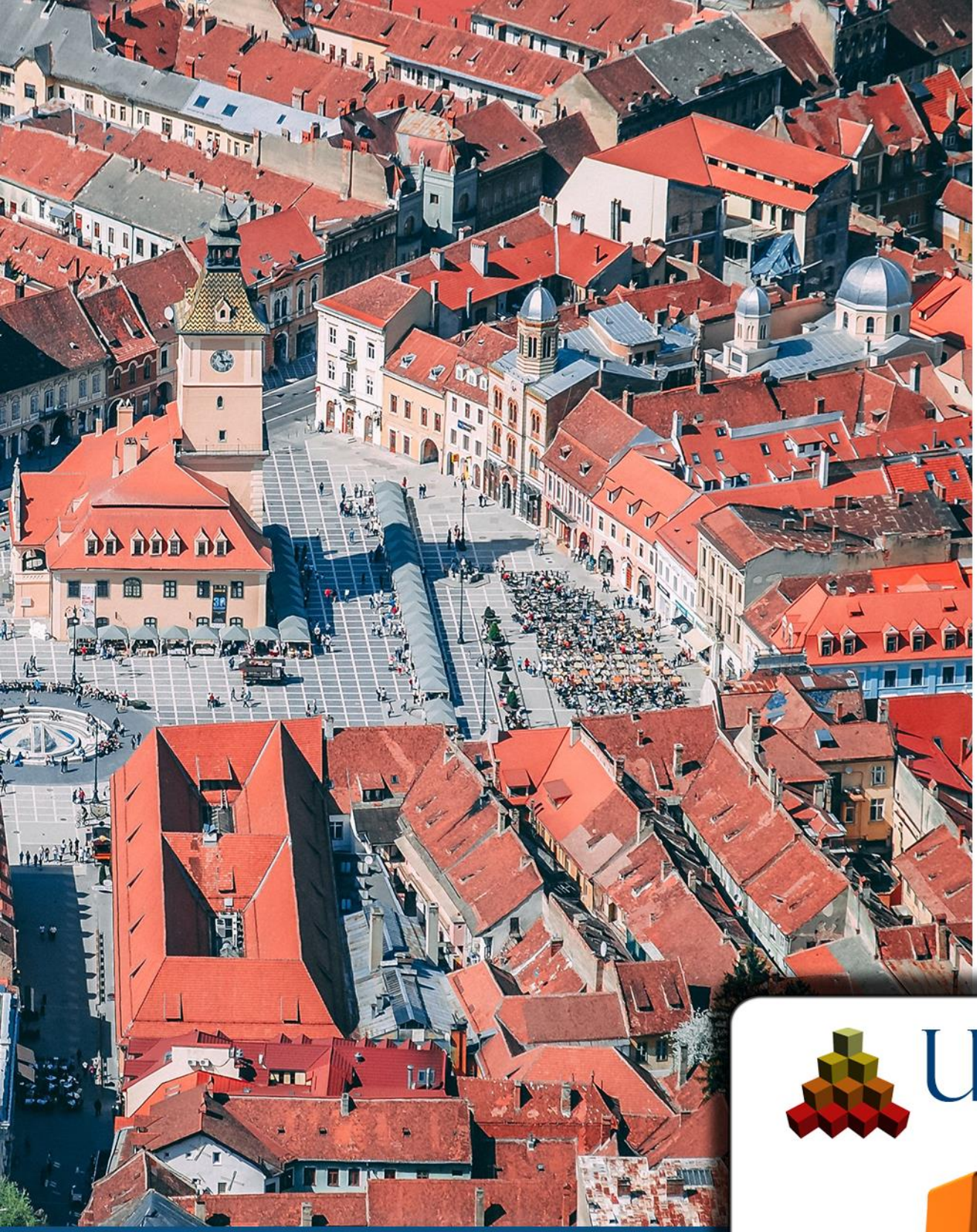


URBAN VISUALISATION & MANAGEMENT GMBH

UVM SYSTEMS

CityGRID® Modeler MANUAL

2025

Contents

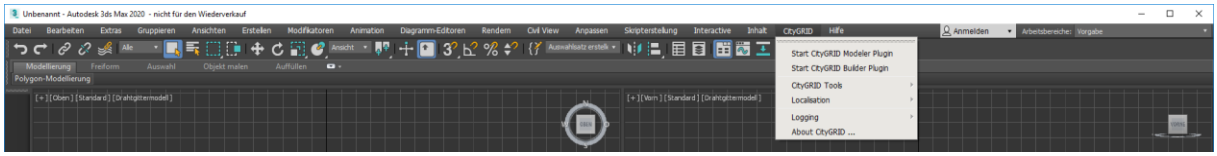
Cover picture: Brasov, Romania, Dan Novac, Pixabay

Note: This manual was produced by automatic translation. Strange expressions and sentence structure may therefore occur. In case of doubt, the German manual is to be used as a reference.

1. City**GRID®** Modeler Basics

*Note: The City**GRID®** is available in three different variants: City**GRID®** Inspector, City**GRID®** Editor and City**GRID®** Texture. This manual covers all three variants. For functions that require at least the Editor module are marked by the symbol E. Functions that can only be run with the Texture module are marked by symbol T. If no icon is present the function is available to all modules, (i.e. also Inspector)*

Modeler is a plug-in to Autodesk 3DS Max. If it is installed correctly, the menu **CityGRID** is available after starting MAX:



The menu **Start CityGRID Modeler Plug-in** is only available after licensing the product (cf. 1.1).

1.1. Start CityGRID Modeler

Click on the **CityGRID** entry to start the Modeler Module. The GUI of Autodesk Max is extended by the City**GRID** functionalities, the viewports are adapted and the selection window is opened (cf. 2.1).

1.2. CityGRID® Tools

You can find special tools here, which can be used outside the City**GRID®** Modules. Currently you will find the BLOB Converting Manager (cf. 3.6.3), which can be used to convert 3D Studio objects (fountains, plaque columns, memorials, etc.) to City**GRID®** data structure so that they can be managed like conventional City**GRID®** buildings.

1.3. Licensing

The menu entry **Start CityGRID Modeler and Start CityGRID Builder** is available after licensing (cf. Manual City**GRID®** Basics).

If the Client successfully connects to the licence server activated module entries will appear under the menu point **Licensing**. City**GRID®** is always licensed, even if the functionality of the manager is not included in the licence. City**GRID®** Modeler and City**GRID®** Builder can be licensed independently from each other.

1.4. Setting Language

Depending on which language is currently active, in the menu **CityGRID** the item **Localisation**, or **Sprachunterstützung**, etc. is available. Please select the preferred language for the user interface.

1.5. Logging

If an unexpected program execution or a program crash occurs, it can be useful to send the City**GRID®** log file to UVM Systems GmbH. You can access this file quickly via the entry **Open Log Folder**. In certain instances it is possible that UVM Systems GmbH will request the comprehensive log file. To create such a log file use the menu entry **Use Comprehensive Logging**. Comprehensive Logging takes more time and should therefore only be used during consulting UVM Systems GmbH.

1.6. The User Interface

After starting the Modeler via the menu **CityGRID > Start CityGRID Modeler Plug-in** the user interface is adapted. The menu **CityGRID** is replaced by the menu **CityGRIDModeler**. A number of additional buttons appears and the Working Set Window (cf. 2.1) is opened.

Main Dialog

Load Units; display of units; Version Management; Reference Coordinate System;

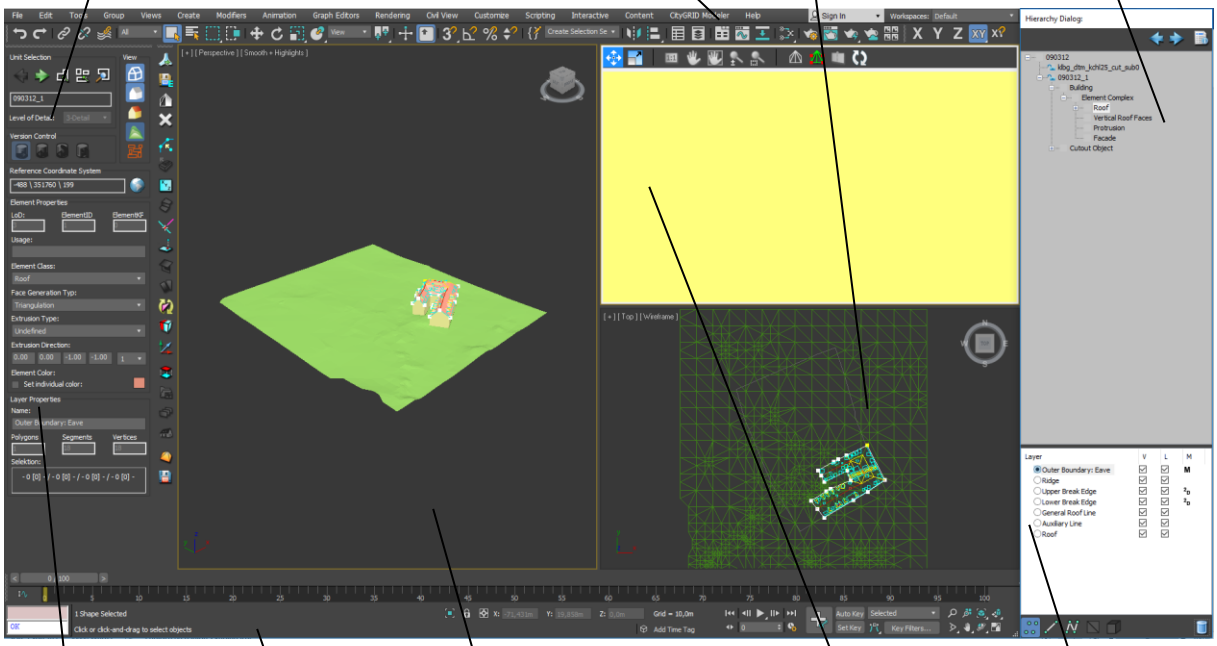
CGModeler Menu

Here, some general functions are available

Top View

Hierarchy Dialog

Display of loaded region, in hierarchy tree form



Properties Dialog

Information area, face generation type; extrusion types; single area coloring

Status bar

Instructions may appear here

3D view

(shows those elements which are activated in the visibility box, in this case polylines, roof faces and façades)

Texture Dialog

Texture images with projected geometry for interactive texturizing

Layer Dialog

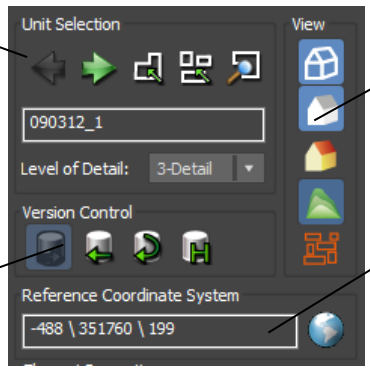
Roof lines and roof faces separated by layers; select editing levels.

In the main window there are the central navigation mechanisms for the following tasks

- Load buildings (units) in the required level of detail (LoD 1-3)
- Display navigation of the 3D-window
- Version administration
- Coordinate offset of the used reference coordinate system

Data Source

Load single Units or areas in a certain Level of Detail



Display navigation

of parts of the building (lines, faces), terrain, textures, selection polygons

Reference Coordinate System

Display of the applied offset values to keep coordinate accuracy

Version Control

Check out, Check in Units

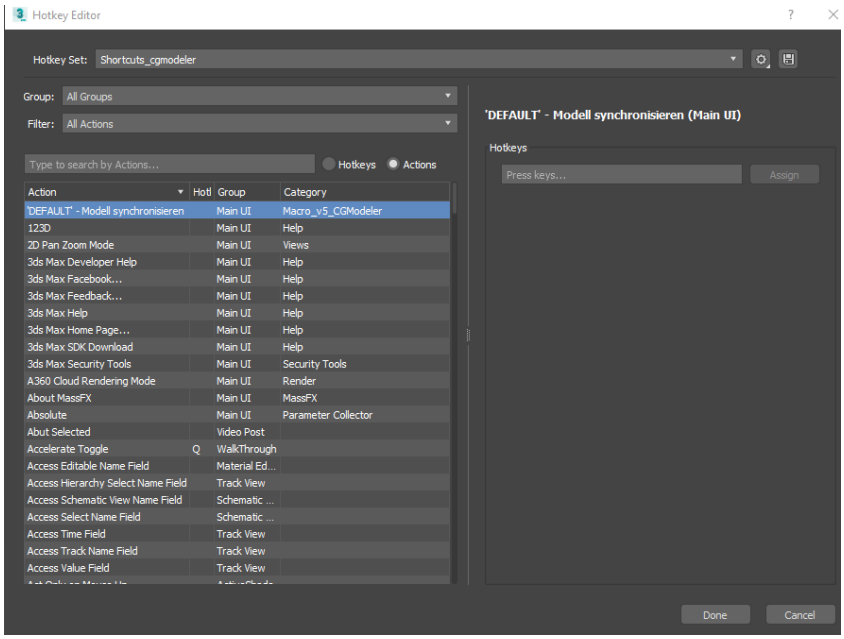
The Command Panel of Autodesk 3D Studio Max is hidden, because only functions of the City**GRID**® Plug-In are used for editing the geometry of building models. For example, City**GRID**® locks all data that is not be editable as a result of on the current active settings.

*Note: If these locks are removed manually, the data integrity can't be guaranteed any more. Geometry data may not be interpreted by City**GRID**® correctly anymore and 3D Studio tends to become unstable.*

1.6.1. Assigning Hotkeys in Autodesk 3D Studio Max

A number of actions of the City**GRID**® Modeler can be started in addition to clicking at the respective buttons by user defined hotkeys. Assigning hotkeys is done by opening the dialog **Customize > Hotkey Editor.** Click on the first entry and then sort by 'Category'. You then will see all Macro_v5_CGModeler functions, which can be assigned to a hotkey.

Each of the following actions of the City**GRID**® Modeler can be assigned a hot key. By clicking on Save... all assigned hotkeys and the current configuration of the 3D Studio user interface is stored. For example the position of toolbars can be individually defined this way.



Note: Settings are saved in file CGModeler.kbdx. Find this file at the installation directory of 3D Studio Max in Folder "UI" of installed language package (e.g. D:\apps\Autodesk\3ds Max 2022\en-US\UI\ cgmodeler.kbdx) or in User Settings (e.g. C:\Users\whe\AppData\Local\Autodesk\3dsMax\2022 - 64bit\DEU\de-DE\UI).

*Advice: Following Hotkeys are recommended for efficient modelling in City**GRID**® Modeler:*

- *Create auxiliary coordinate system from selection: defines local coordinate system*
- *Select active complex from viewport: Allows for geometry picking in viewport.*
- *Change distinguished mode: Assigns/removes distinguished mode from active complex*
- *Triangulate*

1.7. Description of buttons

1.7.1. Standard mode

Open `Working Set Window` Change database/XML file; Change Model/Street/Area

`Export Tool`

`Toggle between Wire frame View and Shaded view` switch on/off

`Close CityGRID`

1.7.2. Edit Mode

`Insert Point` (in point selection mode), `Create Line` (in line selection mode)

`Create new Complexes` (only in line selection mode)

`Coordinates Tool` switch on/off

`Break Line Tool`

`Line intersection Tool` (insert intersecting points)

`Move point to face Tool` (e.g. along a vertical line)

`Roof Protrusion Tool`

`Transformation Tool`

`Face Normals Tool`

`Cut/Merge Tool`

`Coordinate System Tool`

1.7.3. Texture Mode

`Back projection of lines of the active complex`

`Create Material`

`Copy Textures`

`Delete all textures of the active complex`

1.7.4. Terrain Mode

`Terrain Optimization Tool`

`Terrain Clipping Tool`

1.7.5. Triangulate and Save

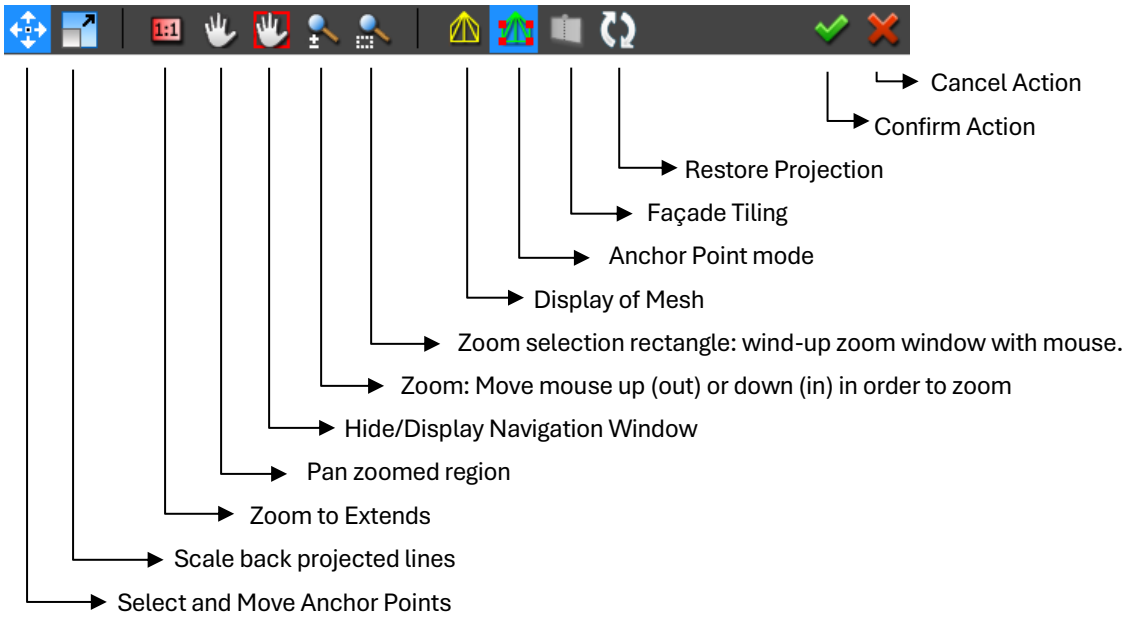
`Triangulate/Apply changes`

`Save Unit`

Note: Clicking at the button `Triangulate/Apply changes` while holding the CTRL-Key pressed, triangulates only the active complex without triangulating connected complexes (cf. the advice about fast triangulation in section 3.1).

Press the SHIFT key and click on the model level in Hierarch Dialog (cf 2.7) to force the triangulation of all model units.

1.7.6. Menu bar in the texture window



1.8. Coordinate System of the CityGRID® Modeler

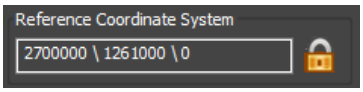
The 3D Models of the buildings can be generated in any cartesian coordinate system. It is not necessary to add reduction constants. City**GRID**® manages coordinates with 7 digits before the comma without losing accuracy. The accuracy is generally restricted to 3 digits after the comma (mm).

We recommend using an unreduced coordinate system for storing 3D building models.

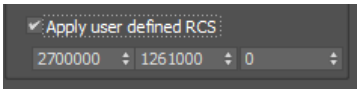
As Autodesk 3D Studio Max in current versions is not able to handle “large” coordinates with the necessary accuracy, City**GRID**® moves the loaded coordinates automatically to a local coordinate system with reduced coordinates for editing. In general, the user need not care about it as long as he remains inside the City**GRID**®

system. Although the coordinate display of Autodesk 3D Studio Max shows reduced coordinates, City**GRID**® will always convert the coordinates back to global coordinates when saving them.

The reduction constants from the reference coordinate system to the local coordinate system are derived automatically when defining a working set (cf. 2.1.3) and are displayed on the graphical user interface.



The automatic coordinate reduction determines the offset value at each new read model. This can lead to increased effort when reading external data (cf. 3.6.2), which shall be reduced by the offset value in advance. As an alternative to automatic coordinate reduction a manual shift can also be introduced. The Options menu (cf. 2.5) allows you to set a fixed offset that is used at model loading.



Once the Use Custom RCS option is enabled, the Modeler will always apply the specified offset. The values entered are always those offset values that have to be added to the reduced coordinate system in order to get to the original system. In order to be able to quickly recognize the active mode for determining the offset value, there is an icon in addition to the figures that can have the following symbols.


Automatic Offset

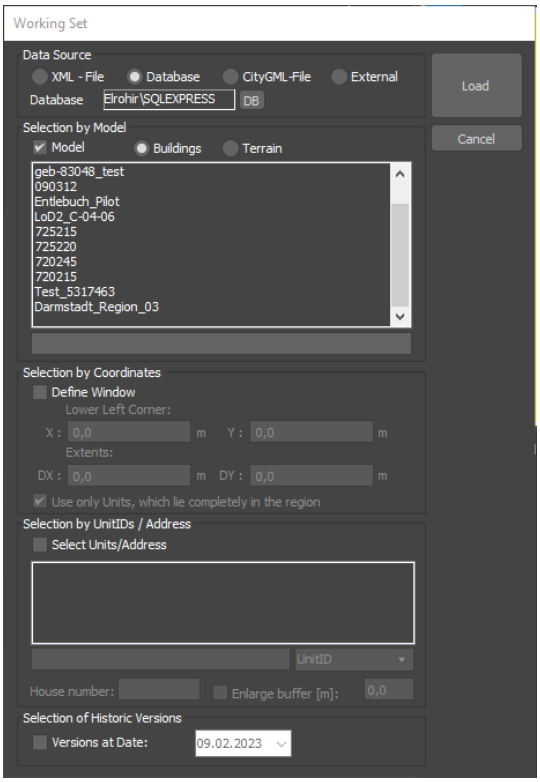

User defined offset


Note: The manual coordinate reduction should only be used if data is always loaded from same geographical area (e.g. city area). Due to implemented coordinate precision of 3D Studio Max, data up to a distance of 10000m can be handled with an accuracy of 1mm. Further increase of 10000 meters distance decreases accuracy by 1 mm.

A wrongly configured Custom RCS can lead to irreversible damage to the data. The values should therefore be set only if necessary and well thought.

2. Working with CityGRID® Modeler

The main task of the CityGRID® Modeler are editing of eave lines, dormer windows or building outlines, as well as modelling the roof surface and adding texture to the facades and roofs. In this section you will find explanations for these tasks step by step:

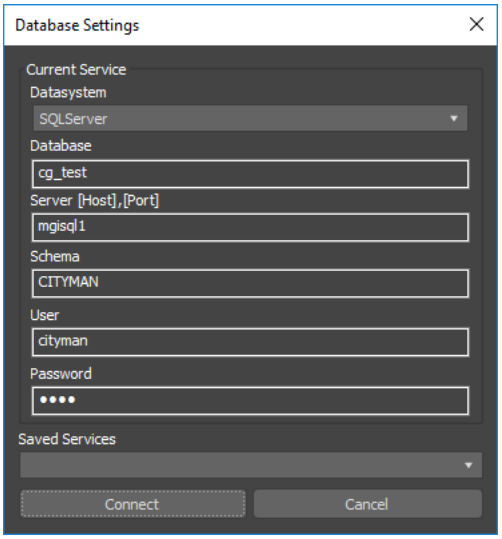


2.1. Definition of the Working Set and the Data Source

At the beginning you need to define the "Working Set" and data source. This is done in the „working set window".

2.1.1. Open/Change Database Connection

1. Open working set window (cf. 1.7.1)
2. Change to Database Mode: Choose *Database* in the selection *Data Source*
3. Open Database Settings Window by clicking the button DB.
4. Type in the name of the installed database service, the name of the schema of CityGRID®-tables in that database, the username and the password. Request these data from your database administrator.



Note: For each database service one directory on a (network) drive must be declared as the path where textures are stored. This directory is an integral component of the data base service. Contents of this directory are administered by CityGRID® and must not be changed manually!

Note: Valid database connection data are stored and can later simply be loaded in the saved services selection. By saving server- and database names/service multiple databases can be accessed quickly. When starting the Modeler always the last active data base connection is tried to be restored

2.1.2. Open/Change Data File

If the XML-Modeler is licensed, the data can be loaded from a file in the XML format specified by UVM Systems instead of a database:

1. Open working set window (cf. 1.7.1)
2. Change to XML Mode: Choose *XML-File* in the selection *Data Source*.
3. Click button  to select XML file.

2.1.3. Definition of the Working Set

For working efficiently Units can be grouped into Models. Switch from *Terrain* to *Model* in *Selection by Terrain* section to select a model from the database.

Note: Typically, a Unit consists of all the buildings and building parts belonging to an address (e.g. main building + garages + sheds, etc.). Unit generation is the user's responsibility and is executed depending on demands and requirements. If no unit is generated, every closed eave polygon and the building edge lines within it forms a separate unit.

Additionally Terrain models can also be accessed in working set window. To do so switch from *Model* to *Terrain* in *Selection from Model* section. All available terrain models will be listed immediately.

A Model is a logical grouping of an arbitrary number of Units. One the other hand, a Unit can belong to an arbitrary number of Models. (cf. Manual City**GRID**® Basics)

The Working Set of a session can be defined by a Model (the recommended strategy), and/or by a UnitID or street name, and/or by a rectangular window and/or historic dates. This is done in the working set window.

1. *Selection by Model*:

   Activate the checkbox *Model* and choose one of the models.

2. *Selection by Coordinates*:

   Activate the checkbox *Define Window* and type in the lower left corner and the extents of the window. *Use only Units, which lie completely in the region* removes partially intersecting units from the selection area.

3. *Selection by Unit/Address*:

   Activate the checkbox *Unit* and enter Unit criteria in Unit Selection windows *Use pull down menu* to switch between UnitID an Address

   - *UnitID:*

     searches the database for the given Name, which can be entered on the left side of the pull down menu. To load multiple Units enter any part of the UnitID (pay attention to upper and low case), wildcard for missing characters are not needed.

     Advice: Use Unit Selection to load single Units or Unit groups without loading a Model in these Units. It is highly recommended to allocate structured UnitIDs for sensible utilization of Unit Selection.

   - *Street:*

     loads all Units, which can be assigned to a street name. For restricting the selectable street names you can type in any part of the street name (case sensitive) in the line below.

   - *House number:*

     Use this field to narrow down street selections. *Enlarge buffer* creates a buffer around the selection from *Street* and *House number* and loads every unit that is (partly) inside this region.

     Note: The selection of a street is only possible in the database mode, if a link to an address database is installed. For installing such a link, please contact UVM Systems.

     Note: Requesting all UnitIDs in the database may take some time. So only select using UnitIDs when necessary.

4. *If you combine more the selections, the common set of Units will be loaded.*

   Example: By selecting the Model "InnerCity" together with the Street "MainStreet" those buildings of the Main Street are added to the Working Set which lie in the inner city.

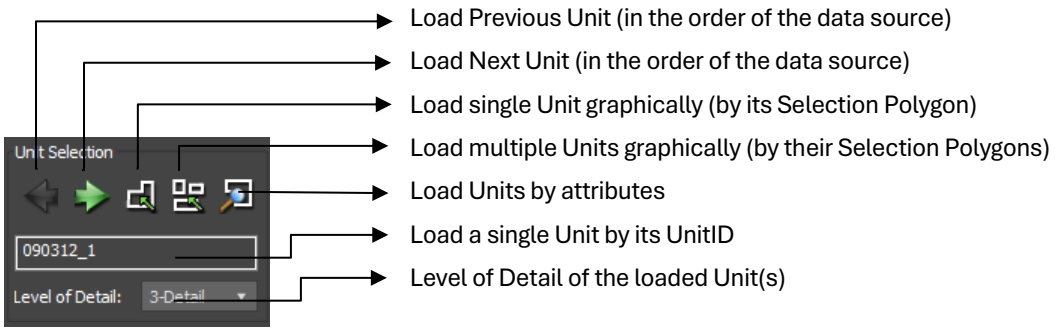
   *Note: To load terrain models in City**GRID®** XML schema without loading associated building models use XML files. Thus a visual check and interactive modelling of the terrain model in the Modeler is possible before starting building modelling or importing into the database.*

By clicking the button Load the working set window will be closed and the Selection Polygons of all Units in the Working Set are loaded. Afterwards the first Unit in the working set is loaded.

2.2. Loading Single Units or Areas in a certain Level of Detail (LoD)

After defining the working set (cf. 2.1.3) single Units or multiple Units of the working set can be loaded.

If no special version of a Unit is loaded, the last stable version is loaded (cf. 2.6).



2.2.1. Load Previous/Next Unit

By clicking at the buttons one Unit after the other is loaded in the order in which they were imported into the database or in which they appear in the XML file, respectively.

Advice: For better orientation the selection polygons can be activated in the display section of the main window.

2.2.2. Select and Load a Single Unit Graphically

By Clicking at the respective button all Selection Polygons of the entire model are displayed in the drawing windows. If you click at one of these Selection Polygons with the left mouse button, this Unit is loaded immediately. With a right mouse click in the drawing window the selection mode can be cancelled.

Advice: By pressing the CTRL-button when clicking the button, the zoom to extents function will be suppressed, thus making it easier to stick to the actual area of interest within the model area.

2.2.3. Select and load multiple Units graphically

By clicking at the respective button the Selection Polygons are displayed in the drawing windows. If you click at one of these Selection Polygons with the left mouse button, this Unit is selected. Using the CTRL- and ALT Key when clicking at the Selection Polygons Units can be added or removed to/from the selection set. Furthermore a window can be dragged by the mouse in order to select several Units at once.

Advice: By pressing the CTRL-button when clicking the button, the zoom to extents function will be suppressed, thus making it easier to stick to the actual area of interest within the model area.

When the mode for selecting multiple Units is activated, two further buttons appear below the standard buttons:

`Load selected Units`

`Cancel loading multiple Units`

Once you are satisfied with your selection press one of the above buttons either to load your selection or to cancel the operation.

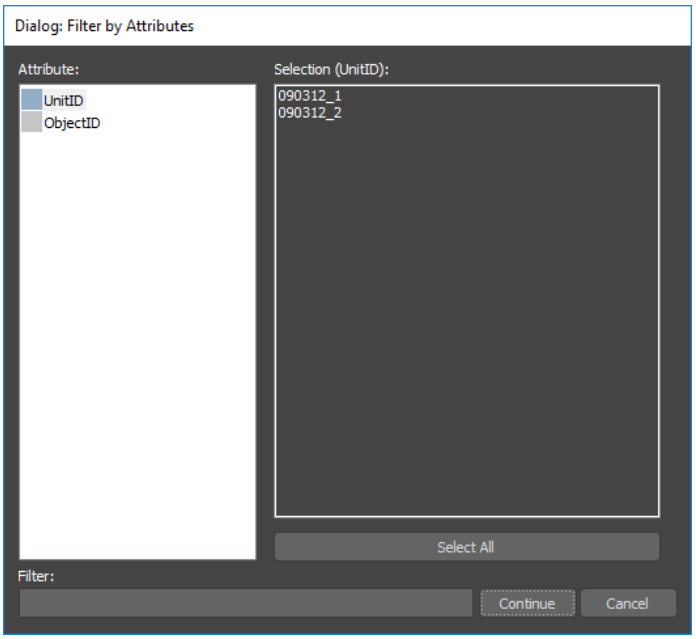
2.2.4. Load a single Unit by its UnitID

The UnitID is an Identifier which can be chosen by the User. It must be unique in a database/XML file. The ID may consist of letters and digits and is case sensitive, i.e. lower and upper case is crucial.

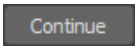
When you type a UnitID into the respective field and confirm it with Enter (or by a mouse click), the Unit will be loaded. If no Unit with that ID exists in the working set, the ID of the last active Unit is displayed again.

2.2.5. Load Units by attributes

If certain attributes of Units or complexes of Units are known, these Units can be loaded specifically via the button  `Load units via attributes`. Th loaded Units are also highlighted in the hierarchy window.



In the column *Attributes* the available attributes are listed, in the column *Selection* the respective values.

By selecting the desired entries in the S*election* column, the list of Units to be loaded is defined, which is transferred to the City**GRID**® Modeler by clicking on 

If the selection is made on the basis of the object ID, the associated Unit in which the object with the selected object ID is located in, is loaded automatically.

For simplified search, a filter field is available in which an independent search filter can be specified for each attribute listed. If you switch between the attributes, the entered search filter is retained. Every entry in the filter field must be confirmed with the enter key.

Advice: To pass multiple filter values to the system, enclosed them in double quotes (") (for example" 123 "" 345 ")

*Advice: If no selection in the selection column is made for a set filter, City**GRID**® Modeler interprets this as a complete selection and loads all listed entries.*

2.2.6. Level of Detail of the Loaded Unit(s)

Units are stored in several Levels of Detail (LoD) can be loaded in any of these levels (only in database mode).

The following LoDs are implemented:

0 ... Plan

1 ... Block Model

2 ... Form Model (with roof shape and ev. roof protrusion)

3 ... Detailed Model (including dormer windows, etc.)

The models of a Unit in lower LoDs are derived automatically from the higher LoD. For the Box Model, a planar eave line is used in an average elevation. This elevation can also be defined by the user (cf. LoD1 elevation in section 2.8.4).

Note: Checkout and Editing is only possible, if the Unit is loaded in the highest LoD

2.2.7. Notes for the Graphical Selection

The Selection Polygons are drawn in different colours depending on the state of the last valid version of the Unit (cf. 2.6). If the default colour scheme had not been customized, the colours indicate different states of units:

- Light gray:

  The last valid version is a stable, non-torn-down version.

- Red:

  The last valid version was checked out in another session of Autodesk VIZ or MAX (presumably another operator works with it). If this unit is loaded, the latest, stable version is loaded by default. In the options window this procedure can be modified.

- Green:

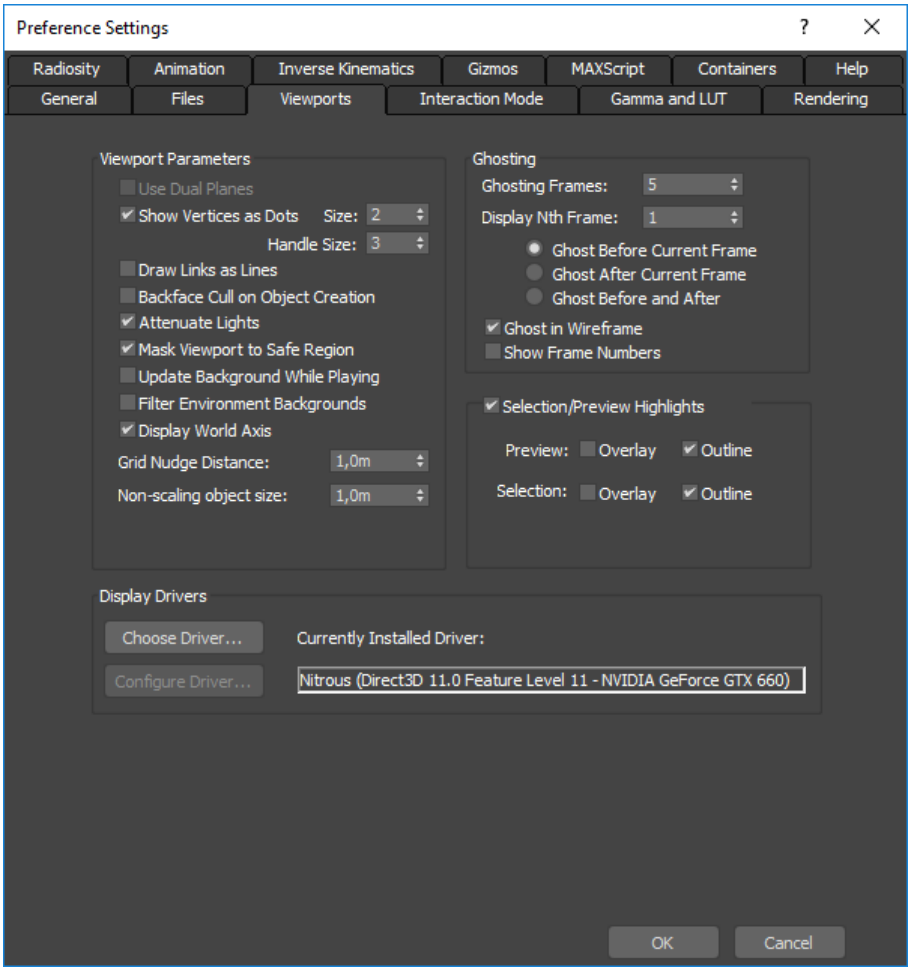
  The last valid version was checked out in the current session of Autodesk VIZ or MAX. If you load that Unit, the checked-out version will be loaded.

- Dark gray:

  The Unit was torn down in its last valid version.

Advice: If you press the CTRL-Key while clicking at the buttons for select and load single/multiple Unit(s), the zoom factor is preserved in the top and front drawing window when the Selection Polygons are drawn. This can help keeping the orientation in complex situations.

2.3. Optimizing the Display Driver in Autodesk 3D Studio Max



To be able to display 3D content, 3D Studio Max must use a suitable 3D driver. Currently there are three different drivers, Direct3D, OpenGL and Nitrous, available in different versions. By default, 3D Studio Max uses the Nitrous driver, which is a proprietary development from Autodesk. To see the best results when working with the City**GRID**® odeler, it is recommended to use the Nitrous -DirectX driver in its most recent version.

