URBAN VISUALISATION
& MANAGEMENT GMBH

UVM
SYSTEMS

City**GRID**®
2024

MANUAL

Solid

Content

Cover picture: Prague, Leonhard Niederwimmer, Pixabay

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

1 Introduction

CityGRID® Solid is a program for processing city model data for 3D printing. Based on existing building and terrain geometry CityGRID® Solid creates a dataset that meets the requirements of 3D printing machines. This includes:

- the preparation of the surface network with topologically correct edge-node structure
- hollowing of the print data, taking into account the minimum wall thickness
- the allocation of print data on physical size of the printing machine

Target of a data processing with CityGRID® Solid is correctly processed data that can be sent to the 3D printer without further processing steps.

1.1 The Solid Surface
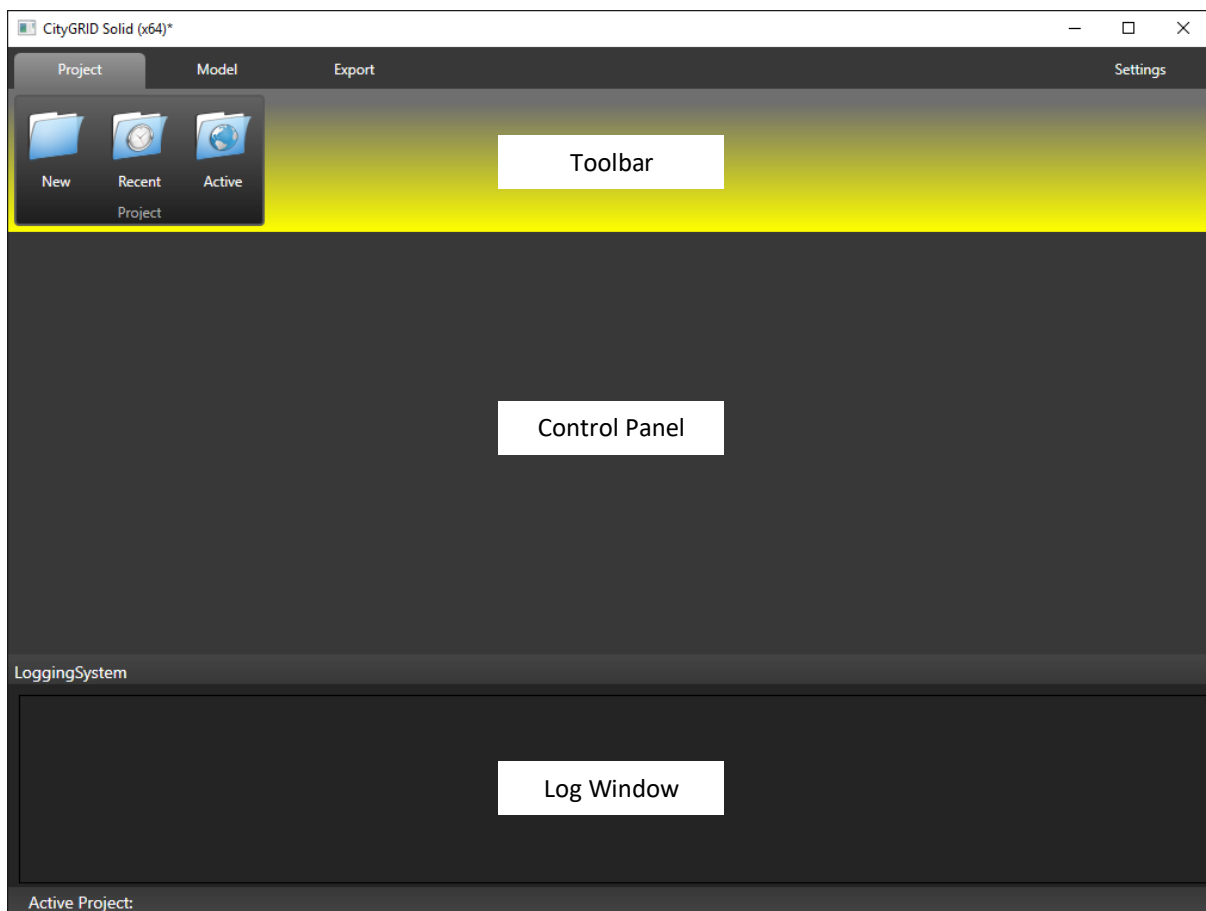
The surface of the solid is divided into the following areas:

- *Toolbar*

  Contains the program functions that can be accessed by tabs.

- *Control Panel*

  Depending on the selected function from the toolbar additional settings appear processes can be started

- *Log Window*

  Every started process is logged in a separate log file which can be found in the accompanying working directory of the project directory. These logs are displayed in real time in log window.

  Note: About the Settings tab, the log file can be deleted by pressing `Reset` *button at any time.*

1.2 Structure of a Solid project

A City**GRID**® Solid project consists of a collection of fixed predefined directories. For the integrity of a solid project preserving this directory structure is essential, therefore manual intervention by the user should be avoided if possible. When a new Solid project is created, a working directory is to be defined and the Solid creates the directory structure independently.

The user is granted access to data of the project directory via page *Run* (see 4.2). In the illustrated matrix buttons can be found to be able to access subdirectories and load files or log files.

Each Solid directory also has a file with the extension*.solproj. This is the centralized management file of Solid project, where global settings are stored. Use this file to open a Solid project in City**GRID**® Solid.
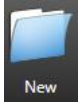
Note: If support is needed, please send the Solid project with all its data to UVM Systems GmbH. If the project is extensive the project directory should be packed and sent after consultation with a supervisor at UVM Systems GmbH.

2 Project

The tab *Project* is used to create new or load existing Solid projects

2.1 *New*

When a new Solid project is to be created, this can be performed by click on the `New` button. This opens a file browser, in which the location of the Solid folder structure (the Solid project) is set. Through this process, all other functions of the Solid City**GRID**® are activated.

When creating a new solid-project, the following information must be provided:

- *Name:*

  The name of the Solid project

- *Path:*

  The path to the Solid project.

- Description*:*

  The description field can contain any text which contains detailed information for Solid project. The description text is displayed in the list of recently opened projects (see 2.2) and supports the locating of drawn solid projects.

- *Scale:*

  Sets the magnification of the 3D print.

