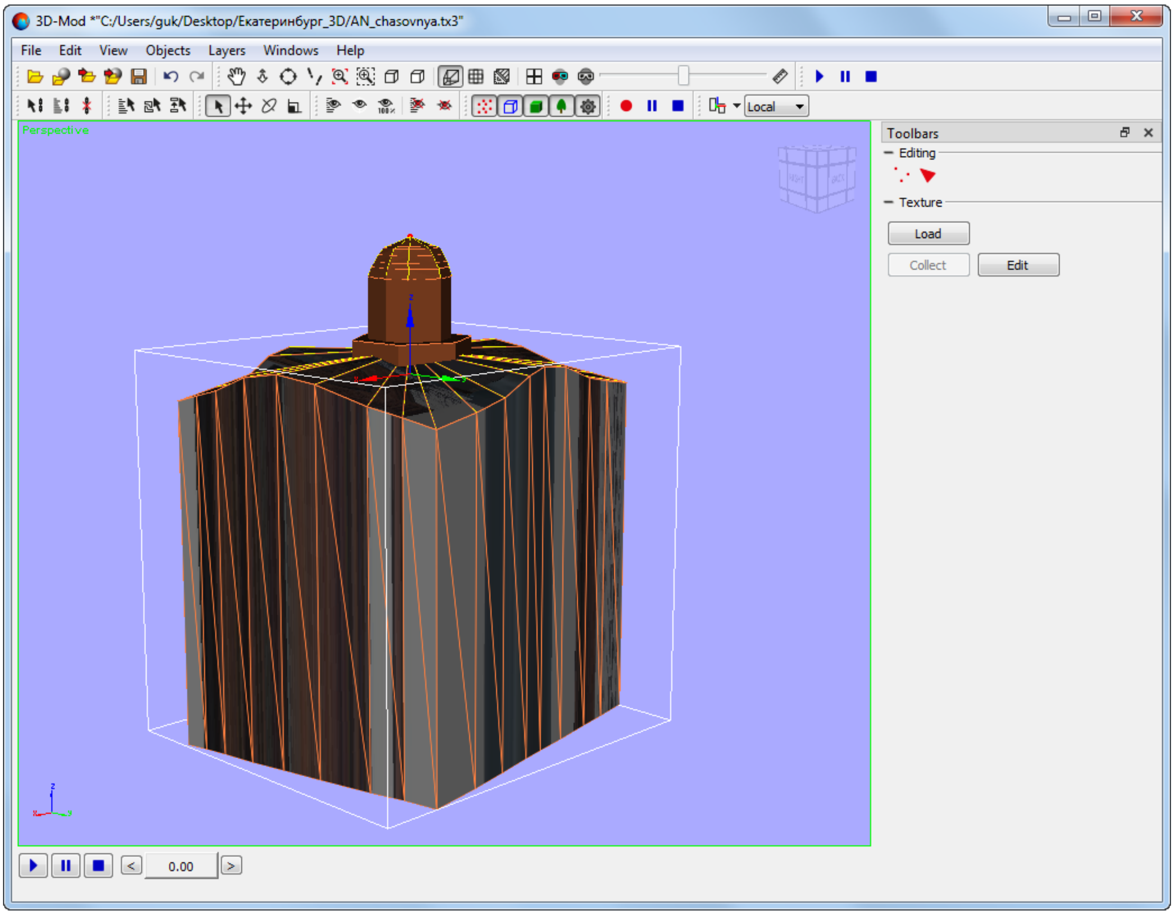


Fig. 151. Texture loading to object

5. [optional] If it is necessary to assign the same texture to multiple objects, perfrom the following actions:

   • Deselect the object and reselect it. In the **Editing** section click the button and in the **Parts** section click the **Add** button. The objects adding mode is on.

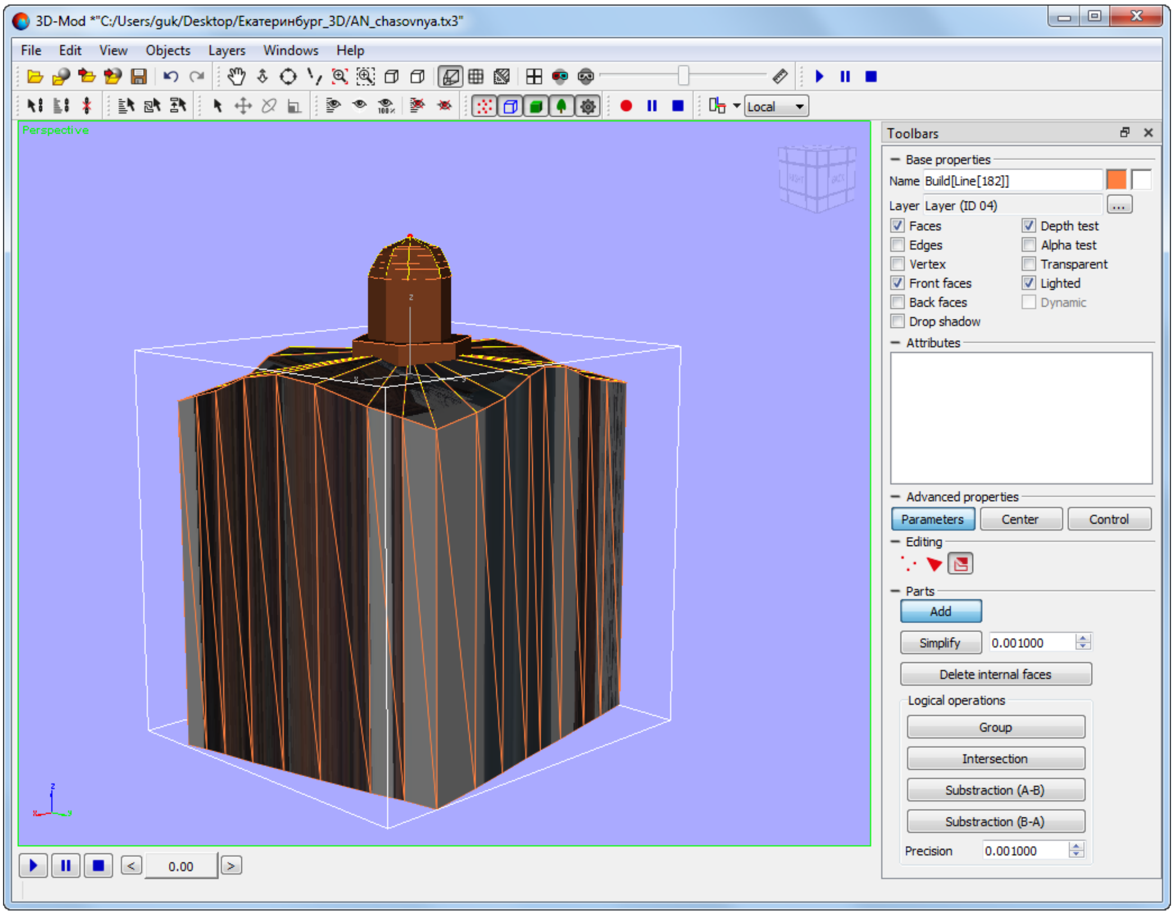


Fig. 152. Objects adding mode

- select other objects using mouse click and click the **Add** button to turn objects adding mode off.

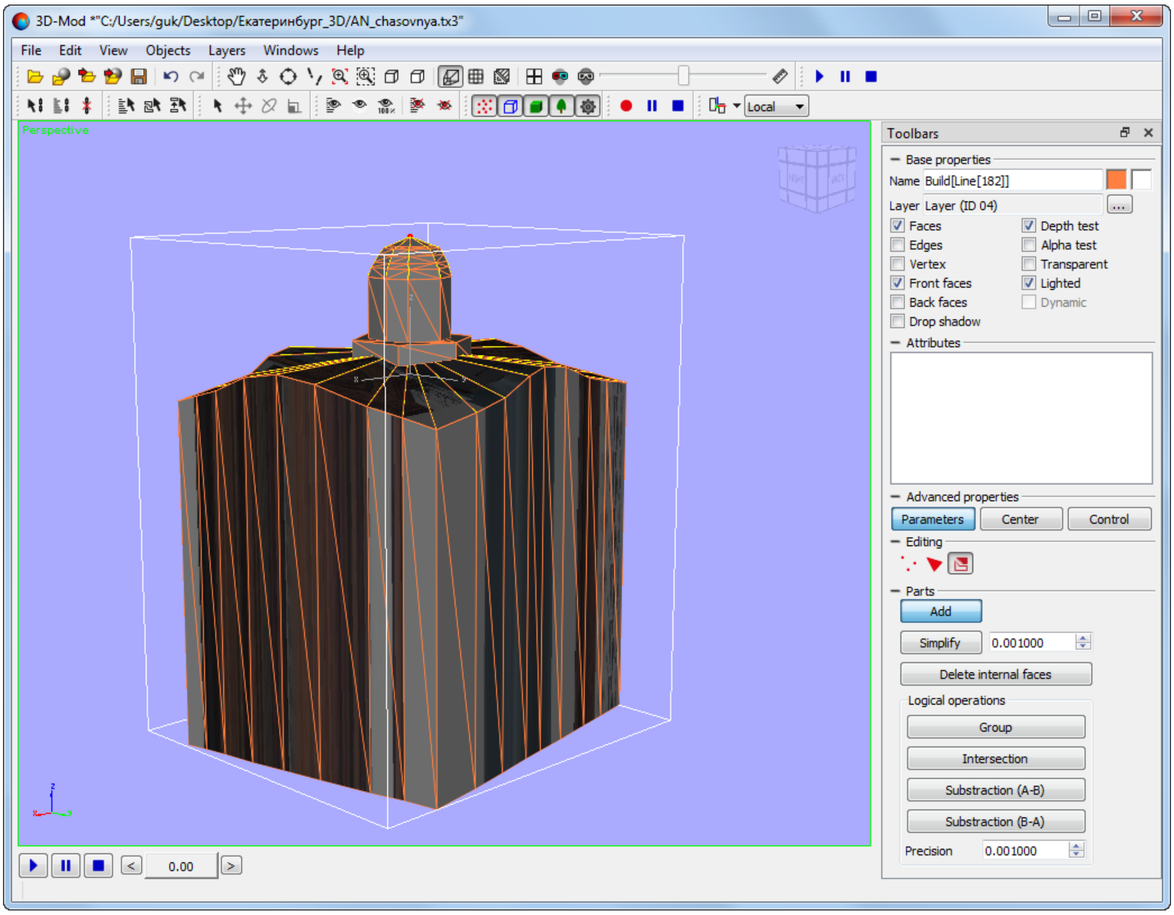


Fig. 153. Turn of the objects adding mode.

- Select **Edit › Edit texture coordinates**. The texturing mode is on.

6. Click the  button and rotate 3D-scene view area to show the front of the object.

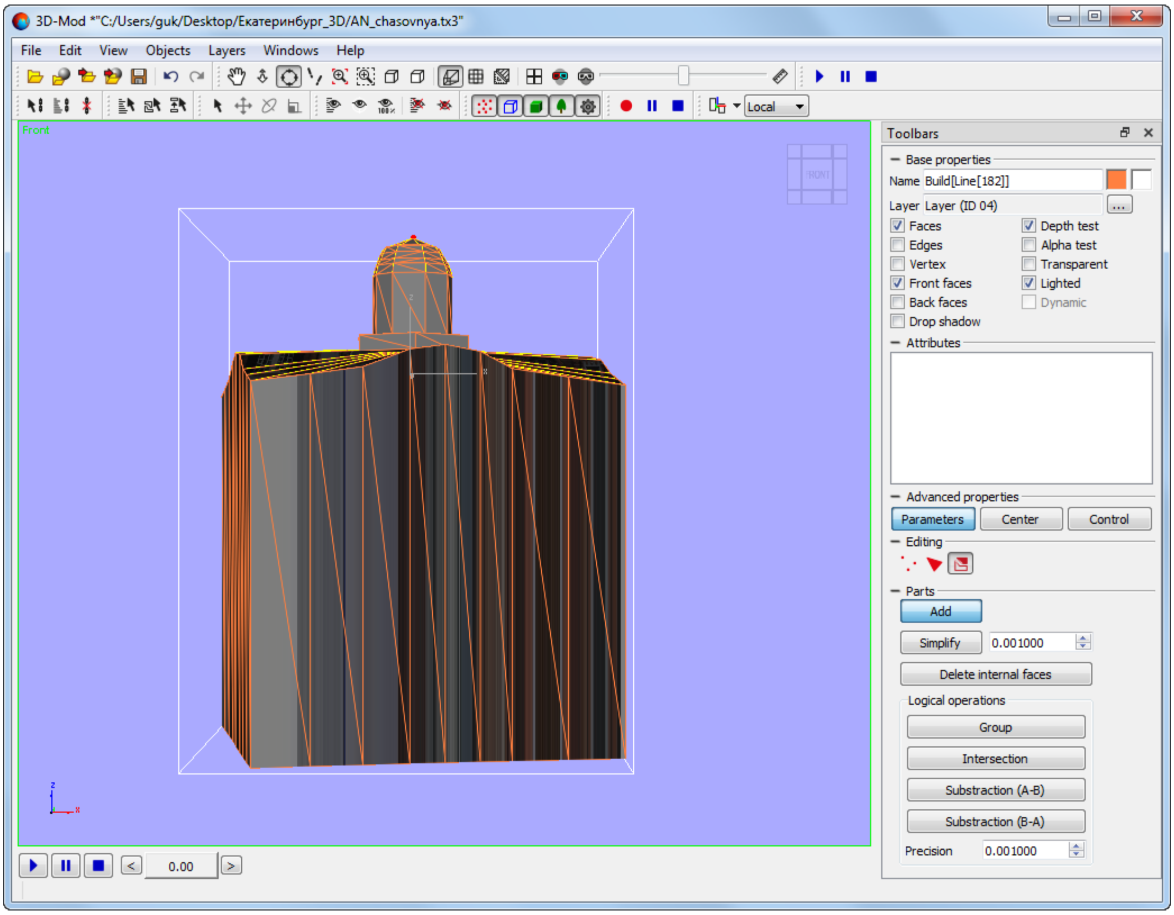


Fig. 154. Front side of the object

7. [optional] Select **Edit › Edit texture coordinates**, to return to the texturing mode;
8. In the **Editing** section click the button. The **Texture editing** window opens.

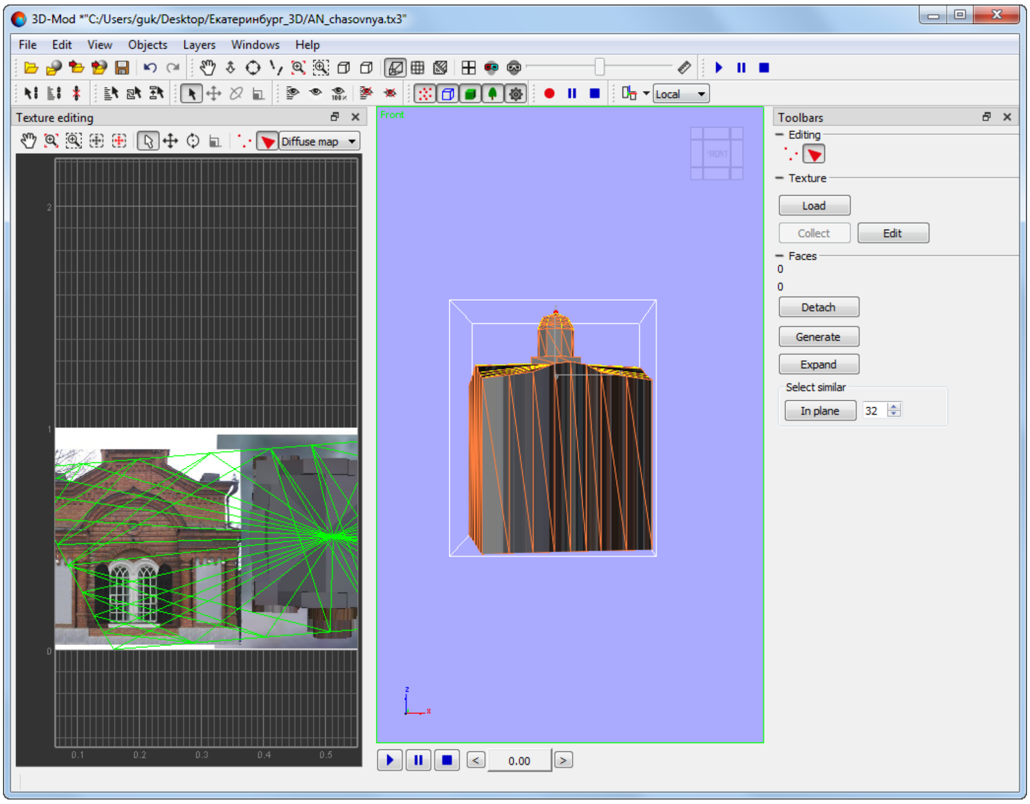


Fig. 155. Texture editing

9. In the main module window press and hold mouse button while selecting all object faces.

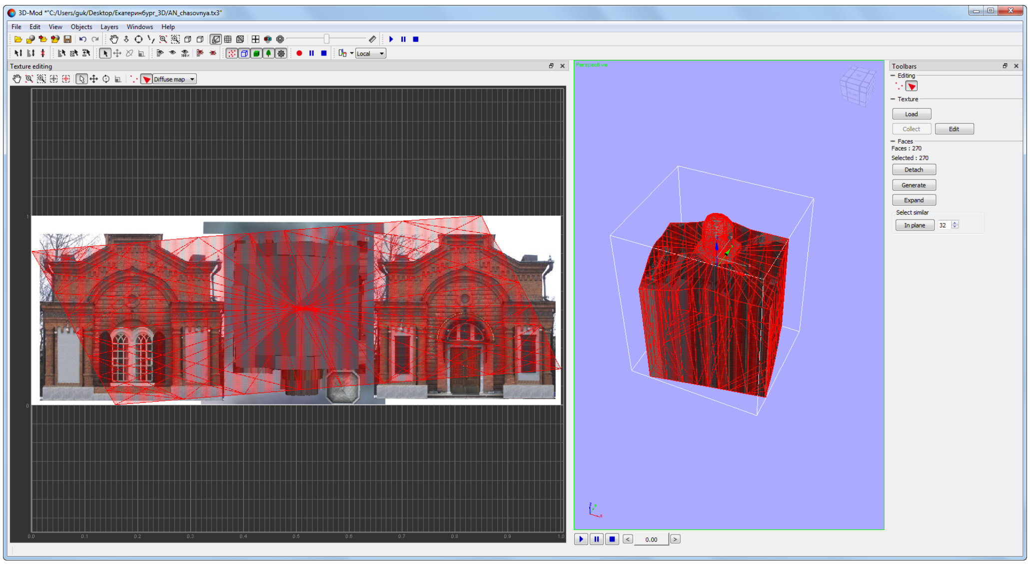


Fig. 156. Selecting all object faces

10. In the **Texture editing** window move viewing area to display the part of texture to be assigned to the front side of the object.

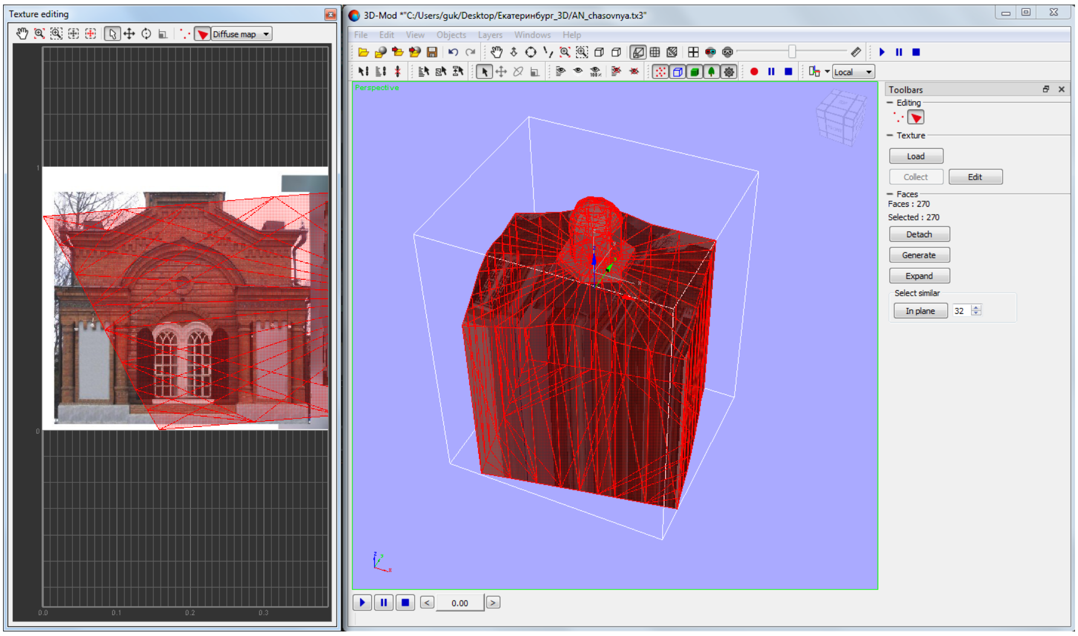


Fig. 157. Part of texture to be assigned to the front side of the object

11. In the main module window click the **Generate** button (or press the **Space** button on the keyboard). In the **Texture editing** window all object faces are displayed.

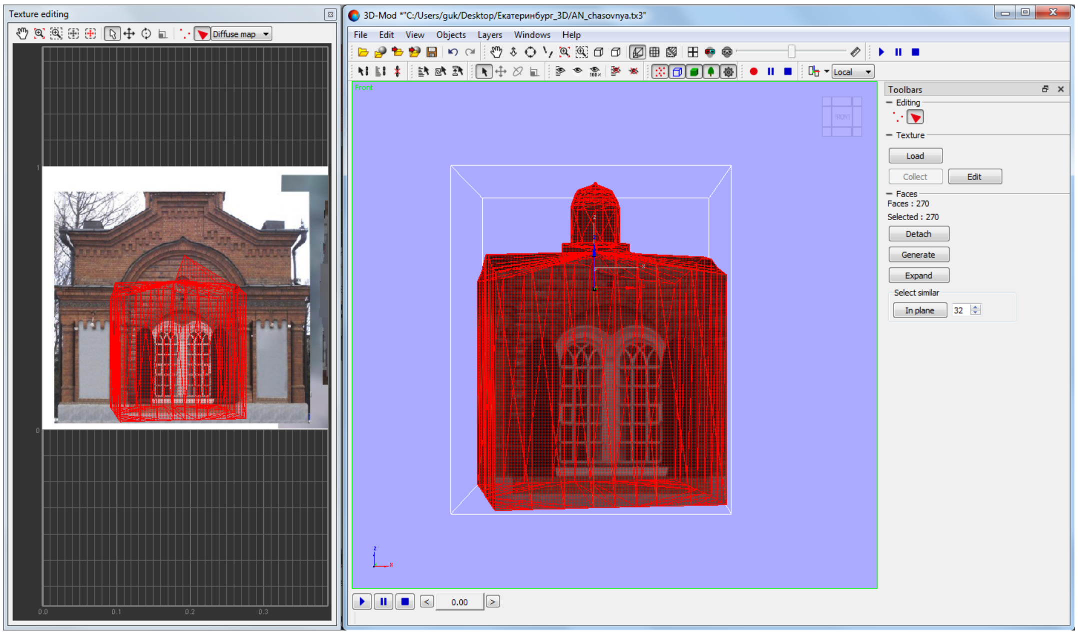


Fig. 158. All object faces in the Texture editing window

12. In the **Texture editing** window click the button and move faces.

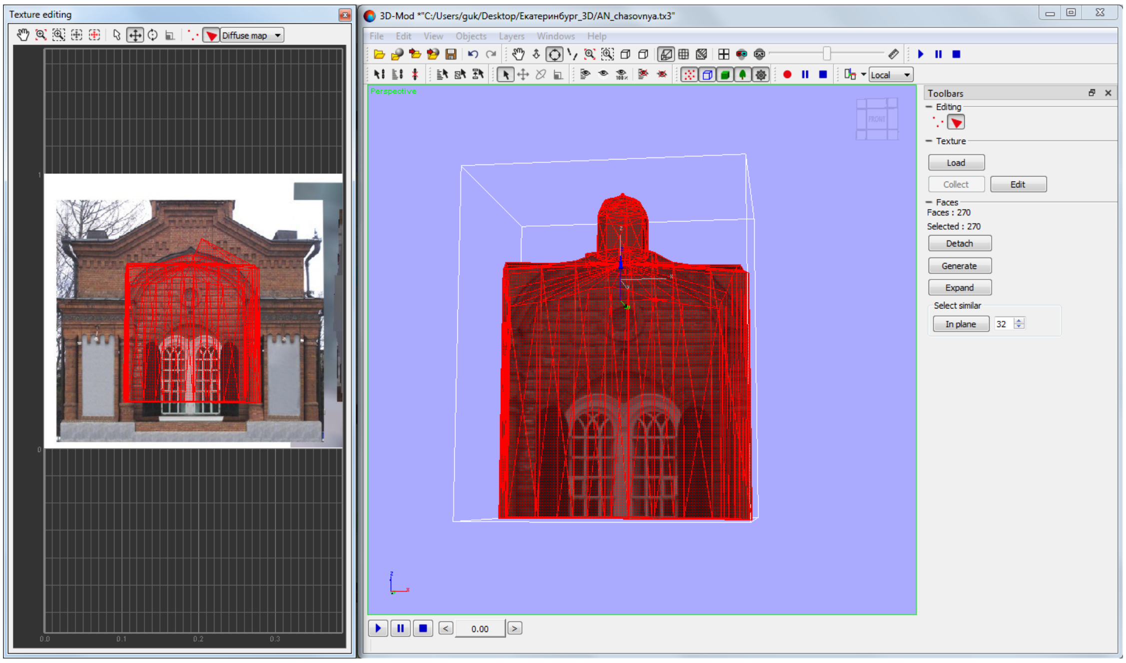


Fig. 159. Moving all object faces

13. Click the button. The points editing mode is on.

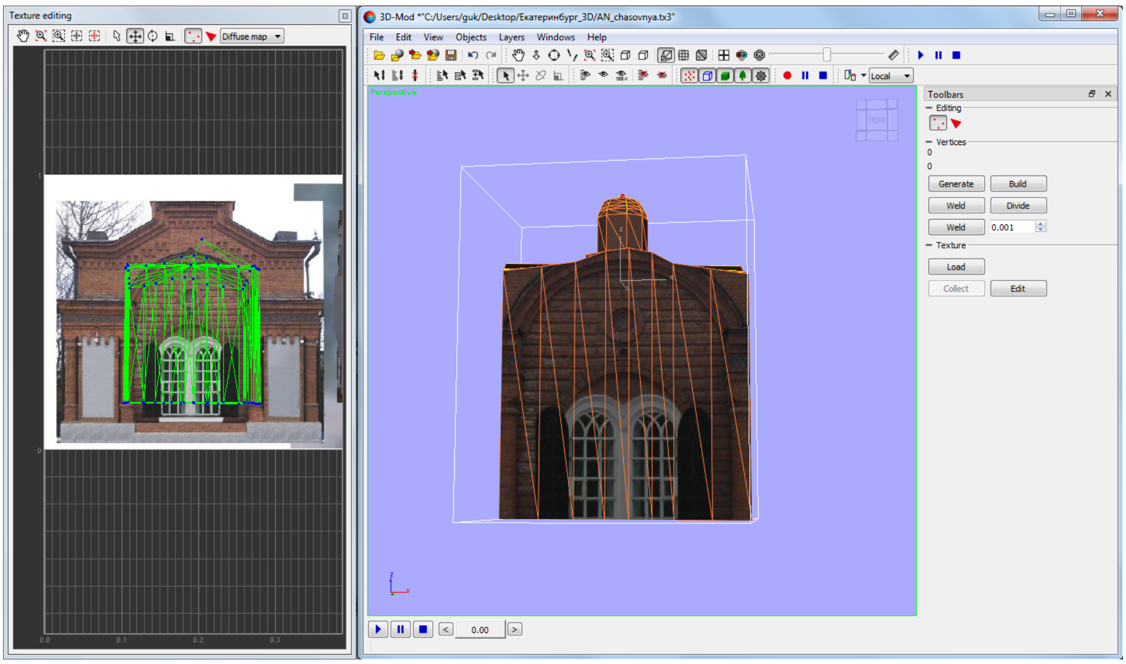


Fig. 160. Points editing mode

14. Select all the points and click the button. The texture coordinates scale mode is on.

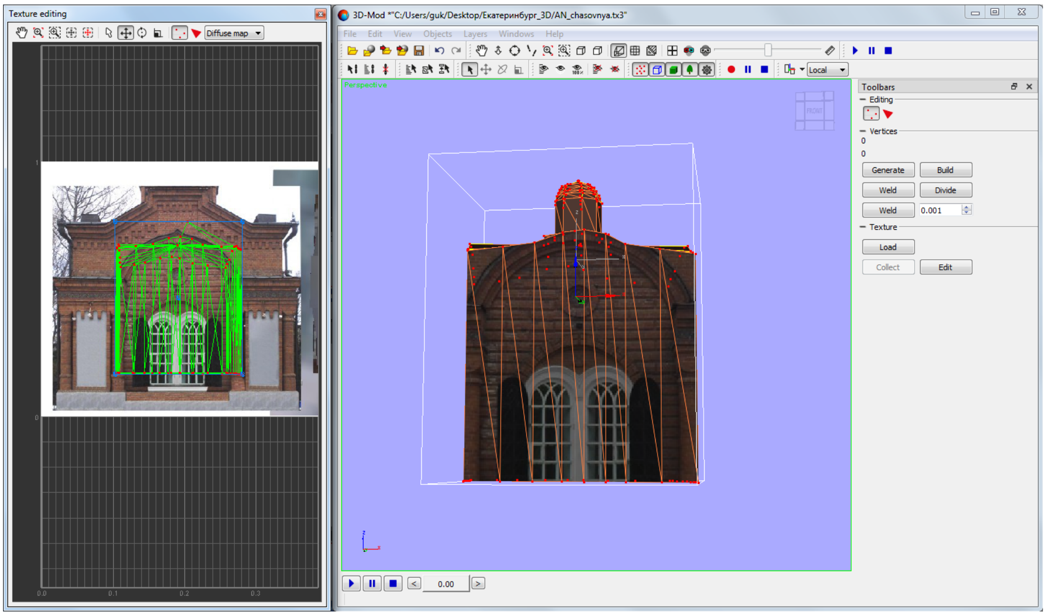


Fig. 161. Scale texture coordinates mode

15. Place mouse cursor on one of the object vertices, press and hold mouse button and change texture coordinates scalebutton. Changes made to the texture are displayed in the main module window.

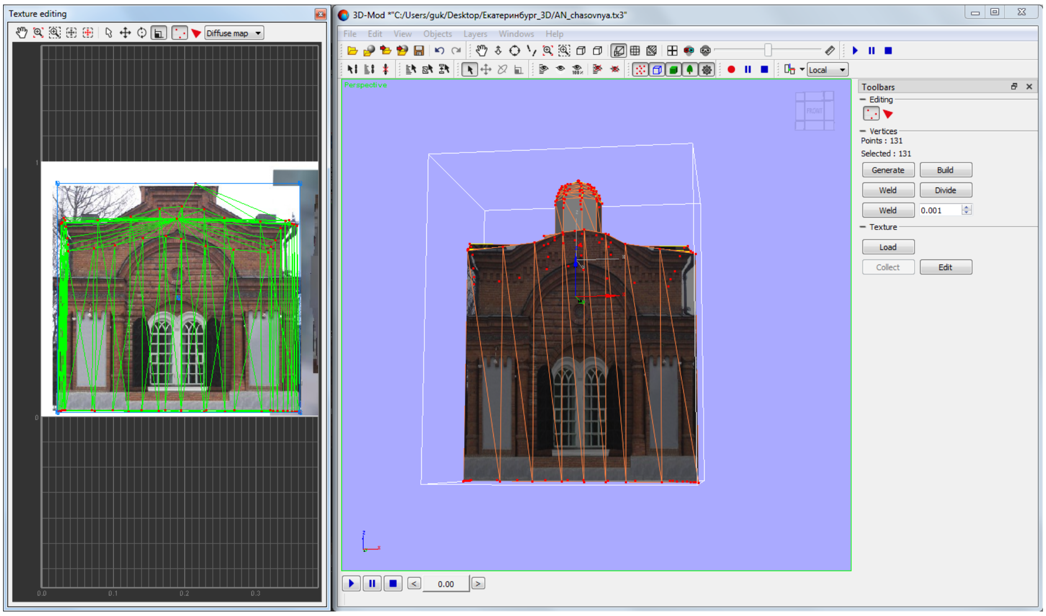


Fig. 162. Front side of the object with texture

16. [optional] In order to move ( ) selected point in relation to another one using snapping press and hold the **B** or **V** key. Vertical or horizontal dashed lines are displayed, that allows to orient a vertex in relation to another vertex.

17. In the main module window move 3d-scene view area on one of the object sides.

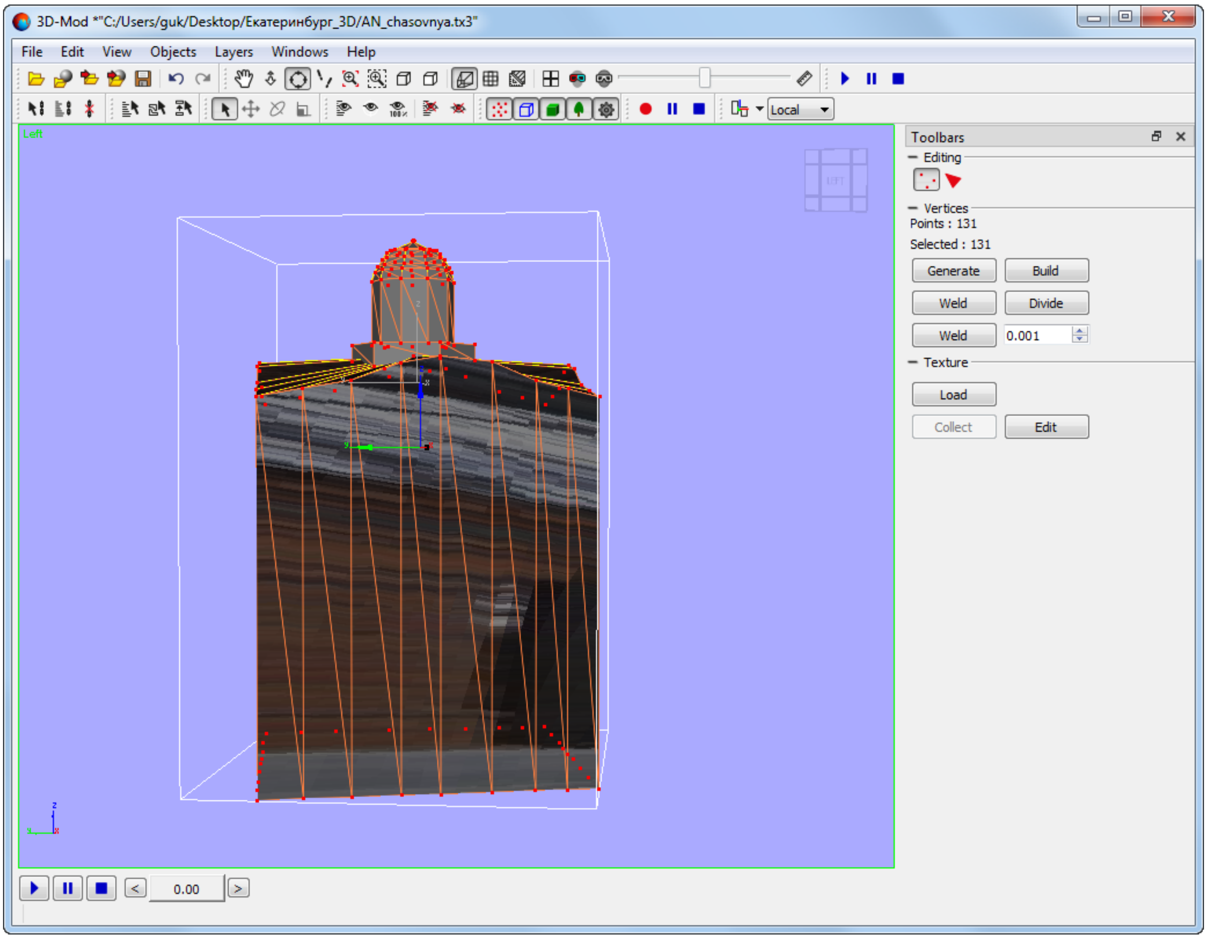


Fig. 163. Right side of the object

18. In the **Editing** section click the button. The **Texture editing** window opens.

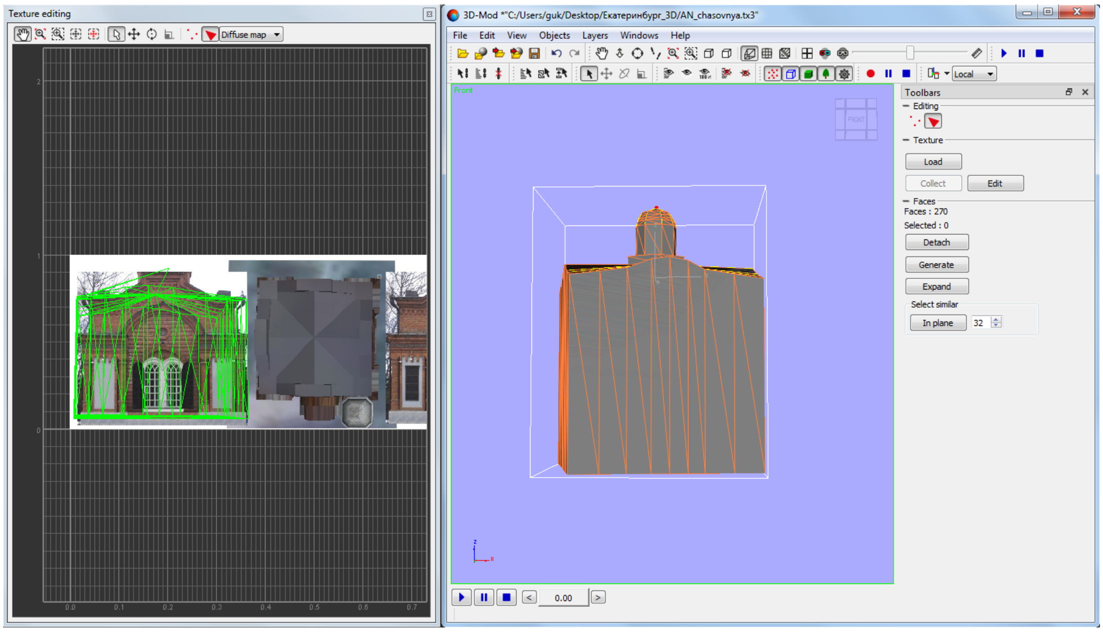


Fig. 164. Texture editing

19. In the main module window press and hold the **Shift** key while selecting faces of displayed part of the object using mouse clicks.

