

# Reference Manual

Version 1.1



TcpMDT  
PointCloud



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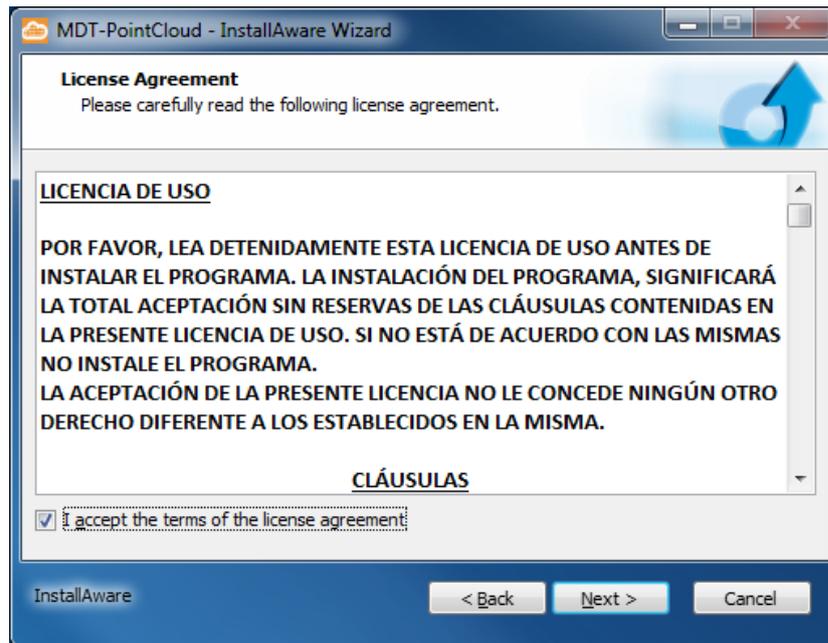
# 1. INSTALLATION

## Requirements

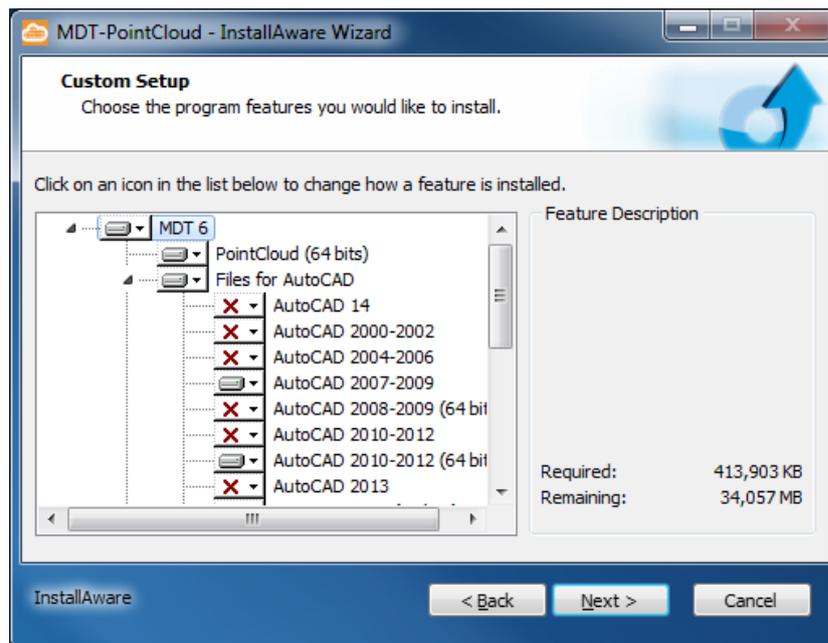
HARDWARE	
Processor:	Dual-core 2 GHz or above
Memory:	Minimum 3 Gb
HD	4 Gb free space (application and examples).
Graphic Card:	Minimum 1024 x768 pixels. Compatible with OpenGL. Chipset NVidia Quadro Fx or above with at least 512 Mb.
Accessories:	3-button mouse + wheel or signaling device with the same function. CD-ROM/DVD reader.
Other devices:	Optional compatible active or passive stereo system .
SOFTWARE	
Operating System:	32 and 64 bit Windows XP / Vista / 7
CAD:	AutoCAD: versions 14, 2000, 2000i, 2002, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013 and compatible. BricsCAD: versions 9, 10, 11, 12 and 13. ZWCAD: versions 2009, 2010, 2011, 2012 and 2012+.
Other software:	NET Framework 2.0, 3.5 and 4.0 Microsoft VC + Runtime 2008 and 2010 Updated software.

## Installation process

Insert the CD-ROM into the corresponding unit and execute the SETUP.EXE program. The usual installation process for the different Windows platforms programs will then begin.



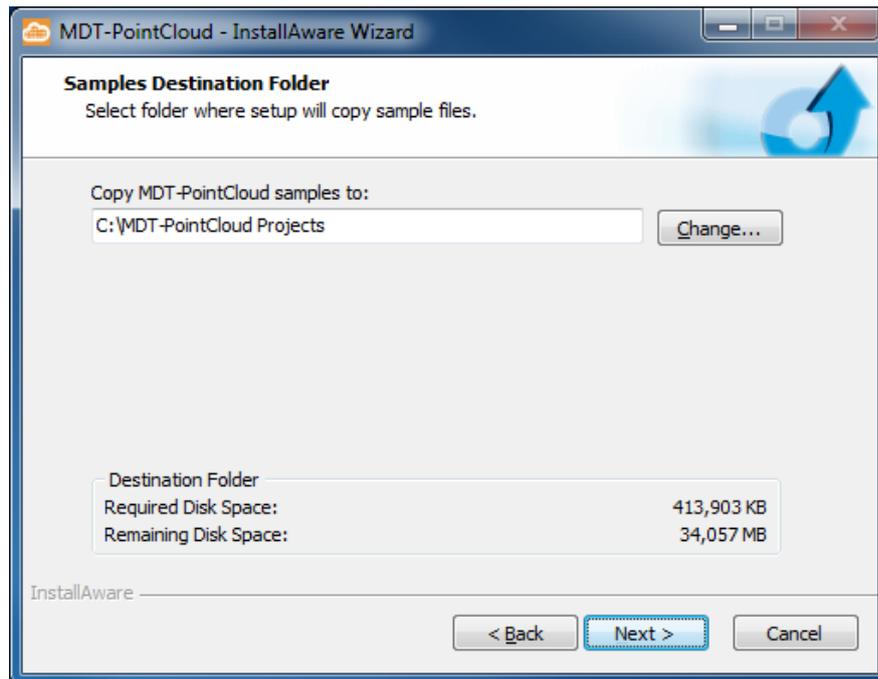
Read the licence carefully. In the event you do not accept the terms, you should cancel the process and return the program to the distributor.



Then select the versions of the CAD for which you wish to install the program. Take into account that MDT 6.5 should be installed in these versions to enable MDT-PointCloud to be executed.

The different options are:

- **AutoCAD files:** this option includes the files needed to execute MDT-PointCloud on AutoCAD platforms, from version 14 to 2013.
- **BricsCAD files:** To be installed when using BricsCAD, from version 9 to 13.
- **ZWCAD files:** Required when using MDT-PointCloud on ZWCAD versions 2009 to 2012+.
- **Documentation:** Manuals in PDF format.
- **Examples:** Files required for user manual tutorials.

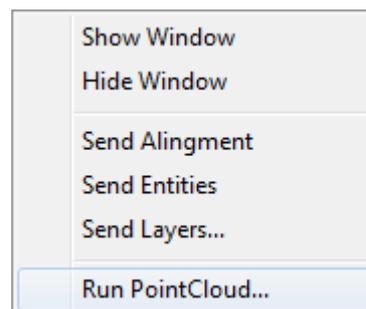


Once the components to be installed have been defined, select the example files folder. All this information enables you to install the program.

Third-party software needed to execute MDT-PointCloud is also installed during the installation process. The installation programs for the software include the corresponding dialog boxes, which are generally executed by clicking on “OK” or “Next”.

## After installation

To start up the application, start one of the CAD applications for which you have installed MDT-PointCloud. The CAD application menu bar or Ribbon should display an “MDT-PointCloud” drop-down box with several options.



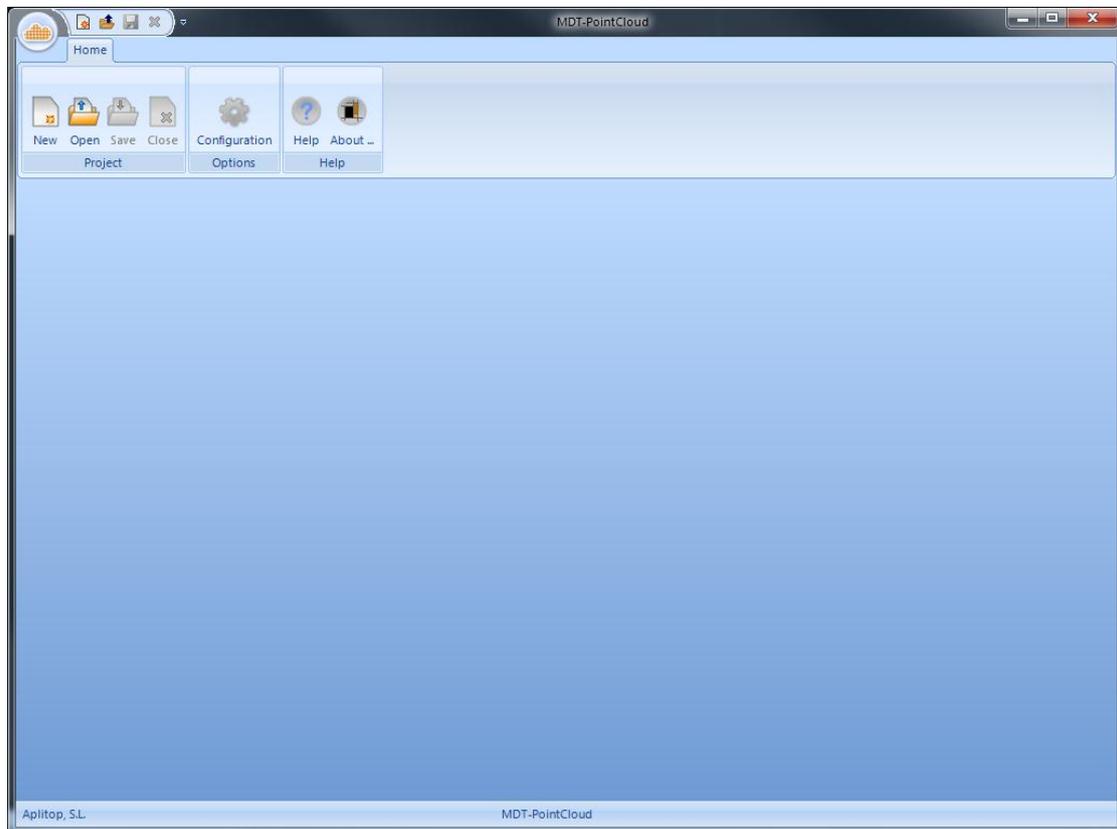
Select the “Run PointCloud...” option to start the MDT-PointCloud application. Remember the CAD application should not be closed whilst using MDT-PointCloud, otherwise MDT-PointCloud will also close as it requires MDT to operate.

Consult the Demonstration Guide to get to know the main features of the application and to begin to work with it. Use the example point clouds which accompany the installation process to check the results obtained are correct.

## 2. USER INTERFACE

### Introduction

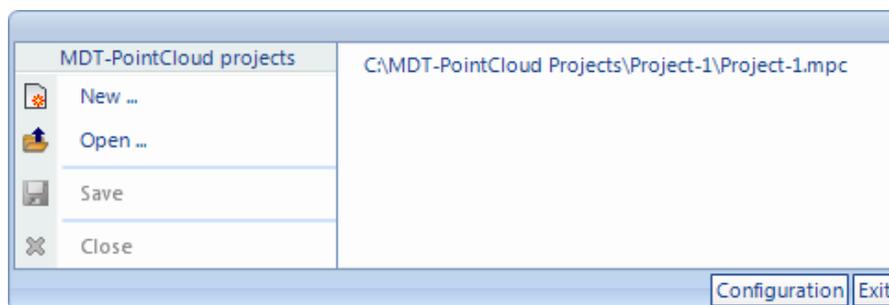
MDT-PointCloud is an application for Windows systems with a user interface composed of a series of windows to facilitate interaction with the user. The main window appears on starting the application.



The quick access buttons and ribbon enable the user to create, open and customize the project's features, and get help about the software.



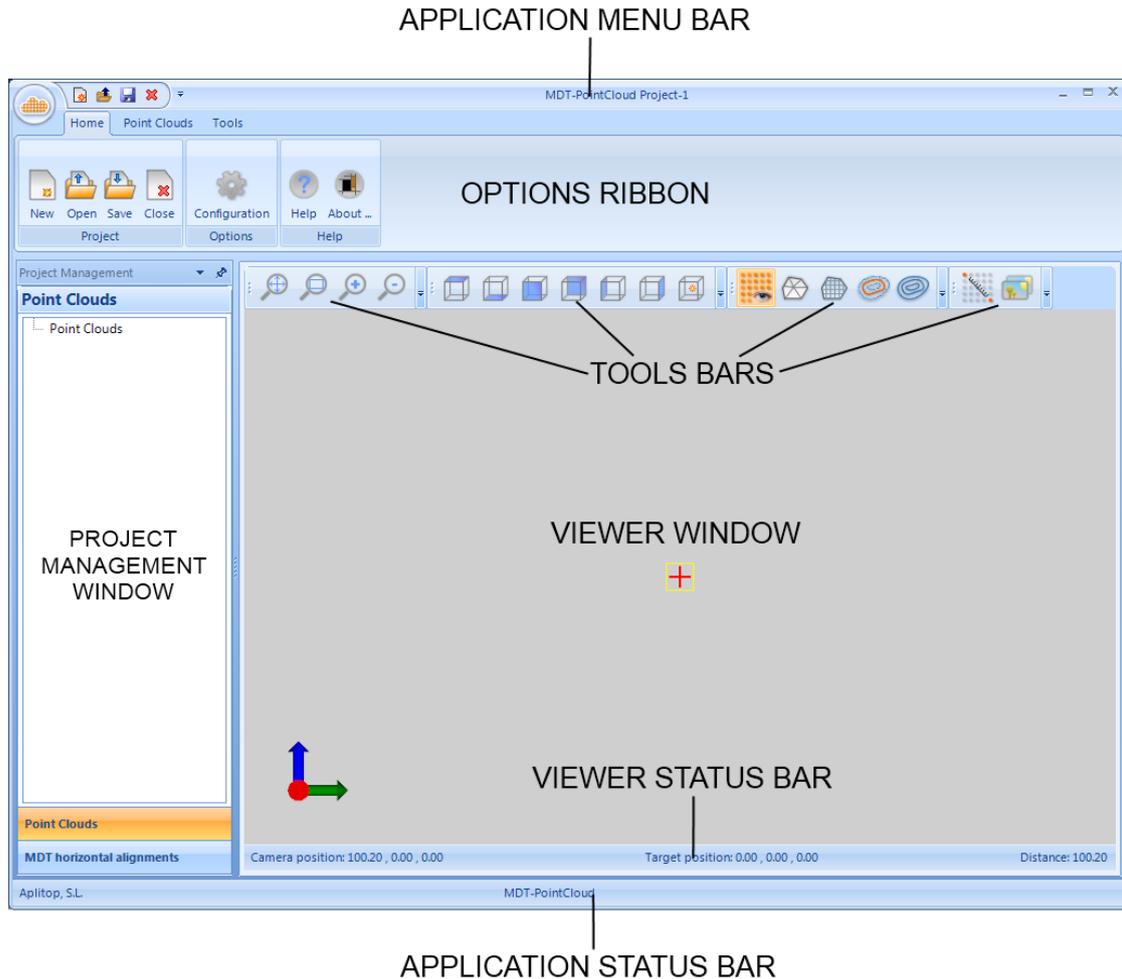
Clicking on the start button opens the start menu, which also facilitates access to the basic application and project options. This menu also contains a list of recent projects.



