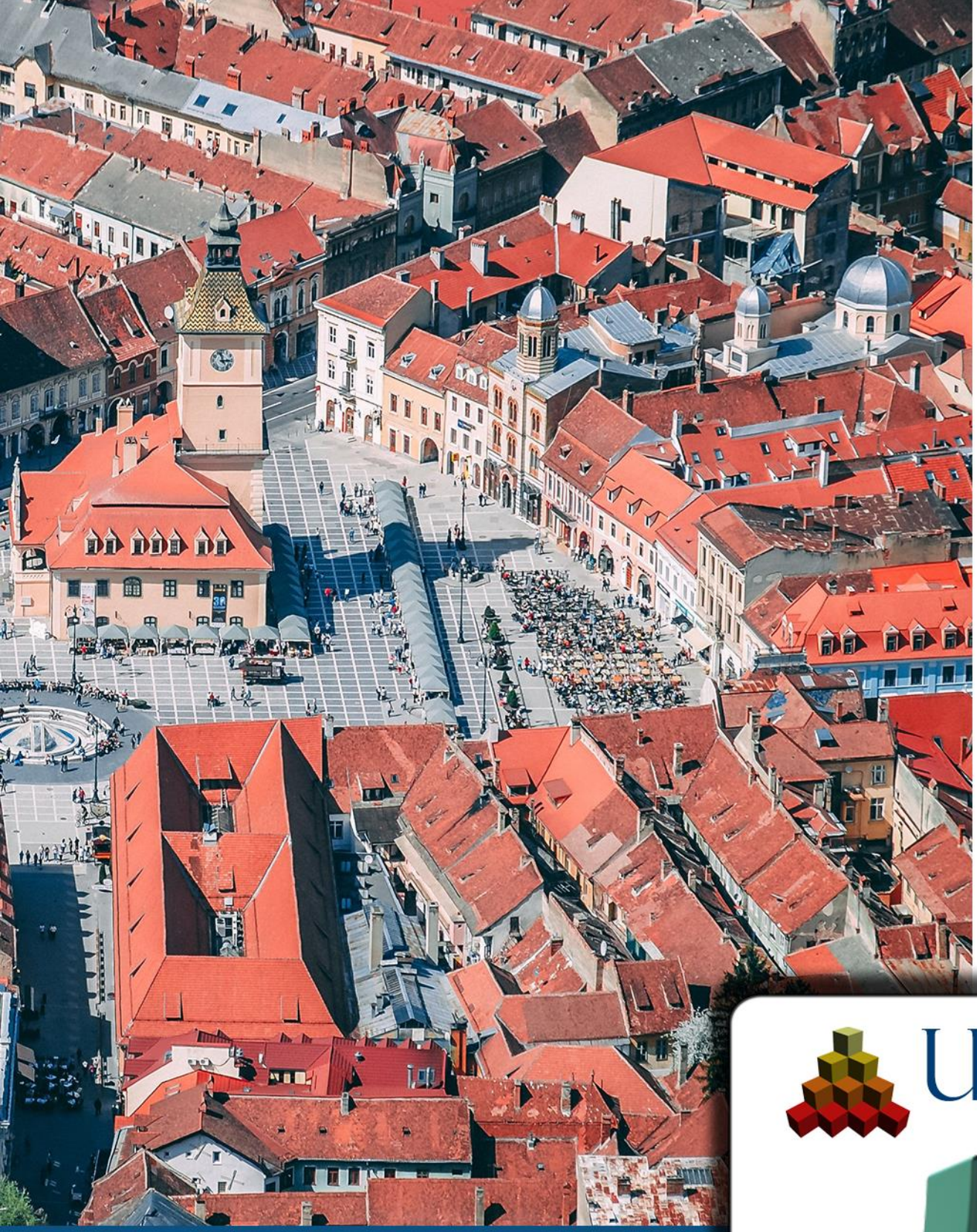


URBAN VISUALISATION & MANAGEMENT GMBH

UVM SYSTEMS

CityGRID® Shaper MANUAL

CityGRID® 2025

contents

Cover picture: Brasov, Romania, Dan Novac, Pixabay

1. City**GRID**® Shaper Basics

Shaper is a stand-alone module of the City**GRID**® Software Suite. With the corresponding data sets, building models can be created semi-automatically from LiDAR or matched pointclouds.

1.1. System requirements

A 3D workstation is recommended for operating the CityGRID Shaper. For exact recommendations see *Manual Basics, Chapter 3.1 System requirements (p. 6)*.

1.2. Geometry concept

Planes are automatically extracted from the pointclouds, whose area of validity is approximately limited with a polygon (alphashape). The intersection of two alphashapes generates an intersection line at a building edge, which is used for the building preview (Smart Preview).

To generate a valid intersection line, two conditions must be met: The two alphashapes involved in the intersection line must be clearly to the left and right of the intersection line respectively, and the two alphashapes must be sufficiently close to each other. The user has no influence on this, the quality of the pointcloud is decisive for this.

If only one of the two requirements is met, an invalid intersection line is created, which is not displayed by default. Under certain circumstances, however, it can be helpful to display these invalid lines. More on this in chapter 2.3.3.3.

A section line can have different states which can be influenced by the user. The intersection of a plane (not its alphashapes) with the base plane creates the baselines, whose state depends on the state of the intersection. Through user interaction, a building preview can be created with the intersection lines and the baselines. When this preview is accepted, possibly edited, and finally saved, the building is saved to a City**GRID**®.xml.

There are four geometry classes in Shaper, which can be in different states:

a) Point geometry:

- Pointcloud points:

Status	**User interaction**
Assigned to a plane	Show/Hide
Not assigned to a plane	Show/Hide
Coloured depending on the assigned plane	Show/Hide

- Vertices:

Are always part of a line, an alphashape or an outline and therefore have the state of their parent geometry. They can only be changed in the accepted state of the parent geometry.

Parent geometry	**User interaction**
Line	Move end vertices or centre point in position
Alphashape	Move, add or delete vertices
Outline	Move, add or delete vertices

b) Line geometry: Shaper uses intersection lines and baselines.

- Intersection lines

Status	**Description**	**User interaction**
Invalid (not displayed)	Intersection lines that have not achieved candidate status because not all requirements have been met.	Are hidden by default but can be shown in certain situations.
Candidate (Red)	Status of a valid intersection line before user interaction.	
Used (Blue)	Intersection line *used* for Smart Preview	***Mouse Hover*** over a line in candidate status changes status to *Used*; building preview is created.
Accepted (Green)	An intersection line *accepted* by user interaction, the preview of this line was accepted, however, in interaction with other candidates, the preview is still dynamically adjustable.	With a **Left mouse click** on the *Used* intersection line, the status changes to *Accepted*.
Completed (Black)	An intersection line *completed* by user interaction. The preview of this intersection line is fixed and can no	Command **Accept Building** or **Finish Building Part**. The intersection lines of these

	longer be changed by other intersection line candidates.	buildings are excluded from further preview.
Deactivated (Grey)	*Deactivated* intersection lines are lines in *candidate* status that are deliberately excluded from the Smart Preview by user interaction. They are no longer used for dynamic face generation.	***'T'*** to deactivate or reactivate intersection lines.
Set aside (Magenta)	Lines in *candidate* status are *put aside* if one of the involved planes has too few points through user interaction to form a valid plane and thus an intersection line with another plane cannot be valid either.	Only lines in *candidate* status are *set aside* if the user filters the pointcloud so strongly with the data filter that some planes have no or too few points. The affected planes are hidden, the associated candidate lines are *set aside*.

- Base lines:

The status of baselines depends exclusively on the status of the originating intersection lines.

Status	**User interaction**
Used (Blue)	Baselines are *used* when the associated intersection line is *used*.
Accepted (Green)	Baselines are *accepted* if the associated intersection line is *accepted*.
Finished/Invalid baselines	Are not displayed

c) Polygon geometry: planes can have two types of polygons.

- ***Alphashape***: is the automatically found boundary of a plane that is only approximated and often too small. If an intersection line between two planes is accepted, these planes get an outline in addition to the alpha shape. An outline can also be drawn in a flat roof situation where there are no plane intersections.
  Editing an alpha shape (adding, deleting, or moving a vertex) has a direct influence on the resulting intersection lines and thus an indirect influence on the face generation.
- ***Outline***: is the user-edited or -created boundary that can delimit the plane more precisely. The extent of the outline determines the face generation. The vertices of an outline cannot be edited if they are on the border of another plane and editing them would change the intersection (ridge) between the planes.
  Editing outlines (adding, moving, or deleting vertices) has a direct influence on face generation.

Note: Editing an outline should not be followed by any more work with the alphashapes concerned or the associated intersection lines, as a user interaction on the outline takes precedence over that of the alphashape.

d) Faces: No status, are derived from accepted lines or outlines

Editable Geometries:

Not all of the geometry classes mentioned can be edited.

a) ***Vertices:***
can be moved, added or deleted depending on their parent geometry.

b) ***Lines***:
- ***Intersection Lines***: Can be modified in length.
- ***Baselines***: Can be moved in the plane.

c) ***Alphashapes***:
Can be changed in their extension by changing their vertices and thus also change the intersection lines.

d) ***Outlines:***
Can be changed in their extension by changing their vertices and thus change the face generation. Not all vertices of an outline can always be changed. The outlines of two planes that are adjacent to each other cannot be changed at the points of contact, as this would result in a change of the intersection line.

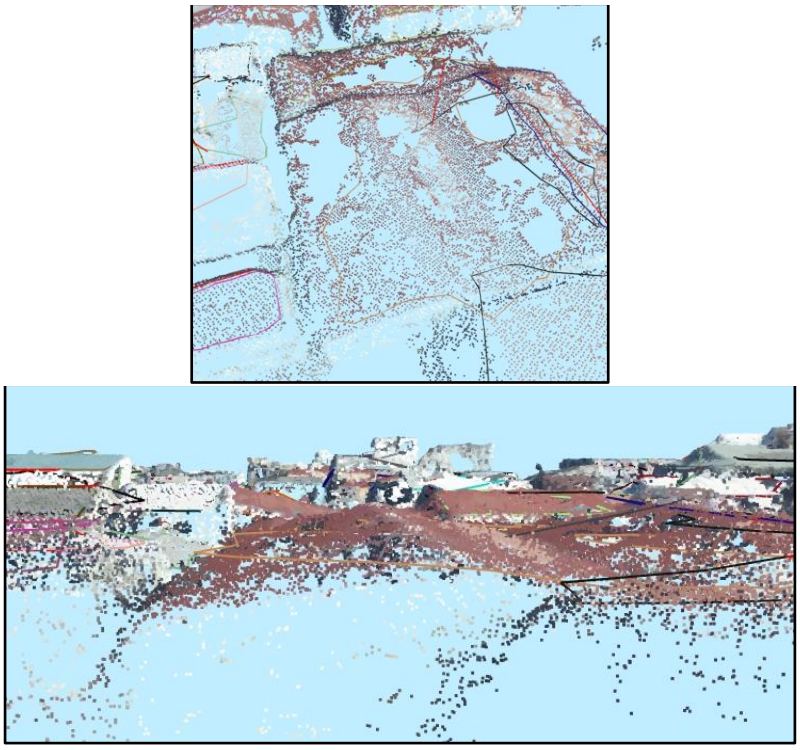
1.3. Data basics

To create City**GRID**® Shaper projects, a Lidar pointcloud dataset or a matched pointcloud dataset in .las or .laz format is required. The best results can be achieved with a classified LiDAR pointcloud. However, if no classification is available, point clouds that have been reduced to the buildings using external - spatial - filtering methods can also be used.
Data quality: A minimum requirement for the data quality of a las point cloud is assumed. Since Shaper assigns points to planes and extracts their boundaries, points must be assignable to planes. **Very noisy point clouds from poorly matched images are unsuitable for plane extraction for understandable reasons**.

Tips for matched pointclouds:

- ***Good image orientation*** with accurate control points is essential for a Shaper pointcloud. A good orientation minimizes scatter points and prevents so-called "double shell effects", which can cause overlapping planes at different heights.
- Furthermore, the ***thinning*** of a matched pointcloud is crucial. A point count of 20-25 points per m^2 should not be exceeded (20-25 cm point spacing).

An example of an unsuitable point cloud: The points are poorly distributed and scatter strongly. The planes calculated with very tolerant settings do not represent the planes in reality.



Note: A denser pointcloud is not always a better pointcloud. Shaper needs a minimum number of about 10 points per m² if these points are sufficiently well distributed. With a very dense matched point cloud, plane extraction is sometimes much more difficult than with a less dense LiDAR point cloud due to scatter points.

Excessive points from terrain, vegetation or other "non-buildings" sometimes affect performance and should be removed before a project is created. In addition, these points can interfere with automatic plane detection and create superfluous or even incorrect planes.
During project creation, a classified point cloud can be analysed regarding its classes and unnecessary classes can be excluded.

Note: Know your data! The point cloud analysis shows the existing classes in the point cloud and an interpretation of the classes according to the ASPRS recommendation. However, the user must verify whether the classes are actually the recommended classes (6...buildings). Sometimes, if the classification is inadequate, the desired points can be found in several classes. In this case, all affected classes can be used.

If no classes are specified, all points in the point cloud are used for plane extraction. However, this is only recommended if the points have already been reduced/thinned or similar beforehand.

To enable productive work, a pointcloud must have at least intensity values, ideally RGB values. If neither is available, the pointcloud can be coloured via a corresponding orthophoto in .tiff or .jpg format during project creation.

Since navigating in the pointcloud alone sometimes causes difficulties, the additional usage of aerial images is recommended. The aerial images (oblique and/or Nadir) must have orientation values that are transferred in advance into a City**GRID**® XML format using an FME workspace and are processed during project creation.

1.4. Start Modul CityGRID® Shaper

The City**GRID**® Shaper is started via the Windows start menu entry.

1.5. Setting the language

Depending on which language is active, the menu item ***Spracheinstellungen*** or ***Localisation*** appears in the Help menu. Select the desired language of the user interface and restart the application.

1.6. Logging

In the event of an unforeseen programme action or a programme crash, it may be necessary to send the log file to UVM Systems GmbH. **Extended logging** can be activated via the menu item **Feedback**. Via the menu item **Send feedback**, the necessary log files are packed together and attached to an email in an installed email client to be sent by the user to the support. Extended logging takes more time and should therefore only be used after consultation with UVM Systems GmbH.

1.7. Data preparation

1.7.1. Pointclouds

- Checking data quality with third-party software (e.g. ***FME)***
- For classified point clouds: check the class assignment (identify building points) (with third-party software e.g. ***FME***)
- For matched point clouds: Reduction of the point density (depending on the point distribution) Point spacing approx. 20-30 cm, 25 points/m2 (with third-party software)
- Elimination of terrain and vegetation points (with third-party software)
- Checking the extent (CRS) and compliance with the CRS of other datasets used (aerial photographs, orthophotos, shp files, etc.)
- If the CRS of the different data sets do not match, reproject LAS data. (with third-party software e.g. ***FME)***

Note: It is easier to project the point clouds into the CRS of the aerial images than vice versa.

1.7.2. Orthophotos (for Colouring the Pointcloud)

- Check that the spatial reference systems between orthophotos and point clouds match. If necessary, reproject the point clouds (with third-party software e.g. **FME**)

- With Geotiff: Convert to Tiff with world-file (up to version 19) (with third-party software e.g. ***FME)***

1.7.3. Perspective aerial photographs (2D window and roof texture)

- Check and, if necessary, edit the orientation file (InPho prj, ContextCapture xml or IO/EO userdefined txt) (using third-party software, e.g. ***Notepad++)***
- Checking the correspondence of the spatial reference systems between aerial images and point clouds. If necessary, reproject the point clouds. (with third-party software z.B. ***FME)***
- Recommended: Convert to jpg and remove excess channels at the same time (Shaper only processes RGB images correctly). Recommended with ***IrfanView***, Batch processing is also possible here.
- Start the CityGRID Orientation Tool and convert the orientation file into a CityGRID xml file (see Manual Image Orientation Tool).