To change the display driver, go to the main menu of the 3D studio and select the menu item **Customize> Preferences**, on the Viewports tab, in the Display Drivers group. The button `Choose Driver` will take you to the selection list of available display drivers. After changing a driver the 3D Studio has to be restarted to make the changes effective.

2.4. Customizing the Views

2.4.1. Customizing the 3D View

The City**GRID**® Modeler works with a central projection in the 3D window, which can be turned, moved and zoomed with the navigation possibilities of Autodesk 3dStudio Max.

These are:

- Pan: press mouse wheel and move mouse
- Turn: ATL Key + mouse wheel pressed and move mouse
- Zoom: ALTGR Key + mouse wheel pressed and move mouse forward/backward.

Note: When changing the active complex it will be zoomed on the extension of the newly chosen complexes if the option "activate automatic zoom" is selected in the right-click menu of the layer window.

2.4.2. Changing the Visibility

The visibility can be changed for all loaded Units simultaneously. In the *View* box the visibility can be switched on and off for the following groups:

- Lines
- *Faces* (they are only after triangulation available)
- *Terrain*: In general, only the needed part of the terrain model is displayed.
- *Textures*: All available textures will be loaded (roof, facade and terrain)
- *Selection Polygons*: The Selection Polygons of neighbouring (not-loaded) Units of the Working Set are displayed, too. This may be useful for better orientation.

Active views are indicated by a colored background. The views set remain valid for the duration of the active session and only change with one click of the user. Restarting the Modeler restores the default settings.

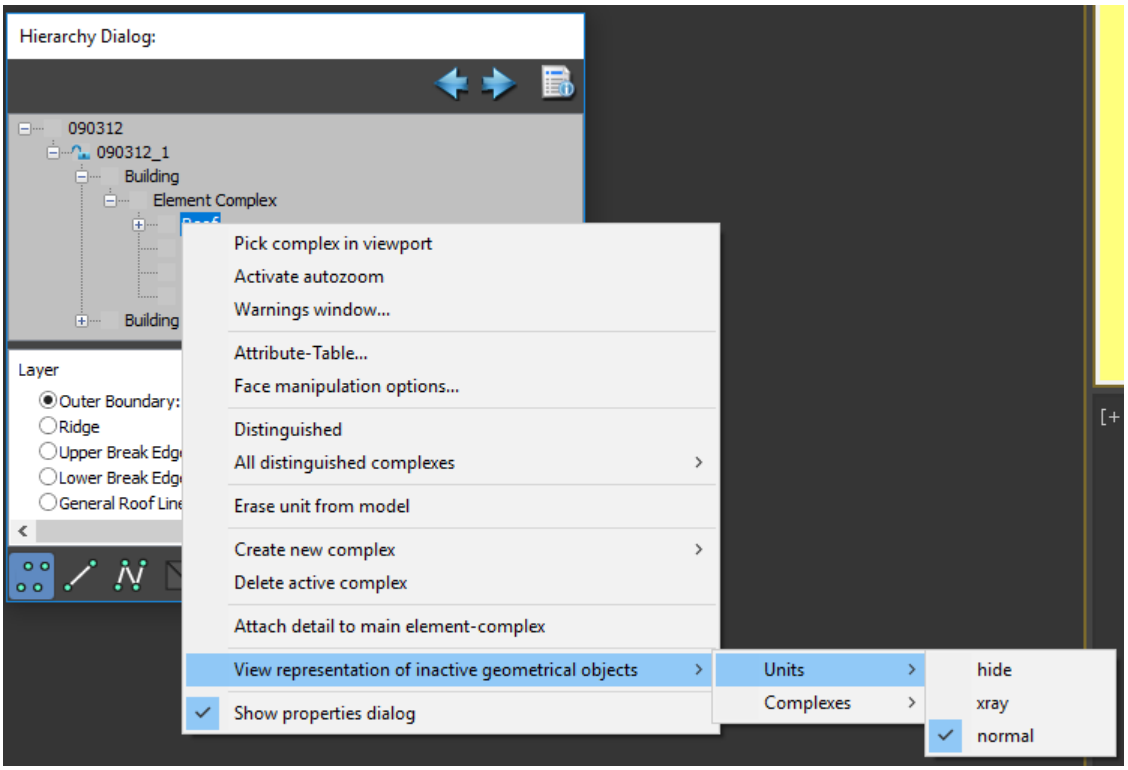
Note: Additionally, in the "Element Properties Window" you can change the visibility of single line layers and Element-Faces. In the Options window you can also choose that the entire terrain shall be displayed.

2.4.3. Display of inactive Complexes

For editing it is always necessary to activate a building complex. This complex is called the Active Complex (cf. 2.7). All other building complexes are inactive. Inactive building complexes can be displayed

- coloured, fully visible,
- gray, transparent,
- invisible.

Changing the appearance of inactive complexes is done in the right-click-menu of the Hierarchy Dialog (cf. 2.7.1).



Under the menu V*iew representation of inactive geometrical objects* the appearance of

- inactive Units
- inactive complexes (other Objects, Element Complexes)

of the active Unit can be changed.

Note: For opening this menu without changing the Active Complex, you need to click into the lower free space or the border of the Hierarchy Dialog.

2.4.4. Changing the Colour scheme (User Defined Default Colours)

The default colours for line and face layers may be customized individually for each user. This will be described in this section.

Further, face layers of single Elements may be assigned specific standard materials. These are stored with the Element and will override user defined standard colours (cf. 2.8.4).

The user defined default colours of line and face layers of Units can be changed by opening the menu **CGModeler > Edit User Defined Default Colour**. A dialog is opened for setting the layer colours individually for each Object class and Element class.

The first layers in the layer selection field are those line layers that exist for the respective Object class and Element class. The last layer is the respective face layer.

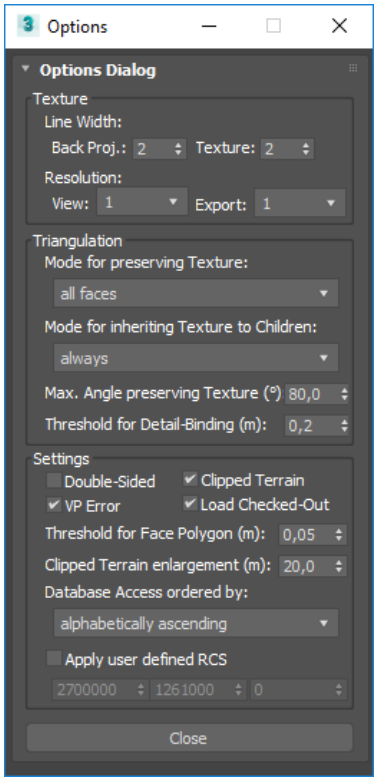
The colour selection dialog can be opened by double-click at the respective layer name or by clicking at the colour field.

The same way colours of terrain faces, Selection Polygons and other as well as the background colour and the colours of the selection and sub-selection can be specified.

2.4.5. Toggle between Wire Frame View and Shaded View

For that purpose a button  in the row of standard buttons is available (cf. 1.7.1).

2.5. Options menu



The Options menu can be accessed via menu **CGModeler > Options**. Here are found the universal parameters for calibrating City**GRID**® Modeler.

Texture

- The *Line Width* defines the size of the re-projected projected lines in the texture module
- The *Resolution* of the texture controls the image quality while working with Autodesk MAX (*View*) as well as the *Export*. The numeric value defines the pixel ratio in mm to reality. E.g. a value of 100 means, that a pixel equals 100 mm.

Triangulation:

- Mode *for preserving Texture* controls the triangulation behaviour of already textured surfaces.
  - *Only unchanged faces* checks if topology of the textured surface would change during triangulation. This happens in particular when points are added in the line framework and therefore the surface formation changes. Areas with a new surface configuration lose the existing texture during triangulation while unmodified areas retain them.

Example:

The left building shows the original state, the façade upper edge with three vertices and the resulting face framework according to this. In the middle image an additional edge is added to the façade upper edge. The right image shows the result of the Triangulation. The right part of the façade is identical with the original state and therefore the applied texture is retained. The surface configuration of left section of the façade however differs from the original state and therefore no texture is retained for this section.

- *All Faces* analyses the object which has to be textured in several ways before assigning textures. First all faces are overlayed with textures if they have textures assigned. Then faces are determined from the remaining which have images applied and a texture can be assigned with a projection.

- *Mode for inheriting Texture to Children* determines the conditions under which textures of a parent element are passed on to the child element complexes.
  - *Always* textures all surfaces of a child element complex from the textures of the parent element.
  - *Only to Elements of corresponding Element Class* ensures that texture transfer occurs only for certain element classes. Roof texture is inherited to element classes, roof, ceiling and combined, facade texture to façade and vertical roof face.
  - *Never* generally prevents texture inheritance.
- *Max. Angle preserving Texture (°)* is used for this determination. It controls how much the surface normal of potential textureable faces can differ from the original surface normal, for which these textures were determined.

Note: The maximum value for the tolerance angle is *90°, which means that all faces which lie up to 90° opposite the actual textured face are automatically assigned the same texture.*

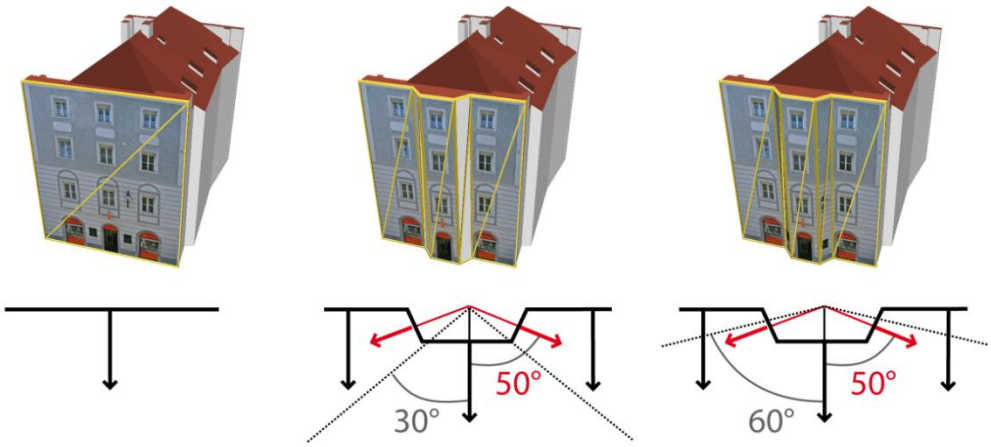
If faces are detected which are within this threshold and don't have a texture, the dimension of the textures, which shall be assigned, are ascertained to fit the faces. If all these parameters are fulfilled the texturing of the faces happens automatically.

Note: For check-up the coverage of the faces with texture images use ***CGModeler > Auxiliary Objects > Show auxiliary data of the texture image*** *to display a schematic view of the textures with their dimension and their surface normal.*

Advice: The interactive allocation of roof texture images (cf.8.1) of LoD3 buildings in Preserve texture at triangulate Mode causes all roofs with detail element complex to get the roof texture from the main roof automatically unless the detail element complexes don't overhang the main roof too much.

In general the setting *all faces* has the effect that already applied textures, façade textures in particular, are preserved during triangulation.

Example:



The left house shows the original state, the façade upper edge exhibits the left and the right vertex as edge and according to this the face framework is built.

In the middle picture the façade upper edge has had a bay added, so that the façade has a clear different form compared to the original state. The threshold for tolerance angle is 30°. In this case the part of the bay where the surface normal is identical with the original picture gets the same texture automatically. The inclined faces of the bay, displayed with red arrows in the schematic view, don't get textures since the contortion of the surface normal compared to the original state is greater than 30°.

The right picture shows the result of setting threshold for tolerance angel to 60°. In this scenario the inclined faces are textureized because the surface normals have less than 60° contortion and the façade segment was covered by the original texture image.

- *Threshold for Detail Binding*. Defines the maximum distance between the vertices of the eave polygon for Detail Element Complexes and the element faces of their parent elements, up to which the conversion of the line framework is triggered in the binding of the Detail Element Complex (cf. 5.4).

Note: The larger the value you select here, the more inaccurately can Detail Element Complexes be modeled to parent faces in the intersection area. At the same time there is an increased risk that fine modeling features may be lost in the binding process With Roof Detail Element Complexes in particular, there is the risk that small side faces may be lost and the roof face merges with the surrounding elements. Depending on the modeling situation, the value may have to be adapted.

Settings

- *Double-sided* displays all surfaces in Viewport in and towards the surface normal direction. Thereby surfaces are viewable from both sides. If this option is not activated, surfaces can only be seen if you look towards their surface normal direction.
- *VP error* (Viewport error, activation recommended): If activated, continuous redraws are made, but could be dispensable with a powerful graphic card.
- *Terrain aperture*: Defines if the whole terrain or only an aperture should be loaded and displayed.

Note: The view of whole terrain models can lead to massive performance loss! The required computing time for Check-Out, Save, Triangulation and Check-In the in particular depends on if the whole terrain model or only an aperture is used!

- *Load checked out Version*: If activated, always the last version is loaded, independent if this version is checked-in or checked-out.

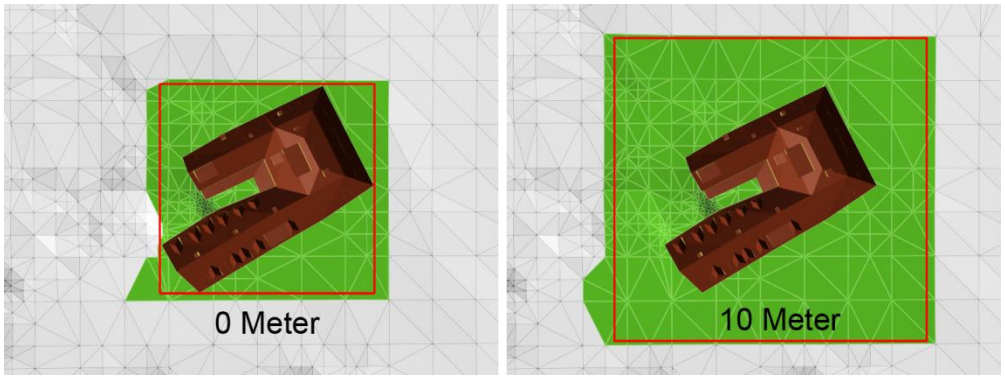
Advice: This option is only active, while a single Modeler is working on a single model, which prevents mutual overwriting!

- *Threshold for face polygon* is the distance of adjacent surfaces normals with length of one meter (unit vector). For small angle values it corresponds with the angle between the surface normal in radian measure.

  Example: A value of 0,01 corresponds with an aberration of 1cm of a one meter long surface normal and respectively an angel of 0,01 π. Converted to degree the value would be 1,8 °.

  Defines when aberrations of adjacent surfaces can be seen as planar and grouped as selection. This parameter has impact on the (red) knuckle lines in Viewport, which are indicators for forced edges while triangulation and are hints on bends inside a polygon. In the same way it controls which surface should be automatically selected if polygon selection is used in the texture mode (c.f. 8.1).

- *Clipped Terrain enlargement*: Defines how far the applied clipped terrain is extended beyond the derived minimal required area. The minimal area is defined by an intersection of each units bounding box with all terrain triangles. Every hit terrain face is used for clipped terrain.



- *Database access ordered by* defines how lists for models, buildings and images are sorted. Alphabetical or creation date, both ascending and descending is available.
- *Use Custom RCS* defines the offset value that is applied at loading of models into City**GRID**® Modeler (cf. 1.8). The figures indicate the offset from the reduced coordinate system to output system.

2.6. Version Management E T

The version management is accessible in the database version of the City**GRID**® Modeler and ensures that older versions cannot get lost, but can be loaded again (cf. manual City**GRID**® Basics). The version management can be used on the one hand for saving the editing history and on the other hand for making comprehensible the building history of a Unit or a DTM. With each version the check out/check in date as well as a comment is stored.

A version can have one of four states:

- "-" (none):

  For stable versions no special state is stored (except for state "torn down").

- "*Checked out*":

  This version is checked out for editing. Only the last version can be checked out. For a checked-out version, there exists always an older stable version.

- "*Disabled*":

  Invalid versions may be locked. (Units only)

- "*Torn down*":

  For Units which have been demolished, a torn-down version is stored as last stable version. This ensures that the Unit exists with its version history so that historical states can be accessed. (Units only)

If not a special version is loaded, the last stable version is loaded (condition 1 or 4) or a checked-out version, if it was checked out in the current session of Autodesk 3D Studio Max.

A unit, of which the last valid version is a checked-out version but which was not checked out in the current session of Autodesk 3D Studio Max, is:

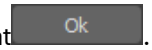
- either currently edited by another operator
- or was checked out in an earlier session of Autodesk 3D Studio Max.

The operator must verify which of the two cases is true and can then – if appropriate – load the checked out version explicitly (cf. 2.6.4).

You can also change the version class of each version in Version Management. Versions may assume the states of "Working Version" or "Historic Version".

*Note: The version control for aerial images can't be accessed at the user interface of City**GRID®** Modeler, as changes there don't require interactive work and can therefore be done globally in City**GRID®** Administrator. Loaded Models always refer to the latest versions for aerial images, old versions can be deleted from database via City**GRID®** Administrator if needed.*

2.6.1. Checking Out a Unit

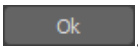
1. Load the Unit in the highest LoD and activate it (cf. 2.2 and 2.7).
2. Click at `Check-Out active data set.`  (cf. 2.6.1)
3. You may provide a comment (such as "Roof correction", "Texturing façade", "Update 2005", etc.)
4. Click at 

.
5. The Unit will be checked out. A new version of the Unit is created in the database. This version is released for editing. When editing the Unit you can store the Unit any time which means that this version is overwritten each time. However, earlier versions are not changed.

Note: If the CTRL key is pressed while clicking at Check-Out active Unit, points 3 and 4 are suppressed.

2.6.2. Checking Out a DTM

1. In Working set window switch from Model to Terrain in Selection from Model Section (cf. 2.1.3)
2. Select the desired terrain model and press 

3. Activate Terrain model in hierarchy window. (cf. 2.7)
4. Click at `Check-Out active data set.`  (cf. 2.6.1)
5. You may provide a comment (such as "Terrain correction", "Update 2019", etc.)
6. Click at 

.
7. The DTM will be checked out and a new version is created in the database. This version is released for editing. When editing the DTM you can store at any time which means that this version is overwritten each time. However, earlier versions are not changed.

Note: If the CTRL key is pressed while clicking at Check-Out active Complex, points5 and 6 are suppressed.

2.6.3. Checking In a Unit/DTM with Saving

1. Activate the Unit (cf. 2.7).
2. Click at `Check-In active data set`  (cf. 2.6.2)
3. Confirm the text or overwrite it.
4. Click at 

.
5. The Unit will be stored and the state of the version will be reset to “None”.

Note: If the CTRL-key is pressed while clicking at Check-In active Unit with Saving, points 3 and 4 are suppressed.

Note: Save with Checkin is a function designed for use at geometry modelling. At interactive texturing Save before checkin is required to store work done in database.

2.6.4. Load a specific Unit Version explicitly

For loading a specific version of a Unit, first the default version of the Unit must be loaded and activated. Afterwards the “Version History Window” can be opened and the desired version can be loaded:

1. Load the Unit and activate it (cf. 2.2 and 2.7).
2. Open the `Version History Window` 
3. Select the desired version (by clicking at *Details* the comment and the date of the version can be viewed)
4. Click at 

for loading the version

Note: Disabled versions cannot be loaded.

Note: Only checked out versions can be loaded with terrain models, loading of any arbitrary version is not yet implemented.

2.6.5. Rejecting a Checked-out Version

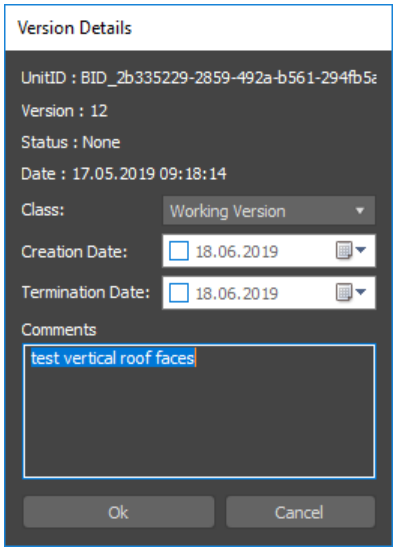
1. Activate the Unit (cf. 2.7).
2. Click at `Rejecting a Checked-out Version`  . The checked-out version will be deleted and the last stable version will be loaded.

2.6.6. Version History Dialog

All actions previously described with Unit versions are recorded in the Version History. Every stable version is listed in the Version History Dialog, starting with the first version of a Unit, which is typically created on import to the database, through to the latest version.

Each version is assigned a unique number and various attributes. The affected version is activated by selecting a line and released for operations. `Load` loads the activated version to Modeler (cf. 2.6.4); `Enable` and `Disable` render a version inaccessible or re-accessible (cf. 2.6.6); and `Details` opens the Properties Dialog for each version.

2.6.7. Mark a Unit Version as Disabled



A checked-out version can be deleted by *Rejecting a* `Checked-out Version` . Other versions cannot be deleted but only marked as disabled.

1. Load the Unit and activate it (cf. 2.2 and 2.7).
2. Open the `Version History Window`
3. If necessary, load another version (not the one which is to be disabled) (cf. 2.6.4)
4. Select the desired version
5. Click at Disable for marking it as disabled.

Note: A version can only be disabled, if another version is loaded.

In a similar way, a version can be enabled again (button “Enable”).

2.6.8. Edit a Unit starting from an old state

Checking out is only possible, if the last stable version of a Unit is loaded in the highest LoD and if there exists no checked-out version.

If you want to edit a Unit starting from a historic state, first you’ll have to mark all younger versions as disabled (cf. 2.6.6). Then, you can check out (cf. 2.6.1).

2.6.9. Converting Working versions into Historic versions

Every checked-in version is a working version by definition. This version class is typically used to model a building in order to save intermediate steps (e.g. main roof modeled, roof landscape ready, texturizing, etc.). In order to implement a time series of the building state in the database, not all of these versions are necessary. Normally, only versions are needed which represent the finished building model, or the state of the building at a specific point in time. To meet this requirement, City**GRID**® offers you the option to convert a working version to a historic version (see City**GRID**® Basics Manual).

1. Load and Activate Unit (cf. 2.2 and 2.6.9)
2. Click on `Open Version History` .
3. Select a working version (stable version).
4. Open Version Details by clicking on Details... .
5. *Class:* change from *Working Version* to*Historic Version*.
6. Enter a *Creation Date* and *Termination Date* as required.

*Note: If you prefer not to specify a date, City**GRID**® interprets this as "the building already exists" or "the building will stand for ever". Otherwise, define a validity period for the specified version.*

7. You can enter a descriptive text for the version under *Comments*.
8. Click on Ok to confirm the conversion.

After this procedure, the Version History Dialog displays the entry *Historic Version* in column *Class* for the active version.

Once a Historic Version exists, a menu is activated at bottom left, permitting you to restrict the view of the Version History Dialog to historic versions. If you change from Check *All Versions* to *Historic Versions*, only Historic

Versions are displayed, and the Creation Dates and Termination Dates are checked whether their chronological sequence is correct. If the chronological sequence is incorrect, the Historic Versions are highlighted in green font.

2.7. Active Complex, active Element, active Data set

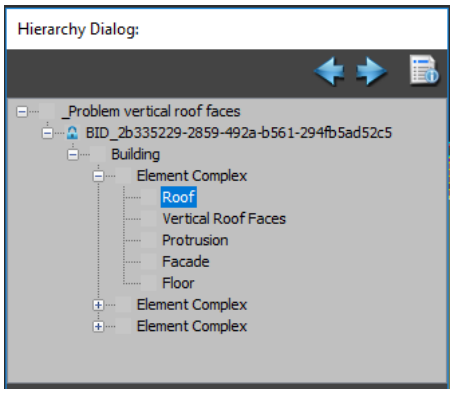
The hierarchy of building complexes is used in City**GRID**® is explained in Manual City**GRID**® Basics. The overall term for Unit, Object, Main Element Complex and Detail Element Complex shall be in the following "Complex".

Only one building complex can be selected as the "Active Complex".

Editing actions are possible only in the Active Complex. Depending on the hierarchy level of the Active Complex (Model, Unit, Object, Main Element Complex, Detail Element Complex), some editing actions are permitted or prohibited.

Units and Terrain models are referred to as active data sets.

2.7.1. Hierarchy Dialog of loaded Units



Only a loaded Unit or a part of it can be set as Active Complex. The loaded Units are shown with their hierarchy as tree in the "Hierarchy Dialog of loaded Units". The Active Complex is highlighted in blue.

In this window, the Units are sorted by their UnitIDs.

The order of Objects in a Unit is arbitrary and may change after editing actions. The same is true for the order of Main Element Complexes in an Object and for the order of Detail Element Complexes in a Main Element Complex.

*Advice: The hierarchy window is a freely positionable control of the City**GRID**® Modeler. After starting, the hierarchy window is positioned at a predefined position. Each user can further adapt the position of this window and also adjust the size. To do this, place the mouse pointer on the edges of the control and then drag the window in the desired direction. The corners can be used to change the size in length and width at the same time.*

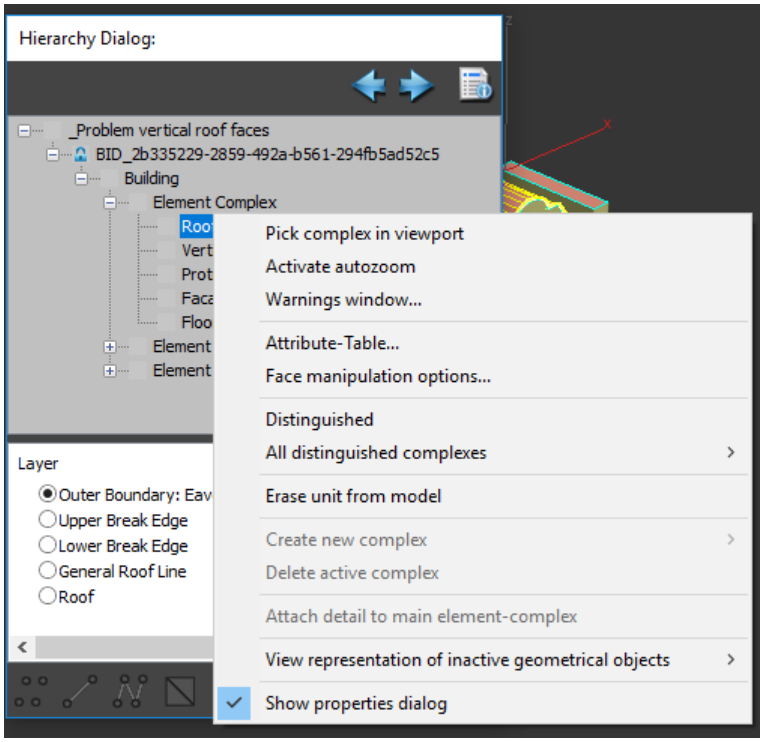
2.7.2. Selecting the Active Complex

Selecting the Active Complex can be done by

- selecting a complex in the tree of loaded Units in the Hierarchy Dialog
- selecting a complex graphically after activating the mode *pick complex in viewport* in the right click context menu in the hierarchy dialog.

Advice: This function can be very helpful for quickly jumping to another active complex. I

After selecting a new complex, the Modeler automatically zooms to the extents of that complex, if the option *activate auto zoom* is selected in the right-click menu of the Hierarchy Dialog.



2.7.3. Highlighting Active Complexes (Search For Attributes)

In order to mark loaded complexes in the Hierarchy Dialog, e.g. to find them more easily later, the program provides a highlighting method. You can use this method to assign a Highlighted status to any complex, with the exception of the model vertex.

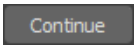
Highlight a complex by

- setting the interactive entry **Highlighted** in the Hierarchy Dialog context menu, which you open by right-clicking on a complex.
- defining attributive search parameters in the loaded complexes in the dialog `Highlight By Attributes`  .

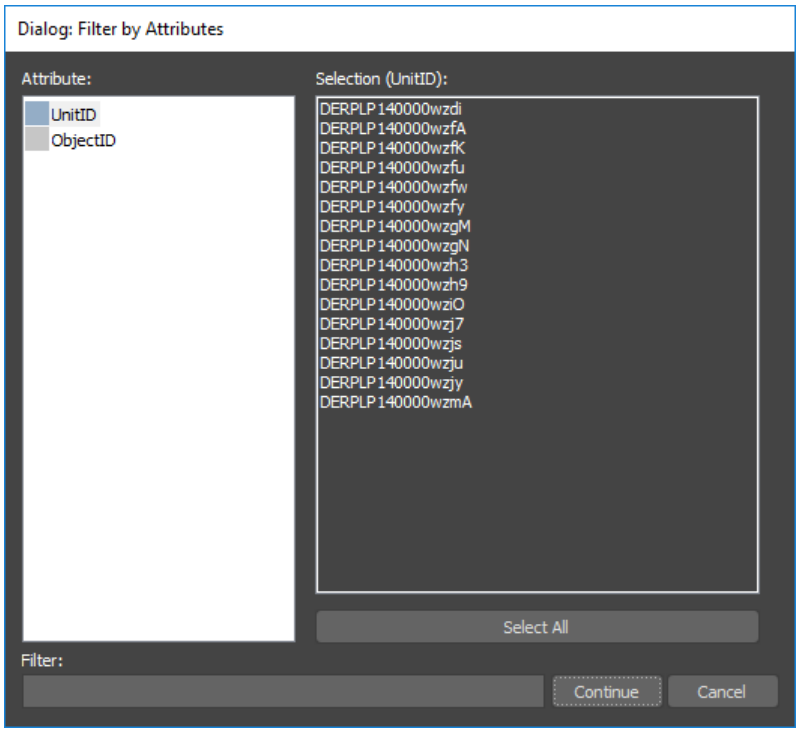
Proceed as follows to highlight complexes by attributes:

1. Load the object you require by selecting `Select Multiple Unit`  or `Load Unit By Attributes`  .
2. Click on `Highlight By Attributes`  .
3. Then select the required attributes in the pop-up dialog.

   List the existing attributes for your search in the Attributes column. The Selection column displays the existing values in the loaded dataset for the attribute you select.

   Define the list of highlighted complexes by selecting the required entries in the Selection column. Click on  to transfer them to City**GRID**® Modeler.

   A filter field is provided to simplify your search. Specify a separate search filter for each of the listed attributes. The specified search filter remains active when you switch between attributes. Confirm each entry in the filter field by pressing the Enter key.



Tip: To transfer several filter values to the system, write them in double quotes (") (e.g. "123" "345").

*Tip: If you make no selection for a set filter in the Selection column, City**GRID**® Modeler interprets this as Select All and loads all the listed entries.*

The buttons `Previous highlighted complex` and `Next highlighted complex` are provided in the Hierarchy Dialog to navigate through highlighted complexes. Click on one of the buttons in the Hierarchy Dialog to change the active complex automatically.

The complexes remain highlighted until a new model is loaded from the data source, or the dialog is re-opened. In this way, any area within a model can be regenerated (cf. 2.2) without losing the highlighted status on each of the complexes.

Right-click on a highlighted complex in the Hierarchy Dialog to remove the marking by deselecting the **Highlighted** entry in the context menu.

Note: To globally cancel all highlights on all Units in the model, hold down the CTRL key and click on `Highlight By Attributes`.

2.7.4. Actions with highlighted Complexes

You can perform various actions on highlighted complex and then process them one by one, Unit by Unit. The available actions always assume a synchronous action which is applicable to each Unit. All actions for highlighted complexes are located in the context menu under the option *All Highlighted Complexes* in the Hierarchy Dialog. Right-click a highlighted complex to open the context menu. The list of actions currently available in the context menu include:

- *Check-out* (cf. 2.6.1)
- *Check-in* (cf. 0)
- *Undo Check-out* (cf. 2.6.5)

Note: You can only use the Check-in and Check-out functions in conjunction with a database. These options are not available for XML files. For databases, at least the selected action must be executable for a highlighted Unit.

- Attribute-Table (cf.7.1)
- Face manipulation options (cf. 5.9)
- *Generate Faces* (Triangulate) (cf. 1.7.5)
- *Delete* (cf. 5.6)

Note: Deleting highlighted complexes takes into account the validity of the remaining complexes. That is to say, when the higher-level complex is emptied by a delete operation (cf. CityGRID® Basics Manual), the complex is removed automatically. If you need to remove an entire Unit as a result, the Unit is set to the status Torn Down in the database (cf. 5.6). In XML files, the Unit is deleted.

- *Remove Highlighted Status* (for all highlighted complexes)

Besides the actions in the context menu, you can also use drag & drop actions with highlighted complexes (cf. 5.8). To execute drag & drop actions successfully, the following rules apply:

- Only deal with complexes with the same Hierarchy level (e.g. Units, Objects, Element Complexes, etc.). If different complexes were highlighted, only the clicked complex is dragged, but not all the other highlighted complexes. Here, it does not matter whether there are other highlighted complexes of the same hierarchy level among the highlighted complexes, or not. In this case, a warning appears in the Warning Dialog (cf. 2.10).
- As soon as you start a drag & drop action for several highlighted complexes, a dialog appears to define the complexes to which the action is applied "`Yes`" drags all highlighted complexes. "`No`" drags the clicked complex. "`Cancel`" ends the drag & drop function without dragging the complexes.
- If you start a drag & drop function for checked-in complexes in the database, the complexes are not addressed and a corresponding warning appears in the Warning Dialog (cf. 2.10).

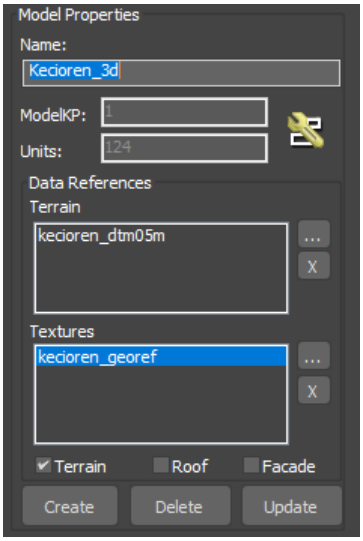
2.8. Properties of the Active Complex

The Properties Window of the Active Complex is docked on the Hierarchy Dialog of loaded Units, if the option *show properties dialog* is checked in the right-click-menu of the Hierarchy Dialog.

Note: For opening this menu without changing the Active Complex, you need to click into the lower free space or the border of the Hierarchy Dialog.

Depending on the hierarchy level of the Active Complex the Properties Window has different appearance.

2.8.1. Model Properties



If the Model the loaded Units belong to is activated in the Hierarchy Dialog as the Active Complex, the Model Properties window is shown in case the option "show properties dialog" is selected in the right-click-menu of the Hierarchy Dialog. Here, the Name of the Model is shown.

- The *ModelKP* indicates the unique database key of the Model (this value is null for XML data sources).
- The value in the field *Units* gives the number of Units belonging to the Model. These two values cannot be edited.
- The button `Model Administration` can be used for adding/removing Units from the Model and creation of new models (cf. 6.1.5).
- In the group *Data References* the terrain models which are assigned to the Model is shown. Furthermore the names of the texture images are given. Define for each texture image if it should be used as *area* – or *roof* texture image or for both.

Note: The terrain texture is always derived online when requested whereas the texture of Units must be precalculated (cf. 7).

2.8.2. Unit/Version Properties

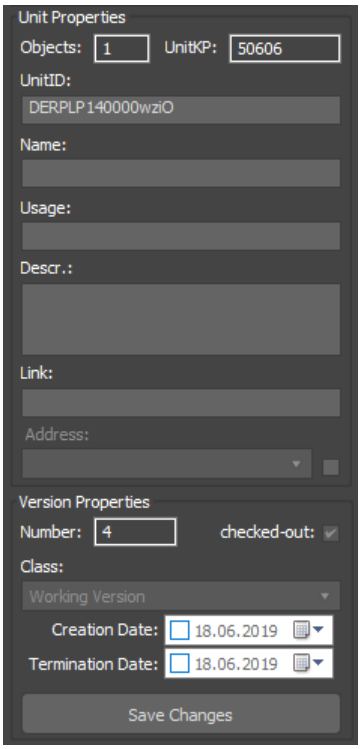
If a Unit is activated in the Hierarchy Dialog as the Active Complex, the Unit Properties window is shown in case the option *show properties dialog* is selected in the right-click-menu of the Hierarchy Dialog.

Non-Editable Fields (Status Information of Unit properties):

- The field *Objects* shows the number of Objects in the Unit.
- The *UnitKP* indicates the unique database key of the Unit (this value is null for XML data sources).
- *Address*: If a link to an address database is installed in the database, the address of a Unit can be shown. For that purpose, the checkbox right to the address field must be checked. Per default it is not checked as each address query needs some (short) time.