> In order to cancel face selection press and hold the **Ctrl** key and cancel the face selection by mouse click.

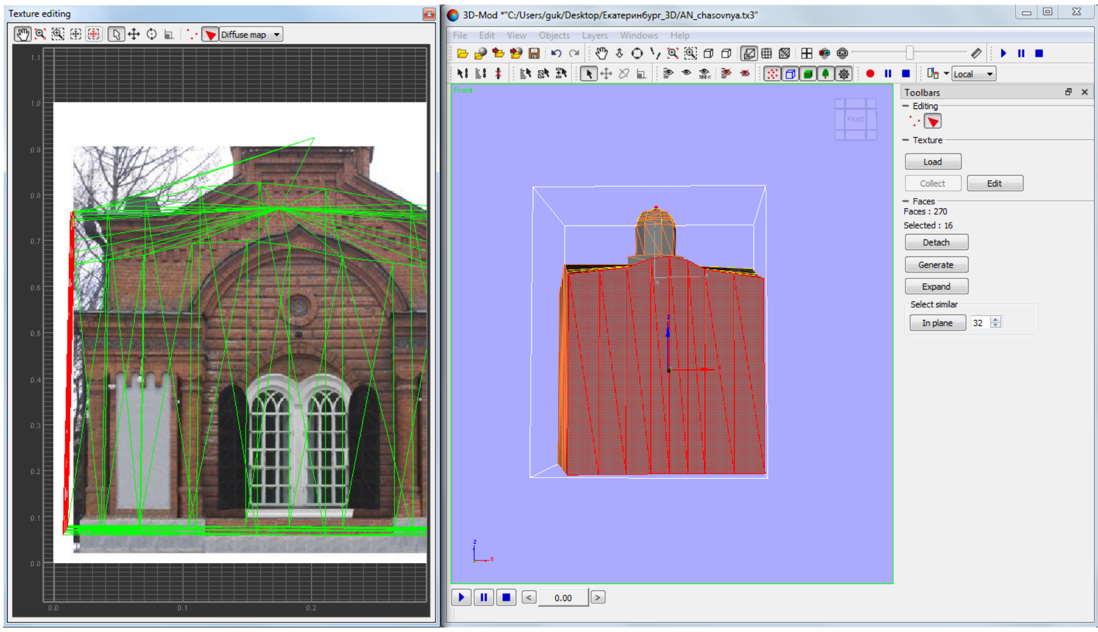


Fig. 165. Selection of faces of object right side

20. In the main module window click the **Detach** (**R**) button. In the **Texture editing** window selected faces are displayed.

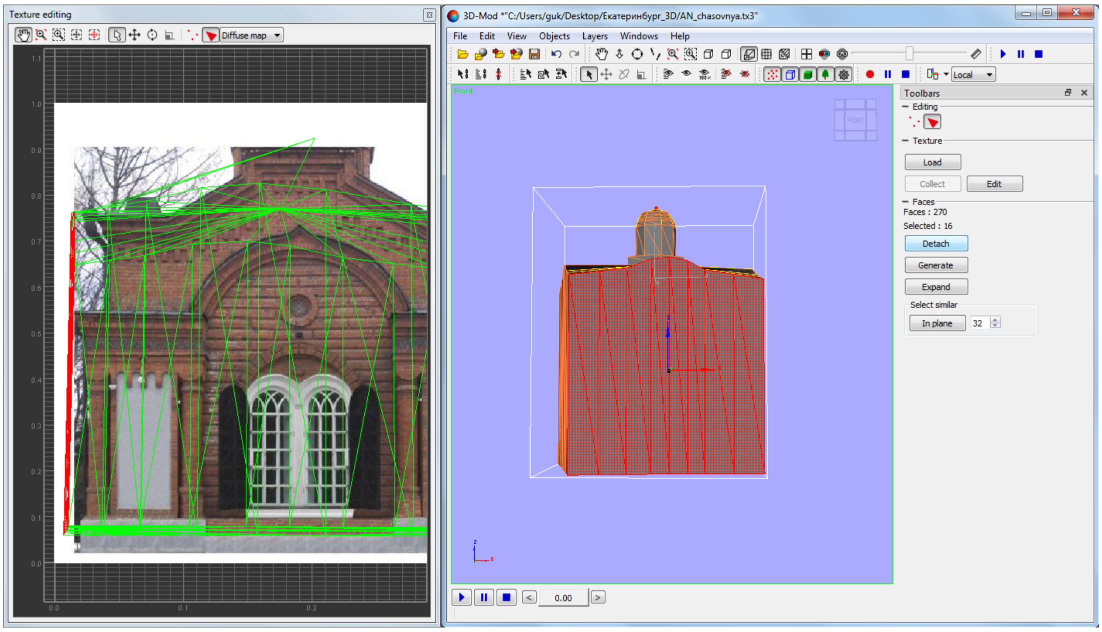


Fig. 166. Displaying selected faces in the Texture editing window

21. In the main module window click the **Generate** button. Faces are displayed in the **Texture editing** window.

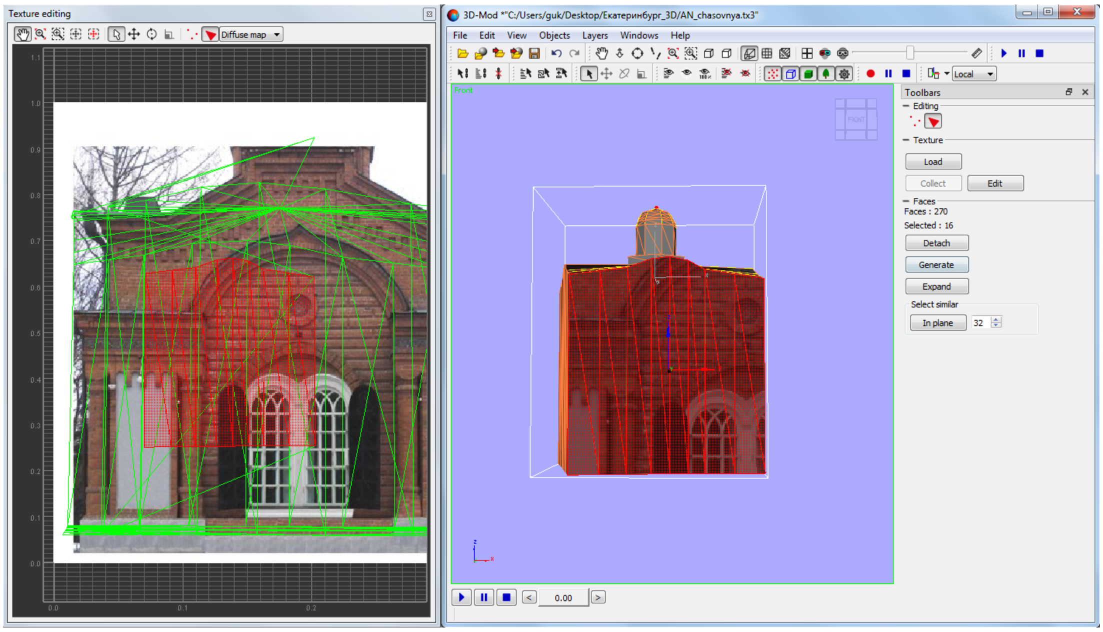


Fig. 167. All object faces in the Texture editing window

22. In the **Texture editing** window click the button. Move and edit object faces in the same way.

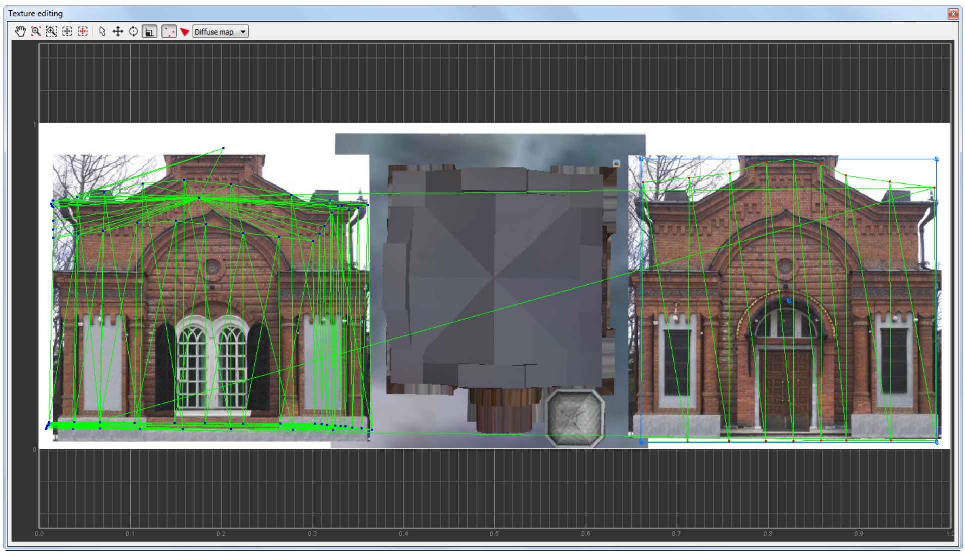


Fig. 168. Faces editing

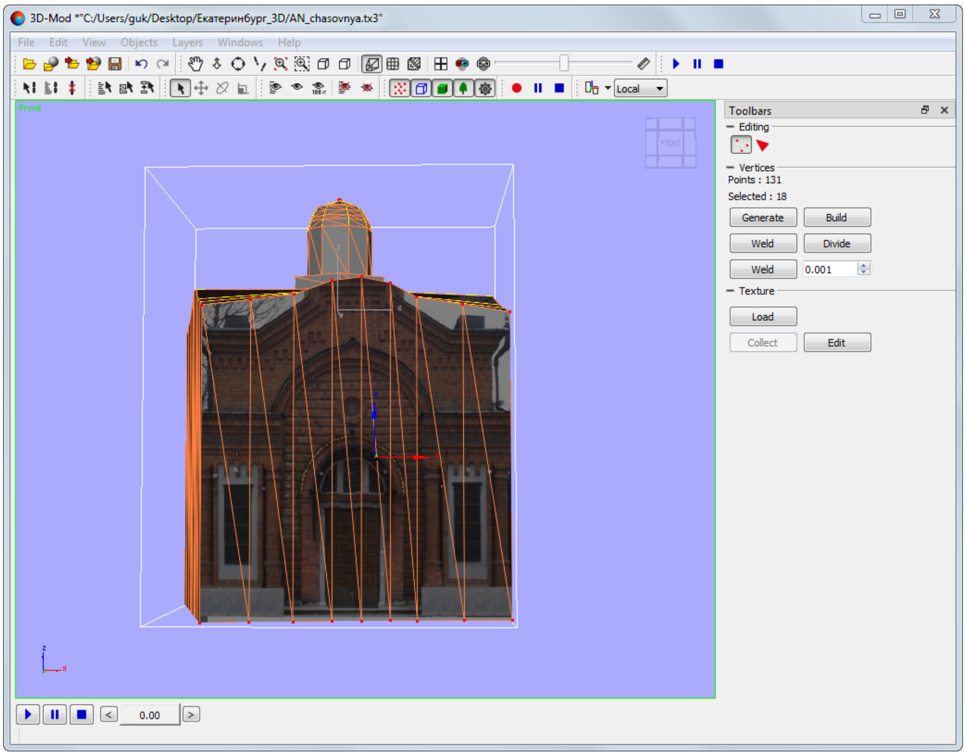


Fig. 169. Right side of the object with texture

The module allows to save object with texture. To do it, select **File › Save** or **File › Save as**.

8.2. Texture editing

The **Texture editing** window is used to edit texture coordinates.

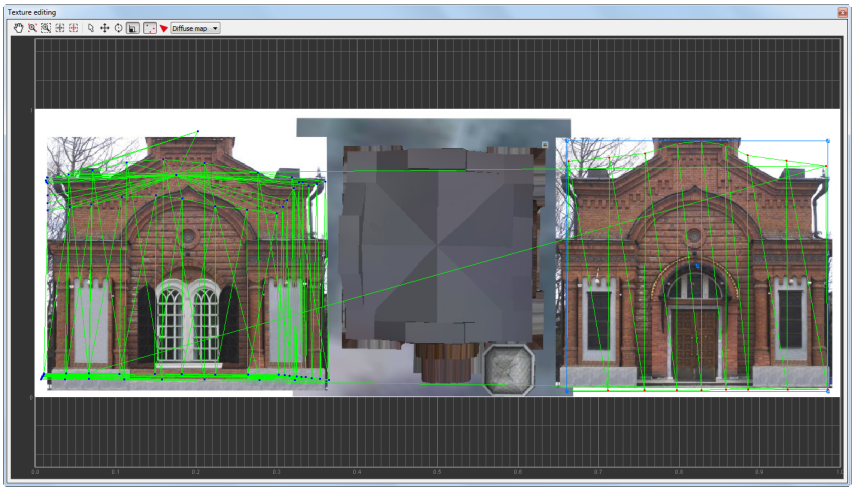


Fig. 170. Texture editing

The toolbox of the window contains the following buttons:

- – allows to move view area of texture in any direction
- – allows to zoom in/zoom out view area
- – allows to zoom in of texture view area selected by rectangle
- – allows to display the whole texture area in view area;
- – allows to highlight texture coordinates in view area;
- – allows to move highlighted texture coordinates in view area;
- – allows to rotate highlighted texture coordinates in view area;
- (in points editing mode only) – allows to turn texture coordinates scale mode on;
- – allows to turn points editing mode on;
- – allows to turn faces editing mode on;

The system allows for editing objects' textures interactively. To open the graphic editor intended for this purpose, select an object with a pre-linked texture, choose **Edit › Edit texture coordinates** (to turn the texturing on), then go to **Texture** section of the main window sidebar and click **Edit**.

The **3D-objects texture editor** window opens. Changes made to the texture in this window are immediately displayed in the main 3D scene viewer.

Before editing, the selected object must already have an assigned texture, which is a single image of one of the following formats: `*.tif`, `*.bmp`, `*.rsw`, `*.img`, `*.ntf`, `*.jpg`, `*.gif`, `*.png`, `*.pix`, `*.jpeg`, `*.jp2`, `*.prf` or `*.tga`.

The **3D-objects texture editor** is not available for `*.json` (`*.b3dm`) objects, i.e. models divided into tiles and having several levels of detail.

8.3. Snapping

Snapping is marker movement, when it “sticks” to different elements of the objects on the screen. It is used to move selected vertex in relation to other vertices vertically / horizontally.

For work in snapping mode the system provides **B** or **V** hotkeys.

V (*3D snapping to vertices*) – marker XYZ-coordinates coincide with coordinates of vertices. When pressing the hotkey, marker moves to the vertex of texture coordinates nearest to the mouse cursor position.

B (*2D snapping to vertices*) – marker XY-coordinates coincide with coordinates of vertices, but value of marker Z-coordinate does not change. When pressing the hotkey, marker moves to the vertex of texture coordinates nearest to the mouse cursor position, but value of marker Z-coordinate remains the same.

Hotkeys are used to temporally turn on (when the key is pressed down) or off (when the key is released) the snapping mode. When the hotkey is pressed, marker moves to a corresponding vertex of texture coordinates.

8.4. Assigning texture to 3D-objects upper faces

The module allows to assign raster map with texture (orthomosaic sheet, for instance) to upper faces of 3D-objects.

The size of the raster map with texture must not exceed 4000x4000 pixels.

To load raster map with texture for upper faces of 3D-objects, perform the following actions:

1. Open layer with vector objects in the system and select **Vectors › Open vectors in 3D-Mod**. The *3D-Mod* module and the **The Parameters of import and building** window open.

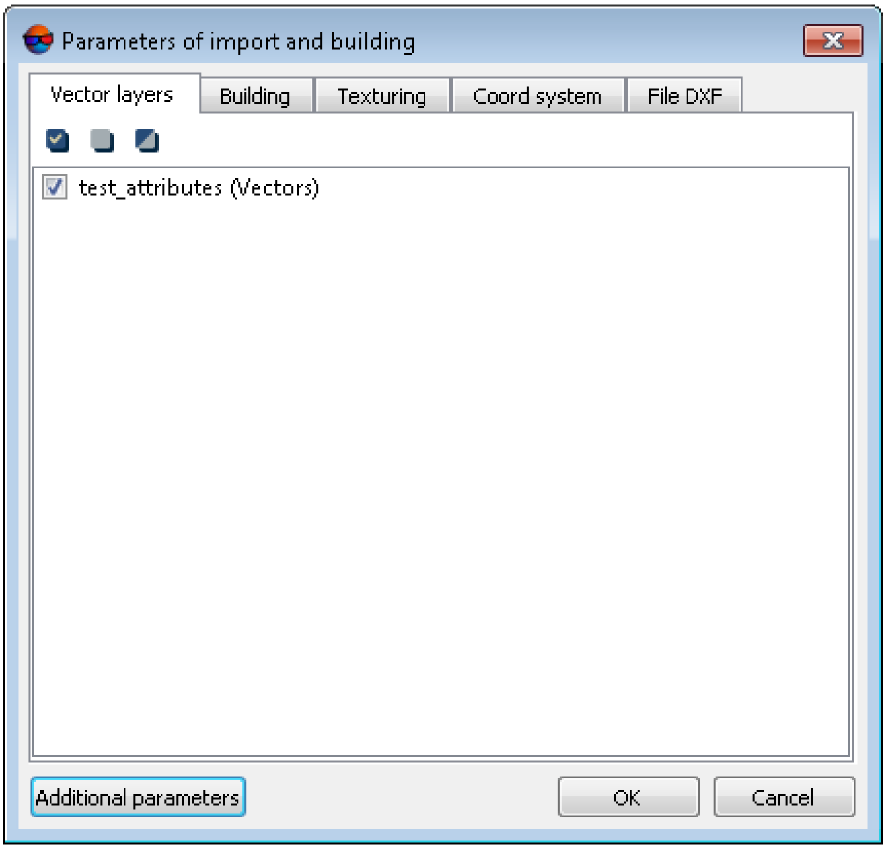


Fig. 171. The Parameters of import and building window

2. Open the **Building** tab and set the following checkboxes (see Section 4.2.1):
   - **Make 3D building**;
   - **Join vertices tolerance**;
   - **Use objects without assignment**;
   - **Overlapped vertices**;
   - **Build objects from closed lines**;
   - **Include points to 3D modeling**;
   - **Process by layers**;
   - **Roof**, **Walls** and **Footing**.

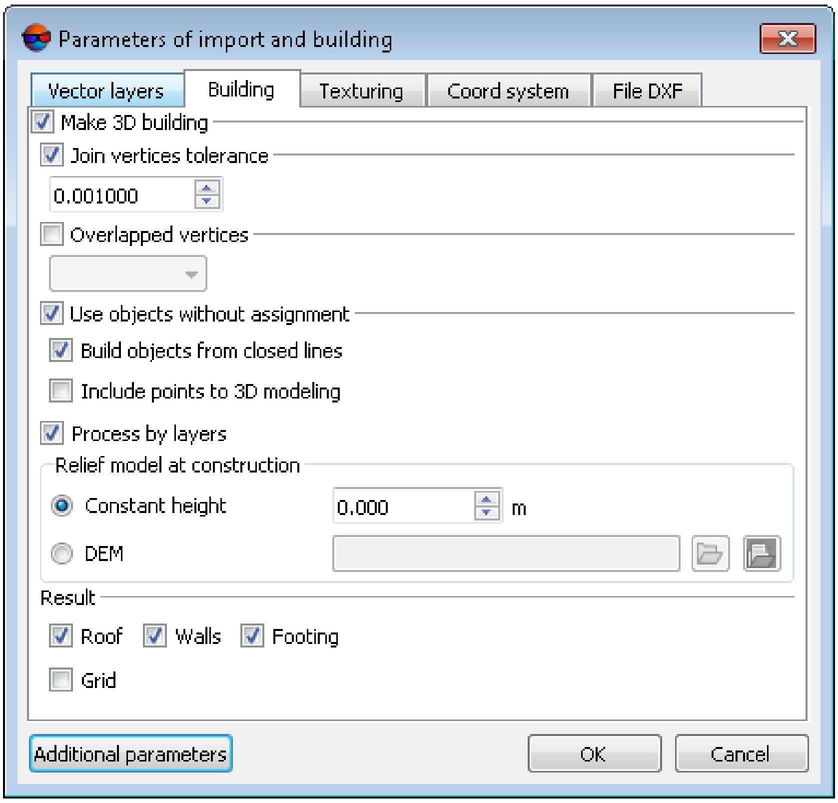


Fig. 172. The Building tab

3. Click OK. Selected layer is loaded to the module.

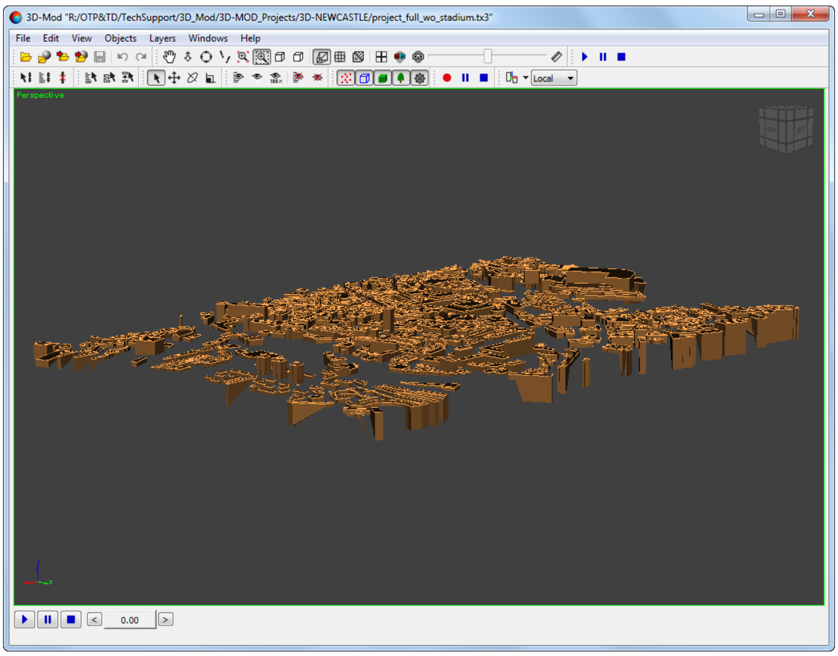


Fig. 173. 3D-objects layer

4. Select objects and choose **Edit › Convert to › grid**.

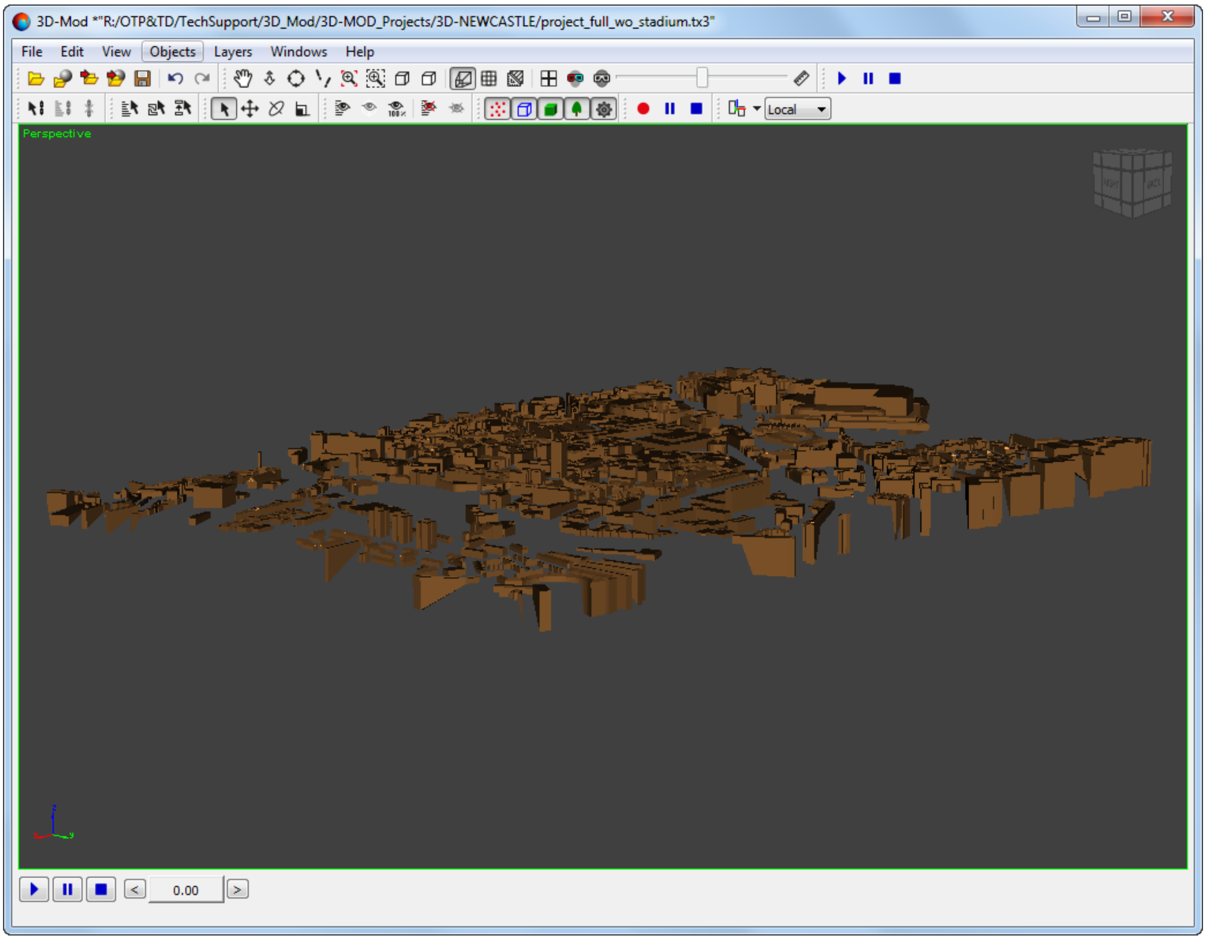


Fig. 174. 3D-objects layer

5. Select objects and choose **Edit › Map georeferenced image**. The **Load texture** window opens. Select a file with raster map and texture by mouse click and click the **Open** button. The **Mapping parameters** window opens:

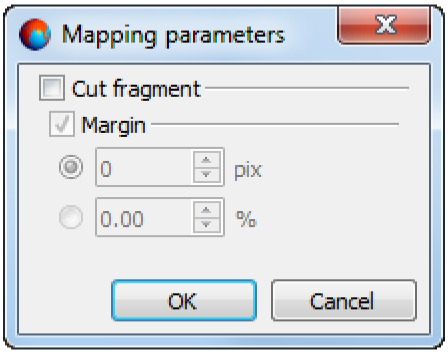


Fig. 175. The Mapping parameters window

[optional] to **cut fragment** from the raster map, set the appropriate checkbox. To setup the **margin**, turn the appropriate checkbox on and specify the needed value in pixels on in percents.

Click OK. The system assigns texture to 3D-objects upper faces.

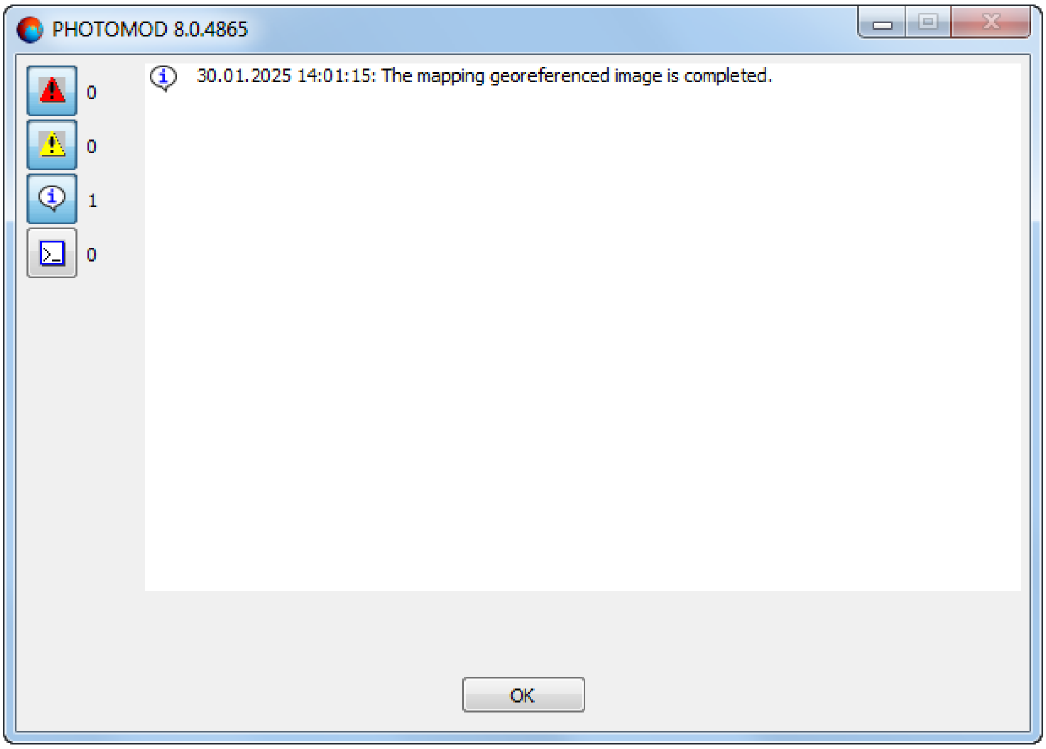


Fig. 176. The dialog box

The size of the raster map with texture must not exceed 4000x4000 pixels. The raster map must be georeferenced.

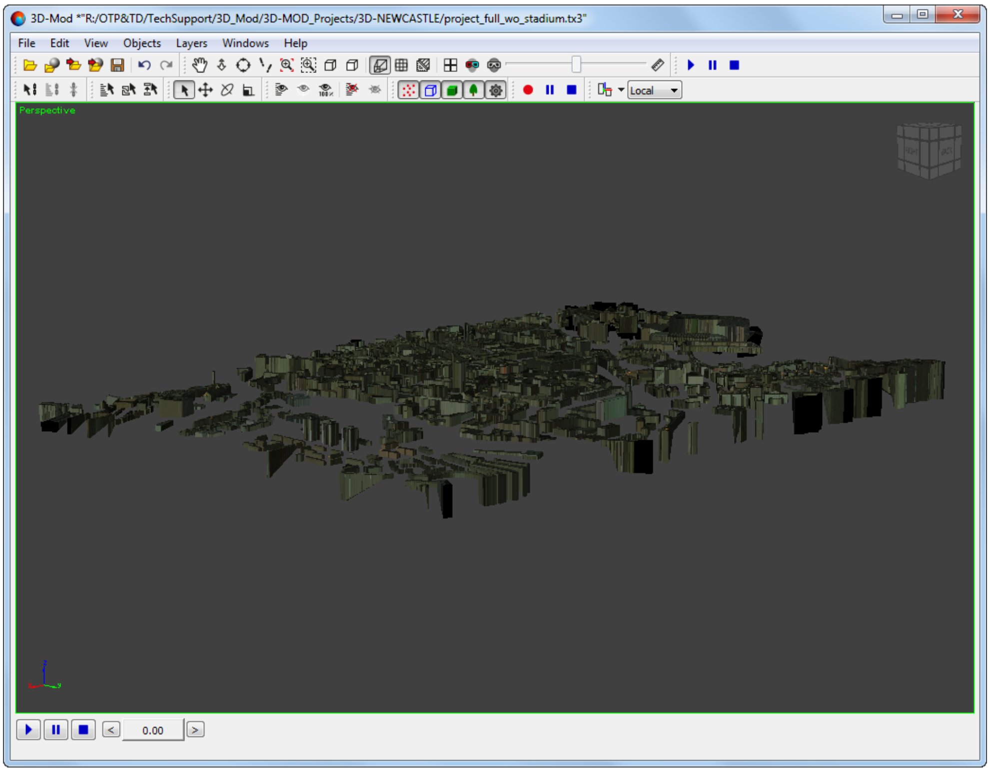


Fig. 177. Assigning texture to 3D-objects upper faces

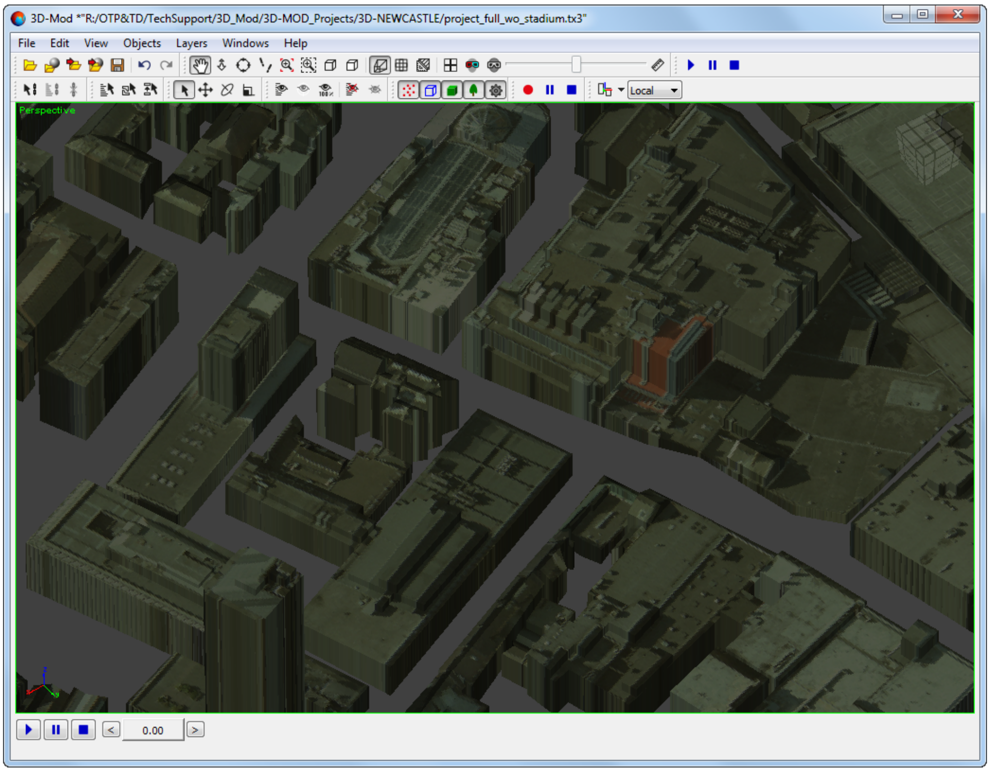


Fig. 178. Assigning texture to 3D-objects upper faces

9. Management of 3D-scene view

9.1. “View” menu

Table 14. Brief description of the View menu

Menu items	Function
Toolbar	to hide/show the following toolbars: 3D-scene view, object control, object view
Moving	to move view area of 3D-scene in any direction
Approach/Distance	to move view area of 3D-scene perpendicular to the screen plane
Rotation	to rotate 3D-scene view area
Zoom	to zoom in/zoom out 3D-scene view area
Zoom region	to zoom in of 3D-scene view area selected by rectangle
Edges	to turn on/of frame displaying
Textures	to turn on/of textures displaying
Anaglyph stereo mode	to turn on anaglyph stereo mode
Page-flipping stereo mode	to turn on page-flipping stereo mode
Perspective	to turn the perspective mode on, i.e. to display 3D space in 2D plane
Grid	to show coordinate grid
Scale rule	to show scale bar
Direction	contains menu items used to display 3D-scene view area in one of projections
Four projections	to display 3D-scene in four projections (front, left, top and perspective)
Camera	to show 3D-scene from camera

9.2. Management of 3D-scene view

Scene – three-dimensional virtual environment, used for #d-objects modelling and visualization.

3D-scene may contain objects of the following types: 2D/3D-objects, orthomosaic, point objects, helpers objects (for example, dummy object or light sources) and surveying cameras, used for scene observation.