1.7.4. Boundary (shp, optional for large data sets)

- Creating a street-level polygon that limits the project area. One polygon per Shp file for a Shaper region project. The data (point clouds, aerial images, etc.) are spatially filtered according to overlap with this polygon and only those that lie within or are intersected are used. (with third-party software e.g. ***QGIS)***

1.7.5. Existing city model data (optional, recommended for updates; CityGRID XML)

- Convert existing buildings to CityGRID XML with the ***FME Workspace X2CGSurface.fme (available at UVM Systems)***

1.7.6. Terrain data (optional, CityGRID XML)

- Convert terrain model to CityGRID XML, with the ***FME Workspace Konversion DTM.fme ((available at UVM Systems)***

1.7.7. Building footprints (optional, SHP)

- External quality control of the building footprints (topological error correction, etc.)
- Unique ID attribute must be present.

1.8. Tips for easier editing

Larger areas (entire cities/municipalities) should be divided into smaller, manageable regions for project creation. On the one hand, this speeds up project creation and, on the other, facilitates subsequent processing.

For more complicated roofs, it is advisable to first obtain an overview of the situation. This initial overview is possible in the point cloud, but it is also strongly recommended to work with aerial images. With a quickly triggered SmartPreview, you can zoom in on a suitable aerial image to better assess the building. Once you have gained a better understanding of the basic roof shape in this way, you should discard the first SmartPreview **(Ctrl + Z)** and then start the actual editing. In the first step (before the SmartPreview is triggered again), the intersection lines in line mode should already be adjusted as precisely as possible to the shape of the roof.

If required, missing alphashapes can be created and edited at this stage and their cutting lines can be adjusted in length. After the corresponding preparation, the actual Smart Preview should be triggered.

Tip:

The user interaction has priority over the SmartPreview. This means that a line set by the user is not overwritten/lengthened/shortened by the SmartPreview. In the case of complicated roofs or situations in which the SmartPreview does not deliver the desired result, the algorithm can be helped by setting the section lines as desired.

For more complicated roofs, you should work as small as possible and always use the **`Finish building part`** function if a closed roof can be created. With the area creation options of CityGRID (penetration resolution), the behaviour of building parts in relation to each other (including roof details) can be set during export.

If an intersection line is displayed but does not create any faces when the SmartPreview is triggered, it may be because the alphashapes involved overlap so much that the line is declared invalid. In this case, it can help to edit one or both alphashapes involved so that the overlaps are minimized.

1.9. FAQ

- *What do I have to do before I can create a project?*
  Data preparation is key:
  1. checking (and if necessary adjusting/reprojecting) the spatial reference systems of images, point clouds, optional data (footprints, terrain model) with FME. Make sure all the data uses the same CRS!

  2. converting orthophoto Geotiff to tif with world file (FME) (currently sometimes still necessary, in future Geotiff should no longer be a problem)

  3. checking the aerial images (nadir and oblique). Nadir images sometimes have 4 bands (RGBA or RGBI). Batch conversion of all images (nadir and oblique) to RGB jpg. This eliminates additional bands and ignores potentially unreadable tiff definitions for CityGRID. (Built-in function for Irfanview)

4. analyse the pointcloud data
    a. on which class are the buildings if the data **is classified**? FME Inspector or Workbench for more detailed analysis).
    b. Reduce the pointcloud if **not classified** by
        i. Classifying with 3rd party software (i.e. Pointcloud technologies)
        ii. Removing terrain and vegetation points (with an infrared band in the imagery you will be able to classify vegetation more confidently)
        iii. Filter the pointcloud. Ideally the points are equally distributed 20-30 points per $m^{2.}$ Consider smaller planes and details
        iv. Use buffered building footprints to only use the building points
        v. Reduce the size of the pointcloud by using a smaller region polygon

5. optional: creation of a region shpfile based on the building footprints. Polygons along streets (QGIS or ArcGIS). Create one shp file per polygon with FME Fanout by RegionID. Consider the sensible size of projects.

6. optional: Split footprint data by region (SpatialFilter FME Workbench), footprint regions-files.

7. optional: convert terrain model to CityGRID xml and split by region (FME Workspace, ask for at UVM Systems)

8. convert the orientation file of the aerial images (.prj, .xml, .txt) to CityGRID XML with the CityGRID Orientation Tool

9. start wizard, one project for each region

10. note: Optional data can also be added to the project later (DTM and footprints)

- *What kind of pointcloud data can I use?*
  Ideally the building class of a classified LiDAR pointcloud. If this is not possible, because your pointcloud is the result of image matching adjust the pointcloud (and your expectations).
    - Reduce the size of your project area
    - Consider classifying with 3rd party software (i.e. Pointcloud technologies)
    - Remove terrain and vegetation points (with an infrared band in the imagery you will be able to classify vegetation more confidently)
    - Filter the pointcloud. Ideally the points are equally distributed 20-30 points per $m^{2.}$ Consider smaller planes and details
    - Use buffered building footprints to only use the building points

Editing:

- *Can I add Intersection lines manually?*
  Intersection lines are the result of intersecting planes (alphashapes). Baselines are the results of the intersection between alphashapes and baseplane. If you need an intersection line, where there currently is none, you can add new alphashapes or edit existing alphashapes so they create valid intersection lines.
- *How can I bend an intersection line?*

Intersection lines are created by the intersecting planes and obey strict criteria. You can adjust their length by moving their end vertices or editing the involved alphashapes.

- *How to change the angle of an intersection line?*
  Intersection lines are created by the intersecting planes and obey strict criteria. You can adjust their length by moving their end vertices or editing the involved alphashapes.
- *How to shorten/divide an intersection line?*
  To shorten an intersection line it's end vertices can be moved along it's vector and thus adjusted in length.
- *How can you add alphashapes?*
  In alpha shape mode with Ctrl, Shift or Shift and mouse wheel (see info box in the respective tool). Tip: Deactivate assigned points so that only points that are not yet assigned to a plane are displayed. This allows the alphashape to be defined more precisely.
- *How can you divide Alphashapes?*
  In alphashape mode. Select an alphashape to activate the corresponding buttons.
- *Can alphashapes be combined/merged?*
  Yes, see answer above.
- *How to raise or lower the position of alphashapes?*
  Alphashapes are defined and locked by the position of their plane. Only their extent can be changed by moving, adding or deleting vertices.
- *Alphashapes are correct, but there are still no intersections lines. How can I fix this?*
  Via the intersection line processing parameters *buffer width* and *overlaps*. Changing these parameters controls how many intersection lines are displayed.
  - Buffer width: What is the maximum distance between alpha shapes in order to generate a valid intersection line? Increasing the value increases the tolerance.
  - Overlaps: What is the maximum percentage of alphashapes that may overlap to generate valid intersection lines? Increasing the value increases the tolerance. Tip: Geometrically correcting overlaps by editing the alphashapes is usually the more precise method of resolving ambiguous situations.
- *When do I use the base plane editing mode?*
  In principle, the Baseplane is automatically set by the lowest point of the alphashapes involved in an active Smart Preview. The Baseplane controls how high the baselines are set. With the Baseplane editing mode, a base plane can be set manually, either at any point or through the lowest point of any plane. However, the automatically set base plane is correct for 99% of situations, so it is currently hardly necessary to set it manually. In the future, however, there may be more functions in this mode.

2. The User Interface

After starting Shaper, an initially empty user interface appears. To be able to see the full scope of Shaper, either an existing project must be loaded (via menu ***File > Open***) or a new shaper project must be created (menu ***File > New***).

Toolbar

Switching the workspace, switching the editing modes, controlling the visibilities

Menu CGShaper

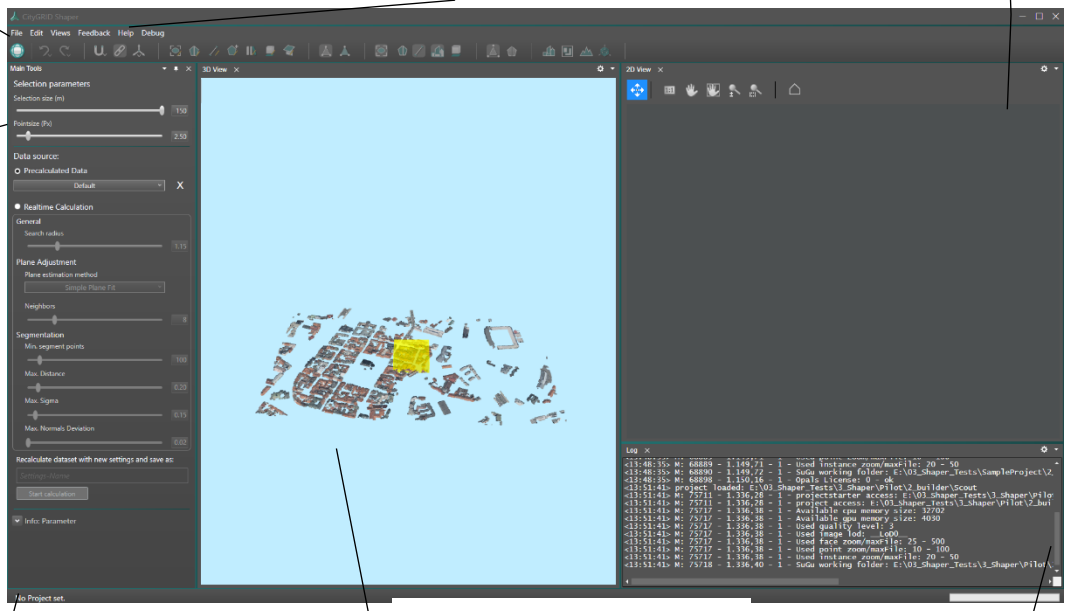
Here you will find general functions

2D Window

Aerial photos with line representation of the active building as a modelling aid

Main window

Main tools depending on the set workspace and editing mode



3D-Window

Display of the pointcloud and the derived geometries (lines, alphashapes and surfaces).

Status bar

If necessary, instructions to the user

Logwindow

Process monitoring

The main window contains the central control mechanisms for the following tasks:

- Setting the data source and potentially recalculating pre-calculated data
- Parameters that change depending on the mode set
- Building creation

2.1. Menu

2.1.1. File

New

Expects the specification of a project folder in which all data created subsequently will be saved. After specifying the project folder, the "Create Shaper Data" dialogue opens, which guides you through the creation of the project. (Chapter 4.1)

Open

Opens an already created shaper project.

Recently opened projects

Shows a list of recently opened projects.

Export

Exports all completed buildings of a project to a City**GRID**® XML file whose location must be specified. Any external data (such as building footprints and DTMs) are also saved in this file.

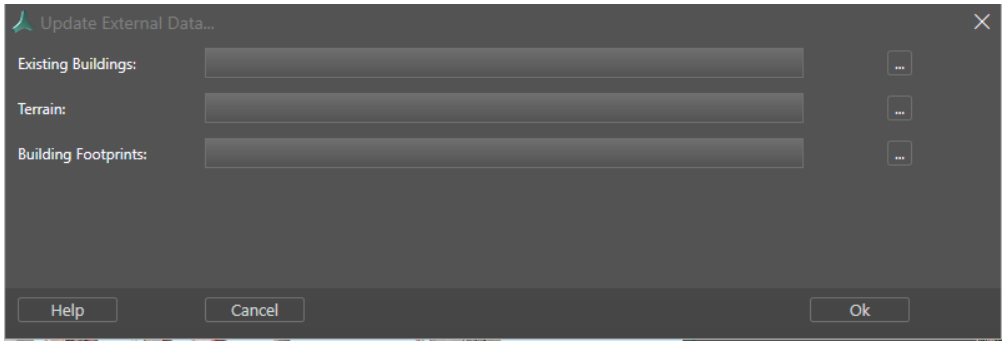
Exit

Exits Shaper.

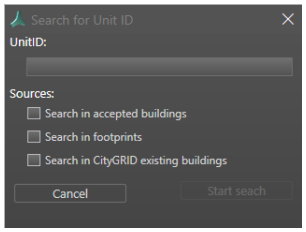
2.1.2. Edit

Optional Data

Opens the dialogue for updating or adding external data (already when creating the shaper project, external data can be added to the project, building footprints, terrain and/or existing city models).



Search



Enables the search for a shaper building, a building from an integrated existing city model or for an integrated building footprint. A string is expected as the search term.

Create Building Attributes

If this option is set, an attribute dialogue is opened when finishing/saving a building, which allows several predefined attributes. These are saved as City**GRID**® unit attributes in the adopted building. This option is inactive, only available if only optional attributes have been defined. If a mandatory attribute has been defined, the dialogue cannot be suppressed.

Edit Attribute Definition

In this dialogue, either attribute definitions that were prepared during project creation can be edited, or new ones can be created.

Note: If buildings have already been saved with an existing attribute definition, a new definition does not change the existing attributes. Even if buildings have been saved without attributes, creating an attribute definition in the editing process will not add attributes to already saved buildings. The attributes created or changed only apply to those buildings that are saved AFTER the definition.

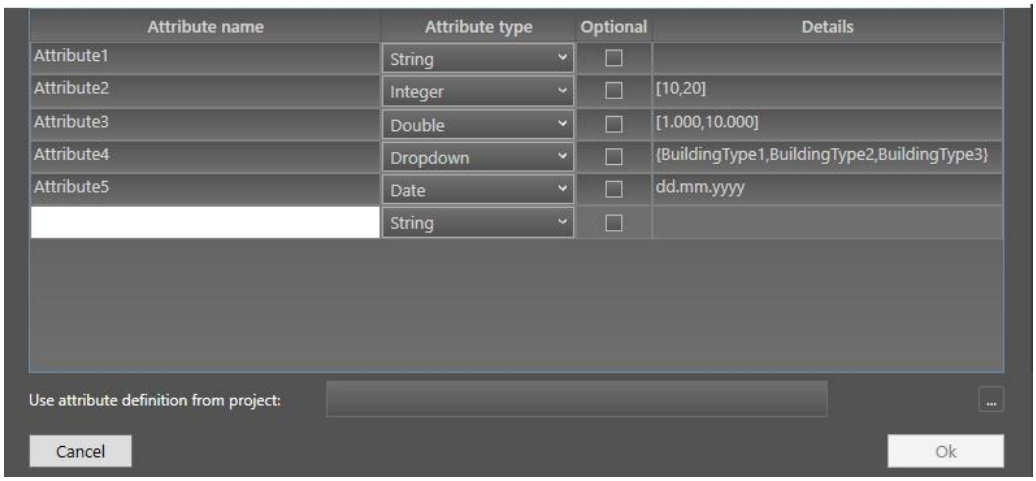


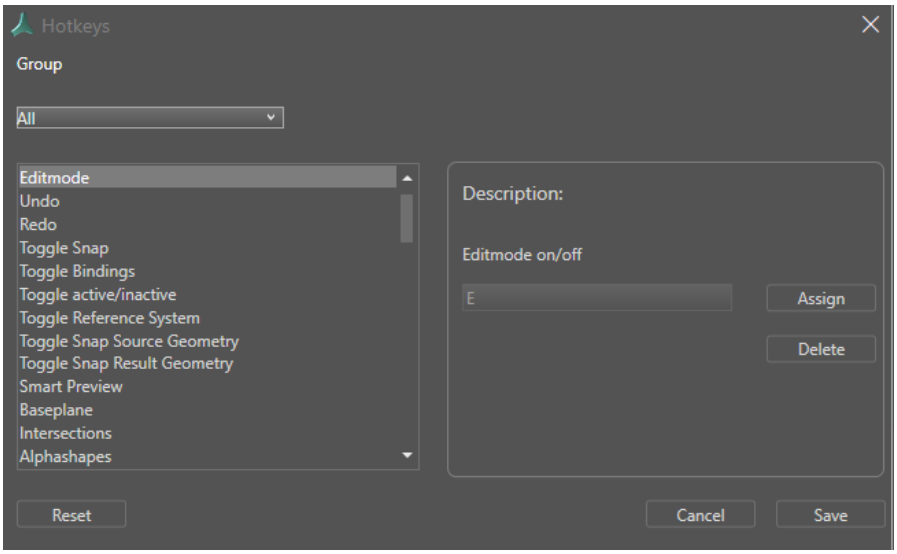
Image Orientation Tool

This option is used to start the image orientation tool from Shaper. For details on how it works, see the Image Orientation Tool manual.