  Note: This parameter controls building generalization and hollowing out during processing taking into account the minimum wall thickness.
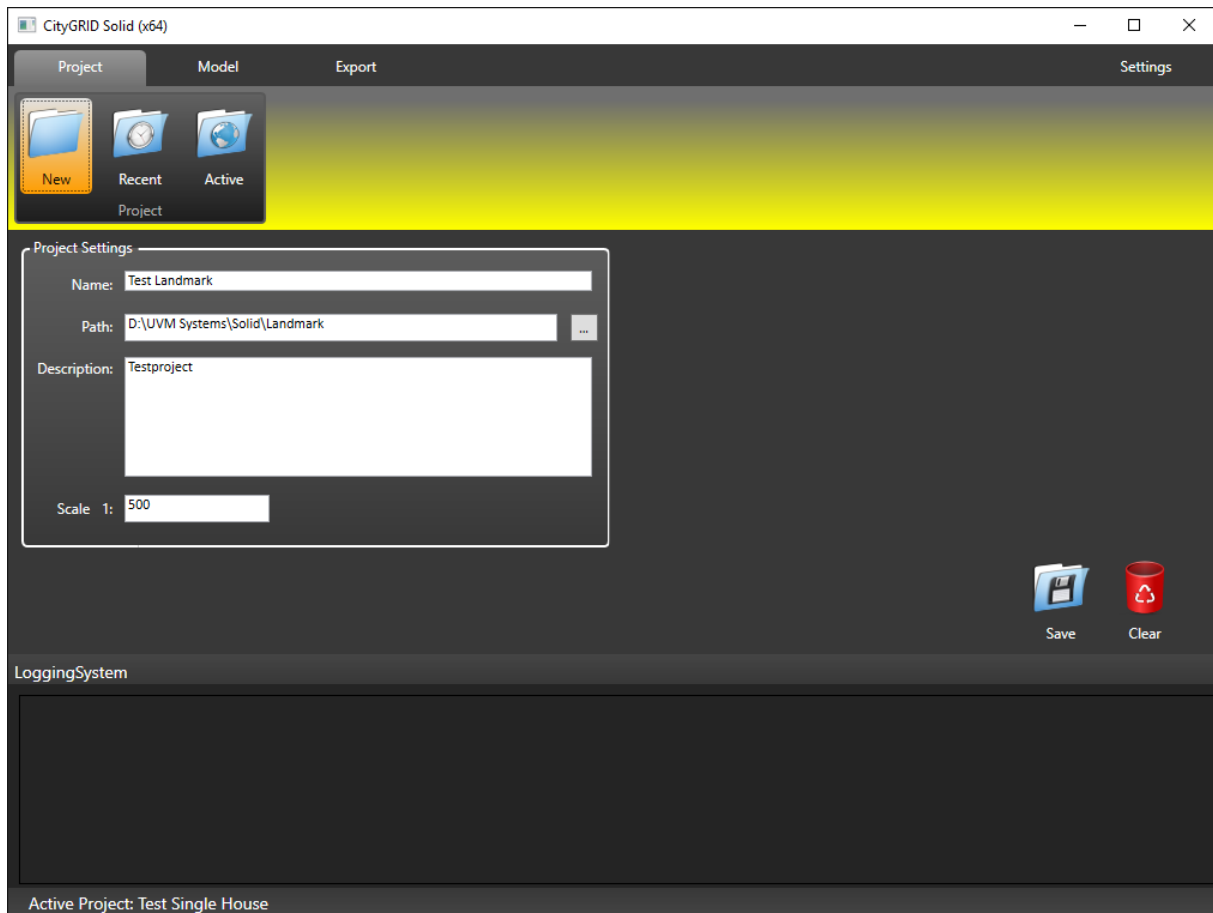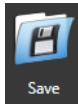
By `Save` button the solid-project is created at the specified path, `Clear` empties the input mask *Project Settings.*
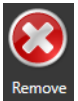
2.2 Recent

At the start of City**GRID**® Solid list *Recent Projects* of recently loaded projects is displayed in the control panel. The button `Recent` reloads this list with every click. For each project, the list of descriptive text is displayed in the *Description* section.

A project can be started by clicking on the `Open` button or by double-clicking.

Once a project has been started, City**GRID**® Solid changes to the *Active* view (see 0) and shows details for the opened project.

Once a project has been clicked in the *Recent Projects* list, the `Remove` button becomes active. Clicking on this will remove the activated model from the list of recently opened projects. The project data themselves remain unchanged by this action.
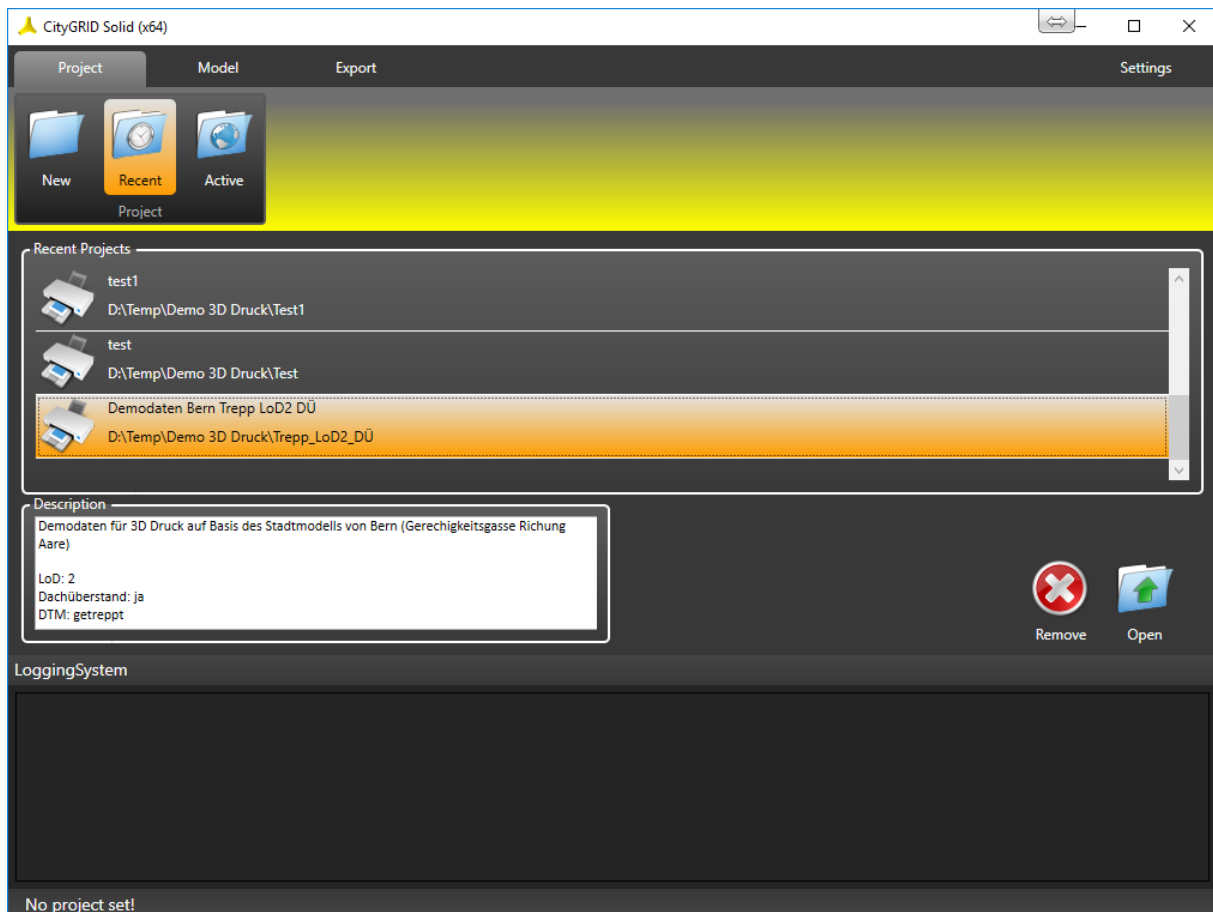
Note: When opening a Solid project, access to the data source (see 3.1) and the path to the export directory (see 4.1) are checked. If an error occurs, the Solid project enters a safe mode that allows working with the already-existing data, or gives the user the option to specify an alternative export path. The security mode is re-checked at each startup and automatically revoked as soon as the data source can be restored. During security mode most features of the solid are not available.
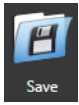
2.3 Active

Once a solid project has been opened, the page *Active* is visible. In this, the basic parameters of the Solid project are presented and, with the exception of the path, ready for changes. If changes to the parameters *Name*, *Description*, or *Scale* are made, they must be confirmed by clicking on the `Save` button. Any change to another function of City**GRID**® Solid also leads to the question whether incurred changes should be saved.