Editable Fields (Unit properties):

- The *UnitID* is an alphanumerical (may consist of letters and digits), unique identifier for the Unit which can be chosen by the operator.
- The *name* of the Unit can be given.



- A detailed *description* can be given. This description is used when publishing for the internet.

Advice: Use CTRL-Return in order to insert a new line.

- A web *link* can be assigned to the Unit.

Non-Editable Fields (Status Information of Unitversion properties):

- *Number*: Defines the version number of the loaded Unit version.
- *Checked-out* indicates whether the Unit is a stable version, or whether it is checked out for editing.

Editable Fields (Unit version properties):

- *Class* indicates the present version class. In the dropdown menu, you can change the version class of stable versions at any time (cf. 2.6).
- *Creation Date*: Defines the start of the version validity period. *If no value is entered,* City**GRID**® *interprets this as "the building has always existed".*
- *Termination Date*: Defines the end of the version validity period. If no value is entered, City**GRID**® interprets this as "the building will stand for ever".

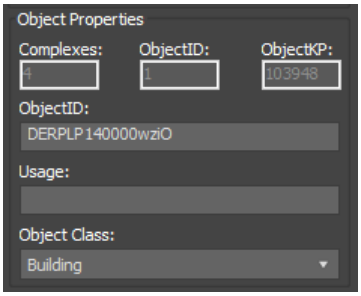
Note: Creation and Termination Dates can be set for every Unit version. However, they are only evaluated for Historic Versions. Nonetheless, it may be practical to fill in the values for working versions so that the individual Creation and Termination Dates exist for later class changes.

By clicking at the button *Save Changes* the new data are taken over and immediately written to the database/data source.

Note: These metadata of a Unit are the same for all versions of the Unit.

Tip: If only the Class or the Creation and Destination Dates need to be changed for a version, it is much faster to execute the action in the Version Details Dialog (cf. 2.6.9), since the save process takes much less time there.

2.8.3. Object Properties



If an Object is activated in the Hierarchy Dialog as the Active Complex, the Object Properties window is shown in case the option *show properties dialog* is selected in the right-click-menu of the Hierarchy Dialog.

- *Complexes:*

  shows the number of Element Complexes in the Object.

- *ObjectKP:*

  Indicates the unique database key of the Object, the *ObjectID* a consecutive number of the Object used by the XML-Modeler.

- *ObjectID*:

  is an alphanumerical (may consist of letters and digits), unique identifier for the Object which can be chosen by the operator. If specified it's shown in hierarchy window instead of the Object Class. The *ObjectID* can also be used for search querries.

- *Usage:*

  is an alphanumerical (may consist of letters and digits), non unique identifier for the Object which can be chosen by the operator.

- *Object Class*

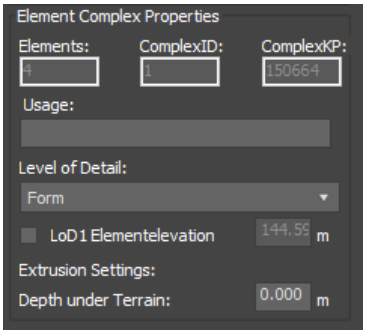
  The object class can be edited for checked out units (cf. 2.6). All classes that are common in CityGML are available for selection. The most important classes in City**GRID**® are:

  - Building
  - Cut-out Object
  - Underground Building

In order to apply changes, the Unit must be triangulated (cf. 3.1) before saving it!!

2.8.4. Element Complex Properties

If an Element Complex is activated in the Hierarchy Dialog as the Active Complex the properties window is shown in case the option *show properties dialog* is selected in the right-click-menu of the Hierarchy Dialog.



- The field *Elements* shows the number of Elements in the Element-Complex.
- The *ComplexKP* indicates the unique database key of the Object, the *ComplexID* a consecutive number of the Object used by the XML-Modeler.
- Each Element Complex can be given any *Usage* in order to support the logical structure in the hierarchy window (e.g. garage, shed, lift annexes, etc.)
- *Level of detail*: The LOD of each element complex can be defined individually. The available options are LOD 3 (detail) and LOD 2 (form). By default the software sets the LOD of detail element complexes to detail and main element complexes to form.

  Note: Be aware that the LOD of main element complexes is always to be set lower or at least equal to the LOD of its detail element complexes. Increasing the LOD of a main element complex will have an effect on the LOD of its detail element complexes immediately.

- *LoD1*: The LoD1 (Box Model) of a Unit is usually generated automatically in an average elevation of the eave line. If a given value for the elevation of the eave line shall be used, the check box left of “LoD1” must be activated and the elevation to be used can be declared (as absolute height). In order to apply changes, the Unit must be triangulated (cf. 2.9.1) before saving it!! This parameter is available for main element complexes only.
- The *depth under terrain* option defines an additional distance in meter, the facade will be extruded under the lowest point of the covered terrain area. This option allows for generating cellar objects and is available for main element complexes only.

  Note: Positive values generate an extrusion under the ground, whereas negative values will let the building float above ground.

2.8.5. Element Properties

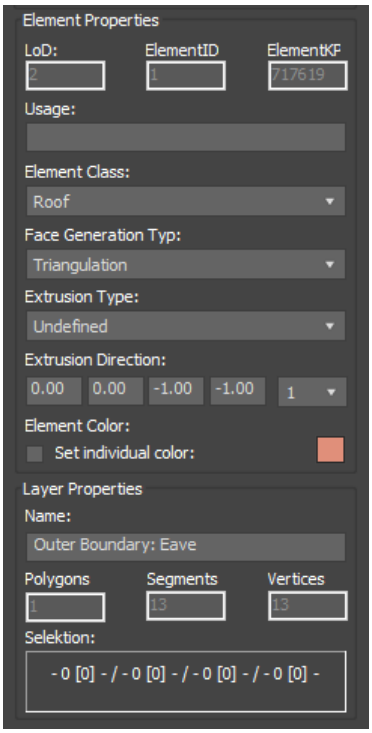
If an Element is activated in the Hierarchy Dialog as the Active Complex, the window "Active Layer” (cf. 2.9) is docked on, case the option *show properties dialog* is selected in the right-click-menu of the Hierarchy Dialog.

This window contains the Properties of the Element-Complex, of the Element, of the Active Layer (cf. 6.8), and the Selection-State-Line (cf. 3.2).

- The field *LoD* shows the Level of Details of the Element, *ElementKP* indicates the unique database key, the *ElementID* a consecutive number of the Element used by the XML-Modeler.
- Each Element can be given any *Usage* in order to support the logical structure in the hierarchy window (e.g. saddle roof, Courtyard facade, etc.)

- The *element class* indicates the interpretation of the element (e.g. roof, ceiling, protrusion, facades, floor). In general it cannot be modified except between roof and ceiling (a ceiling – on the contrary to a roof – has the default colour grey and is not considered at the automatic roof texturizing process.
- The *face generation type* defines the algorithm after the areas are differentiated. In general the face generation type is defined automatically. The orientation of the created areas plays an important role at this process. If the direction of the normal has been set in a wrong way, it will be corrected automatically at the process of triangulation. In addition the face generation can be set bilaterally. By doing so, the areas will be doubled with both area normals.

  A special case is the face generation type "frozen face net". In this case the existent (or directly with 3D-studio methods edited) faces are adopted and not newly derived anymore.



- *Extrusion* comprises the parameters for the *Number of Extrusion Directions*, the *Extrusion Type* and the *Extrusion Direction* itself. Generally, every element has precisely one extrusion direction, which is specified by 0/0/-1. In special cases, it may also happen that different and/or additional directions are set, e.g. with elements in Detail Element Complexes which are bounded by their associated elements in the Main Element Complex (cf. 5.4), or tubes.

  Extrusion Types define the modality of extrusions. Only set the Extrusion Type to generate the face element by extrusion. This is typically the case with façades of Main or Detail Elements. The following types are available at present:

  - *Terrain*: Extrusion projects all points on the terrain, determines the lowest pierce point, and assumes its z value as target size for the extrusion.
  - *Terrain with Ground*: Functions similarly to the *Terrain* Extrusion Type. The difference here is that a ground element is generated automatically at the lowest determined height of the façade element. Since this ground element is generated without the associated lines, it adapts itself automatically to a change in terrain model with every triangulation.
  - *Parent Element*: Generates the faces until they intersect with the faces of the associated parent element. This Extrusion Type is applied to Detail Element Complexes which protrude above the roof, (e.g. dormers).
  - *Parent Element with Hole:* Similar to the previous Extrusion Type. The only difference is that all faces in the parent element inside of the extruded area are omitted. This Extrusion Type is used for details which are located under the roof (e.g. patios).
  - *Parent Element with Auto*-Terrace

    If this Extrusion Type is set and the Detail Element Complex is entirely below the roof of the parent element, the faces are generated analogously to the previous Extrusion Type, which means, that the faces of the parent element within the extruded area are omitted. However, if a Detail Element Complex with this Extrusion Type is not completely below the roof of the parent element, no faces are left out, the faces are generated as with the Extrusion Type *Parent Element*.
  - *Not set*: If the face is created by triangulation, the Extrusion Type is not set.

- Finally a *default material* consisting of a colour and a transparency value between 0 (opaque) and 1 (fully transparent) can be assigned to the Element. This Element default material will be stored together with the Element and overrides the user defined default colour (cf. 2.4.4).
- User-defined colour settings can be adopted for all areas of the same element in the right-click menu of the layer properties.

The Layer Properties will be described in the next section, the Selection-State-Line in section 3.2.

2.9. Active Layer

The geometric data of Elements are grouped in various layers. For various line types a separate layer is available. Furthermore, a layer for faces is available.

City**GRID**® implements a face generation algorithm optimized for building data. Faces are generated automatically from significant building lines. The lines of different layers are used in different ways.

It is the task of the operator with the Modeler to edit the lines so that the faces are generated correctly. In the current software version, although the faces can be edited directly, they are in general not stored, except elements with face generation type set to frozen face net

Editing actions can only be done in the active layer of the active Element, which can be selected in the window "Active Geometry". There, the working level (point, line, polyline, or face selection mode) can be selected.

- *Visibility*:

  The checkbox Visibility ("V") overrules the general visibility and controls the visibility of a specific layer.

- *Linkage (Bindings)*:

  If a vertex/segment in the active layer is moved, all identical vertices/segments/surfaces in other layers of the same Element Complex are also moved, if the linkage to these layers is active. Links can be disabled interactively in order to edit geometry of different layers independently.

  To disable the bindings, the Bindings-button  on the button bar, below the layer selection, is available. This is, as well as the bindings, active by default. Click to disable all kind of bindings (general and special) or enable bindings again. Every triangulation activates all bindings as well as the bind button.

- *Special-Connection (Master*-Slave and 2D):

  Express a data-based combination of layers.

  Master-Salve

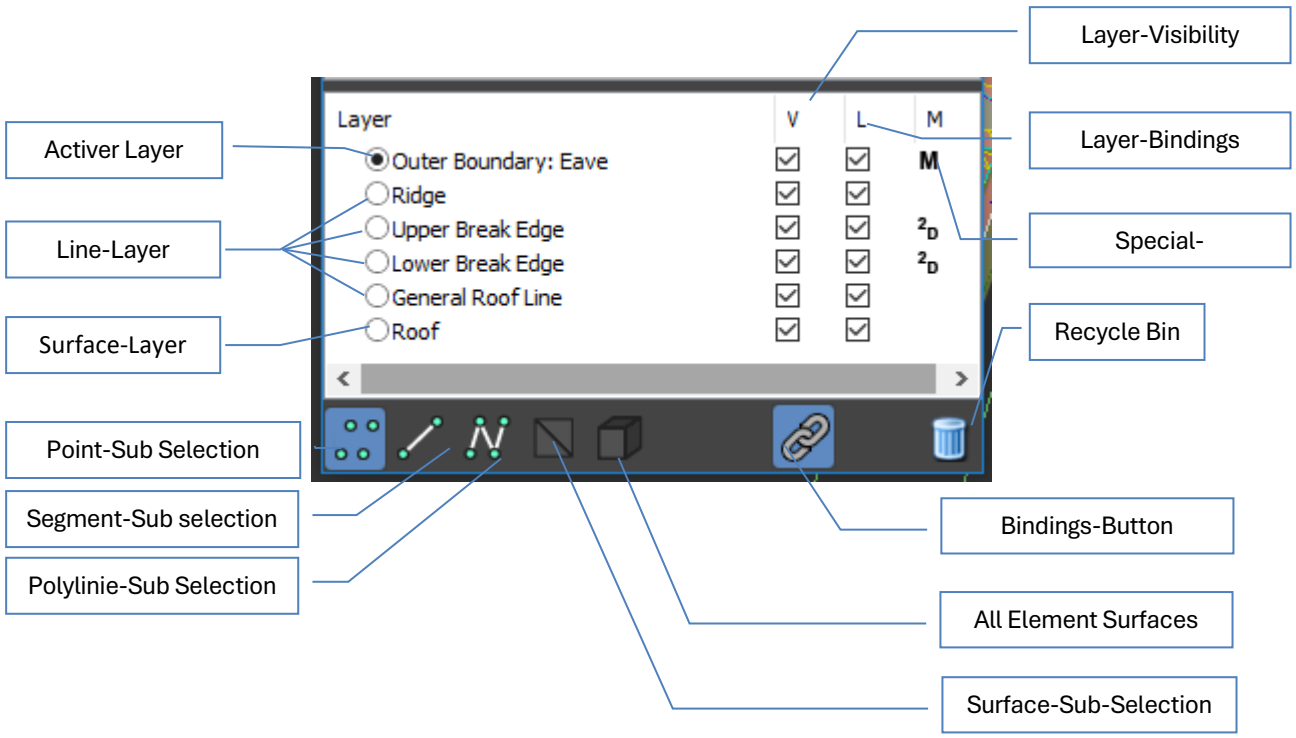
  A line can be the master to an identical line in another Element of the same Element Complex, e.g. the eave line of the Element Roof is the master to the upper facade line (except there is another Element Protrusion in between). Then, the master line has the sign "M". The slave line will have the sign "S" in the respective column.

  Both the master and the slave line may be edited. In both cases, the corresponding line in the other Element is changed in the same way. Master-Slave relations can temporarily be removed by clicking "M" or "S" in active Layer window.

  2D

  2D relations express the connection of two layer in XY position. Modifications in this level will automatically transferred to the second layer of this relation, whereas modifications in Z are only applied to the active layer.

Note: When changing the active layer the zoom is adjusted to the extents of the lines in this layer, if the option "activate auto zoom" in the right-click-menu in the layer window is selected (cf. 2.7.2).



2.9.1. Layer Properties

The layer properties are shown on the window of the Element Complex properties and Element properties (cf. 2.8.4).

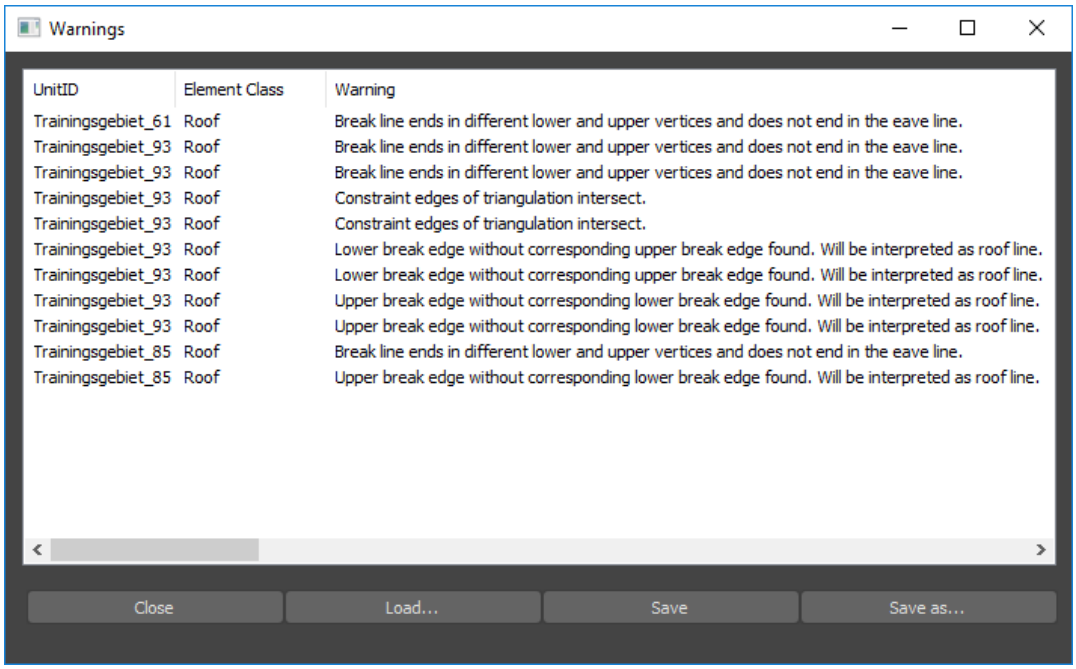
Depending on the active layer, information is given about the content of the layer:

- For line layers, the number of polylines in the active layer and their total number of segments and vertices are displayed.
- For face layers the number of texture images, the number of faces and the number of vertices is displayed.

In addition, the *Name* line contains the layer name of the active layer as freely accessible text. If the layer is a system layer of City**GRID**®, the layer name cannot be changed. On the other hand, all user-defined layers can be renamed using this line.

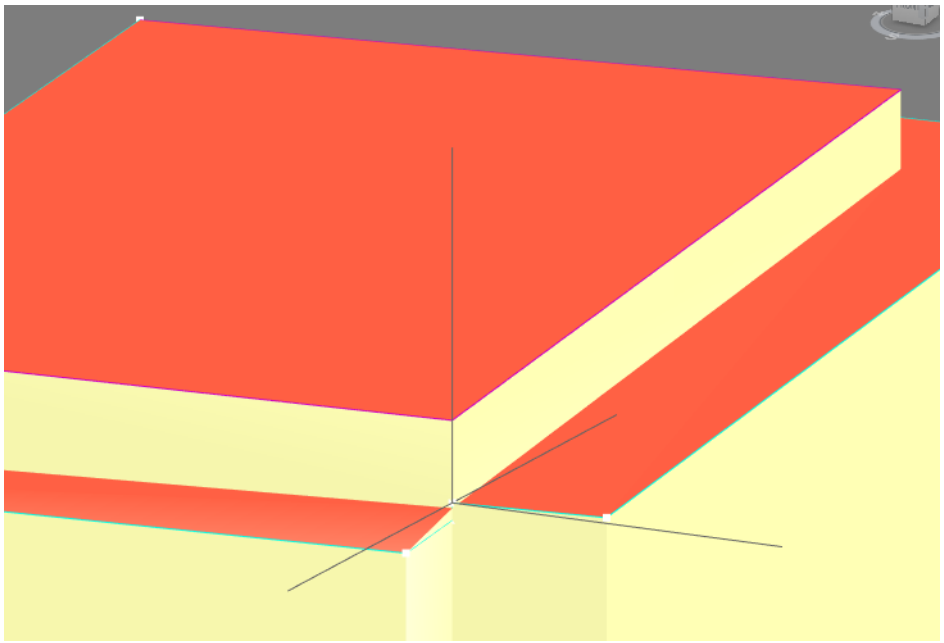
2.10. Warnings window

In the course of working with the City**GRID**® Modeler it will always happen that building models show topological errors (askew intersecting rooflines, not synchronous break lines, etc.) have. Such errors must be corrected by modeling technique to make correct surface models of the buildings. The check for topological correctness of the models takes place in the course of triangulation (see. Manual City**GRID**® Basics), which is triggered in the Modeler by clicking on the button  `Triangulate/Apply changes` (cf. 1.7.5). Once at least one topological problem situation is found, the warning window opens.



In this any warning constitutes a separate line and provides information about the UnitID, the affected Element class and the type of warning.

Note: It often happens that a problem location triggers several warning lines. Once the trouble spot has been fixed are-triangulation will remove all affected rows. The number of lines is thus not a criterion for the total number of issues inside a building!



By double-clicking on a warning line in the Warning window, loads the affected unit in the viewport and focuses on the problem area. This is highlighted by 3D crosses in the viewport. If the problem location is a line segment, the 3D crosses indicate the start and end of the relevant line segment.

Advice: Once the viewport has focused on the problem area, the building lines can be edited and corrected using editing tools of Modeler (see. 3). The effectiveness of editing can be determined by re-triangulation. The warning window can remain open while editing.

If the warning list is created by triangulation from City**GRID**® Modeler it can be assumed that all of the listed units are part of the active model (cf. 2.1) and therefore can also be loaded in the viewport. When externally generated warning lists (City**GRID**® Administrator City**GRID**® Scout, DWG2XML converter, etc.) are integrated via button

Load, it is possible that the Units of the warning list are not part of the active model and therefore can't be loaded. The viewport shows in this case is an empty space.

Advice: To see the active complex (see.2.7.2) in the viewport, select the "Auto Zoom" in the right click menu of the hierarchy window (see Figure in Section 2.7.1..

The buttons Save or Save as... can save the currently displayed warning list. `Save` writes the list in the log file of the Modeler, `Save As` allows saving the list to a desired location. The button Close terminates the warning window.

3. Editing the Geometry

The main goal of the City**GRID**® Modeler is to support the operator in editing the line geometry of buildings until City**GRID**® derives the surfaces correctly. Typical tasks of editing are:

- Adjust topologies (merge non-snapped vertices, adjust intersection lines)
- Complete missing lines
- Detach lines to Detail Elements etc

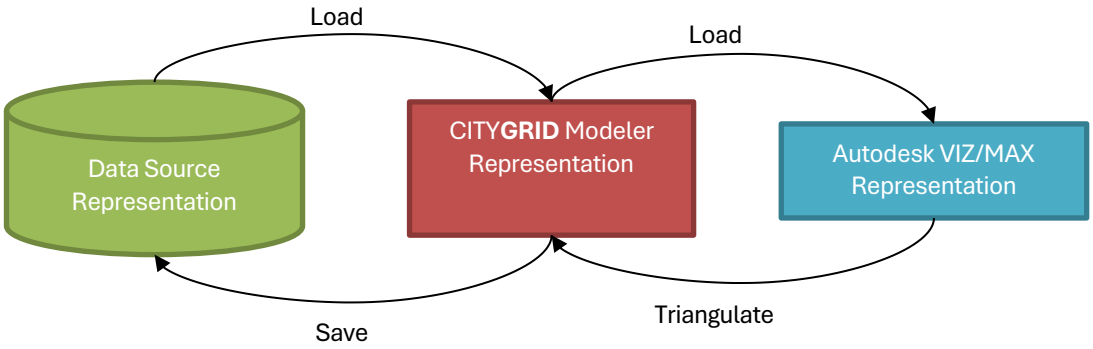
In the next section some ruling principles are described, which apply when editing with the Modeler. Subsequently, typical editing actions are described in the detail.

3.1. Ruling Principles for Editing

1. Version Management: Only a checked-out version can be edited (cf. 2.6)
2. Active Complex: Only the Active Complex can be edited (cf. 2.7)
3. Active Layer: Only lines in the active layer can be edited. (cf. 6.8)
4. Bindings: If a vertex of a line is changed, all other lines of the active Element and of other Elements of the same Element-Complex, which have the same vertex, are changed as well, if their bindings are active. If this is not desired, the bindings can be deactivated in the layer window (cf. 6.8).

Advice: If you have forgotten to deactivate bindings, you can use "Undo" of Autodesk 3D Studio Max for undoing the last editing action. In this step, all actions of bounded lines are undone, too.

1. Snap, Axis Restriction, etc.: For editing the capabilities of snap and axis restriction of Autodesk 3D Studio Max should be known.
2. 3 representations of building models:



When loading a Unit, all three representations are synchronized with the state stored in the data source (database or XML-file).

When **editing**, only the Autodesk-Max representation is changed.

When **triangulating**, the Modeler representation is adopted to the Autodesk-Max representation. This step is necessary after nearly all editing actions (e.g. also after moving Objects by drag & drop or after deleting Objects, ...)

When **saving**, the Modeler representation is stored to the data source. Afterwards a reload is triggered.

Note: If more than one Unit was changed, the saving process first saves the Active Unit. Afterwards, the user will be asked whether the other changed Units shall be saved, also.

Hold the Shift-Key and press the triangulation button to triangulate all loaded units, regardless if units have been changed or not.

1. Working level Point, Line, Polyline Mode: Editing actions are valid either for single vertices, for segments of polylines or for the entire polyline (cf. 2.9).
2. Undo: Editing actions can usually be undone until the last triangulated state.
3. First Edit, then Texturize: If something is changed at the upper edge of the facade, the triangles of the facade usually change when extruded, which might cause loss of applied texture. Typically this happens if the parameters of the façade changed significantly due to the changes in line geometry, so that the texture keeping algorithms can't preserve the applied texture. Thus it is suggested to finish any geometric corrections before adding texture.

Advice: Fast Triangulation:

As described above in top 6, it is always necessary to click at "Triangulate/Apply changes" in order to take over the data. For large, complex Units triangulation may need some time, because all dependencies between Complexes must be regarded (e.g. Detail Element Complexes must be extruded again, if the parent roof has changed, facades must be adapted to changed Cut-out Objects, etc.)

In order to avoid waiting each time until the whole Unit with all dependencies was triangulated, if only little has been changed, it is possible to start a fast triangulation. In that case, only the Active Complex is triangulated. The user must be aware that linked Complexes are not updated in that case! Fast triangulation should therefore only be used for the frequent intermediate triangulations. At the end of the editing, always a complete triangulation must be done.

The fast triangulation is started by clicking at the `Triangulate/Apply changes`  *button while holding the "CTRL"-key pressed.*

3.2. Selection State Line

For editing actions geometry data (points, lines, polylines) of the active layer must be selected. City**GRID**® Modeler searches for identical vertices in other layers and may select them too (depending on settings of bindings and master-slave-connections). Thus, editing actions may automatically be done in bound lines, too.

The selection state is shown in the lowest line of the Element Properties window (cf. 2.8.5).

The first row shows four values: - n1 - / - n2 - / - n3 - / - n4 -with:

	Point Mode	Line Mode	Polyline Mode
n1	Number of manually selected points	Number of manually selected lines	Number of manually selected polylines
n2	Number of points coupled by a master-slave-connection	Number of lines coupled by a master-slave-connection	Number of polylines coupled by a master-slave-connection
n3	Number of points coupled by bindings	Number of lines coupled by bindings	Number of polylines coupled by bindings
n4	Number of points coupled by x/y-bindings (used for break lines)	Number of lines coupled by x/y-bindings (used for break lines)	Number of polylines coupled by x/y-bindings (used for break lines)

The second row indicates the selected points/lines/polylines. It shows any number of strings of type (i-x) with

i ... a number for the i-th polyline of the active layer (starting with 0)

x ... the consecutive numbers of the selected points/lines/polylines (starting with 0)

Example:

Point mode, active layer eave line of the Element Roof:

- 16 - / - 16 - / - 5 - / - 0 -

(0-2..5,18..19)

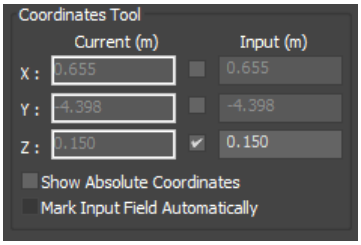
Verbose description: 16 vertices of the master line (eave) are selected. 16 further vertices of the slave line (upper facade line of the Element Facade) are selected, too. 5 further 3D-identical vertices of other layers of the Element Complex are selected, too (e.g. roof lines leading to the eave).

The selected vertices are number 2 to 5 and 18 to 19 of the 0-th polyline of the layer eave

3.3. Usage of basic editing tools

The basic editing tools support standard modelling tasks in simple and complex building models.

3.3.1. Coordinate Tool



The `Coordinate Tool` (cf. 1.7.2) can be opened/closed by the respective button in the column of buttons of the Edit Mode (cf. 1.7.2).

In the left column the current coordinates are shown. In the middle column of checkboxes can be selected which coordinates may be changed by inputting new values. In the right column the new coordinates can be typed in.

The checkbox *Show Absolute Coordinates* enables to toggle between the local coordinates used by Autodesk 3D Studio Max and the coordinates in the reference coordinate system of the data source. (cf. 1.8)

The mode *Mark Input Field Automatically* selects the value in the input field automatically after each selecting of a point in a graphical window. Thus, the new value can be typed in without moving the mouse so that it can select the next point immediately afterwards.

3.3.2. Move a Point

Regard the general notes about editing in section 3.1.

1. `Check out` the Unit (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Select the Active Layer.
4. Activate Point Editing Mode (cf. 2.9).
5. Check Bindings (cf. 2.9).
6. Activate `Select And Move` of Autodesk 3D Studio Max.
7. Select the point.
8. Move the point or type in new coordinates in the `Coordinate Tool` (cf. 3.3.1).
9. Click at `Triangulate/Apply changes` (cf. 1.7.5).

3.3.3. Insert a Point into a Line

Regard the general notes about editing in section 3.1.

1. `Check out` the Unit (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Select the Active Layer.
4. Activate Point Editing Mode (cf. 2.9).
5. Check Bindings (cf. 2.9).
6. Click at `Drawing mode` (cf. 1.7.2).
7. Click at the line and position the inserted point (with or without snap).
8. Click twice with right mouse to end editing session and close tool.

9. Click at `Triangulate/Apply changes` (cf. 1.7.2).

3.3.4. Add a Line (e.g. a Roof, Ridge or Eave Line)

Regard the general notes about editing in section 3.1.

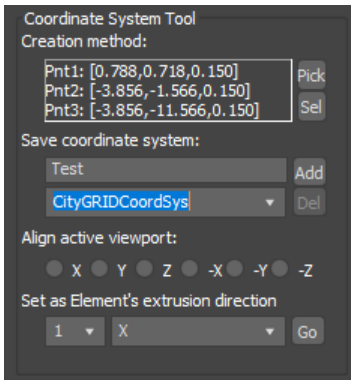
1. `Check out` the Unit (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Select the Active Layer.
4. Activate Line Editing Mode (cf. 2.9).
5. Click at `Drawing mode` (cf. 1.7.2).
6. Insert the line between existing vertices using the snap of Autodesk 3D Studio Max.
7. Click twice with right mouse to end editing session and close tool.
8. Click at `Triangulate/Apply changes` (cf. 1.7.2).

3.3.5. Correct the Elevation of a Ridge Line (or Eave Line etc)

Regard the general notes about editing in section 3.1.

1. `Check out` the Unit (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Select the Active Layer.
4. Activate Polyline Editing Mode (cf. 2.9).
5. Check Bindings (cf. 2.9).
6. Select the line.
7. Either move the line in the correct elevation using the snap of Autodesk 3D Studio Max and the activated axis restriction to Z or type in the absolute elevation in the Coordinate Input Tool.
8. Click at `Triangulate/Apply changes` (cf. 1.7.2).

3.3.6. Coordinate System-Tool



The Coordinate System-Tool can be used for defining local coordinate systems rotated to the world coordinate system that may be useful for modelling (e.g. moving points along the axis of the local coordinate system). The tool can be opened/closed by the respective button in the column of buttons of the Edit Mode (cf. 1.7.2).

In the upper part, two possibilities of defining an individual coordinate system are available:

- definition via an existing line element
- definition via an existing face element

In order to define a coordinate system via a line segment, proceed as follows:

1. `Check out` the Unit (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).

3. Activate `Select And Move`  (cf. 3.3.2)
4. Select the Active Layer.
5. Activate Line Editing Mode  / Point Editing Mode  (cf. 2.9)
6. Open the `Coordinate System Tool`  (cf. 1.7.2).
7. Select the button `Sel`  .
8. Click `Coordinate System Tool`  to close tool.

By pressing the button `Sel` more than once, the adjustment of the coordinate system can be varied according to the incoming line segment. This might turn out to be necessary at the process of the delivery of the coordinate system of a point selection.

In order to define a coordinate system via an existing face element, proceed as follows:

1. `Check out` the Unit  (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Activate `Select And Move`  (cf. 3.3.2)
4. Select the Active Layer.
5. Activate Point Editing Mode  (cf. 2.9).
6. Open the `Coordinate System Tool`  (cf. 1.7.2).
7. Select the button `Pick`  .
8. Click three points to define the face element.
9. Click `Coordinate System Tool`  to close tool.

The individually defined coordinate system will be applied at once, and can be found under “Reference Coordinate System” in the Autodesk 3D Studio Max Main Toolbar. Each manually defined coordinate system is named “CityGRID CoordSys” and thus overwrites the last individually selected City**GRID**® coordinate system.

To save a defined coordinate system you can also use the Coordinate System Tool. Fill in any name in the field under *Save coordinate system* and click at *Add*. By clicking at *Del* you can delete saved coordinate systems. Each named coordinate system can also be found under *Reference Coordinate System* in the Autodesk 3D Studio Max main toolbar. The save coordinate systems remain available in the current session of Autodesk 3D Studio Max.

Based on named coordinate systems you can adjust the view direction of your active viewport. Simply choose a coordinate system in the pull down menu and define the view direction by clicking on of the radio-buttons under *Align active viewport*.

Use *Set Element Extrusion Direction* to define an extrusion direction for elements or element complexes from the set coordinate system. Select the extrusion direction from the first dropdown list. The second list lets you select the axis directions of the set coordinate system. Here, you can always select the inverse direction for each axis. Click on  to set the extrusion direction. This is evaluated during the following triangulation and is adapted to the face net.

<u>Note:</u> Setting extrusion directions is not practical with Detail Element Complexes which are bounded to Main Element Complexes (cf. 5.4) since the extrusion directions in this case are already set precisely.

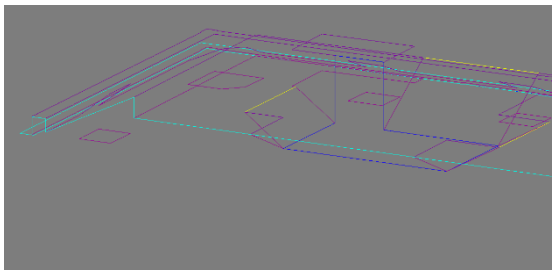
<u>Advice:</u> In general, setting individual extrusion directions is only useful for the primary extrusion direction since it is responsible for the main appearance of the complex. Use the Element Extrusion Direction to set roof face windows with slanted façade faces on the roof, or to create façade details interactively.

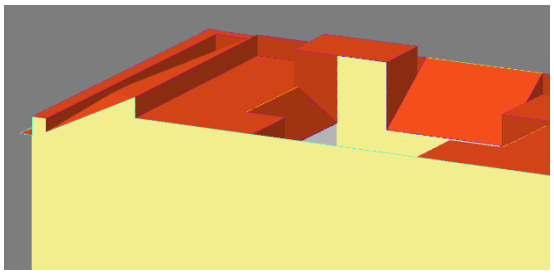
3.4. Working with Special Editing Tools

The special editing tools support editing actions, which have to be done by routine when modelling buildings.

3.4.1. Insert Break Lines (for Vertical Roof Faces)

A vertical Roof Face is named Break Line in City**GRID**®. Such breaklines often appear at more complex flat roof buildings and complex roof areas. Break lines always appear as a line pair (on the layers upper and bottom break line). All lines on both of the layers must be 2D identical and must be available with the same line – vertex - structure. The only difference is possible in the height. Different to all other lines in City**GRID**® the position of digitalization of break lines is of high relevance. Break lines must be drawn anti-clockwise in order to create correct vertical roof faces.



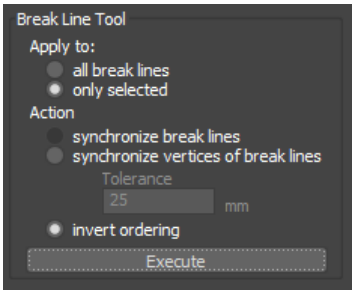


Advice: Rule of thumb: If you would go alongside the break line, the vertical face must be located on the right-hand side.

The editing of a point or a line segment causes the automatic adjustment of the corresponding point or line segment on the corresponding break line layer. This linkage can be temporarily deactivated on purpose using the modeller by manually deactivating the linkage and 2D relations in the layer window. (cf. 2.9).

Regard the general notes about editing in section 3.1.

1. `Check out` the Unit (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Select the active layer upper break edge (cf. 2.9). if necessary create a new layer upper break edge using the right-click menu in the layer window
4. Activate Line Editing Mode (cf. 2.9).
5. Click at `Drawing mode` (cf. 1.7.2).
6. Create a new upper break edge with an orientation, so that the break is right of the edge
7. Click at `Drawing mode` to close digitizing mode
8. Select Polyline Editing Mode. (cf. 2.9).
9. Activate the special editing tool `Edit break lines` (cf. 1.7.2).
10. Select *all break lines* or *only selected* and select the break lines.
11. Select the action *synchronize break lines*.
12. Click at Execute.
13. For all upper break edges corresponding lower break edges are generated at the same position. If the break line ends at the eave line, the tool tries to move the lower break line into the correct elevation. Else it is necessary to move it down to the right height.