Edit Hotkey Settings

A dialogue opens in which the default settings for hotkeys can be changed and reassigned. Hotkeys are preset for a number of actions of the City**GRID**® Shaper. However, these can be changed via the menu **`Edit > Edit hotkey settings`**. Here the existing hotkeys can be displayed sorted by groups. When selecting a command in the hotkey list, the existing hotkey is displayed. Press **`Assign`** and press a new hotkey combination (*Alt* cannot be used because *Alt* is already reserved for menu entries). If a key

combination is assigned more than once, a warning appears in the lower window, but it is still permissible. A key combination can be removed via the **Remove** button. **Reset** resets to the default settings. **Save** saves the defined hotkeys.



Options

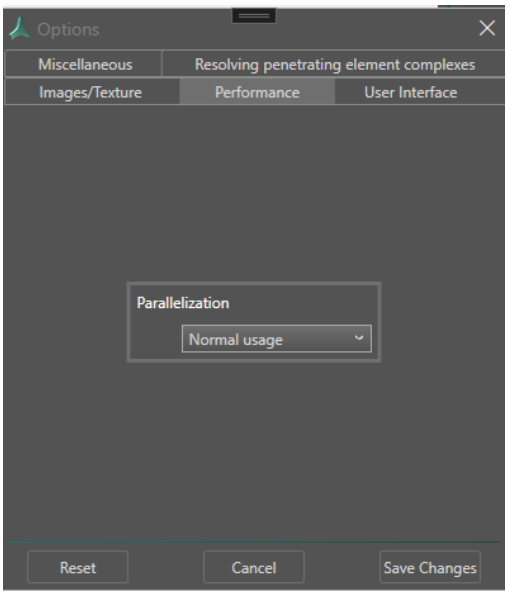
Performance:

❖ Parallelization

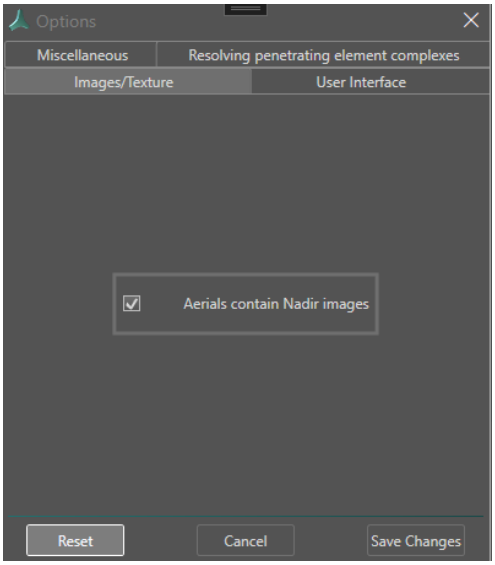
Depending on the available computer resources, a speed-up setting for project creation and real-time calculation can be made here.

- Deactivated: No acceleration is performed. The operations are performed one after the other. The computing time is very long, the proneness to errors is very low.
- Low utilization: Low acceleration is applied. Tasks are distributed across 1 to 2 CPU cores. The calculation time is high, the susceptibility to errors is low.
- Normal usage (default): Moderate acceleration is applied. Tasks are distributed over half of the available CPU cores. Computing time is moderate, error rate increases.
- High performance: High acceleration is achieved. The tasks are distributed across all available CPU cores. The calculation time is significantly reduced, the susceptibility to errors is increased.

Tip: The "High performance" setting is generally not recommended for weaker computers or computers that run other computing-intensive applications in addition to Shaper. In the event of error messages or crashes of the Shaper with high performance, restart the project creation and reduce the acceleration or deactivate it completely,



Images /Texture:

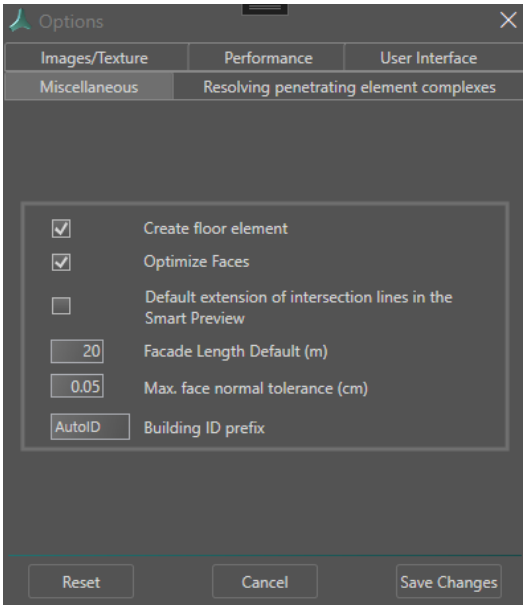


- **Aerials contain Nadir Images:**

  This option is et by default. Shaper generally uses nadir images for roof texturing if they exist. If no nadir images are available, wrong texturing may occur if Shaper does not receive the

information with this option that it should texture with oblique images. If the aerial images used consist only of oblique images, this option must be deactivated.

Miscellaneous:



- **Create floor element:**
  If this option is set a floor element is automatically created at the intersection between façade and terrain when the building is saved.

- **Optimize Faces:**
  Controls whether the faces are optimized during the saving of the building. Recommended.

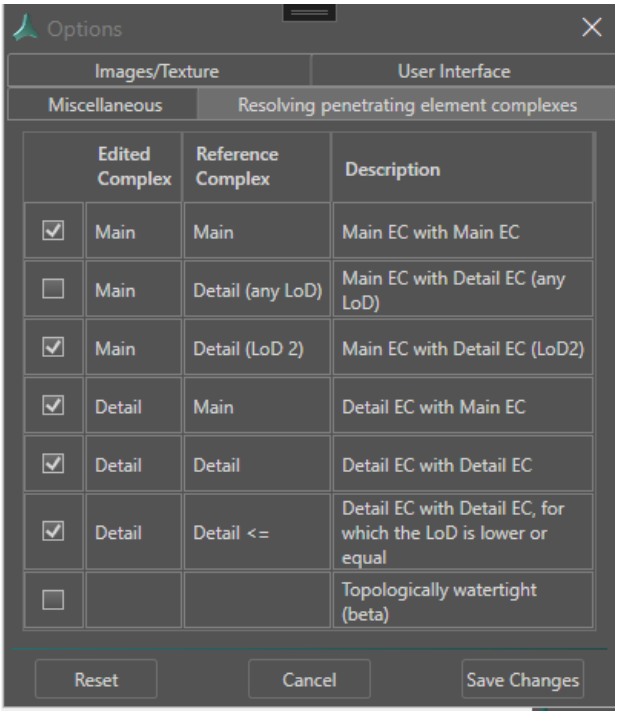
- **Default Extension of intersection lines in the Smart Preview**
  Controls the default behavior of intersection lines in the Smart Preview. If this option is activated, the intersection lines are extended up to the maximum length of the largest alphashape involved. If this option is deactivated, the intersection lines retain their calculated length based on the common edge of two alphashapes depending on the buffer width (Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** S. 45) The behavior can be changed on the fly during SmartPreview by holding down the *RightShift* key.

- **Façade length Default (m):**
  Specifies how far the façades are extruded if no DTM is available. If a DTM is available, this is included in the façade when the building is closed (when saving) and the façade is shortened (or extended) accordingly.

- **Max normals tolerance (cm):**
  Defines the deviation from which neighbouring faces are considered planar and are combined during selection.

- **Building ID prefix:**
  Saves a building ID prefix in the XML file.

Resolve penetrations:



Options for the CityGRID penetration resolution can be set here, which take effect when the building is saved.

- Main Element Complex with Main Element Complex:

  All main element complexes are intersected with all main element complexes within a unit. If faces of an element complex are located within another element complex, they are eliminated. The faces of the lower element complex are always removed. If the element complexes have the same height, the element complex from which the faces are removed is decided by chance.

- Main Element Complex with Detail Element Complex (any LoD):

All main element complexes are intersected with all detail element complexes within the same object. Faces of the main element complexes that lie below detail element complexes are removed.

- Main Element Complex with Detail Element Complex (only LoD 2):

  Works in the same way as the option described above, with the difference that only detail element complexes in LoD2 are considered and the covered space on the main element complex is left free Areas under LoD3 detail element complexes, however, remain unchanged.

- Detail Element Complex with Detail Element Complex:

  Examines detailed element complexes of a main element complex for mutual intersections and cleans them up.

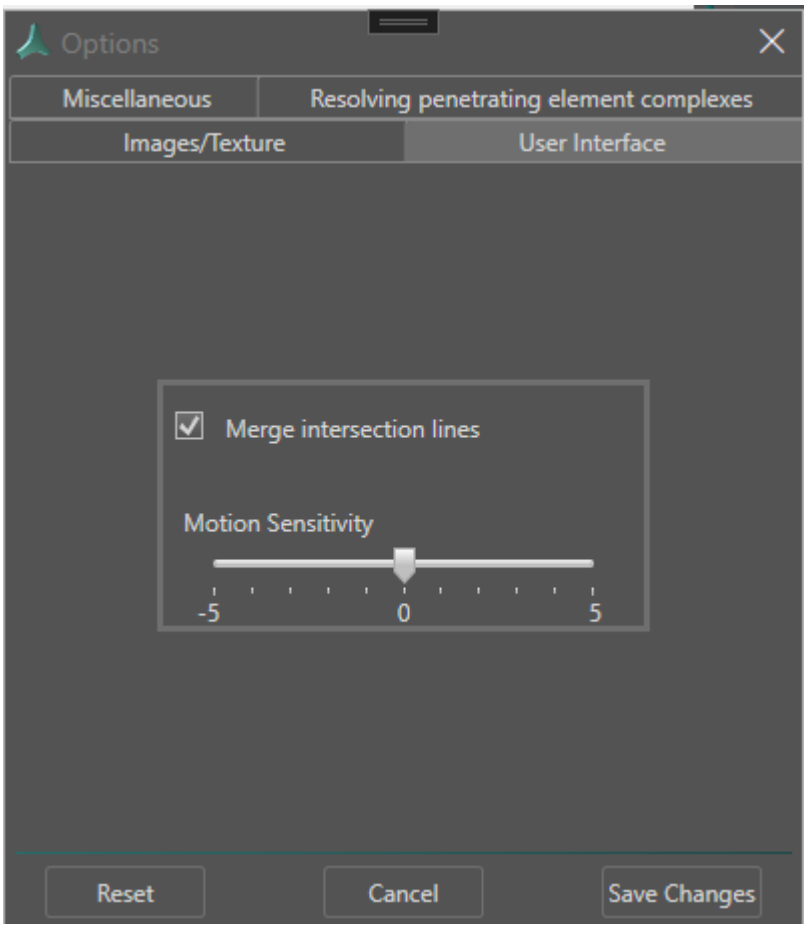
- Detail Element Complex with Main Element Complex

  All detail element complexes are intersected with all main element complexes within the same object. If faces of detail element complexes protrude into the main element complex, the intersection resolution removes them and ensures that the detail element complex faces are intersected exactly with the main element complex.

- Detail Element Complex with Detail Element Complex (LoD <=)

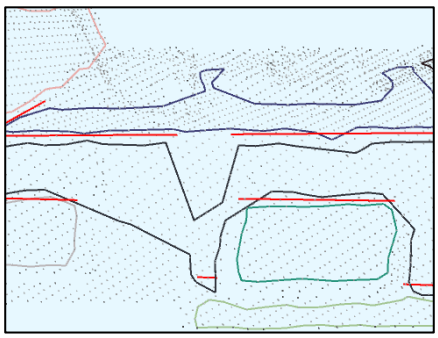
  If an LoD3 detail touches an LoD2 detail, this option eliminates the affected faces of the LoD3 detail while the faces of the LoD2 detail are retained. Details of the same LoD eliminate each other's faces.

User Interface:



❖ **Merge intersection lines:**

If intersection lines between two alphashapes are interrupted by a recess in the alphashape, they can be merged after accepting one of the intersection line segments if this option is set.

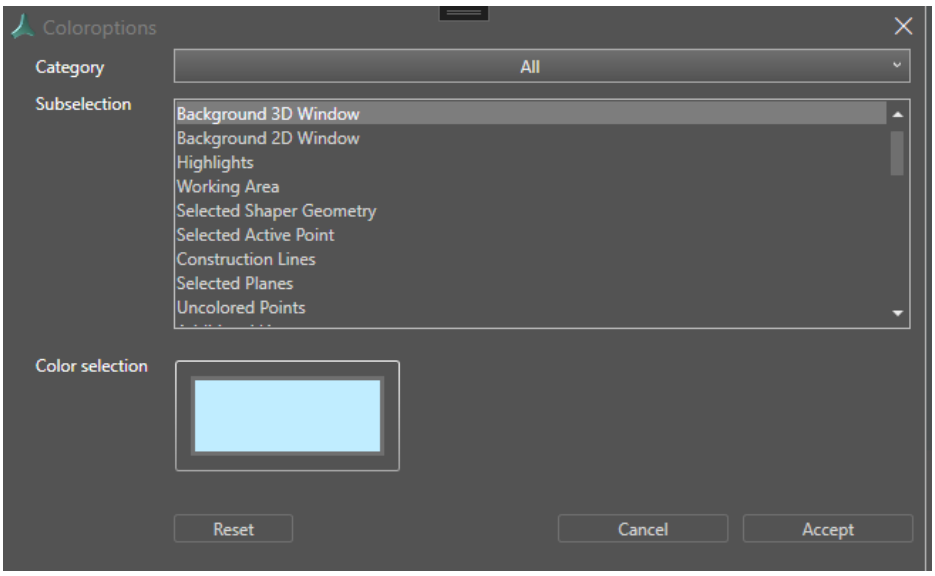


❖ **Motion sensitivity:**

Controls the reaction speed of the Smart Preview to mouse movements. The higher the slider is set, the more sensitive the Smart Preview is to mouse movements.

Colour options

In the colour options dialogue, the default colours for geometries and elements of the user interface can be changed.



2.1.3. View

Save viewpoint

Saves the current view of the 3D window (default hotkey **`Ctrl + F12`**)

Switch to saved viewpoint

Switches to the last saved view of the 3D window (default hotkey **`F12`**)

Scout 3D

The 3D window can be switched on/off.

Texture 2D

The 2D window can be switched on/off.

Logging

The Logging window can be switched on/off.

Main Toolbox

The Main toolbox can be switched on/off.

2.1.4. Feedback

Extended Logging

When troubleshooting, this option can be activated.

Send Feedback

The error description (protocol and additional data) is zipped and added as an attachment in the installed email programme in an empty email.

2.1.5. Help

Shaper Help

Opens the keyword search.

Manual

Opens the Manual of City**GRID**® Shaper.

About CityGRID® Shaper

Shows version information for City**GRID**® Shaper.

Localisation

Allows you to change the language settings, options are German, English, Turkish.

2.2. The Toolbar

2.2.1. General functionalities

Stop Editing 

(Default Hotkey E)
This button can be used to switch from editing mode to the general selection mode. Buildings, that were not saved or edited alphashapes will be discarded.