One of the components of the scene is the background on which the objects are displayed. To set the background color (which is grey by default), select **Settings**. Select the **Rendering** tab and choose desired background color by mouse click.

To manage 3D-scene view, perform the following actions:

- **Moving** () – moving of 3D-scene view area in desired direction.

  To move view area of 3D-scene, press and hold mouse button while moving the area in desired direction.

  If 3D-scene moving mode is off, press and hold the **Alt** key along with middle mouse button while moving the area in desired direction.

- **Approach/Distance** () – moving view area of 3D-scene perpendicular to the screen plane.

  To move view area perpendicular to the plane of the screen, rotate mouse wheel away form you – to zoom in 3D-scene, in opposite direction – to zoom out 3D-scene.

- **Rotation** () – rotation of 3D-scene view area in free plane.

  To rotate view area of 3D-scene in free plane, press and hold mouse button while moving the area in desired direction.

  If 3D-scene rotate mode is off, press and hold the **Shift** key along with middle mouse button while moving the area in desired direction.

- Scene observation from camera () – moving view area of 3D-scene, with imitation of the scene observation from camera. To setup moving parameters use the **Moving** tab of the **Settings** window (see Section 11). To move the “camera” use **W**, **A**, **S**, **D** keys.

  To move the “camera” use **W**, **A**, **S**, **D** keys. Drag the mouse to rotate the camera. To turn off the camera observation mode, press **Esc**.

- **Zoom in /Zoom out** () – zoom in/zoom out of 3D-scene view area.

  To zoom in the whole 3D-scene view area rotate mouse wheel forward. To zoom it out – rotate mouse wheel backward.

  If the zoom mode is off, press and hold the **Ctrl** key along with middle mouse button and move the mouse forward to zoom the view area in, or move the mouse backward – to zoom out.

- **Zoom region** () – zoom in of certain rectangular 3D-scene area. This display option is used to speed up scene view.

  To zoom in some view area, press and hold left mouse button, while dragging a rectangle by the mouse.

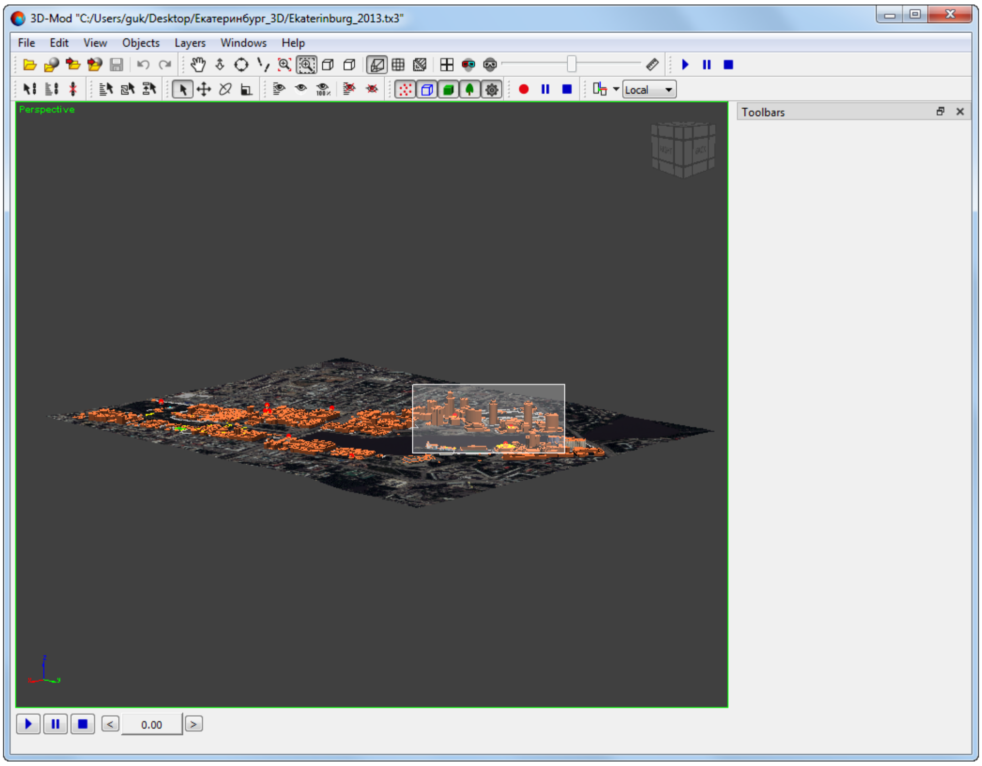


Fig. 179. Selecting area to zoom it in

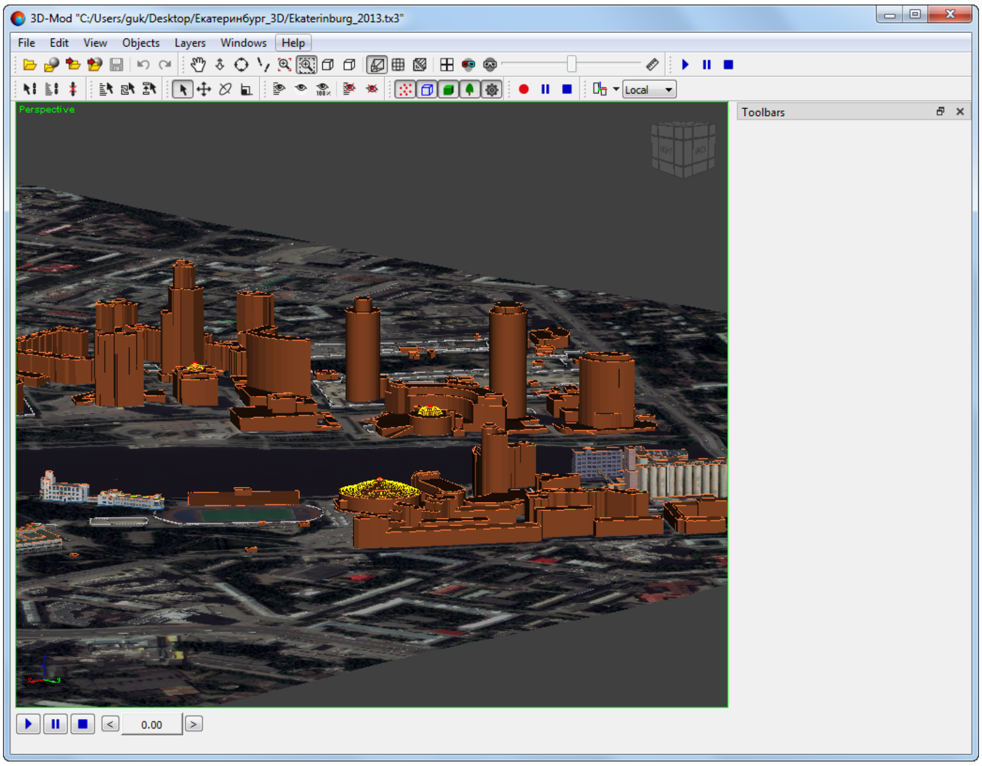


Fig. 180. Selected area zoomed in

- **Perspective** – displaying 3D space on 2D plane. This view option is set by default.

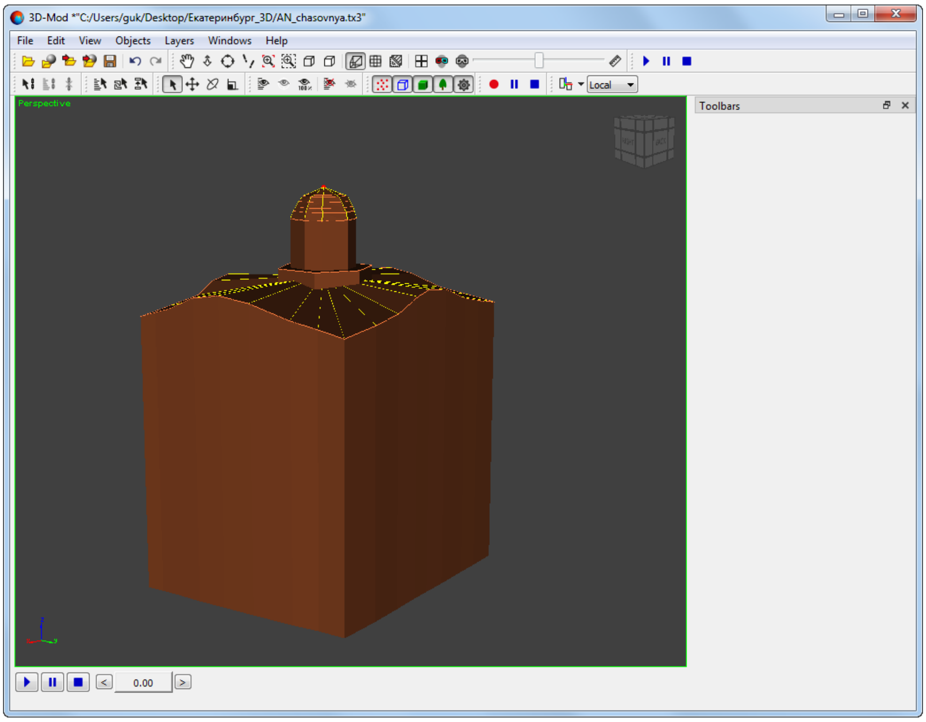


Fig. 181. Displaying 3D-scene in perspective mode

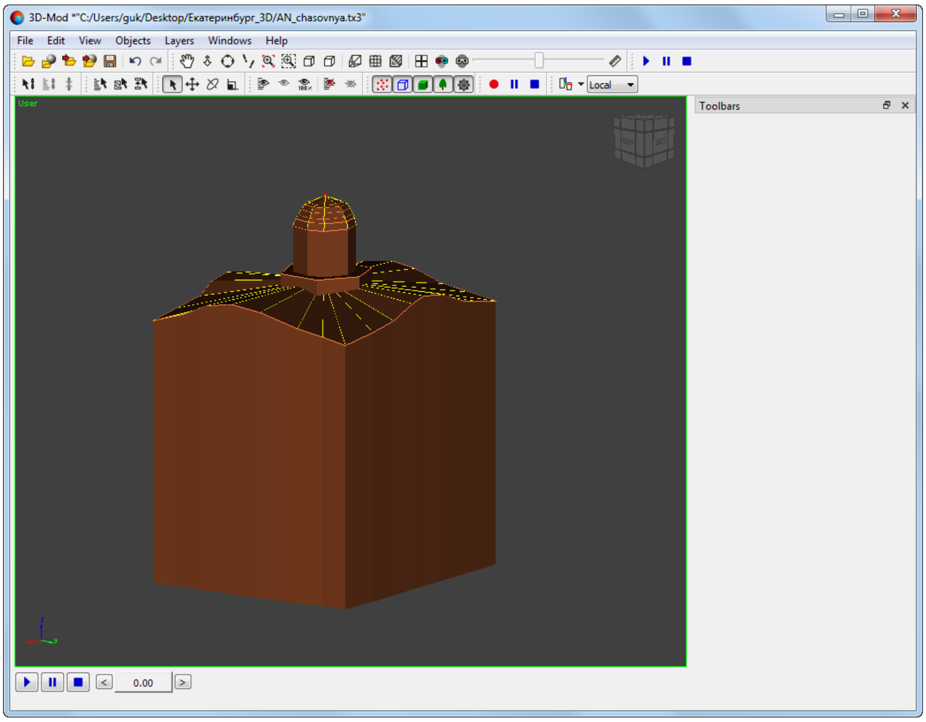


Fig. 182. Displaying 3D-scene without perspective

- **Camera** – displaying 3D-scene in central projection. Shows 3D-scene from camera

It is recommended to place scene's objects in area of camera viewing pyramid.

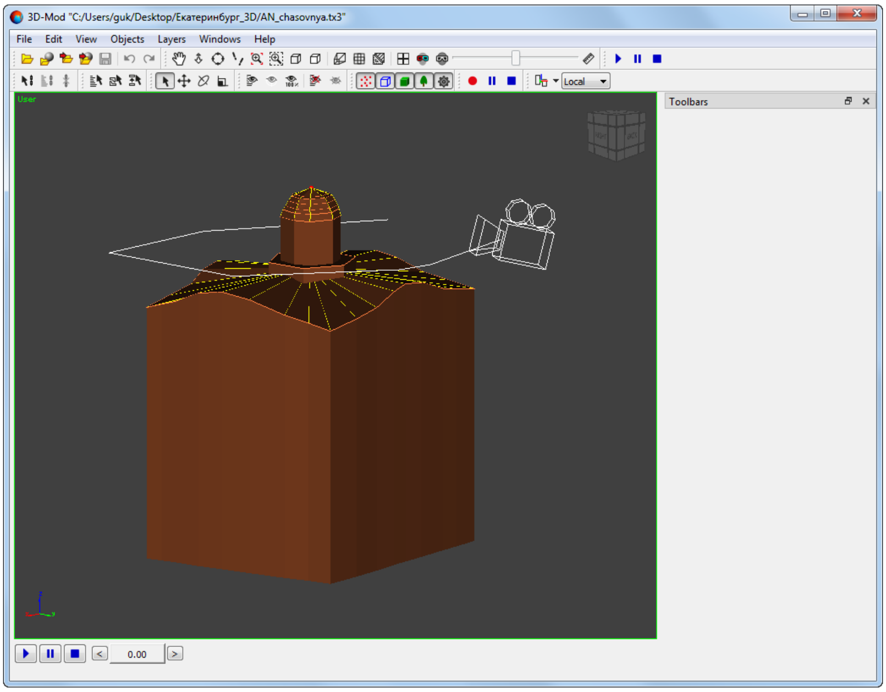


Fig. 183. Object and camera

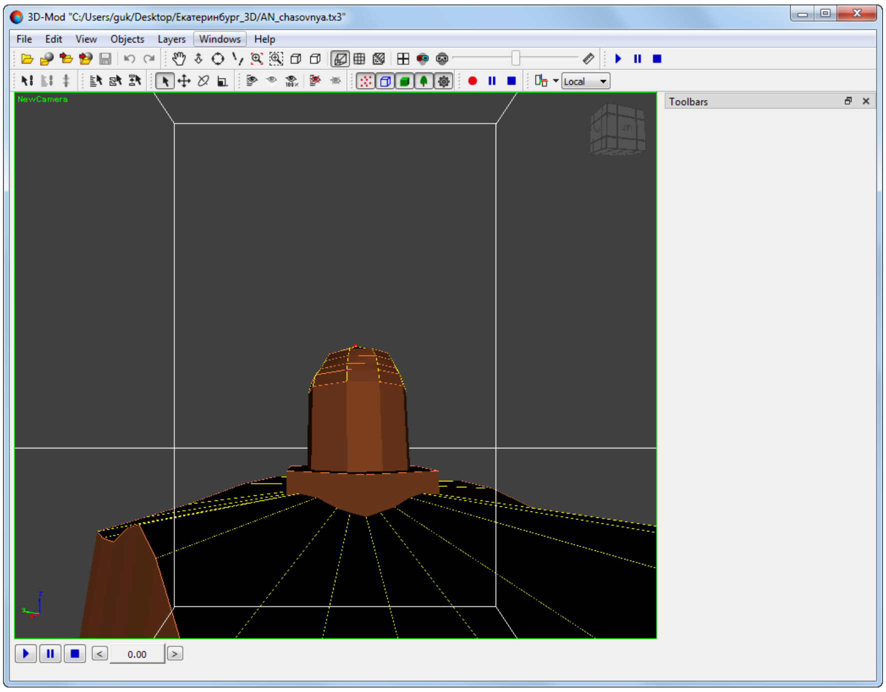


Fig. 184. Object view from camera

9.3. Anaglyph stereo mode

Anaglyph stereo image is formed by color-coding the stereo pair of images, which are intended for the left eye and right eye using accordingly “red” and “blue” color-filters. To view and measure in anaglyph stereo mode special spectral anaglyph spectacles with red and blue filters are used.

Anaglyph stereo measurements mode does not depend on monitor and video card parameters. Anaglyph mode is not completely good for full-featured work with color images.

Anaglyph stereo is available only for HighColor or TrueColor display mode of your monitor.

To turn on anaglyph stereo mode choose **View › Anaglyph stereo mode** or click button of the system toolbar.

9.4. Page-flipping stereo mode

Page flipping (“frame by frame”) display mode provides the most high quality stereo picture because it uses full frames instead of semi-frames. Left and right images of stereopair are displayed one by one synchronously with the frames switching. The shutter glasses are synchronized with vertical refresh rate of monitor that allows to see two images “simultaneously” and make stereo measurements. For working in page-flipping mode you should use a monitor supporting stereo mode, and an appropriate video adapter.

For work in page-flipping stereo mode it is necessary to use shutter glasses. Shutter glasses are liquid crystal glasses synchronized with the vertical refresh rate of monitor. The system supports page-flipping stereo measurements mode using shutter glasses. See more details about stereo glasses and other special equipment for images stereo processing in the “General information about system” User Manual.

To turn on page-flipping stereo mode choose **View › Frame stereo mode** or click button of the system toolbar.

9.5. Grid

The module allows to display coordinate grid. The grid is located in loaded objects plane and covers the entire 3D-scene viewing area. Coordinate grid allows to perform measurements of geometric size of scene objects, and is also used for objects position alignment.

Coordinate grid lines are displayed with different color. Black grid lines are complementary (they are use for the decimal division), grey ones – the main. The actual distance between the lines is determined by current scale of 3D-scene display. With zooming in a distance between grid lines is gradually increasing, with zooming out – distance decreases. To display coordinate grid select **View › Grid** or click the button on the main toolbar. To specify the grid **Settings** open the **Rendering** tab of the appropriate window.

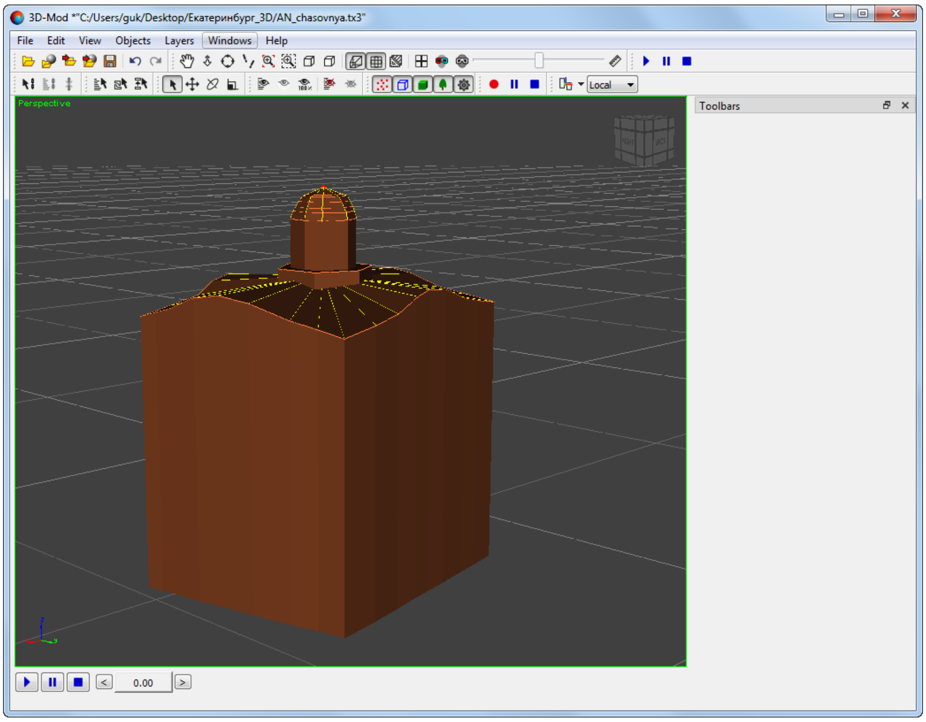


Fig. 185. Coordinate grid – enlarged scale

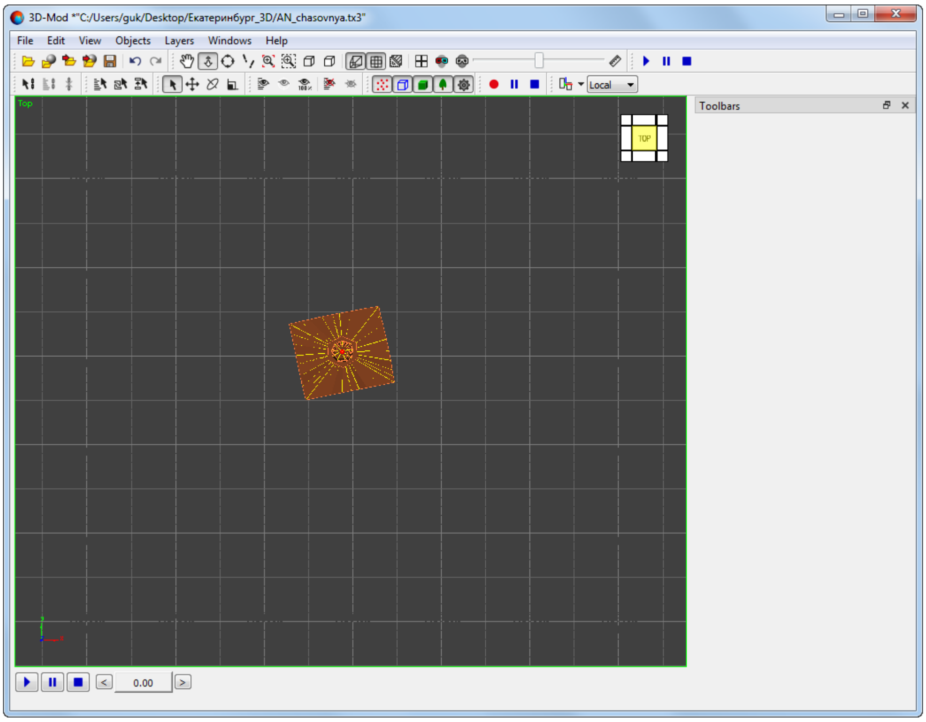


Fig. 186. Coordinate grid – reduced scale

9.6. Scale bar

The module allows to display scale bar. The scale bar is displayed in the lower right corner of the screen. The scale bar division is determined by current scale of 3D-scene display.

The current scale of 3D-scene is displayed in the top left corner of the screen.

The scale bar is not available when the perspective mode ( ) is on.

To display coordinate grid select **View › Scale rule** or click the button on the main toolbar.

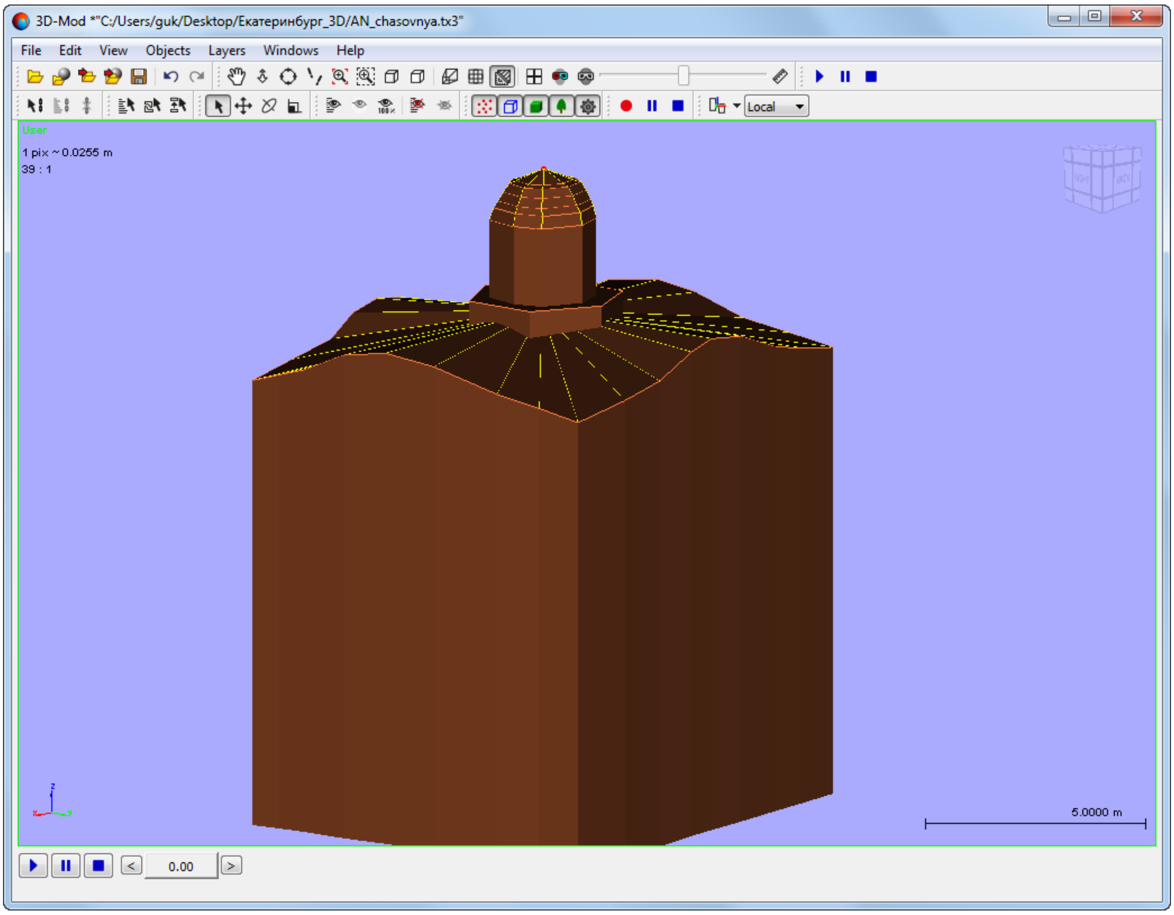


Fig. 187. The scale bar and the current scale of 3D-scene

9.7. Measurements

The system provides possibility to perform measurements within 3D-scene. To go to measurements mode use the button on the main toolbar. When the measurements mode is enabled, the **Measurements** window opens.

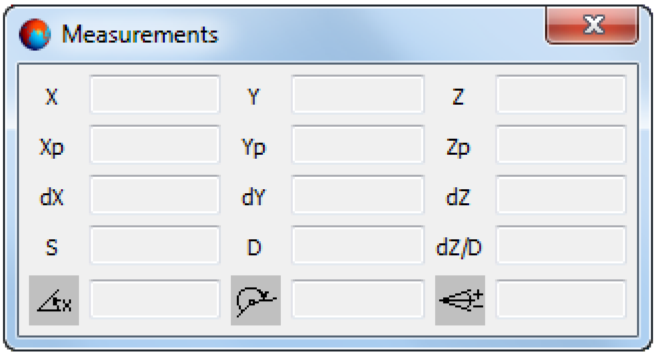


Fig. 188. The Measurement$QUOTE$"window

The window contains fields with mouse cursor coordinates values:

- *X* – cursor X geodetic coordinate;
- *Y* – cursor Y geodetic coordinate;
- *Z* – cursor Z geodetic coordinate;
- *Xp* – cursor Xp geodetic coordinate;
- *Yp* – cursor Yp geodetic coordinate;
- *Zp* – cursor Zp geodetic coordinate;
- *dX* – current segment incrementation by X;
- *dY* – current segment incrementation by Y;
- *dZ* – current segment incrementation by Z;

Besides, the **Measurements** window contains fields with values of the following parameters of segment:

- *S* – a length of segment;
- *D* – a length of horizontal distance (projection on a plane) of segment by Z;
- *dZ/D* – a value of segment slope (Z increment ratio to the horizontal distance);
- – direction of current segment relative to X axis;
- – vertical angle of current segment.

Do the following actions to perform measurements:

1. Click the button on the main toolbar. The **Measurements** window opens:

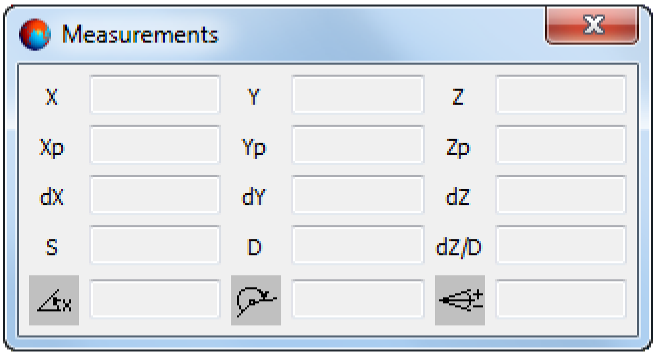


Fig. 189. The Measurement window

2. Place mouse cursor to selected point in 3D-window and click the left mouse button. The first measurement line's vertex is created;

3. Place mouse cursor to next point in 3D-window and click the left mouse button. The system creates temporary line ("rubber line"), that disappears after the measurement cancellation (or after the exit from measurements mode). Parameters of created segment are displayed in the **Measurements** window. The length of created segment is displayed in the vicinity of the second vertex;

   Measurements are performed within only one segment.

4. [optional] to change the second vertex location, place mouse cursor to another point in 3D-window and click the left mouse button;

5. [optional] to change the first vertex location, press the **1** button, place mouse cursor to another point in 3D-window and click the left mouse button;

   To return to the second vertex editing mode press the **2** button on the keyboard.

6. [optional] to cancel the current measurement press **Esc** or **delete** buttons on the keyboard or click the button in the vicinity of the second vertex;

7. To complete measurements, close the **Measurements** window or click the button on the main toolbar (or the button in the vicinity of the second vertex).

9.8. Projection windows

The scene is displayed in module in 3D space, that is why the view area displays not the scene's objects, but objects projection on certain planes.

There are two projection types:

- *parallel projection* (**View › Direction**) – separate points of 3D-objects are transferred by parallel beam of rays on specified projection plane, perpendicular to all set of projection beams;

  A particular case of parallel projection is orthographic projection, when projection plane is aligned parallel to one of coordinate planes of three-dimensional space.

- *central projection* (**View › Camera**) – separate points of 3D-objects are transferred on specified projection plane by beam of rays coming from a point corresponding to the position of the observer's eye. Projection plane is perpendicular to the central ray.

In order to display 3D-scene in four projections at the same time, choose **View › Multiview**. After that the scene is displayed in four projections, each in its own window: front view – `Front`, left view – `Left`, top view – `Top`, and perspective view – `Perspective`.

Projection windows allow to display 3D-scene content in different projections.

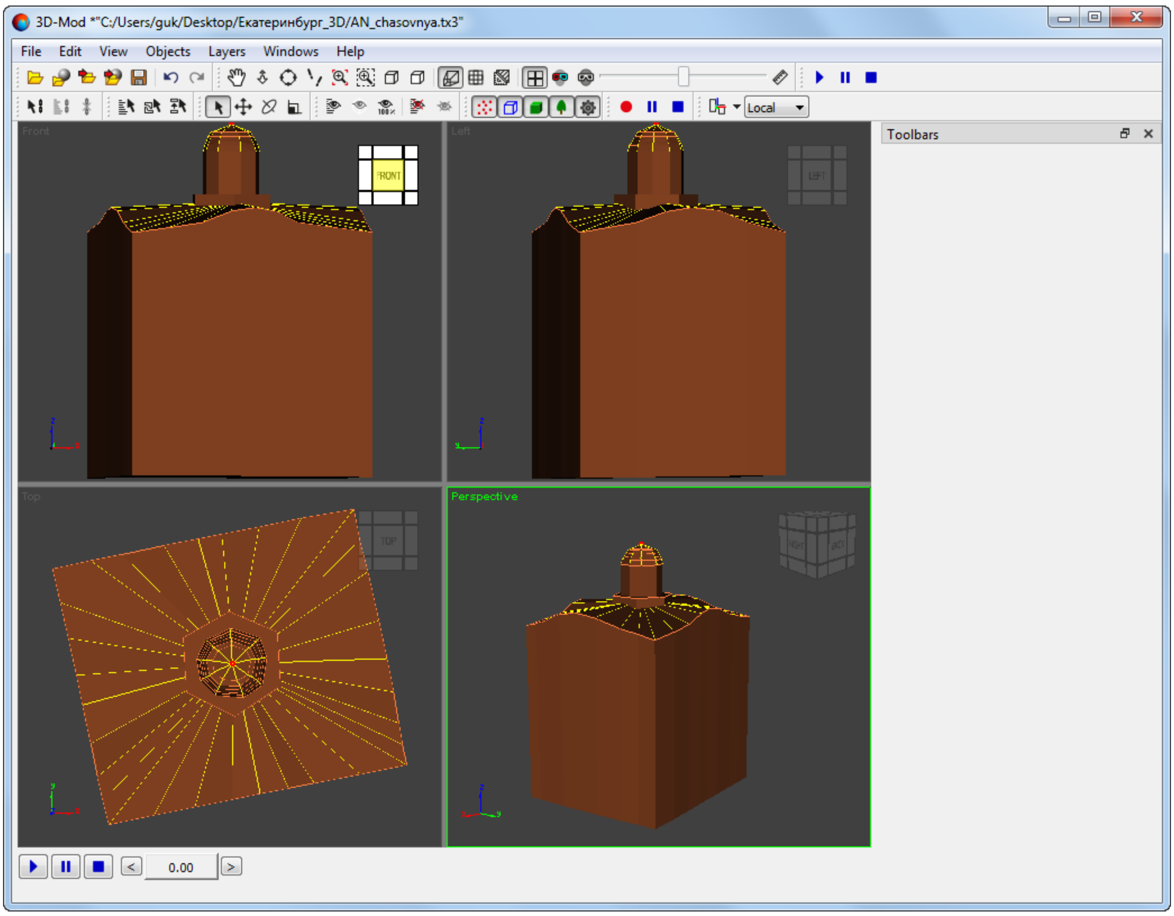


Fig. 190. Displaying 3D-scene in four projection windows (active projection window in perspective)

By default the system displays three windows of orthographic projections (front, left and right view) and fourth window of central projection (perspective view). The active window is shown in the green frame. To make active another window, click desired window inside. After that selected window becomes active, and scene objects become unselected.

To estimate different geometric parameters of 3D-objects, click projective cube to select one of the following projections:

- `Front` – front view;
- `Back` – back view;
- `Top` – top view;
- `Bottom` – bottom view;
- `Left` – left view;
- `Right` – right view;
- `Perspective` – perspective view.

The selected projection is highlighted by yellow.

Rectangular windows separated by vertical and horizontal boundaries, which can be moved using drag and drop. To move window boundaries place the cursor over one of the boundaries between the windows, press and hold mouse button and move the boundary to desired direction.

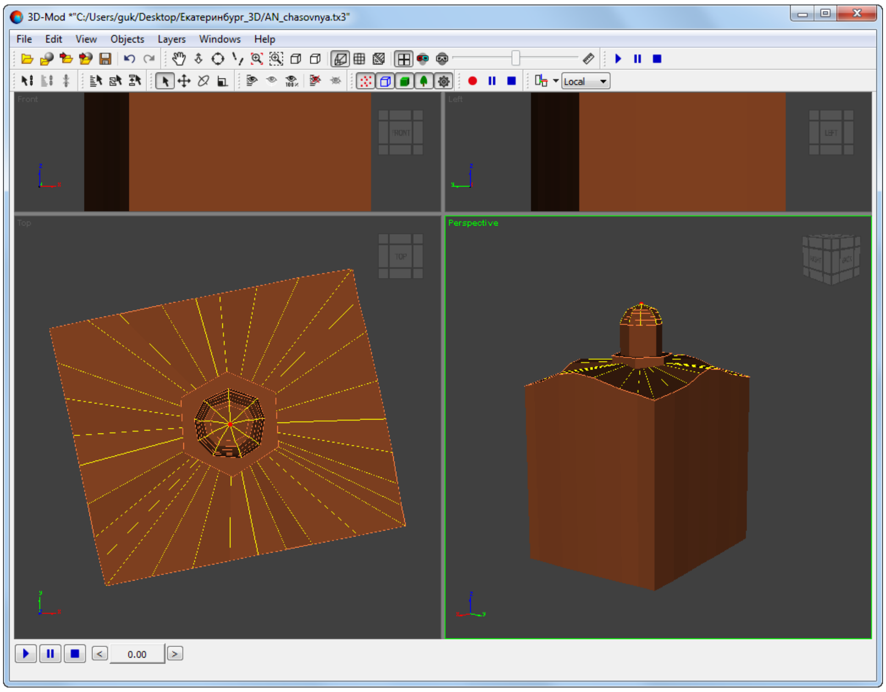


Fig. 191. Projection windows zoom in – top and perspective view

To display 3D-scene view area just in one projection window, select **View › Direction › ...** or select another projection in projection cube using mouse click.