14. Click `Edit break lines`  to close the tool.
15. Select the active layer “lower break edge”.
16. Activate Point Editing Mode.  (cf. 2.9).
17. Select and move the lines in the correct height.
18. Click at `Triangulate/Apply changes`  (cf. 1.7.2).

Note: Lower break edges must have exactly the same X- and Y-coordinates as the corresponding upper break edge. A break edge is a line segment with a starting, an endpoint and various inserted points. Combined line segments are interpreted as multiple break lines.

3.4.2. Adjust Break Lines 

Break lines allow for modelling vertical roof surfaces. For a correct face generation, the following rules must be obeyed:

- For each upper break edge, a lower break edge must exist whose vertices have exactly the same X- and Y-coordinates.
- The orientation of break edges must be in a way that the break is right of the edge.
- Break lines must not end except in the eave line or in positions where the upper and lower break edge converge.

For fulfilling these conditions special editing tools are implemented in the Modeler. In section 3.4.1 synchronizing entire break edges was already explained (for each break upper edge a lower break edge is generated). Further the vertices of the break edges can be synchronized with the same editing tool, so that corresponding break edges will have congruent vertices. Break edges which are displaced a little bit (up to a certain tolerance) can be made congruent.

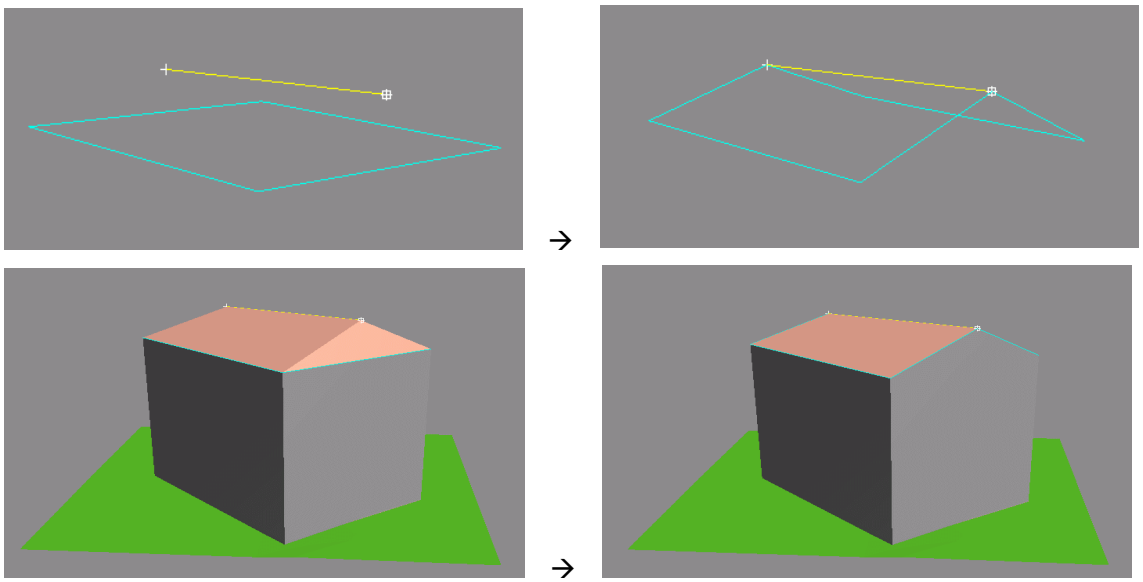
Further the orientation of a break edge can be inverted. Wrongly oriented breaking edges lead to impossible areas in the roof or even cause a breaking up of the roof faces.

Note: The special editing tool for break lines is available only in Polyline  *Editing mode, if the active layer is a break line layer.*

*Note: If a break line system opens into the eaves polygon with upper and lower break edge at different points, City**GRID**® an independently determine the required orientation and correct a possibly wrongly oriented break line. In the case of breaklines without a connection to the eaves, any opening roof lines will be used for orientation. The principle is that on the side of the vertical drop, rooflines can never open into the breaking edge. If there are neither connections to the eaves, nor opening roof lines, there can be no automatic checking of the existing breakline orientation and thus no correction during triangulation. In this case, the direction of rotation must be adjusted via the breakline tool.*

3.4.3. Line Intersection Tool 

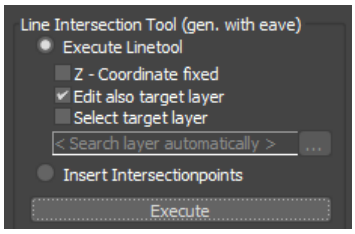
Task: The closed eave line polygon forms a rectangle in the eaves’ height. Additionally there is a ridge line in ridge height. Insert the end points of the ridge line into the eave polygon. In addition the ridge line must be extended/shortened, so that the facade with the gable remains planar.



This task is solved by the special `Line Intersection Tool`.

Regard the general notes about editing in section 3.1.

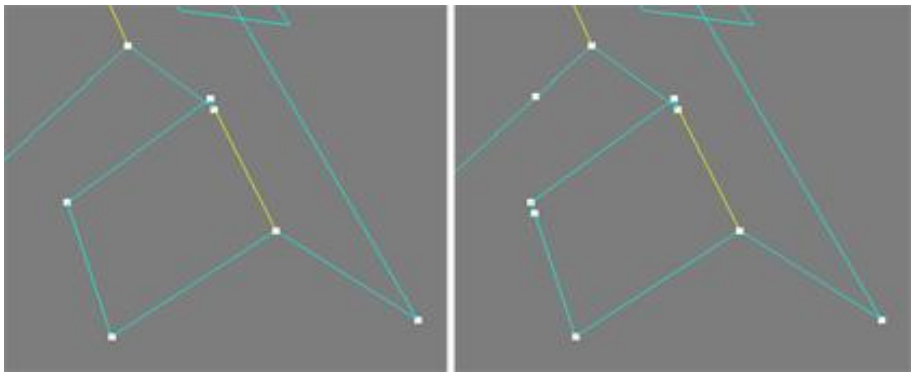
1. `Check out` the Unit (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Select the active layer “ridge line” (or another layer)
4. Activate Point Editing Mode (cf. 2.9).
5. Select the end point(s) of the ridge line(s).
6. Activate the special editing tool `Line Intersection` (cf. 1.7.2).
7. Activate *Z-coordinate fixed*, if the Z-coordinate of the moved vertex shall not be changed. Otherwise the vertex is moved along the ridge line.
8. *Edit also target layer* indicates whether the vertex shall be inserted also into the polygon of the target layer (in our case the eave line). Activate it for our example
9. *Select target layer* allows for selecting the layer, to which the selected vertex will be moved (after clicking at ... the any line of the target layer can be selected graphically). If a target layer is not set manually, the intersection will be carried out with the eave line.
10. Click at Execute.
11. Click `Line Intersection Tool` to close the tool (cf. 1.7.2).
12. Click at `Triangulate/Apply changes` (cf. 1.7.2).



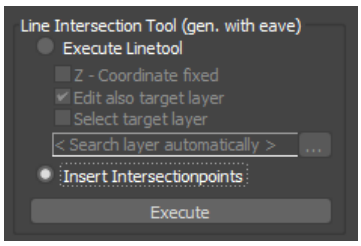
Note: This special editing tool can also be used with other layers than with ridge lines as long as the point editing mode is active.

3.4.4. Include Intersection Point

Frequently line structures overlap themselves due to inaccuracy of the original data capture. The Line Intersection Tool offers a method to calculate the intersection points of such warped line segments, so that a correction can be made more easily.



1. Check out the Unit  (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Select the active layer eaves (or other).
4. Activate `Point Editing Mode`  (cf. 2.9).
5. Activate the special editing tool `Line Intersection` (cf. 1.7.2). 
6. Activate the Option *Insert Intersectionpoints*
7. Select `Execute`
8. Click `Line Intersection Tool`  to close the tool (cf. 1.7.2).
9. Click at `Triangulate/Apply changes`  (cf. 1.7.2).



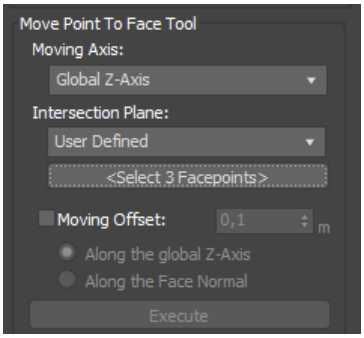
3.4.5. Move a Point into a Face 

This special editing tool allows moving a point along a vertical line into a face. The position of this straight line can also be defined interactively based on existing geometry.

Regard the general notes about editing in section 3.1.

1. Check out the Unit  (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Select the Active Line Layer
4. Activate Point Editing Mode  (cf. 2.9).
5. Make the face to which to be moved visible (cf. 2.4.2).
6. Select the point(s) which are to be moved.
7. Activate the special editing tool `Move Point into Face Tool`  (cf. 1.7.2). The window of the Tool opens.
8. Define the moving axis: The following axis can be used:
   - Global X, Y, Z axis
   - Global refers to the standard coordinate system “World“ by Autodesk Max.
   - Local X, Y, Z axis
   - Local refers here to an individually defined coordinate system tool (cf. 3.3.6)

Advice: If a shortcut was set for the delivery of a local coordinate system, it can be directly appointed within this tool.



- Selected segment
- For this variant a line segment must be selected before the *Move Point into Face Tool* is opened.
- Incoming or outgoing segment
- When selecting a point either the segment directly in front of the point (whose end point is the according selected point), or after the point (whose starting point is the according selected point) can be chosen. The order of the points can be determined from the selection status bar.

9. The following *Intersection Planes* can be indicated:

- *From the active element*

  As an intersection layer the closest area of the element will be taken. For example: Is a point of the layer "General Roofline" (is located in the element "Roof") marked and intersected, the active element is here the roof area.

  Advice: This method is used when lines of the same element are edited (e.g. lines of a roof)

- *From the selected element*

  Click on the button *Select Face Element* and select any face in Viewport. The element corresponding to that face will be calculated and used as an intersection layer. By clicking the button *Select Face Element* again new elements can be selected.

  Advice: Use this method in order to intersect lines with areas of different hierarchy level (e.g. dormers with the main window)

- *From selected area*

  Select one or more connected face triangles before the *Move Point into Face Tool* has been started to use this selection as an intersection layer.

  Advice: When choosing the area triangles, cants within a roof area can be eliminated by intersecting all the other points of a roof with the selected area.

- *User-defined*

  Click the button <Select 3 Facepoints> and subsequently select three points in Viewport (Snap will be activated automatically). These points span the intersection layers. As soon as an intersection layer had been defined, *User defined* will appear instead of *Choose 3 points*. Such a defined intersection layer remains active until a new definition or a reboot of the programme.

  Advice: The user-defined intersection layer does not have to correspond to a real area of the unit. Each position in the room, which can be defined by three points, is possible.

10. Check `Offset` if required. This offset is adjusted onto the points, after having been put into the intersection layer. Next to the size of the offset (positive values move the points in front of the intersection layer), the position of the offset can be indicated. Alternatively, an offset alongside the global Z-axis or face normal is available.

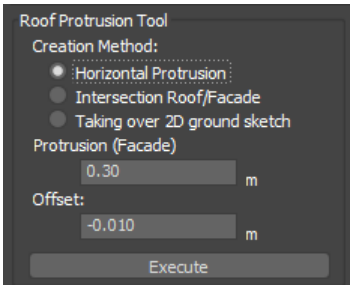
    Advice: the offset is used for modelling roof area windows. Via offset it can be guaranteed that all roof area windows will get a fixed value.

11. Press Execute. The selected point(s) will be moved until they lie in the selected face Via little crosses the position of the points according to the pre-settings will be simulated. By doing so possible unrequested offsets can be corrected, before the *Execute* button will be pressed. In order to

refresh the preview, there must always be an action carried out in the properties window of the point-offset tool.

12. Click `Move Point into Face Tool`  in order to close the tool.

13. Click at `Triangulate/Apply changes`  (cf. 1.7.2).



3.4.6. Generate a Roof Protrusion 

This special editing tool allows to separate eave line and the upper edge of the walls so that protrusion faces are generated in between.

1. `Check out` the Unit  (cf. 2.6.1).
2. Select the Active Complex (the Element roof or facade depending on whether the roof shall be moved outwards or the facade shall be moved inwards) (cf. 2.7).
3. Select Line Editing Mode  (cf. 2.9).
4. Select the active layer eaves or upper facade line.
5. Select the line segments for which the protrusion shall be generated.
6. Activate the special editing tool `Create roof protrusion`  (cf. 1.7.2).
7. Select the method used for calculating the protrusion

   Horizontal Protrusion: The selected line segments will be shifted respective the given amount

   Intersection Roof/Façade: The selected line segments will be shifted respective the given amount and vertically intersected with the roof. This option can only be applied to façades.

   Taking over 2D ground sketch: A given 2D line information stored on a separate layer will be intersected with the roof, where it is lying inside the eave line. The 2D lines have to form a closed polyline (e.g. boundary of a building block, a ground sketch, etc…) The layer can be selected by drop down list or by clicking the  and selecting the line in the viewport.

   <u>Note:</u> All segment on the selected layer will be used for the calculation. Selecting vertical sections leads to implausible results with the creation methods "Horizontal Protrusion" and "Intersection Roof/Façade".

   The algorithm takes the x and y coordinates of the ground sketch and intersects with the roof shape. From this intersection point the Offset will be added or subtracted (depending on the sign of the given value). For visualization purpose it is strongly recommended to use a minimum offset to avoid identical face, which will cause flickering effects.

   <u>Advice</u>: Use this function to optimize protrusion generated with older versions of this tool.

8. Specify *Offset*

   If required, use *Offset* to produce a global height adjustment at the position of the segments projected in the roof. Negative values mean an adjustment in the direction of the terrain.

   An offset is always attached after measuring the roof protrusion and adapting the associated individual height of each vertex point on the selected segments. Every point comprises the specified offset value added to z.

   <u>Note:</u> By attaching an offset, you can generate a space between the roof and the roof protrusion. This would otherwise not be possible using the generation methods "Intersection Roof/Façade" or "Taking over 2D ground sketch". If the building models are sent to a 3D printing method, this space is urgently needed.

Tip: Use this functionality to place façade top edges from previous calculations at the best position in the roof.

Tip: The offset can also be used to integrate abstracted cornices in the building model.

9. Type in the amount of protrusion in meter
10. Click Execute.
11. 11. Click `Roof Protrusion Tool` again to close the tool.
12. 12. Click at `Triangulate/Apply changes` (cf. 1.7.2).

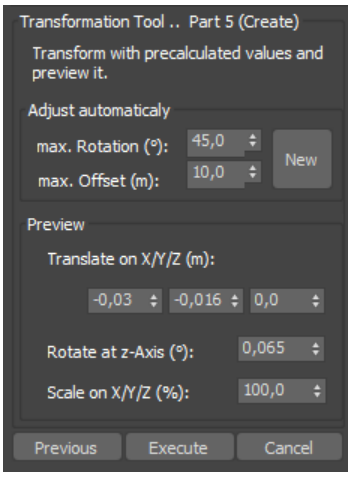
3.4.7. Transform Building structure lines

This function performs a transformation of building structure lines regarding a given reference structure, thus enabling the user to move, rotate and scale his building due to a given ground sketch.

1. `Check out` the Unit (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).

Advice: If more than one objects are to be transformed at once, it is possible to select entire Units.

3. Start the `Transformation tool` (cf. 5.4.2)
4. The first page of the transformation wizard is to define the polygons acting as reference for the transformation. The selection lists the element layers of all complexes found, where all layer names are listed once only. To perform the transformation it is meaningless to which complex the selected layer belongs to. Select the reference layer and click `Next`.
5. Based on the previous selection, the second page allows a more detailed selection by presenting all elements of the selected layer in the viewport. Select the desired reference polygon by clicking on it. Alternatively it is possible to use all polygons as reference also. Click `Next` to continue.
6. Select the candidates for transformation. The selected layers you wish to transform. Click `Next` to continue.
7. Page 4 allows to refine your selection by clicking on single polygons, or to create a sub selection. Click Next to continue.
8. Page 5 performs the transformation based on the previous definitions using default values for the maximum rotation and shifting values. The result of this transformation is displayed in the viewport. Please note, that this is a preview only. The transformation has not been applied to the candidate geometry yet.



Note: The default transformation applies shifts in x and y coordinates only and a rotation around z axis. There is no scaling applied by default.

The proposed transformation can be accepted or adjusted by manual input using the provided sliders, or direct interaction in the viewport.

Adjust automatically:

- *Max.Rotation (°)*: Defines the maximum rotation angle allowed.

Advice: Practise shows that for buildings with a squared ground sketch maximum rotation angles provide suitable results. To avoid the flipping of entire buildings, avoid maximum rotation angles of 90°

The maximum rotation angle for multiple shaped buildings should be reduced to avoid excessive rotations.

- *Max.Offset (m):*

  This defines a search radius around a transformation candidate to look for a reference polygon. If there a multiple reference polygons found within this radius, the one with the shortest distance to the candidate will be used for transformation.

  Clicking the button `New` triggers a new calculation of the transformation based on the new maximum values provided.

Preview:

This section provides sliders for direct interaction. All adjustment will be displayed in the viewport immediately. There are separate sliders for shift offsets in x, y and z coordinates (m), rotation round the z-axis (°), and overall scaling (%).

Advice: The interaction can be done directly in viewport also.

Use `Select and Move`  , `Select and Rotate`  *to perform this interaction. Snapping methods can be applied to refine your input. Be aware that the scaling has to be done by the Transformation tool itself.*

9. Once you are satisfied with the results, click `Execute` to apply the transformations to the geometry. The same transformation parameters will be applied to all dependent complex elements.

   The Transformation tool will close automatically after the calculation.

10. Click `Triangulate/Apply changes`  (cf. 5.4.2) to apply all changes.

3.4.8. Adjust Face Normals 

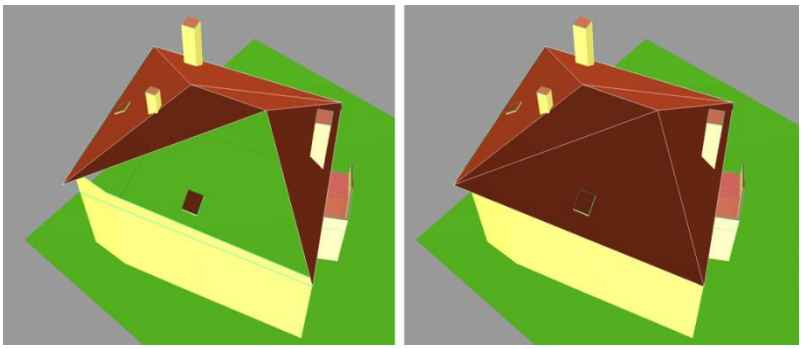
In principle City**GRID**® works on a line oriented approach and derives faces from the line structure using triangulation algorithms. But it is also possible to process just the face net (mesh) of 3D Objects as so called BLOBs (Binary Large Objects) and manage them together with City**GRID**® data

*Note: Typically complex free form objects like fountains, monuments or externally modelled landmark buildings etc. are transferred into BLOB objects for maintenance with City**GRID**®. Commonly these objects are converted in BLOB Conversion Manager, that can be found in menu **CityGRID > CityGRID Tools > BLOB Conversion Manager** in 3D Studio Max. (cf. 3.6.3)*

*It is also possible to convert meshes using FME and the City**GRID**® FME Writer. Doing so CityGML Buildings for example, can be transferred into City**GRID**® system without deriving the line structure of the building.*

The orientation of face normal is of fundamental importance when viewing 3D data in any viewer. A face normal is defined by the sequence of face vertices. If a counter clockwise sequence is given (right hand rule) the face normal points straight up for a horizontally lying face. If the vertices are sequenced clockwise (left hand rule) the face normal is pointing down for the horizontal face. To be visible in any viewer each face must have counter clockwise sequenced vertices.

City**GRID**® ensures that automatically created faces have the correct orientation ("pointing away from the building") so that they are visible in 3D viewers. But as the faces of building imported from outside of City**GRID**® as BLOB objects have been generated elsewhere, it can happen that some faces have the wrong orientation. Whenever this happens it appears as if something is missing from the building (see picture below: left side wrong oriented face normal, right side the corrected face)

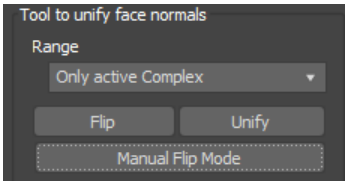


To correct such cases the `Face Normals Tool` is used:

1. `Check out` the Unit (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).

   Advice: Each hierarchy level up to the model level can be chosen. The function affects all lower hierarchy levels automatically, except the detail element complexes. They can be integrated or excluded via user setting (see below).

3. Click `Face Normals Tool` (cf. 1.7.2). The property window of the tool comes up, waiting for the definition of the correction parameters



4. Define *Range*:

   This parameter defines on which hierarchy level the tool should be applied.

   - *Only active Complex*: Affects the currently activated complex in hierarchy window and all subsequent hierarchy level, except the detail element complexes.

     Example: A unit with one object, two element complexes and two detail element complexes would have the following actions carried out if selected at object hierarchy level

     Only active complex affects the object and therefore also the element complexes and within them the roof and façade elements, which would be swapped. But no changes would be made on the faces of detail element complexes.

   - *Active Complex with Details*: Functions the same as *Only active Complex*, but includes all detail element complexes.
   - Selected Faces: This mode can only be used if an element (e. g. roof) is selected in the hierarchy window. The tool will swap all selected faces on the active element and has no impact on unselected faces or other complexes.

5. Select Mode

   - Flip: Swaps all faces, regardless if different orientations are present in the face set
   - Unify: Analyzes all faces for opposite oriented face normals and unifies the face normals based on the majority of the found orientations.

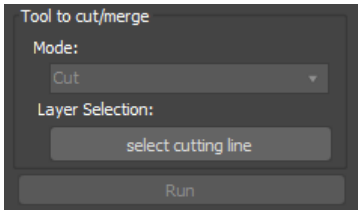
     Advice: After Unity it might be necessary to run flip mode, if the unified faces are oriented in the wrong direction.

   - Manual Flip Mode: Enables an interactive flip mode in the viewport at element hierarchy level. Be aware that flip mode can only be used within the activated element.
   - Hit right mouse button or click `Manual Flip Mode` button to end flip mode.

6. Click `Face Normals Tool` (cf. 1.7.2) again to close tool.
7. Click `Triangulate/Apply changes` (cf. 5.4.2) to apply all changes.

*Note: The `Face Normals Tool` works with all City**GRID®** complexes, regardless if the faces were created by City**GRID®** or not. If the tool is used on City**GRID®** generated faces, the orientation of the faces will change in viewport but at triangulation the system will detect the wrong oriented faces again and correct the orientation automatically. To change City**GRID®** generated faces the face generation type must be set to frozen face net (cf. 2.8.5) prior to usage of the `Face Normals tool`.*

3.4.9. Split Units



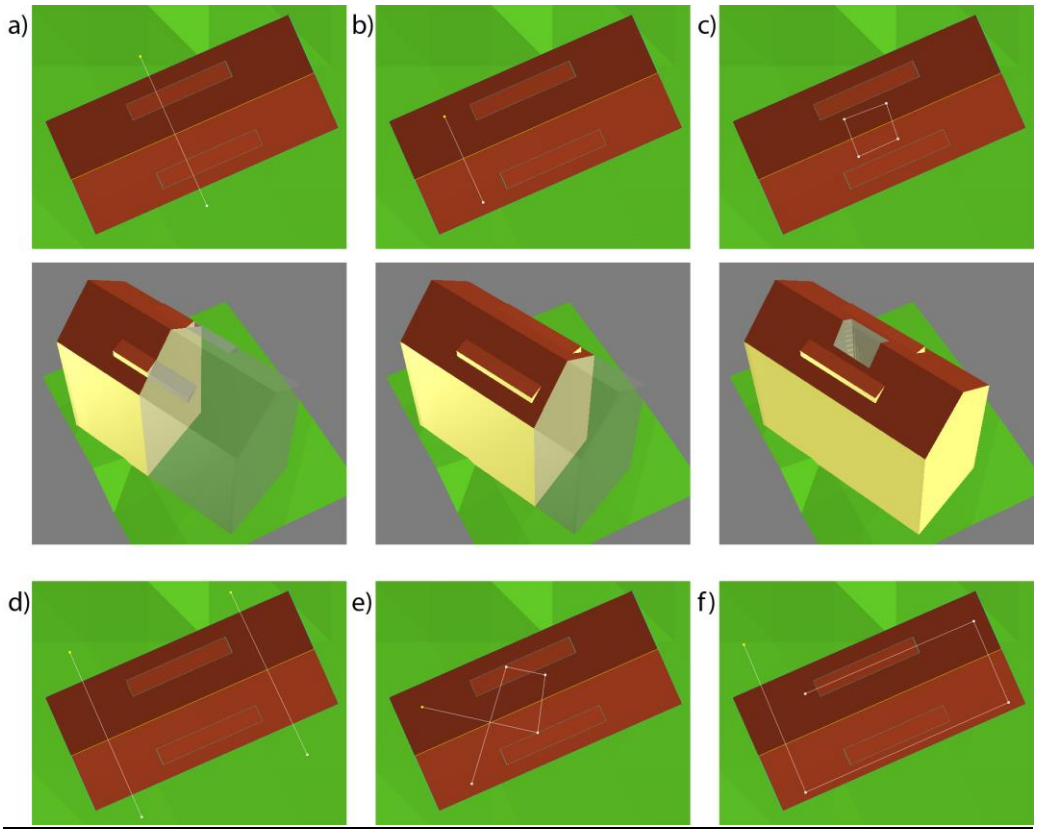
The semantic formation of a building can be modelled in City**GRID®** by the given complex structure (unit to detail element complex cf. Manual City**GRID®** Basics). But in case of too large complexes, due to restitution errors (two adjacent buildings are recognized as one or terraced houses) it might be necessary to split the unit into independent complexes before modelling the semantic formation of the complexes. For that purpose the Split Tool exists in edit tools palette of City**GRID®** Modeler. The tool always operates at unit hierarchy level and splits one unit up into two.

1. `Check out` the Unit (cf. 2.6.1).
2. Select element Roof from to be split unit as Active Complex (cf. 2.7).
3. Create a layer containing the split polygon, e. g. Auxiliary Line (cf. 4.1)
4. Draw the split polygon on the previously created layer
5. Select active complex at unit hierarchy in hierarchy window (cf. 2.7.2).
6. Click `Split Tool` (cf. 1.7.2)
7. Click button select cutting line and select split polygon in viewport. The corresponding layer is displayed in property window of *Split Tool* immediately.
8. Click button Run to execute the split.
9. Click `Split Tool` (cf.1.7.2) again to close the tool
10. Click `Triangulate/Apply changes` (cf. 1.7.5) to apply all changes.

    After the active unit has been split into two separate units using the Split Tool, one unit is given the UnitID from the original unit and the second unit is applied a generated UnitID. If the UnitID needs to be changed, first save the unit and open afterwards the unit property window (cf. 2.8.2)

Example: In the picture below valid and invalid split polygons are shown. Examples a) – c) show valid input situations for Split Tool and the corresponding results. a) has a single split line that extends over the perimeter of the eave line, b) displays a split polygon line that is short of the eave line and c) shows a closed polygon as split line.

Examples d) – f) are representing invalid split situations. In example d) two split polygons are given, e) has a polygon with self intersection and f) shows a line configuration that has only one intersection with the eave line. The second intersection will be computed by extension of the last polygon segment, which leads again to a self intersection split polygon.



Note: Textured units can also be separated without losing the applied texture. After execution of Split Tool the split units will be displayed untextured, but both units still have their texture assigned. Only after triangulation the applied texture will be displayed on both units again!

Note: Only one connected line drawing (polygon) is allowed on the split layer. The polygon must not self intersect but may have the same start and end point (closed polygon)

In case the split polygon extends the eave line polygon of the to be split unit, only the part until the intersection with the eave line will be used for splitting.

In case the split polygon is too short to form an intersection with the eave line polygon of the to be split unit, the split polygon will be linear extends until the intersection is established.

3.5. Modelling with 3D Studio tools inside CG Modeler

Note: Modelling with 3D Studio Max is an expert mode that requires modelling skills in 3D Studio Max. Questions about 3D Studio functionalities and modelling techniques need to be addressed to the Autodesk community or local authorized Autodesk Support. On the part of UVM system no 3D Studio support is offered.

For further detailing of existing City**GRID**® models, it is possible to model faces of elements with 3D Studio Max function, directly from inside City**GRID**® Modeler. The surface mesh can be processed with all 3D Studio Max functionalities and modelled freely. After completion of modelling work the modified mesh can be put back under control of City**GRID**® and managed together with the triangulated surface data. Affected elements are set to face generation type "frozen face net" (see Manual City**GRID**® Basics) and therefore no longer changed by triangulation. All meaningful surface-functions, especially the texture of the tool Modeler, can be used on the newly created mesh.

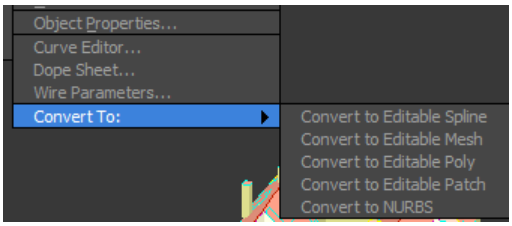
*Note: Material allocations of 3D Studios are not supported and will be lost at saving of City**GRID**® data structure.*

In addition to editing existing meshes, new complexes can be formed, which initially only act as empty containers. Construct any mesh inside this containers, so buildings can arise outside the City**GRID**® triangulation algorithm completely. Creating the empty container is allowed at all hierarchy levels.

3.5.1. Edit existing meshes with 3D Studio functionality

1. `Check out` the Unit  (cf. 2.6.1)
2. Select any element as an active complex (cf. 2.7.2).
3. Select face generation „*frozen face net*“ in Element properties window. (cf. 2.8.5)
4. The mesh can now be edited with 3D Studio functions. All available functions and modifiers may be used.

Advice: If modifiers have been applied to the mesh, the surface network must be converted into an editable mesh again. The relevant function can be found in the right-click menu of the active viewport.



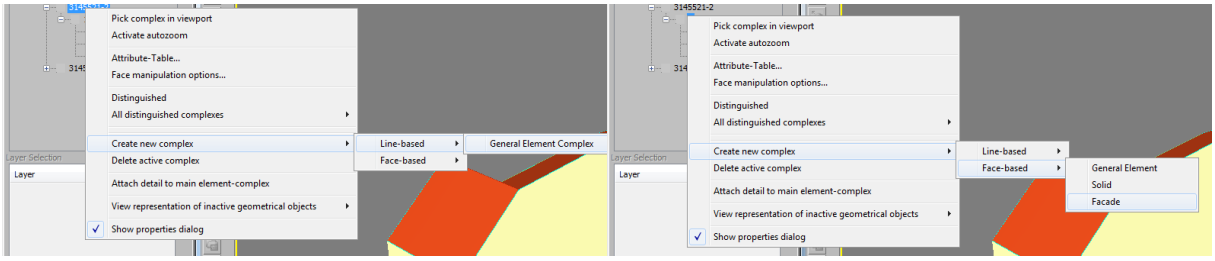
5. Click `Triangulate/Apply changes`  (cf. 1.7.5).

*Note: Editing in 3D Studio Max and triangulation in City**GRID**® Modeler can be repeated in loop.*

3.5.2. Creation of Complexes and modelling with 3D Studio functionality

1. On desired complex level in hierarchy window invoke the right-click menu and select the function *Create new complex*.
2. Select *Line-based*, if new complexes will form faces by City**GRID**® triangulation algorithm, or *Face-based*, if the areas will be built through 3D Studio functionality. In both cases, an empty complex-container with one element is created.

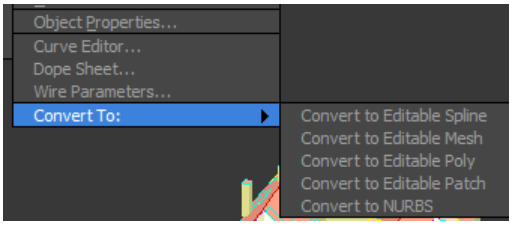
*Note: In context menu Face-based must be selected if the modeling with 3D Studio is to take place. Line-based calls for the construction of lines on the City**GRID**® system layers to derive a surface by triangulation.*



Advice: Element class of the container can be changed at the element properties window. (cf. 2.8.5)

3. The mesh can now be edited with 3D Studio functions. All available functions and modifiers may be used.

Advice: If modifiers have been applied to the mesh, the surface network must be converted into an editable mesh again. The relevant function can be found in the right-click menu of the active viewport.



4. In hierarchy window select the element of the container and activate the surface layer in the Layer window (cf. 2.9)
5. Activate function *Attach* from 3D Studio Command Panel and click the created object in the viewport. Doing so the object is transfered to an City**GRID**® object. Disable *Attach* afterwards.
6. Click `Triangulate/Apply changes`  (cf. 1.7.5).

3.6. Embed External Data Files

3.6.1. Embed CityGRID® data

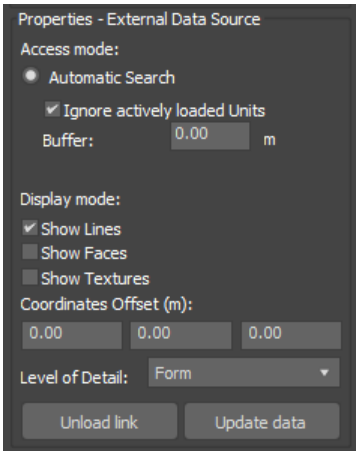
In order to support modelling work external City**GRID**® models from databases and XML-files can be linked (read-only) to a loaded model. Such embedded data sources can be used as help objects, e.g. when snapping, as well as data suppliers for units which are being edited. From linked data sources any complexes can be moved via drag & drop to the active complex, but also only single layers or line segments.

1. Choose **CGModeler > Add external data source** via the menu.
2. Select data source.

*Note: Only data sources with up to date schema can be linked as external data source. If a data source with deprecated schema is selected an info text pops up and the linkage process is canceled. In such a case first load the data source in Administrator (database) or Modeler (XML or database). City**GRID**® will recognize the deprecated schema and start the update process automatically. After successful schema update the data source can be linked as external data source again.*

3. Click `Load` in order to link the model

   In the hierarchy window the model is inserted as entry. Units of this model will not be established yet in this step.



4. Select the linked model entry in the hierarchy window. A properties window opens in which the units to be loaded can be defined.
   - *Access mode*

     Automatic search: Based on the outer polygon of the active unit, units from the linked data source are loaded in a certain buffer.

     Under *Buffer* the buffer amount can be specified.

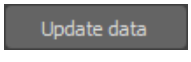
     Ignore actively loaded units suppresses the establishment of units existing in Viewport in the linked model.
   - *Display mode*

     Here the display of linked units can be defined.
   - *Coordinates Offset (m)*

     Offset values in metres can be specified here if the actively loaded model and the linked model use different coordinate systems.
   - *Level of Detail*

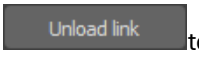
     Select a desired generalization of the linked units.

Note: Modifications at level of detail have only impact on models which are linked from a database. Models from XML files are always loaded in the highest LoD (detail).

5. Click 

in order to load the linked units in Viewport.

   If a new editing area is loaded in the active model, the linked areas automatically adapt to the adjusted settings. For modifications, steps 4 and 5 have to be executed again.

6. Press 

to end the connection between the active model and the linked data source.

Advice: Several external data sources can be linked to the active model simultaneously. For each of these models Display properties can be assigned individually.

Note: Linked models are identical to actively loaded models, with the only difference that no editing procedures can be taken in linked models. Via drag & drop all the existing complexes from a linked model can be moved to the actively loaded model. Layers can be transferred via an ordinary drag & drop procedure but also via drag & drop with the right mouse button. In the last case a context menu appears at the hierarchy windowed the target, in which the mode of the drag & drop procedure can be specified. If you drag the model vertices of the linked dataset by drag & drop, all the loaded Units in the linked dataset are copied to the destination.