Undo 

(Default Hotkey Ctrl +Z)

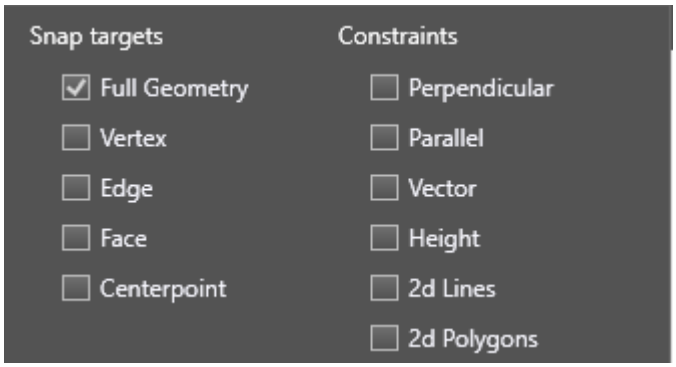
Undoes the last editing action. Right-clicking opens the context menu and allows you to undo several editing actions.

Redo

(Default Hotkey Ctrl +Y)
Restores the last editing action. Right-clicking opens the context menu and allows you to restore several editing actions.

Snapping

(Default Hotkey S)
Snapping is activated with a left mouse click (or with a hotkey), right-clicking opens the context menu for this button, where various snapping options can be set.
With the Snap Tool active, you can select any point on a chosen geometry (snap source) and drag the mouse toward another geometry (snap target).
While dragging, once the mouse position aligns with a snap element of your choice, a new point on the snap source will be calculated and the snap source will be modified depending on the mouse position, the snap element, the snap target and snap constraints.



Snap targets

- Full Geometry: Snaps the shortest distance of between source geometry and target geometry (vertex, line or face).
- *Vertex*: Affects end points of a line, vertices of a polygon, points of a pointcloud
- *Edge:* affects lines, polygon segments, triangle edges
- *Faces:* on roof or façade surfaces
- *Centerpoint: of a face, polygon or a line*

Snap constraints

- *Perpendicular:*
  from any geometry to lines/polygons. Forms an imaginary straight line through the target point, which is normal to the target object (line segment/polygon segment). Snaps to the point of the source object that is closest to this straight line.
- *Parallel:*

from polygon to line/polygon; Projects the target point and target object into the plane of the source object (target object line), or intersects the target object with the source object (target object plane polygon)
Moves the resulting imaginary straight line through the starting point and snaps it to the point closest to the projected target point.

- *Vector:*
  From plane polygon (alphashape/outline) to any geometry;
  Snaps to the point of the source object that is closest to the target point and lies on the vector of one of the neighboring line segments of the source point, A hotkey (default <) can be used to switch between the vectors.
- *Height:*
  From Any geometry to Any geometry. Snaps to the point of the source object that has the same height as the target point.
- *2D Lines*:
  From line to line/ building footprint.
  Intersects both objects in the XY plane. Form an imaginary vertical straight line through the intersection point. Snaps to the point of the initial object that is closest to this straight line.
- *2D polygons*:
  From plane polygon (alphashape or outline) to any geometry. Form an imaginary, vertical straight line through the target point. Snaps to the point of the source object that is closest to this straight line.

Bindings 

(Default Hotkey B)
Bindings are activated by default. The baselines of a roof are connected to each other. If it becomes necessary to move baselines independently in the plane (e.g. in the case of cripple hipped roofs), it is important to remove the bindings beforehand.

Note: Do not forget to reactivate the bindings when the action for which the unbinding was necessary has been completed.

2.2.2. Editing functionalities

Changing the editing mode also changes the available functions in the main toolbox. Detailed description of the editing functions in chapter 2.3.3**.**

Smart Preview 

(Default Hotkey *F1*)
The Smart Preview is the start mode for creating and editing a building. Buildings can be created here by placing the user's mouse over a red intersection line candidate, waiting until it turns blue, and accepting the preview with a click. With the general editing functions (**chapter 2.3.2) faces can be frozen, building**

parts can be closed (the preview is fixed) and **reactivated**. Entire **buildings can be saved, edited in the Modeler,** or **deleted**.

When the workspace is changed from selection mode to editing mode, the Smart Preview mode is set as the start function. You can switch between the editing modes using the hotkey or toolbar.

If the mouse is over an intersection line (red), a preview of the face generation is displayed in Smart Preview mode when this intersection line (now blue) is accepted with a **left mouse click**. (Green) If the mouse is then removed from the line before accepting it, the face generation of the preview is also reset.

By changing the settings that appear in the main toolbox when this mode is activated, the result of this preview can be changed/improved.
Lines (intersection lines and baselines) can also be edited in the Smart Preview, but for advanced line editing functions it is necessary to switch to line editing mode.

- Caps Lock active: As long as the Caps Lock button is active, no new preview is triggered. Lines can be edited in the active preview without adding new areas.
- Create preview faces: mouse hover on **intersection line.**
- Create preview faces only to maximum common length between to alphashapes; RightShift + mouse hover on **intersection line.**
- Extend: **Intersection lines** can be extended by moving the end points with the mouse. When intersection lines are extended, the associated baselines are automatically extended.
- Show disregarded **intersection lines**: *Shift* + *Ctrl* can be used to display invalid intersection lines and invalid segments of valid intersection lines that were discarded during pre-processing because they did not meet one or more criteria for a valid intersection line candidate. With a *Left mouse click*, these intersection lines can be transferred to candidate status and thus used for Smart Preview.
- Click through lines: If **intersection lines** are so close to each other that their vertices lie on top of each other and cannot be selected individually, you can click through the segments of the accepted (green) lines with a hotkey (default **[Space]** to edit a line other than the top line and its vertices.
- Move: **Baselines** can be moved in the plane by moving the centre point up or down with the mouse.
- Split Line: **Baselines** can be split by holding down *Ctrl* and clicking on the line at the desired position.

- Expand and reduce the preview faces: *LeftShift* and *mousewheel Scroll* can be used to expand and reduce the preview.

- Expand and reduce the preview faces: RightShift and mouse wheel scroll can be used to expand and reduce the preview, starting from the maximum preview within the intersection lines.

- Toggle between overlaying **intersection line**s by hovering and *[Space]*

- Extending and reducing the selection tolerance: The selection tolerance - the radius around the cursor in which the candidate lines are used for the SmartPreview - can be extended and reduced with *RightCtrl* and *Mouse wheel scroll*.

Parameter:

- Degree of generalisation: A higher degree of generalisation increases the probability of closing smaller gaps in the Smart Preview, intersection lines are extrapolated.

Edit/Add Alphashapes 

(Default Hotkey F2)
For more complex buildings, it may sometimes be necessary to edit the alphashapes to obtain more accurate intersection line results.

To edit an alphashape it is necessary to select an alphashape, which is then highlighted in both the 3D window and the 2D window. In both windows the vertices of the alphashape can be edited (moved, deleted, added). In the 3D window you can deactivate an Alphashape by clicking on a segment, it changes colour and is displayed in light grey. The intersection lines in which the alphashape is involved disappear in this state. The alphashape can be reactivated with another click. In some cases, alphashapes are too large or too small. The following functions can be used to change the extension of an alphashape.

Edit

- *Left mouse click* selects an alphashape.
- *Hotkey (Default ‚T')* activates/deactivates selected alphashape.
- *Left mouse click* on alphashape segment adds new vertex.
- *Left mouse click* on alphashape vertex moves vertices.
- *Hover over Alphashape vertex + Del* deletes this vertex.
- *Hold down Left mouse click and draw a rectangle* allows multiple selection of vertices.

For slightly bent roofs and other situations it is advantageous to split or merge an alphashape. When splitting an alphashape, the originally assigned points are reordered and assigned to the two new alphashapes. An intersection line is created between the two new alphashapes, making it easier to model slight bends. When an alphashape is selected, the following functions are available:

- *Horizontal division (draw a horizontal dividing line with two clicks)*

allows you to create a horizontal dividing line through the selected alphashape with two mouse clicks.

- *Vertical division draw a vertical dividing line with two clicks)*
  allows you to create a vertical dividing line through the selected alphashape with two mouse clicks.

- *User defined division (draw a user defined dividing line)*
  allows you to create a user-defined dividing line through the selected alphashape with two mouse clicks.

- *Merge* allows you to merge the selected alphashape with another alphashape.

Sometimes alphashapes are not even found, especially for smaller planes (depending on the creation parameters). In these cases, they must be created manually. There are several possibilities for this in the alphashape mode:

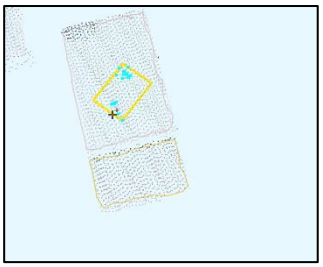
Add:

- Hold *Ctrl* and select one point after another with *Left mouse click* to define a plane. With a *Left mouse click* on the first point the polygon will be closed, and the plane created. At least three points are necessary.

  Hold *Shift* + *Left mouse click* selects a number of points. This selection can be extended or reduced dynamically with a mouse wheel scroll. With an *Left mouse click* the selection is accepted and the alphashape is created.

- Hold *Shift* + *Ctrl* selects a number of points in a forced normal plane (horizontal). This selection can be dynamically expanded or reduced with a mouse wheel scroll. With an *Left mouse click* the selection is accepted and the alphashape is created.

- Hold *Shift* + *Click of the mouse wheel*! several points are selected but not completed. More clusters of points can be added to the selection with the same key combination held down. Only an *Left mouse click* finishes the selection and creates the plane.



❖ **Parameter:**

  ❖ *Application radius* (Slider)
  Within this radius, pointcloud points are searched for during the alpha shape creation. The larger the radius around the mouse position, the more points are added to the selection.

Note: Only one alphashape can be selected and edited at a time. To end the selection and choose another alphashape, press Esc.

Edit Lines 

(Default Hotkey F3)

In line editing mode, intersection lines and baselines can be edited individually. A line must always be selected first. A selected line is highlighted in yellow, depending on its type (intersection line or baseline) different editing options are available. Lines can be edited in line editing mode as follows.

- Lengthen/shorten: *Left mouse click* to the end points of a selected **intersection line**.
- Move: *Left mouse click* to the centre of a selected **baseline**.
- Hold down Ctrl and *Left mouse click* to the selected **baseline**.

Tip: These three functions are also available in Smart Preview mode without selecting the line beforehand

- Deactivate a selected **intersection line** ('T').
- (Re-)activate selected **intersection line** ('T')

Add/Edit Outlines 

(Default Hotkey F4)

The outlines of planes can be edited in some cases, in other cases (flat roofs) they must be created. When intersection lines are accepted in the Smart Preview, outlines are subsequently created automatically - in addition to the alphashapes involved. Sometimes it may be necessary to edit these outlines, for example if the intersection line is shorter than the eaves to be created. Since the baselines automatically adjust to the length of the intersection line, they cannot be extended independently.

Note: Before editing an outline, all actions that affect the lines (extend, move) should be finished. An edited outline is weighted higher than the edited lines, therefore editing the lines afterwards can lead to undesired results.

To make an outline visible and thus editable, the alphashape concerned must first be selected in outline mode. Only then will the created outline be displayed.

Edit:

In the 2D window as well as in the 3D window, vertices can then be added to the outline, moved and in most cases also deleted. Vertices at the intersection line cannot be moved or deleted.

- Press *Esc* to end the active selection.
- *Left mouse click on* an alphashape its outline is also selected.

- De- and (re-)activating a selected alphashape in alphashape mode also de- or (re-)activates its outline.
- *Hover over* on outline vertex and press *Del* deletes this vertex.
- *Left mouse click* on segment adds a vertex
- *Left mouse click* on vertex allows moving.

Note: As there are no intersections of roof planes in flat roof situations, the face-generating outlines must be created manually in this case. There are several ways to do this.

Add:

- Select alphashape, which specifies the plane of the future roof. Draw the desired outline in the 2D window. An outline is automatically created in perpendicular mode after the second click. To suppress this, you must also press *Shift*. The last click must be on the first point to complete the polygon.

Tip: The last corner of a roof does not have to be drawn with the perpendicular mode active, if the first three points have been digitised, the last click can be made on the first point, the polygon is automatically closed, and the last roof corner is automatically created.

Tip: An outline can also be created in the 3D window, but it can be drawn with more control in the 2D window.

Tip: If the main roof is not visible due to a parapet or other roof structures, the creation mode can be selected (In the main plane, In the drawing plane). If in the main plane is selected and the height is set to the height of the parapet using the Set drawing plane button, the outline can be drawn on the parapet in the 2d window, but the outline is created on the plane of the alpha shape.

If building footprints have been included in the calculation for a project (chapter...), these can be used for an easier flat roof creation. The prerequisite is a suitable quality of the footprints. Select the alphashape concerned to define the plane (height and inclination) of the future roof. Activate the button Use footprint and select the footprint that is to be lifted into the plane of the selected alphashape. The new outline is created 2D identical to the building footprint in the plane of the alphashape. The outline can still be edited in these cases as well.

- Parapets:
  A flat roof can also be created immediately with a parapet. To do this, select the creation mode (main plane with parapet), select a point at the top edge of the parapet for the height of the drawing plane, set the width of the parapet (note that this cannot be changed afterwards) and draw the outline in the 2D window on the outer edge of the parapet. After closing the outline, the main roof is at the height of the selected alpha shape, the parapet is at the height of the set drawing plane.

Parameters:

- Creation Mode (Dropdown)
  - ❖ In the drawing plane: The outline is created in the set drawing plane, at 0 the drawing plane corresponds to the main plane.
  - ❖ In the main plane: The outline is created in the main plane (of the selected alphashape).
  - ❖ In the main plane with parapet: The outline is created in the main plane, the parapet in the set height of the drawing plane.
- Height drawing plane (slider) relative height, 0 is the main plane.
- Parapet thickness (slider) must be set before creating a parapet. After that, the width can no longer be changed.
- LoD of the parapet (Dropdown)
  - ❖ 1
  - ❖ 2 Is treated as part of the main roof in City**GRID**® xml.
  - ❖ 3 is treated as a detail element complex in City**GRID**® xml.
- Set drawing plane (button) If this button is activated, a point of the pointcloud can be selected at the desired height. The height of the drawing plane is set to the height of the point.
- Select footprint (button). If this button is activated, a building footprint can be selected, which is subsequently raised to the height of the main plane and accepted as an outline.

Set Baseplane 

(Default Hotkey F5)
The base plane is used to delimit the building planes, the baselines are the result of the intersections between building and base planes.

- ❖ Set base plane automatically. (Default Checked)
  In this mode, the height of the base plane is calculated and set automatically based on the input data.
- ❖ Set base plane manually.
  If the automatically set base plane leads to undesired results for the base lines, it can be set manually in the base plane edit mode
  - A *left mouse click* sets the base plane through the lowest point of the selected alphashape.
  - If *Ctrl* is *additionally* hold down, a point of the pointcloud can be selected through which the base plane is set.

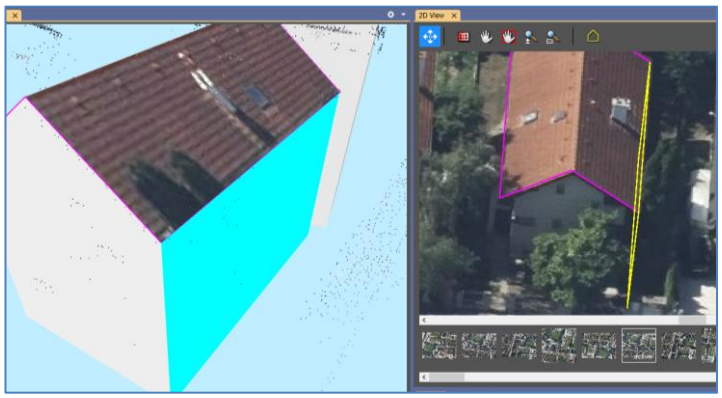
Detail Editing Mode 

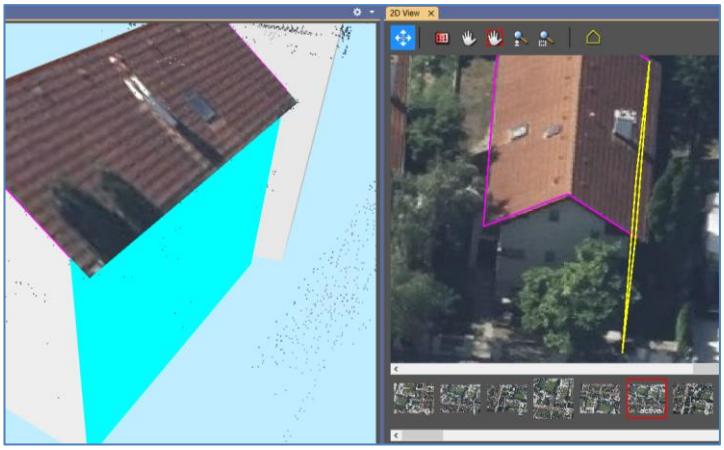
Not yet implemented. (Default Hotkey F6)

Roof protrusion mode 

(Default Hotkey F7)

In a first expansion stage, roof overhangs can be created for finished building parts. A mouse click selects a façade face, *Ctrl* allows you to add further faces to the selection, *Shift* removes faces from the selection. Faces can also be selected using a multiple selection. By holding down the left mouse button, the façades can be moved inwards against their surface normal. Creating protrusions is only possible on *finished buildingparts*. Either one or more facades (coplanar faces) can be selected and dragged against their face normal into the building. The facades are projected on the aerial images which can be used to determine the right position of the façade. Clicking an image with *RightShift* locks it, so it does not automatically select another image). Further functions are planned.