This chapter will provide a brief summary of the most important windows of the application, and an explanation for each of the user interface controls will be given in subsequent chapters.

## Main window

New elements appear in the main window when the user creates or opens a project, such as the project management window or the view window.



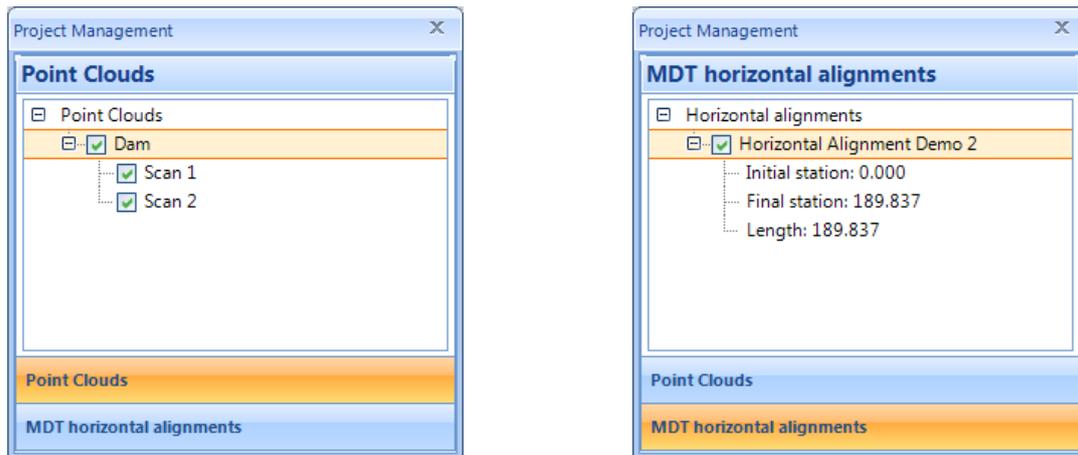
The menu bar shows the application name and the project name in the event a project has been opened. It also contains the aforementioned start and quick access buttons.

The ribbon is located immediately under the menu bar and consists of a series of three tabs containing the different options and functions of the application.

The lower part of the main window contains the status bar of the application. This bar displays the current function in progress, in addition to information on the progress of operations which take a long time.

## Project management window

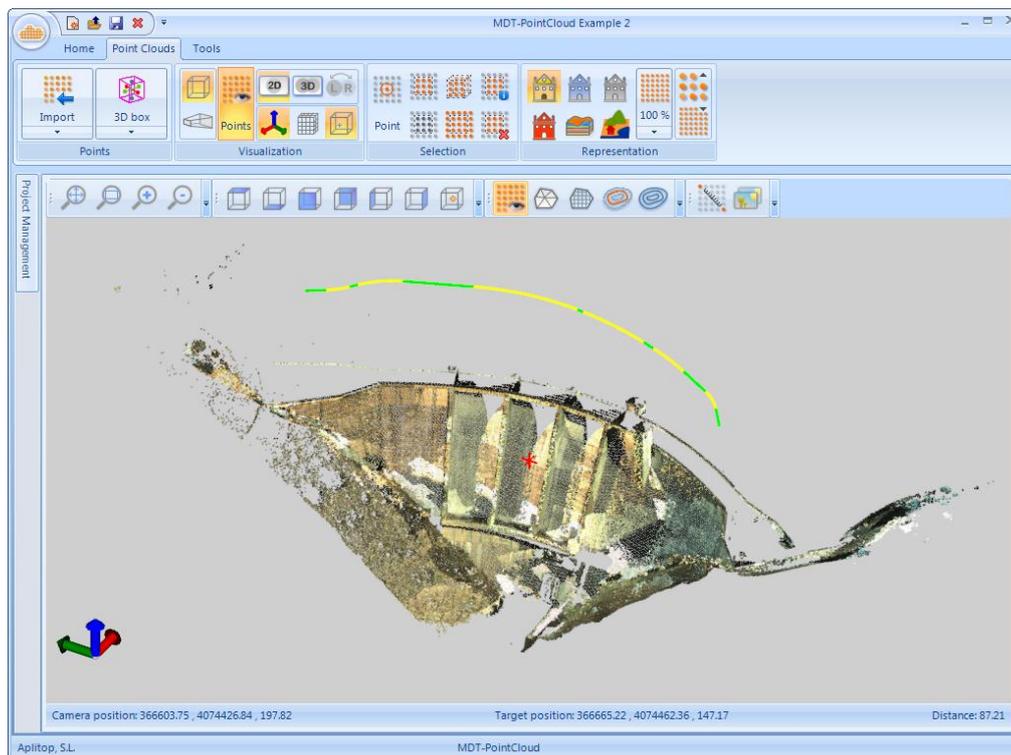
This window first appears on the left-hand side of the main window. The user may position it on the left or right-hand side, in auto-hide mode or as a floating window.



This window displays a list of point clouds and their corresponding scans, and a list of project horizontal alignments, so the right button provides access to both the properties of each item and the specific functions of each one. It also enables the user to show or hide point clouds, scans and horizontal alignments.

## View window

The view window is located in the centre of the main window and displays the point clouds, horizontal alignments and other 3D elements such as surfaces, grids, contours, and CAD entities. It also displays other elements such as the point cloud volume mesh, the 3D axes and the point of interest.



The user may change the view displayed in the window by holding down one of the three mouse buttons and moving the mouse. The basic features of the mouse on the viewer are:

- Rotating the view: Holding down the left button and moving it in any direction.
- Moving the view: Holding down the middle button and moving it in any direction.

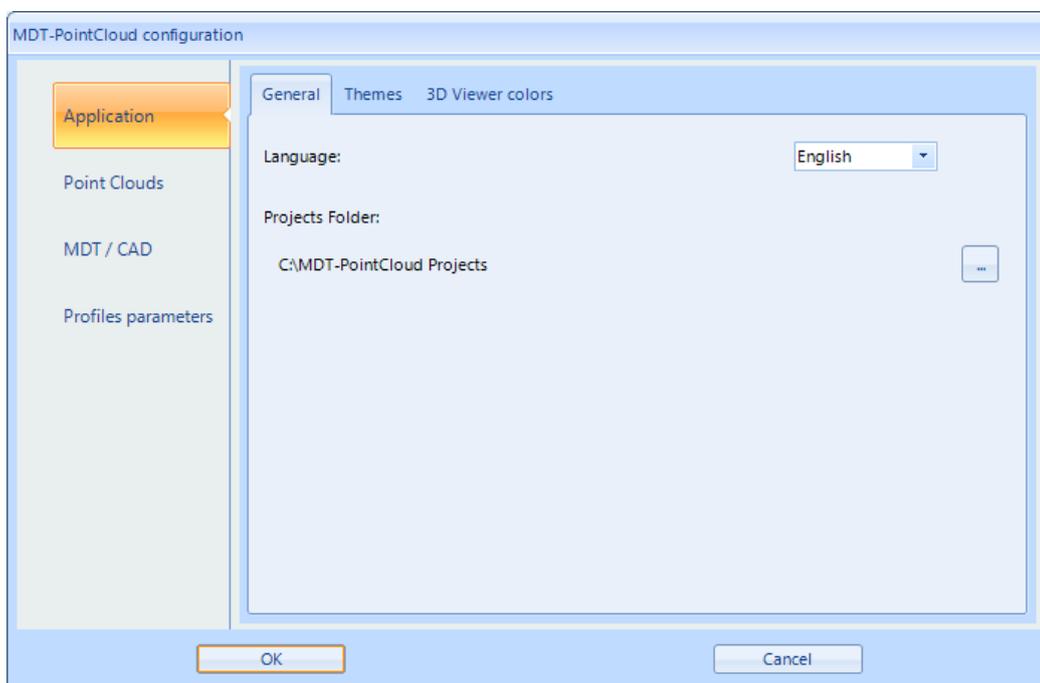
The direction keys (arrows) may be used for the same purpose.

- **Zooming in/out:** By moving the wheel or holding down the right button and moving the mouse forwards or backwards, changing the position of the viewer. This operation may also be conducted by holding down the "Control" key, but what changes is the position of the point of interest. The "Next Page" and "Previous Page" keys may be used instead of the mouse wheel, but without pressing the "Control" key.

The status bar shows the 3D coordinates of the position of the observer or camera (viewpoint) and of the point of interest. It also shows the distance between both points. Top views display the 2D (XY) coordinates of the position of the cursor (arrow or cross) in place of 3D. This facilitates operations involving the selection of points and the editing of horizontal alignments on the terrain.

## Configuration window

This window enables the user to define different features of the application, from the colours of the elements displayed in the viewer to the default parameters for the calculation of profiles and cross sections.



## Other windows

In addition to the aforementioned windows, the application displays different dialog windows when necessary to enable the user to introduce parameters or to check on the progress of the operation underway.

## 3. PROJECTS

### Introduction

The information used by MDT-PointCloud is organised in project mode. Each project comprises a series of imported point clouds and a series of drawn or imported horizontal alignments. Additionally, a current surface and/or grid and a contour from the surface or grid may be created.

All this information is stored in the project folder to enable the user to load and work on previous projects.

### Basic project management

The basic project operations are started from the "Project" group on the "Home" tab on the ribbon.



To create a new project. A dialog window will appear in which the user should insert a project name and a base folder in which the project can be created.

New



To load an existing project. The user should select the MDT-PointCloud project file in the project folder.

Open



This feature saves changes made to the project without closing it.

Save



This last basic function closes the current project and saves it when necessary.

Close

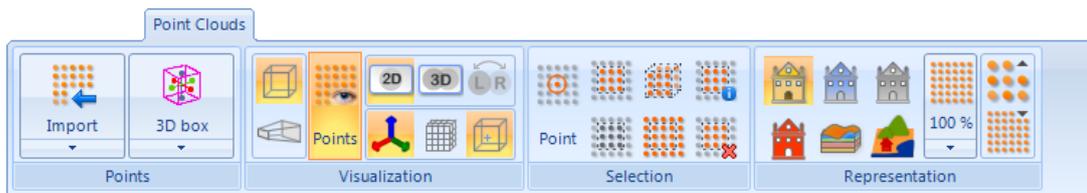
All these options are also accessible using the start button of the application or the rapid access bar located alongside it. In the drop-down menu by the start button, these options are on the left-hand side, whilst on the right-hand side there is a list of recent projects, so the user has direct access to them.

## 4. POINT CLOUDS

### Introduction

The essential information managed by the application are point clouds. To add new point clouds to a project these have to be imported first. Once imported, these point clouds may be used to create profiles or to generate surfaces or grids. Points from point clouds may also be partially exported by selecting or filtering them.

This chapter provides a detailed description of all the features accessed via the “Point clouds” tab on the Ribbon.

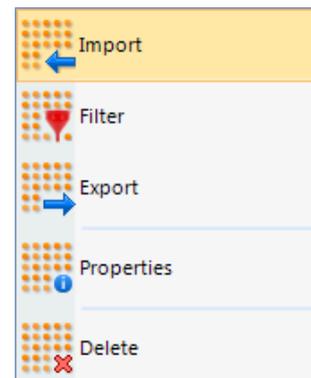


### Importing point clouds

Once a project has been created or opened we may import point clouds. For such, the user should select the “Import” option on the drop-down button in the “Points” group.



Drop-down button



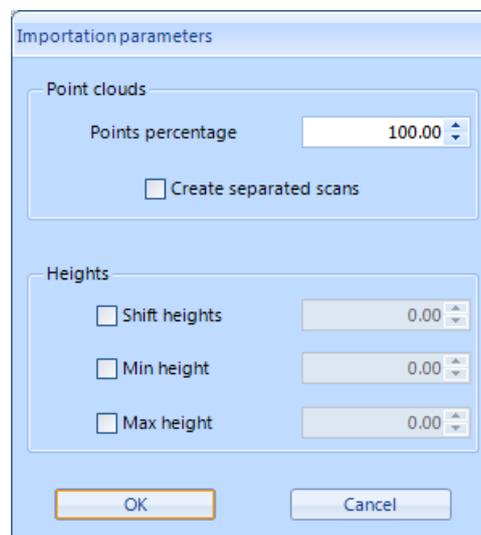
A file selection window will appear in which the user should select the format of the files to be imported and the folder in which these files are stored. The user should select the files to be used in the project from the list available.

MDT-PointCloud is capable of importing a wide range of point cloud file formats:

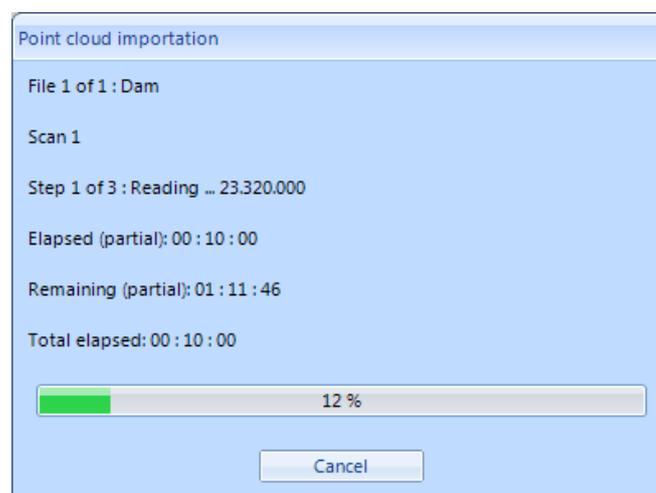
- ArcView (\*.asc)
- LAS/LiDAR (\*.las)
- FARO (\*.fls)
- ASTM E57 (\*.e57)
- Leica ASCII (\*.pts, \*.ptx)
- ASCII points (\*.txt, \*.xyz)
- MDT points (\*.pun)
- ASCII MDT grid (\*.mll)
- MDT binary grid (\*.mde)
- MDT surface (\*.sup)

The import parameter dialog window will then be displayed. This window enables the user to customise the form of import.

- Percentage of points: Define the percentage of points to be imported from the point cloud files.
- Create separate scans: The application will import several files by default and use each one as the scan for a single point cloud. Checking this option will create a point cloud for each scan. In this case, if an imported file contains more than one scan, they will be treated as different point cloud scans.
- Shift heights: If this option is checked the imported points will be subject to a shift in height equal to the value specified.
- Minimum height: If this option is checked all points with a height lesser than that specified will be ignored during the import process.
- Maximum height: If this option is checked all points with a height greater than that specified will be ignored during the import process.