3.6.2. Linking AutoCAD files

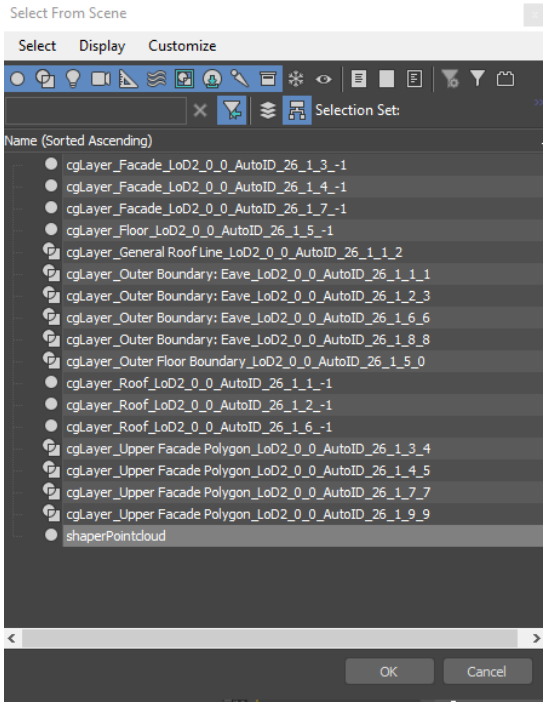
Using the File-Link-Manager of Autodesk 3D Studio Max, AutoCAD DWG or DXF files can be loaded, the data of which can be used as assistance for editing, because they can be snapped to.

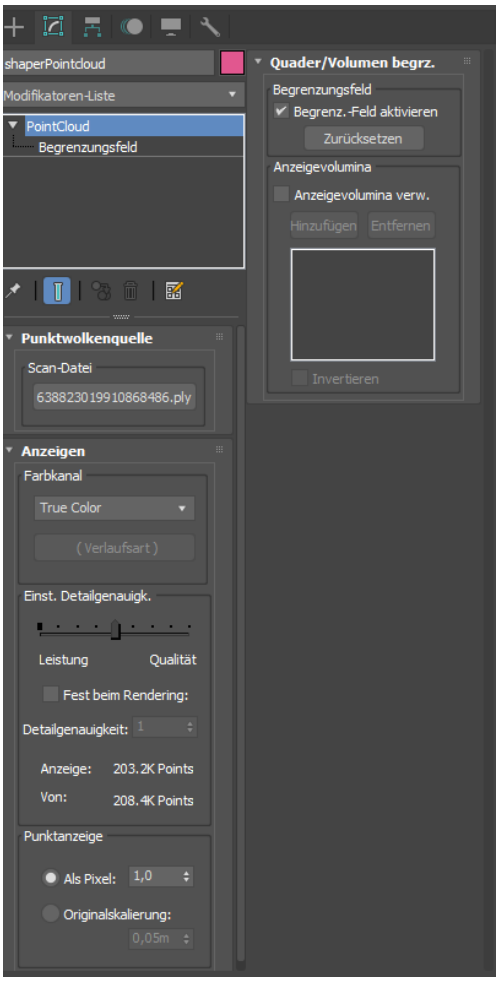
1. Open the File Link Manager of Autodesk 3D Studio Max in the Menu File.
2. Select an AutoCAD DWG or DXF file.
3. If applicable, exclude some layers of the CAD file from display (“Exclude Objects by Layer“).
4. Attach the file
5. Move the new objects to the local coordinate system using the menu **CGModeler>Move Nodes to Local Coordinate System**. In general, all objects can be selected. Click at button `Local Coord`.
6. If the file is not needed any more, we recommend detaching the file again using the menu **File > File Link Manager.**

*Note: Autodesk 3D Studio Max is not capable of working precisely with large coordinates. The programme has access to 8 digits in total. If coordinates with more digits appear, Max rounds automatically; this leads to imprecision. In order to gain full precision of the linked data, it is recommended to already correct the DWG/DXF files for the offset values in a CAD programme, and then embed the data into Max. In this case step 5 can be left out since the linked data already fit with City**GRID®** data.*

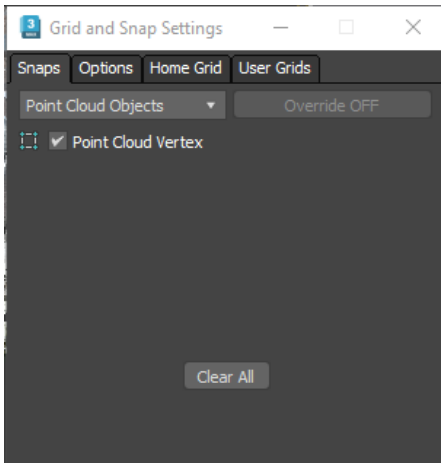
3.6.3. Integrating point clouds

With 3D Studio Max version 2025, point clouds can now also be loaded as auxiliary objects from the Shaper. To do this, a building must be actively loaded from the Shaper (see 3.6.4). Via the menu item **CityGRID - > Modeler -> Auxiliary objects -> Import point cloud from CityGRID Shaper**, the point cloud can be loaded from the active selection area of the Shaper and used as a snap object. The shaper point cloud can be selected via the "**Select from scene**" selection function in order to then change the view via the command panel. Here you can set how many points are to be displayed, which color channel is to be used and the point size can be changed.





The point cloud can be set as the snap target via the **grid and snap settings**.

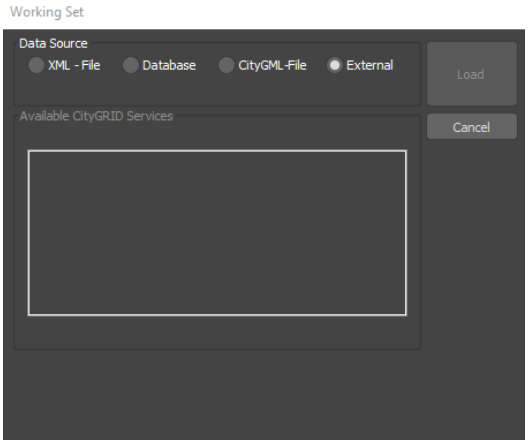


3.6.4. Communication with external CityGRID® Application (Shaper)

To enable the editing of City**GRID**® buildings from other City**GRID**® applications, there is the possibility to set the data source to External and thus put the Modeler in waiting position, provided that the external application has already been started.

As soon as the command is given in the other application (currently only City**GRID**® Shaper), the corresponding building is loaded, and all editing functions of the Modeler are now available.

After finishing the editing (and saving the building), Modeler must be put back into the waiting position by clicking on the button *Working Set Dialog*.



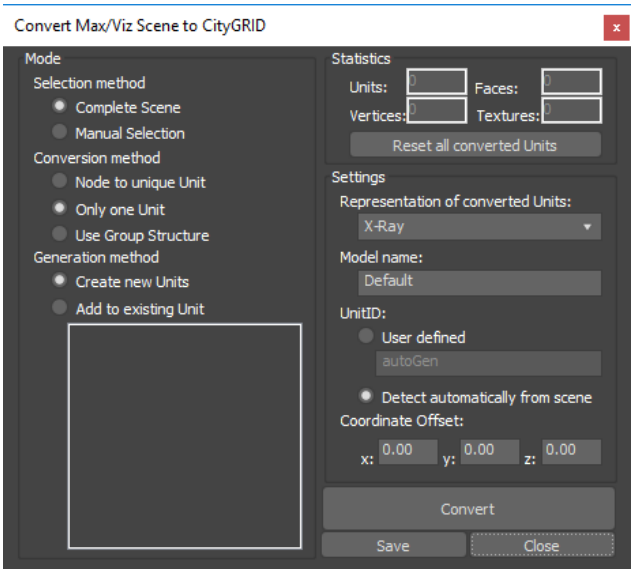
3.7. BLOB Converter

3dStudio offers a wide range of supported import formats, which can be used to read in 3D data from various data sources. To use this data within City**GRID**®, a conversion using the *BLOB converter* is required. This is a tool for converting any geometry object in 3dStudio to City**GRID**® XML data structure. It is a standalone tool and can be started independently from any City**GRID**® application.

*Note: BLOB converter scans the file for objects of type editable mesh and finally converts it to City**GRID®** objects. Therefore we recommend transformation of the imported geometry data into editable meshes and logical grouping prior to the conversion process. (refer to 3D Studio Max manual for further details).*

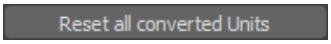
Finally, all texture paths used must be able to be resolved correctly. Currently alternative locations that can be specified via 3D Studio functions will not be evaluated.

1. Open menu **CityGRID > CityGRID Tools > BLOB Conversion Tool** to start BLOB conversion tool.
2. Define Mode
   - *Selection Method*: The *Selection method* can handle two different scenarios. The *Complete Scene* option will scan the entire 3dStudio scene for convertible objects, whereas the *Manual Selection* option restricts the candidates to a subset of selected objects.
   - *Conversion Method*: The conversion method has three options:
3. *Node to unique Unit* converts every object in the scene to a single City**GRID**® Unit. This is the standard option.
4. *Only one Unit* option merges all found object into one single City**GRID**® Unit. The different object will be treated as element complexes in the resulting XML file.
5. The *Use group structure* option is similar to the first option, but converts grouped objects into one City**GRID**® Unit. Use this option for semantic formation of converted objects.
   - *Generation method*: The *Create new Units* option will add new units to the unit list every time the conversion process is started.
   - The *Add to existing Unit* option grants access to the unit list to choose an existing unit from. The found objects will be added to that unit as element complexes then. In combination with the *Manual selection* method this offers a way to build fairly complex units.



*Advice: The tool distinguishes between data conversion and writing to XML. The conversion process can be triggered several times. This will add new units to the unit list. Finally the save button will write this list to the City**GRID®** XML file..*

6. Statistics

The statistics window shows the number of converted Units and textures which will be written to the XML file. Clicking the 

button will clear that list.

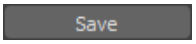
7. Settings

   The settings section gives access to features as the visual representation of the City**GRID**® Units (this can be changed later), the *Model name* and the naming convention for the Units. Through the user defined option a naming template can be defined which will be enumerated automatically. The *detect automatically from scene* parameter extracts the UnitIDs from the 3D scene using the object names. These can be changed in the object's properties.

   Finally the objects can be transformed by *Coordinate Offset* to a given coordinate system. As 3dStudio is restricted in the number of digits for storing coordinates, many models are created in some local coordinate systems. For proper geo referencing it may be necessary to add a coordinate offset to this local system. Be aware that the entered offset will be added to the coordinates.

8. Press button 

to start the conversion process.

9. Press button 

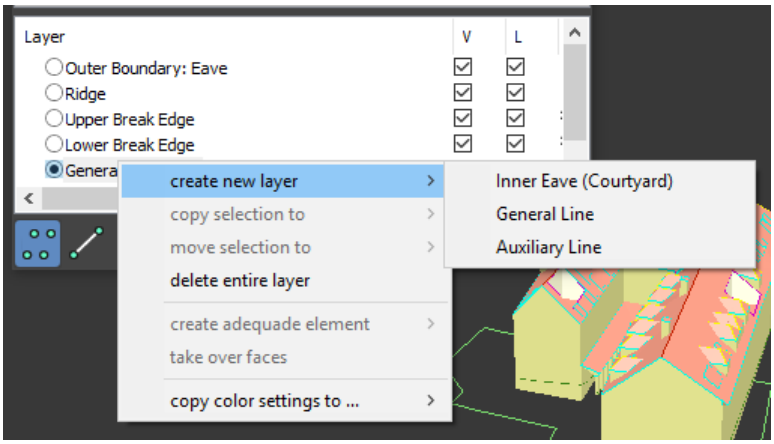
to export all converted data to a City**GRID**® XML file.

4. Operations with lines

4.1. Add a Layer

Building lines are assigned to specific predefined layers. In order to create lines in a layer which is not yet available for the active complex, a new layer can be created as follows:

1. `Check out` the Unit (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Select Line Editing Mode (cf. 2.9).
4. With a right click in the Layers Selection window a context menu appears in which a new layer can be created. By moving the mouse on the area **Create new layer** an additional context menu opens where all producible layers appear. Already created layers cannot be created a second time.



After creating the new layer new lines can be digitized into that layer. However, if triangulation is started, empty layers will be removed again.

4.2. Change Line Type (Layer)

During the face generation, lines are treated in a different way depending on the layer they belong to. Thus it may be necessary to move lines into another layer.

1. `Check out` the Unit (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Select Line Editing Mode (cf. 2.9).
4. Select the line(s) to be changed
5. Move the source layer onto the target layer via drag & drop in the layer window. Instead of the mouse arrow a plus symbol appears for valid target layers and/or a propitiatory sign in all invalid target areas. If segments have been selected, a message appears asking if the selection, the whole layer should be copied or the whole process should be cancelled. After one of the three options has been selected, the process has been completed. Deactivate the linkage (cf. 2.9) to the source layer in order to avoid a deletion of the segment on this layer.

Example: Move lines from layer "Auxiliary line" onto "General roof lines". Select segments on layer "Auxiliary line", click layer "Auxiliary line" in the layer window and keep the button pressed and move it onto the layer "General roof lines". Click the layer "General roof lines" and deactivate the checkbox at the layer "Auxiliary line" in the column "B". Press Key DEL to delete the selection.

As an alternative to the procedure mentioned before another procedure via the context menu is available.

Note: For opening this menu without changing the Active Layer, you need to click into the lower free space or the border of the Layer window. In this way a line can be moved also to a layer, which is not yet available for the active complex.

4.3. Copy/Move a Line into another Building Complex

In this way, lines can be moved/copied into another Object or even into another Unit (if that Unit is checked out).

1. `Check out` the target Unit  (cf. 2.6.1). (the Unit, the layer belongs to, into which the line is to be moved).
2. Display the lines of both the source and the target complex. (cf. 2.4.2)
3. Select steps 1-5 of section 4.2 (optional way).
4. Now, in the context menu select *Layer in Viewport*.
5. In the state line (bottom of Autodesk 3D Studio Max) a line "Select target layer" appears.
6. By clicking at any line of the target layer the layer is selected and the selected line(s) are moved/copied to that layer.
7. You can move the selection via drag & drop. There is always a copy procedure being executed maintaining the layer. The target complex has to be opened in the hierarchy window up to the element, in which the selection should be moved. Now you move the source layer from the layer window onto the target element in the hierarchy tree via drag & drop. Instead of the mouse pointer a plus symbol for valid targets or a propitiatory sign at all invalid target points appears. Again the question appears whether the selection, the whole layer should be copied or cancelled. Spare lines can be deleted at the source layer after the copy process. Linkage does not have to be considered in that case; they do not act as inter-complex.

Note: When moving lines links have to be taken into consideration! Since an offset procedure consist of a copy and deletion procedure, moving the line(segments) has an effect on all 2D identical line(segments) so that these would also be moved. Especially at line(segments), which are 2D identical with the outer bounding polygons (eaves), this can lead to unexpected effects. In that case deactivate the linkage in order to guarantee that only demanded areas are moved.

5. Operations with Complexes

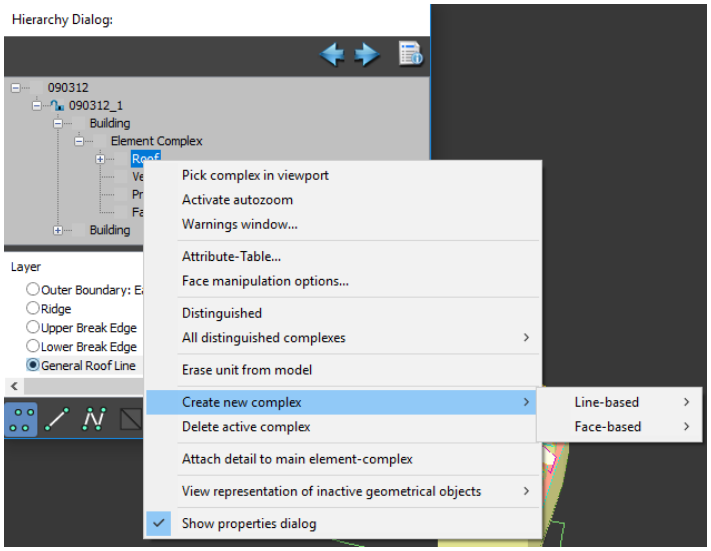
In this section actions are described that change the logical structure of a Unit (Unit, Objects, Element Complexes, etc:) such as moving or deleting an Object, etc. These operations can be done by Drag & Drop in the Hierarchy Dialog or in its right-click menu.

*Note 1: These buttons can only be made available for a checked-out version a Unit (cf. 6.4). The target Unit must be checked out as well. The following actions such as all editing actions **are performed in the Autodesk 3D Studio Max representation of the data. Afterwards, always press the triangulation button in order to take over the changes!!** See section 3.1 for explanations about it.*

5.1. Create empty Complexes

1. `Check out` the Unit (cf. 2.6.1).
2. select hierarchy level above the complex to be created in the hierarchy tree
   - Unit level for a new object
   - Object level for a new Element Complex
   - Element complex for a new Element
   - Element for a new Detail Element Complex
3. Select **Create new complex** in the right-click menu of the hierarchy window.
4. Choose the construction type of the new complex:
   - Line-related create a new complex using the CityGRID® line structure. Such complexes will receive the surfaces via the CityGRID® triangulation.
   - Area-based forms a complex without lines. The surfaces must be created directly using 3D Studio Max design methods and can be managed as a frozen land mesh in the CityGRID® data structure. The triangulation will have no effect on the complex.

   In the pop-up context menu, all available complexes appear.



5. Fill newly created complexes with contents via drag & drop. (cf. 4.14.3)

Note: Empty complexes will be deleted during triangulation.

5.2. Create capped elements

Certain polygons in City**GRID**® are related to each other one by one e.g. eave line and facade upper edge), they create a Master-Slave relation (cf. Manual City**GRID**® Basics). If polygons are already existent at the conversion to City**GRID**®, the Master-Slave relations are automatically set. Sometimes – during the modelling - it might be the necessary case to set these Master-Slave relations after the event, for example, when a Floor element is inserted.

Next to the creation of a corresponding element, the corresponding polygon is simultaneously copied onto the corresponding layer and the Master-Slave relation is set up.

1. `Check out` the Unit  (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Select **Create adequate element** in the right-click menu.
4. Click at `Triangulate/Apply changes`  in order to apply modifications. (cf. 1.7.2)

Advice: Click the following layer in order to create adequate elements with the related layers.

element	*layer*		*element*	*Layer*
Roof	*Outer Boundary: Eave*	→	*Facade*	*Upper Facade Polygon*
Facade	*Upper Facade Polygon*	→	*Roof*	*Outer Boundary: Eave*
		→	*Ceiling*	*Outer Boundary*
Facade	*Lower Facade Polygon*	→	*Floor*	*Outer Floor Boundary*
Floor	*Outer Floor Boundary*	→	*Façade*	*Lower Facade Polygon*

5.3. Detach Complexes 

Modelling Roofs can often be done more efficient, if details at the roof are detached as separate Objects/Detail Element Complexes. First, the lines are prepared in an existing Object/Element-Complex. At this stage it is useful to pay attention to create a closed outline of the Object/Detail Element Complex to be detached. Subsequently, the lines which are to be detached are selected and declared as separate Object/Detail Element-Complex.

The difference between detaching as “Detail Element Complex“, “Element Complex”, and “Object” is as follows:

- A Detail Element Complex has a Parent Element. Its outline lies (mainly) within the eave line of the parent’s roof. Its facade is extruded down to the roof of the Parent Element for all parts lying within the parent’s outer polygon. All other parts are extruded to the terrain. Typical Detail Element Complexes are dormer windows etc.
- A (main) Element Complex or an Object is an independent building complex of the Unit. Its outline is usually not enclosed in the outline of any other building complex. Its facade is extruded down to the terrain model. Each object has at least one main Element Complex (consisting of roof, facade and maybe a protrusion). Typical Objects besides the main Object are sheds, garages, elevators, etc.
- Concerning face generation, there is no difference between detaching as Object or as Element-Complex.

For finding candidates to be detached, an automatic algorithm is implemented that searches for closed polygons in the given layers or in selected lines. When detaching these polygons they are converted into eave lines. Lines, which lie within one of these closed polygons, are added to the automatic candidate suggestion and assigned to the detached Object/Element Complex.

Note: If two face identical segments are found, the algorithm transfers these lines in upper and bottom breaking edge. All other lines are moved in the layer “General roof line”.

If several closed polygons are found, several new objects/elements are generated in the same step. Thus all dormers of a roof can be detached in one step.

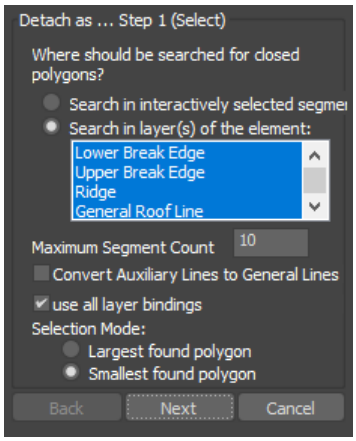
Detaching complexes is done with the following workflow:

1. `Check out` the Unit  (cf. 2.6.1).
2. Select the Active Complex (cf. 2.7).
3. Select Line Editing Mode  (cf. 2.9).

4. Click at `Create new complexes` (cf. 1.7.2).  A detaching wizard consisting of three steps is started.

5. Step 1: Define which lines the automatic algorithm shall search:

   a. *Which lines*
   The automatic candidate search can be restricted to previously interactively selected line segments or to all lines of selected layers.



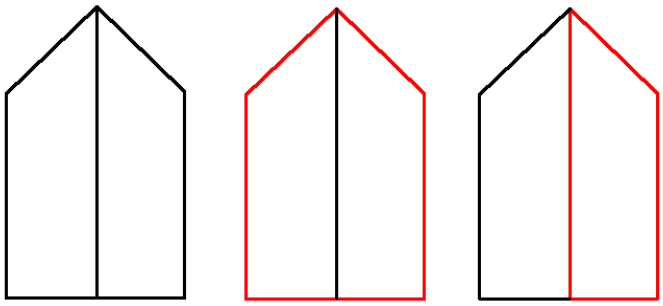
Note: If "Search in interactively selected" lines is selected, all selected line segments that are not part of any and that are not inside any closed candidate polygon are put into a separate candidate. After detaching that candidate, the user must interactively correct the lines (e.g. create a closed outer boundary, etc) before the triangulation algorithm will work. In order to avoid that work we recommend preparing a closed polygon in advance so that the automatic algorithm can find candidates with closed outlines.

   b. *Maximum Segment Count*
   defines the maximum number of polyline segments that define a candidate closed polygon. If a longer closed polygon needs to be found, this number can be increased (which will also increase the time needed for searching candidates).

Advice: You may start a first search with default settings. If the polygon was not found, go back one step in the wizard, increase this value, and try again.

   c. *Selection Mode*
   defines whether the automatic candidate search shall look for smallest possible polygons or for largest polygons (regarding the area defined by the polygon).

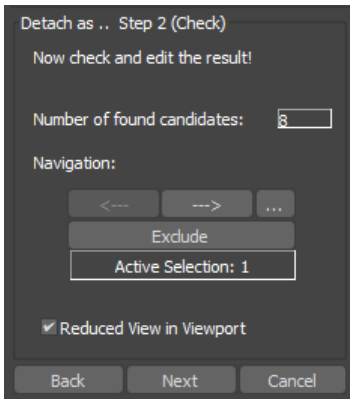
Example: The following image shows the result depending on the adjusted method of choice. On the left lies the initial situation, in the middle the found candidate for the search for the largest polygon and on the right side the result for the search for the smallest polygon. In the right case two candidates cannot be found since every segment is assigned to one candidate only once. The residual segments (black) do not form a self-contained polygon anymore and are not indicated as a potential candidate. They remain at the initial layer. The black line in the middle case (Ridge Line) completely lies within a candidate polygon and will therefore be adjusted to a General Roof Line during detachment.



6. Step 2: Check the candidates found:

   The candidates are shown graphically.
   - Number of polygons found
   - The number of candidates to be detached is displayed.
   - Navigation

- The arrow-buttons allow for navigation through the list of candidates and activating any of the candidates. The button [...] allows for activating one of the candidates by clicking at it in the viewport.
- Reduced View in Viewport
- If checked, all other lines/faces of the active complex are invisible in order to clearly show the candidates. If the checkbox is deactivated, the other lines/faces are shown, too, which may be helpful for orientation.



7. Exclude those candidates that shall not be detached

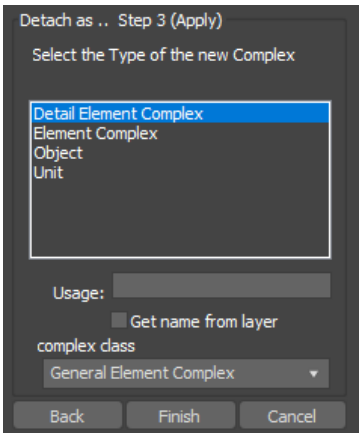
   Active Selection

   One of candidates is the active one (its index in the list of candidates is written in the field "Active Selection"). It is highlighted. This one can be deleted from the candidate list via the button `Exclude` (don't press the DEL-key, because that would delete all lines of the candidate!) As soon as only these candidates remain which need to be detached, click [Next].

8. Step 3: The remaining candidates can be detached as:

   a. Detail Element Complexes of the current main Element Complex.

   b. New Main Element Complexes in the current Object.

   All candidates which are detached as a Detail Element Complex or Element Complex, can be given a name which can be optionally typed in the given description field or is acquired from the name of the source layer.

   *Note: In order to derive the naming of (Detail) Element Complexes from a layer, it is recommended to consider a division into layers when starting a data evaluation and to use these user-defined layers when converting the data into City**GRID®** format. By doing so it is possible to lay various dormers onto a corresponding layer "dormer" by the photogrammetric operator and to include the layer "dormer" into City**GRID®** when conversing. When detaching the lines on this layer, the name can be taken over and can be assigned to the candidate.*

   c. New Objects

   Use the pull down menu to define the Object Class for new Objects. These object classes are currently available:

   - Building
   - Underground Building
   - Cut-out object

   Objects can also have ObjectIDs assigned. If more than one Object is detached all Objects will get the same ObjectID assigned.

   d. New Units. The UnitID of the new Unit can be given.

   Note: If there is more than one candidate, one new Unit with several separate Element Complexes is created in the new Unit.

9. Click at [Finish] to end the wizard.

10. Click at `Triangulate/Apply changes`  (cf. 1.7.2) in order to let the new Objects/Elements derive faces.

Note: If candidates were derived from interactively selected lines and one of the detached candidates or the remaining Element does not have a closed polygon, the Modeler will ask, whether he shall close the outline automatically. If the outline consists of more than one part, this is not possible. In that case, the user is responsible for closing the outline

5.3.1. Modelling a Passage/Overbuilt Object

Passages or other overbuilt areas (arcade passageways) can be modelled by means of Cut-out Objects. The "air space" is modelled as object with "roof lines".

1. Digitize the outline ("eave line") of the Cut-out Object as a polygon in an arbitrary layer of the main object (cf. 3.3.4). Pay attention on snapping exactly to the facade line of the main object at entrances.

Advice: If the facade has already been provided with a texture, the drive can be elegantly digitalized with the setting "Snap to Face" (cf. Autodesk 3D Studio Max Help) in the textured 3D view.

2. Detach object as new cut-out object (cf. 5.3).

3. Click at `Triangulate/Apply changes`  (cf. 1.7.2)

5.4. Binding Complexes

On buildings with a multilevel hierarchy, the most common complex type is usually the Detail Element Complex. Complexes of this type feature an intact parent-child relationship and are also handled as such when generating faces (cf. 2.8.5).

Due to the definition of the line framework in City**GRID**®, the building semantics can be correctly described as attributive, but geometrically they are two totally independent complexes, and the other complex is not updated automatically if any geometric changes are made to one complex. To create the binding for a parent-child complex, you need to transfer the line framework of the child complex and automatically derive the determining extrusion directions (cf. 2.8.5).

Here, every part which has no intersection point with the face of the parent element is extracted from the layer of the Outer Boundary Polygon. City**GRID**® extracts one point from each of the parent faces in the sections, if necessary the (secondary) extrusion direction in which the faces of the child complex (e.g. roof) must be extruded, in order to guarantee a precise clip with the faces of the parent element. Ultimately, a complete face net is formed in combination with the unchanged primary extrusion direction.

The result of binding Detail Element Complexes to their associated Main Element Complex is a precisely intersected face framework of the Detail Element Complex, which updates geometric changes to the face net of the parent complex and always creates correct intersection situations. The basic line framework of the Detail Element is reduced to the necessary line segments and changed to such an extent that the basic properties of a City**GRID**® dataset are no longer valid.

Right-click the Hierarchy Dialog to find the option *Bind Detail to Main Element Complex* to bind a detail element complex to the parent complex. All convertible structures in the selected complex plane are detected by the action automatically and handled accordingly.

Tip: Use the Threshold for Detail Binding parameter in the Options menu (cf. 2.5) to define the tolerance for intersection points between roof faces and boundary polygons.

Tip: If the action is started at the model vertex, the entire dataset is converted. If the action is started at the Unit vertex, all the details in this Unit are converted, etc.

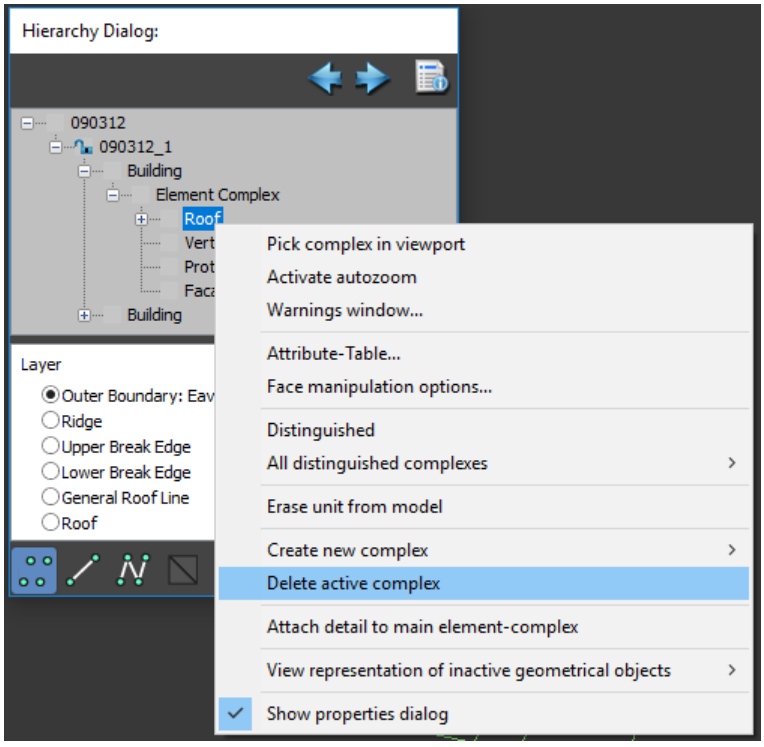
*Note: After the line framework is converted, the editing options are restricted. If complexes can't be transferred to the binding concept, they remain in the previously valid City**GRID**® data structure.*

5.5. Delete Complexes

1. `Check out` the Unit (cf. 2.6.1).
2. Select the Object or Element Complex to be deleted as Active Complex (cf. 2.7).
3. Select **delete active complex** in the right-click menu of the Hierarchy Dialog. Confirm control question with *OK* in order to initiate deletion process.

   Note: For opening this menu without changing the Active Complex, you need to click into the lower free space or the border of the Hierarchy Dialog
4. Confirm warnings if shown[1]
5. Click at `Triangulate/Apply changes` in order to take over the changes. (cf. 1.7.5)

As an alternative to the right-click menu the active complex can be dragged via drag & drop into the recycle bin . Steps 1-2 and 4-5 do not change.



Advice: If the active complex is clicked and dragged, the selected complex appears half-transparently at the mouse position. If the wrong complex has been selected, the drag & drop process can be cancelled by letting the selected complex drop outside the hierarchy window.

Note: The Active Complex is deleted together with all the complexes of lower hierarchy level belonging to the active complex.

Example: If you want to delete an Object, it is deleted together with all of its Element Complexes and their Detail Element Complexes.

5.6. Tear down the entire Unit

1. `Check out` the Unit (cf. 2.6.1).
2. Select the Unit to be torn down as the Active Complex (cf. 2.7).

Note: For opening this menu without changing the Active Complex, you need to click into the lower free space or the border of the Hierarchy Dialog.

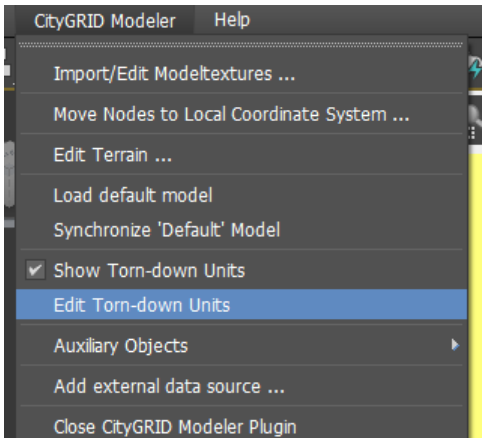
3. Select **delete active complex** in the right-click menu of the Hierarchy Dialog.
4. Confirm the question whether you really want to delete by clicking at Ok.

Note: In the database version of the Modeler, Units are not deleted, but all objects of the current (checked-out) version of the Unit are deleted. The status the Unit is changed from "Checked out" to "Torn down". Thus the last valid version has no geometry any more. However, the Unit with its version history remains further accessible. Older versions of the Unit can thus be loaded again.[1]

In the file based version of the Modeler, the Unit is removed from the file, because there is no version control.

5.7. Show and Load Torn Down Units

1. The Selection Polygons of torn down Units are usually not displayed. In order to be able to access torn off Units, first their Selection Polygons must be displayed: Click **CGModeler> Show Torn-down Units** to activate the display



Note: The colour of the Selection Objects of torn down Units (by default: black) can be chosen in the Options Menu (cf. 2.4.4)

2. After clicking on the menu entry **Edit Torn-down Units** the Selection Polygon of a torn down Unit can be selected graphically which opens the Version History Window of that Unit. The last version has the state “torn down”.
3. As described in section 2.6.4 an older version of the Unit can now be loaded.

5.8. Move Complexes in the Hierarchy Dialog

5.8.1. General notes to drag & drop

- In the Hierarchy Dialog, any Complex (Unit, Object, Main Element Complex, Element or Detail Element Complex, cf. Manual City**GRID**® Basics) can be selected with the left mouse button (Standard drag & drop), dragged to another Complex and dropped there, if the dragged and the target complex are part of checked-out Units. During dragging, the mouse symbol indicates whether it is a valid action.
- If a layer is dragged via drag & drop, next to the standard drag & drop there is a drag & drop procedure available carried out with the right mouse button. Using the last option a context menu is faded in at the target point of the mouse movement in which the procedural mode of the dragged layer can be precisely indicated. Depending on the layer various entries can possibly appear in this context menu.

- By default the drag process of layers takes place within the same unit, i.e. the selection or the whole layer is moved to the new target and will be deleted in this original location. For drag & drop extending the unit the copy process is carried out, i.e. layer and selection will remain at the original position.

  Advice: Keep the CTRL-button pressed in order to switch between copy and move. The contrary action is always executed by default.

- If layers or selection are moved to other elements via drag & drop, there is always the process of adding the moved line structures to existing ones.

  Advice: Keep the Shift-button pressed in order to switch between the actions "add" and "replace".

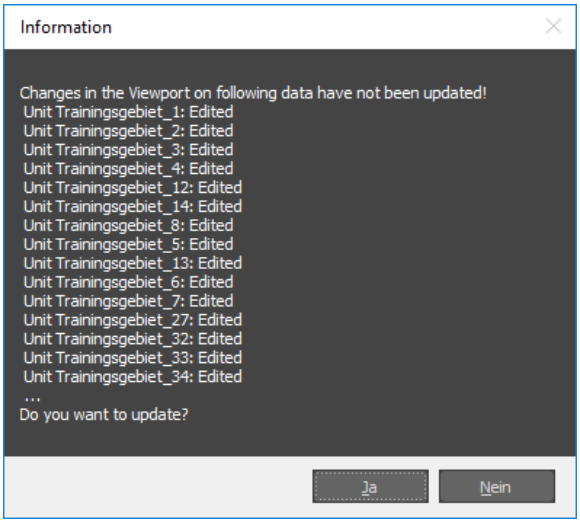
  *Note: Especially at the layers Outer Polygon: Eave and Upper Facade Polygon and/or Lower Facade Polygon and Outer Floor Boundary it has to be noted on part of the Modeler that only **one** 3D polyline exists. Since these layers are in a special relation, lines which are moved/copied onto one of these layers are automatically transferred. If this performance is not demanded, the Master-Slave relation can be temporarily cancelled in the layer window. (cf. 2.9.1)*

- Depending on the hierarchy level of the complex to which the dragged complex is dropped, a new complex of one hierarchy level lower is created there. If the dragged complex is dropped over:
  - ❖ the Model, a new Unit is created,
  - ❖ a Unit, a new Object is added to the Unit,
  - ❖ an Object, a new main Element Complex is added,
  - ❖ a main Element Complex, a new Detail Element Complex is added,
  - ❖ a Detail Element Complex, the action is invalid.
- The dragged complex is removed from the complex to which it belonged to. If afterwards
  - ❖ remains an Object without Element Complexes, the Object is deleted,
  - ❖ remains a Unit without Objects, the entire Unit will be removed. In the database version of the Modeler the Unit will be torn down (cf. 5.6). In the file based version, the Unit will be removed from the file.
- By clicking `Triangulate/Apply changes` after Drag & Drop operations in order to take over the changes, all Units concerned are triangulated automatically. (cf. 1.7.5)

5.8.2. Merge Multiple Units to one Unit with Multiple Objects

This task typically needs be done after the import of a CAD file. The main buildings have to be merged with auxiliary buildings to one Unit.