2.2.3. Visibility functionalities

Show assigned points 

(Default Hotkey Ctrl +9)

Points assigned to a plane can be shown and hidden. Only visible elements are used for selection, snapping, etc.

Show assigned points (colour) 

(Default Hotkey Shift +9)

Points that have been assigned to a plane and coloured depending on the plane can be shown and hidden.

Show Faces 

(Default Hotkey 1)
The faces of the Smart Preview can be shown or hidden. Only visible elements are used for selection, snapping, etc.

Show Alphashapes 

(Default Hotkey 2)
Alphashapes can be shown or hidden. Only visible elements are used for selection, snapping, etc.

Show intersection lines 

(Default Hotkey 3)
Intersection lines can be shown or hidden. Only visible elements are used for selection, snapping, etc.

Show accepted buildings 

(Default Hotkey 4)
Accepted buildings can be shown or hidden. Only visible elements are used for selection, snapping, etc.

Show base plane 

(Default Hotkey 5)
This allows you to control the visibility of the base plane.

Show unused points 

(Default Hotkey 9)
The points that are not assigned to an alphashape can be shown or hidden. Only visible elements are used for selection, snapping, etc.

Show unused data (alphashapes and lines) 

(Default Hotkey 0)
Disabled alphashapes or lines in the selection area can be shown or hidden. Only visible elements are used for selection, snapping, etc.

Show Existing Buildings 

(Default Hotkey 6)
An existing city model in the selection area can be shown or hidden.

Show footprints 

(Default Hotkey 7)

The building footprints of the selection area can be shown or hidden.

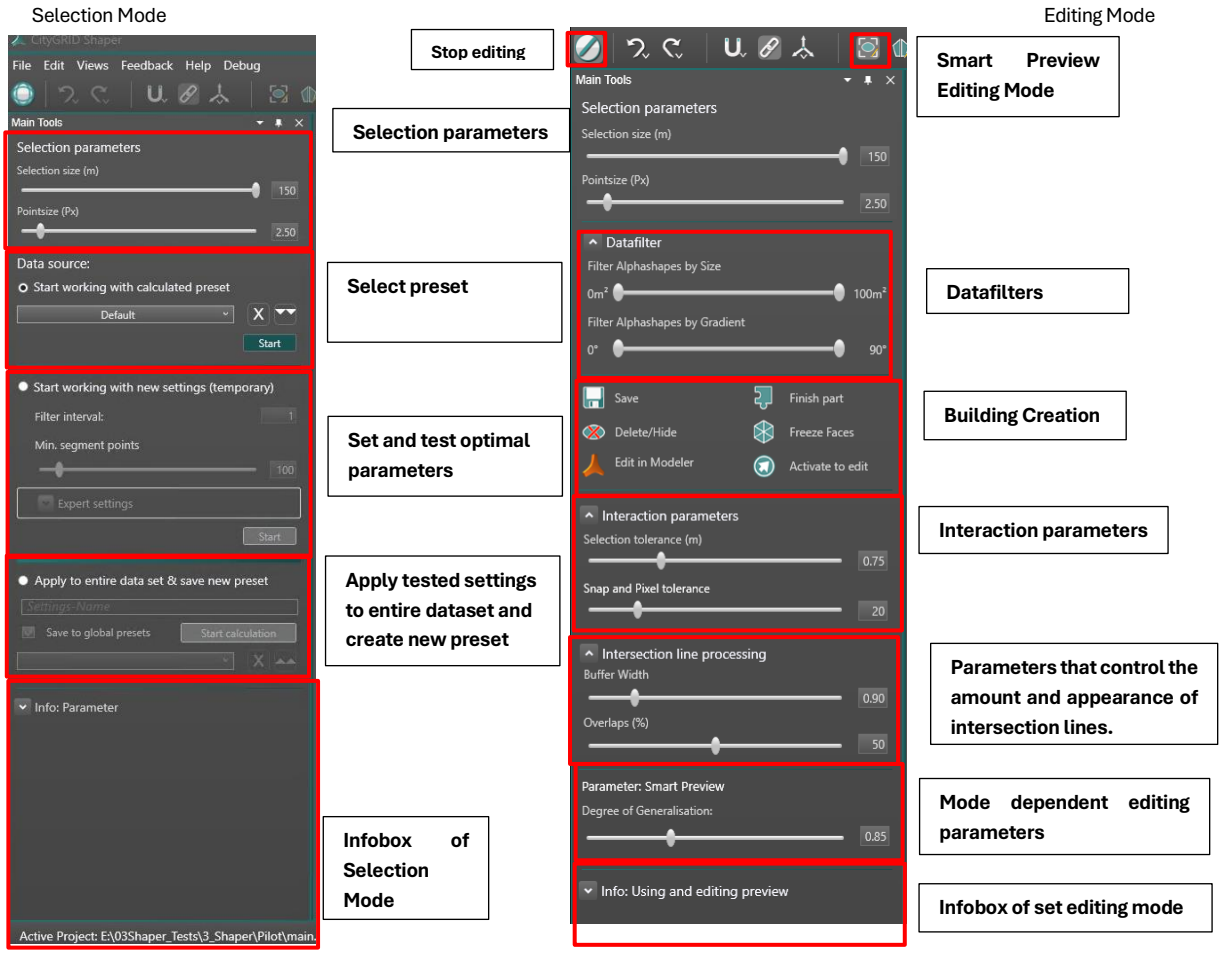
Show DTM 

(Default Hotkey 8)

A DTM can be shown or hidden in the selection area.

2.3. The main toolbox

The main toolbox changes its appearance depending on the selected mode.

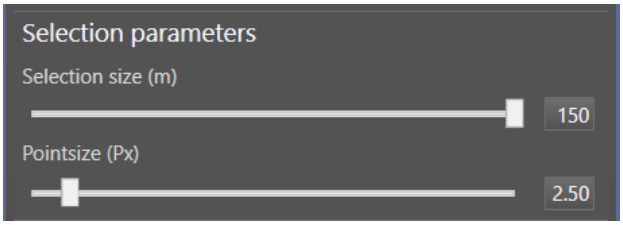


2.3.1. Selection mode

The project is in selection mode immediately after the Shaper project is created or each time Shaper is restarted. This means that all buttons in the toolbar are deactivated, the entire pre-calculated point cloud is displayed in the 3D window and no images are displayed in the 2D window. In the 3D window, the yellow selection cube can be dragged over the point cloud with the left mouse button to define a new selection area. The selectable point cloud is then colored green.

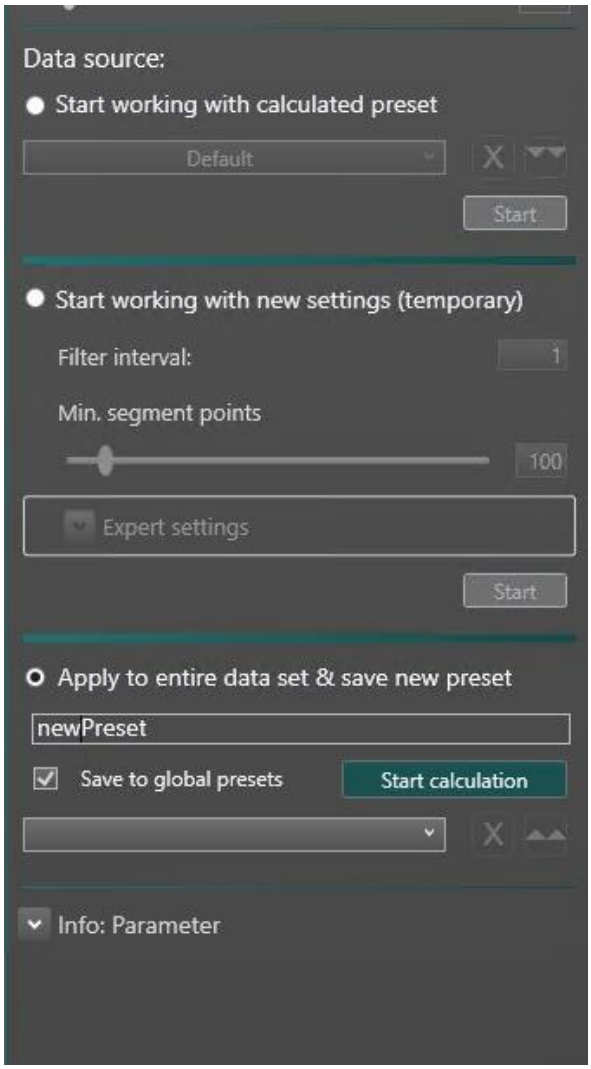
The planes must be extracted directly after the project has been created. In this environment, the user can test the best settings for their point cloud using the **`Start working with precalculated preset`** option. Once the optimum settings have been determined, they must be applied to the entire data set to create a new plane preset. Several precalculations can be created and later applied using the option **`Start working with new settings (temporary)`**. The associated **`Start`** button can be used to switch to the editing mode of the selected area.
In the main toolbox, this selection area can be changed using the selection parameters.

Selection parameters



- Selection size:
  controls the size of the selection range.
  For pre-calculated data the maximum is 150 m, for real-time calculation the maximum is 500 m.
- Point size:
  controls the display of the point size of the pointcloud.

Data source



`Start working with precalculated preset:` If a precalculation of the plane has already been created, it is written as an entry in the drop-down list, where it can be selected to quickly switch to edit mode with the **`Start`** button. Pre-calculated datasets can be deleted with the button. X

The button transfers the settings of the selected precalculation to the settings of the following option.

`Start working with new settings (temporary):` In order to create a plane precalculation with the optimum settings for the existing point cloud, its effects can be tested "on the fly" in a small selection area in this option. After setting the parameters, the corresponding **`Start`** button is used to switch to the editing mode of the selection area.

Filter interval:
Shaper works inefficiently with point clouds that are too dense. A point density of over 30 points/m2 is not recommended, as this can severely impair plane extraction and lead to duplicated or overlapping planes. Matched point clouds in particular are often too dense if they have not been processed beforehand. The filter interval enables a more or less rigid thinning of the point cloud in which only every nth

point is used. If a value of 1 is entered, every point is used, the point cloud is not thinned out, a value of 10 receives every 10th point, etc. Test the best value for your data here.

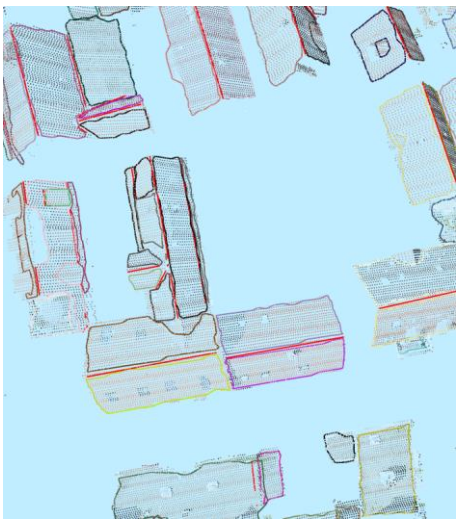
Tip: Ensure clearly defined planes with as little overlap as possible.

Min. segment points:

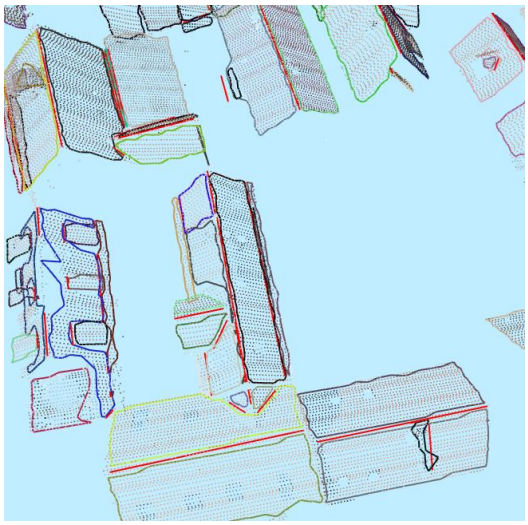
Specifies the minimum number of points required to define a valid plane and its alpha shape.

A lower number is often useful for very thin point clouds. The default value of 100 is optimized for regular LiDAR point clouds with a point spacing of 20 cm or a point density of 25 points per m2. However, even in these situations it can happen that too few planes are found. A lower value allows for smaller planes, so it can make sense to create several precalculations with different values. This allows you to switch between them as required. Denser point clouds require higher filter values to avoid extracting an unnecessary number of planes. Test this value on your data. Alphashapes should be determined for all important planes; there should not be an excess of small planes.

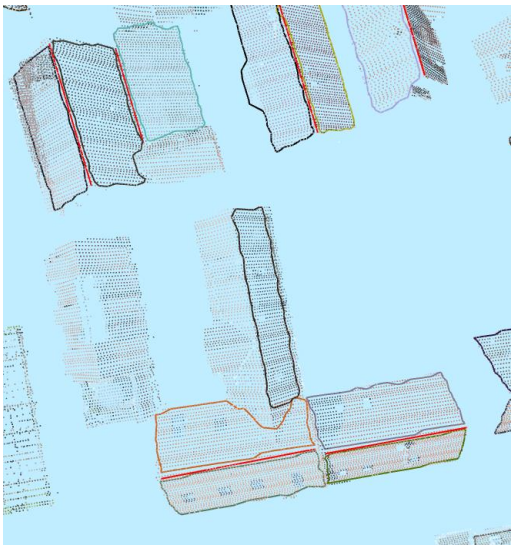
Tip: Alphashapes should be determined for all important planes; there should not be an excess of small planes.



Value 100 (point distance 20 cm)

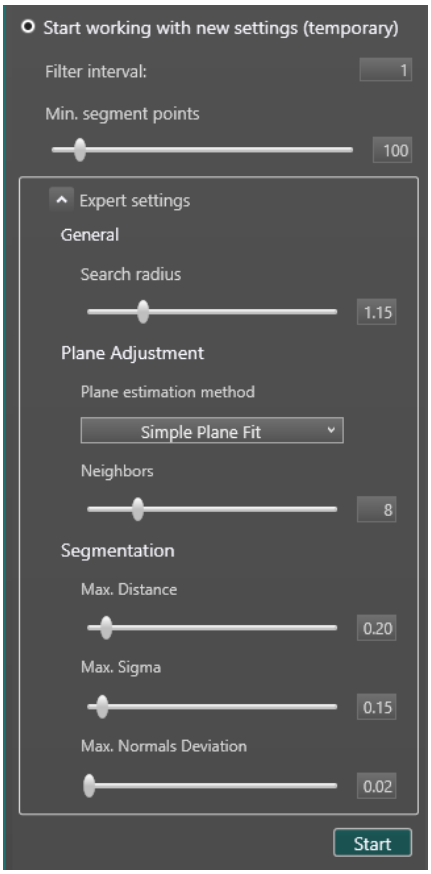


Value 20



value 450

Expert settings



The default values of the expert settings are usually suitable for most possible situations. For more complex point cloud situations, it may be necessary to change these values.