Acceptance will lead to the import process consisting of three phases (reading, processing and generation) per file in the event of separate scans, and two phases per file (reading and processing) plus a phase common to all (generation) if imported together. The time taken to import will vary in accordance with the number of files, points per file, file format and import parameters defined. A progress window will appear during the import process to inform the user of the status of the process.

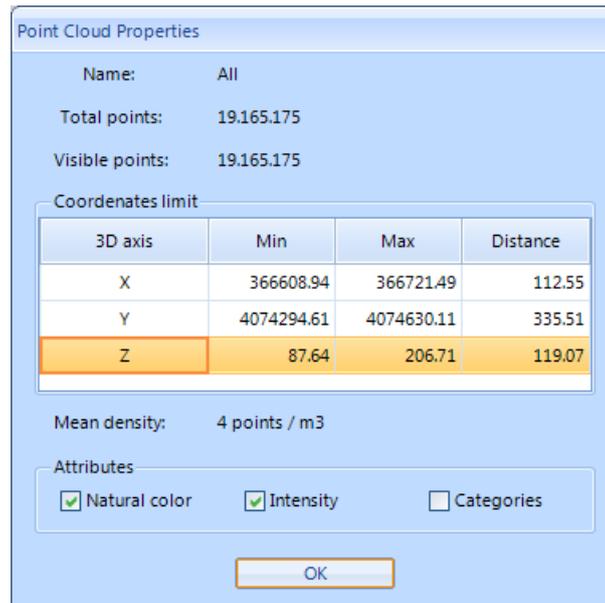


## Managing point clouds

Once a point cloud has been imported it will be added to the list of point clouds in the project management window and displayed in the view window.

Clicking on a item in the point cloud tree with the right button will activate the context menu in relation to the item in question and the options available.

- a) The following options are available for the “Point clouds” root:
  - a.1) Properties. The properties dialog of all the point clouds will be displayed.



This window shows the total number of points in all the clouds, the total number of visible points, the 3D box aligned with the axes containing all the point clouds, the average density of points in this 3D box and the attributes of the point clouds (if any of the point clouds has colour, intensity and/or LAS/LiDAR categories).

- b) For a point cloud:
  - b.1) Properties. The same as in paragraph a.1), but only at point cloud level, whereby the properties arise from the scans making up the cloud.
  - b.2) Activate all. Shows all the point cloud scans in the viewer.
  - b.3) Deactivate all. Hides all the point cloud scans.
  - b.4) Rename. Changes the name of the point cloud.
  - b.5) Delete. Deletes the point cloud (and all its scans) from the project. This option is also present on the left drop-down button in the “Points” group on the “Point clouds” tab on the Ribbon.
- c) For a scan:
  - c.1) Properties. The same as in paragraph b.1) but only at scan level.
  - c.2) Rename. Changes the name of the scan.

Point Cloud Properties

Name: Scan 1

Total points: 7.724.997

Visible points: 7.724.997

Coordinates limit

3D axis	Min	Max	Distance
X	366608.94	366721.49	112.55
Y	4074294.61	4074630.11	335.51
Z	88.94	181.98	93.04

Mean density: 2 points / m3

Attributes

Natural color     Intensity     Categories

OK

Both the point clouds and the scans shown in the project management window have a checkbox on their left to activate or deactivate them (their visibility). If an item is deactivated it will not appear in the viewer. If a point cloud is deactivated its number of points and volume will not be included in the properties of the “Point cloud” root node.

If the points have associated categories, in the Properties dialog will appear a button with the text “?” next to the label “Categories”. This button provides access to the Categories Histogram window.

Point Cloud Properties

Name: Example 1

Total points: 2.061.567

Visible points: 2.061.567

Coordinates limit

3D axis	Min	Max	Distance
X	531000.00	531999.99	999.99
Y	4757000.00	4757999.99	999.99
Z	551.50	1152.31	600.81

Mean density: < 1 point / m3

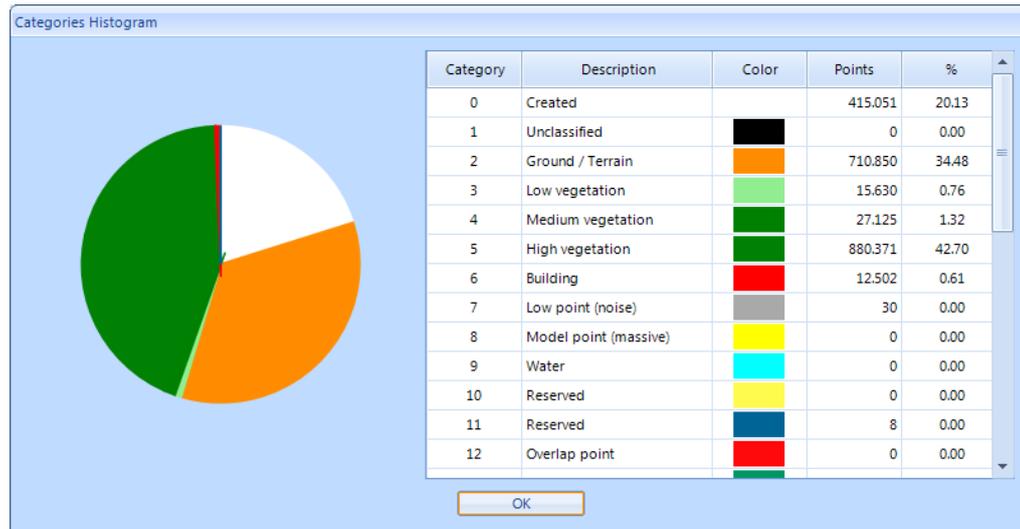
Attributes

Natural color     Intensity     Categories ?

OK

This window has two parts:

- On the left there is a circular diagram, where are represented the different categories, with its associated color. The size of each piece of the diagram is proportional to the percentage of points of the category relative to the total number of points.
- On the right we have a table with a row for each of the 32 LAS categories. Each row shows the category number, description, current color, number of points in that category and percentage of points relative to the total number of points.



Both diagram and table are interactive, so when user selects a piece of the diagram, the associated row is selected in the table, and viceversa. Obviously, there are no pieces associated with categories with zero points.

### Viewing of points

Different manners in which the points are showed may be established using the buttons contained in the “Visualization” group of the “Point clouds” tab on the ribbon.



Orthographic view.

Orthographic



Perspective view.

Perspective



Show/Hide points.

Points



2D view (mono).

Mono



3D view (stereo). Requires special hardware.

Stereo



Invert stereo (if 3D view is activated).

Invert



Show/Hide 3D axes

3D axes



Show/Hide the 3D mesh volume of the point clouds.

3D volume



Show/Hide the point of interest.

Point of  
interest

### Selection of points

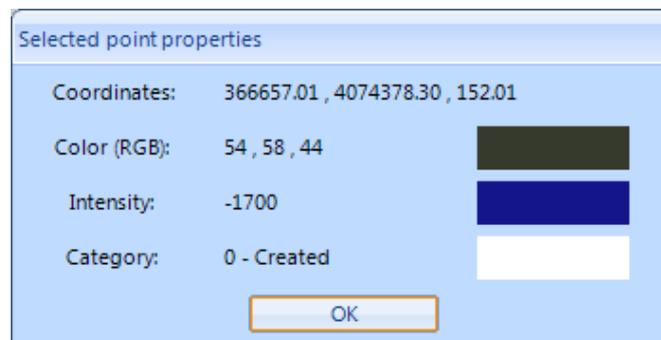
The “Selection” group on the “Point clouds” tab on the ribbon contains a series of buttons for selecting operations.



Selection of a single point.

Point

On selecting a single point a window appears displaying its properties (coordinates, colour, intensity and category).

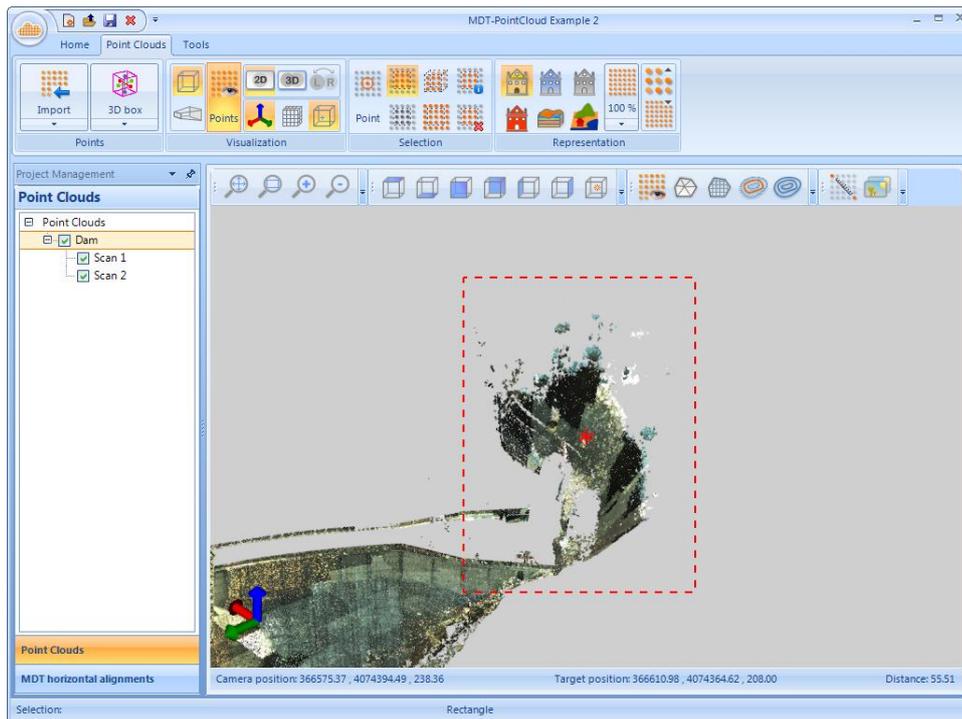


Category 0 will be assigned by default to points from point clouds with no category info.

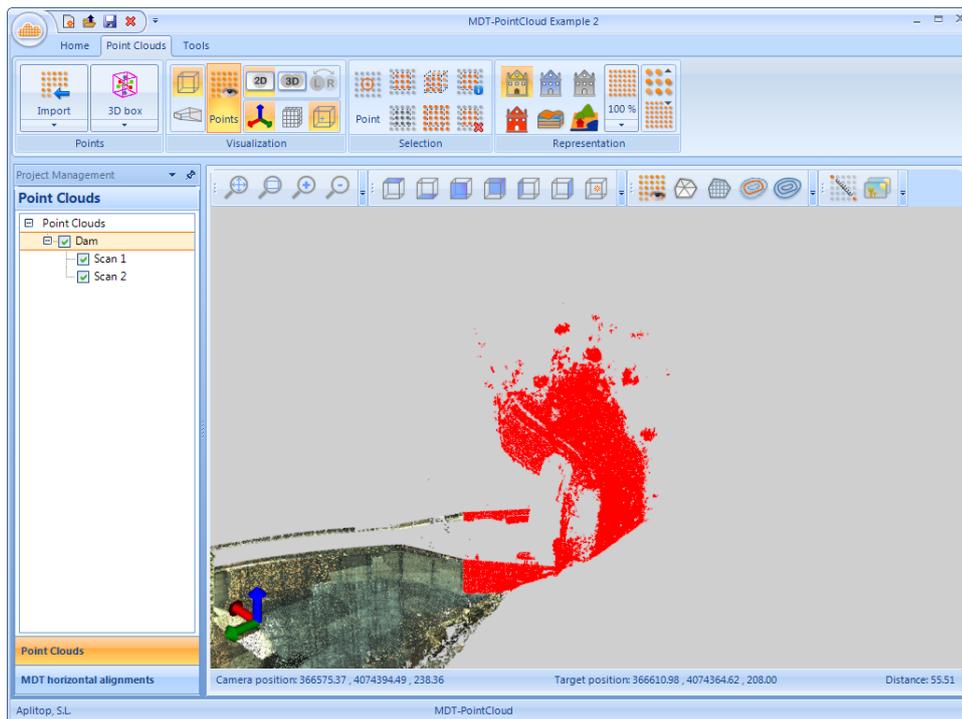


Rectangle

Selection of a set of points in a rectangle.



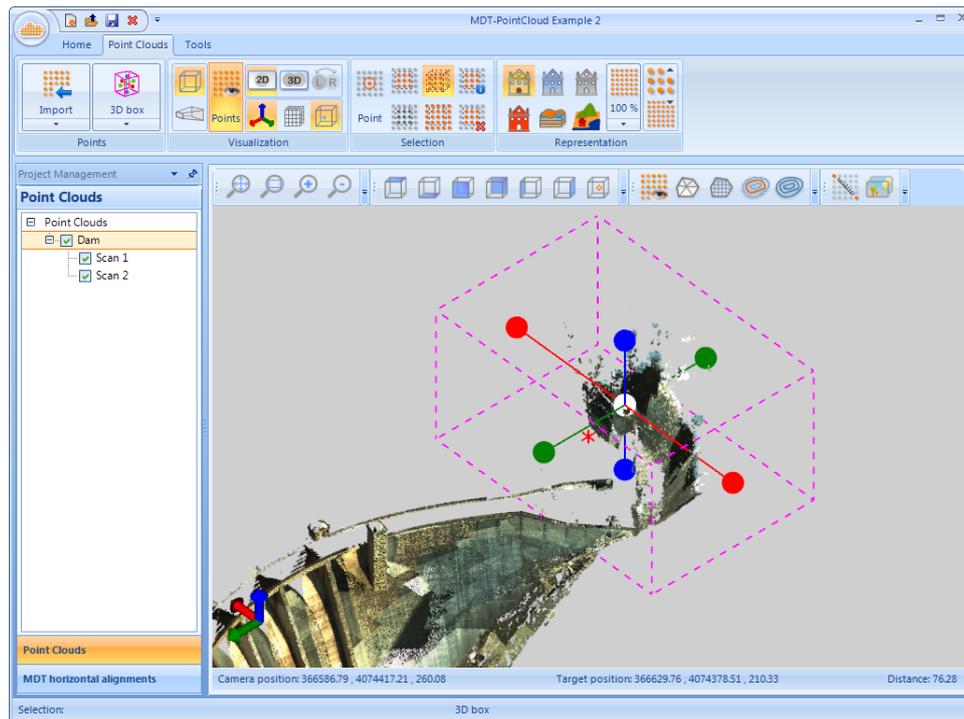
All the points inside the area are shown as selected.



3D box

Selection of a set of points in a 3D box aligned with the axes.

A 3D box is displayed in the viewer, the size of which may be altered and moved using the left button on the mouse. The right button ends the selection process.