1. Load all buildings which are to be merged to one Unit (cf. 2.2.3).
2. `Check out` all Units concerned (cf. 2.6.1).
3. In the Hierarchy Dialog, move the Unit to the target Unit with drag & drop (cf. 5.8). All Objects of the old Unit are added to the target Unit and the old Unit disappears from the Hierarchy Dialog.
4. Repeat step 3 for all Units to be merged with the target Unit.



5. Click at `Triangulate/Apply changes`  to take over the changes (cf. 1.7.5). All Units concerned are triangulated.

6. Click at `Save`  (cf. 1.7.5). A status bar appears listing the most recent modifications at the units.

The unit that has been moved will always be indicated with the status „Delete“; the one which was moved to has the status “Update“. If you press *Yes* in the status window, all affected units will be saved.

5.8.3. Move an Object to another Unit 

1. Load all buildings  which are to be merged to one Unit (cf. 2.2.3).
2. `Check out` both Units concerned  (cf. 2.6.1).
3. In the Hierarchy Dialog, move the Object to the target Unit with drag & drop (cf. 5.8).
4. Click at `Triangulate/Apply changes`  to take over the changes (cf. 1.7.5). All Units concerned are triangulated.
5. Click at `Save`  (cf. 1.7.5). All Units concerned are saved.

5.8.4. Detach an Object to a separate Unit 

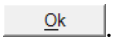
1. Load and `Check out` the Unit  (cf. 2.6.1).
2. In the Hierarchy Dialog, move the Object to the hierarchy level Unit with drag & drop (cf. 5.8). A new Unit is created with a suggested UnitID starting with "autogen".
3. Click at `Triangulate/Apply changes`  to take over the changes (cf. 1.7.5). All Units concerned are triangulated.
4. Click at `Save`  (cf. 1.7.5). All Units concerned are saved.

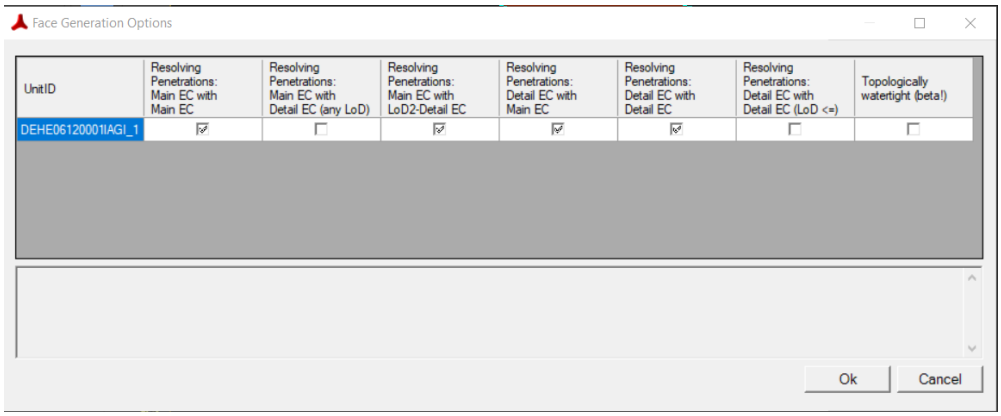
<u>Note:</u> We recommend assigning a UnitID to the newly created Unit immediately (cf. 2.8.2)

5.9. Penetration Analysis

City**GRID**® derives faces by default from the line structure of the building models (see. Manual City**GRID**® Basics). Depending on the accuracy of restitution buildings can thus overlap and form surfaces inside of another structural body. To remove these commonly unwanted faces, Penetration Analysis is available. It is an extension of the triangulation algorithm, for detection and removal of interior face sections. Penetration analysis affects element complexes, the face generation options of surface manipulation (see. Manual City**GRID**® Basics) can be adjusted individually.

5.9.1. Options of Penetration Analysis for active Unit

1. Load and `Check out` the Unit  (cf. 2.6.1).
2. In hierarchy window click any complex (Unit - Element) with right mouse button to bring up the context menu.
3. Select **Face manipulation options**.
4. Check desired options in upcoming window and confirm by clicking  .



*Note: See Manual City**GRID**® Basics for explanation of available face generation options together with sample figures.*

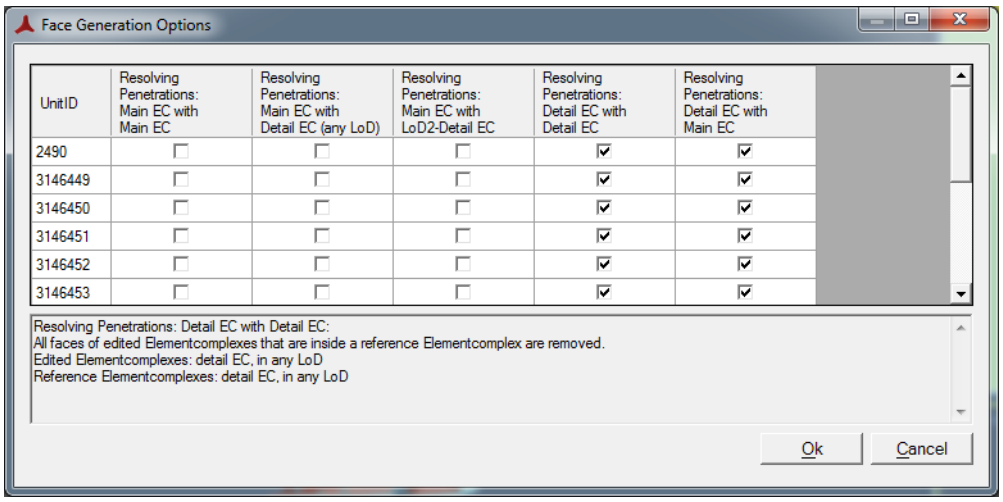
5. Click at `Triangulate/Apply changes` to take over the changes (cf. 1.7.5). All Units concerned are triangulated.
6. Click at `Save` (cf. 1.7.5). All Units concerned are saved.

5.9.2. Options of Penetration Analysis for multiple Units

1. Load region (cf. 2.2.3).
2. In hierarchy window right click each Unit and chose Distinguished from context menu (cf. 2.7.3).
3. In hierarchy window right click to open context menu and select **All distinguished complexes > Check out** if units are loaded from database.
4. In hierarchy window right click to open context menu and select **All distinguished complexes > Face manipulation options**.
5. Check desired options in upcoming window and confirm by clicking Ok.

Advice: By clicking on column header respective option for all units can be set.

*Note: See Manual City**GRID**® Basics for explanation of available face generation options together with sample figures.*



6. Click at `Triangulate/Apply changes`  to take over the changes (cf. 1.7.5). All Units concerned are triangulated.
7. Click at `Save`  (cf. 1.7.5). All Units concerned are saved.
8. In hierarchy window right click to open context menu and select **All distinguished complexes > Check in** if units are loaded from database.

6. Operations with Models

Models are logical groupings of arbitrary numbers of Units. Looking from the other way round, a Unit can be contained in an arbitrary number of Models.

For the database version of Modeler, changing which Models a Unit is assigned has no impact on the Unit itself! Thus removing Units from a Model does not delete the Unit from the database. However in the XML Version of City**GRID**®, deleting a Unit in Modeler will delete the data in the XML File. Each Model can be assigned a terrain model, roof texture image(s) and terrain texture image(s).

Models are usually already generated during the import of XML data. Additionally a part of an existing Model can be declared to a new model at any time. Models can easily be deleted again.

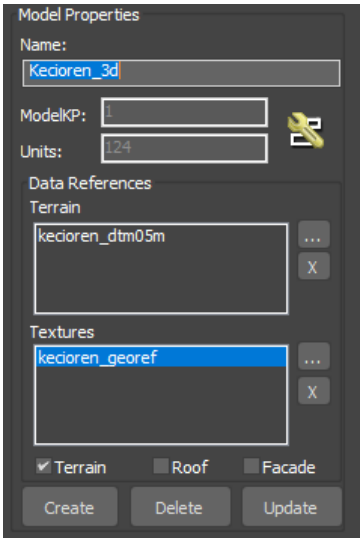
Note: There is always a Model with the name "DEFAULT", which contains all Units of the data base. If for some reason Units are not contained in the Default Model, you can add all missing Units using the menu „CGModeler – Synchronize 'Default' Model".

The following steps are permitted only if the Working Set was chosen by a Model (cf. 2.1.3).

6.1. Creation and maintenance of Models

Operations with models are only available in the database version of the Modeler.

6.1.1. Create a new Model from existing Units

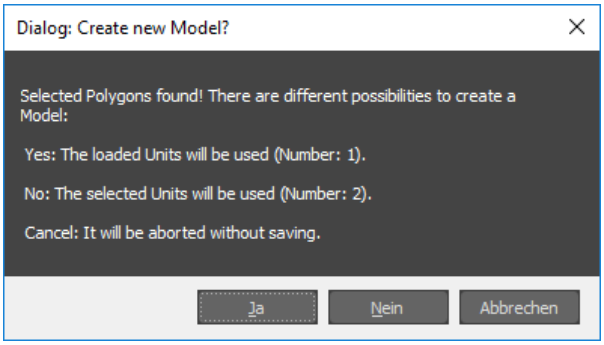


1. Load all Units which are to be grouped to a Model (cf. 2.2.3).
2. Open the *Model Properties Window* (cf. 2.8.1).
3. Type in a new Name of the new Model.
4. If necessary, change further Model Properties (cf. the following sections).
5. Click at Create. The new Model is created directly in the database.
6. Finally you can select whether the new model shall be made to the new Working Set.
7. If necessary, load the new created model by confirming with `Yes`.

Note: In some cases it is necessary use the DEFAULT model to create a new model. Due to the fact that the DEFAULT model is not a working model and therefore cannot be selected in the model selection windows, it must be built separately in the Menu ***CGModeler -> Load Default Model****. Depending on amount of the stored data loading of the DEFAULT model can take a fairly long time*

6.1.2. Establish model from Selection Polygons

1. Open the *Model Properties Window* (cf. 2.8.1)
2. Click the button `Model Administration`.
3. In the graphic windows the selected Selection Polygons are shown. Select these units which should be summed up to a new model.



Advice: By dragging a Selection rectangular more units can be selected at once. Via the CTRL key units can be added for a selection, via ALT-key they can be removed from the selection.

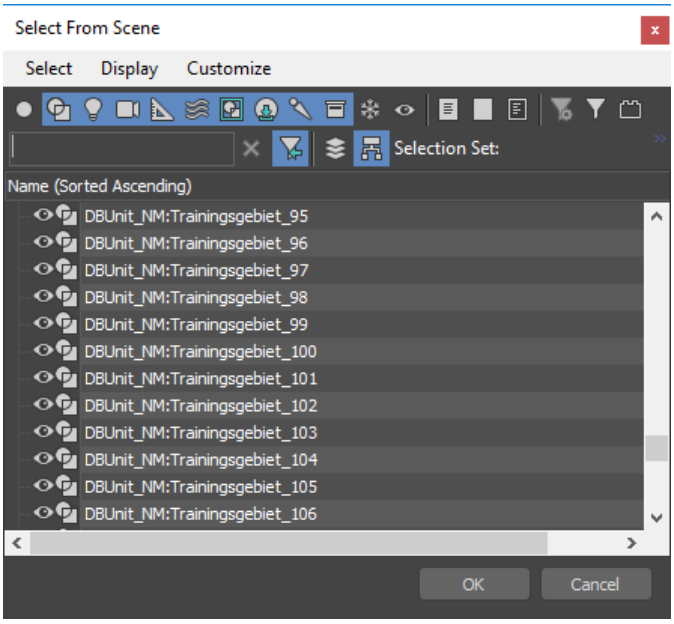
4. Under *Name* indicate the name of the model to be created.
5. Click Create
6. Specify the settings of the model in the status bar.

   `Yes`: Create models from loaded units.

   `No`: Create models from the selected polygons.
7. If necessary, re-load the created model by answering the control question with a *Yes*.

6.1.3. Establish model from UnitID

1. Open the *Model Properties Window* (cf. 2.8.1)
2. Click the button `Model Administration`.
3. Click `Select by Name` in main button bar of 3D Studio.
4. Press button `Shapes` in row „Display“, in case it is not activated (highlighted in orange).
5. In the window all selection polygons of the currently loaded model are displayed by their name. The name of each selection polygon is constructed as follows: DBUnit_NB: Unit name. By selecting the desired Units by mouse click on the corresponding name (hold SHIFT to select multiple names or CTRL to individually add names to selection) or by entering a text string in the field “Find”.

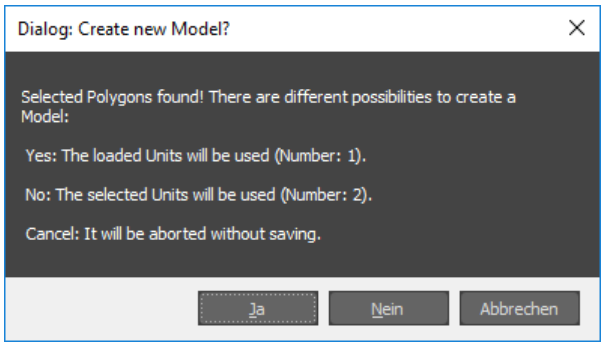


*Advice: If the names of Units which should be composed to a model are known, this model can be created efficiently by using so called wildcarding the text field “Find”. Use * as wildcard in 3D Studio. For example entering “*9.03” selects all selection polygons with the string 9.03 somewhere in their name.*

6. Confirm selection by clicking Ok.
7. Under *Name* indicate the name of the model to be created.
8. Click Create
9. Specify the settings of the model in status bar.

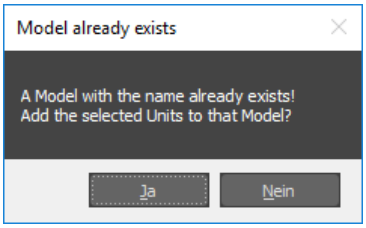
   `Yes`: Create models from loaded units.

   `No`: Create models from the selected polygons.



10. If necessary, re-load the created model by answering the control question with a *Yes*.

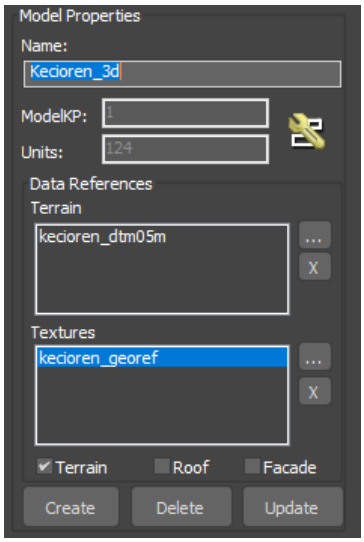
6.1.4. Add Unit(s) to a Model



Adding Unit(s) to an existing Model is done in the same way as creating a new Model. Execute all steps of section 6.1.2. In step 3, type the name of the existing Model. After clicking at *Create*, the message appears that the Model already exists.

Confirm the question with *Yes* in order to add the Unit(s) to the existing Model.

6.1.5. Remove Unit(s) from a Model



Removing a Unit from a Model removes only the containment relation between Unit and Model, but does not have any effect on the appearance of the Unit in the database.

There are two alternatives to remove Units from a Model:

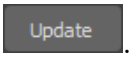
Remove multiple Units:

1. Open the *Model Properties Window* (cf. 2.8.1)
2. Click the button `Model Administration`. 
3. In the viewports, only the Selection Polygons are shown. Select those Units that shall be removed from the Model and delete them (e.g. with the DEL-key).
4. Click at `Update`. Those Units for which the Selection Polygon was deleted will be removed from the Model (directly in the data source). The Units themselves will remain in the database at least in the Model 'DEFAULT'.

Remove a single Unit:

1. Open the *Hierarchy dialog* (cf. 2.7.1) and select the Unit you want to remove with the right mouse button.
2. In the context menu select **Remove Unit from Model**.

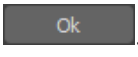
6.1.6. Change the Name of a Model

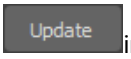
3. Open the *Model Properties Window* (cf. 2.8.1).
4. Type in a new name.
5. Click at 

. The new name will be saved directly in the data source.

6.2. Assign a New Terrain Model

1. Open the *Model Properties* Window (cf. 2.8.1).
2. Click at the button 

beside Terrain. A selection window with all terrain models available in the data source is opened.
3. Select the desired terrain model.
4. Click at 

. The selection window is closed.
5. Click at 

in order to save the new assignment in the data source.

From that time, the new terrain model will be used in the face generation process when the facades of Units are extruded.

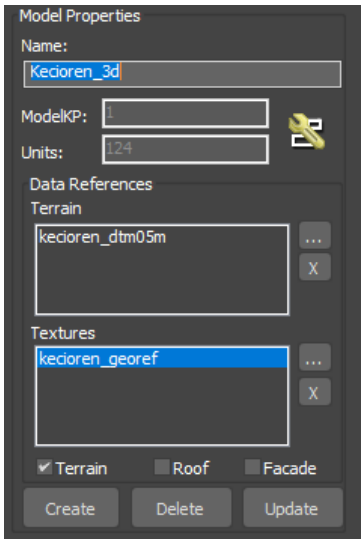
A terrain model in the database can be assigned to any number of Models.

Advice: In order to adapt all Units of the Model to the new terrain model without having to check out and triangulate each Unit individually, continue in the following section.

Note: Several terrain models can be assigned to one model. Each terrain has to be added in the way mentioned above. It is recommended not to assign overlapping terrain models since it cannot be predicted which terrain will be used (e.g. at extrusions of facades).

Note: If the database holds more than one version of a terrain model, the latest version will be assigned to the model.

6.3. Delete a Model



Deleting Models is available only in the database version of the Modeler.

Models can be deleted again any time (exception: the model "DEFAULT"). The Units remain untouched in the data base. Only the relation to the model is deleted.

1. Select the Model to be deleted as Working Set (cf. 2.1.3).
2. Open the Model Properties Window (cf. 2.8.1).
3. Click at Delete.
4. Confirm the question whether you really want to delete the Model. The Model will be deleted from the database. Afterwards, the Working Set Window is opened to select a new Working Set.

Note: If a corrupt Model exists in the database, it will be deleted automatically after a failure of loading it.

6.4. Assign Texture Images to a Model

1. Open the *Model Properties Window* (cf. 2.8.1).
2. Click at the button ... beside Textures. A selection window with the names of all images available in the data source is opened.
3. In the lowest line of the selection window a filter can be given: all images, all ortho-images or all images with perspective projection.
4. Select the desired image.
5. Click at Ok. The selection window is closed.
6. Activate the corresponding checkboxes for Area and/or Terrain to specify the usage of the image.
7. Click at Update in order to save the new assignment of the texture image to the Model in the data source.

Advice: Use standard Windows functions for multi selection in selection window.

To texture a terrain with multiple images, it is necessary that the image boundary coincide with adequate edges of the TIN. It must be clear that a triangle of the TIN needs to be fully covered by one texture image, otherwise this triangle can't be textured. We recommend using orthophotos for terrain texturing. The boundaries of a set of orthophotos usually define a regular grid. City**GRID**® Administrator provides a tool for intersecting a regular grid structure with a TIN. This makes sure, that a series of orthophotos can be used for terrain texturing (cf. Manual City**GRID**® Administrator)

An image in the database can be assigned to any number of Models as texture image.

Deleting a texture image assignment can be done by selecting the image name in the list of texture images and by clicking at the button  right of the list. The assignment of that image to the Model is removed, but the image remains in the database.

Advice: For texturing roofs the original aerial photographs with their perspective orientation parameters are suitable. Using these parameters each roof triangle can be projected into the image and texture coordinates can be determined. Orthophotos are in general not suitable, since these were usually produced using the terrain model and therefore have displaced roofs (except true orthophotos).

For texturing the terrain we recommend a map or a True Orthophoto. Normal orthophotos often show displaced buildings in the area of the road. You get the same effects, if the perspective aerial photograph is used directly.

The terrain texture is always calculated online and need not be pre-calculated.

Advice: In order to adapt all Roof Textures of the Units of the Model to the new texture image without having to check out and edit each Unit individually, continue in the following section.

7. Attribute Management

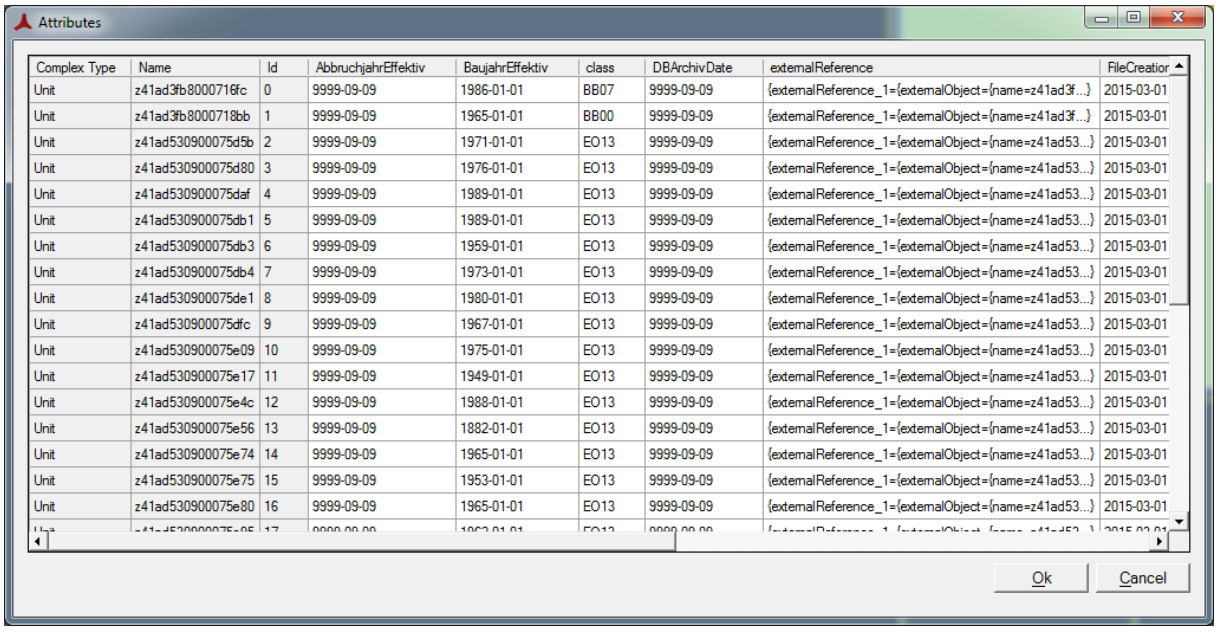
7.1. Attribute Table

Besides building semantics and geometry attributes can also be managed with City**GRID**®. These attributes can be assigned to each hierarchical level. In order to set and inspect the attributes an attribute table can be opened, from the City**GRID**® Administrator and City**GRID**® Modeler (see manual City**GRID**® Modeler).

Attributes can be assigned to each City**GRID**® complex type. Unit attributes are version-independent and act on all existing versions of the unit (see. 2.6). Object, Element Complex, and Element attributes, are depending on the version. Existing attributes are inherited automatically during check out of a unit.

Note: Each attribute change, except for the model attributes must be confirmed by `Triangulate / Apply Changes` *(see. 1.7.5). For model attributes a window directly comes up when closing the attribute table to save pending changes.*

Via attribute table attributes can be set, inspected, altered and deleted. New attribute columns can also be created and existing deleted. Depending on hierarchy level displayed content of attribute table may vary, but basic functionality remains always the same.



Complex Type	Name	Id	AbbruchjahrEffektiv	BaujahrEffektiv	class	DBArchivDate	externalReference	FileCreation
Unit	z41ad3fb8000716fc	0	9999-09-09	1986-01-01	BB07	9999-09-09	{externalReference_1={externalObject={name=z41ad3f...}	2015-03-01
Unit	z41ad3fb8000718bb	1	9999-09-09	1965-01-01	BB00	9999-09-09	{externalReference_1={externalObject={name=z41ad3f...}	2015-03-01
Unit	z41ad530900075d5b	2	9999-09-09	1971-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075d80	3	9999-09-09	1976-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075daf	4	9999-09-09	1989-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075db1	5	9999-09-09	1989-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075db3	6	9999-09-09	1959-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075db4	7	9999-09-09	1973-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075de1	8	9999-09-09	1980-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075dfc	9	9999-09-09	1967-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075e09	10	9999-09-09	1975-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075e17	11	9999-09-09	1949-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075e4c	12	9999-09-09	1988-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075e56	13	9999-09-09	1882-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075e74	14	9999-09-09	1965-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075e75	15	9999-09-09	1953-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01
Unit	z41ad530900075e80	16	9999-09-09	1965-01-01	EO13	9999-09-09	{externalReference_1={externalObject={name=z41ad53...}	2015-03-01

The attribute list is made up of the following components:

- *Complex type:*

  Shows type of selected hierarchy level. All known City**GRID**® Complex classes (Unit to Detail Element Complex) are available.

  Note: By right-clicking on Complex type column header, the display of different complex types is found in the context menu under ***visibility****.*

- *Name:*

  Specifies the UnitID of the respective complex. This attribute is present in each complex type.

- *Id:*

  Is a serial number that identifies the list items of the attribute table with a unique ID. The ID is assigned at runtime and is not related to existing attributes.

All other columns are optional and represent the actually occurring attributes per complex type. If complex types have different attributes and are displayed together, the attribute table always shows the totality (union) of all

existing attributes. If a complex type doesn't have a particular attribute set, the corresponding record will appear empty in attribute table. At save only set attributes are written.

Click OK to confirm, or Cancel to discard changes.

*Note: For automated filling of attributes from external data the FME City**GRID**® Writer can be used. In order to develop a customized solution, please contact your advisor at UVM Systems contact.*

7.2. Open Attribute Table

The attribute table is accessed via the right-click menu of the hierarchy window and appears as a floating window that is placed over the viewport of the Modeler. Size and position of the window can be set by the user individually.

Note: Model and Unit attributes can also be edited in CityGRID® Administrator (see manual CityGRID® Administrator). Especially for Unit attributes it is more advantageous than the processing in Modeler because check out of Units can be omitted..

7.2.1. Open Attribute Table for active Complex

1. Load and Check `out` the Unit  (cf. 2.6.1).
2. Select active Complex (cf. 2.7.2).
3. Click the active complex with the right mouse button in the hierarchy window and from the context menu select the entry **Attribute-Table**.

7.2.2. Open Attribute Table for multiple Complexes

1. Load all desired Units (cf. 2.2)
2. Distinguish all need Complexes in hierarchy window. (cf. 2.7.3)

Advice: In order to distinguish all units or objects of the loaded selection, feature `Select distinguished complexes by attributes`  *(cf. 2.7.3.) can be used.*

3. In hierarchy window right-click and select All distinguished complexes > Check Out. (Only needed at working with databases)
4. In hierarchy window right-click and select All distinguished complexes > Attribute-table.

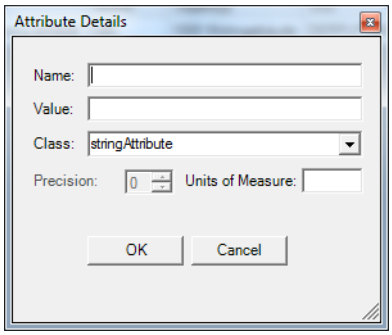
Note: 3.The attribute table opens only in the edit mode, if all distinguished complexes are checked out. (cf. 2.6.1) If at least a checked in complex is found, the attribute table opens in a viewing mode that does not allow changes. Run check out for all distinguished complexes before you open the attribute table in edit mode.

7.3. Editing Attribute Table

7.3.1. Create new attribute column

1. Open Attribute Table (cf. 7.2)
2. Right-click an existing column header (e. g. ID) in attribute table and select **New Column**.

3. Define *Column name* and *data class* in Attribute Details window. Available classes:



4. *String*: arbitrary text strings
5. *Date*: Date in all common spellings
6. *Double*: Point numbers, the number of decimal places can be defined under *Accuracy*.
7. *Integer*: integer values
8. *Boolean*: True (1) / False (0)
9. *List*: Attribute, which in turn contains a list of the attributes listed above.

   Define *Units of Measure* (UOM) for all numeric attributes.

   Specify *Value* at column definition if applicable. This value will spread over all selected list entries.

10. Click OK for creation of column, or Cancel to discard changes.

Note: In attribute table, each column name is unique, the upper / lower case must therefore be observed. The reapplication of an attribute of the same name is not admissible.

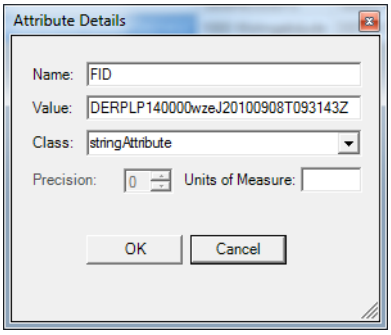
*If multiple attributes of the same name must be created (eg. externalRefernces in CityGML) this can be done only via FME. When reading such attributes into attribute table City**GRID**® converts these attributes into a simulated list attribute and cares for correct reconversion at saving. The lists behave like ordinary attributes list, and can also be changed in the values. By changing the column names separate list attributes will be created instead. Returning to the initial state is no longer possible in this case..*

11. Click at `Triangulate/Apply changes`  to take over the changes (cf. 1.7.5). All Units concerned are triangulated.
12. Click at `Save`  (cf. 1.7.5). All Units concerned are saved.

7.3.2. Modify existing attribute column

1. Open Attribute Table (cf. 7.2)
2. Right Click an existing column header, with the exception of *complex type*, *name* and *ID*, in the attribute table and select *edit*.
3. Apply changes.

Note: Changes to the data class are allowed only if existing values don't interfere with new data class. If conversion to the desired class is not possible, a message appears showing name and the affected value, separated by "." (point) (eg. Unit_1.hallo). The first 20 problem cases are listed.



4. Click OK for creation of column, or Cancel to discard changes.
5. Click at `Triangulate/Apply changes`  to take over the changes (cf. 1.7.5). All Units concerned are triangulated.
6. Click at `Save`  (cf. 1.7.5). All Units concerned are saved.

7.3.3. Delete existing attribut column

1. Open Attribute Table (cf. 7.2)
2. Right Click an existing column header, with the exception of *complex type*, *name* and *ID*, in the attribute table and select *delete column*.

3. Click OK for creation of column, or Cancel to discard changes.
4. Click at `Triangulate/Apply changes`  to take over the changes (cf. 1.7.5). All Units concerned are triangulated.
5. Click at `Save`  (cf. 1.7.5). All Units concerned are saved.

7.3.4. Select (and modify) column entries

1. Open Attribute Table (cf. 7.2)
2. Right Click an existing column header, with the exception of *complex type*, *name* and *ID*, in the attribute table and chose *select column*. All fields of the column are selected by this action.
3. Now right click any selected cell and select *edit* to change the value of the cells, or *delete* to remove the values.
4. Click OK for creation of values, or Cancel to discard changes.

Advice: Cells can be selected / deselected via standard Windows mechanisms.

7.3.5. Sorting columns

1. Open Attribute Table (cf. 7.2)
2. Left click an existing column header. A small triangle is showing up, indicating that sorting is based upon this column now. Displays the tip upwards there is a rising order. Clicking again on the same column header will change the sort order to descending order.

8. Texture

CityGRID® offers two possibilities for the process of texturizing:

- semi-automatically via oriented image files
- interactively via freely-taken picture

The (semi-)automatic process of texturizing requires the import of oriented image files into the data source including additional assignment to the working model; the texturizing process can run automatically subsequently for all units of a model or only for parts of the same.

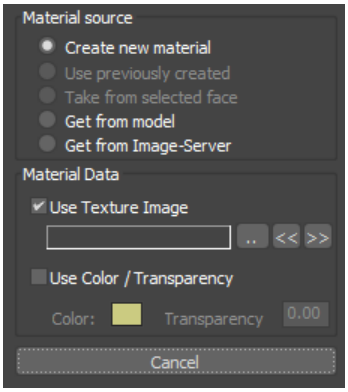
The process of interactive texturizing takes place on the element in CityGRID®, unit per unit. Carrier of the texture information is the face and not the structure line of a building like at the modelling process. It is not of relevance which element the face belongs to so that every face in CityGRID® can also carry a proper texture.

8.1. Interactive texturizing

1. Load and `Check out` the Unit (cf. 2.6.1).
2. Check *Textures* in *Display* section of Main window to display textures in Viewport (cf. 2.4.2).
3. Select the Active Complex (cf. 2.7).
4. Choose the face layer of the active complex (cf. 2.9.1)
5. Select *polygon selection* (cf. 2.9.1).
6. Select the faces to be textured in the preview window. The polygon selection automatically selects all related faces with equally adjusted face normal and those for whom the threshold for coplanar faces is within range.

Advice: In order to add faces to a selection, keep the CTRL button pressed while clicking. To deselect faces keep the Alt-button pressed.

7. Click at `Load Material` (cf. 1.7.3)



The properties window opens in which the material to be mapped has to be defined. The material describes how a 3D object performs under the influence of light.

Firstly, the material source needs to be defined:

- Create new material

  A new material without colour, transparency and image information is created. It is used in the case when a material not yet existing in the scene needs to be created.

- Use previously created:

  Uses material that was created at last call of *Create new material*. Usable for faces with identical or similar image data.

- Take from selected face:

  Serves to re-load material already mapped from a face into the texture window.

- Derive automatically from model:

  If oriented images are assigned to the model and the selected faces are existing in the image, the selected face is mapped semi-automatically with the material. (cf. 6.22).

- Get from image server:

  Establishes a connection to a mobile mapping images server for semi-automatic texturing.

Material data determine appearance of the material source defined before.

- *Use texture image*:

  If (default setting) activated, the material uses the texture image. It can be loaded via [...] button. As soon as an image is loaded, the filename appears in the adjacent description field. Via buttons [<<] [>>] the previous/next image can be determined as Texture Image.

  *Note: All common graphic formats are supported. However, jpg2000 format is not supported in this City**GRID®** version.*

- *Use colour/transparency*:

  If no texture image should be assigned, instead, a uniform face colour can be assigned to the material. Fields for colour and transparency are activated if the checkbox is set. In order to modify the colour settings, you must click into the *Colour* Field. Consequently the colour mixer of Autodesk 3D Studio Max opens. The value for transparency ranges from 0 (opaque) to 100 (transparent).

  Note: Texture Image and colour can be assigned to a material simultaneously; however, when maintaining the standard settings in Autodesk 3D Studio Max only the texture is displayed. A coloured mixture (multiplication) of colour and texture image does not take place. Transparency and texture image are shown simultaneously, though.

8. Click [Apply Material] in order to resume the material settings.

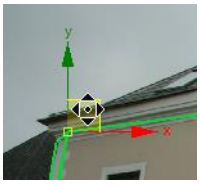
   Depending on the settings the selected faces are mapped with colour/transparency, semi-automatic texturizing processes are carried out or the chosen texture image is loaded into the texture window for further editing.

9. Geometry and texture are now combined in the texture window. After the faces to be textured have been marked in advance and the according texture image has been specified, the image and the mesh of the selection are faded in the texture window.

   Advice: The line colour of the projected mesh as well as the background colour can be adapted in menu CGModeler-Edit User Defined Default colours (cf. 2.4.4) in Object Selection "Miscellaneous Module Colours", Element Selection „Texture window". Line thickness can be modified in the options dialog (cf. 1.7.1). Modifications become active when loading the material data into texture window afterwards.

   There are always four points of the mesh, which are taken as a basis for the calculation of the even equalization, marked by a square. These are the most external points (support points) which represent, in general, the vertices of a facade.

   For a successful texturizing process the mesh has to be covered with the situation in the image. This can be done by clicking any vertices of the mesh and dragging them to the corresponding position in the image. Dragging an anchor vertex causes the adjustment of all spare points of the mesh, except the remaining anchor points. Use scale mode for simultaneously adjustment of all anchor points.

   If a marked point is selected, a drag or scaling cursor appears above the point, depending on the transformation mode selected (cf. 1.7.6). The x axis is always displayed in red and the y axis in green. In addition, a square (drag mode) or a triangle (scaling mode) are displayed between the axes. When you move the mouse across an axis or the square/triangle, the affected section is highlighted in yellow, and the mouse pointer changes its shape. If the axes are highlighted, the point can be dragged/scaled along them. If the square or triangle is highlighted in yellow, dragging takes place in the x and y directions, and scaling occurs in both directions.