- **General**
  - ❖ Search radius
    Controls the size of the search radius within which points are selected for segmentation. It also controls the accuracy of the alphashapes. If alphashapes frequently "break up" (i.e. several polygons within an alphashape where there should actually only be one), it is recommended to reduce the radius.

In general, sufficient quality of the input data must be ensured. Nevertheless, there are possibilities to address different problems in the specific data set.

- **Plane Adjustment**
  - ❖ Method for plane estimation (selection): depending on the choice of plane estimation, the number of neighbours must be increased.
    - ❖ Simple plane fit
      Recommended for clean, clear (LiDAR) pointclouds. It is the fastest, simplest plane adjustment without discarding outliers (stray points), 8 neighbours are sufficient (default value).
    - ❖ robust plane fit
      Recommended for well-matched pointclouds or rougher LiDAR pointclouds. It is an iterative adjustment in which the points with the largest deviation are successively removed from the point

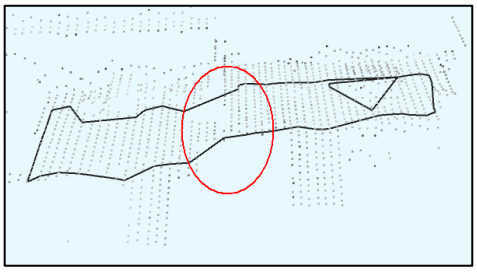
selection. Due to the iterative nature of the adjustment, robust plane adjustment is somewhat more time-consuming than simple plane adjustment. The number of neighbours must be increased for this method. This method only works if there are not too many gross errors. In addition, there must be correct points around the gross errors, otherwise the errors will not be recognised as such. In general, there should not be more than 20% of wrong points in the pointcloud to use this method.

- ❖ Minimum Covariance Determinant
  Recommended for imprecisely matched pointclouds with many outliers. The robust plane fit with minimum covariance determinant generally allows for more errors (not unlimited!) than the robust level matching. The number of neighbours must be further increased for this.

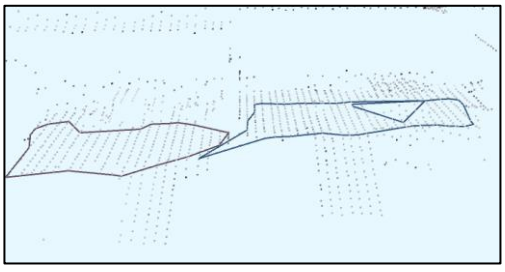
Note: too many neighbours can "smear" the surface normals at the edges, which can again lead to difficulties in alphashape creation. With difficult data, it is recommended to work with a sample to make it easier to work out the ideal values for the entire data set.

- ❖ Neighbours (Slider): Number of neighbour (points) to be used for the plane estimation. Depending on the choice of plane estimation, the number of neighbours must be increased.

- **Segmentation**:
  - ❖ Min. segment points
  - ❖ Controls the minimum number of points needed to form an alphashape. The lower the number of points, the more alphashapes are formed. By default, at least 100 points are necessary for an alphashape. If no alphashapes are found for smaller planes, but they would be necessary for sensible modelling, it is helpful to set a lower value here.
  - ❖ Max. distance (Slider)
    Defines the maximum distance a point may lie from a plane in order to be assigned to this plane. An increase in this value is recommended especially for unstable data, as it increases the tolerance for the formation of planes. If, for example, a plane is found from points lying close together where there should actually be two planes, it is helpful to reduce the maximum distance so that the distance between the points is higher than the value of Max. Distance.



Max. Distance = 0.20m



Max. Distance =0.10m

  - ❖ Max. Sigma (Slider)
    Sets the maximum normal accuracy used. If points have a maximum Sigma, that is higher than the setting of this value, they are not used for segmentation. Recommended is a value close to or lower than the set Max. Distance. Assuming the Max. Distance is set very high (tolerant), and Max. Sigma is quite low (strict), points that would still be used for segmentation due to their distance will still be removed due to the strict Max. Sigma value. Thus, too few planes may be found again.

❖ Max. Normal deviation.
Defines how much the normal of a point may deviate in order to be used as a seed point. A seed point is the point from which the plane found is extended further and further by adding points that fit into the plane. The default value of 0.02 m is sufficient for most data situations, but if the quality of the pointcloud is rather insufficient and no planes are found, it can help to increase this value to also allow "worse" points.

`Apply to entire data set and save new preset:`
If satisfactory values are found for the settings, a name for a new precalculation can be entered here. These settings are then applied to the entire point cloud and saved. Depending on the size of the data set, this process can take several hours.

- ***Start calculation***

Calculates the alphashapes with the new settings for the entire data set, which can take some time.

- ***Save to global presets***

If this checkbox is activated, the values of the settings are saved in a global xml file that can be accessed from other projects. This means that new values do not have to be determined for similar point cloud data.

2.3.2. General parameters and functionalities

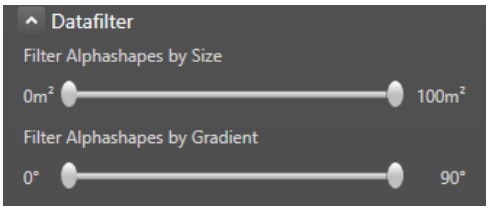
When switching from selection mode to editing mode, the settings in the main toolbox change. Some of them remain the same across all special editing modes (general editing functions), some change depending on the mode set.

Selection parameters

❖ Selection size: In edit mode, the selection size controls the range of points displayed.
❖ Point size: Controls the point size of the pointcloud.

Data filter

❖ Data filter: Filters the visible data (alphashapes and intersection lines) by different criteria. (Size, gradient

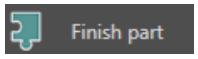


Building creation

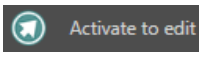
❖ 

`Freeze Faces` (Button) locks the preview faces in place, so new lines can be accepted without changing the frozen faces. Frozen faces will be optimized, when the building is saved.

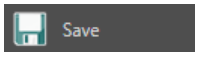
Tip: The "Freeze faces" function makes it easier to work on complex components by making it possible to lock accepted surfaces. This prevents unwanted changes by SmartPreview and allows step-by-step editing. After saving the entire building, components with frozen faces are optimized and broken down into logical building parts.

- 

`Finish Buildingpart` (Button) takes over the generated faces and lines of a building part and creates a separate building part.

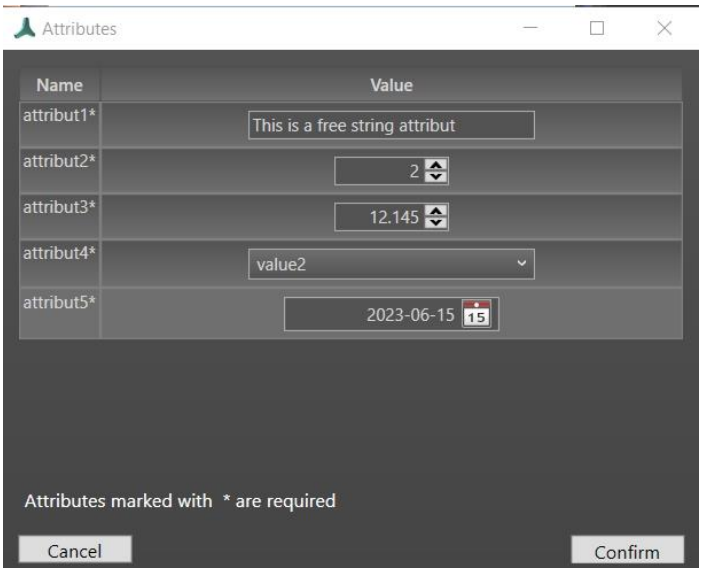
- 

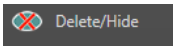
`Activate to edit` (Button) Allows the re-editing of a building part or frozen faces that has already been completed.

- 

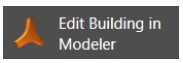
`Save` (Button) accepts a building (which can consist of several building parts or frozen faces) and writes it to a City**GRID**® xml file. An accepted building can no longer be edited in Shaper.

If Attributes (see *Menu > Create Building Attributes*, 0) is activated, an attribute dialogue is opened in which the corresponding values for the building can be entered. By pressing the *Confirm* button, the building is written into the XML file. This process cannot be undone.



- 

`Delete/Hide` (Button) Deletes an accepted building. This process cannot be undone.

- 

With `Edit Building in Modeler` an accepted building can be loaded and edited in the Modeler, provided the Modeler has already been started and placed in waiting position. **See Modeler Manual, Chapter 3.6.3**. Editing buildings in Shaper is blocked until the editing is saved and finished in Modeler, Modeler is brought back to the waiting position and the open dialogue in the shaper is closed with *Stop editing*. The edited building(s) is/are subsequently updated in Shaper.

Note: It is no longer possible to edit these buildings again in Shaper.

Parameter

- **Interaction parameters**
  - Selection tolerance (m)

    The selection tolerance affects all operations that work with pointcloud points in the 3D area. It is the radius around the mouse position in which, for example, intersection lines are accepted in the Smart Preview (as a result of planes in pointclouds). The larger this value is, the larger is the area around the mouse position in which the points necessary for creating alphashapes are selected.

    Tip:

    *In the Smart Preview, the selection tolerance can also be changed using the key combination of **RightCtrl** and **mouse wheel scroll**.*

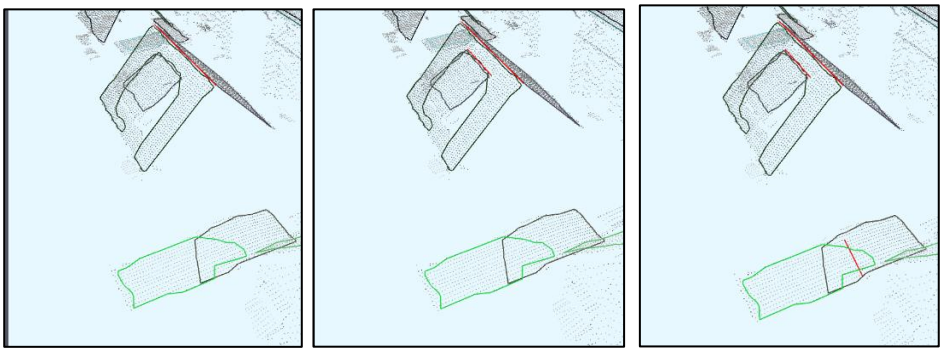
  - Snap and Pixel tolerance (px)

    The snap and pixel tolerance works accordingly to the selection tolerance on line- and alphashape segments as well as vertices. Only those segments/vertices can be selected that are within this radius around the mouse position. The value of this slider affects also the snap tolerance, which determines the maximum distance of a snap target to the snap source.

- **Intersection line processing**
  - Buffer width (m)

    Specifies the maximum width of the strip around the intersection line between two alphashapes to be offered as a valid intersection line candidate. The value influences the number of intersection line candidates found, the higher the value, the more valid intersection line candidates are found.
  - Overlaps (%)

    Intersection lines of overlapping alphashapes are displayed depending on the set degree of overlap. Such overlaps of two alphashapes occur more frequently the flatter the intersection angle between the two planes involved. So, if the value for the allowed degree of overlap is set higher, the intersection lines of flatter intersecting alphashapes are suggested as candidates. The lower the value, the less intersection lines of flat intersecting alphashapes are suggested as candidates.



overlaps: 0.05 | overlaps: 0.15 | overlaps: 0.55

2.3.3. Parameters of detailed editing functionalities

Depending on the set editing mode (Smart Preview, Edit lines, Edit/add alpha shapes, Edit/add outlines), various parameters can be set here, or functions can be used to edit them. *For detailed descriptions, see chapter Editing functionalities.*

Smart Preview features and parameters

The following features and parameters are available in the Smart Preview, descriptions of the actions can be found in the mode's infobox. (see chapter 2.3.4)

- CapsLock
- Lengthen/Shorten
- Show unconsidered intersection lines
- Change selected line
- Move
- Divide Line
- Expanding and reducing the preview faces
- Expanding and reducing the selection tolerance
- AutoComplete

Parameter:

- *Degree of generalization*

Alphashape features and parameters

Edit:

- *Left mouse click* selects an alpha shape.
- *Hotkey (Default ‚T')* deactivates/activates the selected alphashape
- *Ctrl pressed and Left mouse click on Alphashape segment adds a new vertex*.
- *Hover over* Alphashape-Vertex + *Del* deletes Vertex.
- *Hold down Left mouse click and draw rectangle allows multiple selection of vertices*
- *Left mouse click on Alphashape Vertex moves vertices*.
- *Horizontal division*
- *Vertical division*
- *User-defined division*
- *Merge*

Add:

- *Ctrl + Left mouse click*
- *Shift + Ctrl + Mousewheelscroll*
- *Shift + Click* of Mousewheel!

Parameter:

- *Application radius*

Line features and parameters

- *Shorten/lengthen*
- *Move*
- *Divide*
- *Deactivate*
- *(Re-)Activate*

Outline features and parameters

Edit

Vertices can then be added to the outline and in most cases, deleted in the 3D window, and moved in both the 2D window and the 3D window. Vertices on the intersection line cannot be moved or deleted.

- *Delete Vertex*
- *Add Vertex*
- *Move Vertex*

Add:

- *Draw outline vertices in the 3D or 2D window*
- *Shift suppresses right-angle constraint*
- *Select footprint*

Parameter:

- *Creation mode*
- *Height of drawing plane*
- *Thickness of parapet*
- *LoD* of parapet
- Set drawing plane

Baseplane features and parameters

Setting the baseplane:

- *Left mouse click on pointcloud point*
- Ctrl + *Left mouse click*

Protrusion features and parameters

Selection of facade faces:

- *Left mouse click for single selection*
- *Ctrl + Left mouse click adds faces to selection*
- *Shift + Left mouse click subtracts faces from selection*
- *Multiselection (rectangle)*

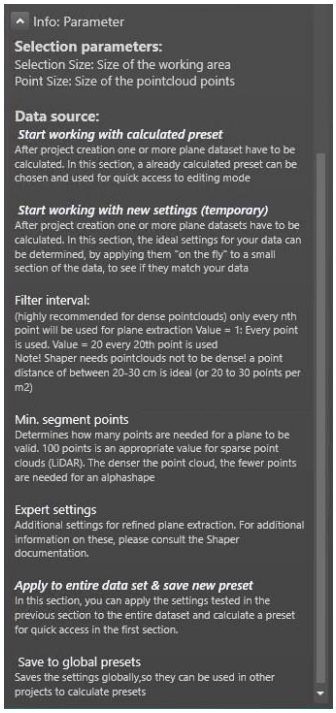
Create protrusion:

- *Drag and Drop*

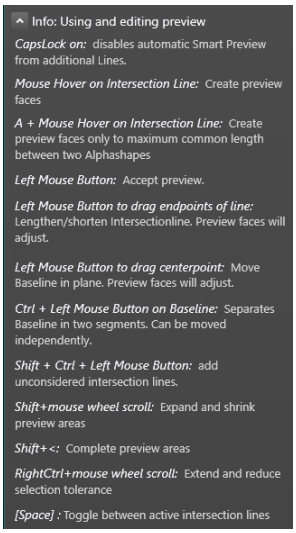
2.3.4. Infoboxes

In every editing mode as well as in the selection mode there is an info area at the bottom of the main toolbox, that describes the most important actions of every mode. It is highly recommended to consult those info boxes before editing.