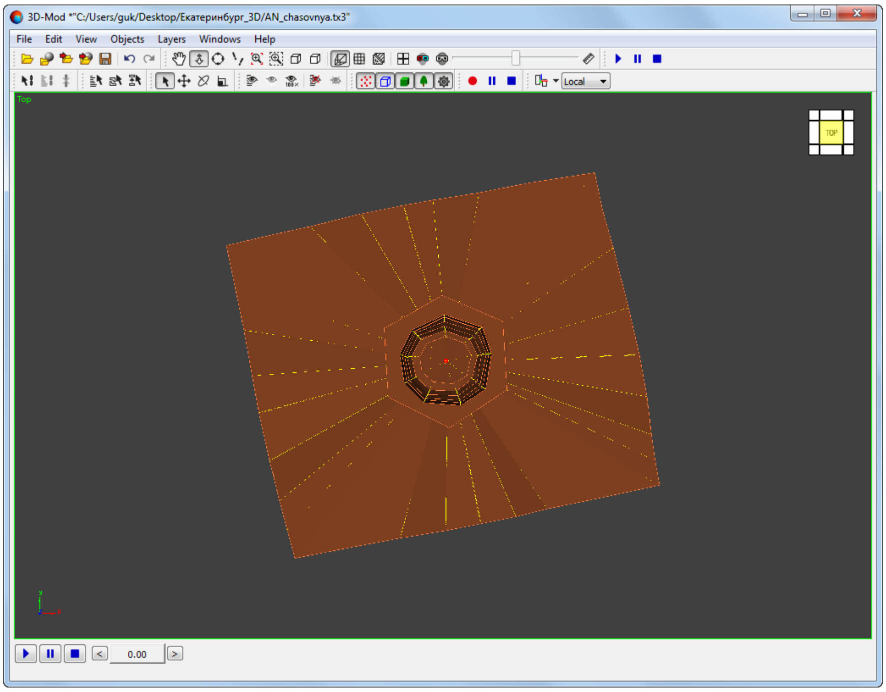


Fig. 192. 3D-scene display – top view

10. Management of objects display

10.1. The “Objects” menu

Table 15. Brief description of the “Objects” menu

Menu items	Function
Show points	to display point objects, used to fix certain coordinates of three-dimensional space to attach position of the scene observation point to scene’s background image
Show lines	to display outlines of objects external faces
Show buildings	to display 3D-objects
Show library	to display standard library objects
Show auxiliary objects	to display objects, intended to simplify three-dimensional modelling operations
Hide selected	to hide selected objects
Hide by name	to hide objects in view area using their names in the list
Show only selected	to display only selected objects, and not selected objects are not displayed in the view area
Show by name	to show hidden objects in view area using their names in the list
Show all	to show all hidden objects
Move to layer	to move objects from one layer to another
Build	to build 3D-objects using 2D-objects

10.2. Basic object’s properties

To setup object display parameters, select the object. The **Base properties** section is opened.

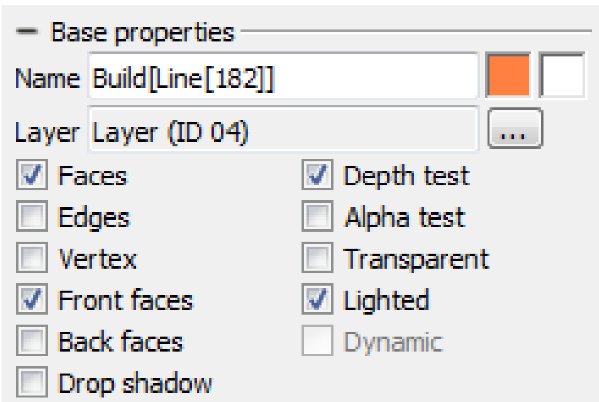


Fig. 193. Basic object’s properties

In the **Base properties** section set the checkboxes to display the following:

- **Name** – a name of selected object;

  To change a color of selected object, choose desired color by double click the rectangle and push OK.

- **Layer** – a name of a layer, where the object is located;
- **Faces** – object faces;
- **Edges** – edges located on the back side of the object;
- **Points** – object vertices;
- **Front faces** – object front faces;
- **Back faces** – object back faces;
- **Depth test** – eliminating invisible surfaces of distant objects, located behind close objects;

  To display objects in full clear the **Depth test** checkbox.

- **Alpha test** – texture coordinates are loaded with transparent background;
- **Transparent** – allows to create a transparent object;

  To create a transparent object, select object by double click the second square near the **Name** field, select alpha channel colour and set the **Transparent** checkbox on.

- **Lighted** – object lighting using embedded light sources;
- **Dynamic** – the checkbox is on, if camera is located on the trajectory polygon. Otherwise, the checkbox is set off.

10.3. Parameters of surface layer

To configure parameters of surface layer display, select orthoimage. The **Properties** section is opened.

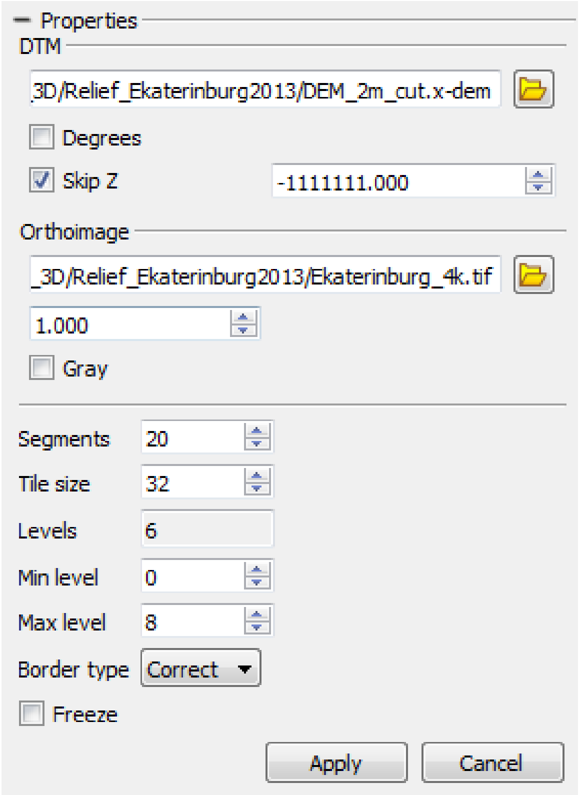


Fig. 194. Parameters of surface layer display

The **DEM** section is used to configure the following parameters:

-  – to select a DEM out of active profile resources;
- **Degrees** – for correct reading coordinate values from DEM file in degrees;
- **Bad Z** – to reject specified value.

The **Orthoimage** section is used to configure the following parameters:

-  – to select an orthoimage or map of terrain out of active profile resources;
- **Gray** – to display a single averaged channel `Grey scale` as output file channel (see more details in "GeoMosaic" User Manual).

Segments – DEM cell size in pixels;

Tile size – number of cells in a tile;

Levels – number of detail levels;

Min level – high level of image details;

Max level – low level of image details;

Freeze – allows to edit only selected area of orthoimage, with no change to other areas.

To save and apply changes click the **Apply** button in the **Properties** section.

10.4. Objects displaying

The module allows to manage scene objects display.

To display point objects, that hold certain coordinates of 3D space, select **Objects › Show points** or click the button.

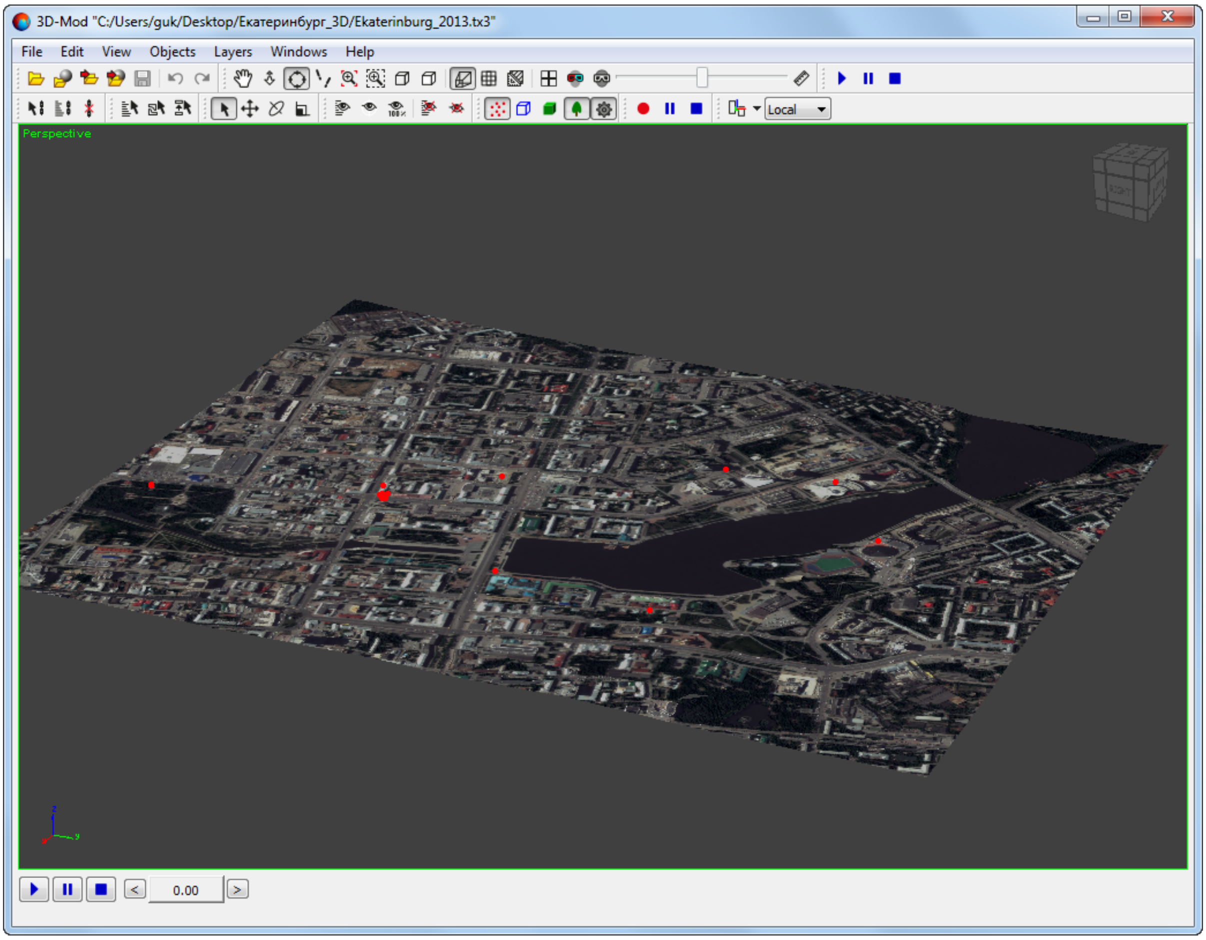


Fig. 195. Point objects displaying

To display outlines of objects external faces select **Objects › Show lines** or click the button.

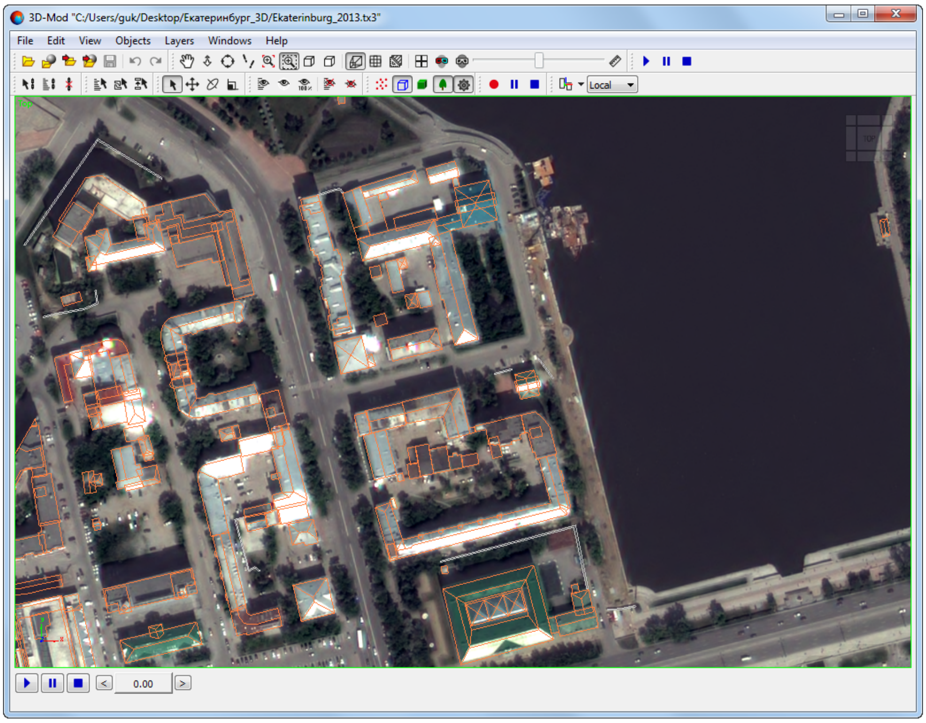


Fig. 196. Objects outlines displaying

To display 3D objects, select **Objects › Show buildings** or click the button.

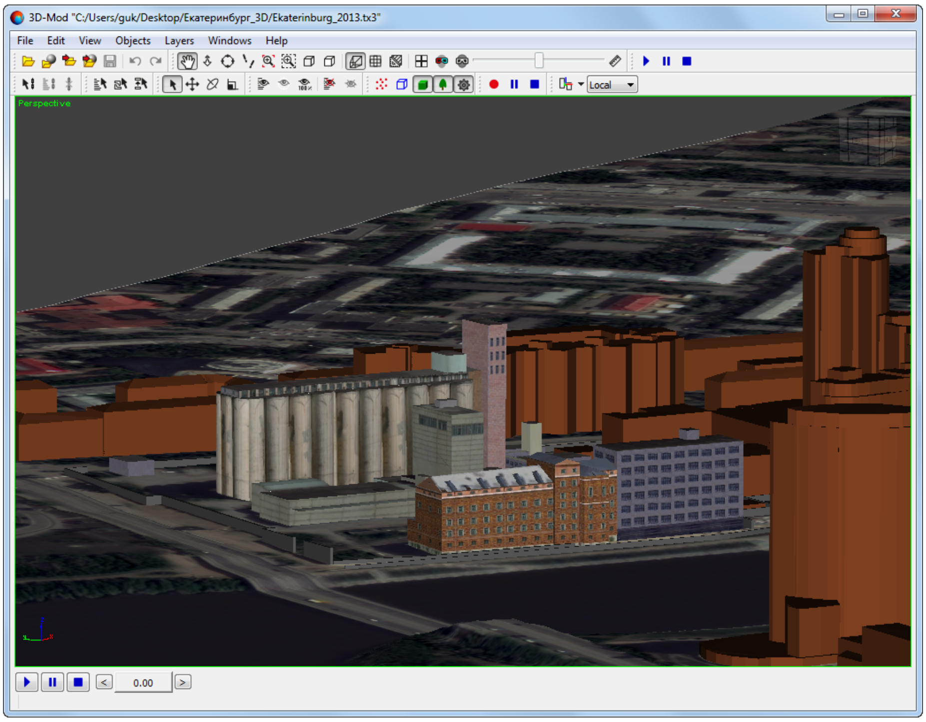


Fig. 197. 3D objects displaying

To show objects, intended to simplify three-dimensional modelling operations (for example, dummy object or light source), choose **Objects › Show helpers** or click the button.

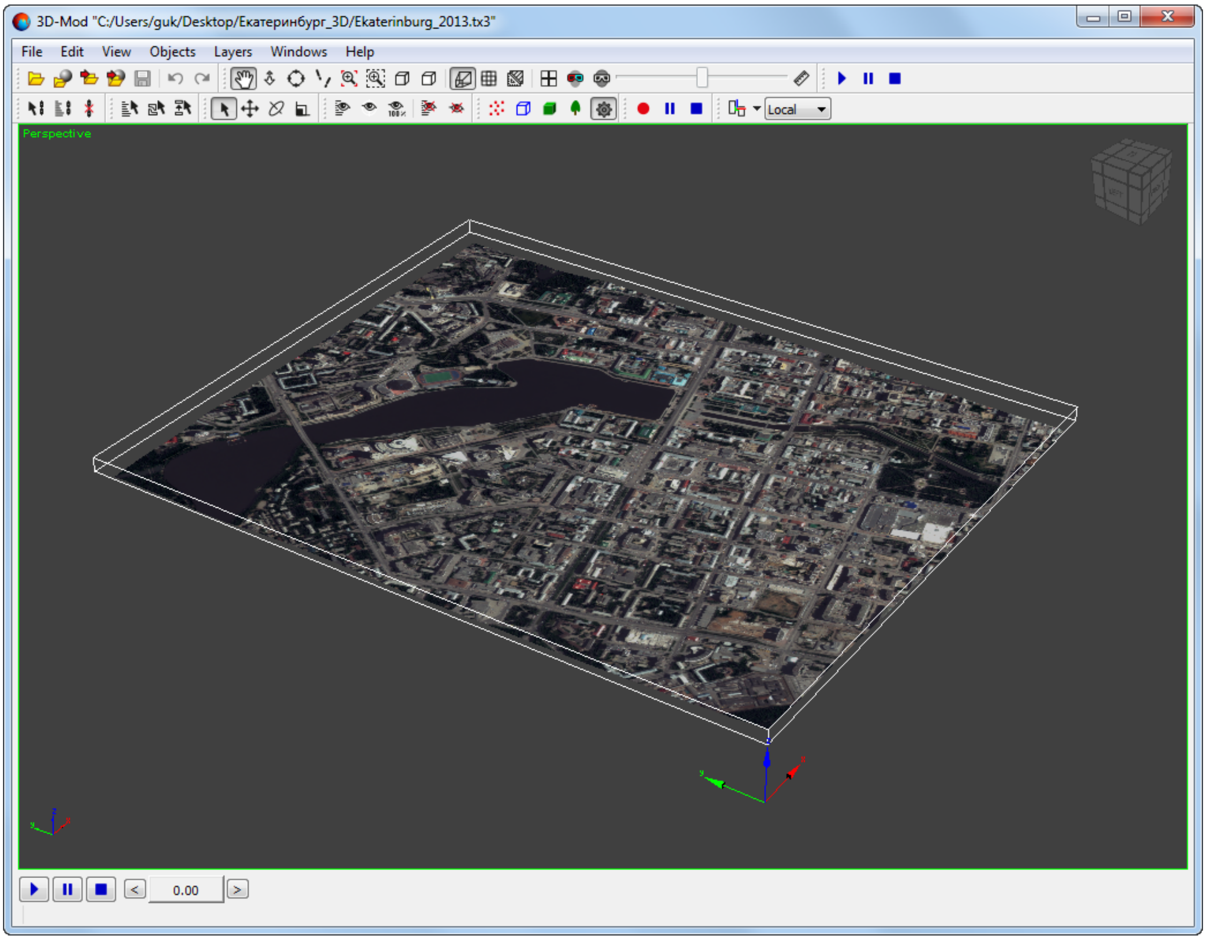


Fig. 198. Bounding box displaying

10.5. Objects displaying in final scene

Prior to 3D-scene playback or record it is necessary to select objects, you wish to display in a final scene.

The module allows to hide some objects from view area. This allows to seed up scene playback operation.

To hide single or multiple objects from view area, select the objects and choose **Objects › Hide selected** or click the button on the main toolbar.

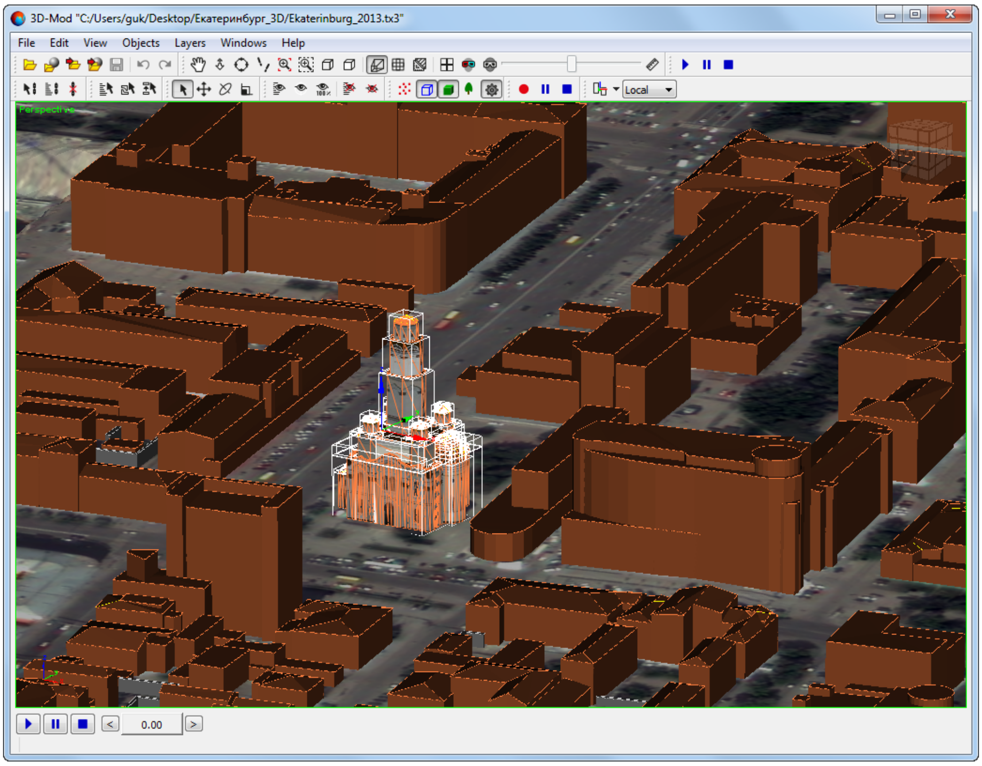


Fig. 199. Objects selection

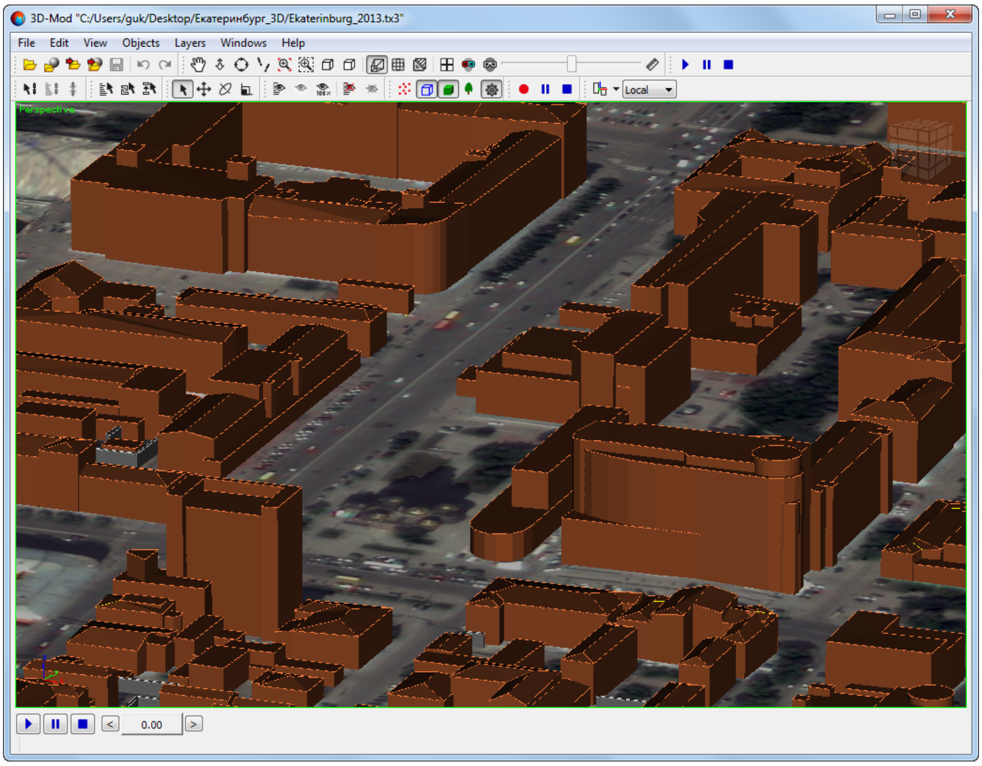


Fig. 200. Selected objects are not displayed

In order to hide a single object or objects group in the list, perform the following actions:

1. Select **Objects › Hide by name** or click the button on the main toolbar. The **Hide objects** window opens.

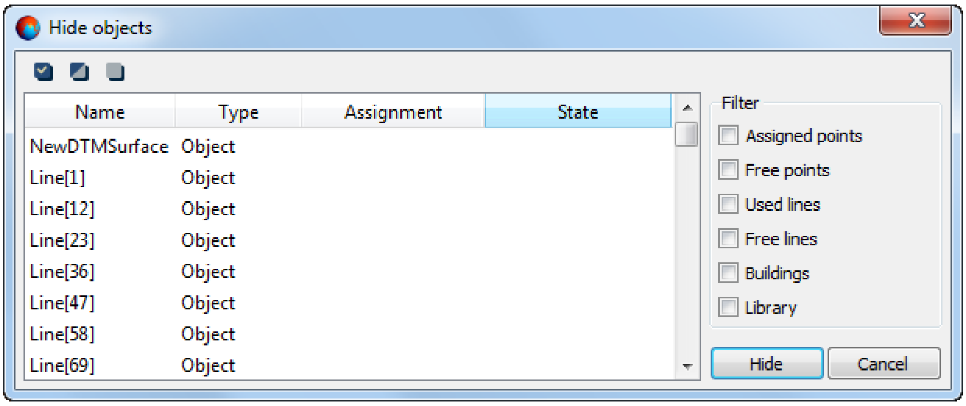


Fig. 201. Hide objects from the list window

The list of 3D-objects contains the following columns:

   - **Name** – a name of an object;
   - **Type** – object type, which is assigned to an object during its creation in the system (Object, Outline, LibPoint, None) (see detailed description of object attributes in the “Vectorization” User Manual);
   - **Assignment** – shows object’s assignment;
   - **State** – shows objects, used for 3D-creation (`Занятый`) or not used (`Свободный`).

2. The **Filter** section allows to select objects type to be shown in the list.

3. [optional] To show in the list outlines, converted to buildings, set the **Buildings** checkbox on.

4. [optional] To show in the list point objects, converted to objects during creation from DXF-file library, set the **Library** checkbox on.

5. To manage objects selection in the list, use the following buttons:

   - – allows to select all objects in the list;
   - – allows to invert objects selection order;
   - – allows to deselect all objects.

6. Select objects by mouse click and click the **Hide** button.

To select a group of objects, press and hold the **Shift** key, and click objects sequentially.

To view the list of objects hidden from view area or to show hidden objects from the list, perform the following actions:

1. Select **Objects › Show by name** or click the button on the main toolbar. The **Show objects** window opens.

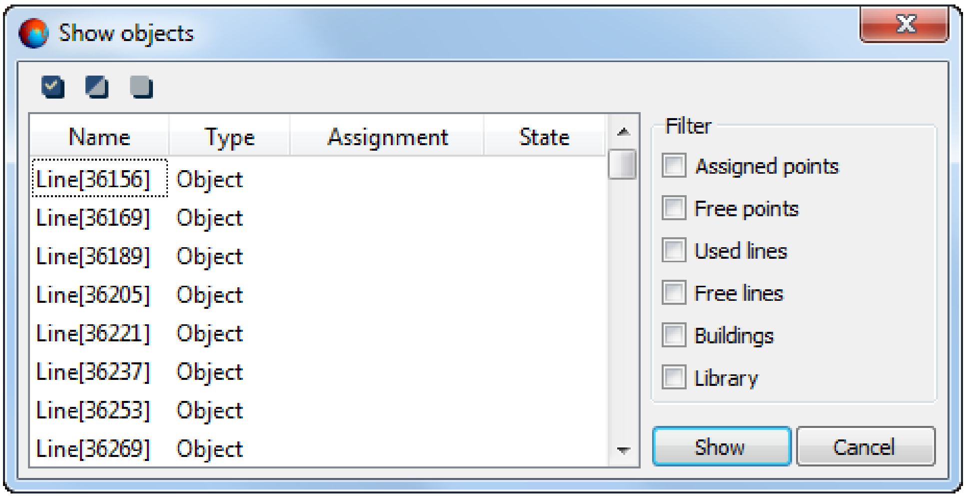


Fig. 202. Show objects from the list window

The list of 3D-objects contains the following columns:

- **Name** – a name of an object;
- **Type** – object type, which is assigned to an object during its creation in the system (Object, Outline, LibPoint, None) (see detailed description of object attributes in the "Vectorization" User Manual);
- **Assignment** – shows object's assignment;
- **State** – shows objects, used for 3D-creation (`Занятый`) or not used (`Свободный`).

2. The **Filter** section allows to select objects type to be shown in the list.

3. [optional] To show in the list outlines, converted to buildings, set the **Buildings** checkbox on.

4. [optional] To show in the list point objects, converted to objects during creation from DXF-file library, set the **Library** checkbox on.

5. To manage objects selection in the list, use the following buttons:

- – allows to select all objects in the list;
- – allows to invert objects selection order;
- – allows to deselect all objects.

6. Select objects by mouse click and click the **Show** button.

   To select a group of objects, press and hold the **Shift** key, and click objects sequentially.

To show all hidden objects select **Objects › Show all** or click the button on the main toolbar.

To show in the view area just selected objects, highlight them and select **Objects › Show only selected** or click the button on the main toolbar.

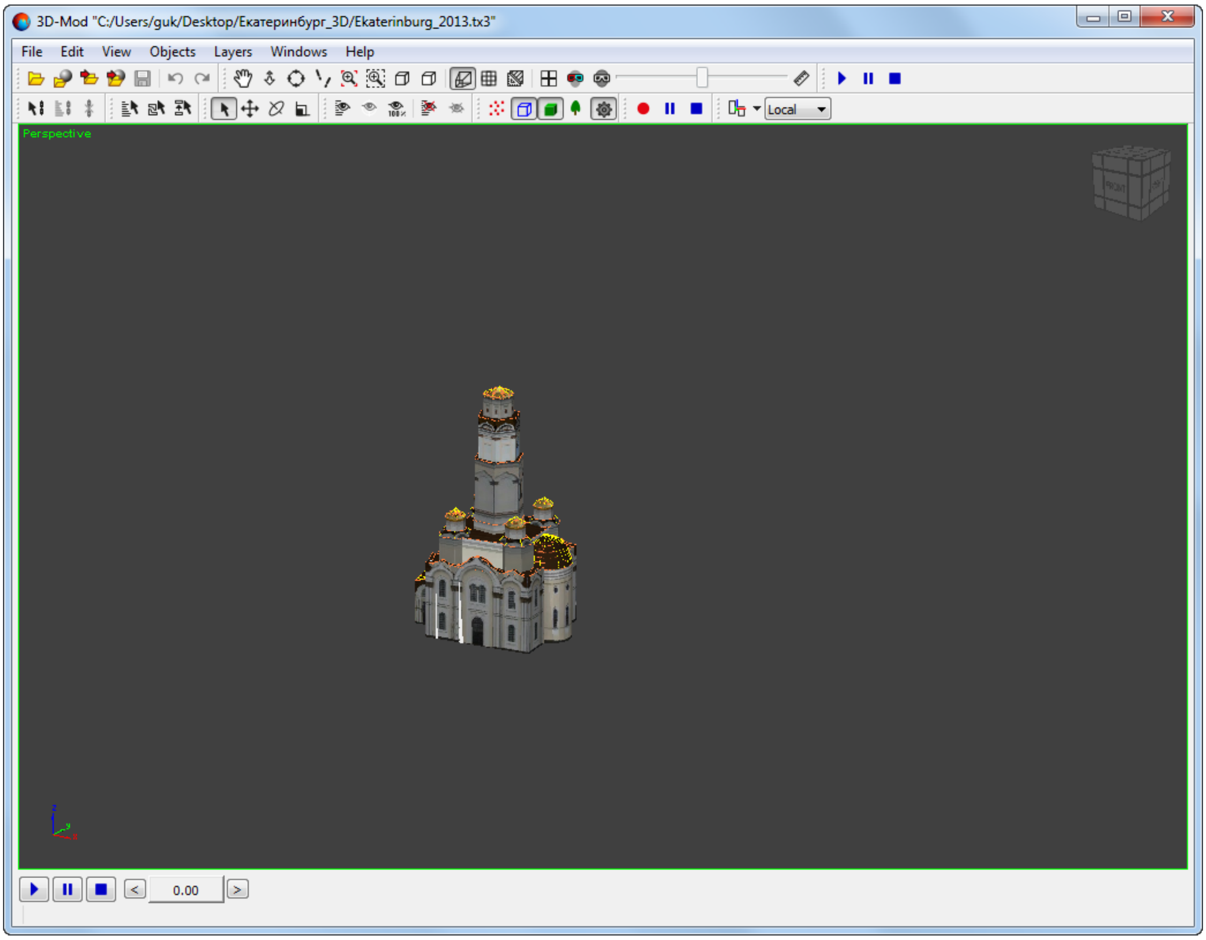


Fig. 203. Show selected objects only

10.6. 3D-scene layers

Distribution of objects in layers significantly accelerates the work with scene objects, if there are many objects.

It is recommended to move objects with the same type to the same layer.

To open a list of 3D-scene layers, select **Layers › List of layers**. The **Layers** window opens.

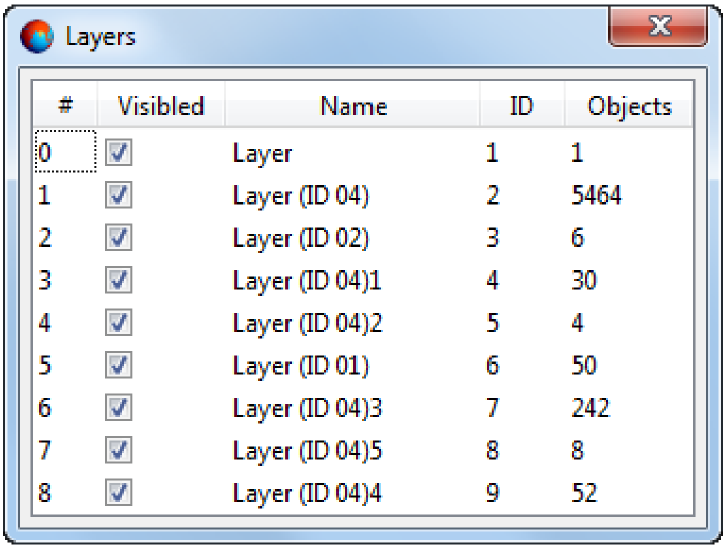


Fig. 204. The list of 3D-scene layers

The **Layers** window contains a table with the following columns:

- **#** – layer number by its creation order;
- **Visible** – shows weather layer is displayed in view area;
- **Name** – layer name, that is shown in the main module window in the **Base properties** section. Default layer name is LayerN (where N – integer);
- **ID** – identifier assigned to a layer;
- **Objects** – number of objects in a layer.

To remove a layer right click it and select **Delete layer**.

To rename a layer right click it and select **Rename layer**.

To move objects from one layer to another, select them and choose **Objects › Move to layer...**. Select target layer for objects moving by mouse click and click the **Select** button.

To create a new layer and to add objects there, perform the following actions:

1. Select **Layers › List of layers**. The **Layers** window opens.

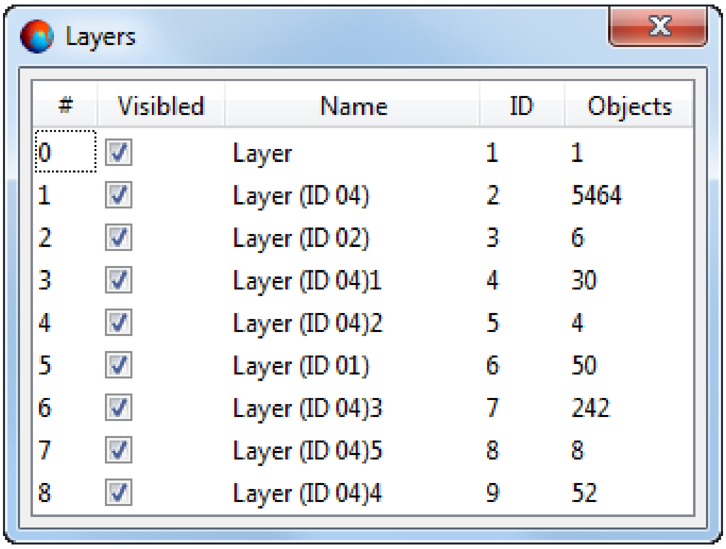


Fig. 205. List of layers of 3D-scene

2. Right click any layer. The context menu opens.

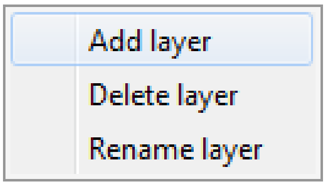


Fig. 206. Context menu

3. Select **Add a layer**. A new layer is created.

4. In view area select objects to be added to a new layer.

5. Select **Objects › Move to layer...**. The **Select layers** window opens.

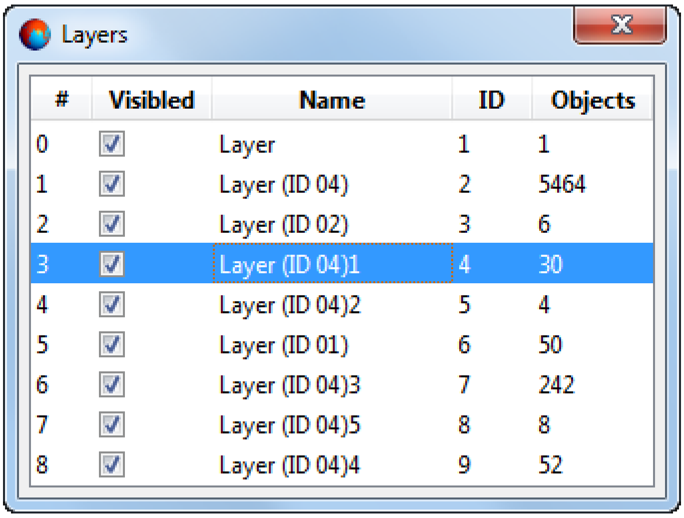


Fig. 207. The window used to select layer to add selected objects

6. Select a new layer by mouse click and click the **Select** button. Selected objects are added to a new layer.

To move selected object to another layer, in the **Base properties** section click the ... button. The **Select layers** window opens. Select a new layer by mouse click and click the **Select** button.