Note: Changing the project scale is a serious intervention in the Solid project and leads to reset of already present processing steps (see 4.2). Therefore, change the magnification only wisely!
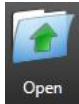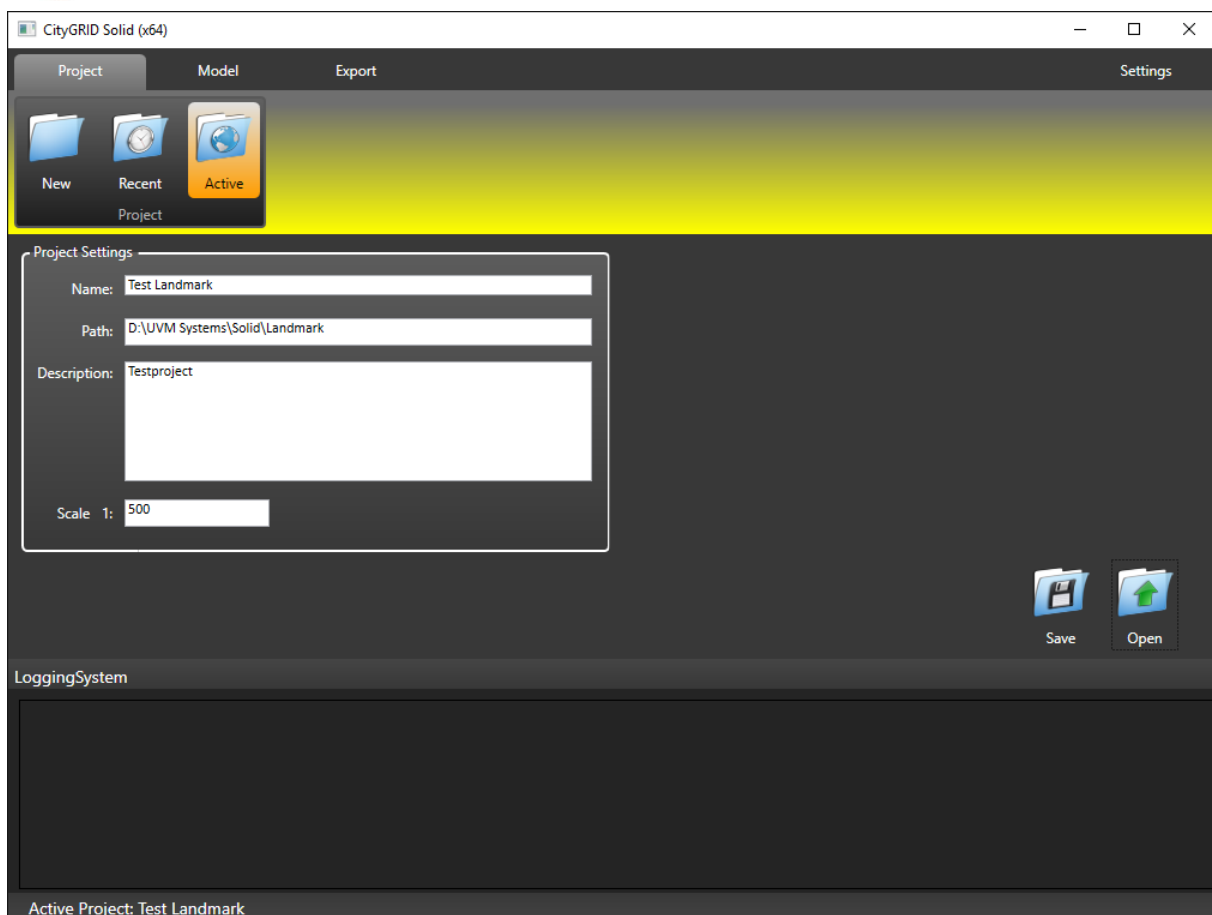
If Solid projects, which are not included in the list of recently used projects, are to be opened, a file browser can be opened on the `Open` button.

Note: To open a Solid project is always choose the solproj file.

3 Model

The tab *Model* is used for the specification of to be processed city model data. Here you specify which buildings and terrain models shall be prepared for 3D printing and define clipping rules.

3.1 *Load*

The button `Load` opens a page where data sources are involved, which include the areas to be printed. It is possible to select individual files or database connections.

Note: In the current version of CityGRID® Solid only CityGRID® files or CityGRID® database connections can be selected.

The command group *Source* carries an indication of whether data from a file or a database connection are to be loaded. If the radio button is set to `File` the button ⬚ appears for opening a browser. In this the desired file is selected.

When `Database` is selected, City**GRID**® Solid automatically opens the last registered database connection. If there is no connection, or the database is not available, the database logon dialog (see 5.2) is displayed.

Advice: Database connections can be changed on the Settings tab on the button `Database` *(see 5.2).*

Once a connection is established to a data source, all found (terrain) models appear in the selection list *Selection by model*. In the case of City**GRID**® data the list contains all models and terrain models of the data source. Each list item precedes an icon that characterizes at a glance the nature of the model:

Model with Units

Model with Units and Terrain model

Terrain model

Once a model has been selected in the list the text box *Information* displays parameters of the model. These are:

- Name of the model
- Number of Units in the model
- Number of terrain models
- Number of orthophotos (terrain texture)
- Information whether the buildings have texture
- Information about the spatial extent of the data in the coordinate system of the data.

Note: This feature is not available in security mode because changes would inevitably lead to reload of the base data. However, these can only be derived from an established connection to the data source.
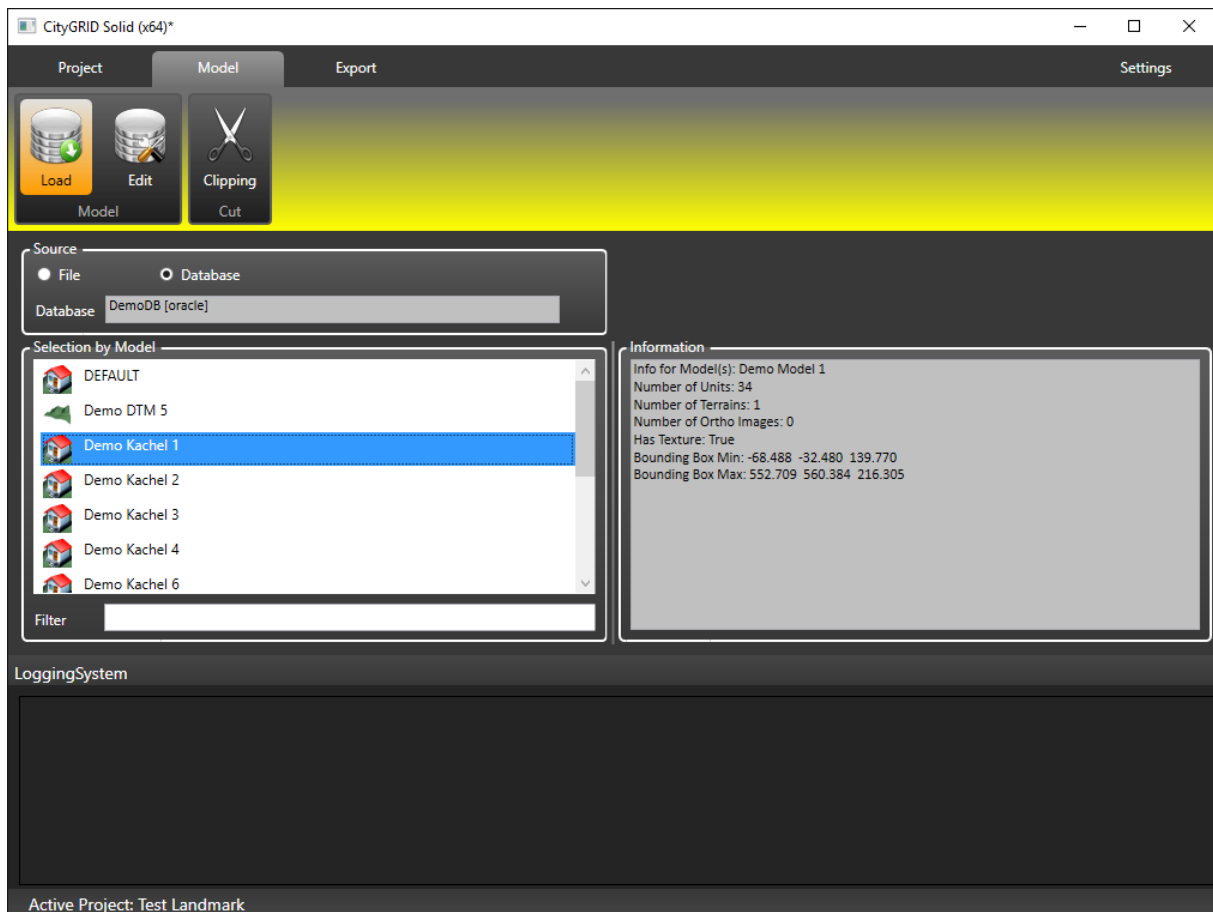
3.2 Edit
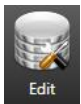
Once a data source has been integrated into Solid project via the `Edit` button a more accurate allocation of to be processed data can be done. Separated by buildings (Units), digital terrain models and orthophotos (raster with world file), all data of the data source, and already to the project assigned data is displayed.