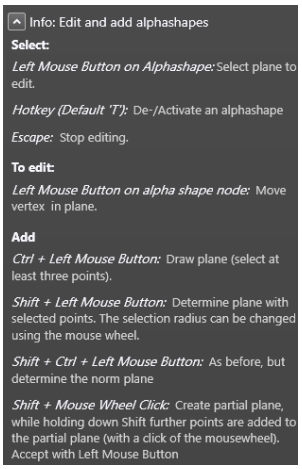
Selection Information:



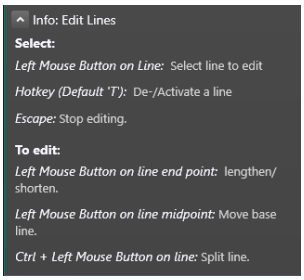
Smart Preview Information:



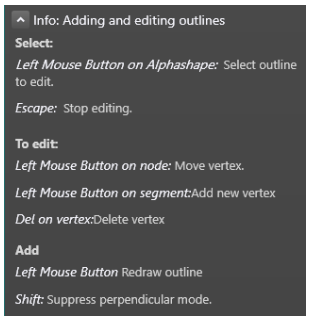
Alpha editing Information:



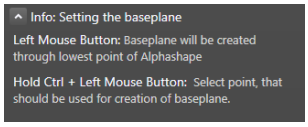
Line editing Information:



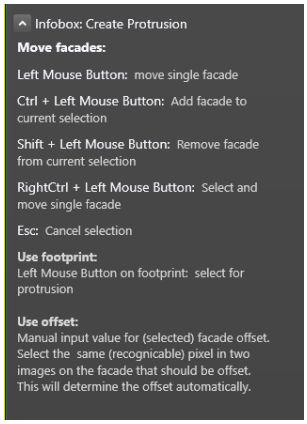
Outline Information:



Baseplane Information:



Protrusion Information:



2.4. The 3D Window

In the 3D window the calculated pointclouds and the derived data (depending on the visibility settings) are displayed. The alphashapes, the intersection and base lines, as well as the surfaces can be displayed here. All lines and polygons can be edited here in the corresponding editing modes.

Moving in the 3D window:

- Rotate with right mouse button.
- Pan by pressing the mouse wheel.
- Zoom by scrolling the mouse wheel.
- Draw a selection rectangle with the left mouse button

2.5. The 2D Window

In the 2D window the calculated aerial images are displayed. In the image selection it is possible to switch to another aerial image. The active building is represented in the selected aerial image with intersection lines and a face representation. In the different editing modes, it is also possible to edit in the 2D window. (Outline, alphashape and lines).

Move in 2D Window:

- Zoom by scrolling the mouse wheel.
- Pan by pressing the mouse wheel.

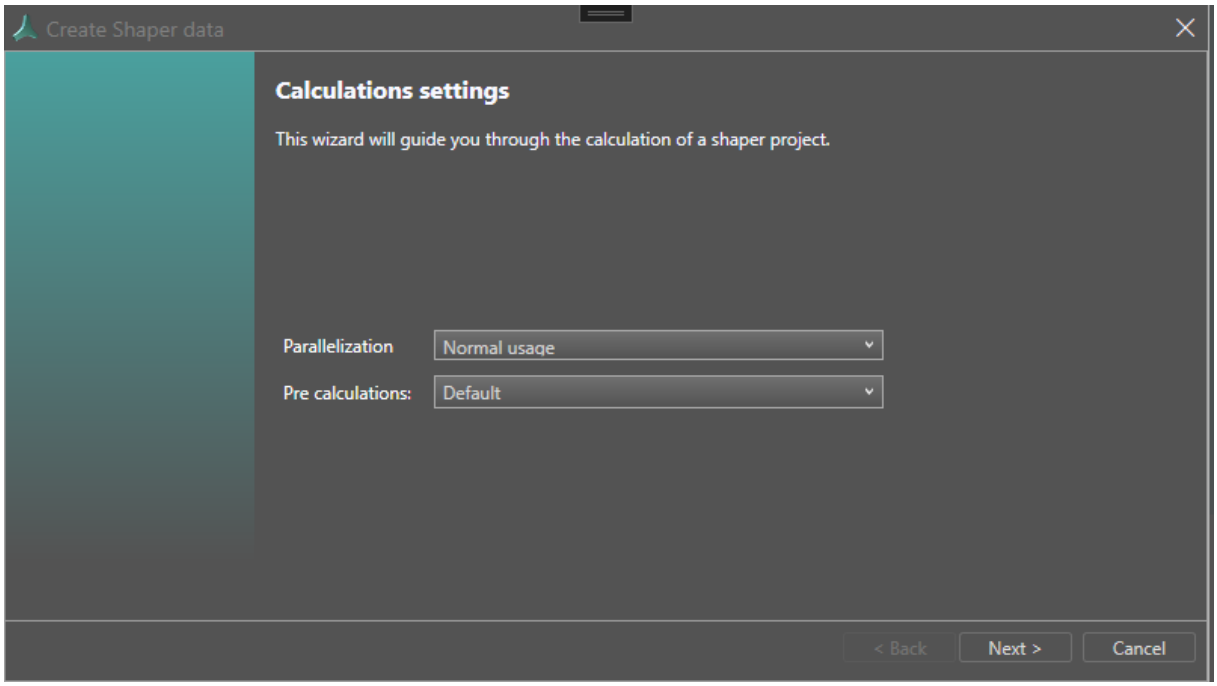
2.6. The Log Window

All Shaper processes are logged in the log window. If there are any crashes or warnings, they are displayed here.

3. Working with CityGRID® Shaper

4.1. Creating a Shaper project

A project directory must be entered under the menu item *File->New*. Subsequently, the wizard Create Shaper Data opens automatically and guides you through the creation of the project. The paths to the source data for the City**GRID**® Shaper project are set here. (Point cloud(s), orthophotos (optional), aerial images (optional), environmental data (optional)), as well as parameters for their integration).



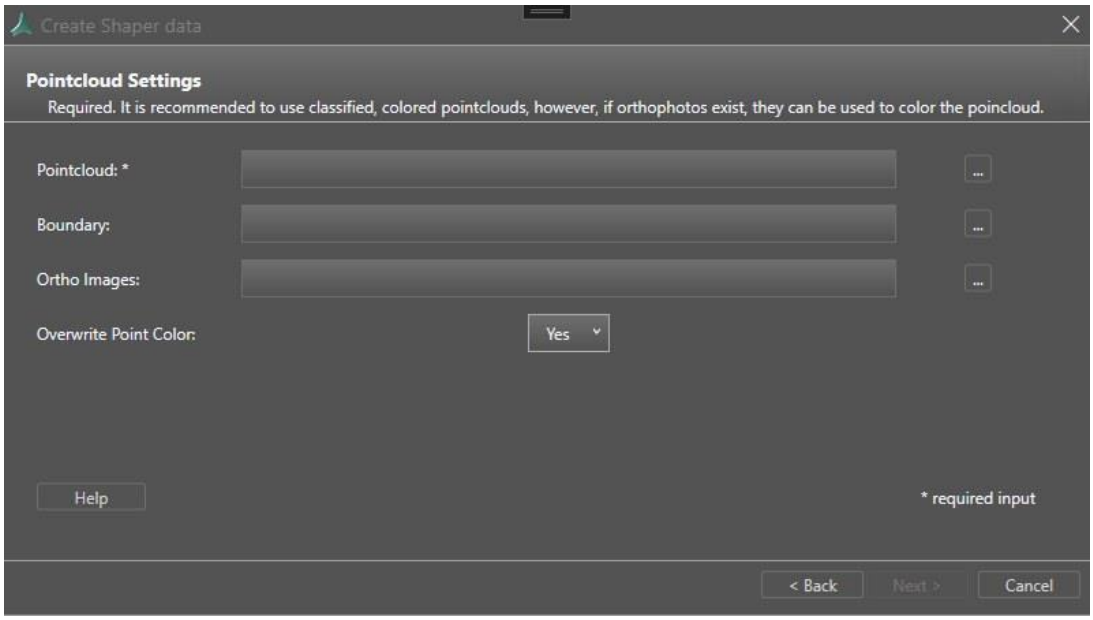
❖ Parallelization: Depending on the available computer resources, a speed-up setting for project creation and real-time calculation can be made here. These settings can be changed in the project's options lateron

- Deactivated: No acceleration is performed. The operations are performed one after the other. The computing time is very long, the proneness to errors is very low.
- Low utilization: Low acceleration is applied. Tasks are distributed across 1 to 2 CPU cores. The calculation time is high, the susceptibility to errors is low.
- Normal usage (default): Moderate acceleration is applied. Tasks are distributed over half of the available CPU cores. Computing time is moderate, error rate increases.
- High performance: High acceleration is achieved. The tasks are distributed across all available CPU cores. The calculation time is significantly reduced, the susceptibility to errors is increased.

Tip: The "High performance" setting is generally not recommended for weaker computers or computers that run other computing-intensive applications in addition to Shaper. In the event of error messages or crashes of the Shaper with high performance, restart the project creation and reduce the acceleration or deactivate it completely,

- Precalculation:
  If there are already global settings from other projects, these can be used for the precalculation of the alphashapes during project creation, which can later be used for quick access to editing mode. If “None” is selected, no precalculation will be created, it then has to be created in the Selection Mode. (see chapter 2.3.1)

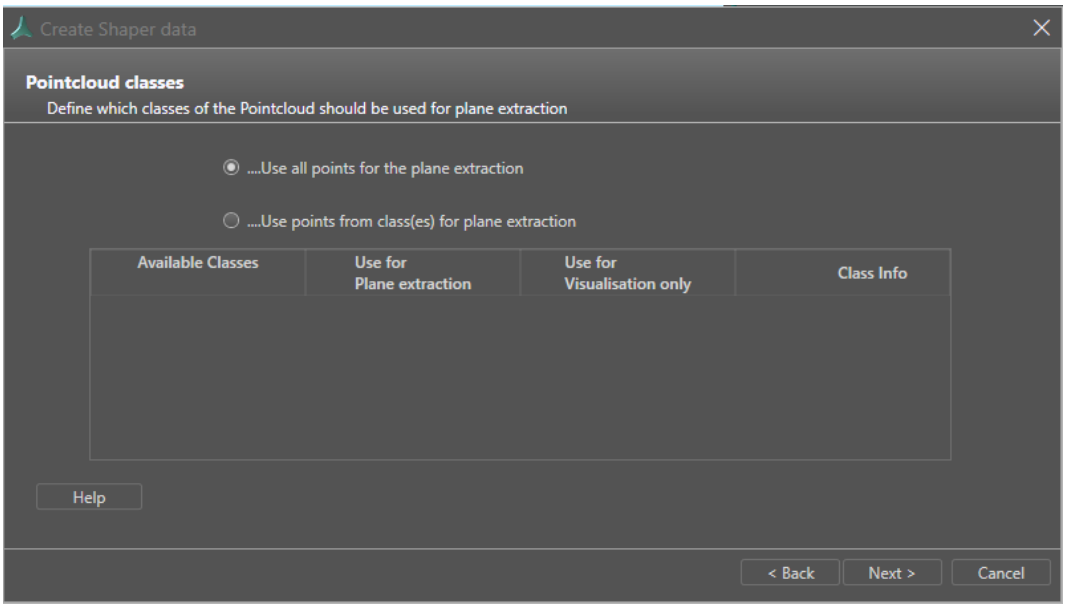
3.1.1. Pointcloud settings (required)



- Pointcloud: Selecting one or more .las or .laz files (required)
- Boundary: Select a shape file containing one or more polygons that restricts the pointcloud(s) to a working area. For example, building footprints (processed with buffer) or an area boundary. (Optional)
- Orthophoto: Select one or more ortho images to colour the pointclouds. (Optional)
- Overwrite point colour: Controls whether an already coloured pointcloud is to be overwritten with the values of the orthoimage.

Help: Provides more detailed information about the parameters on this wizard page.
Next: Switches to the aerial image parameter settings.

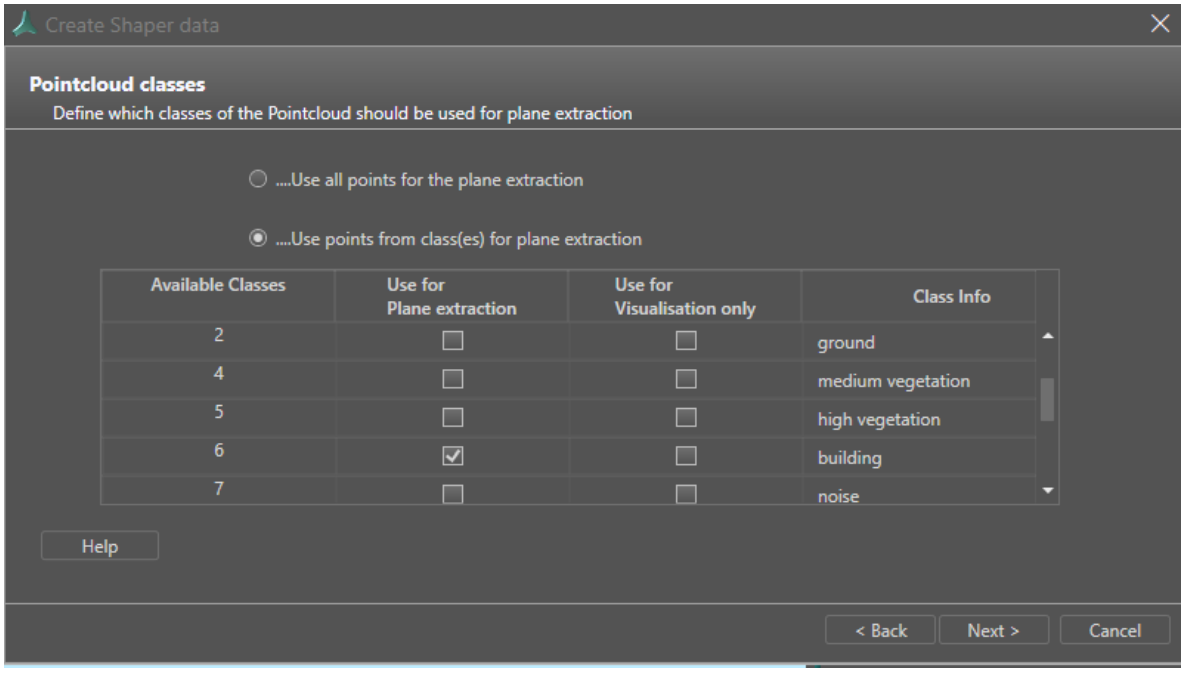
3.1.2. Pointcloud Classes



- Use all points for plane extraction: All points of the selected las/laz files are used for plane extraction.

Note: This setting is only recommended, if the pointcloud is cleaned up/reduced beforehand. Unclassified pointclouds should be reduced with spatial methods. Classified pointclouds should be checked for relevant classes.

- Use points from class(es) for plane extraction: If this setting is checked, the selected las/laz files are analysed for classes. The process can be aborted when the relevant classes are shown in the table below. With this setting at least one class must be used for plane extraction. All other classes can be used for visualization purposes. For these no planes will be extracted.