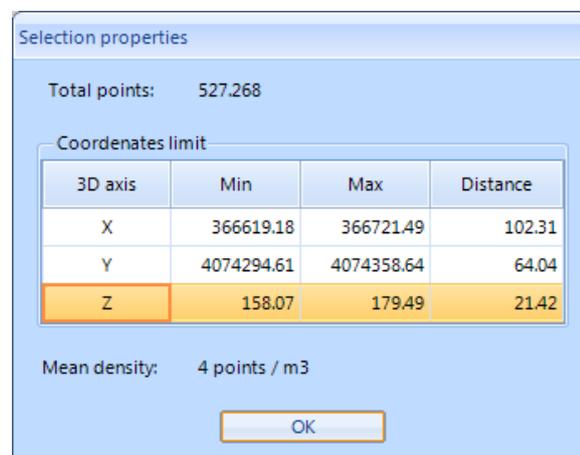
All the points falling inside the 3D box will be selected.



Properties

Properties of the set of selected points.

Displays a properties window (total number of points, 3D volume and average density of points). The operation involving the definition of the properties of a selected item may take several minutes if the point cloud and/or the number of points is large.



Hide

Hide selected points.

The points selected are no longer visible. It is very useful to filter point clouds. The hidden points will not be considered in calculations.



Restore

Restore points.

Points hidden previously reappear in the viewer.



Clear selection.

All the points currently selected will be cleared (unselected).

Clear

### Representation of points

The “Representation” group on the “Point clouds” tab on the ribbon provides the buttons required to decide on how to represent the points.



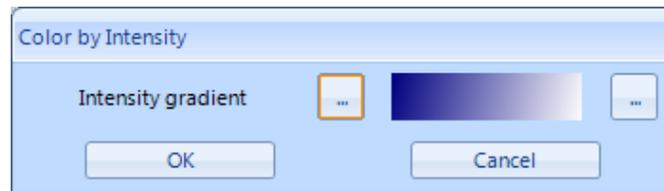
The points are represented in the same colour read when imported. Points with no specific colour will be displayed in white.

Natural colour



Points will be represented in accordance with a colour gradient (defined by the user) based on the intensity of the points. Points with no specific intensity will be displayed using average intensity.

Colour intensity



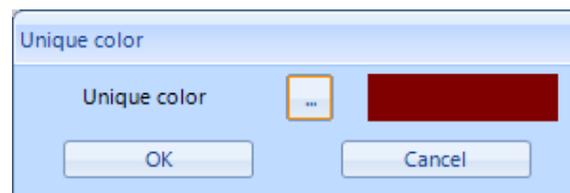
Points will be represented in accordance with a gray scale based on the their intensity. Points with no specific intensity will be displayed using average intensity.

Gray intensity



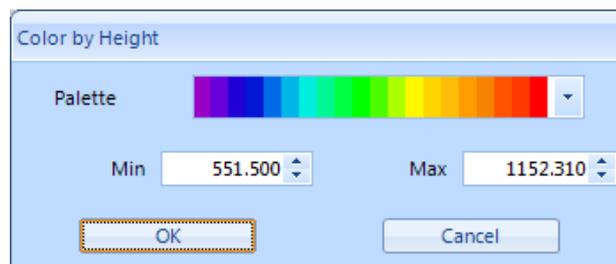
All points will be represented in the same colour (defined by the user).

Unique colour



Points will be represented in a colour in accordance with the height (Z value). The user may choose from a set of colour palettes. The user may also define the range of heights in relation to the palette, representing the points beyond the range in the current unique colour.

Colour by height





Colour by category

Points will be represented in the colour assigned to the corresponding category. The application uses 32 categories (0 to 31) in accordance with the LAS/LiDAR specification. The user may define the colour assigned to each category, in addition to specifying which categories are visible and which are not (filtered by category).

LAS/LiDAR categories configuration

Visible categories:

Number	Description	Color	Visible
0	Created		<input checked="" type="checkbox"/>
1	Unclassified		<input checked="" type="checkbox"/>
2	Ground / Terrain		<input checked="" type="checkbox"/>
3	Low vegetation		<input checked="" type="checkbox"/>
4	Medium vegetation		<input checked="" type="checkbox"/>
5	High vegetation		<input checked="" type="checkbox"/>
6	Building		<input checked="" type="checkbox"/>
7	Low point (noise)		<input checked="" type="checkbox"/>
8	Model point (massive)		<input checked="" type="checkbox"/>
9	Water		<input checked="" type="checkbox"/>
10	Reserved		<input checked="" type="checkbox"/>
11	Reserved		<input checked="" type="checkbox"/>
12	Overlap point		<input checked="" type="checkbox"/>



100 %

It is impossible to display all the points in a point cloud containing several million points. The application will represent a pre-set maximum number. This option ensures 100% representation of the maximum representable number.



75 %

Display of up to 75% of the maximum representable number.



50 %

Display of up to 50% of the maximum representable number.



25 %

Display of up to 25% of the maximum representable number.



10 %

Display of up to 10% of the maximum representable number.



Increases the size of the points represented.

Increase



Reduces the size of the points represented.

Reduce

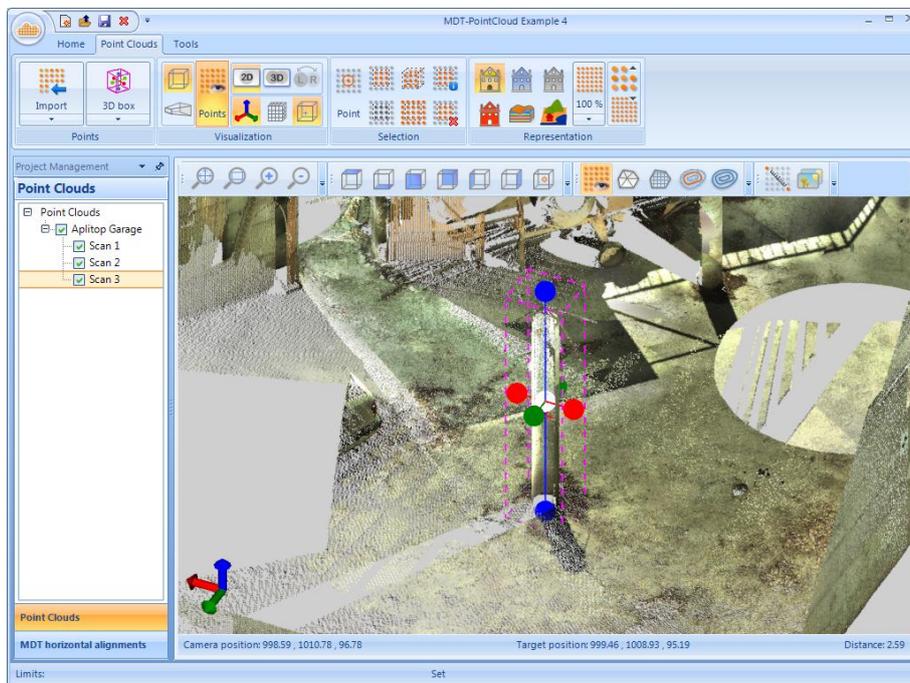
### Limitation of points

Means of reducing the number of points to be displayed have been mentioned previously, either by means of the deactivation of point clouds / scans, selecting and hiding points or filtering points in accordance with the category. There are three additional features which enable the user to work exclusively with the points contained in a 3D volume. These features are available using the right-hand drop-down button of the “Points” group on the “Point clouds” tab on the Ribbon.



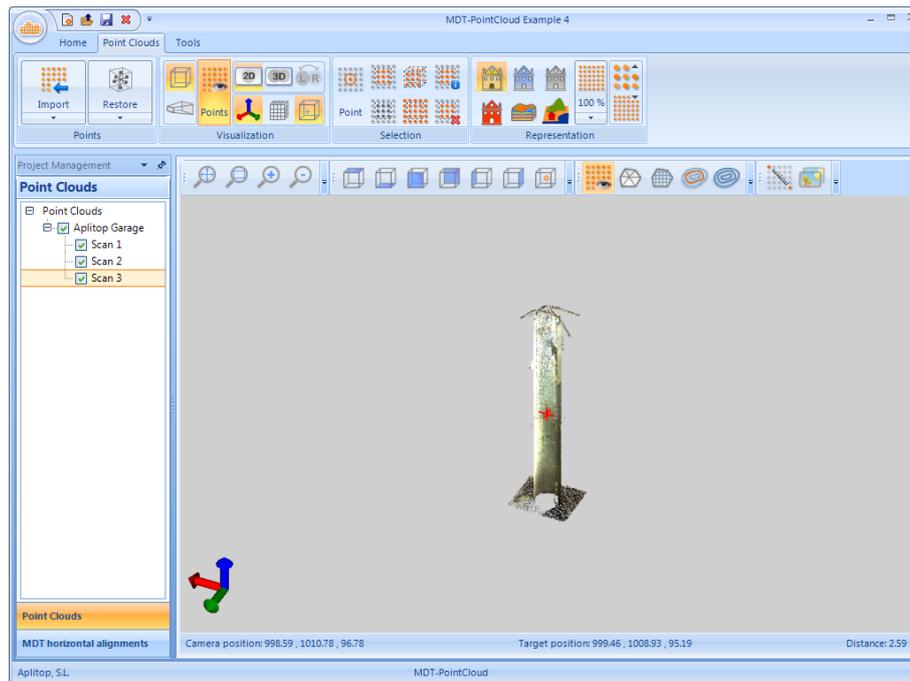
Enables the user to define a 3D volume aligned with the axes in a similar way to selecting using a 3D box.

3D box



Limits the view of the points contained in the 3D volume defined using the 3D box feature.

Limit



Restores the display of all the visible points of the point clouds in the project.

Restore

## Filtering point clouds

To filter point clouds, the user should use the “Select” option on the left-hand drop-down button of the “Points” group on the “Point clouds” tab.



Filter the selected points or visible points if there is no selection, from the existing point clouds, and creates a new one with these points.

Filter

In MDT-PointCloud, filtering is the same as generate a new point cloud from the selected or visible points of the previously imported point clouds. So, there are two possibilities:

- If there is a set of selected points (via rectangle or 3D box selection), the new point cloud will contain only that set of points.
- If there is no selection, the filter operation will generate a new point cloud with all the visible points of the rest of point clouds. This means that hidden points or points outside limits (it set) will be ignored, and wouldn't be added to the new point cloud.

The new point cloud will contain a single scan. All the properties of the filtered points will be kept (position, color, intensity and category).

## Exporting point clouds

In order to export points to a file, the user should select the points to be selected using a rectangle or 3D box. The next step is to select the “Export” option on the left-hand drop-down button of the “Points” group on the “Point clouds” tab.

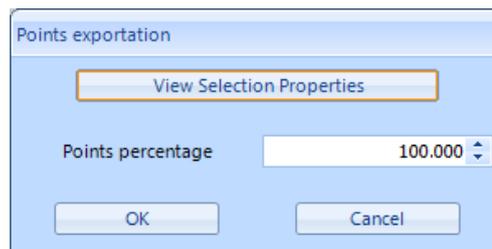


Exports the selected points to a file in a format compatible with TcpMDT.

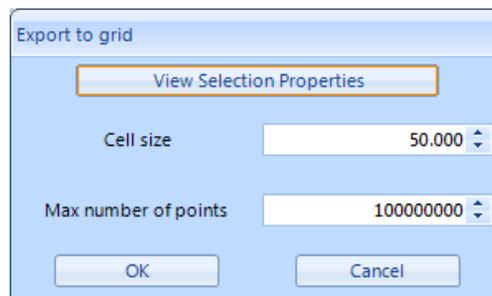
### Export

Points may be exported as individual points, a grid or surface. In accordance with the option selected the associated dialog box will appear to enable the user to customise the manner in which the export operation is conducted.

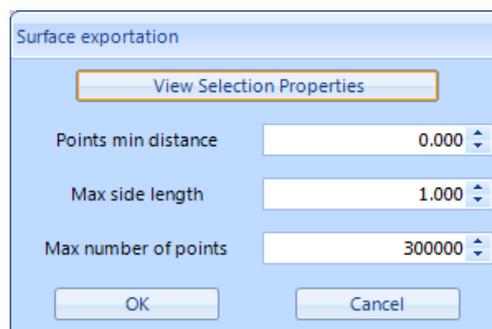
ASCII points (\*.pun, \*.txt, \*.xyz) Defines the percentage of the total number of points selected to be exported.



MDT Binary Grid (\*.mde) Defines the size of the grid cell and the maximum number of points used to create it.



MDT Surface (\*.sup) Defines the minimum distance between the vertices of the triangles to be formed, the maximum length of the side of the triangles and the maximum number of points used to create the surface.



The three dialogue windows include the “View Selection Properties” option to enable the user to check the number of points and 3D volume in relation to the selection process. This will make it easier to decide which amounts should be assigned to the different parameters.

As mentioned previously, the operation to determine the properties of a selected item could prove costly, depending on the total number of points and the number of points selected. For this reason the user is recommended not to use this option in large point clouds with large number of selected points.

## 5. VIEWER TOOLBARS

A set of tool bars is located in the upper part of the window which enable the user to control different aspects of viewer.

These bars may be moved within the upper part of the window or used as floating windows to facilitate user access.

### Zoom tools

The zoom bar consists of four buttons which enable the user to change the distance between the viewpoint and the point of interest (the base point located in the center of the window).



Extension

This feature places the point of interest in the center of the 3D volume defined by the point clouds, and places the view point at the appropriate distance to show the whole image.



Window

This feature enables the user to define a rectangle (similar to that for selecting points with the rectangle). The point of interest is located in the center of the rectangle and the viewpoint moves towards the point of interest to fit into the rectangle.



Zoom in

Place the viewpoint half way from the point of interest.



Zoom out

Place the viewpoint twice the distance from the point of interest.

### Viewing tools

The view bar possesses seven buttons which enable the user to place the viewpoint in line with the point of interest in relation to the 3D axes, or place the point of interest in a point visible from the point clouds.



Upper

View in line with the X and Y axes along the decreasing Z axis. Maintains the point of interest and alters the position of the viewpoint.



Lower

View in line with the X and Y axes along the increasing Z axis. Maintains the point of interest and alters the position of the viewpoint.



Frontal

View in line with the Y and Z axes along the decreasing X axis. Maintains the point of interest and alters the position of the viewpoint.



Rear

View in line with the Y and Z axes along the decreasing X axis. Maintains the point of interest and alters the position of the viewpoint.



Left

View in line with the X and Z axes along the decreasing Y axis. Maintains the point of interest and alters the position of the viewpoint.



Right

View in line with the X and Z axes along the decreasing Y axis. Maintains the point of interest and alters the position of the viewpoint.



Point

The user is required to indicate one point from the point clouds. The viewpoint is maintained and the point of interest is located at the position of the point the user has selected.

## Show / hide tools

The show/hide toolbar enables the user to activate and deactivate the visibility of some of the graphic elements shown in the view window. See the chapter “Surfaces, Grids and Contours” in this manual for a detailed description.



Points

This button, also present in the “Visualization” group on the “Point clouds” tab on the Ribbon, enables the user to activate and deactivate the visibility of the point clouds.



Surface

This button makes it possible to activate and deactivate the visibility of the current surface if one has been created. It also exists in the “Surfaces” group on the “Tools” tab on the Ribbon.