The command group *Model Properties* is divided into columns *Project* and *Data Source*, and is furthermore sub divided into *Units*, *DTM* and *Images* series. The column *Data Source* contains all the information about the included file or the active database. In the *Project* column all data assigned to the Solid project will show up.

Note: All data that is listed in the selection lists of the column Project participate in the print processing.

In order to exchange data between the data source and Solid project the buttons ← → are available.

Note: The items in the selection lists are unique. A record may therefore appear only in the Project or Data Source column.

Each list contains a maximum of 1000 entries to keep list navigation performant. To view the next entries use the buttons ＾ ＾ ＾ ＾

Advice: If selections were made in the selection list, they must be assigned to the Project prior to loading new entries.

Each list has an associated filter field that the selection can be limited.

The Preview area displays a schematic representation of all the assigned data. Use the checkboxes to switch on and check off data groups.

💡 *Advice: The graphical representations have tooltips and display the name when the mouse moves over it. Similarly, the colour display changes when in the Project selection lists a selection is made.*

❗ *Note: This feature is not available in security mode because changes would inevitably lead to reload of the base data. However, these can only be derived from an established connection to the data source.*

3.3 Clipping

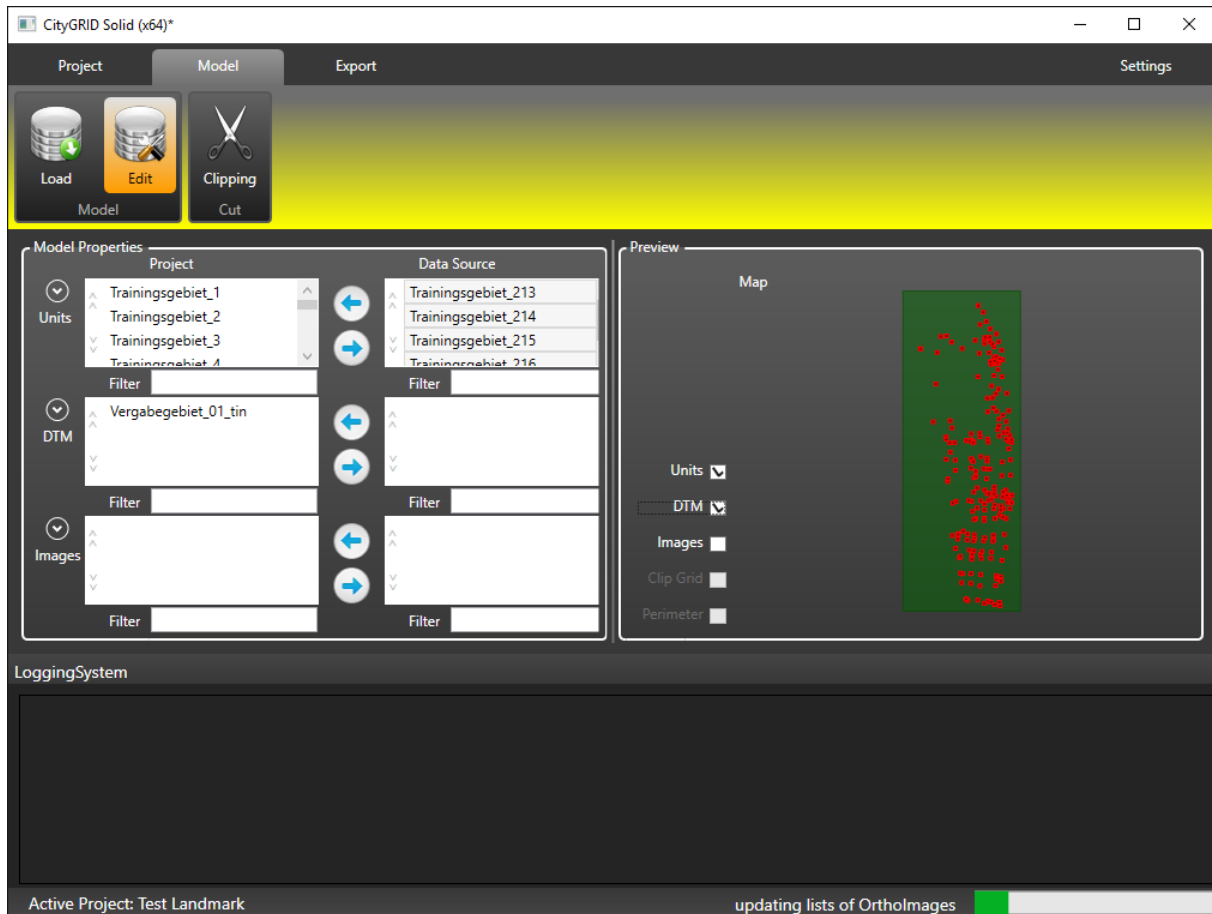The page `Clipping` allows the trimming of the printing area on the basis of a polygon, and the allocation to the physical size of the printer in 2D. Clipping is optional and must be activated if required.

- *Clip to Perimeter:*

If the parameter *Clip to Perimeter* is set to *Yes*, a shape file can be selected on the button ⬚, which may contain exactly one polygon. Assigned to the project data (see 3.2) will be intersected with this polygon and thus printing area limited.

❗ *Note: Clipping affects only on terrain models and buildings lying totally outside the polygon. Intersected buildings are not cut and remain with the printing area.*

- Clip to Build Volume

divides the loaded data to areas that fit into the printing space of the 3D printer. The space size can be defined on the page *Printer* on tab *Settings* (see 5.1). By applying the print scale (see 2.1) the print data is divided into matching tiles.

In the matrix *Clipping Grid (Projected Coordinates)* the coordinates of the fundamental point, and the mesh size of the tiles can be defined. Cells *Rows* and *Columns* provide information on the expected number of rows and columns of clipping grid.
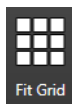
In the group *Print Size (mm)* the dimensions of the tile in the print scale are shown. If the calculated tile size exceeds the physical size, the background of the cells *X, Y* and Z will turn red. In this case, the tile sizes *delta X* and *delta Y* must be reduced so that the print tiles fit back into available printer space. The button `Fit Grid` sets a space optimized tiling and overwrites a possibly present tile division.

Advice: Use Fit Grid to get a rough indication of the distribution of print tiles. If necessary, the tile expansion can then be brought to nearest round values.