11. Module settings

The module allows to configure general module parameters and display options of 3D-scene data.

To configure module parameters select **File › Settings**. The **Settings** window opens.

The window contains the following groups of parameters:

- main 3D-scene parameters on the **Scene** tab;
- parameters of 3D-scene display on the **Rendering** tab;
- parameters of scene elements display on the **Editing** tab;
- texture parameters on the **Textures** tab;
- mouse parameters on the **Navigation** tab;
- parameters of 3D-scene view area moving (observation from camera) on the **Moving** tab.

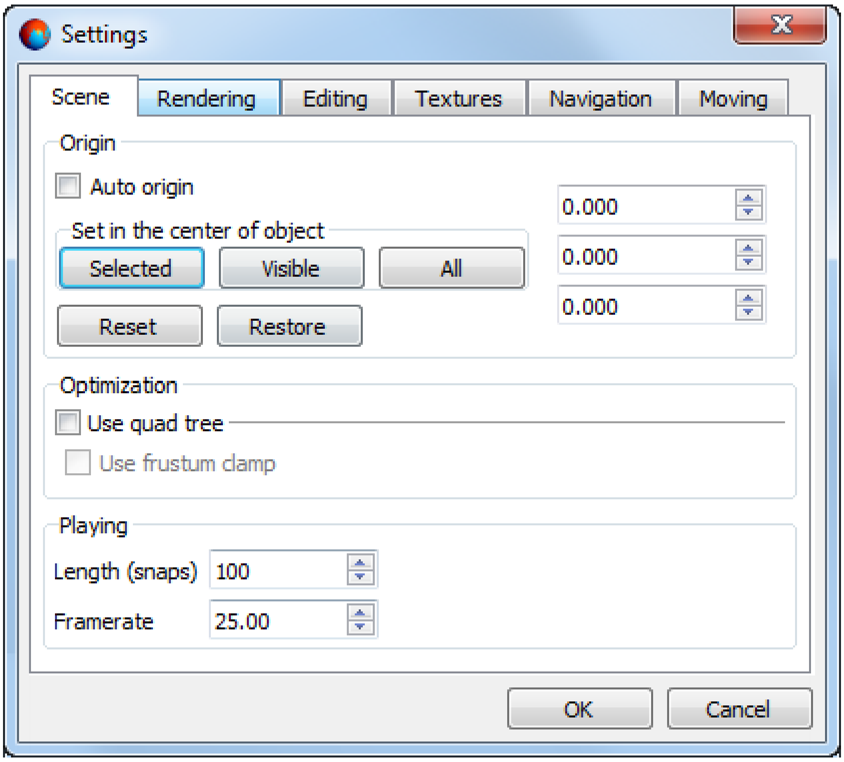


Fig. 208. Main parameters of 3D-scene

The **Scene** tab allows to configure the following 3D-scene parameters:

- The **Origin** section shows XYZ coordinates of 3D-scene center, and it is also possible to configure the following parameters:
  - **Auto origin** – allows to automatically calculate 3D-scene center (origin);
  - **Set to center of scene** – allows to set 3D-scene center to center of **selected** objects, **visible** objects or **all** objects of 3D-scene;
  - **Reset** – allows to set 0 value to 3D-scene center;
  - **Restore** – allows to restore previous coordinate values of 3D-scene center.
- In the **Optimization** section:
  - **Use quad tree** – allows to edit 3D-scene which contains big data volume;
  - **Use frustum clamp** – allows to display all objects when dealing with big volume data.
- In the **Playing** section:

Scene playback duration is calculated by the following formula: **Length (snaps)** / **Framerate** (100/25 = 4 seconds in given example).

- ○ **Length (snaps)** – number of frames;
- ○ **Framerate** – playback frame rate.

☞ It is impossible to input zero or negative value of the **Framerate** parameter. Minimal value accepted by the system is 1.0.

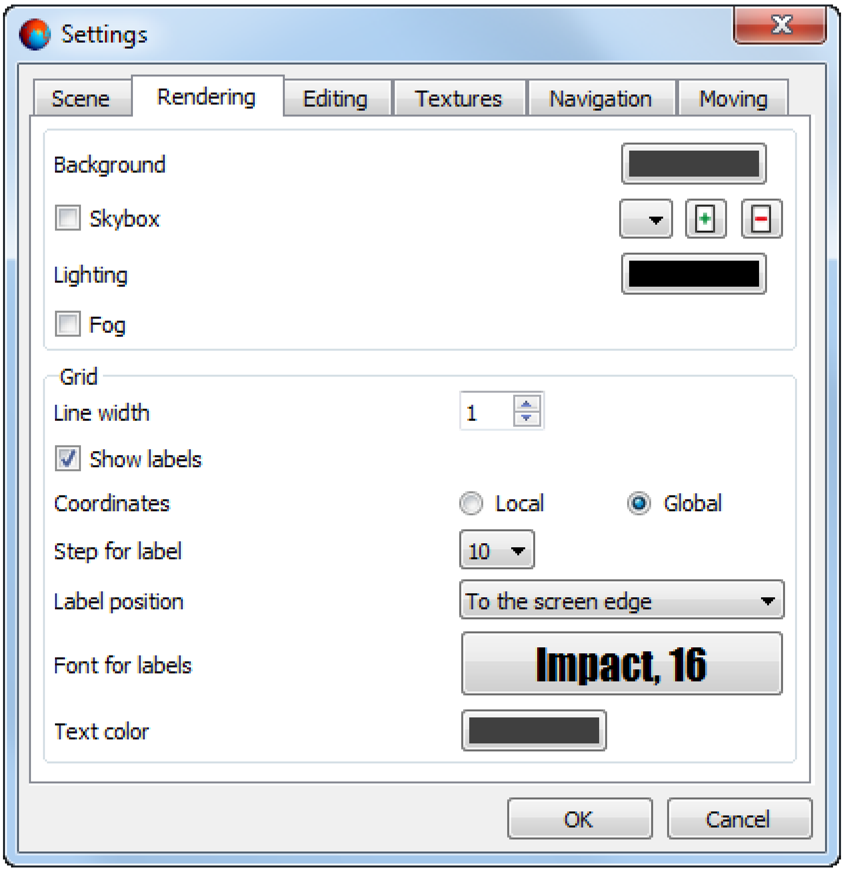


Fig. 209. Parameters of 3D-scene display

The **Rendering** tab allows to configure the following parameters of 3D-scene displaying:

- **Background** – 3D-scene background color;
- **Skybox** – imitation of sky and horizon in the whole 3D-scene space;
- **Lighting** – color of objects lighting by light sources;
- **Fog** – imitation of fog in the whole 3D-scene space.

The **Grid** section allows to specify the following coordinate grid settings:

- **Line width**;

- The opportunity to **show labels** of coordinates;
- The opportunity to select the **coordinates** type – **local** or **global**;
- The coordinates **label spacing** – **1**, **5** or **10** grid steps;
- The **labels arrangement**: **at edges of screen**, **on central axes** or **at nodes with step** (see the **labels spacing** parameter above);
- The **fonts for labels**;
- The **text color**.

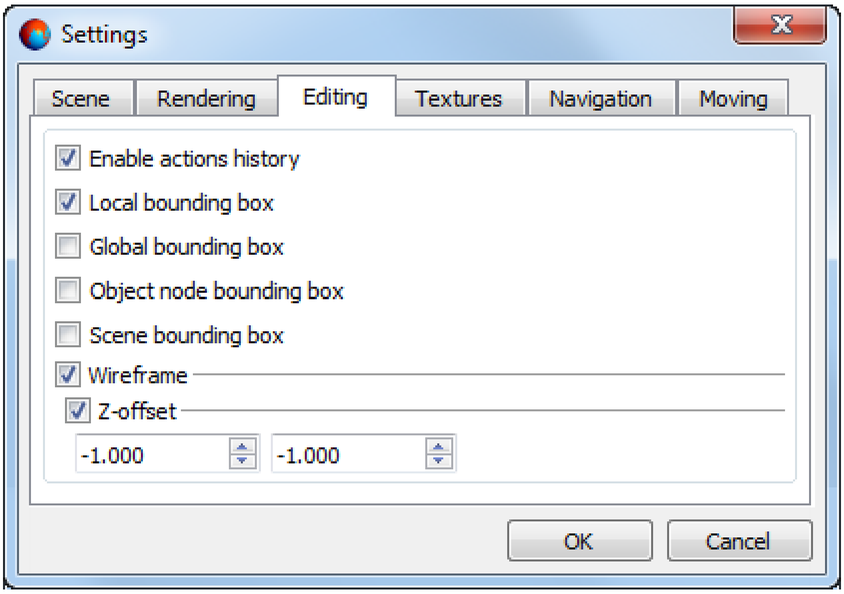


Fig. 210. Parameters of scene elements display

The **Rendering** tab allows to configure the following parameters of 3D-scene displaying:

- **Enable actions history** – allows to **cancel** or **redo** the last operation (see Section 6.1);
- **Local bounding box** – allows to display a bounding box in object's coordinate system;
- **Global bounding box** – allows to display a bounding box, described around an object in the global coordinate system;
- **Object node bounding box** – allows to display a bounding box, described around selected area;
- **Object node bounding box** – allows to display a bounding box, described around selected area;

- **Wareframe** – allows to display objects wareframe, containing faces.

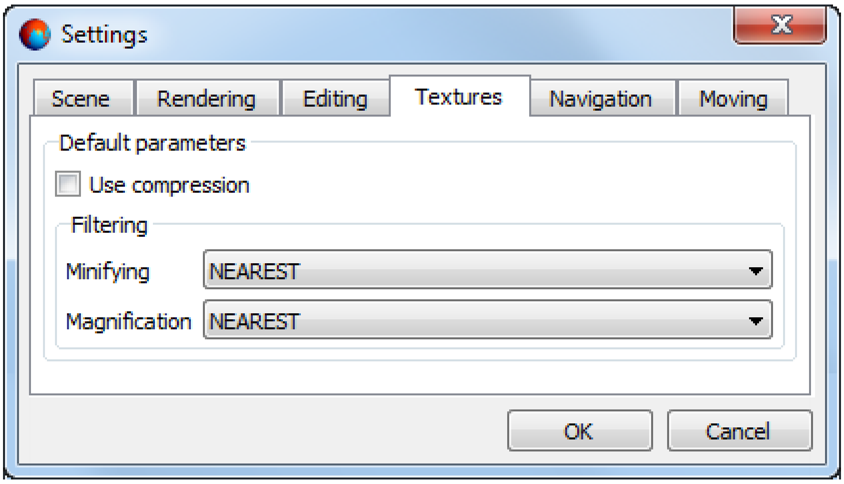


Fig. 211. Texture parameters

The **Textures** tab allows to configure the following texture parameters:

- **Use compression** – allows to load textures in compressed form;

When the **Use compression** checkbox is on, the system reduces the quality of loaded textures.

- In the **Filtering** section select one of the following options of edge pixels smoothing in texture image:
  - **Minifying**;
  - **Magnification**.

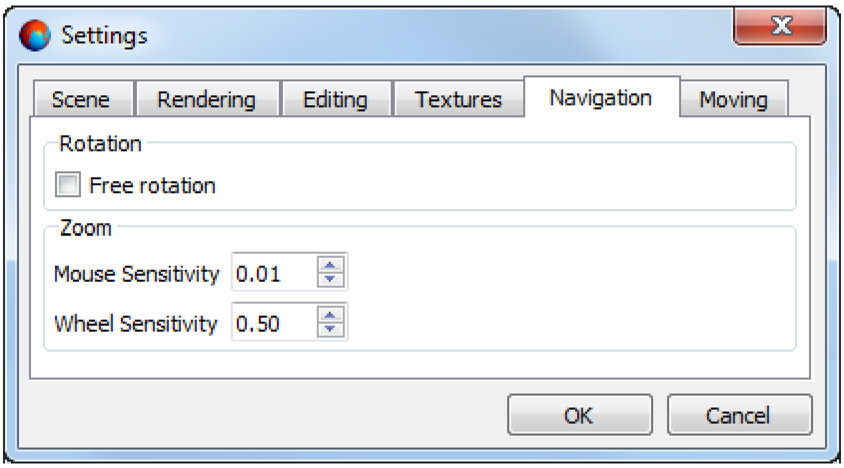


Fig. 212. Mouse parameters

The **Textures** tab allows to configure the following texture parameters:

- **Mouse sensitivity** – allows to configure mouse pointer speed for actions requiring increased accuracy; the greater the mouse sensitivity value, the faster the speed of the pointer.
- **Wheel sensitivity** – allows to configure scrolling speed; the greater the wheel sensitivity value, the faster the scrolling speed.

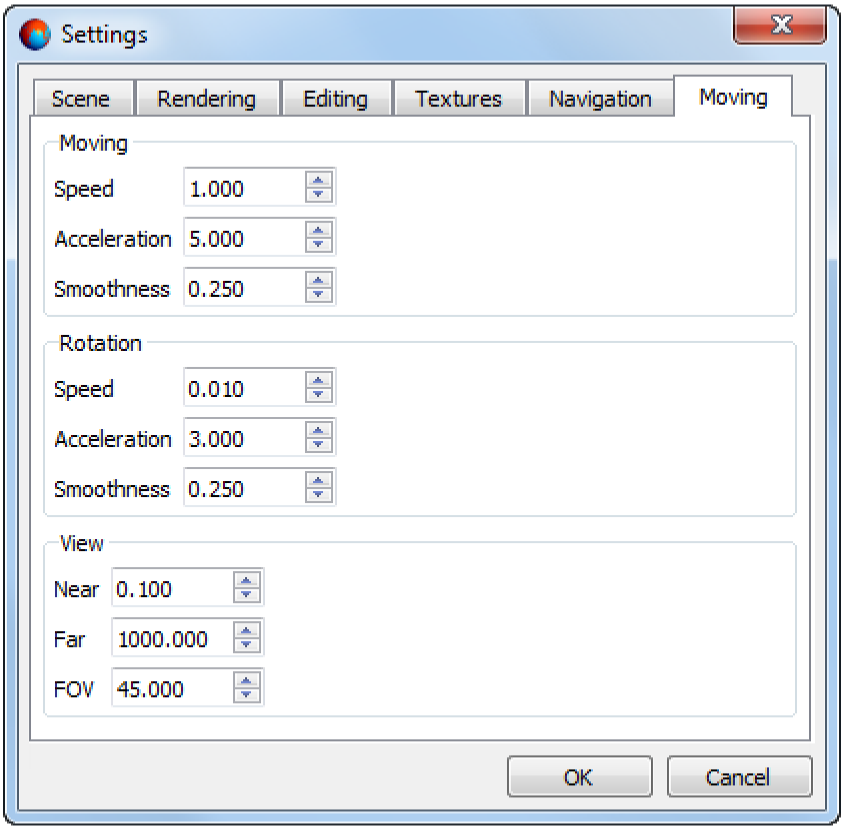


Fig. 213. Parameters of 3D-scene view area moving

The **Moving** tab is used to configure the following parameters of 3D-scene view area moving (observation from camera):

- In the **Moving** section.
  - **Speed** – 3D-scene moving speed;
  - **Acceleration**;
  - **Smoothness** – smoothness of moving.
- In the **Rotation** section:
  - **Speed** – 3D-scene rotation speed;

  ◦ **Acceleration**;

  ◦ **Smoothness** – smoothness of rotation.

- In the **View** section define the following settings:

  ◦ **Near** – clipping plane nearest to the camera (objects located closer than this plane are not displayed in the projection window of this camera);

  ◦ **Far** – far clipping plane (objects that are farther of the plane are not displayed in the projection window of this camera);

  ◦ **FOV** – camera field of view in degrees.

12. Animation

12.1. Scene animation

Animation – operation of forming series of images (frames) of scene view, observed through a camera. Each frame shows scene change compared to a previous frame.

Perform the following actions to create a scene animation:

1. Open 3D-scene or create a new one;

2. Select **View › Multiview**. 3D-scene is opened in four projection windows;

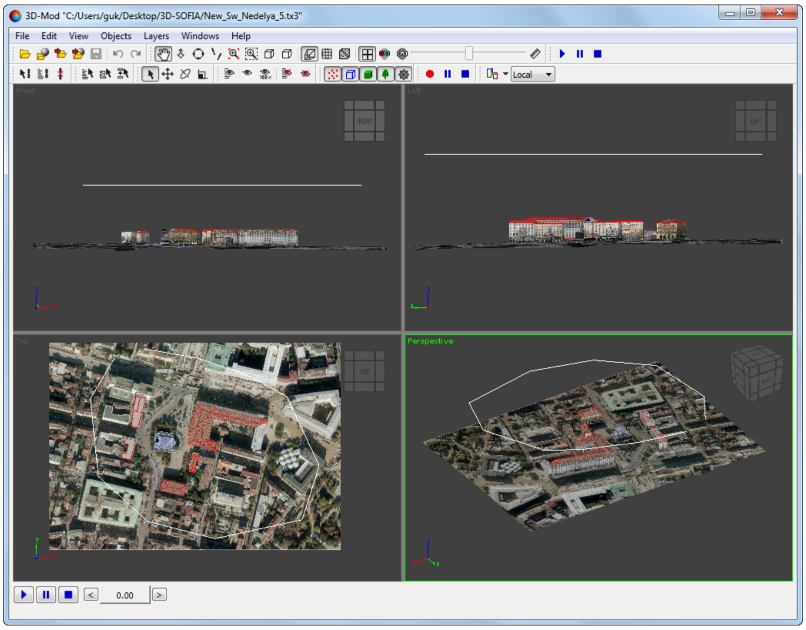


Fig. 214. 3D-scene display in four projection windows

3. Select **Edit › Create › Polyline**;

4. [optional] Set the **Loop** checkbox on to create path polygon (if needed);

   There is a possibility to create a path polyline, that is a non-closed trajectory to move a camera along it.

5. Create path polygon;

6. Move the polygon over 3D-objects (**Advanced properties › Origin › Edit pivot**);

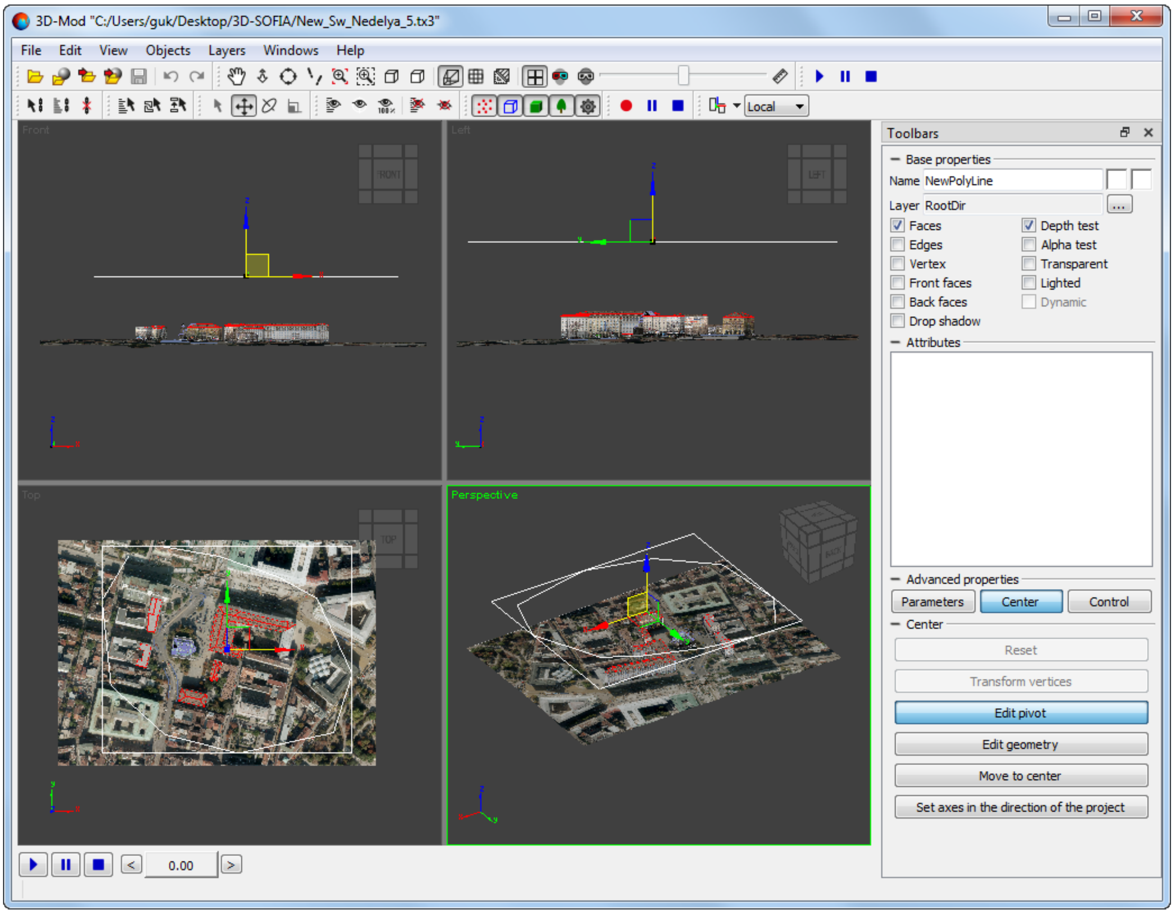


Fig. 215. Polygon of camera move path

7. Select **Edit › Create › Camera**. The camera is created;

8. In the **Advanced properties** section select the **Control** tab and open the drop-down menu, corresponding the button. Click `Path Controller` in drop-down menu;

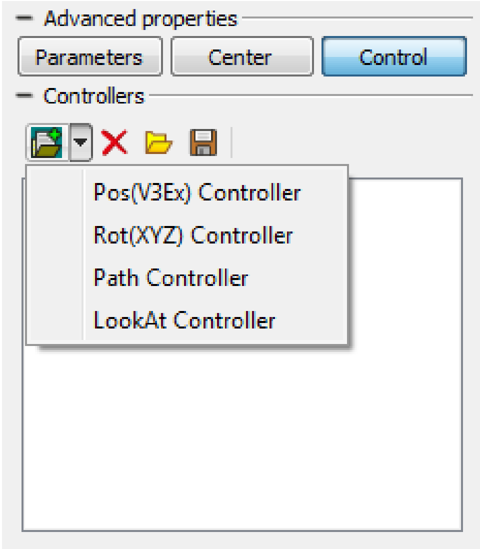


Fig. 216. The drop-down menu

9. Click `Path Controller` in controllers list;

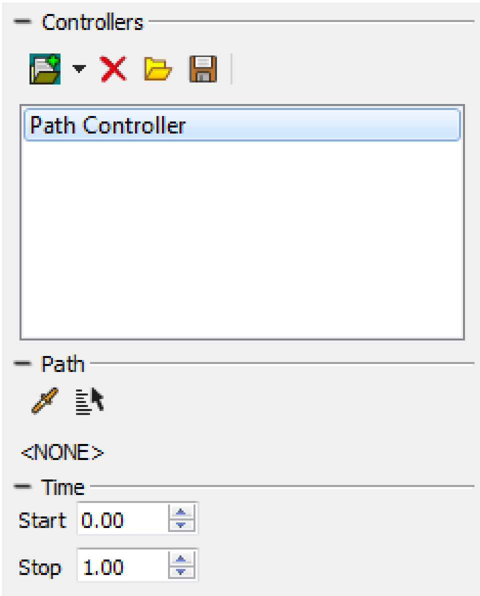


Fig. 217. Camera controllers list

10. In **Path** section perform one of the following actions:

   * [optional] click the button (**Pick**) and select path polygon by mouse in 3D window;

   * [optional] click the button (**Select**). The **Select objects** window opens. Select created path polygon from the list and click the **Select** button.

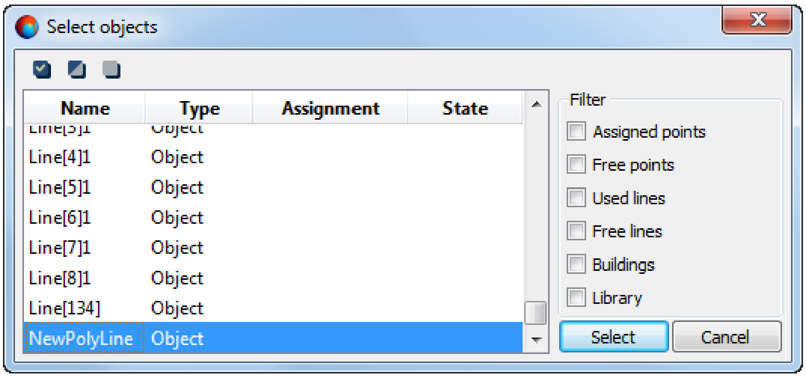


Fig. 218. Select objects from the list window

11. After that the camera is positioned in the beginning of path polygon;

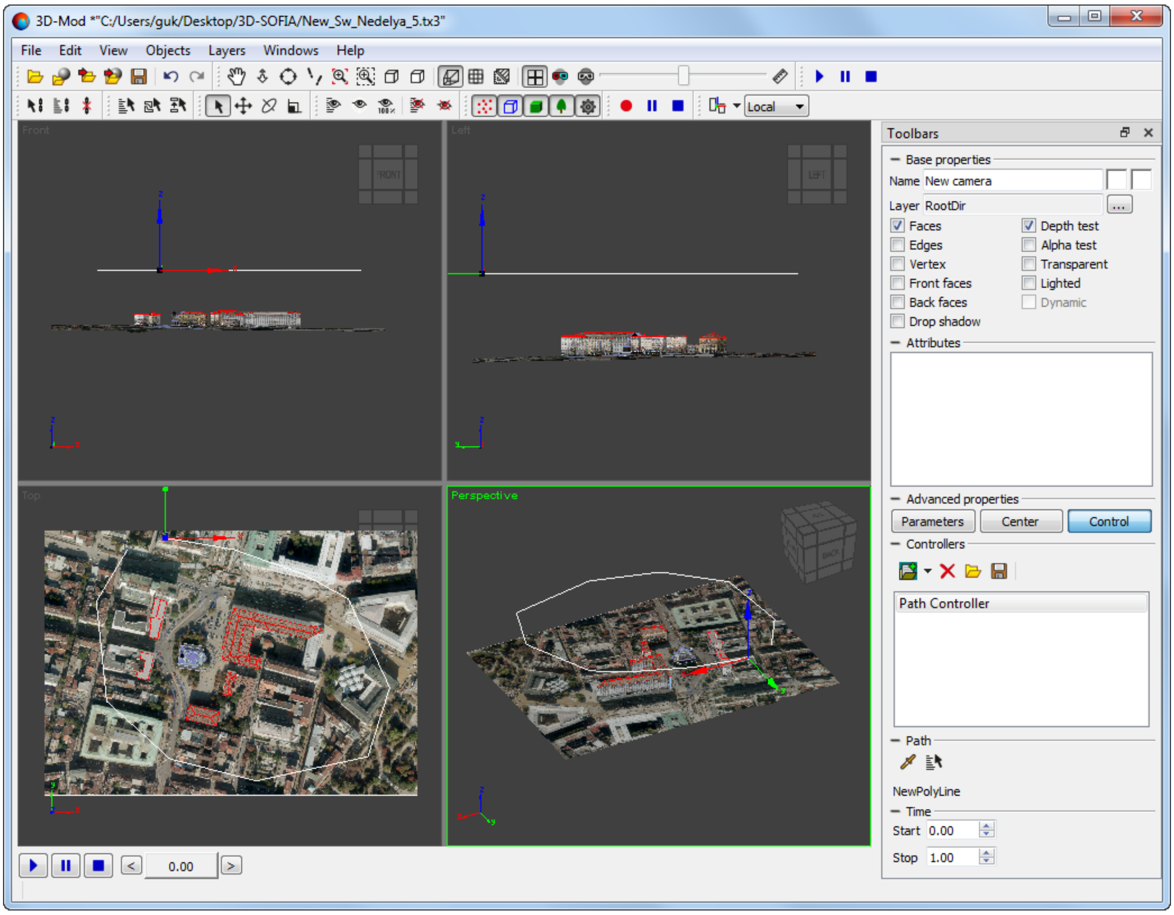


Fig. 219. A camera set on the selected path polygon

12. In the **Time** section specify a traverse time for camera, in seconds, in the **Stop** field;

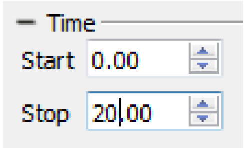


Fig. 220. Camera timer

13. [Optional] Set the delay for the start of camera motion in seconds in the **Start** field;

Total time of camera motion includes time of the delay. Therefore, with the given values: **Start** - 10 sec .; **Stop** - 20 seconds; is takes 10 seconds for the camera to pass a full path after a 10 second delay.

Steady position of the camera at given time may be convenient when performing animation of the object's movement in the viewing area.

It should be noted that the *duration of a scene playback* (which is the ratio of **Length (snaps)** to **Framerate**, see paragraph **22**) and the *time of camera movement* (set in seconds) are two different values that can be set independently.

14. [optional] To hide path polygon in the view area, click the button and in the **Hide objects** window select a polygon;

To show all hidden objects select **Objects › Show all** or click the button on the main toolbar.

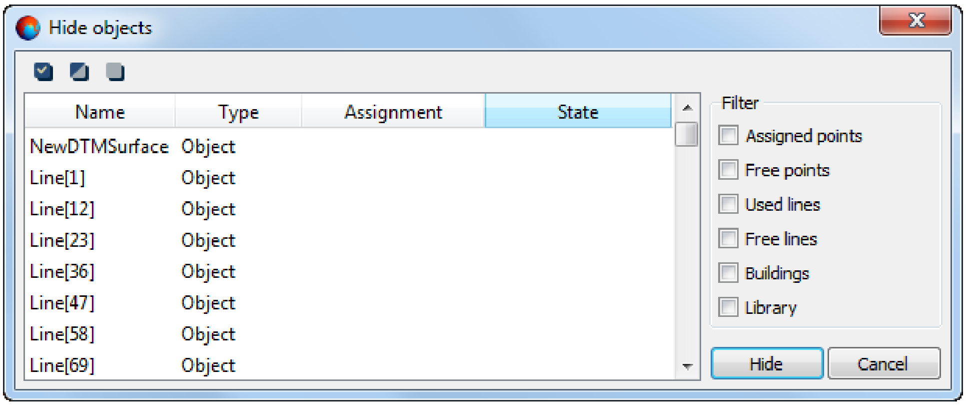


Fig. 221. Hide objects from the list window

15. In the **Advanced properties** section, in the **Control** tab open the drop-down menu, corresponding the button. Click `LookAt Controller` in drop-down menu;

16. Click `LookAt Controller` in controllers list;

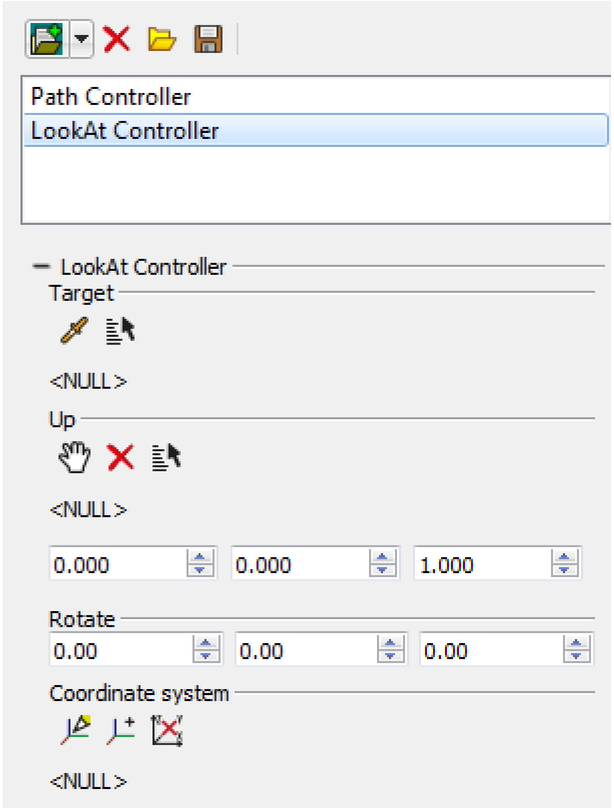


Fig. 222. Camera controllers list

17. In the **Target** section click the button (**Select**). The **Select objects** window opens;

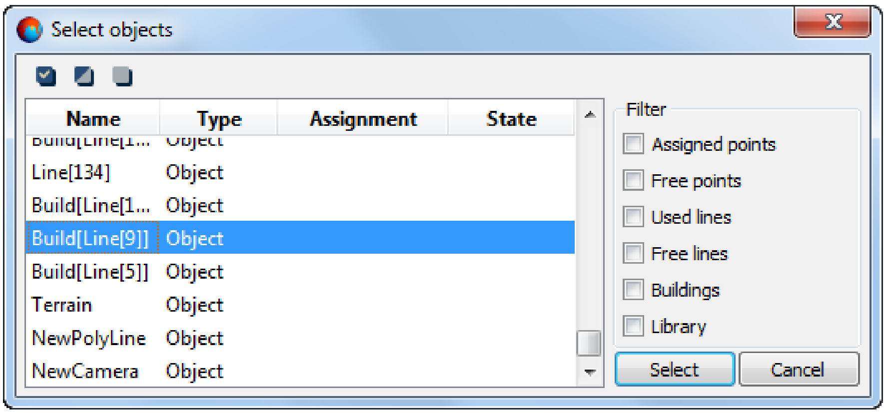


Fig. 223. Select object from the list window

18. Select object by mouse and click the **Select** button. After that coordinate axis of the camera lens is directed toward the selected object;

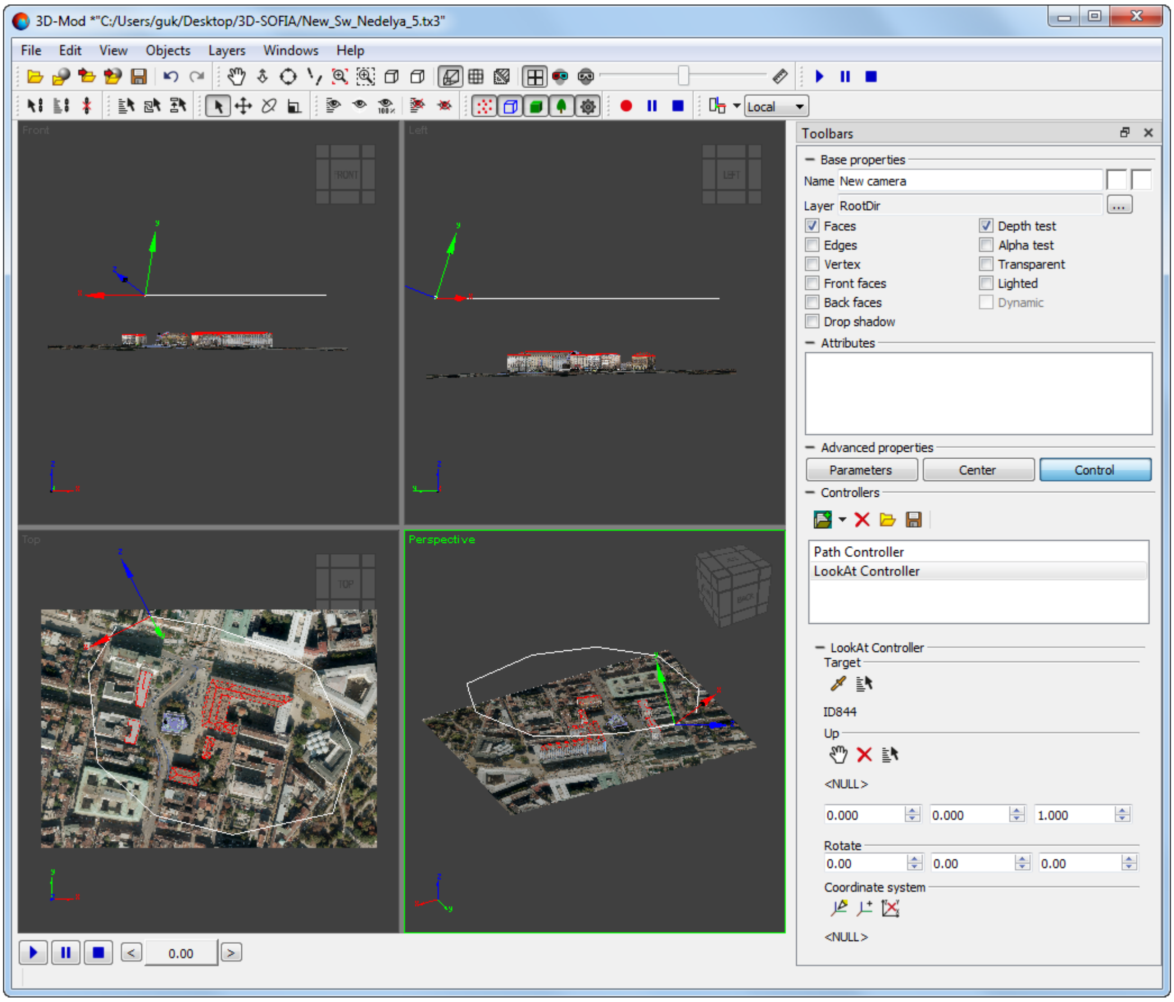


Fig. 224. Camera lens directed towards the selected object

19. [optional] To adjust the direction of the lens or camera coordinate system, configure the following `LookAt Controller` parameters:

   - **Up** – allows to select or specify an object to direct top object face;
   - **Orientation** – allows to rotate a camera in relation to selected coordinate system axis;
   - **Coord system** – allows to select or specify axes of object coordinate system to assign this coordinate system to the camera.