Grid

This button makes it possible to activate and deactivate the visibility of the current grid if one has been created. It also exists in the “Surfaces” group on the “Tools” tab on the Ribbon.

Major  
Contours

This button makes it possible to activate and deactivate the visibility of major contours when such contours have been created (requires surface or grid). It also exists in the “Surfaces” group on the “Tools” tab on the Ribbon.

Minor  
Contours

This button makes it possible to activate and deactivate the visibility of minor contours when such contours have been created (requires surface or grid). It also exists in the “Surfaces” group on the “Tools” tab on the Ribbon.

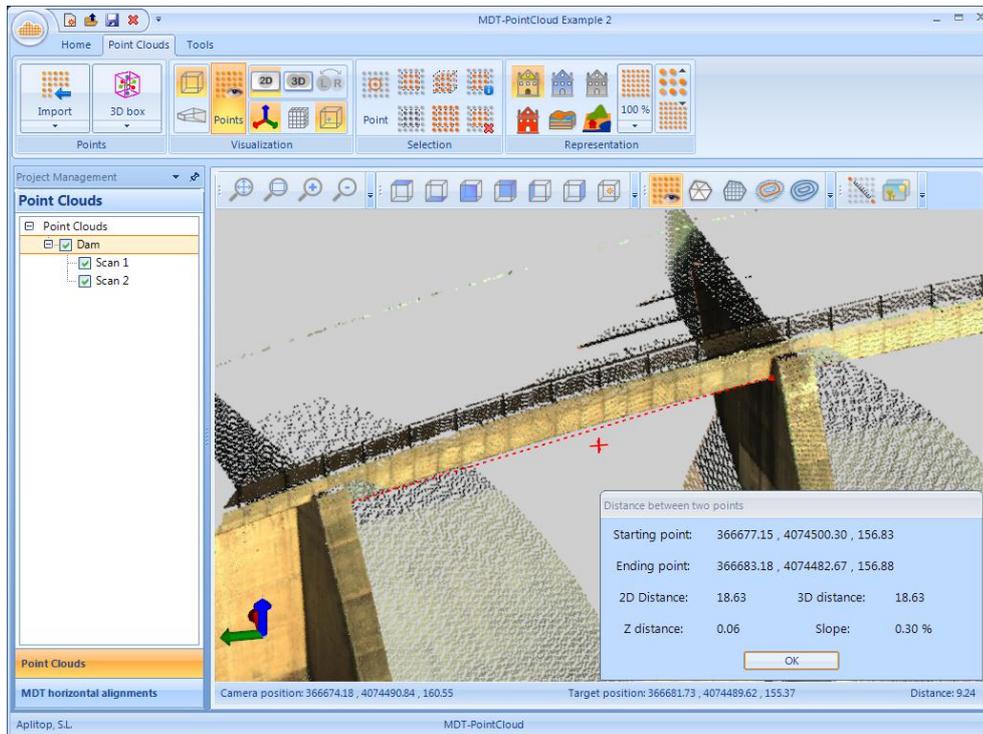
## Useful tools

This toolbar contains a pair of features for measuring the distance between points in the clouds and to copy the image of the current view to the clipboard.



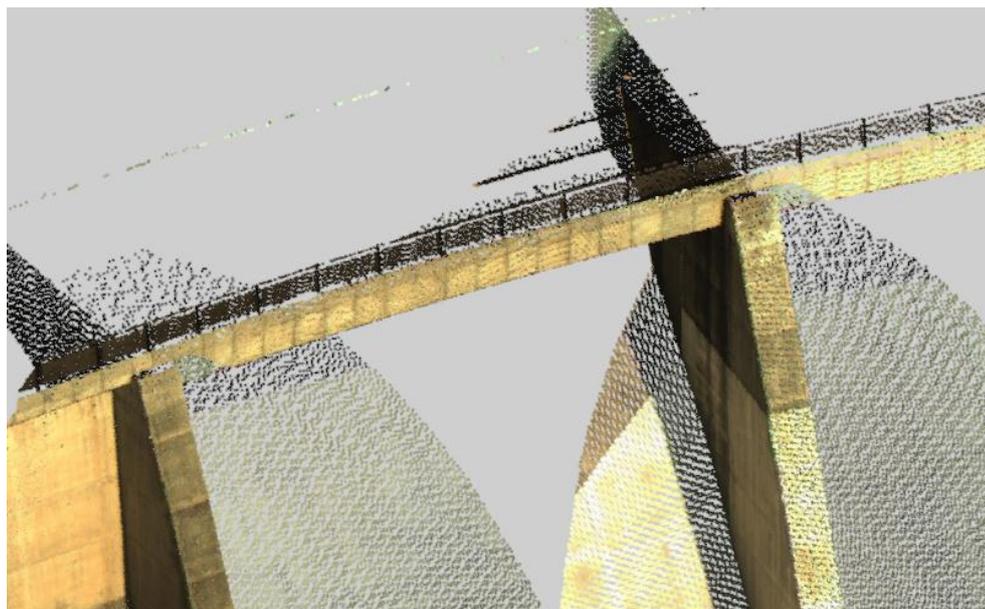
This tool enables the user to measure the distance between two points in the point clouds. For such, the user should first indicate two points in the clouds. The result is displayed in an information window.

Distance



On using this tool, the image in the window is copied to the clipboard. The user may then access this image in any document using the desired application.

Copy



## 6. HORIZONTAL ALIGNMENTS AND PROFILES

### Introduction

The calculation of profiles and cross sections (of points) is one of the main features implemented by MDT-PointCloud for the use of point clouds. This is why the application features different tools for importing and creating horizontal alignments, in addition to the editing of certain horizontal alignments (under specific conditions), from which profiles are created.

Once an horizontal alignment has been included in a project, the user, as is the case with point clouds, may define the its visibility and view mode. Text and graph related information on it is also available, including the analysis of the horizontal alignment.

The profiles created may be edited and used via the “Profile Editor” application which accompanies MDT-PointCloud.

### Horizontal alignment management

Most of the horizontal alignment management tools are accessible using the buttons included in the “Horizontal alignments” group on the “Tools” tab on the Ribbon.



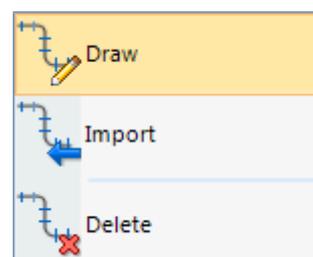
Additionally, some of the following activities may be conducted directly in the horizontal alignment list in the project management window (right button on the mouse). The user may also remane the horizontal alignments, in the same way as point clouds and scans.

### Creation of horizontal alignments

The “Draw” option is located on the left-hand drop-down button of the “Horizontal alignment” group of the “Tools” tab, and enables the user to draw an horizontal alignment on the point cloud.



Drop-down button



The drawing of the horizontal alignments is conducted in horizontal view and in orthographic mode. These horizontal alignments consist of straight segments only.

The left-hand button of the mouse is used to define points and the right-hand button to end the drawing. The mouse wheel is used to zoom in and out and the central button to move the view.

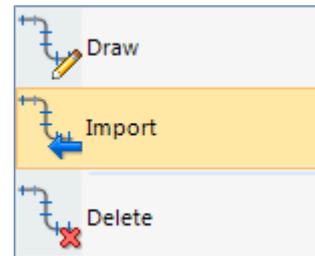
After the horizontal alignment has been created it will appear on the list of horizontal alignments in the project management window and will be visible in the view window.

### Importing a horizontal alignment

Another option available on the left-hand drop-down menu is horizontal alignment “Import”.



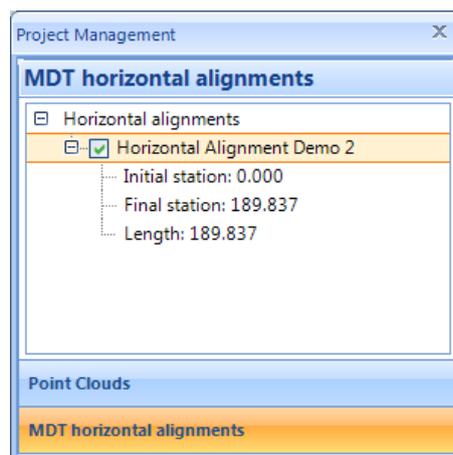
Drop-down button



On clicking on this option the user should select an horizontal alignment file (\*.aje) and optionally a grade line file (\*.ras) associated with the horizontal alignment. As in the creation process, after importing the file a new element is added to the list of horizontal alignments in the project management window and the horizontal alignment is shown in the view window.

### Information on horizontal alignment

The application shows the user diverse information on the horizontal alignments included in the project. The project management window shows the initial and final stations of each horizontal alignment and their lengths.



More detailed information on the selected horizontal alignment in this window may be obtained using the following tools:



List

Shows a dialog window with a table containing details of the different horizontal alignment elements.



Analyse

Shows a small window with the station and distance in points defined by the user in the view window.

### Editing of horizontal alignment

MDT-PointCloud enables the user to edit horizontal alignments in accordance with the following conditions:

- 1) All the alignment elements must be straight lines (segments). Curves and clothoids may not be used.
- 2) Associated grade lines may not be used.

All the horizontal alignments within the application will then be editable, whilst imported horizontal alignments may be edited or not in accordance with compliance with the conditions.

Operations involving the editing of horizontal alignments are always performed in horizontal and orthogonal view, and require an horizontal alignment to have been selected from the horizontal alignments list in the project management window.



Add

The add vertices to the horizontal alignment feature enables the user to insert a new vertex between two existing vertices of the horizontal alignment. The left-hand button of the mouse is pressed down to define and released to position the vertex, and the right-hand button cancels or ends the operation to add vertices to the horizontal alignment.

The two vertices between which a new vertex is inserted are defined by the position of the cursor at the time the left-hand button of the mouse is pressed (the nearest two consecutive vertices).



Edit

The edit horizontal alignment vertices feature enables the user to “move” the X, Y position of the vertices, similar to that of the add feature.

In this case, pressing the left-hand button selects the nearest vertex to the cursor, and releasing the button places the vertex in the position of the cursor.



Delete

The delete vertices feature enables the user to remove vertices from the horizontal alignment as in the aforementioned features.

The operation ends when the user presses the right-hand button of the mouse or when only two vertices are left on the horizontal alignment being edited.

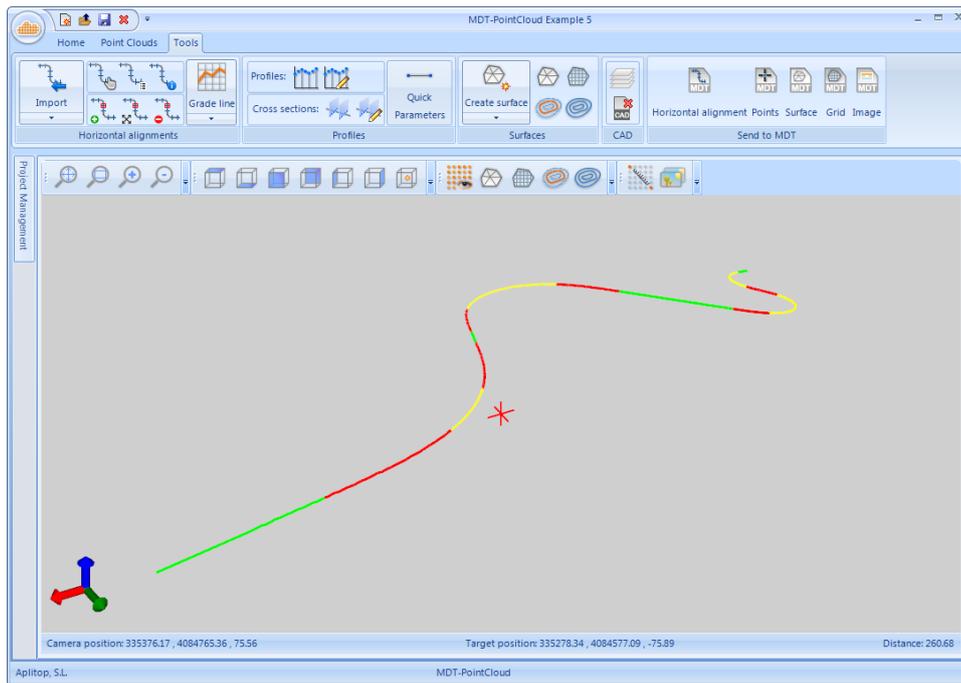
### Viewing of horizontal alignments

As with the point clouds, the horizontal alignments on the horizontal alignments list in the project management window possess a small activation box to either show or hide the horizontal alignments. Furthermore, the right-hand drop-down button in the “Horizontal alignment” group on the “Tools” tab on the Ribbon enables the user to define which heights the axes are to be displayed in.



Grade line

Horizontal alignments imported with an associated grade line file will be displayed in the heights defined on the grade line. The remaining horizontal alignments will be displayed in a height of zero.



All the horizontal alignments will be displayed in the maximum height (ceiling) of the image defined by the point clouds being used.

Maximum



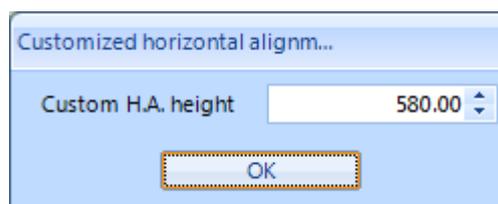
All the horizontal alignments will be displayed in the minimum height (base) of the image defined by the point clouds being used.

Minimum

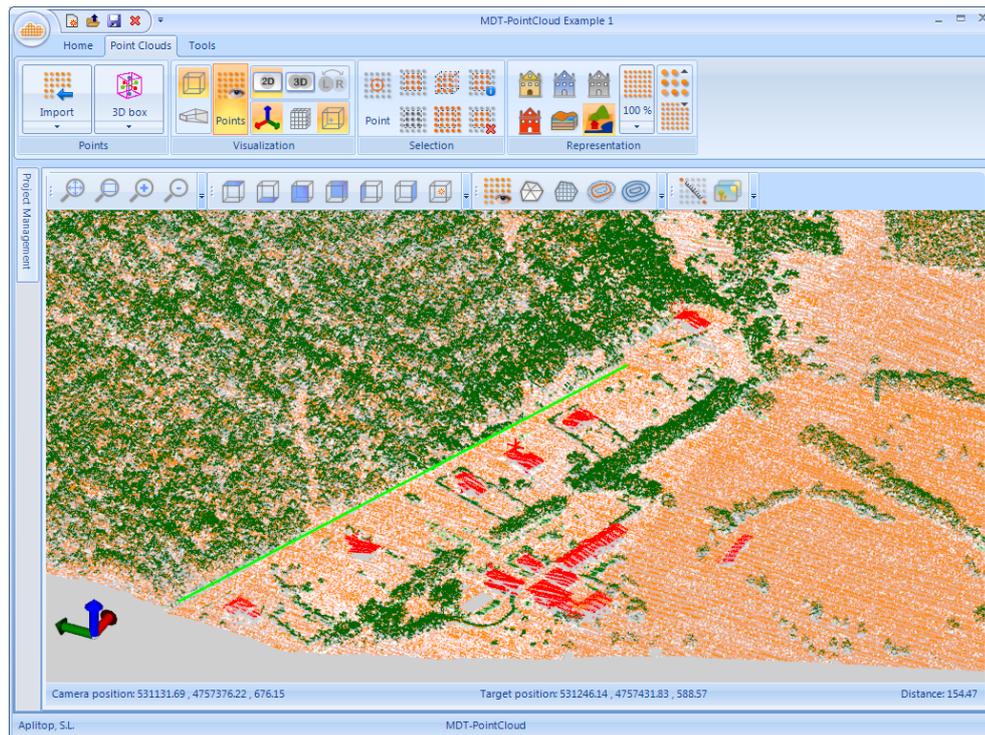


All the horizontal alignments will be displayed in the height defined by the user via a dialog window for that purpose.