Note: A vertical adjustment to the physical size of the printer can't currently be done, the red background of the cell Z is only a visual warning that the print data must be submitted to further processing before they are printable. This processing currently has to be done outside of City**GRID**® Solid.
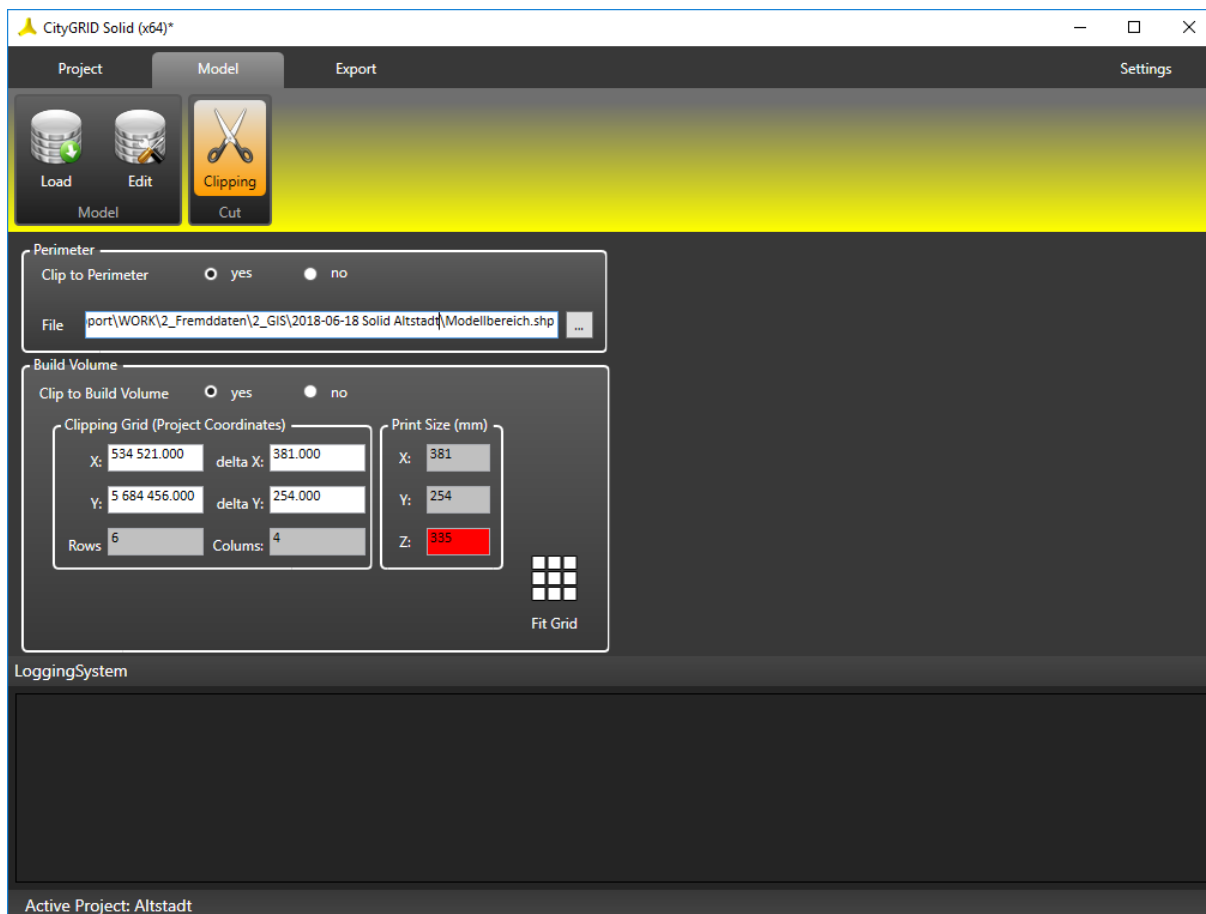
Note: This feature is not available in security mode because changes would inevitably lead to reload of the base data. However, these can only be derived from an established connection to the data source.

4 Export

On tab *Export* the parameters of 3D printing preparation are set, severity of the terrain model is defined and location and output format specified. Furthermore, the preparation of the print data is started and the progress shown graphically.

4.1 Export Settings

The page *Export Settings* provides a set of parameters to define the type of data processing for the 3D print. A distinction is made between parameters of the raw data processing for buildings and terrain models, or the appearance of the output data.
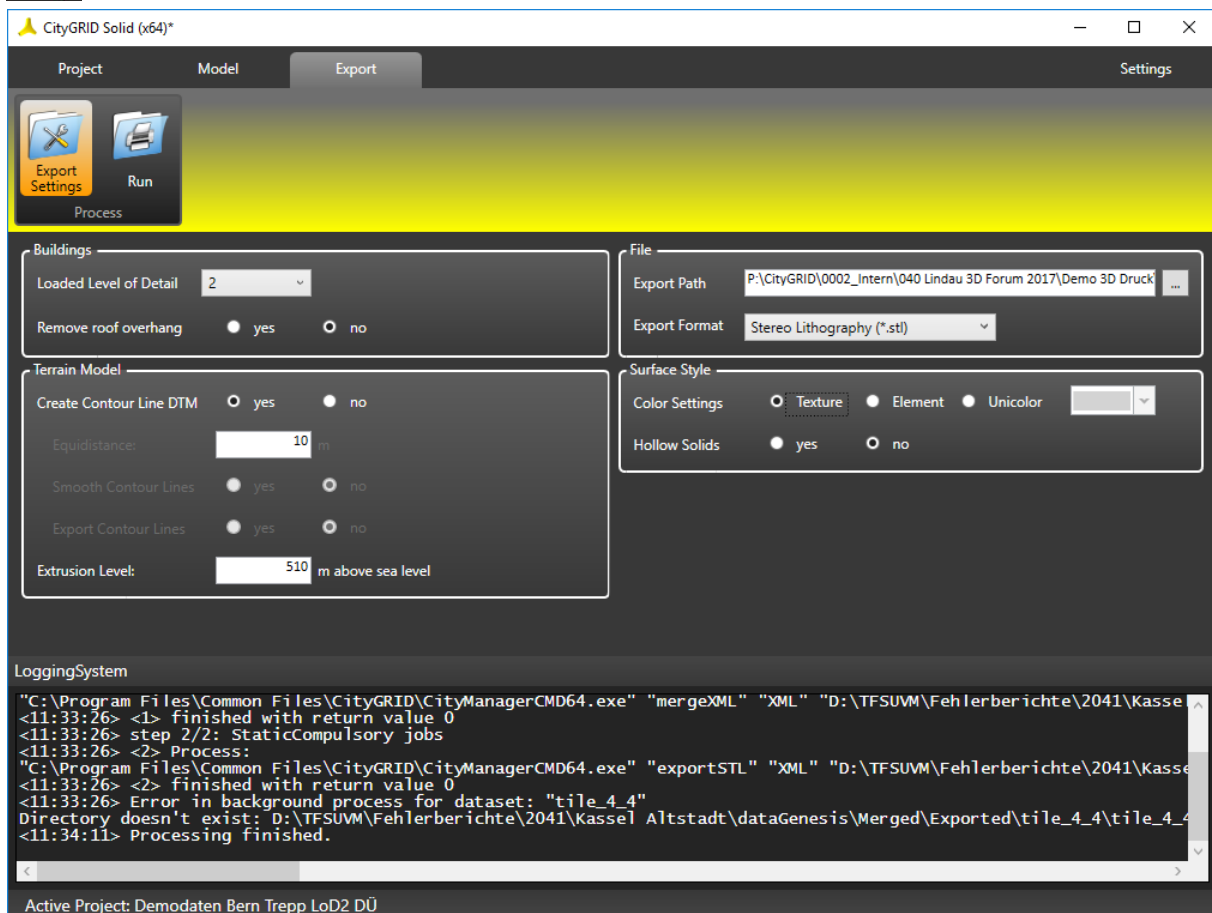
Buildings

- *Loaded Level of Detail:*

    Determines the level of detail the building models are to be loaded. This parameter only has effect when the data is loaded from a CityGRID® database.

    Note: The level of detail is an indicator of the detailing of a building. The higher the value, the more detailed is the building model. Commonly used are the LoD stages 1 (block model), 2 (roof shape model) and 3 (roof detail model).

- *Remove roof overhang:*

    removes the roof overhang surfaces of building models. The roof areas are cropped to the extent of the facades and any gaps between walls and roof areas are closed.