20. Choose **View › Camera › NewCamera**. 3D-scene is displayed as from camera lens;

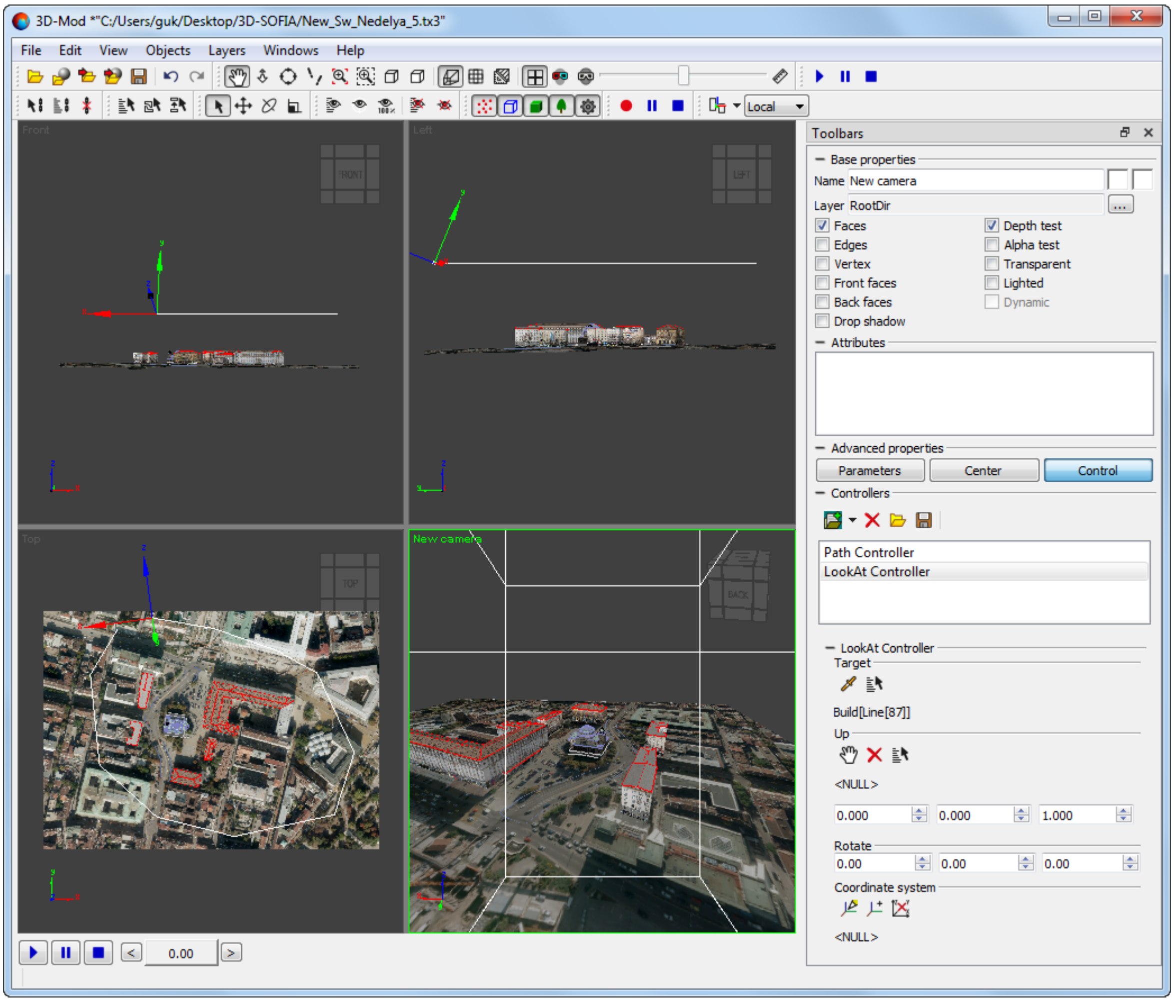


Fig. 225. 3D-scene display in four projection windows from the camera lens

21. [optional] To configure desired view of 3D-scene from camera, setup camera parameters in the **Advanced properties** section;

22. [optional] To change scene playback duration select **File › Settings** and input the **Length (snaps)** and **Framerate** values on the **Scene** tab;

    - **Length (snaps)** – number of frames;
    - **Framerate** – playback frame rate.

Scene playback duration is calculated by the following formula: **Length (snaps)**/ **Framerate** (100/25 = 4 seconds in given example).

It is impossible to input zero or negative value of the **Framerate** parameter. Minimal value accepted by the system is 1.0.

It should be noted that the *duration of a scene playback* (which is the ratio of **Length (snaps)** to **Framerate**) and the *time of camera movement* (set in seconds, see paragraph **13**) are two different values that can be set independently.

For example, with the following parameters on the **Scene** tab:

- **Length (snaps)** – 1000;
- **Framerate** – 25;

(i.e., the duration of the scene playback is 40 seconds) and the following parameters in the **Time** section:

- **Start** – 20;
- **Stop** – 40;

(camera movement for 20 seconds after a 20 second delay) - the end of the 40 second scene will coincide with the camera reaching the end point of its path.

23. Choose **View › Multiview** or click the button to display the whole area of active projection window.

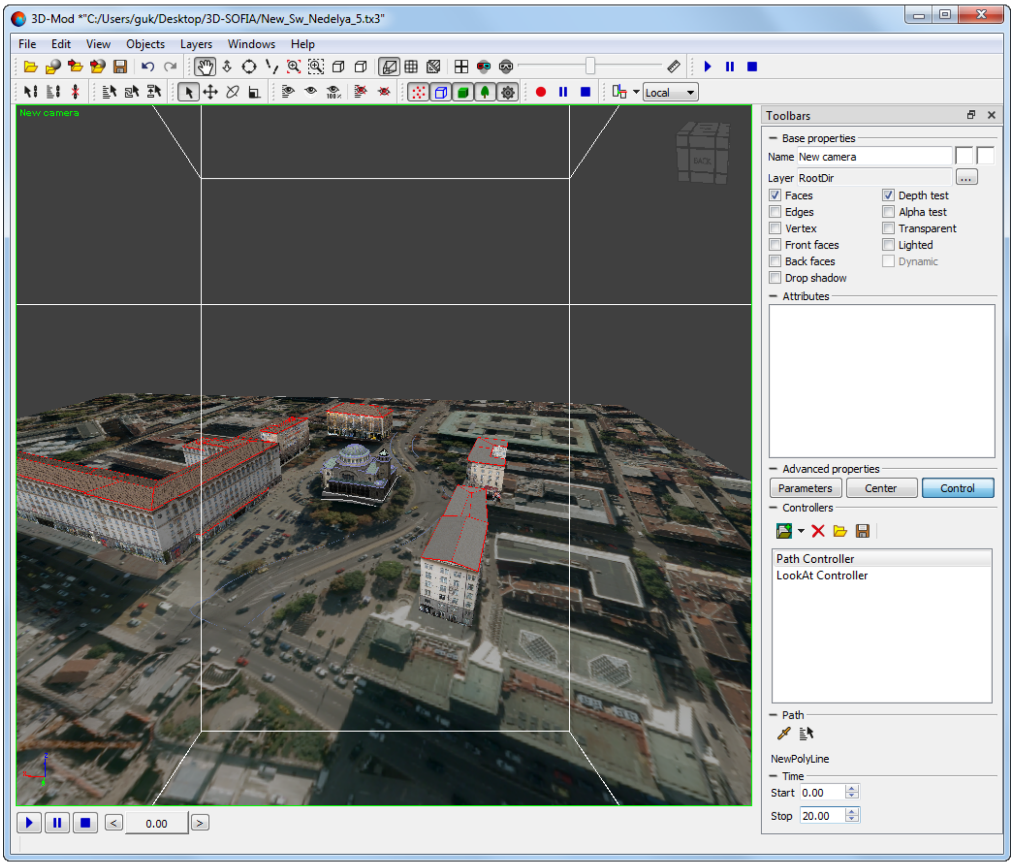


Fig. 226. 3D-scene display from the camera lens

24. Click the button to perform scene playback.

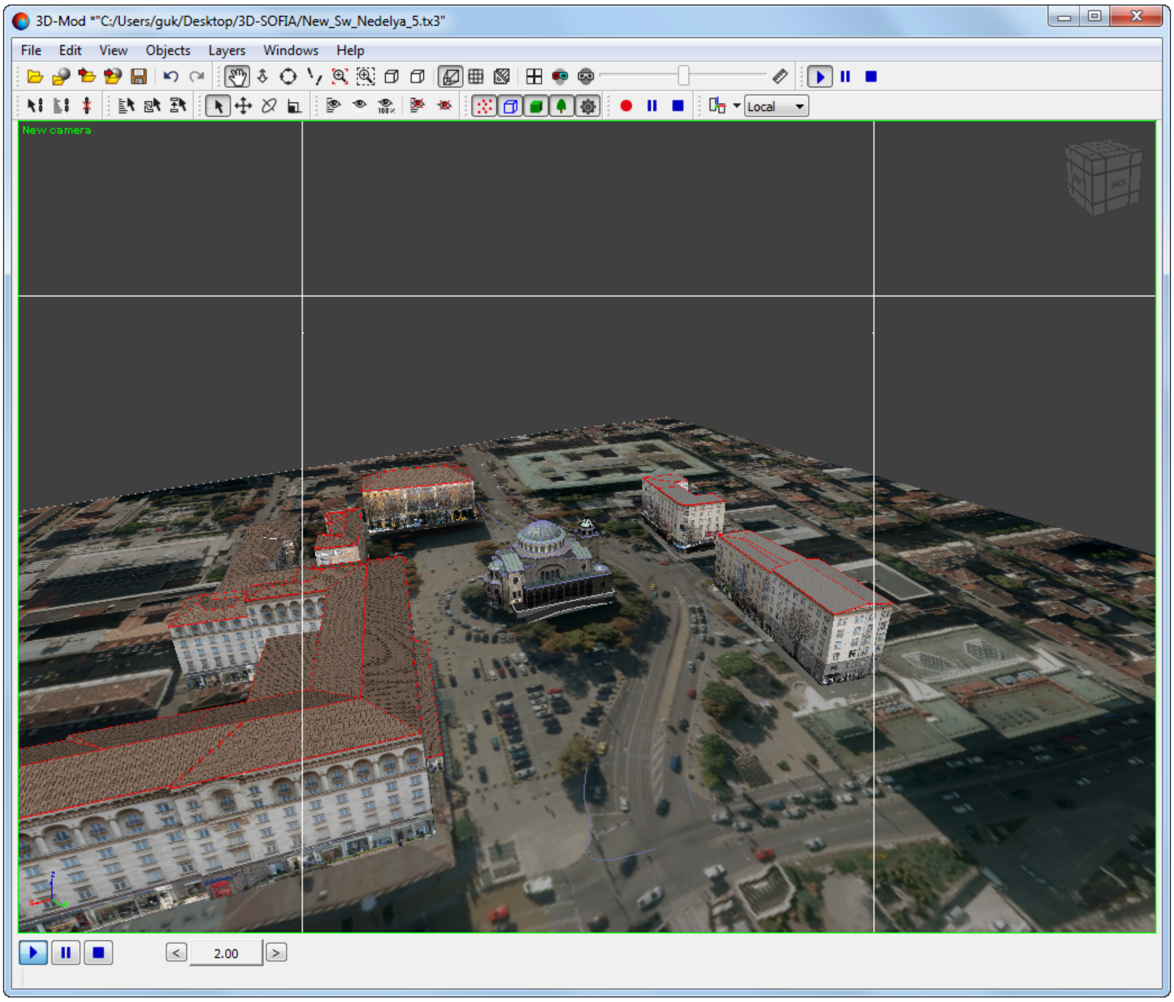


Fig. 227. Scene playback

There are the following buttons used to manage scene playback:

To watch the movement of the camera along the path “from aside”, select **View › Camera › Projection**. To display a 3D scene from the camera lens, select **View › Camera › NewCamera**. It is possible to switch between views during the playback.

- 0.00 (frame selector) – allows to pass to any of adjacent frames;
- – allows to start 3D-scene playback;
- – allows to temporarily stop 3D-scene playback;
- – allows to pause 3D-scene playback.

12.2. Animation of object rotation

The module allows to animate object rotation in scene view area using specified path.

In order to create animation keys of object rotation and start object animation, perform the following actions:

1. Maximize the scene scale.
2. Select an object.

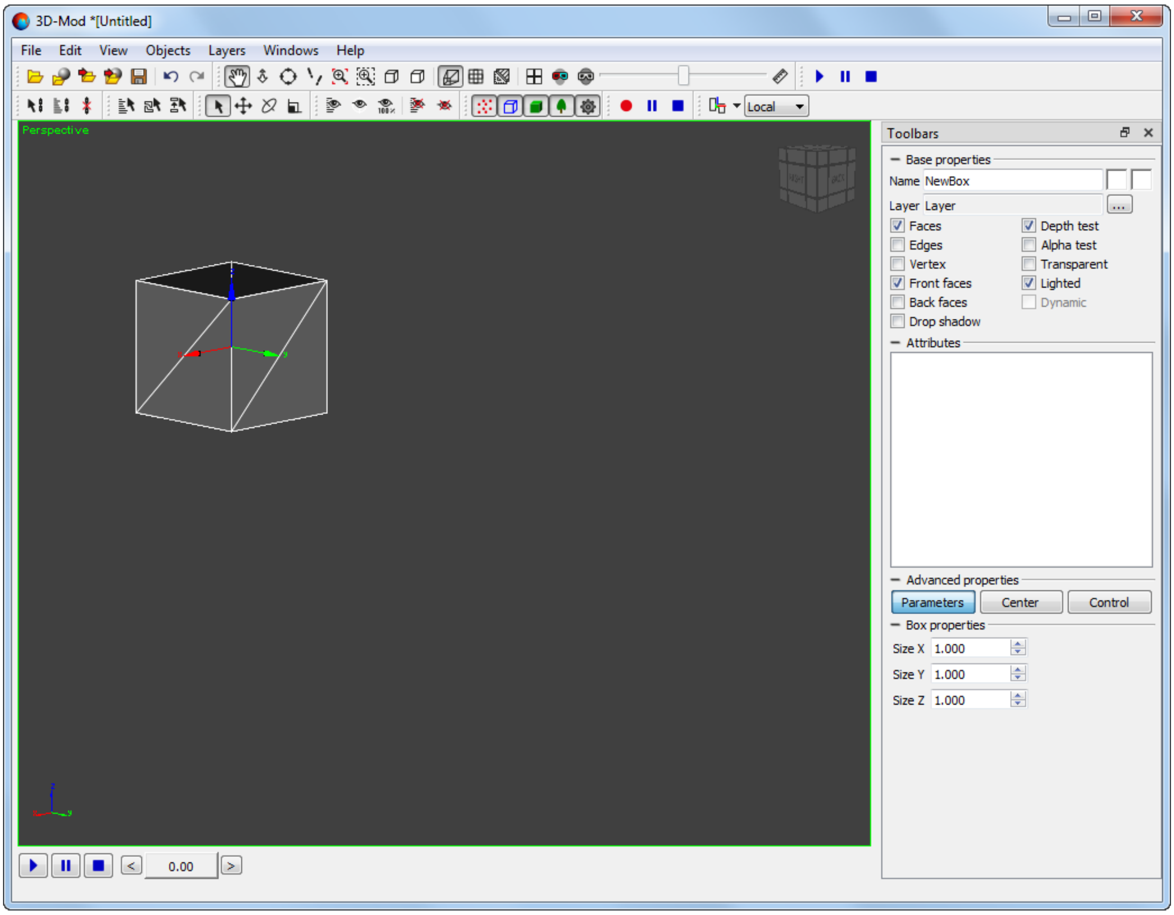


Fig. 228. Selected object

3. In the **Advanced properties** section, in the **Control** tab open the drop-down menu, corresponding the button. Click `Rot (XYZ)Ex Controller` in drop-down menu;
4. In the **Properties** section click the button. The **Rot (XYZ)Ex Controller** window opens. The selected objects rotation mode is on.

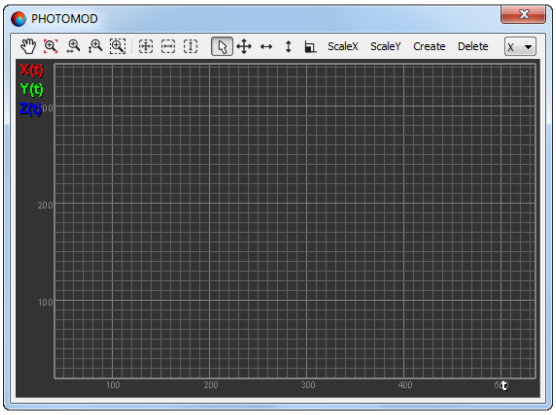
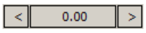


Fig. 229. Rotation controller

5. [optional] Move the frame selector  to `0.0` position.

6. Rotate the object along a single axis or in a free plane.

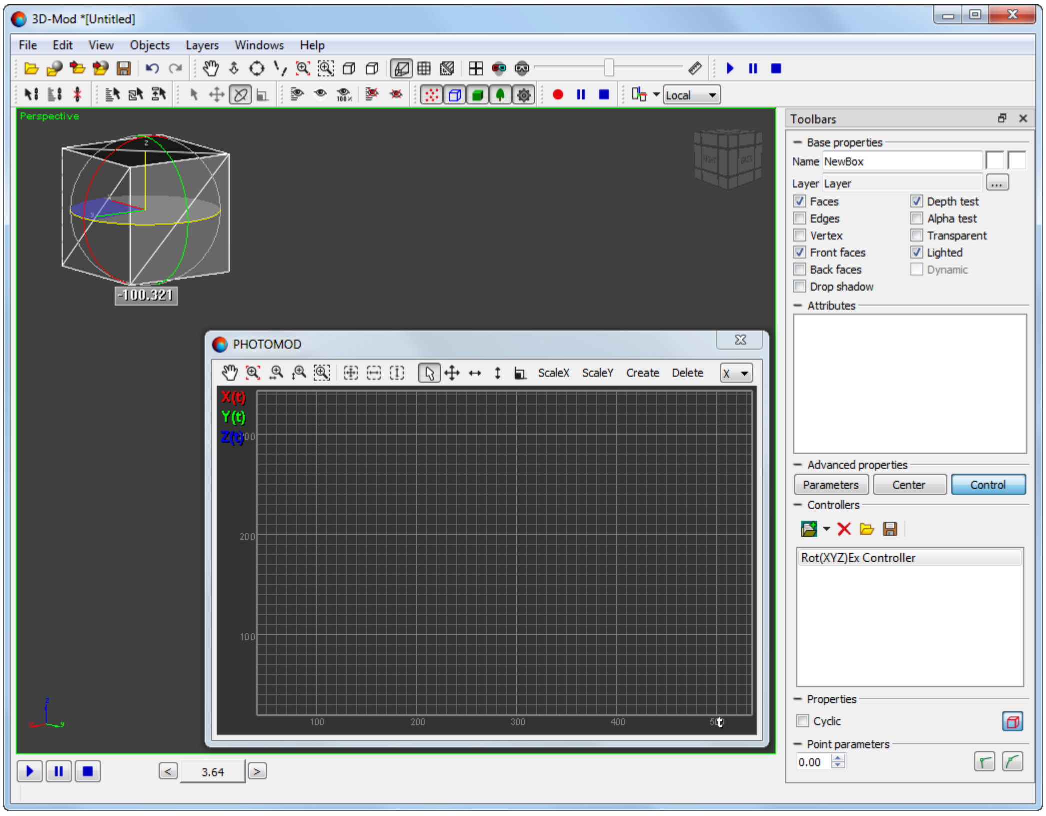


Fig. 230. First object position

7. Move the frame selector to desired number of seconds.

8. Rotate the object along a single axis or in a free plane.

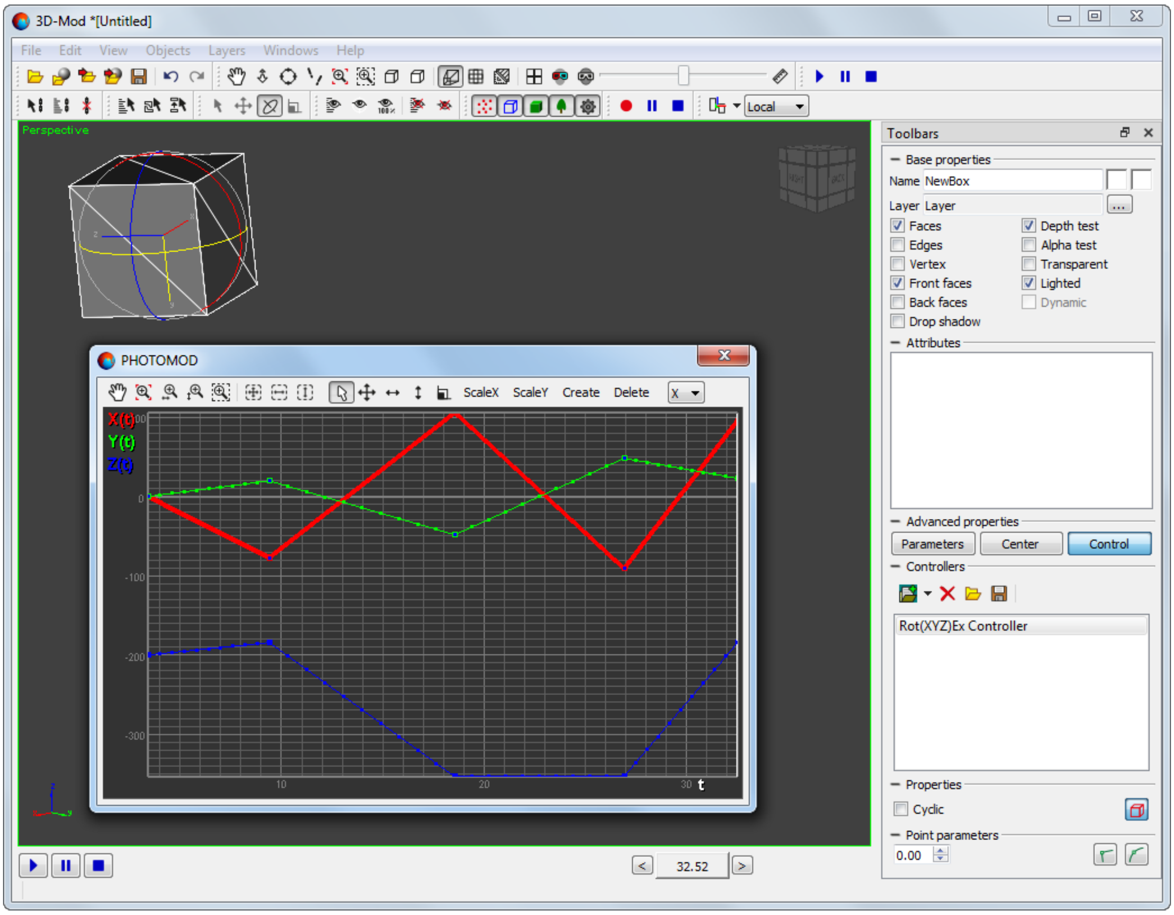


Fig. 231. Third object position

9. In the **Rot (XYZ)Ex Controller** window click the button. Animation keys chart area is displayed.

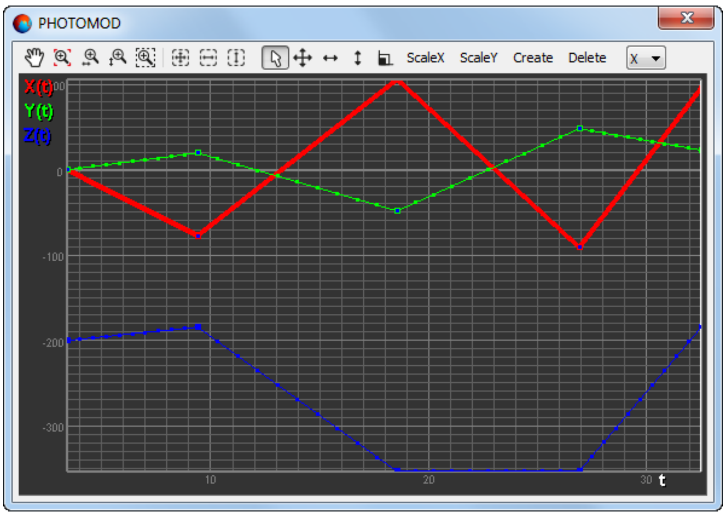


Fig. 232. Animation keys chart

10. Continue creation of new animation controls used to rotate an object.

11. [optional] To adjust the torque of the object in space, perform the following actions:

    1. Select animation key in the **Rot (XYZ)Ex Controller** window.

       Select animation key on the active rotation axis of the object (in the **Rot (XYZ)Ex Controller** window is highlighted by a thick line).

    2. Specify time value in the **Point parameters** section.

12. [Optional] Edit the object's rotation path along the axes in the **Rot (XYZ)Ex Controller** window.

13. [optional] To repeat the object animation set the **Loop** checkbox on in the **Properties** section.

14. [optional] To replace a straight line between animation keys by a curve select animation keys and click the button. Otherwise, animation keys are connected by straight lines.

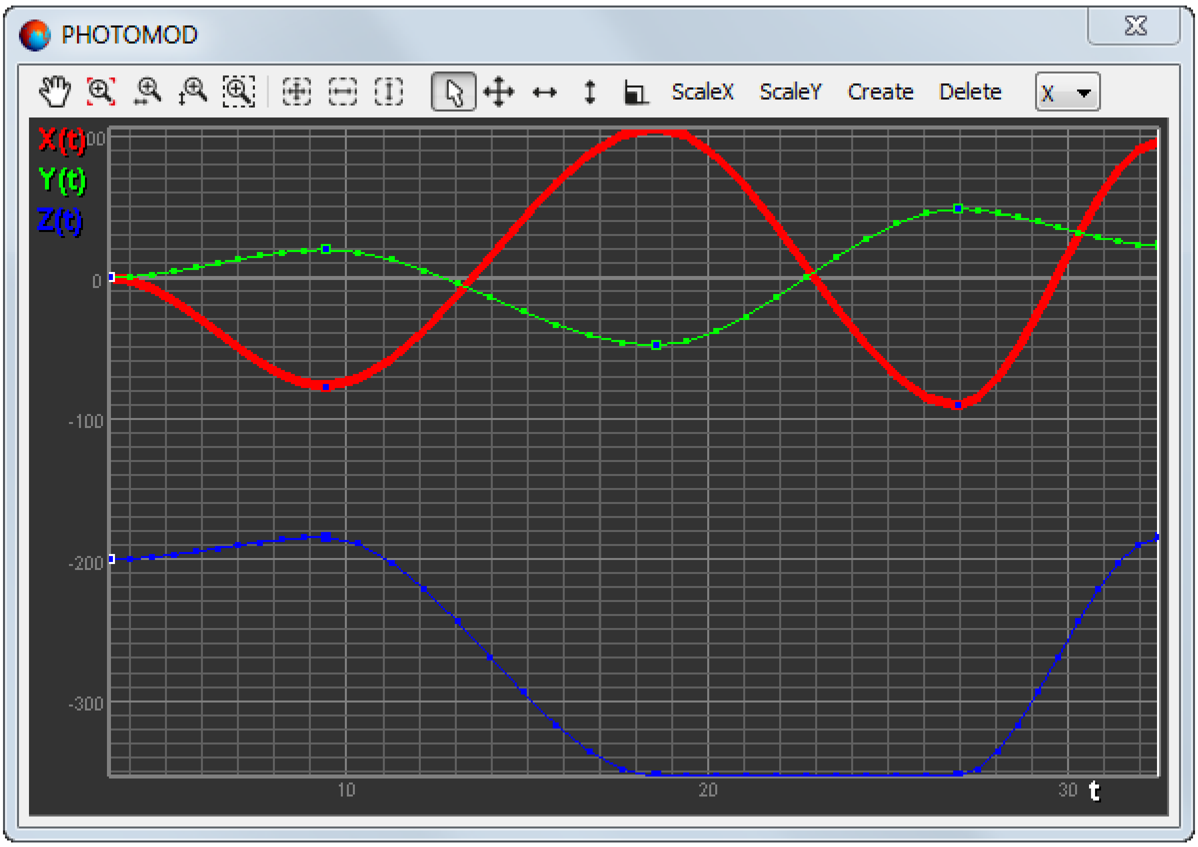


Fig. 233. Creating a curve between animation keys

15. Move the frame selector to `0.0` position.

16. Close the **Rot (XYZ)Ex Controller** window to complete animation keys creation.

17. Click the ▶ button to playback object movement animation.

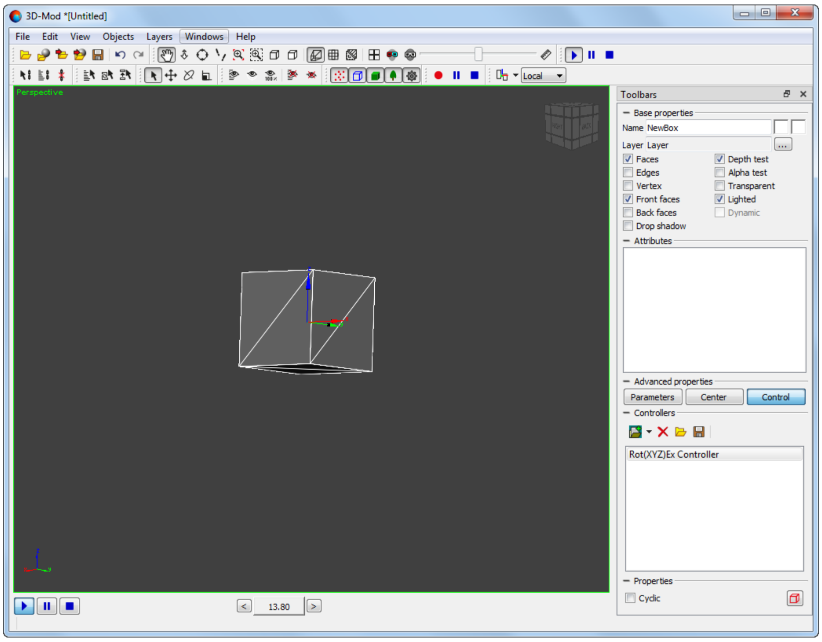


Fig. 234. Playback of object rotation animation

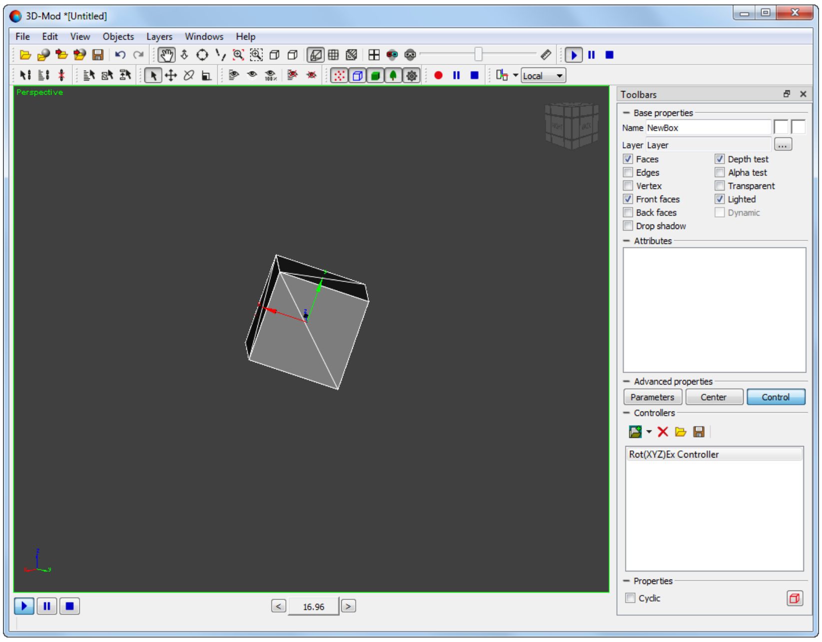


Fig. 235. Playback of object rotation animation

12.3. Animation of object movement

The module allows to animate object moving in scene view area using specified path.

In order to create animation keys of object moving and start object animation, perform the following actions:

1. Maximize the scene scale.

2. Select an object.

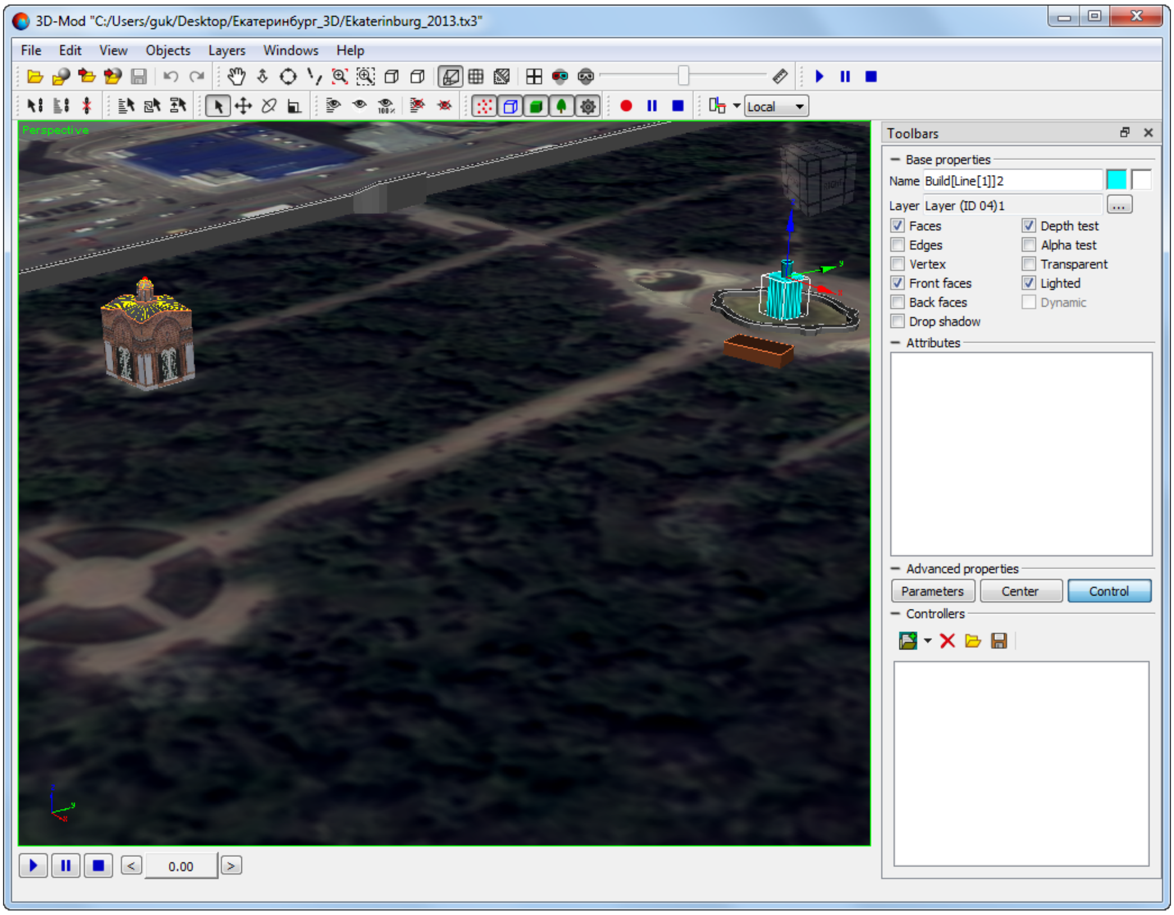


Fig. 236. Selected object

3. In the **Advanced properties** section, in the **Control** tab open the drop-down menu, corresponding the button. Click `Pos (V3Ex) Controller` in drop-down menu;

4. In the **Editing** section click the button. The **Pos (V3Ex) Controller** window opens.

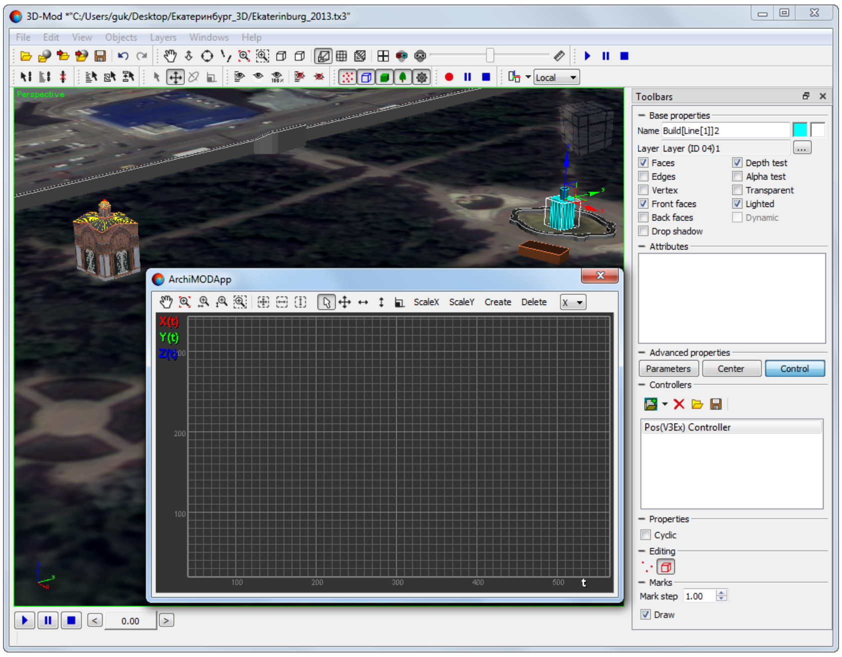
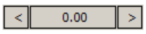


Fig. 237. Moving controller

5. [optional] Move the frame selector  to `0.0` position.
6. Move the object to the first point of scene's space.