Personal



This enables the user to place the horizontal alignment on the terrain in order to view it clearly in 3D.



The paragraph on horizontal alignments in the configuration chapter provides the information required to set the view of the horizontal alignments (assignment of colour to the different alignments).

## Calculating profiles

The application features three different ways of calculating a profile: quick, profile and cross sections. The result of each creation operation is shown in the “Profile Editor” application which accompanies MDT-PointCloud. The following paragraphs explain the three types of profile generated by the application, whilst the use of the Profile Editor is detailed in the following chapter of this manual.

### Quick profile



Quick

The quick profile tool enables the user to draw an horizontal alignment of only two vertices, and to calculate its longitudinal profile. Such horizontal alignments are not stored in the project and are not included on the list of horizontal alignments, nor displayed in the window.

The regression strip to be used will be that selected for the calculation of profiles, reason for which this tool does not have a dialog window.

Parameters

With this button, the user has access to a dialog which allows setting the value of the regression strip for quick and profile operations.

During computing of quick profile, station 0 will be assigned to first selected point. The station assigned to second point will be the distance between both points. Otherwise, if the line defined by them cuts the current alignment, it will be used as reference and station 0 will be assigned to the intersection, and for every point the station will be their distance to intersection, whose sign will depend of the side (negative for left and positive for right) in respect of the alignment.

### Profiles



Calculate profile

Once an horizontal alignment has been selected, this tool will enable the user to calculate the (points) profile. The user will be required to specify the creation parameters.

The parameters required are the initial and final stations between which the profile will be created and the regression strip.

Once the profile has been calculated it is displayed in the “Profile Editor” to enable the user to view and edit it.



Edit profile

This tool enables the user to select a profile file (\*.lns) and to start the “Profile Editor” to view and edit it. The profiles generated within a project are stored in the “Temporal” folder of the project. Use the “Profile Editor” to save them in another location.

### Cross sections



Calculate cross sections

Once an horizontal alignment has been selected, this tool will enable the user to calculate (points) cross sections. The user will be required to specify the creation parameters.

The parameters required are the initial and final stations between which the cross sections will be calculated, cut interval, regression strip and the length of the profiles on the left and right of

the horizontal alignment.

Once the cross sections has been created them are displayed in the “Profile Editor” to enable the user to view and edit them.

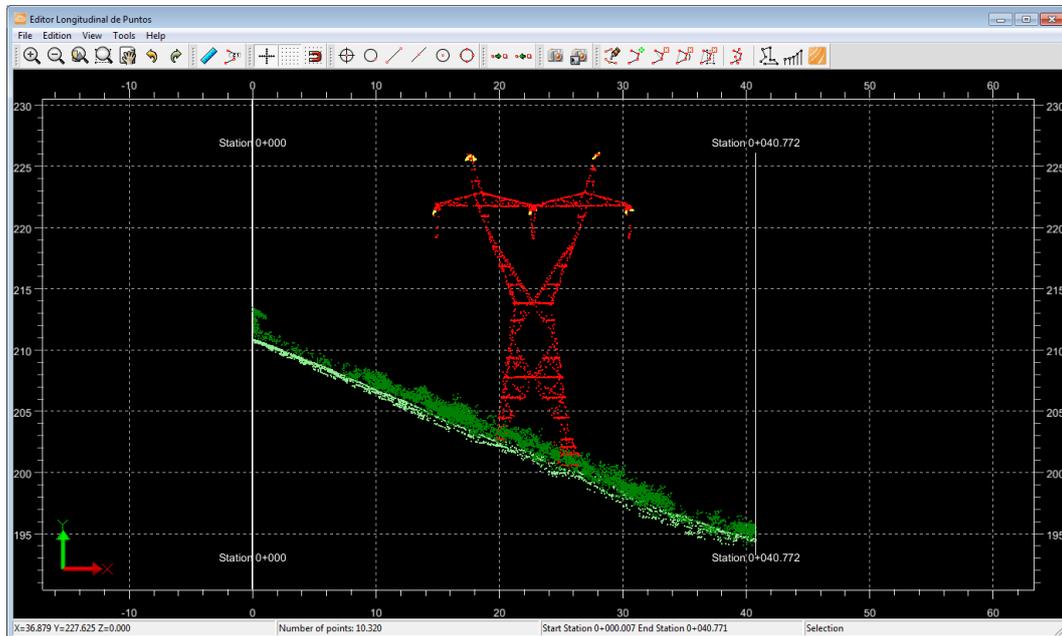


Edit cross  
sections

This tool enables the user to select a cross section file (\*.trs) and to start the “Profile Editor” to view and edit it. The cross sections generated within a project are stored in the “Temporal” folder of the project.

## 7. PROFILE EDITOR

Enables the user to edit profiles and cross sections generated using the *MDT-PointCloud* application individually and to export it to cross section and profile files compatible with MDT .



A toolbar is located at the top of the application, most of whose icons are the same as those found in the horizontal alignment, grade line and profile, etc. editors. They also operate in an identical manner. The following specific commands are included in this application.

 Increases the size of the points.

Expand points

 Reduces the size of the points.

Reduce points



Joins the polylines we have selected in a single polyline.

Join



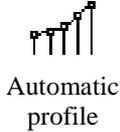
Polyline

This tool enables the user to draw a polyline on the point cloud. The first click of the left-hand button of the mouse adds the initial vertex of the polyline. Holding down the left-hand button and moving the mouse over the point cloud enables the user to add vertices automatically or clicking repeatedly on the left-hand button to add vertices manually.

Clicking on the right-hand button of the mouse opens the context menu with the following options for the polyline created:

- End polyline.
- Open/Close polyline.

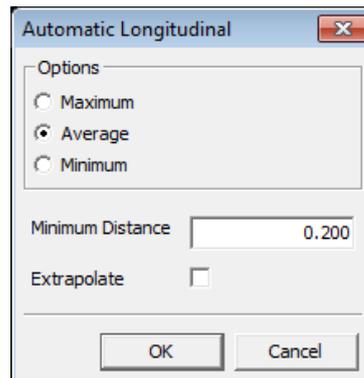
- Delete last vertex (the delete button may also be used).



This tool enables the user to create the profiles of all the cross sections or longitudinal profile being viewed. Only one polyline per profile is created.

The initial point of each profile will always be the point furthest to the left, and it will then be created to the right until the end of the cloud.

On selecting this tool a dialogue box will appear to enter the settings.



The minimum distance represents the minimum gap between the points on the creation of a profile in the event of finding points.

The extrapolate option, in the case of a longitudinal profile, ensures the single points extrapolate the ends of the polyline so it coincides with the nearest single point. If we are editing a cross section file, a vertex with a zero displacement will be added on the creation of an automatic profile.

Using the maximum, minimum or average options enables us to select the points making up the profile using the maximum or minimum point or the average of the nearby points (in accordance with the minimum distance).

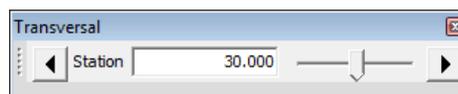


Send to CAD

A command to send the **LNS** or **TRS** file being edited to AutoCAD or a similar application.

A **TRS** file may contain several profiles, and the following toolbar will enable the user to change the profile by using the arrow buttons, the drop-down bar or inserting a name in the editing box.

On changing profile the polylines already drawn will be stored.



The graphic display of the point cloud is located under the toolbar.

Clicking on the left-hand button selects the object in the position of the mouse, and if nothing is there we enter the window selection mode and the application waits for a second click of the left-hand button to select the elements inside the rectangle formed by the two positions. Pressing the **Delete** key removes the items selected, and pressing the **escape** key cancels the selection.

A status bar is located at the bottom of the window which provides information on the current profile and the status of the editor.

## Exporting

We may export the following formats:

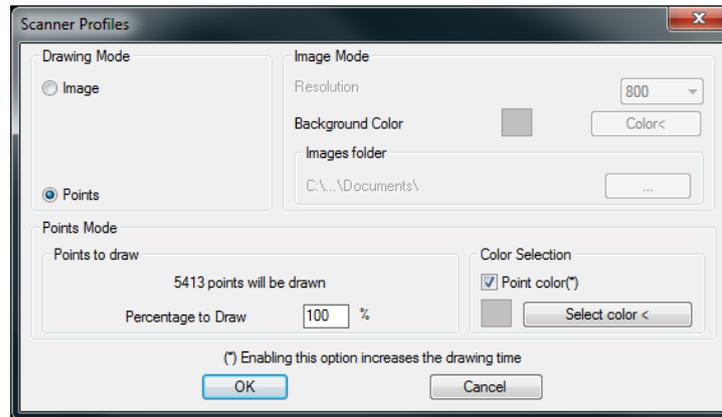
- Longitudinal: In this case the user needs to select the polyline to be exported.
- Point longitudinal: Exports the profile being viewed to a **.LNS** file. It may be a longitudinal or cross section profile.
- Point cross section: Saves all the profiles to a **\*.TRS** file.
- MDT cross section: Saves the polylines to a **\*.TRA** file compatible with MDT.
- DXF file: Saves the polylines of the current profile to a dxf file.

## 8. DRAWING OF POINT-BASED PROFILES

This command enables the user to draw longitudinal profiles generated using the *MDT-PointCloud* module.

The profile is stored as a point cloud, and MDT draws it as a point cloud instead of as a polyline as usually occurs. Furthermore, it also provides the possibility of inserting the profile as an image, an option which is highly useful for situations in which the point cloud is particularly dense and the drawing of the profile is extremely time consuming due to the large number of points involved.

The following window will appear on clicking on the command:

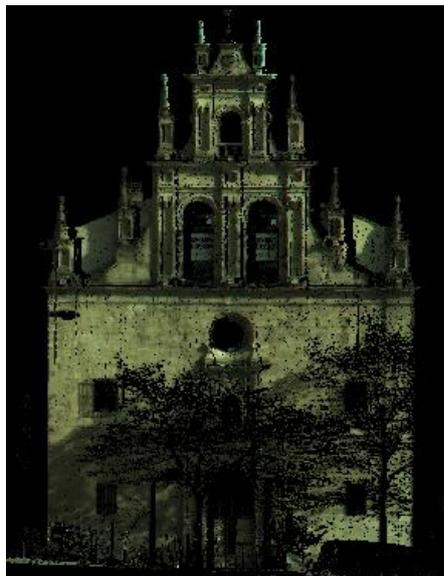


**Drawing mode:** We select the mode in which the profile is to be drawn, and as indicated previously, it may be drawn as a point or as an image inserted in CAD.

### Image Mode

In the case of inserting the profile as an image, the user may select the resolution to be used to insert it. MDT operates with the most common resolutions. The image is stored in the folder of the user's choice. It is also possible to customise the background colour of the image.

The figure below shows a profile inserted as an image:



## Points Mode

If the user opts to insert the profile as a point cloud, different options exist to reduce its density and thereby speed up the creation of the profile in accordance with its size.

**Points to be Drawn:** The software shows the total number of points to be drawn, and varying the amount of the percentage enables the user to reduce the total number of points to be drawn. There should be a balance between the total number of points and those actually drawn, in order to ensure the final sketch does not contain a number of points which will complicate its management, but which at the same time contains a sufficient number in relation to the drawing in question.

**Selection of Colour:** Each point may or may not contain a property with its own colour, and this option enables the user to select a single colour for all the points in the cloud or a colour for each point.

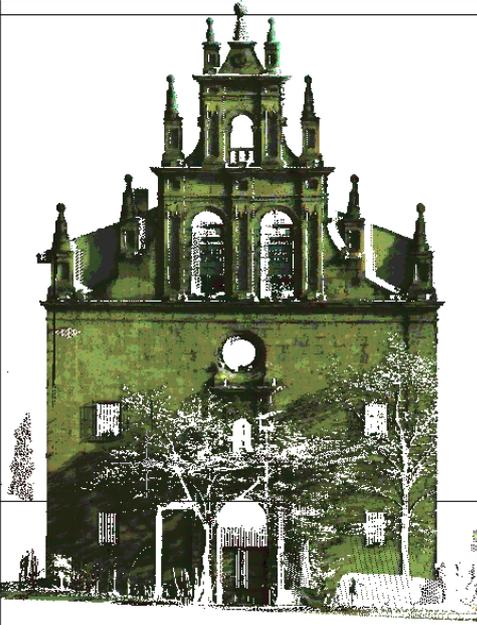
The latter option will slow down the process of drawing the point cloud.