Terrain Model

- *Create Contour Line DTM:*

generates a height layer model from read TIN.

  o *Equidistance:*

  Let you define the vertical distance between adjacent horizontal planes. The value must be indicated in meters and is applied to the input data. If *Clipping* (see 0) was enabled on the tab *Model*, the height of layers models will be adjusted accordingly.

  o *Smooth Contour Lines:*

  applies a smoothing algorithm to contour lines (isohypses) derived from the TIN. Closely spaced areas are protected and not subjected to smoothing. Likewise isohypses that intersect by the smoothing are identified and unsmoothed.

  o *Export Contour Lines:*

  extracts the formed isohypses to dwg data and stores them under the specified Export Path (see below)

  Note: For preparation of a height layer model, the software package FME by company Safe Software is used. On exporting computer a supported instance of FME must be installed. By default, the past three years versions are always supported by CityGRID® Solid.

  Note: The smoothing of the contour lines is also done via FME. Since the smoothing of contour lines is a complex process and FME, in the currently available version, does not support in this regard, it may happen that the smoothing result tends to overlap. Where possible CityGRID® Solid recognizes such cases and tries to avoid them, but if this is not feasible, the terrain model has to be exported without smoothing.

- *Extrusion Level:*

specifies up to which altitude the terrain models are extended vertically. The value has to be understood as an absolute value.

  Advice: By setting the extrusion Level all terrain models of a project will be extruded to the same level. Thereby, all the print data can be placed side by side without showing altitude jumps. If an area with significant elevation differences is to be printed and the available vertical printing space size is exceeded, processed data must be trimmed in another program. A vertical clipping is not included in the scope of CityGRID® Solid. In such a case the printing unit must be equipped by a substructure, which requires selectively cropping of the print data.

File

- *Export Path*:

specifies the location of the processed print data.

- *Export Format:*

defines the output format. The formats Stereolithography (.stl), Wavefront Object (OBJ) or 3mf (3D Manufacturing Format) can be chosen.

  Note: Stereo Lithography files have no texture information and are therefore suitable only for data to be printed mono chomatically. If texture should be taken into account, and the printing method supports it, the Export to 3mf oder obj must be selected.

Surface Style

- *Color Settings:*

Determines the surface behavior of the print data.

  o *Texture*:

  Controls whether any existing textures of the raw data should be taken into account during the print process.

o *Element:*

Adopts the **CityGRID**®® standard colors for roof, façade, terrain etc.

o *Unicolor:*

Uniformly colors all areas of the data set. The color selector can be used to determine the desired color tone.

Note: The color settings are only available for obj and 3mf export formats. The stl format does not support color and always produces monochromatic print data, which also disables color selection on Solid user interface.

- *Hollow Solids:*

activates the hollowing out of print models to save the printer supplies. Taking into account the minimum wall thickness of the printer (see 5.1) **CityGRID**®® Solid specifies a grid in the print data and builds subtraction bodies that undermines the 3D objects. Because some 3D printers also offer algorithms for hollowing of the printing units, this option scan be witched optional in **CityGRID**®® Solid and should only be activated if needed and cross checked with the printing company.

4.2 Run

On the *Run* page, the actual data processing is started and their progress displayed. About a predetermined sequence of processing steps **CityGRID**®® Solid prepares the print data from the raw data, and outputs the result, after successful processing, in the desired format. If problems or errors occurred during preparation will be marked as well as successfully treated data. Affected data is provided for further processing in **CityGRID**®® Modeler.

About a matrix the *Run* page shows the data to be processed line by line. A grouping in *Unit* and *Terrain* takes place. The processed Unit / Terrain stands ready on its own line. The name follows in case of buildings the UnitID and terrain models of TerrainID.

Note: In the case of large printing projects with many units these are combined to form parts to obtain the structure and clarity of the matrix.

If *Clip to build volume* (see 0) option is enabled, the name of the Units / terrains changes on "tile_X_X", (schema "tile _" [line number] _ [column number]). The tile_1_1 is located in the lower left corner.

Advice: Use the map on the page Edit (see 3.2), to inspect the structure of the clipping grid. All bounding boxes of the imported data are used to derive the clipping grid. The matrix of the Run page displays only those cells in which actual buildings or terrain data can be found.

The columns of the matrix show the *Name* and *Type* of the data packet, as well as the applied operation. All data processing is performed in the project directory in a predetermined folder structure as **CityGRID**®® XML corresponding to the operation steps. The following steps (stages) are traversed during print preparation in succession:

- *Original*:

The Units and Terrain Models from the data source, in their unaltered state, exported to a local file in the format **CityGRID**®® XML. If a height layer model should be created, it will be generated by an FME process (either directly in the directory containing the Stage or – if tiling is required – initially in a directory "shared" and then the respective tiles in the directory of the stages).

- *Clipped*:

This stage is only available if a tiling or / and a clipping should be made by a perimeter (see. 0). It will cut the respective records of the tile boundary / perimeter.

- *Manipulated*:

o *Building:*

A coordinate transformation in a local coordinate system is done as well as a scaling to the print scale is performed and in the Units are changed to centimetre. (Intermediate file "scaled.xml"). Thereafter any missing floors are inserted and roof overhangs removed.

- o *Terrain:*

  If ortho images are present and a textured print model shall be created, all necessary ortho images are fetched from the data source (intermediate file "orthoImages.xml"). Thereafter, as for buildings, the print scale is applied (intermediate file "scaled.xml"). Finally, the terrain surface is converted into a solid by adding side walls and bottom surface.

- *Watertight*:

  An attempt is made to convert the solids to a topologically "watertight" mesh surface. Small holes are closed if necessary. The surfaces are combined to element complexes in such a way that only a single solid is contained therein. Duplicate faces are thereby extracted in individual solid.

- *Hollowed*:

  This stage is only available if terrain under buildings must be punched and / or solids to be hollowed out. Initially, all the records are combined into one "merged.xml" file. After that the terrain under buildings is punched (intermediate file "embossed.xml", if the option is selected). Finally, all solids are hollowed out (if that option is selected).

- *Exported*:

  If there is no Stage *Hollowed*, all the records are first combined into one file "merged.xml". This is then converted to the target format.

- *Result*:

  The results from the Stage *Exported* are copied to the destination directory.

Via the `Run` button, the print preparation starts and successively goes through the reprocessing steps presented above. `Cancel` interrupts the current preparation, but leaves the work steps that have already been successfully completed in the Solid project so that the processing can be continued at a later date. `Reset` resets the Solid project to the original state and also removes all intermediate results from the project directory.
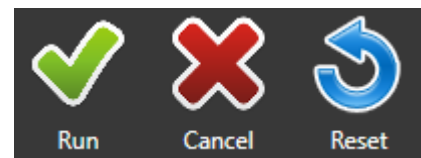
The progress of the work package is expressed in the matrix by the background colour of the corresponding cell. The colours have the following meanings:

Data in Solid – project was processed correctly.

Data in Solid project are outdated. A new processing is required.

Data have not been created in solid project and therefore missing.

During processing, the states of the stages change permanent. Through parallel computation, it may also happen that data packets are processed at different rates. Only at steps, that will make a joint processing of all data necessary, the individual stages will wait for each other again.

Each Stage shows in addition to the background colour up to four icons. The following meanings and functions are associated with the icons:

Enables the Stage for processing. By setting a checkbox all other checkboxes in the following stages are automatically set.

Opens the working directory with the processed data of the Stage. In this directory, the raw data (step "original") or the intermediate results as XML City**GRID**® lie. By clicking the icon, a file browser opens.

The processed data does not meet the requirements for 3D printing and require further processing. By clicking the icon, a log file will open with information about the problem areas. This log file can be read into the City**GRID**® Modeler warning window and shows the trouble spot on the 3D window, when the associated XML data is also loaded in the Modeler, (see Manual City**GRID**® Modeler)

The print processing could be carried out successfully. This icon is no other function assigned.