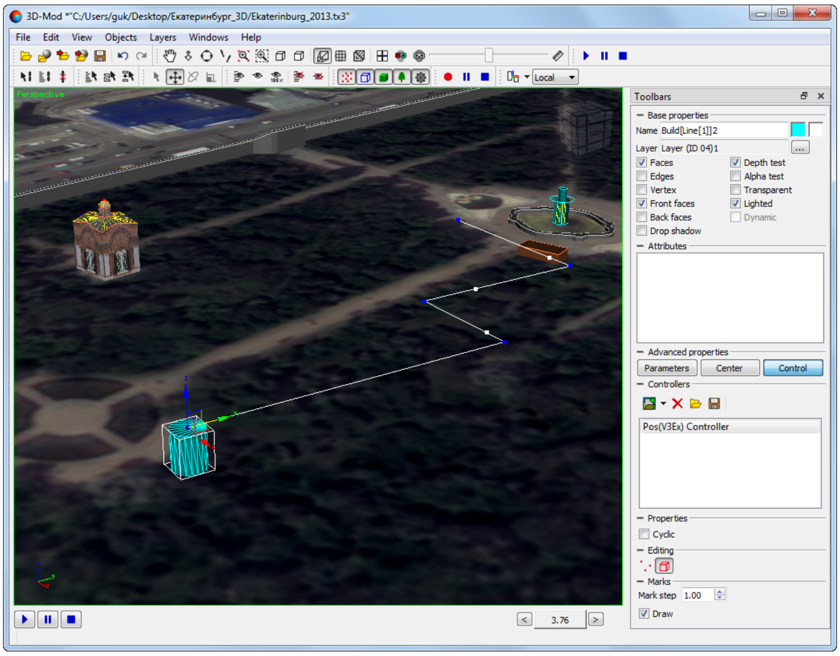


Fig. 238. The first point of scene space

7. Move the frame selector to desired number of seconds.

8. Move the object to the second point of scene's space.

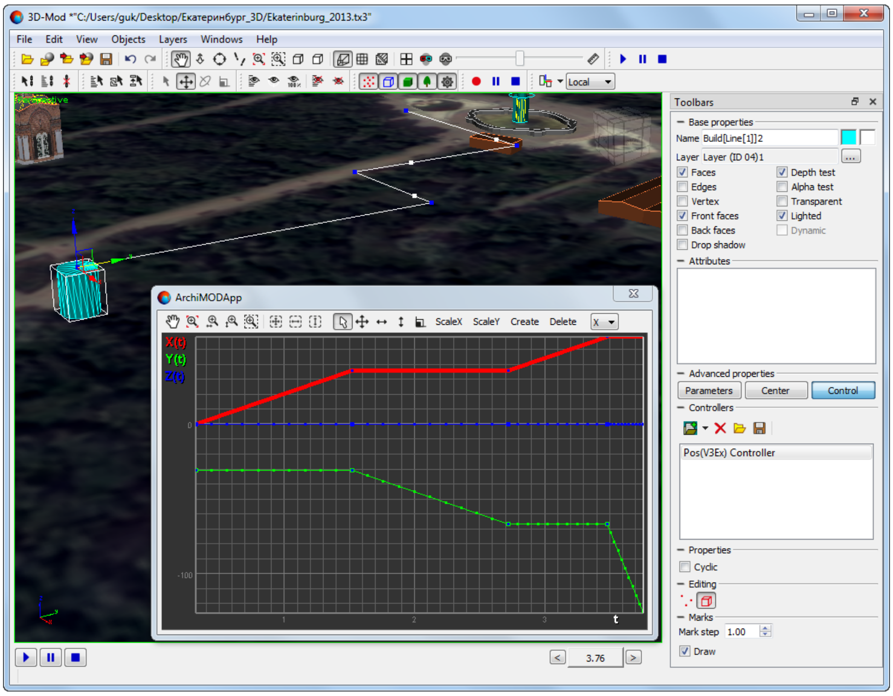


Fig. 239. Object moves to the second point

9. In the **Pos (V3Ex) Controller** window click the button. Animation keys chart area is displayed.

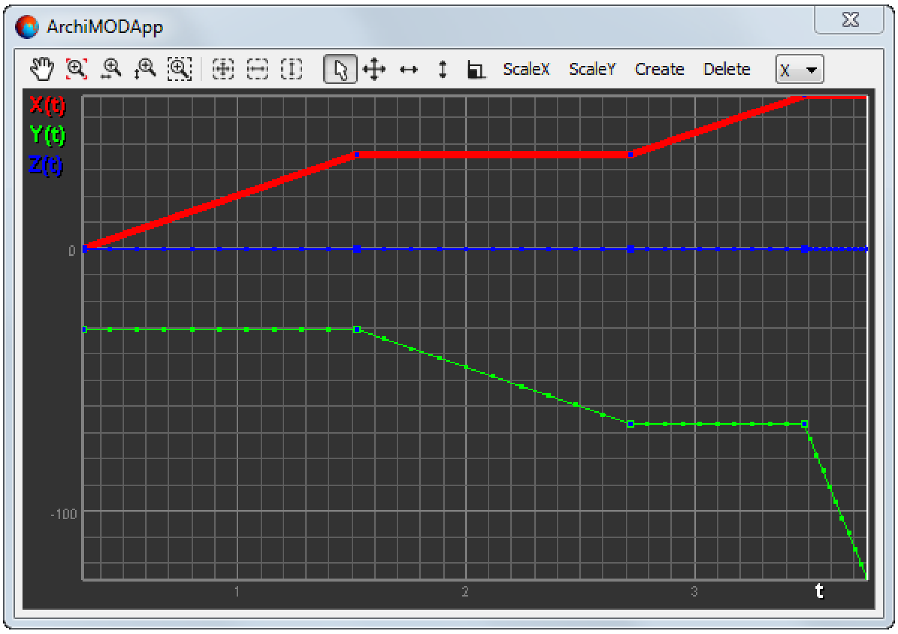


Fig. 240. Animation keys chart

10. Continue creation of new animation keys used to move an object.

11. [optional] To adjust object shift moment in space, perform the following actions:

    1. Select animation key in the **Pos (V3Ex) Controller** window.

       Select animation key on the active rotation axis of the object (in the **Pos (V3Ex) Controller** window is highlighted by a thick line).

    2. In the main module window click the button.

    3. Specify the **Time** value in the **Points** section.

12. [Optional] Edit the object's rotation path along the axes in the **Pos (V3Ex) Controller** window.

13. [optional] To let an object move along a curve, select animation keys and in the main module window click the button and the button. Otherwise, the object moves along a straight line.

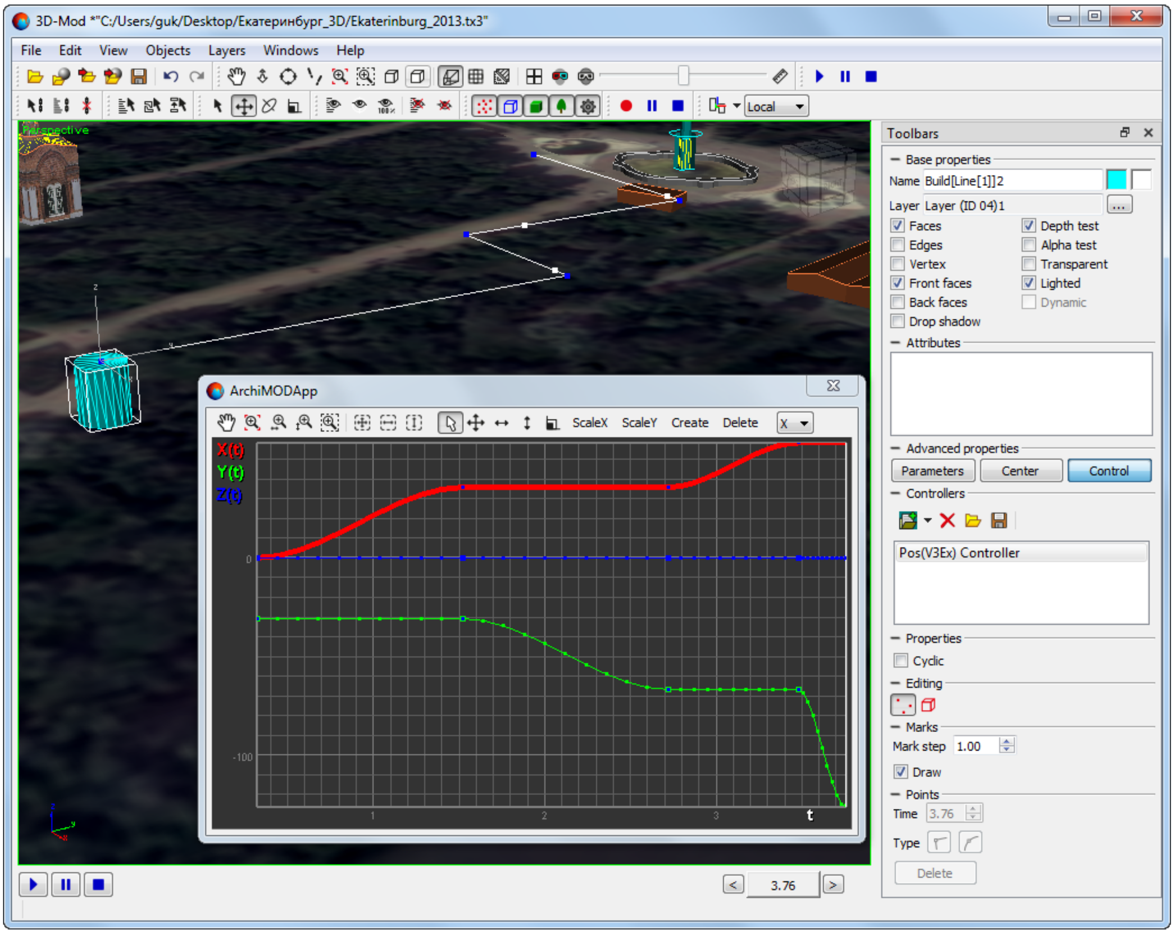


Fig. 241. Creation a curve line for object moving

14. [optional] To repeat the object animation set the **Cyclic** checkbox on in the **Properties** section.

15. [optional] In the **Marks** section input the **Mark step**.

16. [optional] To hide marks of animation keys in a view area, clear the **Draw** checkbox.

17. Move the frame selector to `0.0` position.

18. Close the **Pos (V3Ex) Controller** window to complete animation keys creation.

19. Click the button to playback object movement animation.

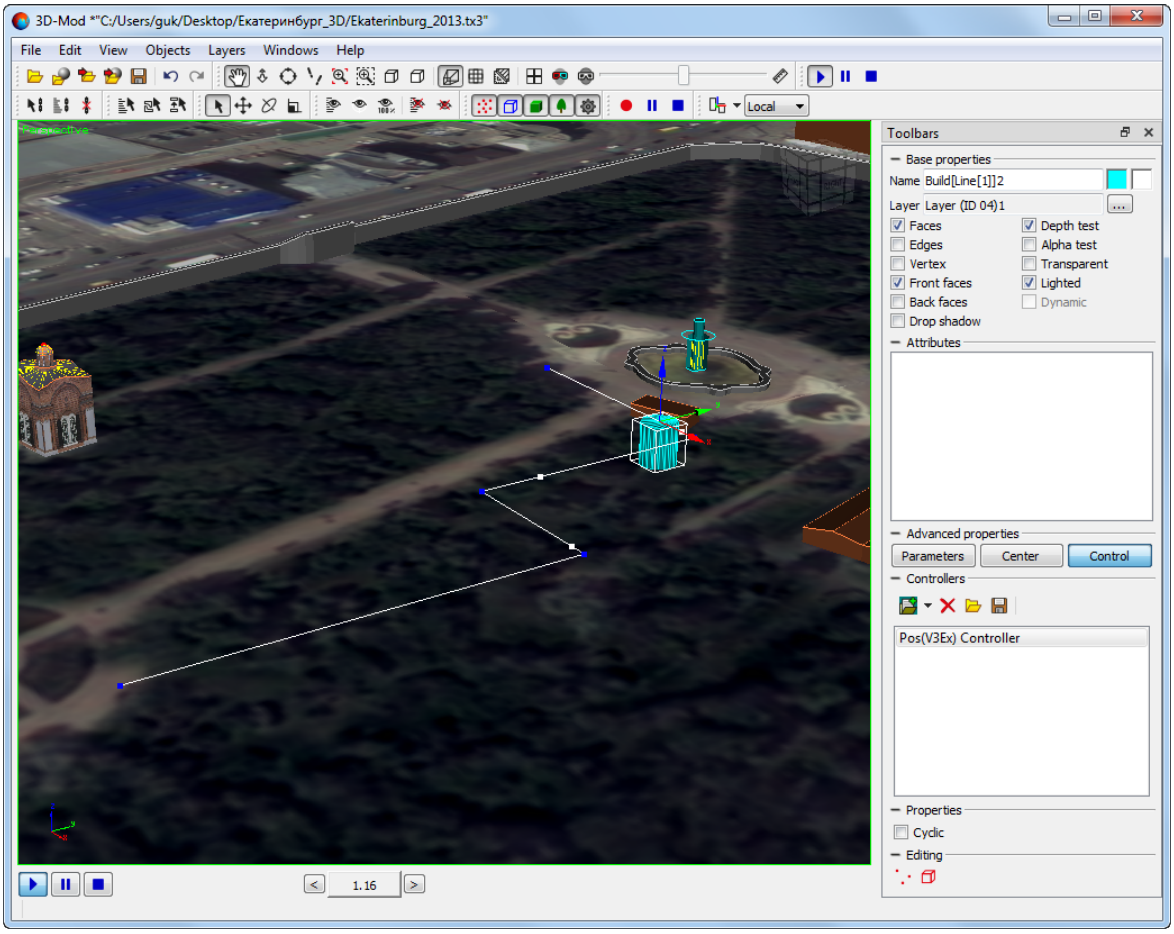


Fig. 242. Playback of object move animation

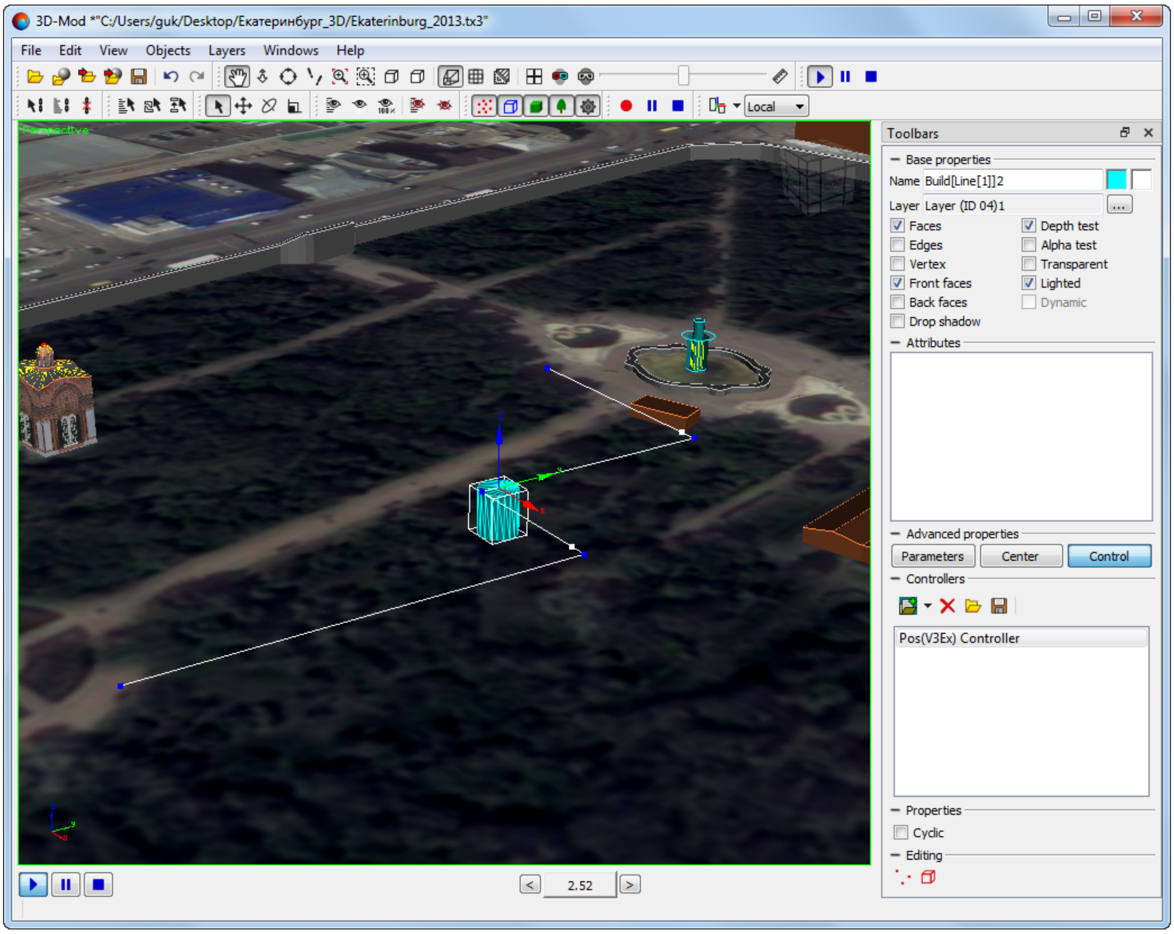


Fig. 243. Playback of object move animation

12.4. Controllers

Animation controller – a means for controlling an animation object or a scene.

The module provides controllers of the following types:

- *key controllers* (`Pos (V3Ex) Controller`, `Rot (XYZ) Controller`) – use animation keys;
- *procedure controllers* (`Path Controller`, `LookAt Controller`) – use values specified by user.

In order to animate object rotation or moving, and for scene animation there is a possibility to create controllers. To do this the **Controls** tab in the **Advanced properties** section is used.

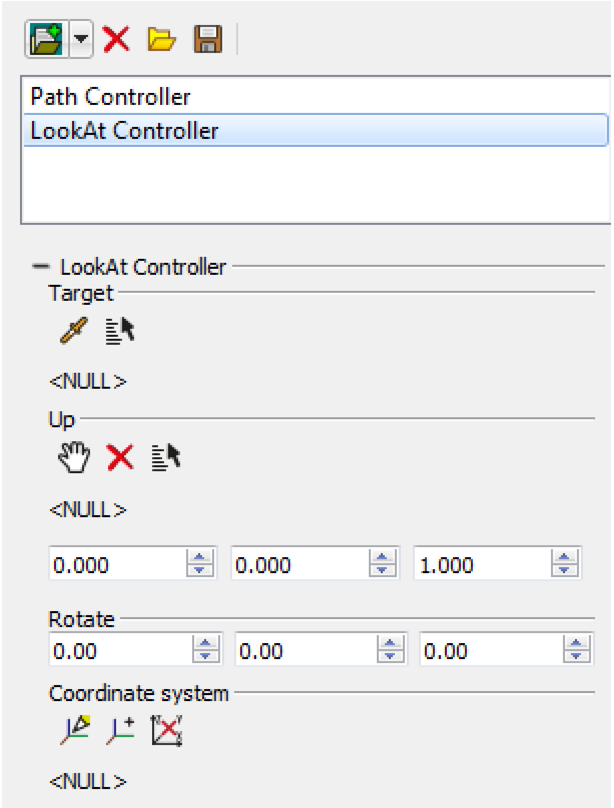


Fig. 244. Controllers

No more than two controllers can be assigned to one object.

Open the drop-down menu, corresponding the button, to add a controller. Select one of the following controllers using mouse click:

- `Pos (V3Ex) Controller` – allows to create object move animation in view area;
- `Rot (XYZ) Controller` – allows to create object rotation animation in view area;
- `Path Controller` – allows to move a camera along path (open or closed);
- `LookAt Controller` – allows to orient a camera lens in direction of one of the scene objects.

To remove a controller from the list click the (**Delete**) button.

To load controller parameters for selected object click the (**Load**) button. The **Load controllers** window opens. Choose the `*.tx3` file and click the **Open** button.

To save the controller parameters click the (**Save**) button. The **Save controllers** window opens. Choose the `*.tx3` file and click the **Save** button.

12.5. Controller window

The **Rot (XYZ)Ex Controller** window is used to create rotation animation keys.

The **Pos (XYZ) Controller** window is used to create moving animation keys.

The horizontal scale shows the move / rotate time of the object in seconds. The vertical scale shows the move / rotate path of the object.

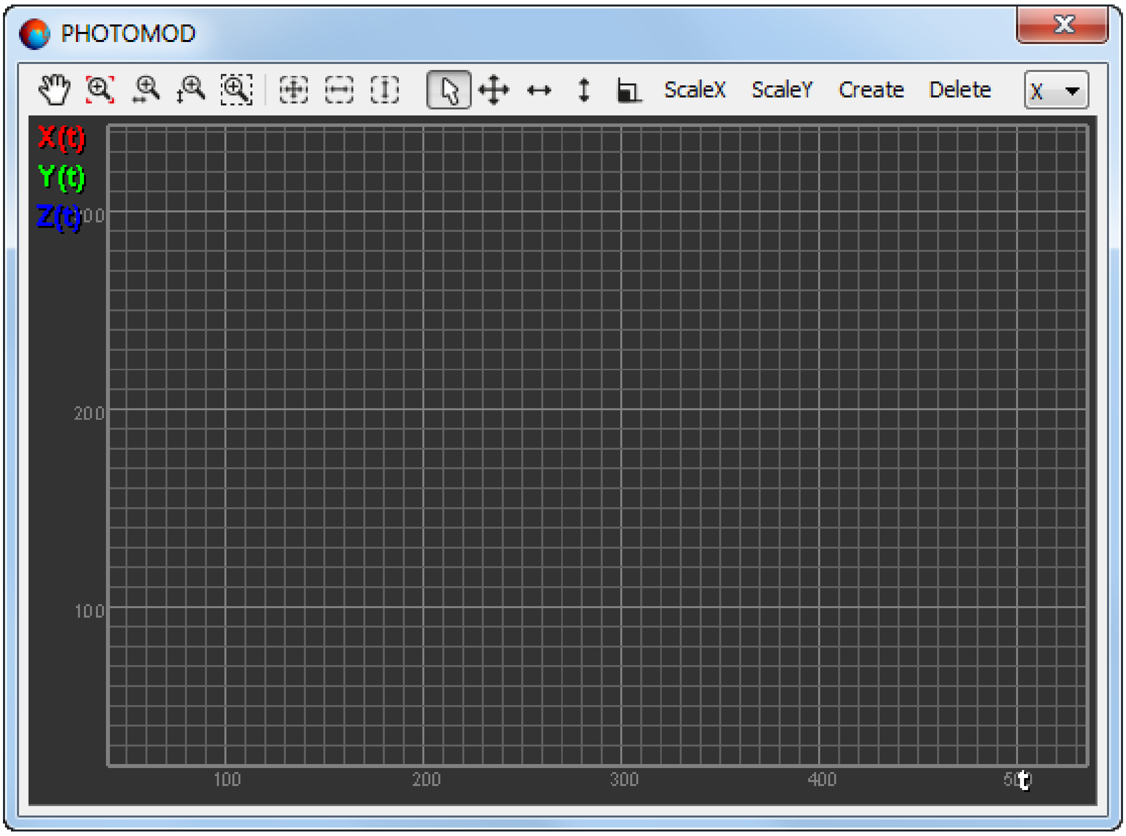


Fig. 245. The Rot (XYZ)Ex Controller window

The toolbar of the **Rot (XYZ)Ex Controller** and **Pos (XYZ) Controller** window contains the following buttons:

-  – allows to move a view area of animation keys in any direction;
-  – allows to zoom in/zoom out view area
-  – allows to zoom in/zoom out time coordinates grid;
-  – allows to zoom in/zoom out space coordinates grid;
-  – allows to zoom in any part of view area selected by rectangle;

- – allows to display just animation keys chart in view area;
- – allows to display chart area with maximal time scale in view area;
- – allows to display chart area with maximal time scale in view area;
- – allows to turn on selection of animation keys mode;
- – allows to move in arbitrary direction animation keys highlighted in view area;
- – allows to move horizontally animation keys highlighted in view area;
- – allows to move vertically animation keys highlighted in view area;
- – allows to turn on zoom of selected animation keys in arbitrary direction;
- – allows to turn on zoom selected animation keys horizontally;
- – allows to turn on zoom selected animation keys vertically;
- – allows to turn on adding of animation keys mode;
- – allows to remove selected animation keys.

The drop-down list on the toolbar of the **Rot (XYZ)Ex Controller** and **Pos (XYZ) Controller** windows allows to select the active axis of the object's movement / rotation when editing the object's trajectory of movement / rotation.

13. 3D-scene recording

The module provides possibility to create a video file, generated from animated frames of 3D-scene. AVI (or MPEG-4) video format is used to save a file with animated frames.

AVI (Audio Video Interleaved) – video files format with `*.avi` extension. It is used in applications that work on *Windows* platform.

Prior to record 3D-scene to a videofile it is necessary to create a series of frames, i.e. to perform scene animation.

Perform the following actions to create a scene video file:

1. Click the button on the main toolbar. The **Save record** window opens. Choose a folder to place a file in *Windows* system. Specify a file name in the **File name** input field. Click the **Save** button. The **Codecs** window opens.

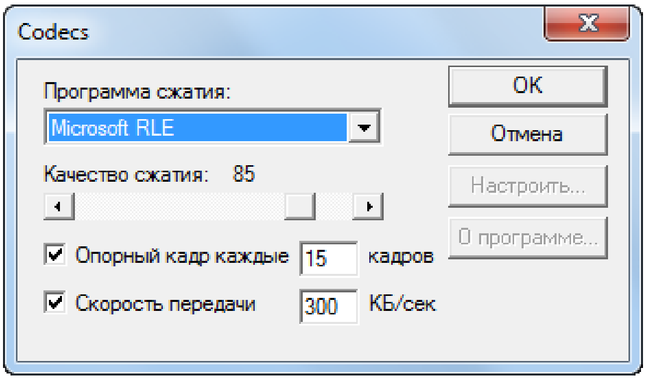


Fig. 246. Parameters of videofile creation

2. [optional] Set video recording settings.

   It is recommended to select *Microsoft Video 1* program from the **Программа сжатия** list.

3. Click OK. A video recording process is started.

4. Click the button on the scene replay toolbar (or on the upper part of the main toolbar) to start 3D-scene playback;

5. Click the button on the scene replay toolbar (or on the upper part of the main toolbar) to stop scene playback;

6. Click the button on the lower part of the main toolbar to stop video recording. Video file in AVI format is created.

   To view created video, the file should be opened with the *VLC media player* program.

Appendix A. Coordinate systems

The coordinate system in the module is a set of three axes (X, Y, and Z), which define object orientation in scene space.

The module provides the following coordinate systems:

- `Local` (default system) – with origin in the “reference” point of selected object. Z-axis is used to show an object height, X-axis – is used to show an object width, and Y-axis – is used to show an object length.

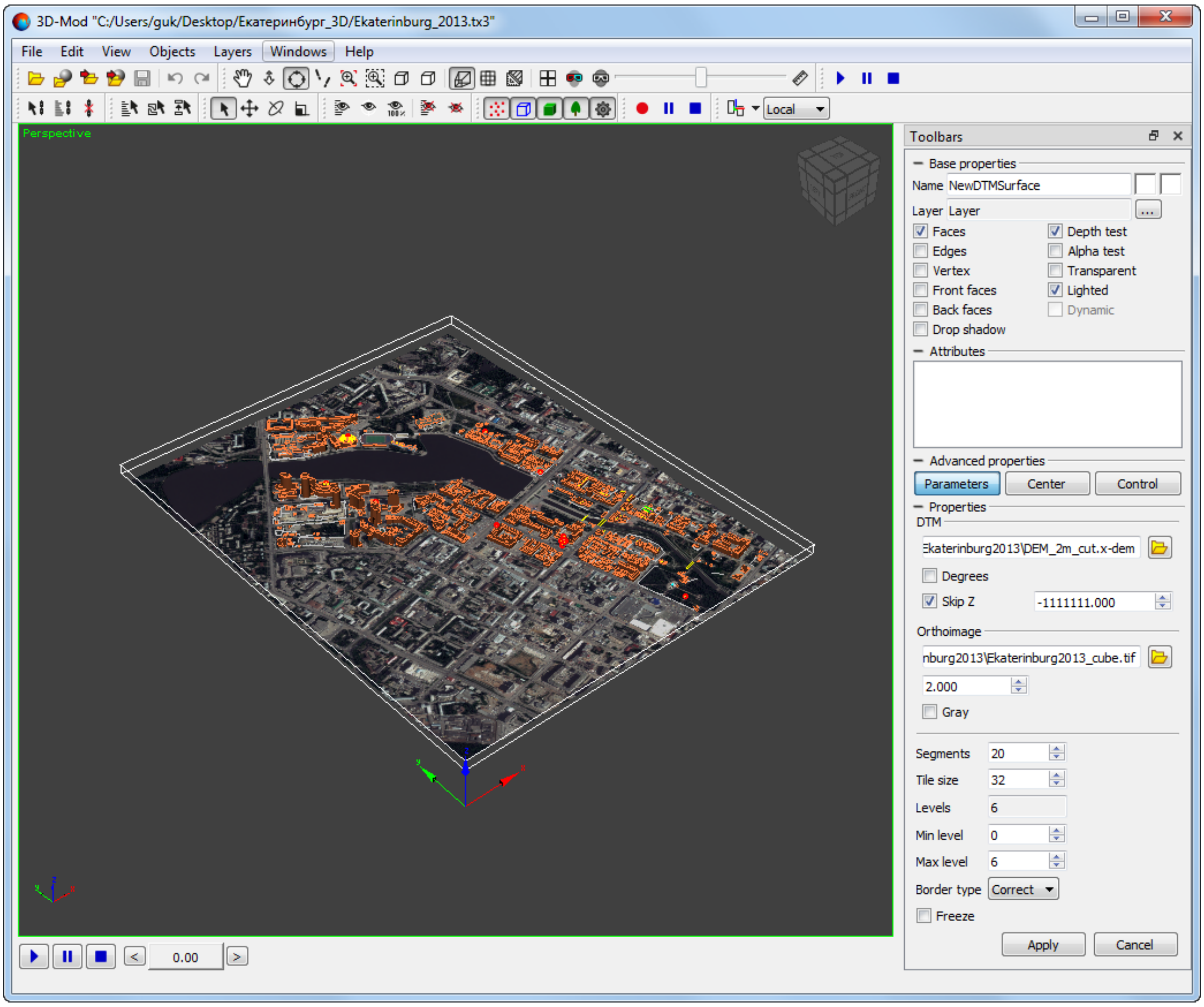


Fig. A.1. Local coordinate system

- `Parent` (used for objects with hierarchical relationships) – with origin in the “reference” point of selected object. Z-axis is used to show a parent object height, X-axis – is used to show a parent object width, and Y-axis – is used to show a parent object length.

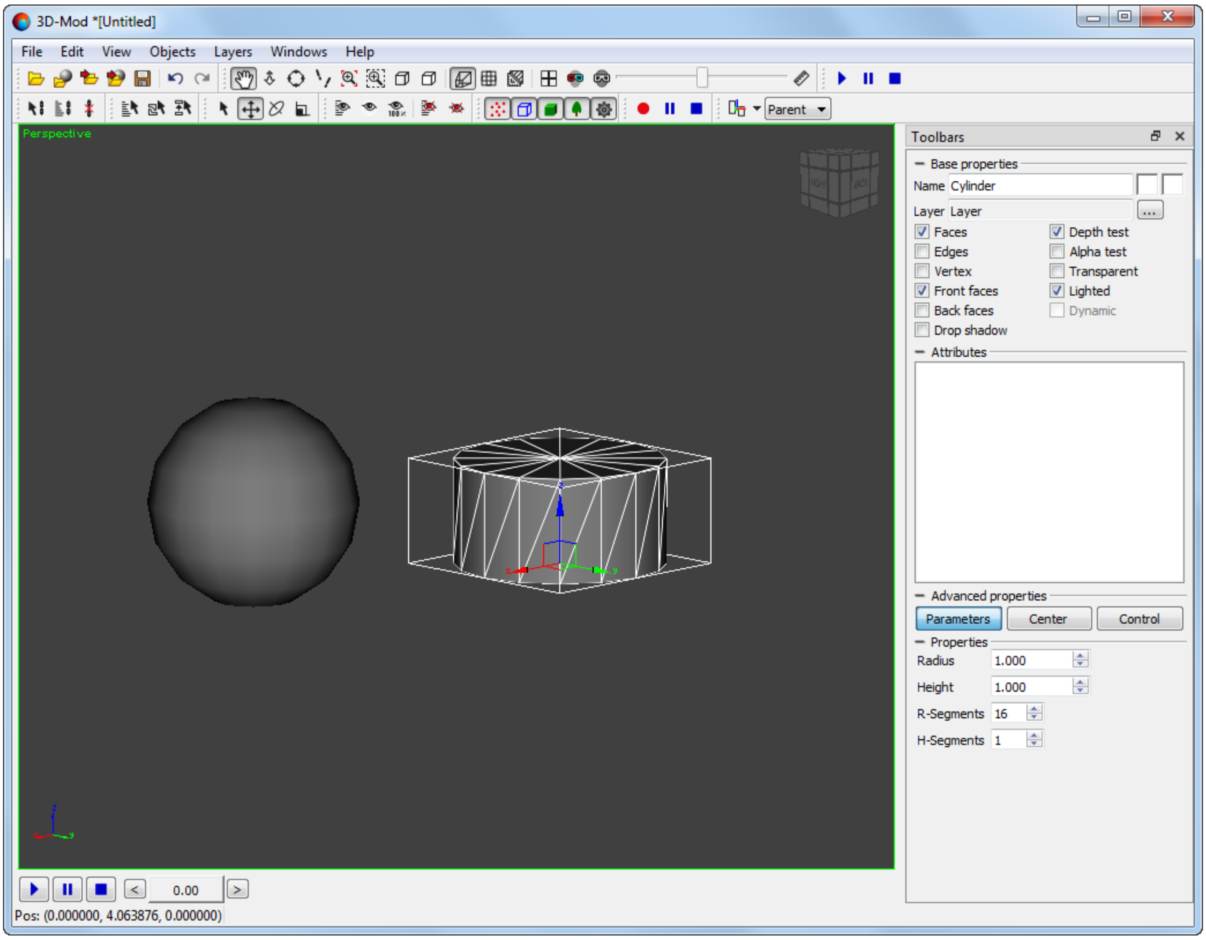


Fig. A.2. Parent coordinate system

- `Global` – with origin in zero point of 3D-scene space. Z-axis is used to show a scene height, X-axis – is used to show a scene width, and Y-axis – is used to show a scene length. Direction of the coordinate system axes is displayed in the lower left corner of the module's window.

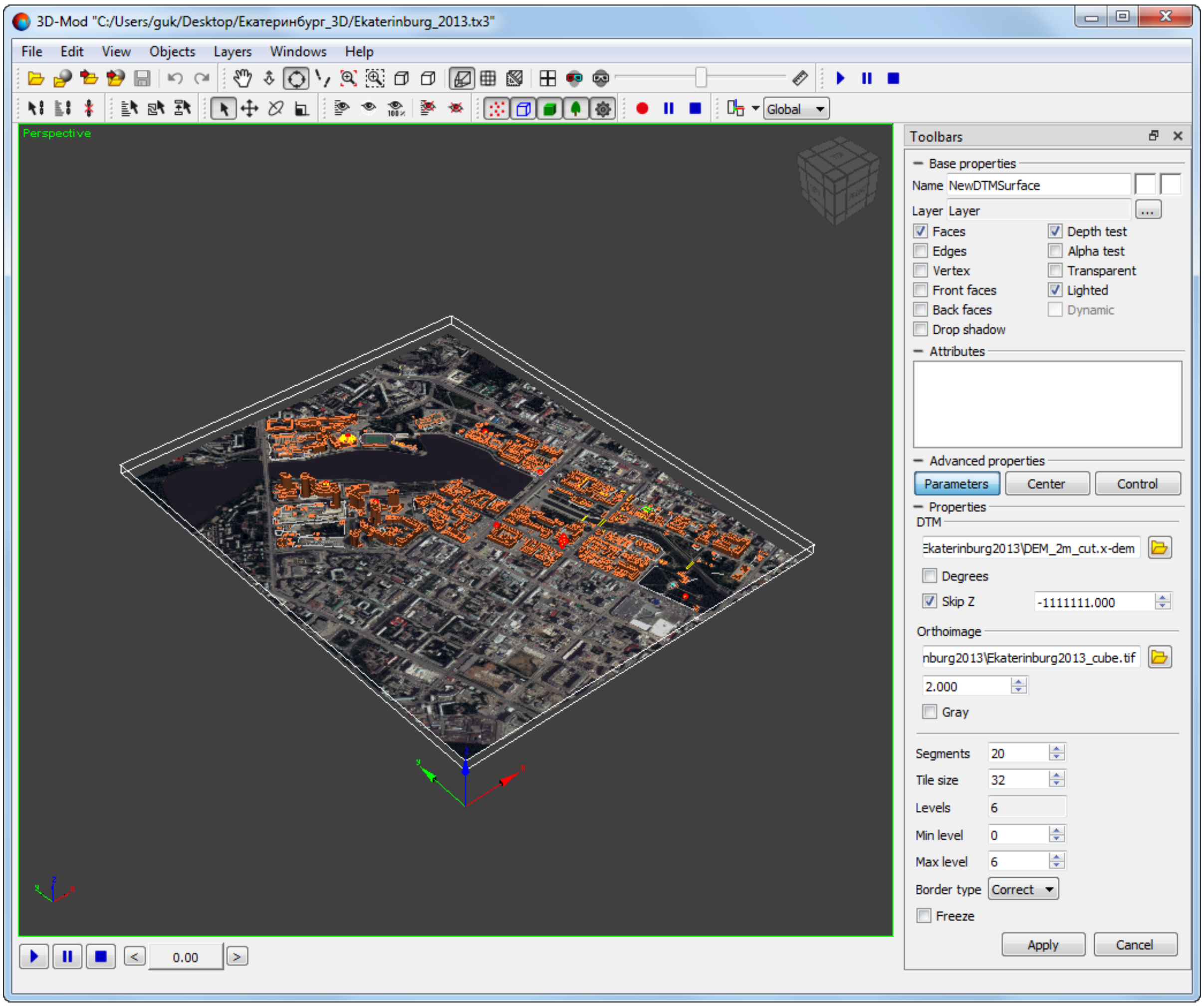


Fig. A.3. Global coordinate system

- `View` – with origin in zero point of 3D-scene space.