There follow below several profiles drawn as point clouds in which the percentage of points varies:

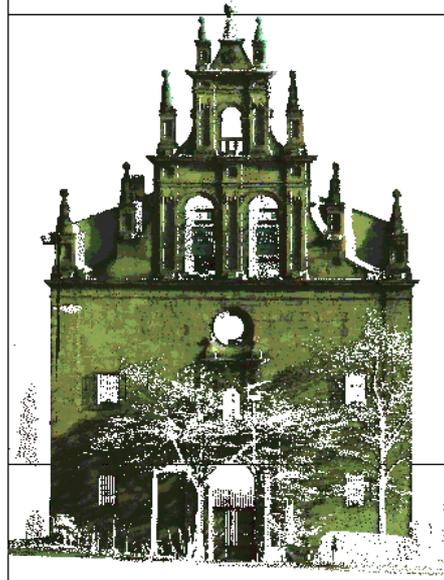


*100% sketch of the point cloud.*

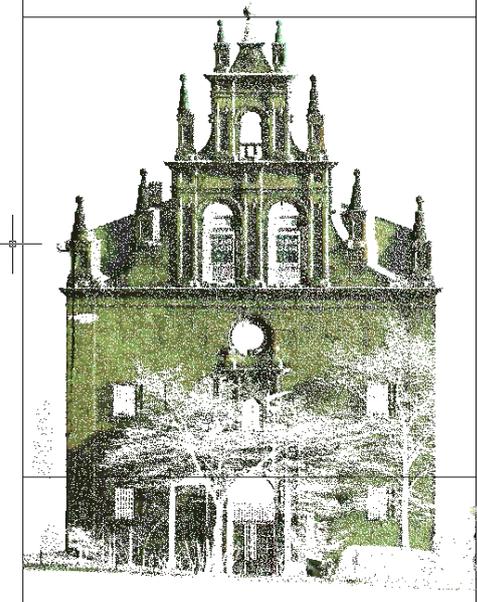
*1,819,652 points*



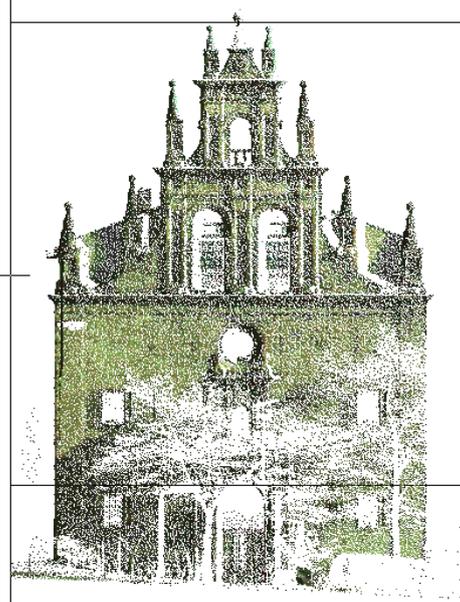
50% sketch of the point cloud.  
909,826 points



25% sketch of the point cloud.  
404,845 points



10% sketch of the point cloud.  
125,457 points



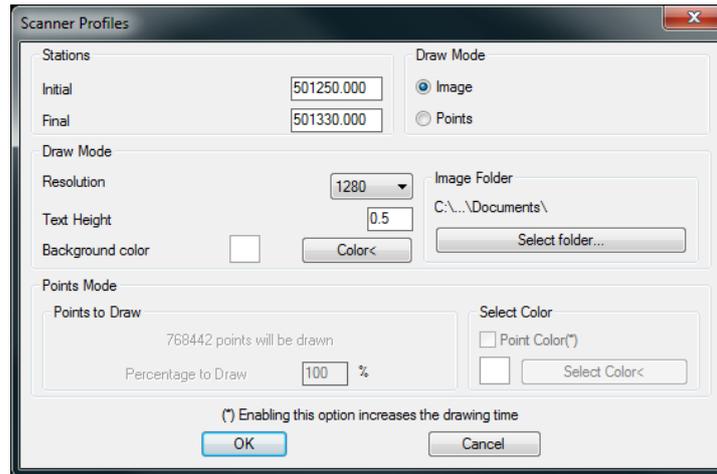
5% sketch of the point cloud.  
95,245 points

## 9. DRAWING OF POINT-BASED CROSS SECTIONS

This command enables the user to draw cross section profiles generated with the MDT-PointCloud module.

These profiles are displayed as a point cloud in CAD, and the user may also choose to draw it as images. The latter option is recommended in situations in which the cross section point clouds are very dense and drawing them would take quite some time.

Clicking on this command reveals the following window, explained below:

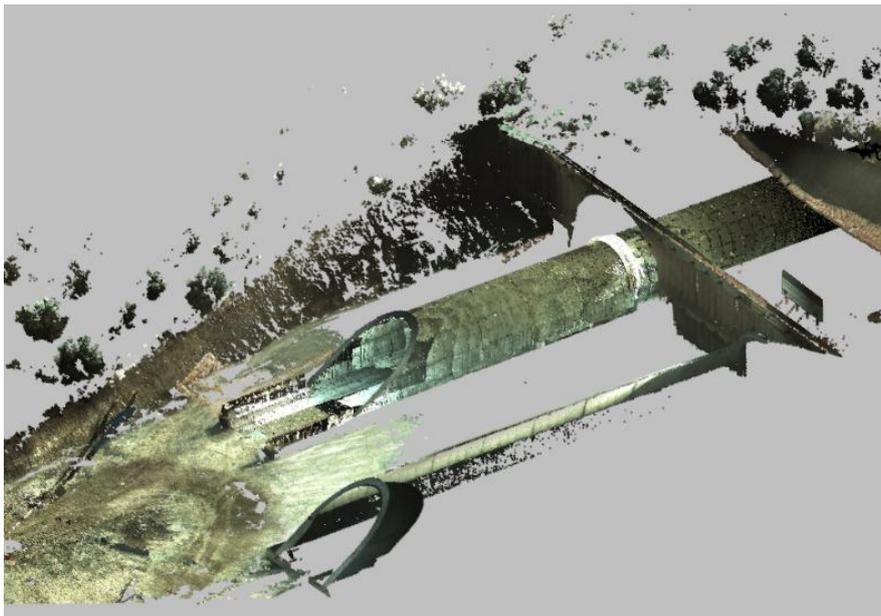


**Initial station:** Initial station from which the cuts are drawn .

**Final station:** The final station up to which the cuts are drawn.

**Drawing Mode:** We indicate the form in which the profiles are displayed, the two possibilities being an image or a point cloud.

The following image, and more specifically the central tunnel, has generated a series of cross sections in the terrain, the result being shown in both image and point mode.



## Image Mode

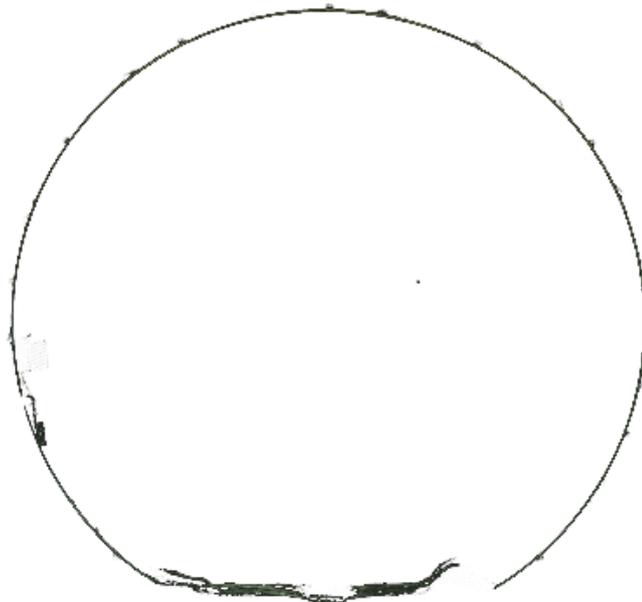
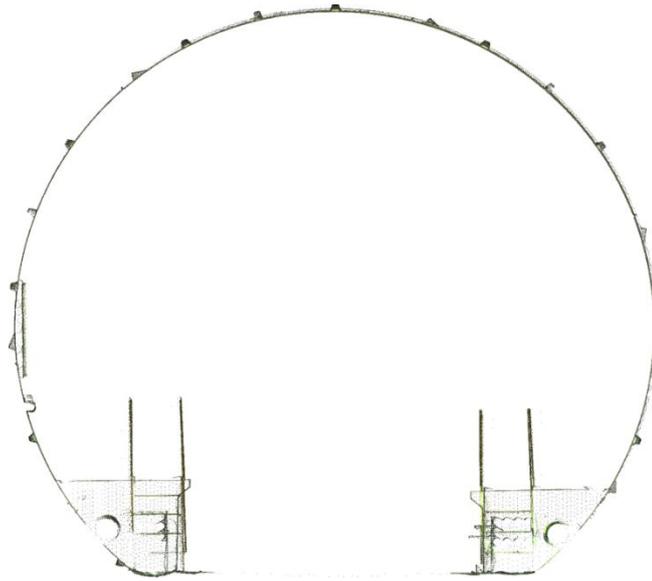
**Resolution:** Selects the resolution used to insert the image. Enables the user to select from among the most common resolutions.

**Height of text:** Selects the height of the texts of the stations associated with each image.

**Background colour:** Selects the background colour of the images.

**Image folder:** Selects the folder in which the images to be inserted in the drawing are created. These images will be in BMP format.

Several cross sections are illustrated below:



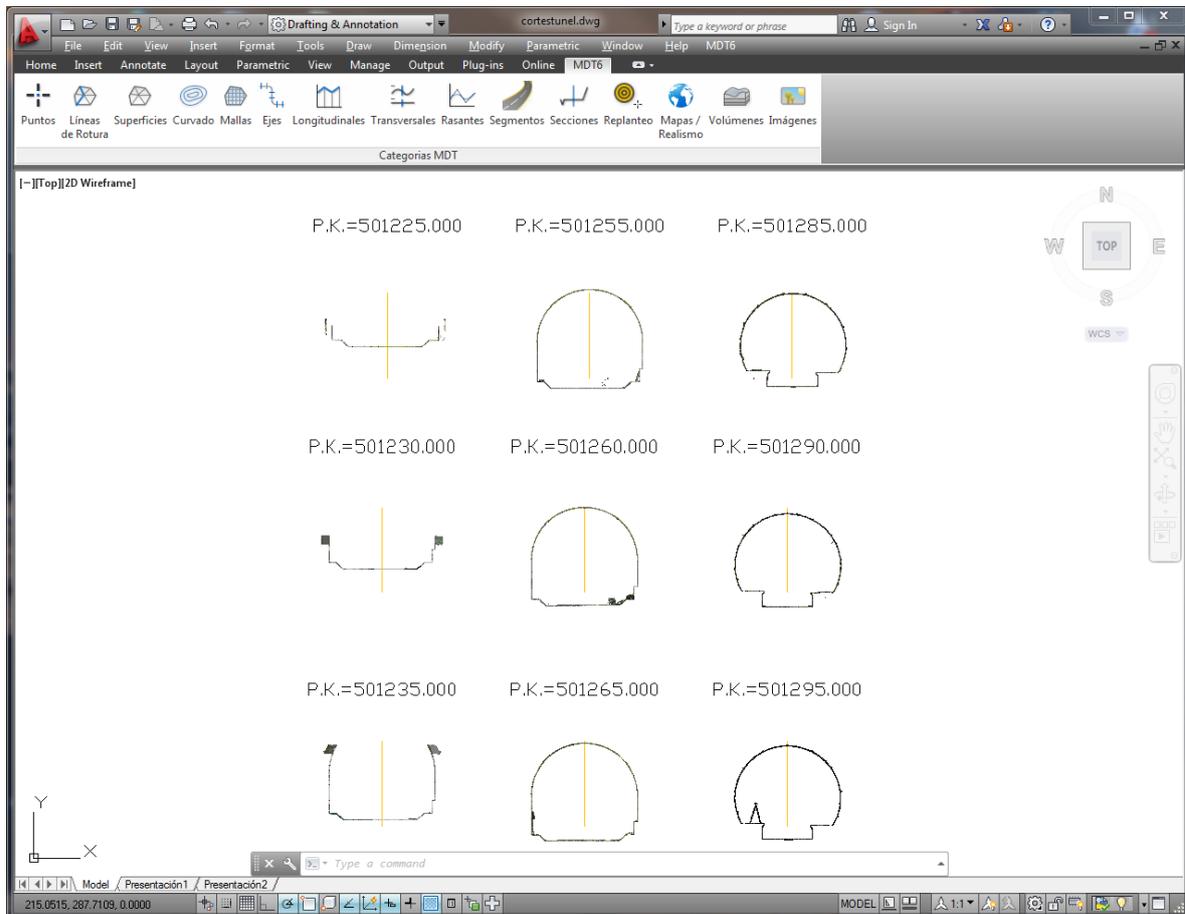
## Points Mode

This option involves the profiles being displayed as a point cloud. If the user opts for this alternative for displaying the profiles, several parameters are also available for customising the display of the cuts, in addition to increasing the speed of drawing.

**Points to be drawn:** The user indicates the percentage of point to be drawn, and the importance of this parameter lies in the fact that a high number of points results in the drawing process being extremely time consuming. Likewise, an extremely low number of points will hamper viewing of the profile.

**Selection of Colour:** Additionally, the user will have the possibility of displaying the points in their own colour or in a preset fixed colour. Points do not always have information on the colour, and in this case the colour selected will be used.

A group of profiles drawn in this manner is illustrated below:



## 10. SURFACES, GRIDS AND CONTOURS

### Introduction

MDT-PointCloud implements tools for the generation of surfaces and grids using point clouds. These tools are particularly recommended for LAS/LiDAR type point clouds, as the surfaces and grids are always created in relation to the XY plane. Moreover, a tool to obtain the contours of an existing surface or grid is included.

These and other related tools are accessible via the “Surfaces” group in the “Tools” tab on the Ribbon.

The application will store a surface, grid and contours for each project to ensure that these items are stored with the rest of the project information when created. This enables the user to display them when reopening the project.

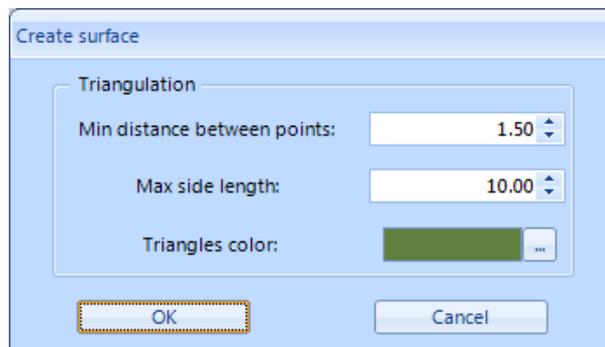
### Surfaces

There are three tools to use with MDT-PointCloud surfaces and which enable the user to create surfaces from point clouds, import surface files and activate or deactivate the current surface.

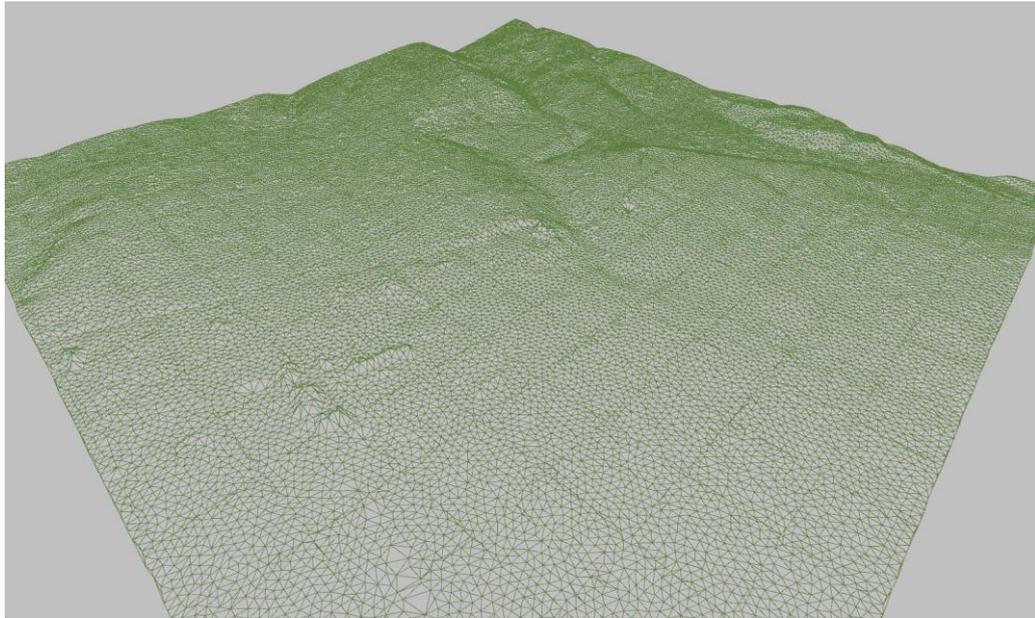


Create surface

This tool, located in the drop-down button of the “Surfaces” group in the “Tools” tab, creates a new surface from the points selected if they exist, or based on all of the points if not. The user should set the necessary triangulation parameters.