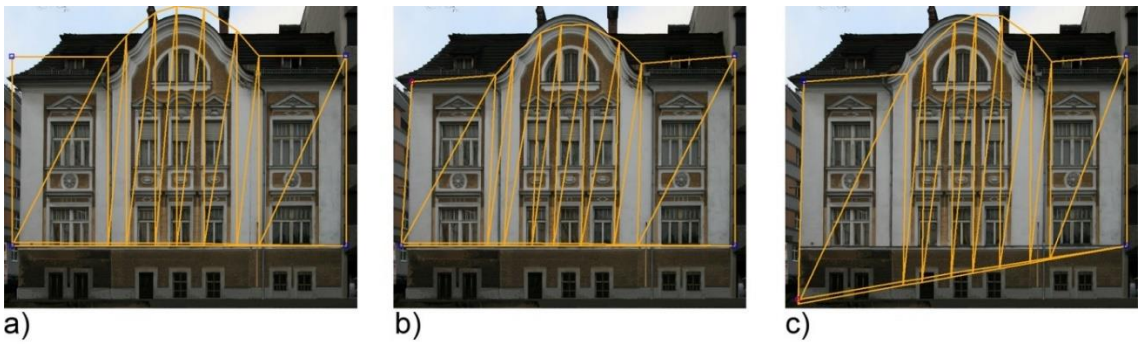
   Tip: In order to activate a point, it is advisable to drag a small selection square around the point, instead of clicking on the point directly.

   In order to move several points at once, a selection rectangular can be created in the texture window by clicking and dragging it over the required area. Subsequently, the mouse pointer has to be clicked and dragger over a selected anchor point. The selection remains unchanged until one vertex outside the selection is clicked or a new selection rectangular is created.

By clicking the mouse wheel the cut-out of the texture window can be moved (Pan), scrolling the mouse wheel causes a magnification/diminution of the displayed cut-out (Zoom). The same actions can also be carried out via the buttons of the texture window. (cf. 1.7.6)

Note: If facades are textured and a terrain has been assigned to the model, the Terrain Intersection Line in the facade face will be faded in. This line should be covered with the completion of the facade in order to gain best texturing results. The steeper the area is, the more bottom facade edges and Terrain Intersection Lines diverge, since the facades are always extruded to the deepest intersection point of the terrain model and the upper façade line, projected on the terrain. Parts of the facade are therefore located under the terrain.

Example: a material with a texture image should be assigned to a facade face. The facade face was selected in the preview window via polygon selection, a material was created and the texture image was loaded into the texture window together with the mesh (a). Now the four external vertices are adapted to the image step-by-step. Starting with the left top corner (b) the geometry of the mesh changes with each additional adapted point (c – e). After having finished the adaptation (e) an ortho image (cf. below) will be calculated and applied to the facade faces. Subsequently, the mesh in the area of the round arch in the roof will be adapted to the image in a better way (f).

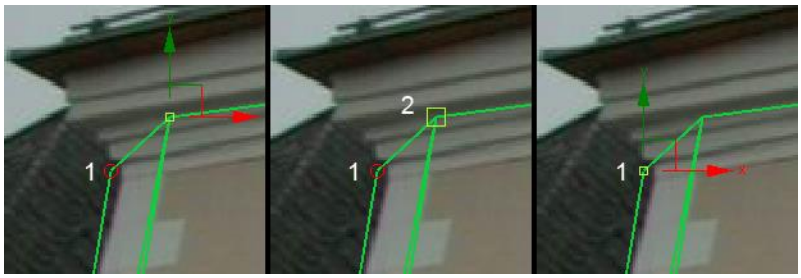


Click the mouse wheel to shift the detail of the image view (pan). Scroll the mouse wheel to maximize / minimize the detail displayed (zoom). The same actions can be executed using the buttons on the image view (cf. 1.7.6).

To change the selection of anchor points, select a non-anchor point and hold the left mouse button down above it. The point is then highlighted by a red circle and all four anchor points represent a green square. Use drag & drop to drag the clicked point to one of the four anchor points. When you release the mouse

button above the selected anchor point, the selected point adopts the status of an anchor point and the previous anchor point become a normal support point in the face net.

Example: Let's assume you want to transfer an automatically selected anchor point to an adjacent support point. Drag the mouse pointer over Point 1 until a red circle surrounds it. Click and hold down the left mouse button and drag the point over Anchor Point 2 which is marked by a green square. When the mouse pointer is over Point 2, release the mouse button. The anchor point of Point 2 then assumes the status of Point 1. When you reselect the new Point 1, you can then use it to adjust the face net.



10. Once the face net is adjusted to the image situation, click on Execute in the Texture Dialog (cf. 1.7.6) to transfer the configuration setting in the Texture Dialog to the 3D model. In this step, the perspective view is distorted by the set anchor points in order to calculate an orthophoto. The orthophoto is also clipped to the size of the required image detail plus a buffer area and placed on the selected face of the 3D model.

    Note: Four points are required to calculate an orthophoto using projective rectification. If only three face points are available, it is not possible to perform an orthophoto calculation. In this case, the texture process takes place by maintaining the perspective of the texture image.

11. If necessary, you can execute even smaller corrections on the face net to adapt the image even better to the geometry (Texture Coordinate Mode). In Texture Coordinate Mode, all support points of the face net can be manipulated. Changes to the face net are now displayed in the preview window on the 3D model.

    Click on `Restore Face Net By Orientation Parameters` (cf. 1.7.6) to restore the original state.

12. Click the button `Transform Using Anchor Points` (cf. 1.7.6) to return to the four highlighted anchor points and re-execute the orthophoto calculation, as described in Point 10 above. Click on `Cancel` (cf. 1.7.6) in the restarted Anchor Mode to restore the result of the first orthophoto calculation in the Texture Dialog.

    Note: For calculating the projective rectification exactly four identical points are used. We recommend adjusting already these points accurately (step 9) although there is the possibility to correct them later (step 11). By correcting the points in step 11 only texture coordinates are changed, but a poorly transformed image is not corrected. Correctly transformed images can be needed in following applications (e.g. for the export to a GIS).

13. Click `Save` (cf. 1.7.5). By doing so the texture coordinates are saved and the texture image including image pyramid (in a database) are saved in the data source.

8.1.1. Texturize long facades with multiple photos

Note: Only faces of element façade can be split up. For façade elements with face generation type frozen face net (cf. 2.8.5) an automated split is not applicable.

1. If textures have already been mapped, save first. Then execute steps 1 to 10 of the previous section in order to texturize a long facade section with the overview image.

   Subsequently, the facade can be divided into several tiles on recognizable vertical alignments.

2. Click on the button `Break up the facade`  (cf. 1.7.6) in texture window to start splitting mode.
3. In the texture window a separation line can be set at any position (with the left mouse button). This digitized position will be drawn up vertically and a separation line (green) will be drawn into the mesh. By clicking and dragging the separation line it can be modified in the position. Dragging a line to the left or right margin of the texture window leads to the deletion of the separation line.

Note: It is recommendable to set the separation points to recognizable vertical alignments (e.g. left bound of a window axis).

4. Set as many additional division lines as demanded.
5. By clicking the button `Apply`  , the separation mode will be ended, the division of the selected faces into the amount of parts, which have been set before, will be started and applied texture is removed. By clicking Cancel  , all changes are discarded.

Now every single section with its proper detail image, as mentioned in the previous section, can be newly textured.

Advice: To access the tiled facade sections switch from polygon selection  *to face selection*  *(cf.2.9) By doing so every single face triangle can be selected.*

When fitting (step 9) it has to be considered that the vertical triangular edge is concordant with the vertical alignment used at the division.

8.1.2. Edit existing textures

Execute steps 1 to 6 of section 8.1. By doing so, only select such segments which have been textured with the same texture image.

7. Click `Create Material`  (cf. 1.7.3).

   Again, the properties window opens, in which the option *Take from selected face* has to be selected.

   In the texture window the image, which has already been assigned to the selection, is loaded and is displayed with the fitted mesh. Modification at the mesh are applied to the 3D model in the preview window in real-time.
8. Clicking `Restore Mesh`  (cf. 1.7.6) rejects the modification at the mesh and restore the initial state.

Note: After finishing correctional work, there is no need to recalculate the texture.

9. Click `Save`  (cf. 1.7.5)

8.2. Semi-automatic texturing from mobile mapping data

In addition to the interactive texturing of handheld shooting, the connection to the image server of mobile mapping systems is another way to create high-resolution textures. The images are taken from street level and therefore suitable for texturing of facade surfaces. Roofs and structures on the roof on the other hand can't be textured from mobile mapping data.

1. Load and `Check out` the Unit  (cf. 2.6.1).
2. Place a Check in the *Textures* in *Display* section of Main window to display textures in Viewport (cf. 2.4.2).
3. Select the Active Complex (cf. 2.7).
4. Choose the face layer of the active complex (cf. 2.9.1)

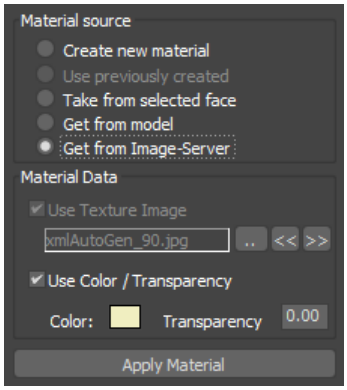
5. Select *polygon selection*  (cf. 2.9.1).
6. Select the faces to be textured in viewport. The polygon selection automatically selects all related faces with equally adjusted face normal and those for whom the threshold for coplanar faces is within range.

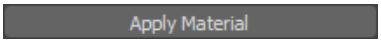
Advice: In order to add faces to a selection, keep the CTRL button pressed while clicking. To deselect faces keep the Alt-button pressed.

7. Click at `Load Material`  (cf. 1.7.3)

   Choose Material source:

   - *From image Server*: The connection to a server with the geo-referenced images is established.



8. Click 

to accept the material settings.

   Now, depending on the image server, a log in window appears, for specification of credentials (obtained from the mobile mapping company) and the EPSG code for the coordinate system appears. The connection to the image server is maintained throughout the City**GRID**® Modeler session.

   In texture window you can see all eligible pictures for the selected facades after the transfer from the image server completed.

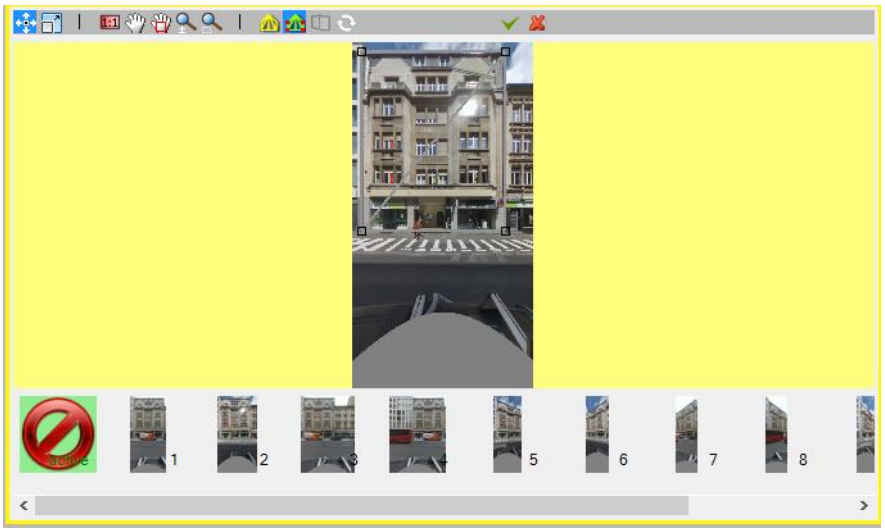
   In the thumbnails the candidate pictures are strung, as they are best from the viewing angle: the far left displays the currently applied recording with "0" and shown with a green background. To the right of "1" is the best, with "2" the second best, etc.

Note: Ten shots are always requested from the server. If no suitable image can be found among the proposals, further recordings can be requested, as long as suitable images are available on Image Server.

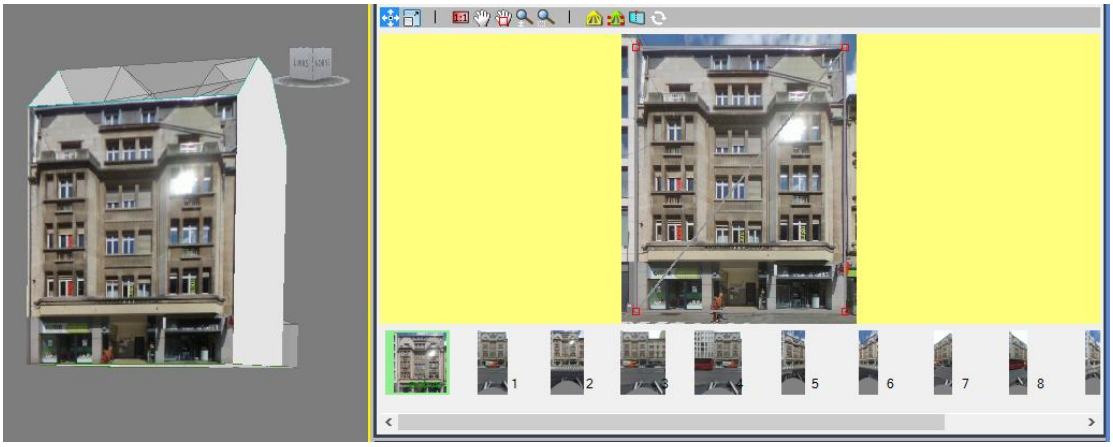
Images that are available on the image server, but which may not be accessed with the given credentials and, or can't be loaded from the server show this symbol. If the image "0" icon shows the icon, the selected area bears currently no texture information.

9. Now the best shot can be selected using the thumbnails. In texture window the selected area is displayed immediately, combined with the selected image.

Advice: When choosing, make sure that any possible large obstructions such as trucks are in front of the facade.

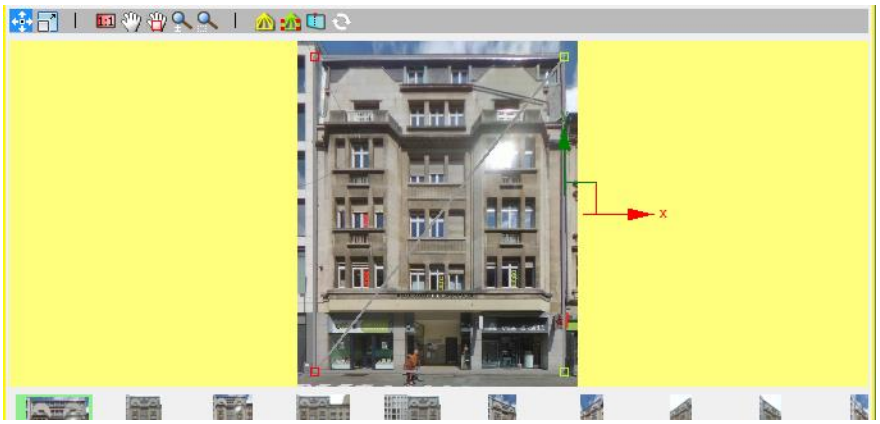


10. With  the selection is confirmed and the selected facade elements are automatically textured. The result can be seen in the viewport immediately on the 3D model.



11. Because of inaccuracies in the georeferencing of mobile mapping images or in the geometry of the building models, it minor errors in texturing result may occur. Such errors can be easily fixed in the texture window using the texture coordinate points (see. 8.1)

<u>Advice</u>: Typically, the facade is mapped too narrow or too wide. In such cases, we recommend to select the left and right texture coordinate points and jointly adapting in the X direction.



The adjustments using the texture coordinate points are immediately used for the texturing of the selected facade elements.

Other interactive texture adjustments are usually not required in mobile mapping situations, but all the functions described under 8.1 could be used in principle to revise the texturing.

12. Click at `Triangulate/Apply changes` to take over the changes (cf. 1.7.5).

13. Click at `Save` (cf. 1.7.5). Thereby the orientation parameters and the texture coordinates are saved and the texture pictures along with the image pyramid stored in the data source.

8.3. Copy existing textures

In general textures are unique for every face. However, there are complexes in a city model which can share identical texture images. For example, chimneys, columns and the like can be textured quickly by using a texture image repeatedly. Also buildings with recurring façade patterns can be – under certain circumstances – mapped using repeated texture images.

Note: Only textures with known orientation values can be copied.

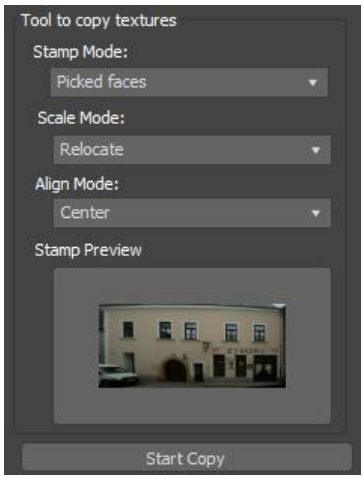
Advice: Note when copying textures that no distinctive objects can be found in the image source (cars, trees, monuments, wall damages, etc.). The more homogenous the texture image to be copied is, the more inconspicuously it can be copied onto other parts of buildings.

1. Check *Textures* in *Display* section of Main window for display of textures in Viewport (cf.2.4.2).

2. In *Layer Selection* select face layer in Polygon Mode (cf. 2.9.1). Depending on the selected *Stamp Mode* (see below) the selected element is either of importance or not.

3. Click `Copy Texture` (cf. 1.7.3)

4. Define *Stamp Mode*, *Scale Mode* and *Align Mode* in properties window for optimal copy results.



- *Stamp Mode*:

Defines on which faces the copied texture will be mapped. The following methods are offered:

- *Picked faces*:

  Texture will be copied by interactive selection of faces in viewport. As soon as the cursor hovers over a face, the mouse symbol changes to a crosshair as a hint for the user. Once you click a face, all triangles within the criteria of co-planarity will be textured with the copied texture.

- *Picked element*:

  Functions the same way as *Picked faces*, but copies the texture to the whole element

Advice: Use this mode on equally textured objects such as columns or chimneys.

- *Only selected faces*:

  If faces were selected prior to start of `Copy Texture Tool` in one element, only these faces will get the copied texture assigned.

- *All faces*:

  Copies the texture to all faces of the active complex. No selection is needed in this stamp mode.

- *Whole texture (Element)*:

This is a special function for coping texture compilations (different images) from one element to another. To transfer the texture compilation a reference face from the source and target elements must be specified interactively. Using this reference face the orientation and transformation can be computed and the copied texture can therefore be placed smoothly. (see example copy texture on dormer windows)

- Whole texture (Element Complex):

  Works the same way as Whole Texture (Element) with the difference being that all textures of the element complex will be transferred during copy (e.g. roof and façade texture of a dormer window)

- *Scale Mode:*

  Defines how the copied texture will be mapped. The following methods are offered:

  - *Unchanged*:

    This parameter keeps all orientation parameters of the original texture image and doesn't change the position of the image at texture mapping.

    Advice: Use this method if objects in front of already textured objects should be textured with the same image, e.g. oriels.

  - *Relocate*:

    Use this mode to adjust the position but not the scale factor, of the copied texture, based on the target. The orientation parameters will be adjusted to the new position in way, that the face normal of the to be textured face and the image aspect are continuous.

    Note: Both described functions can only be used successfully, if the image dimensions are big enough to cover the target faces. If a face to be textured exceeds the perimeters of the image dimensions of the source image, no image will be copied to that face; it remains untextured.

    To prevent such dimension differences between copied image and selected face, always use the largest found face(s) as source for texture coping (cf. 8.1) By doing so one can be sure that the image dimensions always exceeds the geometric perimeters of the faces to be textured.

    To see the image dimensions in viewport open menu ***CGModeler > Auxiliary Objects > Show auxiliary data of texture images****. Around every texture image a thin grey border is drawn, representing the available image dimension. Click* ***CGModeler > Auxiliary Objects > Delete Auxiliary Objects*** *to hide the lines in viewport again.*

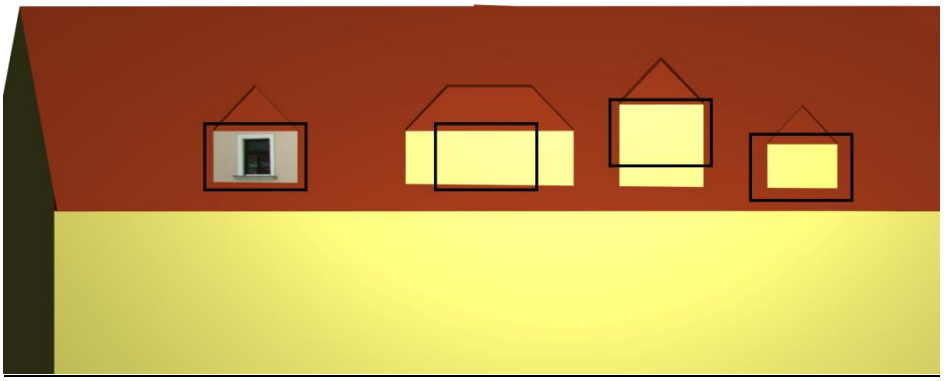
    Advice: Use this mode to copy textures on shape related faces.

    Example: Image dimensions and potential target faces.

    The following figure shows the relation between image dimension of the source image, drawn as black rectangle, and target faces for texture copy.

    On the left dormer window the source texture is mapped which should be transferred to the other three dormer windows. On second and third (from left) dormer the texture can't be copied in Scale Mode "Unchanged" and "Relocate" as the dimension in width (second) or height (third) exceeds the available image dimension and no scaling is applied at the selected Scale Mode. Only the right dormer has a face with smaller perimeters than the image dimension and therefore a valid situation for texture copy. The dormer window will get the image assigned.



- *Scale*:

  Functions the same way like Relocate but applies a scale factor to the source image, based on the shape of the target faces. The scale factor is derived by analysis of the largest change between source and target dimension. This value will function as global scale value for the whole texture.

  Advice: Use this method on faces with more or less related proportions to the source face to keep the scale factor in an acceptable region.

- *Align Mode:*

  At Scale Mode "Relocate" and "Scale" the settings in this mode will decide where the insert point of the copied texture will be placed. Every combination from Top, Centre and Bottom as well as Left, Centre and Right can be specified.

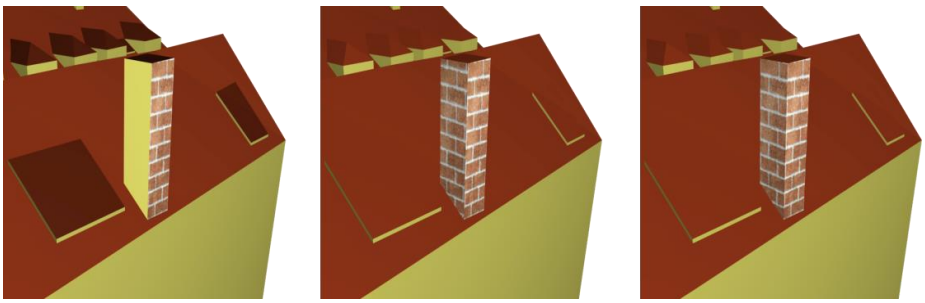
  Advice: Benefit from Align Mode if regularly patterned textures (e. g. brick texture) should be copied and at the edges of two copied textures no mismatch should be visible

  Example: Results from copy texture with different Align Modes

  Left image shows the initial situation: One façade face of the roof detail is textured by a brick texture. This texture shall be copied to all faces of the chimney.

  Middle image shows the result under usage of Align Mode "Center Top". A clearly visible mismatch between the mapped textures can be seen leading to an inconvenient result.

  Right image shows the result under usage of Align Model "Center". The textures fit together smoothly at the edges and the result look homogeneous.



5. After specifying parameters for coping a source image, it must be loaded in to stamp. Use the button under the section *Stamp preview* to select any desired texture in viewport. As soon as a texture has been selected a thumbnail image is drawn in the stamp button.

   Note: If no image is loaded into stamp, "Empty Stamp" is written in the stamp button. In case a face has been textured interactively (cf. 8.1) prior to use of `Copy Texture Tool`, the mapped texture image is used as stamp immediately.

   To exchange the image in stamp, simply re click the button and select any new texture in viewport. The previously loaded image will be removed from stamp.

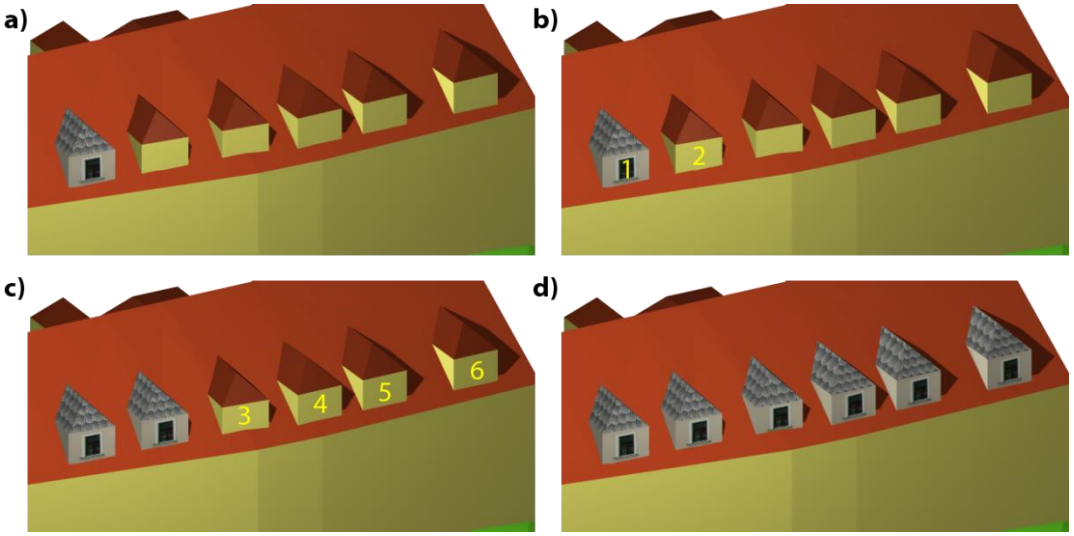
6. Click button Start Copy to start coping texture based on the specified copy parameters. As long as the copy mode is active no new texture can be loaded into stamp.
7. To finish copy mode re click Start Copy button.
8. Click `Copy Texture` (cf. 1.7.3) to close the copy tool.
9. Click `Save` (cf. 1.7.3)

Note: Note when copying textures that the proportion of source and target faces are nearly the same.

Example: Copy texture on dormer windows

By using the stamp mode "Whole Texture"time for texturizing identical complexes can be reduced dramatically. Especially details on roofs (e. g. dormers) which often have the same appearance and are therefore most suitable for texture copying. Do as follows to transfer texture compilations from one dormer to another:

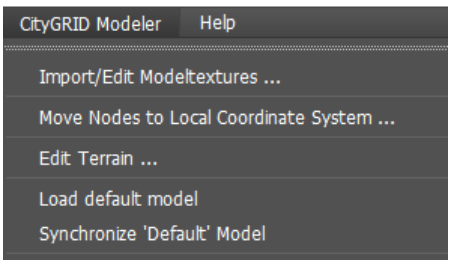
Texture one element complex interactively (cf. 8.1 (suggested to start with the largest instance), as reference complex for copy texture (step a). Now start Copy Texture Tool, use "Whole Texture (Element Complex)" as Stamp Mode and "Relocate" as Scale Mode. Click the stamp button and load the image showing the window into stamp. This face can easily be identified in every other dormer and is therefore is the most suitable as a reference face. (Step b 1) Now click "Start copy" and select the front face of the next dormer. (Step b 2) The system now adjusts orientation parameters of the texture formation based on the selected reference face. If the faces of the target dormer are lying within the image dimensions all textures will be copied to the selected dormer. (Step c) Use the same procedure on all other dormer windows to transfer the texture. In each dormer the front face must be selected as reference face again (Step d) If a dormer is not fully textured, it is an indication that a conflict between image and face dimensions has occurred. Change over from Scale Mode "Relocate" to "Scale" or texture the affected complex interactively (cf. 8.1).



8.4. Importing texture images with orientation parameters

For the building and terrain texture usually aerial photographs or orthophotos are available. These must be imported together with their perspective orientation parameters and/or with their geo-reference into the data base.

1. Open the menu **CGModeler > Import/Edit Modeltextures**. The Texture Images Window is opened.



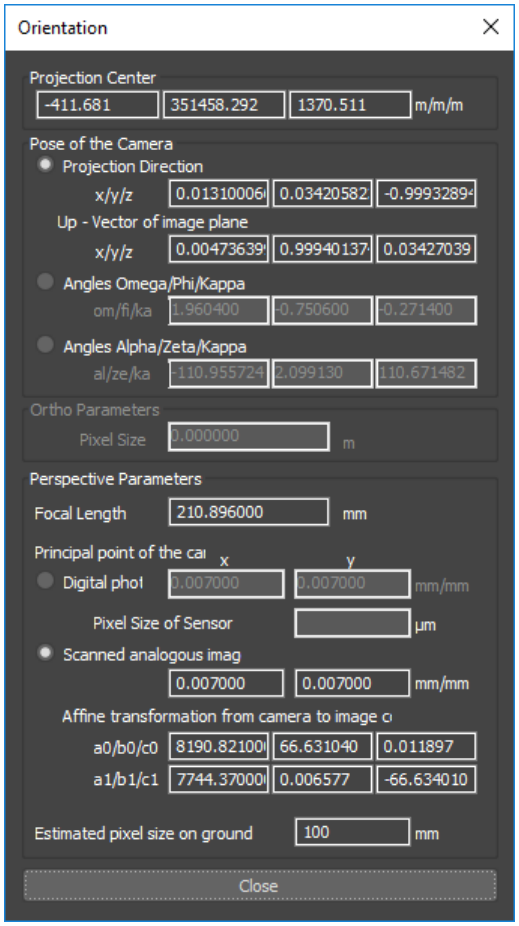
2. Using the button … beside *ImageFile* an image file can be selected. The file name is suggested as texture name.
3. If necessary change the name for the texture image, under which it will be stored and can be found in the data base (the texture name needs not be the same as the file name!)

   *Note: In case the image name already exists in database, a new version of the image is created. Models referencing this image are automatically updated to the latest version of the image. Unchanged all roof textures will remain. To actualize the roof textures run the function for automatic roof texturing (cf. Manual City**GRID®** Administrator)*

4. Choose the type of orientation parameters: *Perspective* for original central perspective photos or *Ortho* for corrected Ortho-images or maps.
5. Either load a file with orientation parameters using the button … beside *Orient.File* (the supported file formats are customer specific) or open a window for manually providing these parameters by clicking at Ori. Depending on the type of image the following parameters are contained:
   - For all types: Parameters of the exterior orientation:
     - Projection centre (x/y/z-coordinates)
     - Pose of the camera in space
       - 2 vectors: projection direction + up-vector of the image plane in space
       - angles omega/phi/kappa in ° (degrees)
       - angles alpha/zeta/kappa in ° (degrees)
   - For Orthophotos: pixel size in m
   - For perspective (aerial) images
     - Parameters of the interior orientation of the camera (from the calibration protocol): For scanned analogous images:
       - Focal length in mm
     - For directly digitally recorded photos:
       - Principal point of the camera (x/y-coordinates in the camera coordinate system in mm)
       - Principal point of the camera (x/y-coordinates in the camera coordinate system in pixel)
     - For scanned analogous images
       - Principal point of the camera (x/y-coordinates in the camera coordinate system in mm)
       - Affine transformation from camera coordinates to image coordinates:

$$\begin{pmatrix} x \\ y \end{pmatrix}_{[pixel]} = \begin{pmatrix} a_0 \\ a_1 \end{pmatrix} + \begin{pmatrix} b_0 & c_0 \\ b_1 & c_1 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}_{[mm]}$$

     - Estimated pixel size on ground (on the object): It should be estimated, in order to be able to provide the image of the image pyramid in the suitable resolutions.



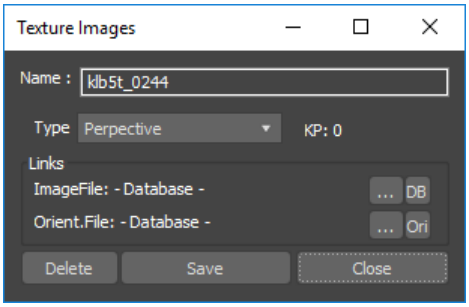
6. Using the button Save the texture image will be stored in the database/XML file. A copy of the image file is stored in the texture path of the database or in the sub-directory “images” of the XML file. Further

an image pyramid is generated (database only), so that the image can quickly be loaded in different resolutions.

Note: If the geo-reference of orthophotos is available in Tiff World format (.tfw for *.tif, *.jgw for *.jpg, etc), it will be interpreted automatically.*

Subsequently, the roof and/or the terrain can be textured with the texture image (cf. 6.4).

8.5. Change orientation parameters for existing texture images



1. Open the menu **CGModeler > Import/Edit Modeltextures**. The Texture Images Window is opened.
2. Using the button `DB` beside *ImageFile* a window for selecting one of the texture images of the database is opened.
3. Select a Texture Image and click at Ok.
4. The Texture Image is loaded together with its orientation parameters. In the Texture Images Window, besides *ImageFile* and *Orient.File* a hint is written that they come from the database.
5. Click at Ori beside *Orient.File* and continue in Step 5 of section 8.4.

8.6. Delete a texture image from the database

1. Load a Texture Image: Steps 1 to 4 of section 8.5
2. Click at Delete for deleting it in the database. References to that image in Models (as roof texture image or as terrain texture image) are deleted (one can see that only after renewed loading the Model). However, the roof textures of Units, which were calculated from that image are not deleted. If you want these textures, too, please refer to section 8.9.

8.7. Project lines onto model texture image

In order to be able to examine the accuracy of the orientation parameters of the roof texture image and/or the accuracy of the roof lines, that part of the texture image that is valid for the Unit can be displayed together with the lines of the Active Complex projected onto this image:

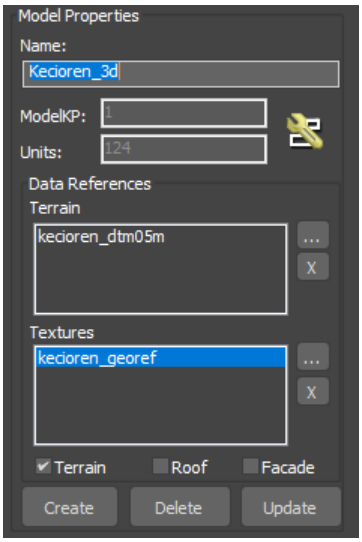
1. Check *Textures* in *Display* section of Main window for display of textures in Viewport (cf.2.4.2).
2. Select the Active Complex (cf. 2.7).
3. Click at `Back Projection` (cf. 5.4.3). The roof texture image will be loaded, the relevant part of it is extracted and the roof lines will be projected onto this image.

Note: Updating the roof texture can include several roof texture images and therefore texture large parts of an urban area at once. If several texture images are assigned to a model, the following rules should be kept in mind:

- Perspective images are used prior to Orthophotos for calculating the roof texture.
- If perspective aerial images are used, a 5% band will be removed to ensure that the fiducial marks are excluded from the texture.

- The image will be chosen, so that the parallax effect is minimal. (The Images will be sorted ascending by the angle between the element centre point beam to the projection centre of the picture and the extrusion direction of the elements).

Optionally every assigned model image can be back projected by double clicking the desired image in *Textures* list in *Model Properties* window



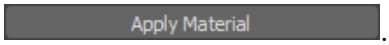
1. Open Model Properties window (cf. 2.8.1)
2. In list *Textures* select an image and double click the entry to get the image loaded into material window together with back projection of the active complex.

Advice: Use this method to check the appearance of the active complex in different model images, in case it's known in which images the complex can be found. This can be necessary if the best suitable image has some visual obstacles (trees, tower crane etc.) included and an image without this objects must be found.

8.8. Interactive texturizing from oriented images

1. Load and `Check out` the Unit  (cf. 2.6.1).
2. Check *Textures* in *Display* section of Main window for display of textures in Viewport (cf.2.4.2).
3. Select the Active Complex, e. g. "roof" (cf. 2.7).
4. Make face layer (e.g. roof) in the layer window to active layer.
5. Activate polygon selection  (cf. 2.9.1)
6. Select all faces in the preview window to be textured.

Advice: In order to add faces to a selection, press when clicking the CTRL-button. In order to deselect faces, keep the ALT-button pressed.

7. Click `Load Material`  (cf. 1.7.3)
8. Choose *Derive automatically from model* as material source.
9. Click 

. Subsequently, a selection of the oriented texture image will be created, which contains the whole object. This selection will be – according to the orientation parameters - saved as a texture image of the active element in the data source. The texture coordinates will be calculated for this image. The created texture will be immediately projected on the roof in the preview window. If necessary (if the orientation parameters have not been precise enough, or the geometry is not exact), projected triangles can be re-adjusted.
10. Click `Save Unit`  (cf. 1.7.3)

8.9. Delete textures of the active complex

1. Load and `Check out` the Unit  (cf. 2.6.1).
2. Check *Textures* in *Display* section of Main window for display of textures in Viewport (cf.2.4.2).
3. Select the Active Complex (cf. 2.7). Depending on selected hierarchy level, the deletion of various complexes takes place.