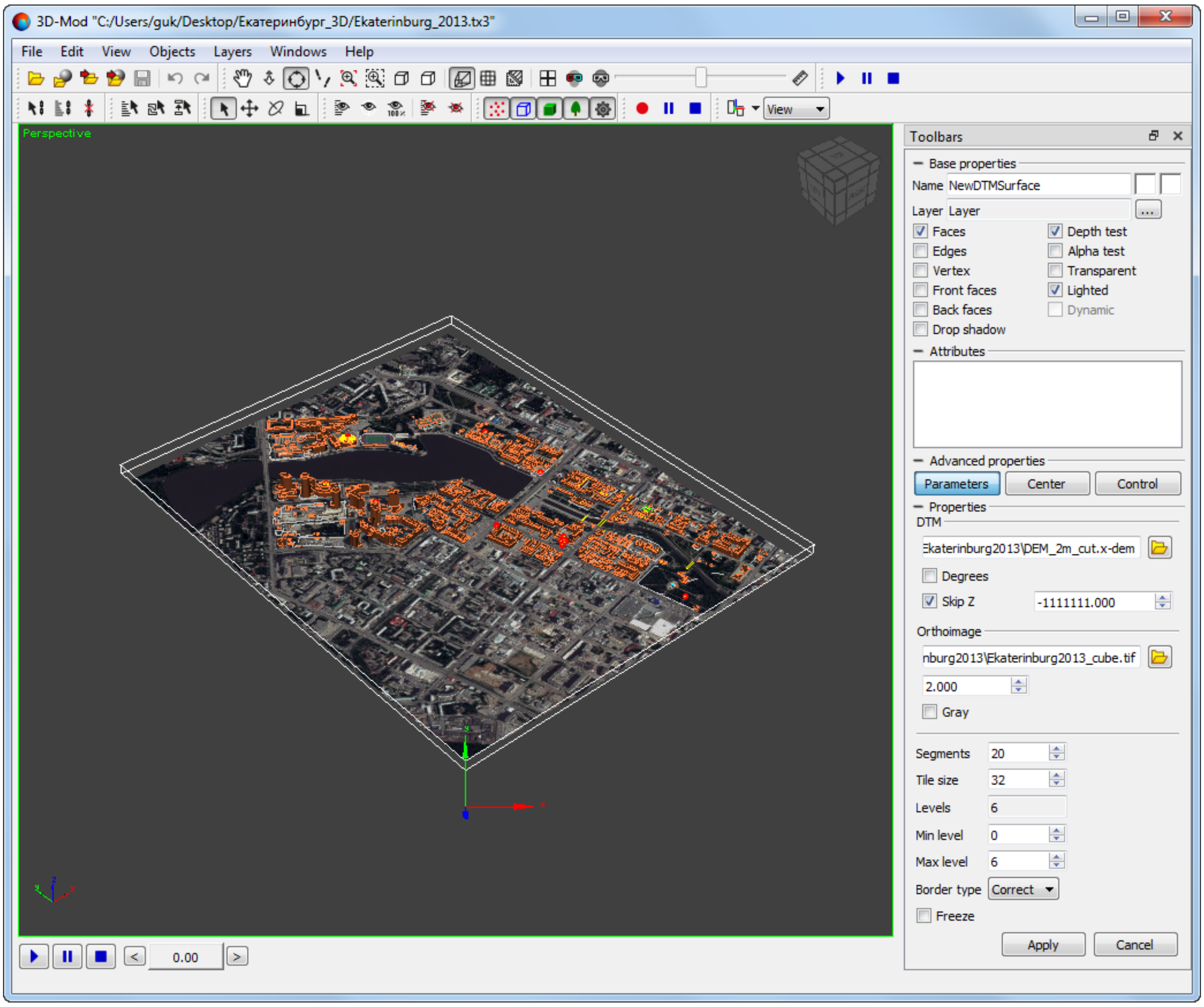


Fig. A.4. View coordinate system

- `Grid` – axes of selected object coordinate system are directed the same as axes of coordinate grid coordinate system.

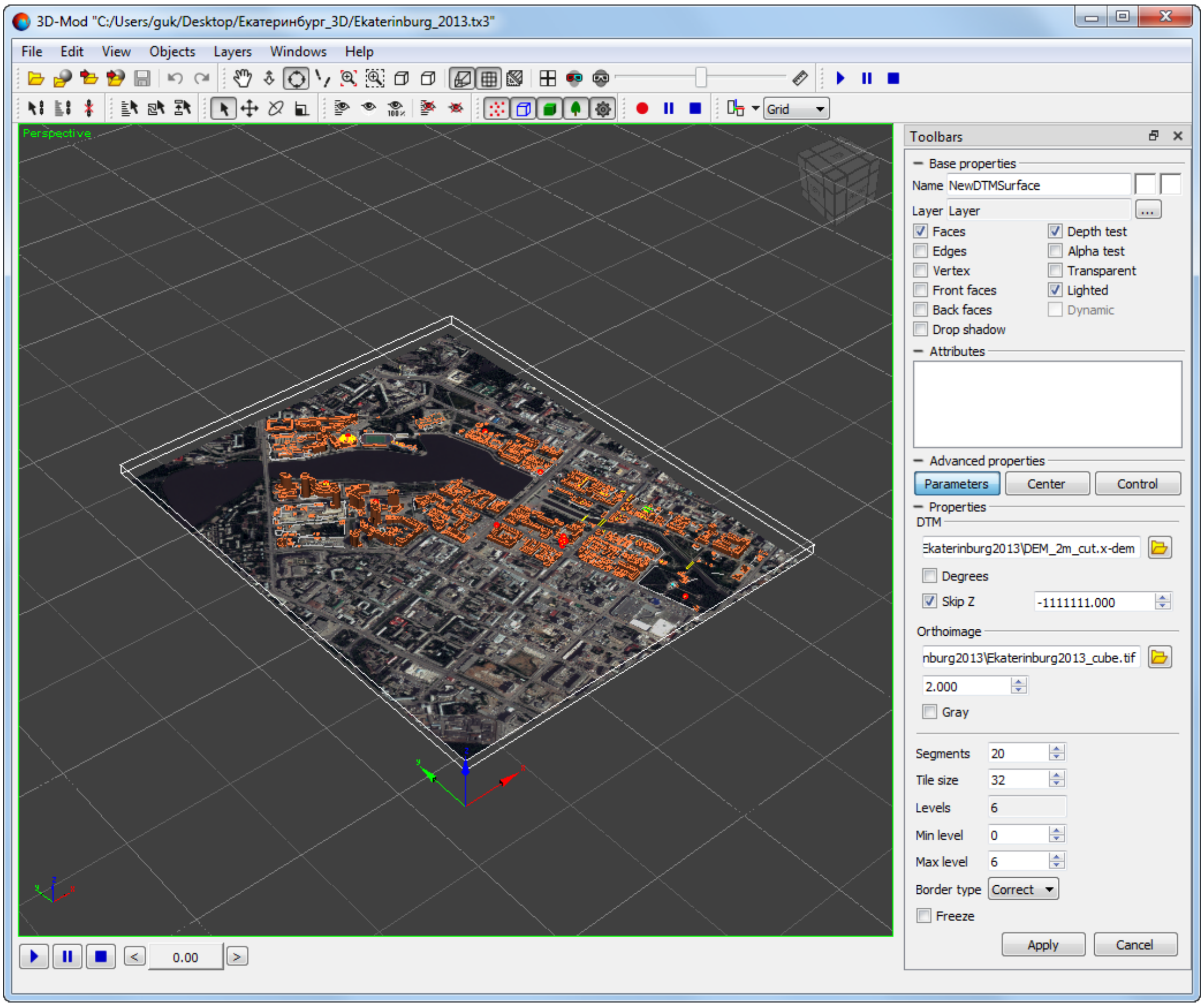


Fig. A.5. Grid coordinate system

It is possible to choose one of the following ways to display a coordinate system of selected objects:

- `Individual` – allows to display coordinate system axes for each selected object;
- `Common` – allows to display common axis of selected objects coordinate system.

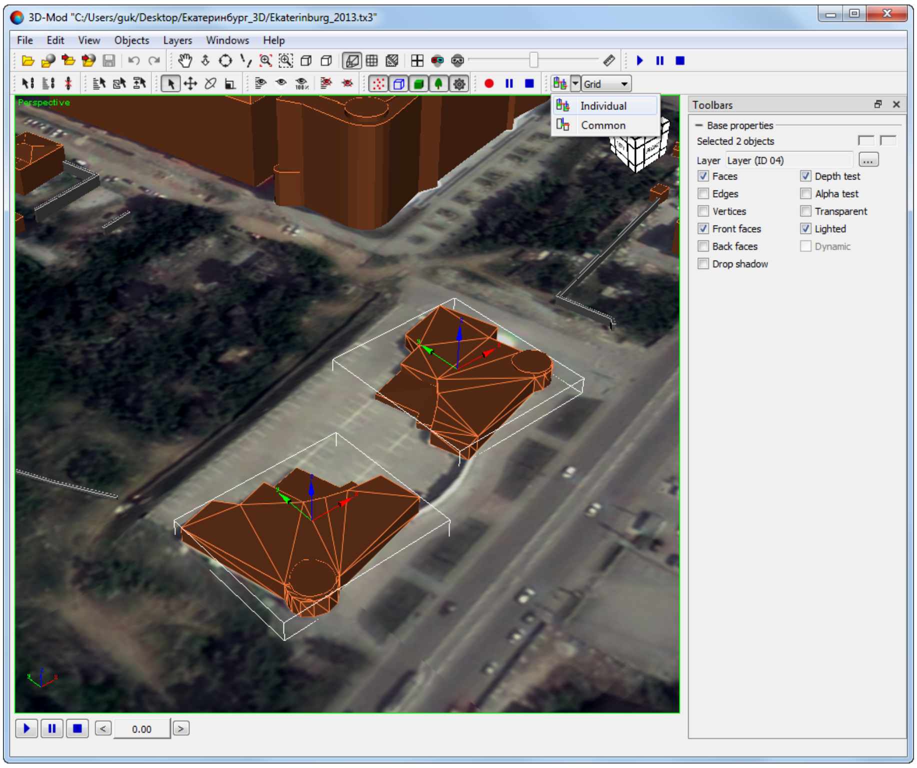


Fig. A.6. Individual axes of objects coordinate system

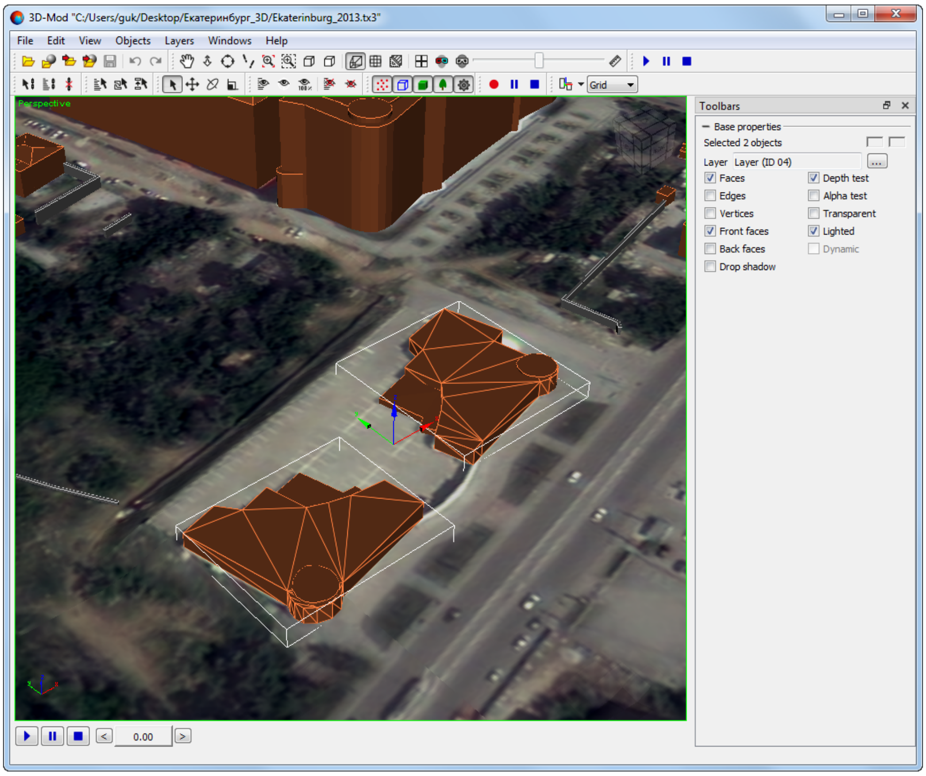


Fig. A.7. Common axis of objects coordinate system

Appendix B. Editing textures

The system allows for editing objects’ textures interactively. To open the graphic editor intended for this purpose, select an object with a pre-linked texture, choose **Edit › Edit texture coordinates** (to turn the texturing on), then go to **Texture** section of the main window sidebar and click **Edit**.

The **3D-objects texture editor** window opens. Changes made to the texture in this window are immediately displayed in the main 3D scene viewer.

Before editing, the selected object must already have an assigned texture, which is a single image of one of the following formats: `*.tif`, `*.bmp`, `*.rsw`, `*.img`, `*.ntf`, `*.jpg`, `*.gif`, `*.png`, `*.pix`, `*.jpeg`, `*.jp2`, `*.prf` or `*.tga`.

The **3D-objects texture editor** is not available for `*.json` (`*.b3dm`) objects, i.e. models divided into tiles and having several levels of detail.

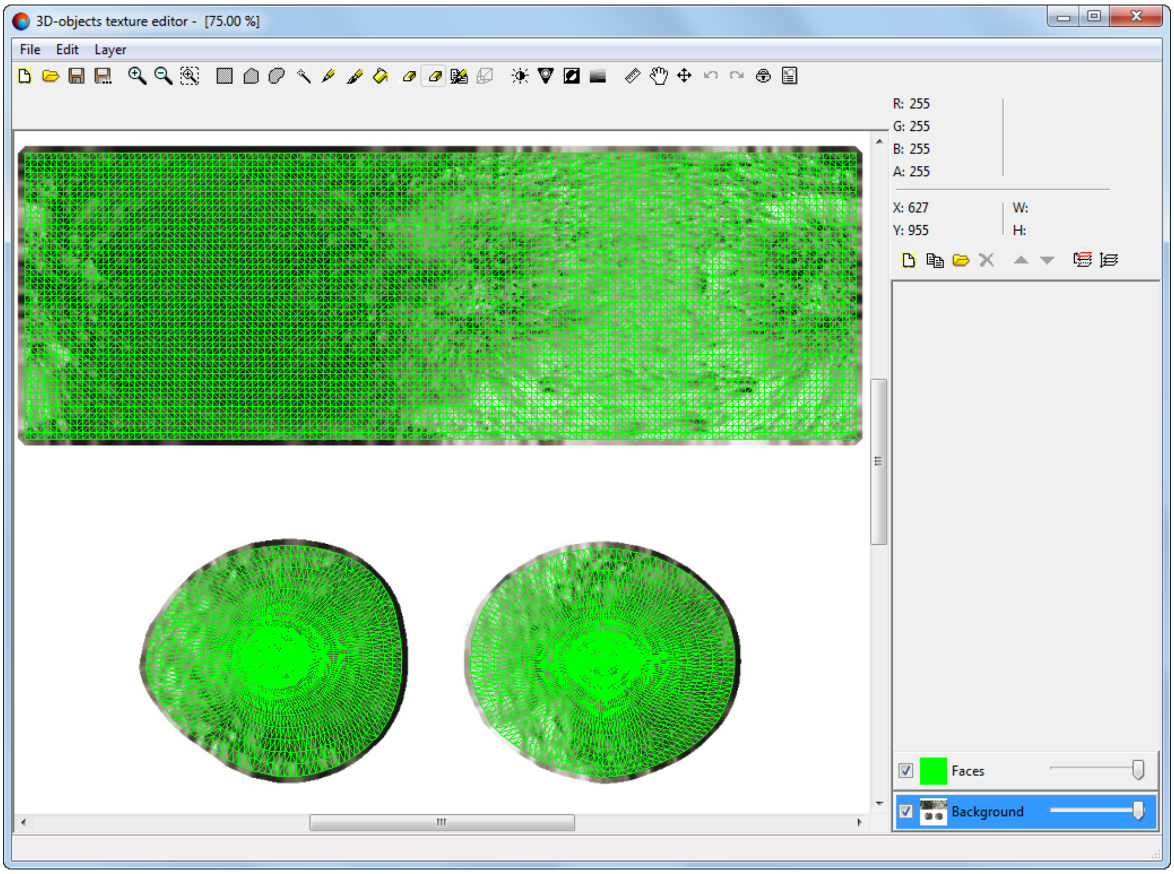


Fig. B.1. The 3D-objects texture editor window

In the **3D-objects texture editor** window that opens, the following layers are automatically loaded:

- An uneditable vector layer that displays 3D object **faces**;

- A **Background** raster layer that contains the current texture of the object.

The **Faces** layer allows the user to visually correlate the corresponding sections of a 3D object surface with their textures.

The configurations of the **Background** and **Faces** layers (both mutual and individual) directly depend on the construction features of a particular 3D object, as well as on the format used for recording and storing data.

B.1. The “3D-objects texture editor” window interface and its elements

The **3D-objects texture editor** window GUI contains the following elements:

- the main menu bar;
- the main toolbar;
- subtoolbar (displayed only if certain editing modes are used);
- the Layer manager;
- the work area is used for viewing and processing with loaded data;
- the work area is used for displaying an information about the current marker coordinates and selected image area, optionally ( ):
    - **X**, **Y** (pixels) are the current cursor coordinates in the image coordinate system (the origin is the lower left image corner);
    - [optional] **W**, **H** (pixels) are the width and height of the selected rectangular image area, respectively;
    - **RGBA** is the raster image pixel color (located in the active layer) that corresponds to the cursor position.

B.1.1. Brief description of texture editor menu

Table B.1. Main image editor menu

Menu	Function
File	to create, open or save raster image (buttons of main toolbar are duplicated by **File** menu items)
Edit	to edit raster images using different ways (buttons of main toolbar are partly duplicated by **Edit** menu items)
Layers	to manage layers (buttons of layer manager toolbar are duplicated by **Layers** menu items)

B.1.1.1. The “File” menu

Table B.2. Brief description of the File menu

Menu items	Function
New	to create a new texture with specified parameters (width and height in pixels), replace the current object texture with it
Open	to load a raster image as a texture, replace the current object texture with it
Save	to save a raster image in the *Windows* file system
Save as	to save a raster image in the *Windows* file system with a different name and extension

To cancel loading or creating a new texture and return to the previous texture, use the cancel key ( ) in the main **3D-mod** window toolbar.

The system provides for creating (or loading) a new layer with a raster image without deleting existing layers. Use the and buttons in the Layer Manager toolbar for this (see below).

B.1.1.2. The “Edit” menu

Table B.3. Brief description of the Edit menu

Menu items	Function
Cancel	to cancel the last operation
Redo	to repeat the last cancelled operation
Cut	to cut out a selected part of a raster image (current layer)
Copy	to copy the selected part of the raster image of the current layer (duplicated with the **Ctrl+C** hotkeys)
Paste	to paste a copied (cut) part of a raster image as a new layer (duplicated by **Ctrl+V** hotkeys)
Select	to activate the tool for selecting adjacent image pixels that have similar color characteristics (the so-called Magic Wand, duplicated by the button in the main toolbar)
Perspective	to enable the projective transformation of the selected image elements, duplicated by the button in the main toolbar
Rotate	to turn on rotating of selected image area
Scale	to turn on scaling of selected image area

B.1.2. Toolbar

Table B.4. Brief description of main toolbar

Buttons	Function
	to create a new texture with specified parameters (width and height in pixels), replace the current object texture with it
	to load a raster image as a texture, replace the current object texture with it
	to save a raster image in the *Windows* file system

Buttons	Function
	to save a raster image in the *Windows* file system with a different name and extension
	to zoom in an image by one step
	to zoom out an image by one step
	to drag a rectangle by mouse to zoom in area of image (click the left mouse button and drag a rectangle by mouse to zoom)
	to select a rectangular region in the raster image
	to select a region in a raster image that has the shape of a polygon with straight segments (Polygonal lasso)
	to make a freeform selection in a raster image (Lasso)
	to activate the tool for selecting adjacent image pixels that have similar color characteristics (the "Magic Wand")
	to enable the "Pencil" tool
	to enable the "Brush" tool
	to enable the "Paint" bucket tool
	to enable the "Eraser" tool
	to enable the "Soft eraser" tool
	to enable the "Clone brush" paint mode (so called Clone stamp tool or Healing brush tool)
	to enable the projective transformation of the selected image elements
	to edit image brightness and contrast
	to edit image saturation
	to invert raster image colors
	to posterize image
	to hide or show vertical and horizontal rulers (in pixels). The origin is the lower left image corner
	to move view area in any direction
	to turn on moving of selected image areas
	to cancel the last operation
	to repeat the last cancelled operation
	to switch the action log on/off
	to open the undo log containing a list of recent editing operations

Keeping the action log when processing very large images can require significant resources and, accordingly, negatively affect system performance.

To disable the chosen image editing mode, select the appropriate menu item again (click the appropriate button in the main toolbar) or press **Esc**.

B.1.3. Layer manager

The following layer types are supported in the **3D-objects texture editor** window.

- An uneditable vector layer that displays 3D object **faces**;

- A raster layer that contains the object's texture.

The Layer Manager is located on the right side of the **3D-objects texture editor** window. It contains its own toolbar as well as a list of all open layers, each item of this list includes the following individual layer management tools:

- Layer name;
- [optional] A thumbnail of the raster image loaded as a layer;
- A checkbox to customize the layer's visibility;
- A slider to customize the layer's opacity.

The active layer is selected by clicking the left mouse button. The active (selected) layer is blue-filled in the Layer Manager.

The Layer Manager toolbar provides the following buttons (which are completely duplicated by the corresponding **Layer** menu items):

- **Create new layer**;
- **Copy layer**;
- **Load layer**;
- **Delete selected layer**;
- **Move up layer**;
- **Move down layer**;
- **Merge visible layers**;
- **Merge all layers**.

B.1.4. Undo log

The system allows to undo edit operations of raster images, and also to redo recently undone operations.

To cancel the last operation click the button of the main toolbar. To redo the last undone operation click the button.

In order to open the recent editing operations list click the button.

To cancel a group of operations double click in the **Undo log** on line with action to which you want to undo changes. To redo all undone operations, double click the line with action to which you want to redo changes.

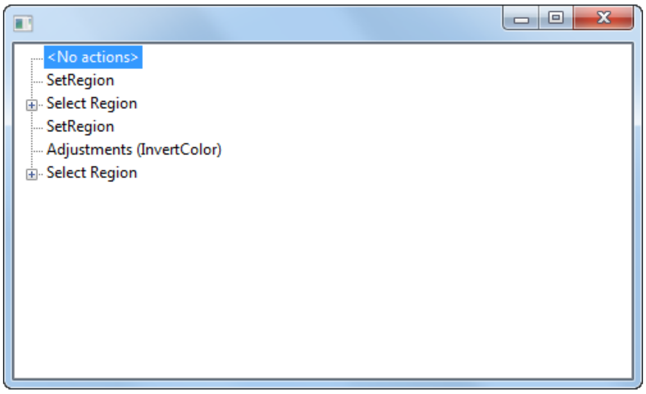


Fig. B.2. Undo log

When working with a very big images using of undo mode slows down editing operations. To increase the performance, disable the undo log creation (click the button on the main toolbar).

B.2. Raster image operations

B.2.1. Selecting image elements

B.2.1.1. The “Magic Wand” tool

The system provides for selecting adjacent image pixels that have similar color characteristics. To enable this mode, click in the main toolbar of the **3D-objects texture editor** window (or choose **Edit › Select**).

Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the **3D-objects texture editor** window. The enabled selection mode is also indicated by the cursor shape changing accordingly.

To select the desired regions of the image, move the cursor over it and click the left mouse button. To add another image fragment to the selected area, move the cursor over it and click the left mouse button while holding down the **Shift** key. To deselect one certain, already selected area of the image, move the cursor over it and click the left mouse button while holding the **Alt** key.

In the **tolerance** input field, the stringency of the selection of pixels added to the selected one is to be set. Zero deviation allows you to add only pixels of absolutely identical color to the selection. Increasing the value of this parameter leads to a less strict selection, allowing you to add image areas of similar, but not completely identical, hues to the selected image. The selection of a specific value for this parameter is defined by the characteristics of the task being performed.

B.2.2. Paint tools

If there is an active selection of any area of the image, then the paint tools used will be active only within this area.

B.2.2.1. The “Pencil” tool

To enable this mode, click  in the main toolbar of the **3D-objects texture editor** window. Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the window.

The system allows the user to set the **size** (the created line weight) and the **color** (the standard palette is for color selection).

B.2.2.2. The “Brush” tool

To enable this mode, click  in the main toolbar of the **3D-objects texture editor** window. Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the window.

The system allows the user to set the **radius** (determining the line weight), line **density** (in percent), and **color** (the standard palette is for color selection).

B.2.2.3. The “Paint bucket” tool

To enable this mode, click  in the main toolbar of the **3D-objects texture editor** window. Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the window. The enabled Paint bucket tool is also indicated by the cursor shape changing accordingly.

The system allows the user to set the Paint bucket **color** (the standard palette is for color selection).

In the **tolerance** input field, the stringency of the selection of pixels added to the image fragment for which the filling with the selected color is performed. Zero deviation allows you to apply the Paint bucket tool to an image fragment that contains pixels of absolutely identical color. Increasing the value of this parameter leads to a less strict selection. The selection of a specific value for this parameter is defined by the features of the task being performed.

B.2.2.4. The “Eraser” tool

To enable this mode, click  in the main toolbar of the **3D-objects texture editor** window. Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the window.

The system allows the user to set the **size** (the line weight the eraser operates within).

B.2.2.5. The “Soft Eraser” tool

To enable this mode, click in the main toolbar of the **3D-objects texture editor** window. Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the window.

The system allows the user to set the **radius** (determining the line weight the eraser operates within) as well as the **density** (in percent), determining the intensity of the eraser’s impact.

B.2.2.6. The “Clone Brush $QUOTE$" tool

This tool allows, for example, to retouch small local image defects by using multiple copies of adjacent image fragments used as data sources (so-called *samples*).

The following steps are recommended when using this tool:

1. To enable the Clone brush, click in the main toolbar of the **3D-objects texture editor** window.

   Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the window. The enabled tool is also indicated by the cursor shape changing accordingly;

2. Set the **radius** determining the size of the image fragment to be copied and the line weight within which the Clone brush operates;

3. Set the **density** determining the intensity of the brush impact (in percent);

4. Mouse over the desired image region and click the left button (the cursor is a circle with the specified **radius**).

   A circle is displayed on the selected image region, limiting the fragment of the image used as a data source. The additional **Copy** mode is also automatically activated (see the appropriate button in the subtoolbar).

5. Without disabling the optional **Copy** mode, perform one of the following:

   - [optional] Using pinpoint clicks of the left mouse button, create copies of the selected area (see the previous paragraph) in the required areas of the image;

   - [optional] Hold down the left mouse button and use this tool, similar to the Brush tool. In this case, a mask of a given size (see item **2**), used to define a fragment of the image that serves as a data source, is scrolling in the so-called sliding window mode, parallel to the mouse cursor path.

If the sliding window mask falls on an area of the image that has already been changed during the current tool session, then, when sampling, the changes made will be taken into account if the **Copy changes** checkbox was previously set in the subtoolbar.

Otherwise, only unchanged original image area will be sampled.

A tool session means moving the mouse cursor while holding down the left button (creating a continuous line using the clone brush).

Changes made to the image during previous sessions will in any case be taken into account when sampling.

6. [Optional] To change the location of the sampling area, disable the **Copy** mode, clicking the appropriate button in the subtoolbar, and repeat the steps described in the two above paragraphs.

B.2.3. Transformation tools

Transformation tools are available both for a selected image fragment and for a raster layer as a whole (exception for the **Background** raster layer, for which only projective transformation of the selected area is available).

B.2.3.1. The “Projective Transformation” tool

This tool allows, for example, to fill gaps in object textures by creating a copy of another area of the image and transforming it in accordance with the required angle.

The following steps are recommended when using this tool:

1. [optional] Select the desired image area and copy it to the new layer (**Ctrl+C**, **Ctrl+V**), then move it within the canvas, if needed ();
2. To enable the projective transformation mode, click in the main toolbar of the **3D-objects texture editor** window (or choose **Edit › Perspective**).

   Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the **3D-objects texture editor** window. The enabled selection mode is also indicated by the cursor shape changing accordingly (displayed when hovering over the transformed area).

   The transformed area (regardless of its shape) is additionally highlighted using a rectangle (within which it is inscribed), the segments of this rectangle are displayed as dashed gray lines, and the vertices are the so-called checkpoints. Locations of these checkpoints will further determine the nature of the projective transformation. The additional **Setup** mode is automatically activated (see the appropriate button in the subtoolbar);
3. [optional] Without disabling the **Setup** mode, adjust the location of the checkpoints by moving the vertices of the created rectangle. To do this, point the cursor at one

of the vertices and, holding the left mouse button, move the cursor, changing the position of the vertex;

When the cursor is close to a vertex (checkpoint), a small gray square is displayed near the cursor (on the right and below), indicating that it is possible to interact with the vertex.

In order to return the checkpoints to their original positions, click **Reset** in the subtoolbar. When the positions of the checkpoints are reset, the additional **Setup** mode is automatically activated

4. To disable the **Setup** mode and enable the **Transforming** mode, click the **Transforming** button in the subtoolbar;

   To set projective transformation options, change checkpoint locations (see how to do this in the above paragraph). After moving at least one of the points, a copy of the modified image fragment is displayed in the work area, subjected to an appropriate transformation (limited by dashed green lines).

   If the user sets an obviously incorrect mutual arrangement of checkpoints that prevents the projective transformation, the gray dashed lines limiting the initial transformation area turn red, and the copy of the transformed area, which allows you to evaluate the potential results of the operation, will no longer be displayed.

In order to return the checkpoints to their original positions (where they were before being displaced during transformation), click the **Setup** button in the subtoolbar. When the positions of the checkpoints are reset, the additional **Setup** mode is automatically activated

In order to return the checkpoints to their original positions (before the first editing of their location), click **Reset** in the subtoolbar. When the position of the checkpoints is reset, the additional **Setup** mode is automatically activated.

5. To **apply** the transforms and quit the projective transform, perform one of the following:

   • [optional] Click **Apply** in the subTulbar, then click  in the main toolbar;

   • [optional] Click  in the main toolbar and confirm transformation in the appropriate dialog box.

B.2.3.2. The “Rotation” tool

The following steps are recommended when using this tool:

1. [optional] Select the desired image area;

2. To enable the rotation mode, choose **Edit › Rotate**.

Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the **3D-objects texture editor** window. The enabled selection mode is also indicated by the cursor shape changing accordingly (displayed when hovering over the transformed area).

The transformed area (regardless of its shape) is additionally highlighted using a rectangle (within which it is inscribed), the segments of this rectangle are displayed as dashed gray lines, and the vertices and segment midpoints are the so-called checkpoints. Interactions with these checkpoints will further determine the nature of transformations;

3. Set rotation options in one of the following ways:

   - [optional] Adjust checkpoint locations by moving them. For this, mouse over one of the points and holding the left mouse button, move the cursor to change the point position;

     When the cursor is close to a checkpoint, a small gray square is displayed near the cursor (on the right, below), indicating that it is possible to interact with this point.

   - [optional] Enter the appropriate value (in angular degrees) in the **Angle** input field;

     To reset the layer (fragment) under processing to its original location (scale), click on the subtoolbar.

4. [optional] To change the scale of the layer (fragment) under processing, enter the appropriate values (in percent) in the input fields for the **X** and **Y** axes;

5. To apply the transforms and quit editing, perform one of the following:

   - Click in the subtoolbar, then choose **Edit › Rotate**;

   - Choose **Edit › Rotate**, then confirm transformation in the appropriate dialog box.

B.2.3.3. The “Scale” tool

The following steps are recommended when using this tool:

1. [optional] Select the desired image area;

2. To enable the scaling mode, select **Edit › Scale**.

   Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the **3D-objects texture editor** window. The enabled selection mode is also indicated by the cursor shape changing accordingly (displayed when hovering over the transformed area).

The transformed area (regardless of its shape) is additionally highlighted using a rectangle (within which it is inscribed), the segments of this rectangle are displayed as dashed gray lines, and the vertices and segment midpoints are the so-called checkpoints Interactions with these checkpoints will further determine the nature of transformations.

3. Set scaling options in one of the following ways:

   - [optional] Adjust checkpoint locations by moving them. For this, mouse over one of the points and, holding the left mouse button, move the cursor to change the point position;

     When the cursor is close to a checkpoint, a small gray square is displayed next to the cursor (on the right, below), indicating that it is possible to interact with this point.

     Checkpoints corresponding to the rectangle vertices allow for scaling on both the **X** and **Y** axes at once.

     Checkpoints corresponding to segment midpoints allow for scaling the fragment only along one of the axes.

   - [optional] Enter appropriate values (in percent) in the input fields for the **X** and Y axes;

     To reset the layer (fragment) under processing to its original scale (location), click on the subtoolbar

4. [optional] In order to also rotate the processed layer (fragment), enter the appropriate value (in angular degrees) in the **Angle** field;

5. To apply the transforms and quit editing, perform one of the following:

   - [optional] Click in the subtoolbar, then choose **Edit › Scale**;

   - [optional] Choose **Edit › Scale**, then confirm transformation in the appropriate dialog box.

B.2.4. The Color hue tools

The Color hue tools are available both for a selected image fragment and the whole raster layer.

B.2.4.1. The “Brightness” and “Contrast” tools

The following steps are recommended when using this tools:

1. [optional] Select the desired image area;

2. To enable editing mode, click in the main toolbar

   Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the **3D-objects texture editor** window

3. Set brightness and/or contrast in one of the following ways:

   - [optional] Using sliders;
   - [optional] Entering required values in the appropriate fields (arbitrary units);

   To discard the entered values, click in the subtoolbar

4. To apply the transforms and quit editing, perform one of the following:

   - [optional] Click in the subtoolbar, then click in the main toolbar;
   - [optional] Click in the main toolbar, then confirm transformation in the appropriate dialog box.

B.2.4.2. The “Intensity” и “Saturation” tools

The following steps are recommended when using this tool:

1. [optional] Select the desired image area;

2. To enable editing mode, click in the main toolbar

   Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the **3D-objects texture editor** window.

3. Set intensity and/or saturation in one of the following ways:

   - [optional] Using sliders;
   - [optional] Entering required values in the appropriate fields (arbitrary units);

   To discard the entered values, click in the subtoolbar.

4. To apply the transforms and quit editing, perform one of the following:

   - [optional] Click the subtoolbar, then click in the main toolbar;
   - [optional] click in the main toolbar, then confirm transformation in the appropriate dialog box.

B.2.4.3. The “Posterize” tool

The following steps are recommended when using this tool:

1. [optional] Select the desired image area;
2. To enable editing, click in the main toolbar

   Extra tools that allow the user to set options for work with this tool are displayed in the upper part of the **3D-objects texture editor** window.

3. Set the desired options using the Levels slider or enter the required value in the appropriate field:

   To discard the entered values, click in the subtoolbar.

4. To apply the transforms and quit editing, perform one of the following:
   - [optional] Click in the subtoolbar, then click in the main toolbar;
   - [optional] Click in the main toolbar, then confirm transformation in the appropriate dialog box.