Data of this stage was saved again after the automatic processing by City**GRID**® Solid and have a younger creation date, as noted in the project file. Typically, data were processed in the Modeler in

this case. A re-processing of the following stages should be carried out to apply the changes to the print processing. At the stages "Watertight" and "Hollowed" a recheck for watertightness can be carried out, which is meaningful after an interactive overhaul of non-printable data in City**GRID**® Modeler.

Note: The 3D printability is checked after the operations Watertight and Hollowed. The corresponding icons can therefore occur only in these columns.

5 Settings

On Tab *Settings* general settings for operating the City**GRID**® Solid are made. The settings made are from the project independently and will be retained when program is restarted.

5.1 *Printer*

On page *Printer* 3D printing machines are registered for which data are to be prepared with City**GRID**® Solid. Any number of printers can be registered. The assignment of the printer for the project is done when creating the project, by selecting the machine to the *Printer* page.

Specify following parameters to register a 3D printer:

- *Machine Name*:

  By this name the printer ismanaged by City**GRID**® Solid.

- *Description*:

  Use field *Description* for documentation for printing machine . It can accommodate any descriptive text and serves for detailed description.

In addition to the *Printer Properties* any registered printer must have set the information on the physical size (*Build Volume*). The specified dimensions are used for automatic tiling of a print area (see 0), and the warning when exceeding the model extents. All information must be expressed in millimeters.

- *Length*:

  Defines the longer side of the build volume.

- *Width*:

  Defines the shorther side of the build volume.

- *Height*:

  Defines the geight of the build volume.

- *Minimal Width*:

  Specifies the minimum wall thickness of the print modell. This varies depending on the printing method and materials and is therefore bound to the printing machine.
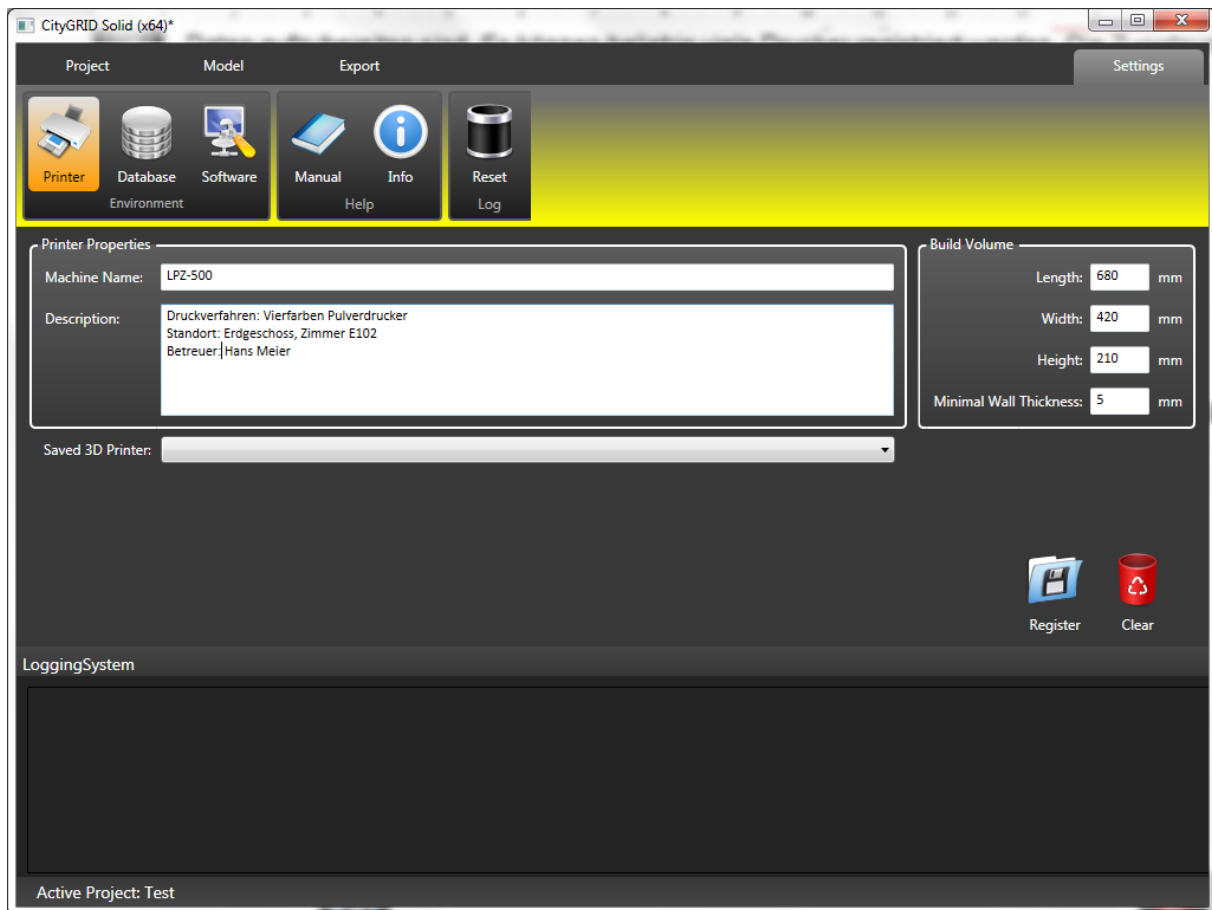
Note: The minimum wall thickness is used for hollowing of the print model and is therefore an integral part of each CityGRID® Solid project. A subsequent change of the minimum wall thickness can result in the resetting of the print processing and subsequent recalculation of data.

Note: The build voulme height is used only for permit verification of the model height, but does not cause clipping of the print model. If the model height exceeds the build volume height, further clipping of print data with appropriate software has to be done.
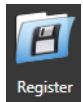
Using `Register` button the printer is registered in City**GRID**® Solid, `Clear` empties the input mask *Printer* and removes the printer from the *Saved Printer* list if it was included. All registered printers can be called up via the selection *list Saved Printer* and assign to the loaded project.

5.2   Database

On the *Database* credentials can be entered to City**GRID**® databases. When the last active database connection can be established again when starting a City**GRID**® Solid project, the program opens this independently.

For a new database connection following information must be provided:

- *Provider:*

  Specifies the database management system. Currently you can change between Oracle and MSSQL.

- *Server:*

  Specifies the name of the database server. This parameter must be specified only for MSSQL databases.