<u>Examples:</u> If a unit is activated on unit-level, deletion of various textures of this unit is carried out. If the same unit is activated at the element-level "roof", only all roof textures and textures of bound detail element complexes are deleted, but not the facade textures.

4. Click at `Delete all textures of the active complex`  (cf. 1.7.3)

5. Click `Save Unit`  (cf. 1.7.3)

9. Terrain Models

The City**GRID**® system is based on an existing terrain model, but is no efficient software for the production of terrain models. This should be done in advance using some terrain modelling software. The model can afterwards be converted into the standardized XML format supported by City**GRID**® and imported into the data base (cf. Manual City**GRID**® Administrator).

When working with the Modeler only a TIN (triangulated irregular network) is used. Only for exporting in VRML (cf. 10) in a Level of Detail (LoD) < 3 (Detail) an elevation grid is necessary.

During the face generation usually the terrain model which is assigned to the active model is used. If no model is available, the "DEFAULT" terrain model is used.

Note: After the setup of a database a terrain model with the name "DEFAULT" must be imported into the data base.

9.1. Terrain Model editing

City**GRID**® Modeler is designed for building modelling. During these modelling tasks minor adoptions to the terrain model can become necessary in order to create high quality city models. For that purpose City**GRID**® Modeler offers the possibility of terrain editing in a small scale. Performed changes can then be stored back to the data source.

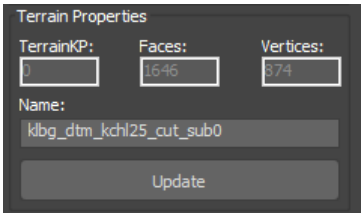
*Note: City**GRID**® Modeler is not a terrain modelling software and will never claim to be considered as one. Following described procedures and functions are meant for micro level terrain optimization and editing or for optimization of terrain models for visualizations in real time environments like City**GRID**® Explorer.*

Terrain models are displayed in hierarchy window of the Modeler (cf. 2.7.1) as soon as Terrain display is activated in Modeler's Main window (cf. 2.4.2) All visible DTMs in viewport are listed directly under the Model hierarchy entry in hierarchy window and are prepared for editing od display of specific information.

Dependent on set display settings in Options menu (cf. 2.5) the complete terrain model can be seen or just a clipped part around loaded Units. I case of a clipped terrain model, "_sub" is added at the end of the terrain name for better indication.

To activate a Terrain model select the corresponding entry in hierarchy window. As soon as a DTM has been activated the corresponding properties window comes up in the lower part of Modeler's control section. Following information can be extracted from there:

- *TerrainKP*: Unique database identifier of DTM (zero at XML files)
- *Faces*: Count of currently loaded faces in viewport
- *Vertices*: Count of currently loaded vertices in viewport
- *Name*: Assigned terrain model name. On demand a new name can be specified and by cklicking Update button be assigned.



9.1.1. Interactive Terrain Model editing

After activating a terrain model in hierarchy window it's free for editing in case of an XML as data source. In case of a database stored DTM `Check out` (cf. 2.6.2) must be done prior to any editing operation.

For every terrain model all sub selection modes (vertex, segment, face, polygon, element) in layer window are valid and available (cf. 2.9) The only entry in layer window is *Terrain*, no other layer can be included and *Terrain* is locked for changes. By selecting appropriate sub selection modes (typically face or polygon) sections of the terrain model can be selected and edited individually by usage of 3D Studio standard operations, as well as by City**GRID**® Modeler functions.

Note: If clipped terrain is set in Options menu no border vertices, segments with at least one border vertex as well as faces with at least on border vertex can be selected. Turn off clipped terrain to access geometry affected geometry.

Example: Editing actions by usage of 3D studio functions

- *Selection of vertices, edges or faces*
- *Delete vertices or faces by pressing Del- key*
- *Moving of vertices using Select and Move ....*

On selections following City**GRID**® Modeler functions can be applied:

- Drawing Mode (cf. 3.3.3): Use this function to draw new faces. By using Snapping function precise drawing from existing vertices is guaranteed. Turn sub selection mode to `Face` or `Polygon` for direct draw of new geometry. `Face` sub selection mode allows drawing of single triangle faces, whereas `Polygon` mode allows creation of large areas in on drawing session. A drawn polygon is sub divided into triangle by 3D Studio automatically.

  *Note: Mind drawing direction at creation of new faces. A drawn face will be visible at single sided display mode (default mode in City**GRID®** Modeler, cf. 2.5) if the vertices of the face are digitized counter clockwise.*

- `Coordinates-Tool` (cf. 3.3.1): Use this tool for unique setting of coordinate values to a selection, e. g. a unique height value.
- `Move Point to Face Tool` (cf. 3.4.5): A selection of vertices can be calculated in a previously defined plane. Use this tool to assign height values from a reference plane.

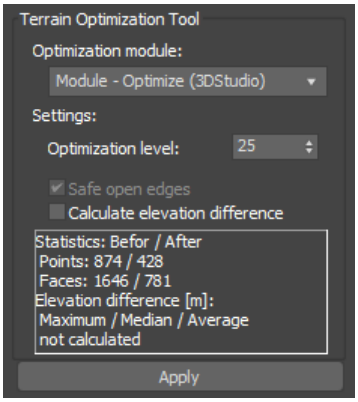
  Advice: Intersection plane "selected Element" and "selected Face" only influence vertices right underneath the selected Element or Face. All other selected vertices will remain at their position. To adjust these vertices switch to "User defined" mode.

- `Face Normals Tool` (cf. 3.4.8): By usage of this tool all faces or only selected faces of the terrain model can be flipped. This influences visibility in viewport in single sided display mode. (cf. 2.5)

9.1.2. Optimize Terrain Models

Depending on used terrain modelling software created TINs might have been put under an optimization routine to reduce triangle amount by keeping specified accuracy parameters. Not all terrain models must have passed this procedure, which leads to disproportional triangle count for representation of the earth surface. As a consequence such terrain models influences response time and therefore performance in software and can also cause massive problems in real time 3D visualizations. Total triangle count is still the limiting factor of available viewing systems.

To offer relief the `Terrain Optimization Tool` is available. Using built in 3D Studio technology this tool removes step by step vertices from terrain models and readjusts the face net. Mainly based on the face normals direction vertices are selected for elimination. The smaller aberration between neighbouring face normals is the more likely common points will be removed and affected faces recreated, leading to reduction of triangle count.



To optimize terrain models do as follows:

1. Activate terrain model in hierarchy window.
2. Check out if necessary (cf. 2.6.2)
3. Click `Terrain Optimization Tool` (cf. 1.7.4) to start.

The tools properties window comes up in main bar of City**GRID**® Modeler, offering a set of parameters to specify the optimization. Equipped with default optimization settings a first optimize is also performed on activated terrain model. Adjust available parameters to find best suitable optimization:

- *Optimization module*:

  Defines used optimization method. Currently three different methods are available: *Optimize*, *MultiRes* and *ProOptimize* (3D Studio 2010 or higher). All functions are built in tools from 3D Studio Max for thinning out vertices and faces. *Optimize* forces an on the fly calculation of face distribution based on altered *Optimization levels*, whereas both other optimization modules pre calculate possible levels.

- *Optimization level*:

  Rules intensity of optimization. Ranging from 0 (no optimization) to 100 (maximum optimization), with a default value of 25, this value approximately estimates how many points will be removed. E. g. an optimization level of 50 will remove some 50% of all loaded vertices, obeying the rule that neighbouring faces with similar oriented face normals will be favoured. Section *Statistics* in properties window compares not optimized with currently optimized terrain model and calculates corresponding vertex and face count.

- *Safe open edges*:

  Judges if border points of loaded terrain model can be affected (unchecked) or not (checked) by optimization. Optimization module *MultiRes* can't take advantage of this parameter.

  Advice: It's strongly advised to activate" Safe open edges" at optimization of terrain tiles to keep accuracy of fit.

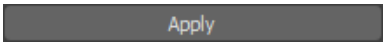
- *Calculate elevation difference*:

  Calculates a height difference model from not optimized and optimized terrain models and derives statistical parameters from it for estimation of applied height changes. Maximum height difference, median and arithmetic mean are computed and displayed in section *Elevation difference [m]*. All values are derived by usage of non-negative values from difference model.

  Note: Depending on face and vertex count of terrain model, calculation of elevation difference can become highly time consuming! Use option therefore carefully as no interruption of once started calculation is possible.

Any parameter change will directly affect terrain model and lead to recreation of terrain model in a preview.

4. By clicking 

previewed terrain model is accepted and replaced the original terrain model in viewport.
5. Click at `Triangulate/Apply changes`  and `Save`  to take over changes (cf. 5.4.2).
6. `Check in` terrain model eventually.

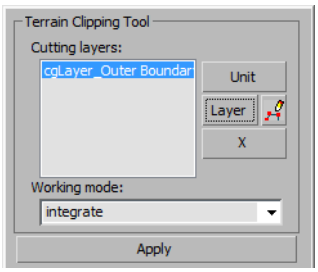
Note: After terrain optimization an update of façade extrusion might become necessary (cf. ***Fehler! Verweisquelle konnte nicht gefunden werden.****)*

9.1.3. Clip, Cut out and integrate lines into Terrain Model 

Besides interactive editing and optimization of terrain models sometimes given structures must be integrated to readjust the face configuration, the whole DTM must be reshaped using a clipping polygon or sections inside the terrain model, following some closed polygons have to be removed. On demand given elevation values can be respected and the existing terrain model be adjusted to the given heights, or only the 2D information from the lines is taken for the called actions. All these tasks can be executed in `Terrain Clipping Tool`  (cf. 1.7.4)

1. Activate terrain model in hierarchy window.

2. Check out if necessary (cf. 2.6.2)



3. Click `Terrain Clipping Tool`  (cf. 1.7.4) to start. The tools properties window comes up in main bar of City**GRID**® Modeler. Define here to be used Lines and Layer as well as the applied working mode.

- Cutting Layer:

  Displays which layer will be integrated into the terrain model. At start layer list is always empty und must be filled by user action in one of the three ways:

  - By clicking Unit a Unit in viewport can be selected and the Terrain Intersection Curve is automatically inserted into layer list.

     *<u>Advice:</u> Regional selection*  *for loading of new Units (cf. 2.2.3) is also available during terrain modelling.*

  - By clicking Layer every line in viewport can be selected. Valid are all Unit lines, 3D Studio created lines and via `File Link Manager` (3D Studio, cf. 3.6.2) linked lines.

     *<u>Advice:</u> Use File Link Manager for Import of existing GIS line data that has to be integrated into a terrain model. Doing so vector areas can be created for colouring for visualizations.*

  - Drawing mode offers possibility for free hand drawing in viewport. Every drawn line is automatically added to the layers list. Press button to start drawing mode. First click in viewport starts a new sketch, a right click ends the sketch. Second right click ends drawing mode and returns to Terrain Clipping tool.

     *<u>Note</u>: City**GRID**® doesn't support tangential curves (Bezier curves). Found tangential curves are automatically straightened based on existing vertices. Any curved representation in viewport is without effect!*

  Click X to remove Layers from *Cutting Lines* list.

- Working Mode:

  Rules how lines are integrated into the terrain model. Every mode can use existing 2D or 3D information from cutting lines. The 3D mode is indicated by "with elevation" extension in selected *Working mode*.

  - *Integrate*:

    Adjusts the face configuration of terrain models by given lines. Existing Faces are cut and the lines are so included into the terrain model. Dimensions of the terrain model remain unchanged.

     *<u>Advice:</u> This mode can be used for interactive integration of break edges (with elevation) as well as for calculation of GIS data into the DTM.*

  - *Cut out*:

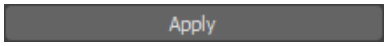
    Given lines are integrated into the terrain model and face configuration is modified. For closed polygons the interior area is removed from the terrain model to form holes. All open polylines have the same effect like *Integrate* mode.

     *<u>Advice:</u> Use this mode to cut holes into your terrain model.*

  - *Clip*:

    Given lines are integrated into the terrain model and face configuration is modified. For closed polygons the exterior area is removed from the terrain model. All open polylines have the same effect like *Integrate* mode.

Advice: Clip is typically used to reshape terrain models on a given boundary.

4. By clicking 

Lines in Cutting Lines list are integrated into the terrain model. The layer list is emptied and the tool is ready for next calculation process.
5. Click at `Triangulate/Apply changes`  and `Save`  to take over changes (cf. 5.4.2).
6. `Click Terrain Clipping Tool`  (cf. 1.7.4) to end.
7. `Check in`  terrain model eventually.

9.2. Merge Multiple Terrain Models to a single Terrain Model

1. Open the menu **CGModeler > Edit Terrain**
2. Select *Create new Terrain* in the assistant and click at `Next`
3. Select a name for the terrain to be created.
4. Choose any number of existing terrains to be merged.
5. Click at `Start`. A new terrain model will be created and stored in the database.

9.3. Expand a Terrain Model by existing Terrain Model(s)

1. Open the menu **CGModeler > Edit Terrain**.
2. Select *Expand an Existing Terrain* in the assistant and click at *Next*.
3. Choose the terrain to be expanded (“Base Terrain“)
4. Choose any number of existing terrains.
5. Click at `Start`. The selected terrain models are added to the base model which is stored in the database afterwards.

9.3.1. Derive ElevationGrid

The elevation grid of a terrain model is usually not necessary. Only for exporting in VRML (cf. 10) in a Level of Detail (LoD) < 3 (Detail) an elevation grid is necessary.

1. Open the menu **CGModeler > Edit Terrain**.
2. Select *Derive ElevationGrid* in the assistant and click at *Next*.
3. Select the grid width in both coordinate directions.
4. Choose the terrain model to be updated.
5. Click at `Start`. The elevation grid will be derived and stored together with the terrain model.

Merge, expand and convert to Elevation Grid is available only for the database version of the Modeler.

10. Export of Data

The following export formats are supported. For some of them not all meta data are stored. Only the export to the open XML format defined by UVM Systems stores all information, so that this format can be used for a complete data transfer.

Format	Geometry	Texture	Unit/Object/Element hierarchy + meta data
xml	●	●	●
gml	●	◐	◐
VRML	●	●	○
kml	◐	●	◐
DWG/DXF	●	○	○

As City**GRID**® is a Plug-in in Autodesk 3D Studio Max, the scene can additionally be saved as max-file (with geometry and texture) or the export supported by Autodesk can be used.

*Note: Keep in mind that default save and export functions of Autodesk 3D Studio Max disregard the coordinate offset values of City**GRID**® Modeler. We strongly recommend entering theses values in file name, to preserve the possibility of a combination with non coordinate-reduced data.*

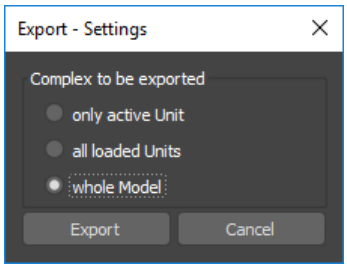
10.1. Exporting XML, DWG/DXF, CityGML and VRML

10.1.1. General export settings

The active Unit, an area (the loaded part of the Working Set), or a Model can be exported.

1. Define a Working Set (cf. 2.1)
2. Load the part/Unit to be exported (cf. 2.2)
3. Click at `Export` (cf. 1.7.1).

   Select the path, file name and file format in the file browser.
4. The Export Settings Window is opened in which the following parameters are given:



   - *Only active Unit*:

     exports the Unit currently selected in hierarchy window
   - *all loaded Units:*

     writes all the data that is currently in viewport of the Modeler to the export format. This also applies in particular to the clipped terrain, if in the export settings the corresponding option is set. In order to export the entire terrain model, deactivate the checkbox in the options menu of the modeler. (cf. 2.5)
   - *whole model*:

     exports all the data in the model, regardless of how much of it was loaded.

     Note: The options only active unit *and* all loaded Units *are only available if a Unit is active in hierarchy window.*
5. You can now set further export parameters in the format-specific export settings window
   - *LoD*:

     Specifies the generalization of the buildings to be exported. DETAIL (LoD 3) is the highest possible level, BLOCK (LoD 1) represents the lowest. (see Manual City**GRID**® Basics)

- *Historic version*:

  Specifies whether the export is to be performed for historic versions. If this option is selected then data corresponding to the specified time is exported from the database irrespective of whether the version corresponding to the specified export date is the most recent version or not.

- *Prefix Texture Files*:

  Sets the input string before the texture name of the exported texture images. If no value is specified, images will receive the images names allocated by the database.

  Note: The use of the prefix is necessary when using multiple databases, if exports are to be merged from these databases in another database (e. g. CityDB).

- *Bounding Box*:

  Optionally define a rectangular export region by specifying minimum/maximum X and Y values in the defined coordinate system of the data. Units partially covered by this bounding box will be exported too.

- *Export data:*
  - For *Units* just the primary data (lines), or also derived faces, eventually together with textures may be exported. Depending on the selected export format and the supported data types, the offered export options may differ.
  - *Terrain* faces, eventually with texture, may be exported too.
- *General settings*:
  - The *texture resolution* (in mm at the object) can be defined.
  - For DXF, in general different layers are generated for the different types of lines, e.g. all ridge lines of all Units are written to the same ridge layer. If *Unit → Layer* is selected, for each Unit a layer is created, in which all lines of the Unit (of any type) are written.
  - *Remove coplanar Faces* eliminates all congruent faces within a Unit. By doing so buildings with one large interior room are exported, regardless of the assembling of City**GRID**® complexes.
  - *Join Polygons* controls up to which canting adjacent polygons can be seen as planar and therefore be exported as a single surface. Tolerance indicates the distance of adjacent surface normal with length of one meter (unit vector) in meters. For small angle values it corresponds with the angle between the surface normal in radian measure.

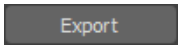
    Example: A value of 0,01 corresponds with an aberration of 1cm of a one-meter long surface normal and respectively an angel of 0,01 π. Converted to degree the value would be 1,8°.

- *Coordinates Reduction:*
  - *Origin of the local coordinate system* defines the zero-point of the used coordinate system for export. If the checkbox is activated, the input coordinate system is used, otherwise it will be replaced by the local coordinate system.

    Tip: By using these parameters VRML-files in particular can be transformed into a local coordinate system at the export, so that commercially available viewers can display them without any difficulties. VRMLs with country coordinates often have difficulty displaying regional coordinates because of the digit length.

    If using an alternative coordinate origin, it is recommended to add the offset value to the file name.

6. Click 

to start the process.

Note 1: When exporting texture a subfolder with the name „images“ is created in the directory of the export file, into which the texture images are exported. If this directory existed already, texture images are exported into the existing directory. The export file and this subfolder belong together! If the export file is copied/moved

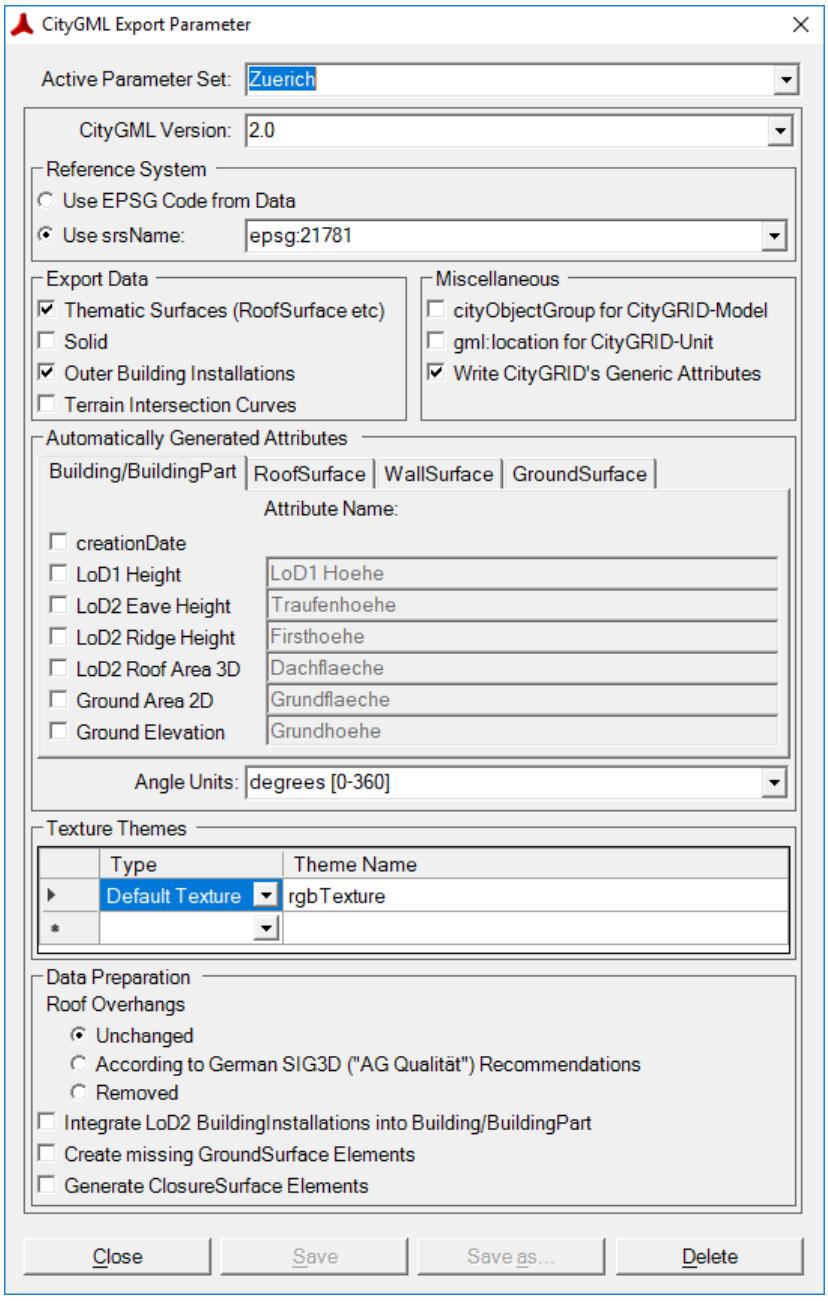
to another place, also the folder "images" must copied/moved with it, otherwise the textures won't be available any longer.

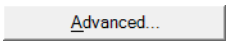
Note 2: If a terrain model is exported into VRML in a Level of Detail (LoD) smaller than 3, an elevation grid is needed. See section 6.15.3 for generating it.

Notes: You can only export historic states at model level. If you have checked the corresponding checkbox, only historic versions are exported at the specified time. All working versions are not considered, even if they are valid at the specified time.

10.1.2. Advanced CityGML export settings

As an interchange format for city model data CityGML offers over VRML and DXF a set of individual specifications during export. Parameters such as CityGML version, attribute integration to semantic transformations in the buildings to be exported can be defined in its own settings window.



In the export window for CityGML the button 

is available to open the window for the export parameters.

With each City**GRID**® installation a standard set of parameters is supplied, named DEFAULT. Changes to the default parameter set are not possible. Changes at the default export parameters must be saved to a new parameter set when you exit the window. In addition to the default set of parameters an arbitrary number of additional export settings can be stored.

*Note: All parameter sets are stored in the file citygmlexport.ini in the log directory of City**GRID**®. Please provide this file to UVM Systems when you need support with CityGML export.*

- *Active Parameter Set:*

  Invokes the saved export settings. After initial installation, only the default parameter set is available.
- *CityGML Version*:

  Defines which version of CityGML standards shall be written.
- *Reference System:*

  specifies the information about the underlying coordinate system of the dataset
  - *Use EPSG Code from Data*:

    accesses the stored EPSG code from model (cf. manual City**GRID**® Administrator). If no EPSG code was assigned srsName “unknown" will be written to CityGML file.
  - *Use srsName*:

    Provides the ability to specify an EPSG code directly. Set EPSG codes at model are ignored thereby. The allowable spellings are listed in the dropdown list. The "#" characters are to be replaced by the user.
- *Export Data*:

  regulates which geometry objects are written at export.
  - *Thematic Surfaces:*

    creates thematic surfaces of the CityGRID® elements for each building. (Roof to RoofSurface, facade to Wall Surface etc.)
  - *Solid*:

    combines all City**GRID**® Elements of one building to one Solid.
  - *Outer Building Installations*:

    exports City**GRID**® Detail Element Complexes.
  - *Terrain Intersection Curves*:

    writes the intersection curve of the buildings.

Note: To see the building data in CityGML export, either Thematic Surface or Solid has to be checked.

- *Miscellaneous:*

  groups parameters not assigned to groups explicitly.
  - *cityObjectGroup for CityGRID Model:*

    generates an independent CityObject group for every exported City**GRID**® Model
  - *gml:location for CityGRID Units:*

    writes a representative insert point of the Unit in CityGML file.
  - *Write CityGRIDs Generic Attributes*:

    exports all existing attributes from City**GRID**® data set.

*Note: Attributes for Models, Units, Objects, Element Complexes and Elements can be managed by City**GRID**®*

- *Automatically generated Attributes*

  offers the possibility of certain attributes of the geometry data to be deduced. The attributes are added to the specified complexes. All calculated values, with the exception of basic level (NN) are given in relative height of the building. The attribute name can be defined by the user. Attributes that do not appear useful for certain complexes are grayed out by default.

  - *Creation Date*:

    writes the current date when exporting to the CityGML file.

    Note: Creation date therefore relates to the creation time of the GML file and not the generation of the model itself.

  - *LoD1 Height*:

    calculates the mean of the highest and lowest point of the eave polygon.

  - *LoD2 Eave Height*:

    is the lowest point of the eave polygon.

    Note: If the parameter "Roof overhangs according to German SIG3D ("AG Quality") Recommendations" is set the lowest point of the upper facade polygon is used.

  - *LoD2 Ridge Height:*

    delivers the highest building point as an attribute value

  - *LoD2 Roof Area 3D*:

    delivers for each building or each Building Part the sum of the individual roof areas in square meters.

    *Note: The calculation uses each LoD2 area. Thus, an area is included under roof details when the surface form was not adjusted accordingly in City**GRID**® (extrusion type "Extrude to parent with holes", or on the penetration analysis, see manual City**GRID**® Modeler)*

  - *Ground area 2D*:

    indicates the constructed area of the building in square meters. If floor polygons are present, the area is calculated. Otherwise, the upper edge of the facade polygon serves as a reference. Possibly present courtyards are included in the calculation. If no upper facade line is available, any upward facing surface is used.

  - *Ground Elevation:*

    is the lowest point of the building at sea level (based on the used coordinate system).

  - *Steepness*:

    defines the slope angle for every polygon. This parameter is only useful at Roof Surfaces.

  - *Exposition*:

    indicates rotation of areas towards north direction. Positive values rotate from north through east to south, negative over west. Horizontal surfaces doesn't have set exposition values.

  - *Angle Units*:

    determines whether Steepness and Exposition are given in degrees (0-360) or grads (0-400)

    Advice: If generic attributes also have angle values, it is advisable to choose the same angle units for the automatically generated attributes.

- *Texture Themes*

  allows to determine which topics are written to the CityGML file. (cf. manual City**GRID**® Administrator)

  - *Type*

offers a choice between the standard color, standard texture and any other texture themes. Standard colors are the set City**GRID**® surface colors (*see* Manual City**GRID**® Modeler), standard texture all previously applied textures and Named Theme is a user defined texture theme (e.g. solar potential)

Note: At option standard texture standard colors will be used, for untextured areas.

*Note: Named Texture Themes are currently not supported by City**GRID**®.*

- *Theme Name*

  specifies the texture theme that was given during automatic texturing. (cf. manual City**GRID**® Administrator)

Data Preparation

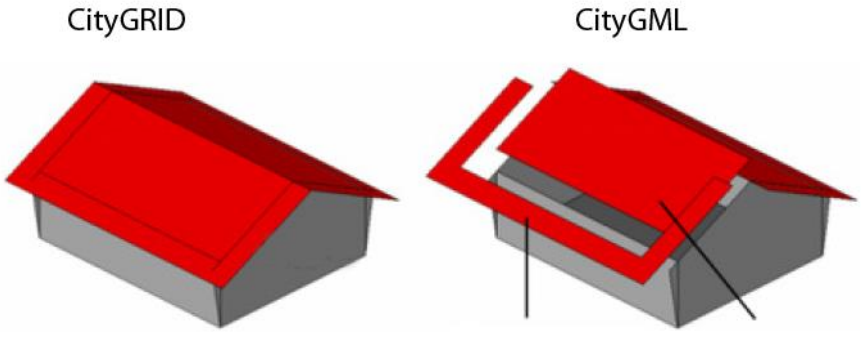
offers the possibility models to influence geometry or semantics of the building, before they pass through the CityGML Export.

*Note: Each option of data preprocessing modifies the geometry of the building during the export process, which on the one hand leads to the result being (significantly) different from the City**GRID**® dataset and on the other hand increasing the susceptibility to geometrical errors that can arise from fully automatic processing. The options should therefore be activated only when needed.*

- *Roof overhangs*
  - *Unchanged*

    leaves the roof overhang analogous to the situation in City**GRID**®. The roof areas remain geometrically identical to the original data set (possibly grouped together as coplanar polygons, if the corresponding general export option has been set, see 10.1.1). The roof overhang element of the City**GRID**® dataset, however, remains unconsidered because there is no equivalent in the CityGML data model.
  - *according to German SIG ("AG Qualität"):*

    Recommendations modifies existing roof overhangs such that they are becoming independent BuildingParts. City**GRID**® roof overhang elements are dissolved and areas facing towards ground are. Building roof is trimmed to intersection of upper facade polygon and roof faces. The roof overhang fits directly to the so-formed roof element, but forms an independent structure.



Roof with roof overhang Roof overhang Roof Surface

  - *Removed*

    Modifies existing roof surfaces such that only those parts of the roof are preserved, which can lie within the facade polygons. Roof surfaces and façade surfaces are flush with each other.

- *Integrate LoD2 BuildingInstallations into Building/BuildingPart:*

checks all Detail Element Complexes for their set LoD. At LoD2 City**GRID**® roof details are converted to individual CityGML Building Parts and crops roof faces underneath the roof details and modifies building semantics accordingly. Thus in CityGML former roof details will appear as part of the main roof.

- *Create missing GroundSurface-Elements:*

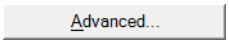
  City**GRID**® complexes typically have no floor surface when the facades are extruded to the terrain model. But if floor surfaces (Ground Surfaces) are desired they can be generated during export via this parameter.

- *Generate ClosureSurface Elements:*

  In coplanar surfaces CityGML provides the opportunity to introduce so-called closure surfaces. The coplanar surfaces are dissolved out of the thematic surfaces and stored as separate objects. If necessary, they can be displayed or deliberately omitted. By Closure Surfaces internal surfaces can identified and building with maximum interior room can be produced.

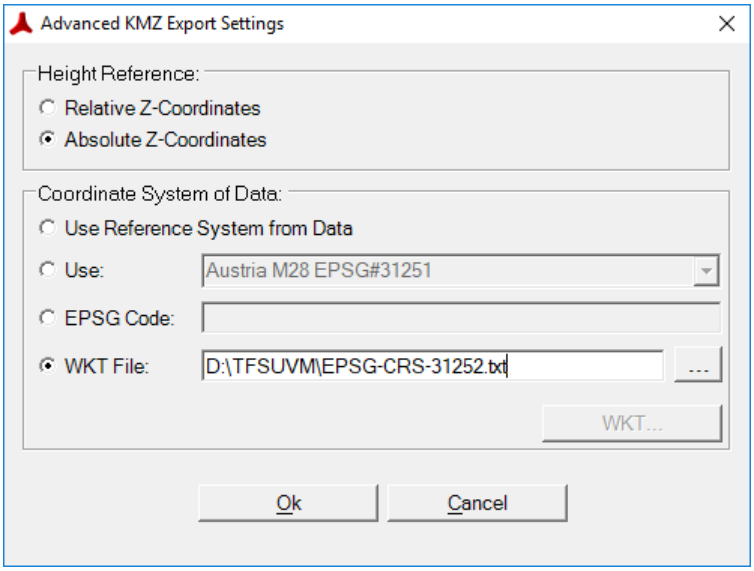
If parameters are changed, al modifications must be stored to active parameter set (button Save) or a new parameter set has to be created (button Save As). During export the most recent parameter set is used. It does not matter whether you exported from City**GRID**® Administrator or Modeler.

10.2. Advanced KMZ export settings

In KMZ export window the button 

is available to open the window for the export parameters. The height reference, as well as the underlying coordinate system of the dataset can be defined therein.

1. Run steps 1 to 5 from section 10.1
2. Open Advanced settings



- *Height Reference:*

  defines placement of Units on Google Earth terrain model.

  - *Relative Z-Coordinates:*

    Places the units via a central insertion point at the Google Earth terrain model. This will ensure that the building does not float above the ground. However, the height accuracy can‘t be guaranteed then.

  - *Absolute Z-Coordinates:*

    Uses the existing height values of the Unit in order to convert it into the coordinate system of Google Earth. Thus, the buildings retain their actual 3D position and altitude accuracy. If the generalized terrain model from Google Earth deviates too much from the used CityGRID® model, there is a risk that units float, or plunge into the terrain.

- *Coordinate System of Data*

  determines which coordinate system is used for translation into geographic coordinate system of Google Earth

  - *Use Reference System from Data:*

    Uses the information of the coordinate system of the model (c.f. **Fehler! Verweisquelle konnte nicht gefunden werden.**). If a model coordinate system not set, this method can't be applied.

  - *Use:*

    provides a list of currently implemented coordinate systems, from which a suitable system should be chosen.

  - *EPSG Code:*

    Allows you to enter a valid EPSG code (http://www.epsg-registry.org/) to define the coordinate system. As input only, the code number is expected.

  - *WKT File:*

    Provides the ability to make a coordinate system via a Well Known Text (WKT) file available. The structure of the WKT file can be obtained by selecting a predefined coordinate system (see *Use*).

Note: With the WKT file you can define any coordinate system, regardless of whether there is a valid EPSG code or not. In particular, local offset values can be considered this way.

Note: Buildings are placed in Google earth based on their bounding box. From this box one point is selected and calculated on the ground. If you alter the height of the Google Earth Terrain by adjusting the height multiplication, the buildings position will be readjusted automatically, based on the selected point. As a consequence of this some buildings might lie partially under the terrain or fly over it depending how strong and inhomogeneous the terrain changed around the reference point.

3. Press Export to start the process.

Note: You can only export historic states at model level. If you have checked the corresponding checkbox, only historic versions are exported at the specified time. All working versions remain unconsidered, even if they are valid at the specified time.

Note: During the export, a kml file and a folder named "link" are created under the specified filename to which every exported Unit is saved as a kmz file. If several Google Earth exports are written to the same destination folder, a separate kml file is created for each export, but the "link" folder is used as the common save folder.

11. Error Reporting

The City**GRID**® software is developed, tested and used internally by UVM Systems, and strive for an error-free product. Nevertheless we cannot guarantee that errors will not occur while your work with it.

The data base concept and the version management however ensure that data cannot be lost. Should, due to software error, the edited version become corrupt, there is always the last stable version stored, in which nothing has changed. In important cases corrupt versions can usually still be repaired if the error is found.

Through experience we are aware that the following errors may occur:

1. Autodesk 3D Studio Max crashes without prior warning/message: The reasons for such fatal errors are usually problems of 3DS itself and are beyond our control.
2. If you get a City**GRID**® Error messages it is typically because of corrupt data. Usually, continuing to work is possible.
3. Script-Errors: The reasons for these are often mistakes in operating with the software. In most cases continuing working is possible. If further problems occur, we recommend exiting the Plug-in City**GRID**® and starting it again.

If you want to send an error report, please enclose the following information/data:

1. Verbal description of the actions which produced the error

   Log file: You can find the protocol in your profile under: \Application Data\CityGRID\CityGRID.log or. Administrator.log. Find the log files also in the specified place if you've set the Log Path in Settings menu of City**GRID**® Administrator

Note: Please backup this file immediately after a crash, because the renewed starting of the software may cause the file to be overwritten.

Advice: In Modeler, the directory of the log file can be opened using the menu „CGModeler – Logging".

For bugs in Modeler:

1. Export the data to xml (cf. 10)
2. Export the data to "City**GRID** ASC Scene Export" (analogously to xml-Export)

If the bug can be reproduced in the Modeler, we ask you for the additional information:

1. Re create all actions to the point before the error occurs
2. Switch on *Use Comprehensive Logging* via the menu *CGModeler – Logging* (note: this slows down the software significantly)
3. Execute the action which produced the error.
4. Save the log file (cf. step 2 above)
5. Switch off again the comprehensive logging command

Please send error reports to support@uvmsystems.com

12. Contact

UVM Systems GmbH

www.citygrid.at

www.uvmsystems.com