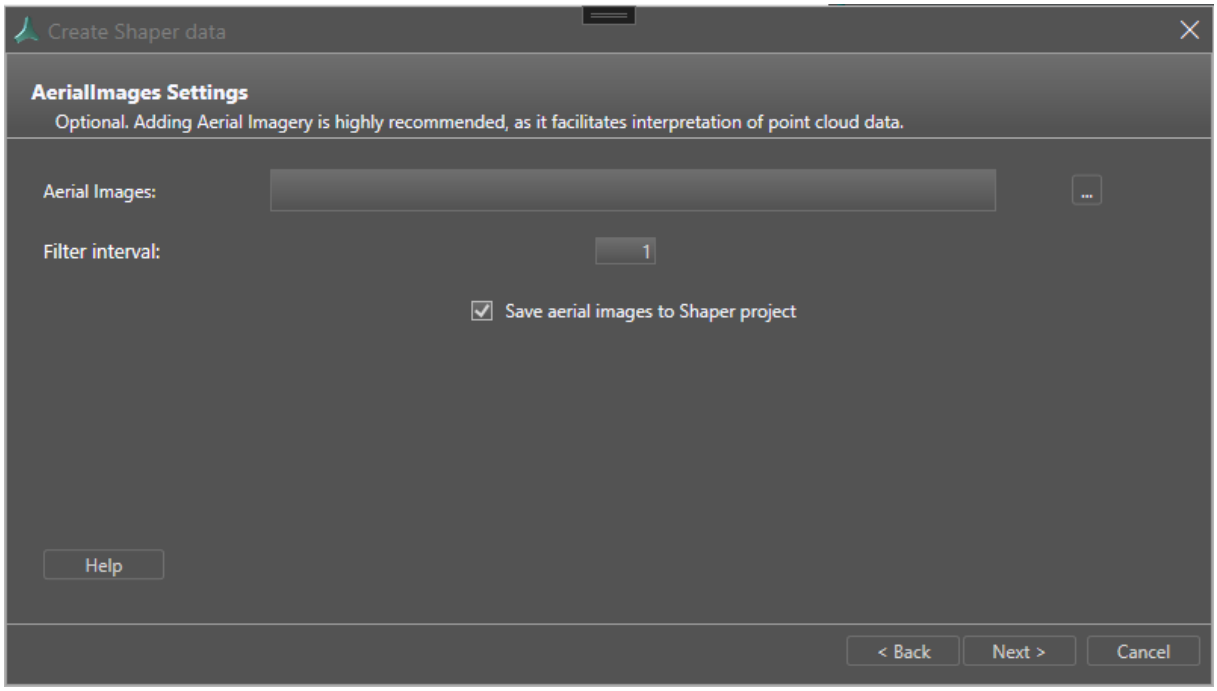


- ❖ Available Classes: Shows the available class codes of the selected files.
- ❖ Use for plane extraction: At least one of the available classes must be selected.
- ❖ Use for Visualization only: The points of the selected classes will be used only for visualization purposes. All unchecked classes will not be processed further. Planes will not be extracted.
- ❖ Class Info: Description of the classification codes according to ASPRS recommendations. The user must ensure that the classification corresponds to the recommendations. It is not checked whether class 6 really only contains building points.

Help: Provides more detailed information about the parameters on this wizard page.

Next: Switches to the aerial image parameter settings.

3.1.3. Aerial Image Settings (optional)



- ❖ Aerial images: This navigates to the aerial image orientation file(s) in the form of a City**GRID**® xml file.
- ❖ Filter interval: Only every nth image is used. 1 = every image is used, 10 every 10th image is used. Recommended for drone projects, where there is a high overlap and a high image count.

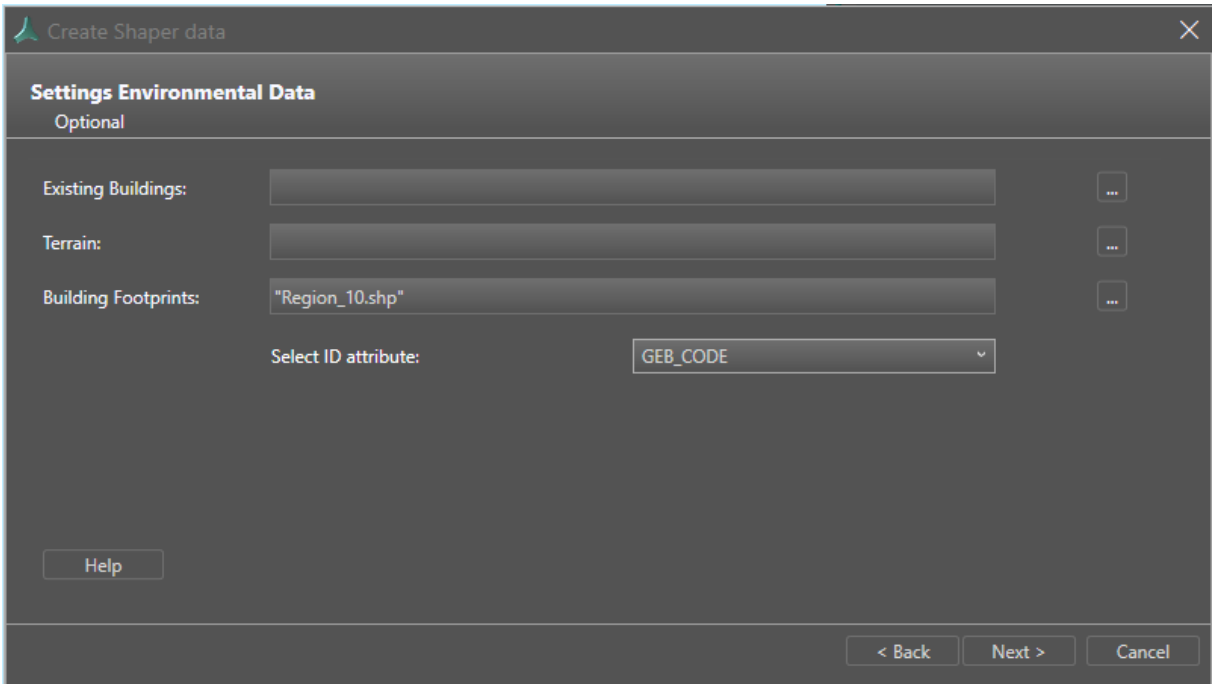
> *Tip: With a high number of images, it is advisable to start with a high filter value, as this massively reduces the calculation time. If it is determined during the first review of the finished project that too few images cover the working area, the value can be gradually reduced. With approx. 6500 images, a filter value of 50 has proven effective.*

- ❖ Save aerial images to Shaper project: If checked the images will be copied to the Shaper project, which increases project size and processing. If unchecked, the images will remain at their original location and

will be referenced in the project file. When distributing the project onto other devices the original location has to be accessible or the project has to be recalculated with the option checked.

Help: Provides more detailed information about the parameters on this wizard page.
Next: Switches to the settings of the environment data.

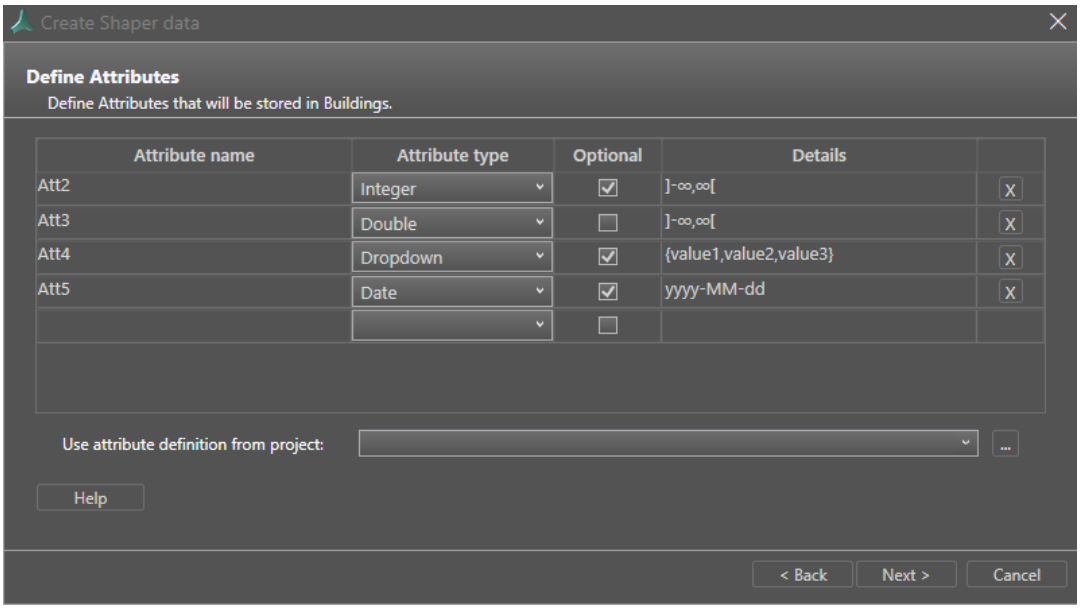
3.1.4. Environment Data Settings (optional)

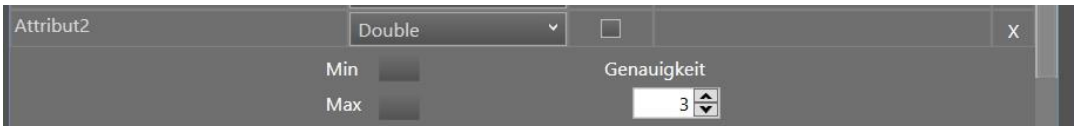


- Existing buildings: Existing City**GRID**® city model data can be added as reference data to a shaper project. This facilitates city model updates. Requires City**GRID**® XML.
- Terrain. Terrain data can be used to get a better impression of an area to be modelled. If a terrain is available, the building facades of the models are intersected with it and written into the file as Terrain Intersection Line (TIC). Requires City**GRID**® XML.
- Building footprints: For easier orientation in the shaper project, or as modelling aids for flat roof buildings. Are written into the file as User defined Plane during export. Requires ESRI shp. Footprint data requires a unique ID attribute. The specified files are automatically analysed for a matching attribute. If there are several attributes that match the criteria, the attribute names are offered to the user for selection in a drop-down list.

Help: Provides more detailed information about the parameters on this wizard page.
Next: switches to attribute definition.

3.1.5. Settings attribute definition (optional)





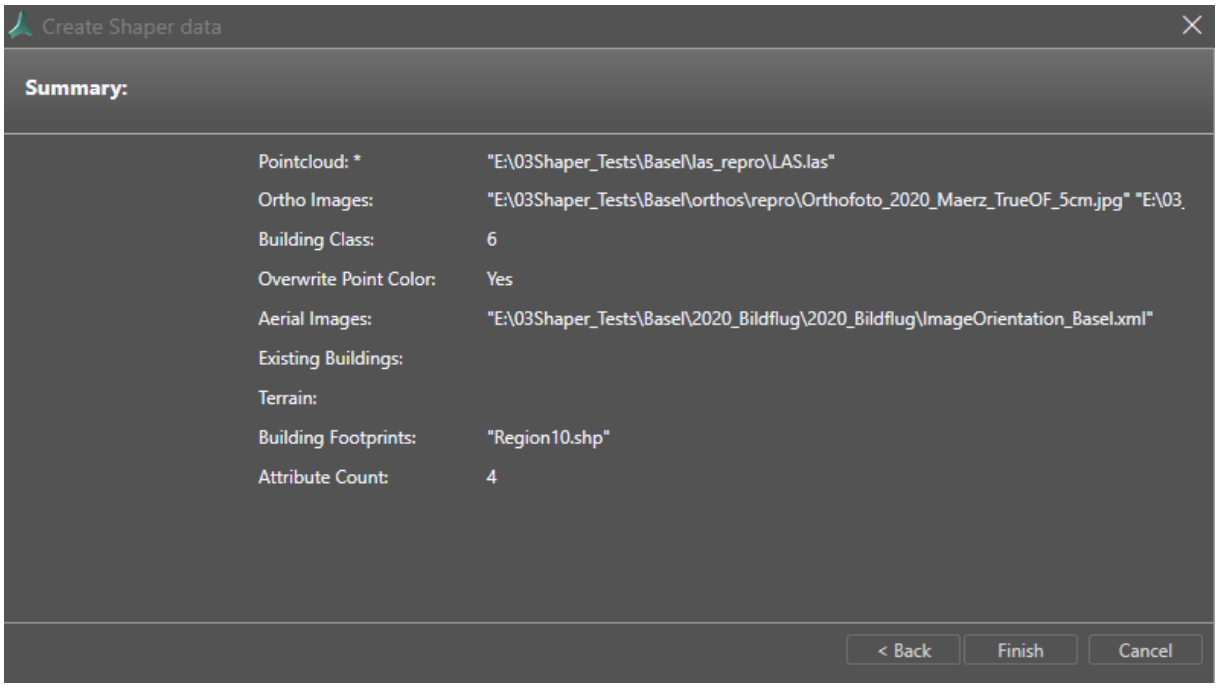
In the attribute definition, attributes can be defined for buildings that are valid for the entire project. They can be edited or deleted subsequently. You can choose between 5 ***types*** for the attribute definition.

- ***String***. Allows a user-defined text field.
- ***Integer***. Restricts the entry of a value to integer values. A min and a max value can be entered.
- ***Double***. Allows decimal numbers. A Min and a Max value can be entered, as well as a precision.
- ***Dropdown***. Allows you to choose between predefined values,
- ***Date***. Allows you to enter a date in a predefined format. There are four predefined formats to choose from, but a user-defined format is also possible.

Tip: Instead of creating a new attribute definition manually, the definition from an existing project can also be used by navigating to an existing project file with the ... button.

The ***Optional*** column indicates whether an attribute is required or not.
The ***Details*** column shows a summary of the definition given.
The ***X*** button allows you to delete a line.
Help: Provides more detailed information about the parameters on this wizard page.
Next: Switches to the summary.

3.1.6. Summary



- ❖ Shows an overview of the set parameters.

Finish: Starts the calculation of the shaper project. Depending on the amount of data, this may take several hours.

Note: To be able to use a fully calculated shaper project, the program must be restarted after the calculation and the new project loaded.

4.2. Integrating and updating external data

For certain areas of application, the integration of various external (auxiliary) data is useful.

- ❖ Building footprints
  Facilitate orientation in the pointcloud, in outline mode footprints enable the quick creation of (some) flat roofs. The prerequisite is a certain minimum accuracy and topicality of the footprints. Flat roofs that are created using a building footprint should not have a roof overhang. In this case, the roof must be subsequently processed and extended.
  The footprint data must have a unique ID attribute. The file, that is provided by the user will be analysed for a suitable attribute. If more than one suitable attribute is found within the file, the user can choose the id field from a dropdown list.
- ❖ Terrain

Creates an intersection with the created façade surfaces and gives a realistic impression of modelling.

- Existing building models

  Facilitate the updating of an existing city model, as new building models can be snapped to the existing buildings and thus gaps avoided. If errors are found in the existing city model, the affected building can be identified with an original file and edited there.

  The data can either be included right at the beginning when calculating the shaper project (Chapter 3.1.4) or subsequently with **Menu > Edit > Optional data** (Chapter 2.1.2.1)

  2.1.2.1).

5. Known Problems

- In some cases, TIF images with certain specifications cannot be processed correctly. These aerial images (in the known situations nadir images with alpha channel) cause grayscale roof textures when they are processed.
  This does NOT affect all nadir images and not all TIF with alpha channel. So far, the problem has only occurred with TIFs that cannot be opened in other applications (Photoshop, GIMP) or can only be opened in a roundabout way. Images from Trimble, Vexcel/Ultramap are sometimes affected.

Tip: To ensure that the images are not converted to grayscale after a long calculation time, it is recommended that all images are converted to jpg before processing (IrfanView, FME, GIMP, Paint.Net).

- It is strongly recommended to divide areas with large amounts of data into regions before creating the project.

6. Error Handling

The City**GRID**® Software is developed, tested, and maintained by UVM Systems with the aim of being error-free. Nevertheless, we cannot exclude the possibility of errors occurring during processing.

The database concept and version management guarantee that data cannot be lost. If an error in the software actually corrupts the data of the edited version, there is still the last stable version, which has not changed. In important cases, corrupt versions can usually still be repaired if the error has been found.

The following errors can occur:

If you want to send a bug report, please include the following information/data:

1. description of the actions that led to the error.
2. send the data in the menu **Feedback > Send Feedback** to the City**GRID**® Support Team

For errors in the shaper:

If the error is reproducible in the shaper, we also ask for a detailed log:

1. perform all actions before the error occurs.
2. activate in the **menu Feedback > Extended Logging** (slows down the software considerably).
3. Execute the action that produces the error. 4.
4. send the data in the menu **Feedback > Send Feedback** to the City**GRID**® Support Team
5. deactivate detailed logging again.

Please send bug reports to support@uvmsystems.com

7. Contact

www.citygrid.at

www.uvmsystems.com