- *Database/Service:*

  For MSSQL databases this field contains the database name, with Oracle databases the service Name.
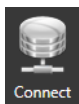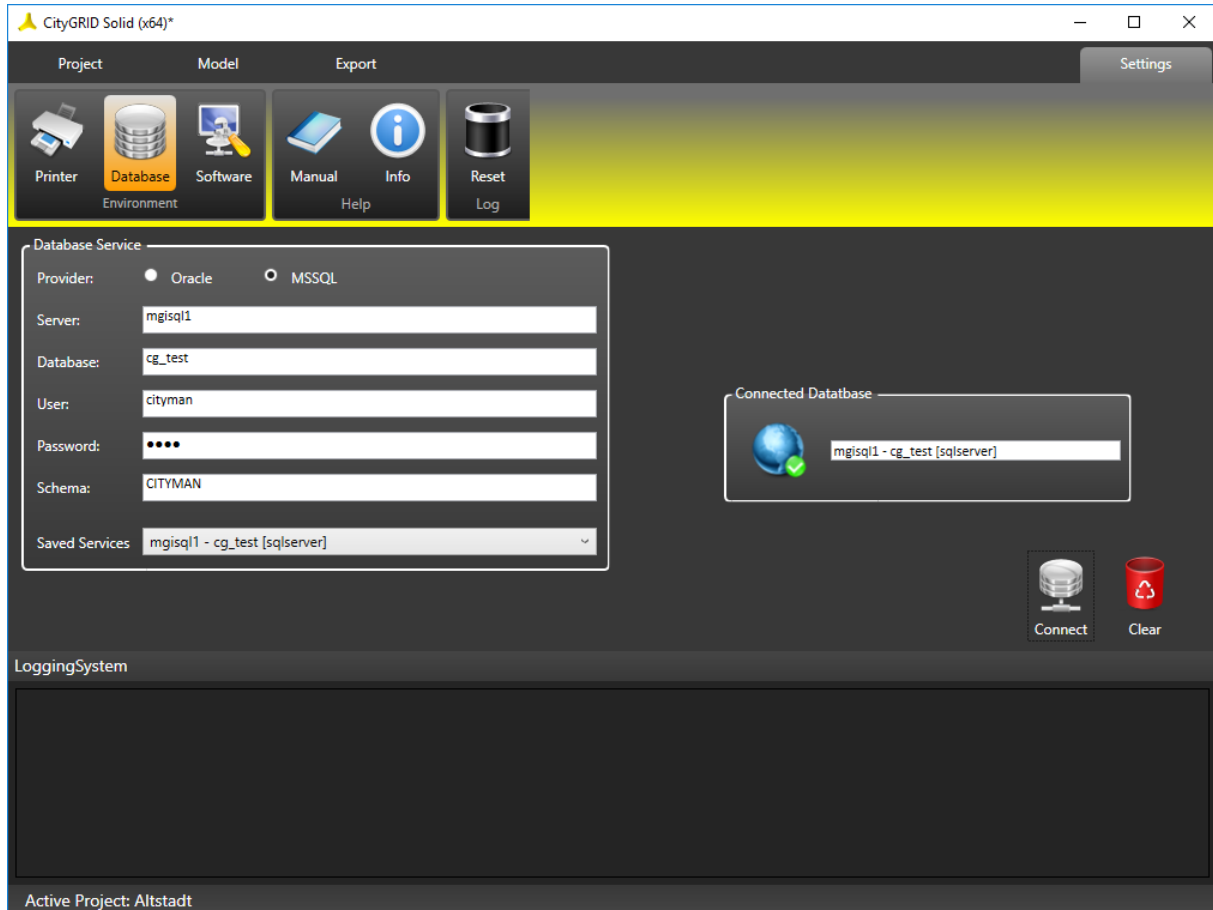
- *User:*

The username for database access.

- *Password:*

    The corresponding user password for the database access.

- *Schema:*

    The name of the database schema. This is often the same as the username.

Once all the login parameters are passed, the connection may be established to the database via the button `Connect`. The current database connection appears in the Connected Database Field.

Each registered database connection is registered in the *Saved Services* List.

By clicking on the `Clear` button, all input fields with the database parameters are emptied. If the database connection is already entered in the *Saved Services* list, it will be removed from it, provided there is no upright connection to the database. If necessary, disconnect the database connection before clearing.

5.3 Software

The page *Software* provides a selection list of installed FME versions and allows you to enable a detailed logging.

- *Use FME version*

    lists all installed versions of the program Feature Manipulation Engine by Company Safe Software (www.safe.com). If multiple versions are found, you can select the preferred version.

Note: FME is required for processing of a height layer model (see. 4.1). If no suitable FME version is found, this type of terrain model processing is not available.

- *Repair Tool*

  Offers the possibility of using a Windows tool for automated leak testing and correction during print preparation. Print data which were not waterproof and thus printable via the implemented City**GRID**® leak-tightness correction can thus be processed to the greatest extent possible for 3D printing.

  Note: This option works only on Windows 10. Older operating system versions do not offer this service.

- *Activate Comprehensive Logging*

  enables verbose logging. This is needed in case of failure of the software to enable UVM Systems GmbH to do debugging. In normal operation verbose logging can be disabled.

  Advice: Verbose logging produces much more extensive log files, which leads to increased memory requirements and reduced performance!
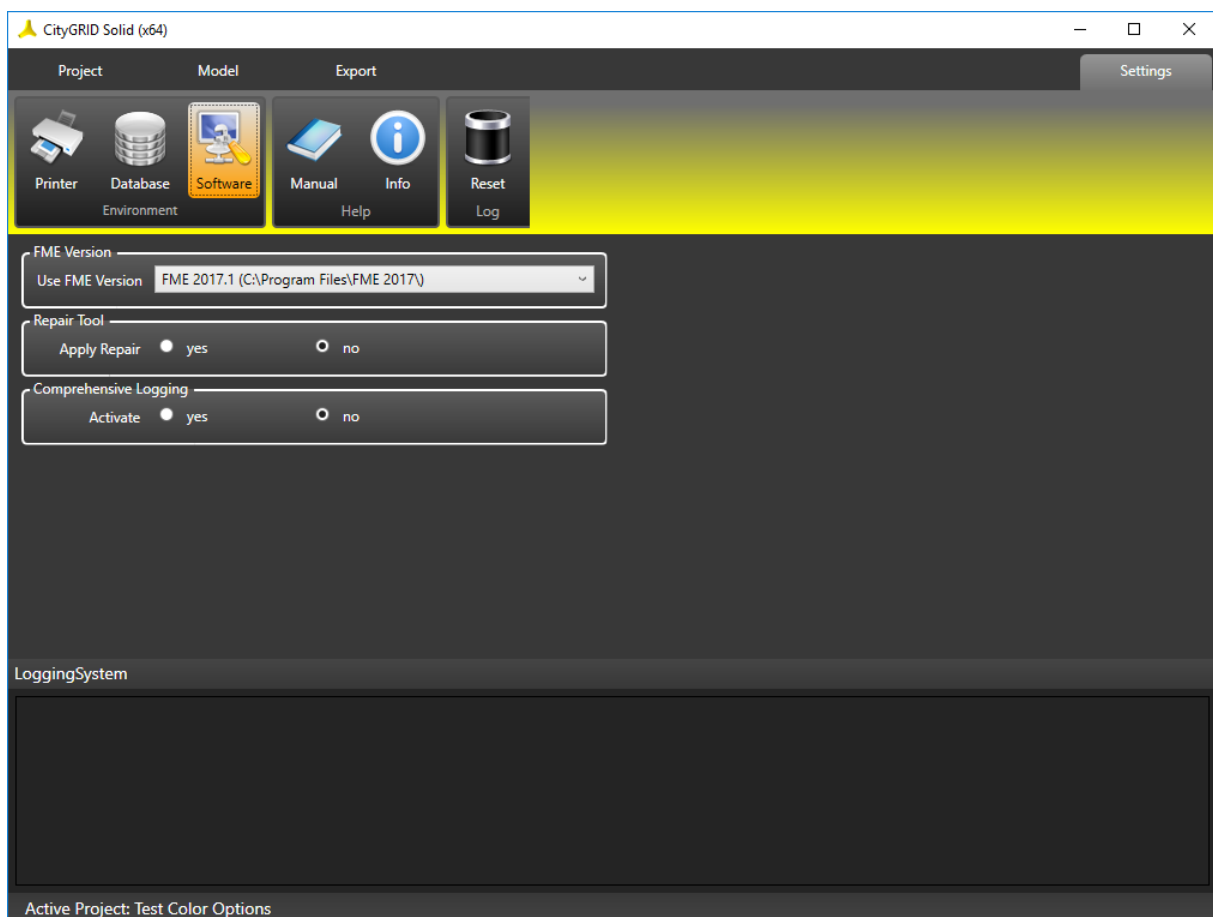
5.4 Manual

By clicking on the button `Manual` the City**GRID**® Solid manual opens in a PDF Reader. The manual will be displayed in the language of the operating system by default. About the Windows Start menu the manual can be accessed in other languages.

5.5 Info

The `Info` button calls up the page with the version information of the currently installed City**GRID**®
version. Please attach a screenshot of the page, at each request for support.

5.6 Reset

By clicking `Reset` the log window will be emptied.

6 Contact

UVM Systems GmbH

www.citygrid.at

www.uvmsystems.com