The application will suggest a minimum distance between points based on the properties of the loaded point clouds (number of points and 3D volume) in order to ensure the creation of the surface does not take too long. The user may alter this amount and set a maximum side length for the triangles forming the surface. The user may also define the colour used to draw the surface.



Import  
surface

To import a surface click on this feature and select the surface file (\*.sup). As with the creation of a surface, the imported surface will be converted into the current surface, replacing any existing surface.



Show  
surface

This feature is available on both the Ribbon and the display window toolbar, and activates and deactivates the visibility of the current surface.

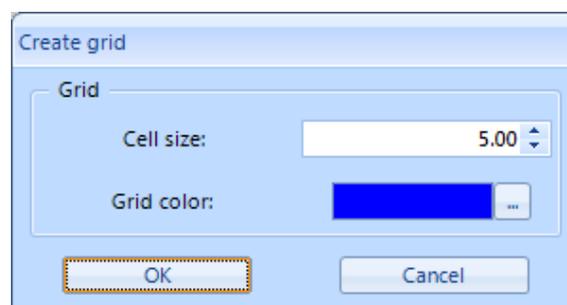
## Meshes

The application possesses the same features for the creation, import, export and activation/deactivation of meshes as for surfaces.

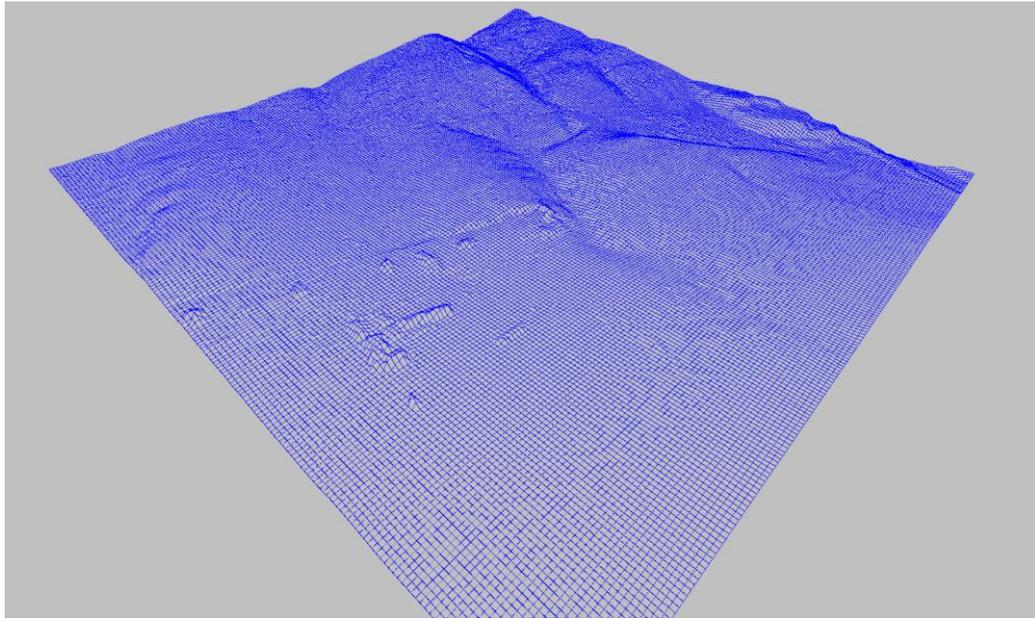


Create  
grid

The command for the creation of grids can also be found in the drop-down button of the “Surfaces” group in the “Tools” tab. The grid is created from the points currently selected. All visible points will be used if none have been selected. The user should define the parameters set forth in the dialog box which appears when this tool is activated.



It is possible to define the size of the grid cell and the colour to be used in the view window.



Import  
grid

The process for importing a grid is the same as that for importing a surface. The user is required to select the grid file (\*.mde), which will be imported and converted into the current project grid.



Show grid

This feature is available on both the Ribbon and the view window toolbar, and activates and deactivates the visibility of the current grid.

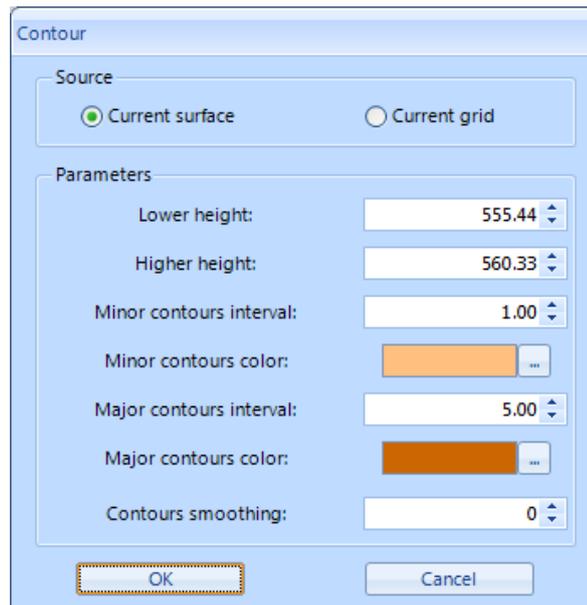
## Contours

Once a surface or grid has been created or imported, its contours may be generated. The application features a function which generates contours and two functions to activate and deactivate the visibility of major and minor contours.

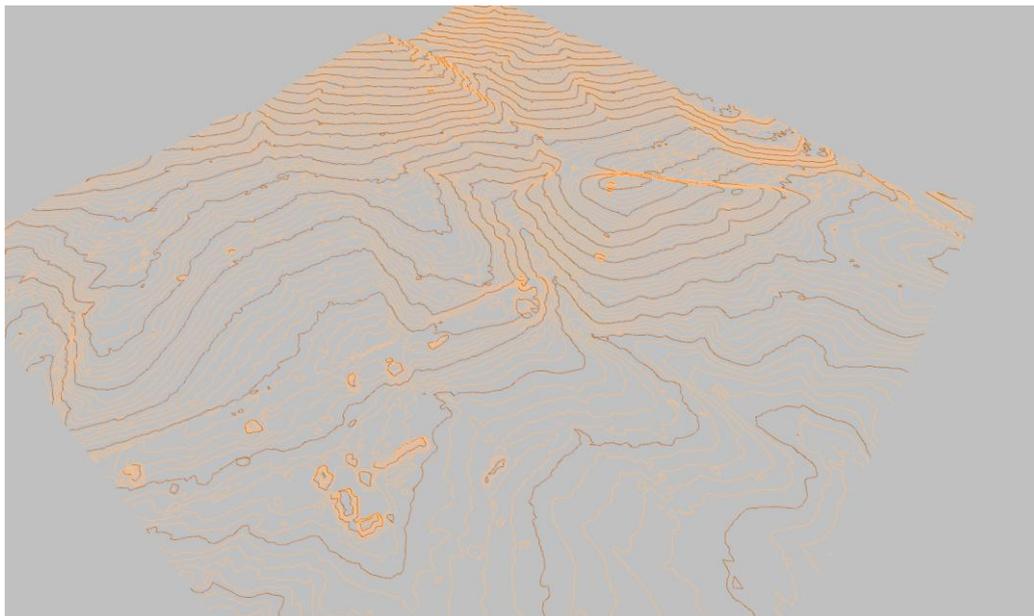


Contours

The contour feature is also available on the drop-down button of the "Surfaces" group and requires the prior existence of a current surface or grid. Users should opt whether or not to include contours in the current surface or grid in the dialog window which appears.



The contour parameters also need to be defined, enabling the user to limit the range of heights within which the interval between minor contours and their display colour, the interval between major contours and their display colour, and the smoothing factor (from 0 to 10), are generated.



Major  
contours

This feature is accessible in both the “Surfaces” group on the “Tools” tab and the view window toolbar and enables the user to activate and deactivate the visibility of major contours.



Minor  
contours

This feature is also accessible in both the “Surfaces” group on the “Tools” tab and the view window toolbar and enables the user to activate and deactivate the visibility of minor contours.

## 11. INTERACTION WITH TCP-MDT AND CAD SYSTEMS

### Introduction

The MDT-PointCloud application was designed with the idea of providing MDT with the possibility of working with point clouds, given the poor performance of CAD systems in relation to this type of information. Indeed, the application is operated via MDT and requires a CAD system with an installed MDT. A series of features has been implemented to allow for interchange and information sharing between MDT and MDT-PointCloud, in order to enable the user to transfer data from one application to the other.

### Sending information to MDT

The buttons which provide access to the different options for sending information from the application to the CAD system in which the MDT is executed are located in the “Send to MDT” group in the tools tab on the Ribbon.



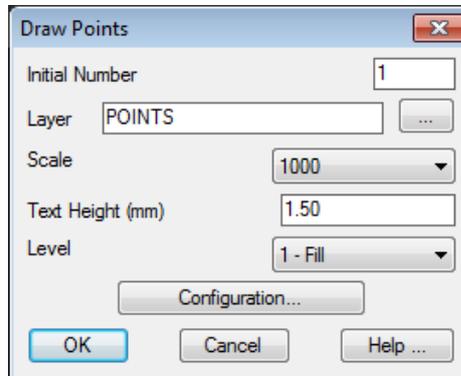
Horizontal alignment

This feature enables the user to send the selected horizontal alignment to the CAD system. This option is useful when wishing to edit a drawn horizontal alignment on the point clouds with MDT-PointCloud.



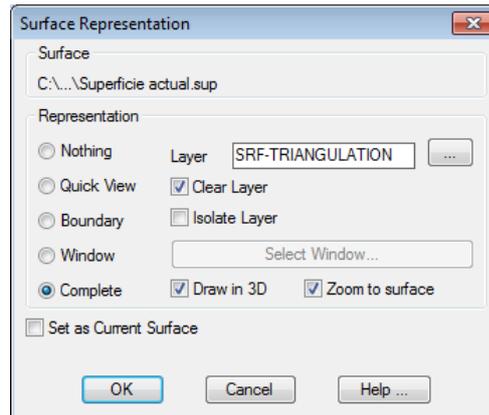
Points

This feature enables the user to send the selected points. The point export dialogue box appears and the user defines the percentage of the selected points to be sent to the CAD system. A CAD system with MDT will display the “Draw Points” dialog box to enable the user to define how the points are to be drawn.



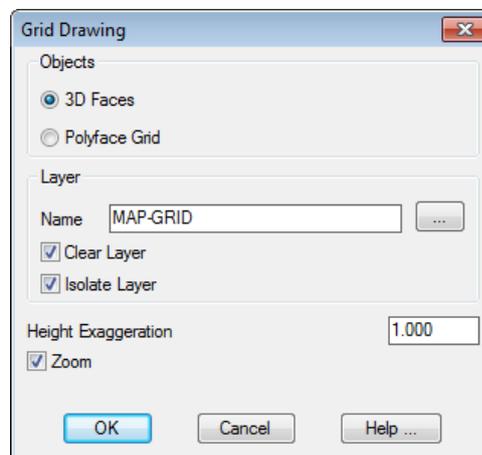
Surface

Once a surface has been created or imported, or in other words, when a current surface exists, it may be sent to a CAD system with MDT. The CAD system will display the “Surface Representation” dialog window to enable the user to define the display parameters.



Grid

As occurs with surfaces, it is also possible to send the current grid to the CAD system with MDT. The CAD system will display the “Draw Grids” dialog box to enable the user to define certain parameters in relation to drawing grids.

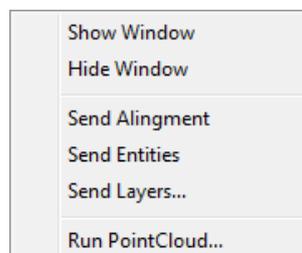


Image

The feature for sending geo-referenced images to MDT is designed for LAS/LiDAR type or scanned files in which the point of interest is on the surface of the land. A top view of the current view is generated and sent in geo-referenced form to the CAD system in order to provide a top view of the area of interest of the point cloud in the CAD system.

## Receiving information from MDT

The multi-item “MDT-PointCloud” option is located on the menu of the CAD system in which MDT is executed.



The first two options are to show and hide the MDT options (floating) window for communication with MDT-PointCloud.



Then come the three options which enable the user to actually send information from the CAD system with MDT to the MDT-PointCloud application. These options are:

- **Send Horizontal Alignment:** Enables the user to send an horizontal alignment from the CAD system to the application, which is then added to the list of horizontal alignment and displayed in the main window. This feature may also be activated using the “Alignment <” button in the floating window.
- **Send Entities:** This feature enables the user to indicate entities in the CAD system, which are then displayed in the “MDT-PointCloud” application. MDT-PointCloud will create a layer for each entity in its absence. This feature may also be activated using the button in the floating window.
- **Send Layers:** This third option for sending items from the CAD system to the application enables the user to send full layers. The same feature is activated using the “Layers” button in the floating window.

Sending items between the CAD and MDT-PointCloud is limited to lineal entities (lines and polylines), reason for which only this type of item will be visible in the MDT-PointCloud view window.

The final “Run PointCloud...” option enables the user to execute the MDT-PointCloud application. The “Run...” button in the “MDT6 – Point Cloud” floating window may be used for the same function.

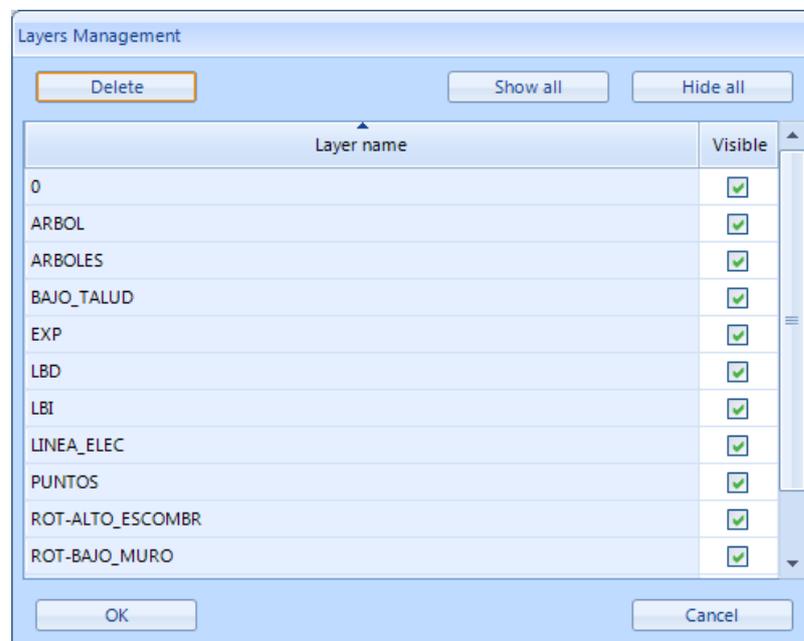
## Display of CAD elements

MDT-PointCloud implements certain options in relation to the control and management of CAD items using the buttons of the “CAD” group on the “Tools” tab in the Ribbon.



This option provides the user with a dialog box for the management of CAD drawing layers partially or totally stored in MDT-PointCloud.

Layers



The user may delete drawing layers and choose to make each layer visible or not.



This option deletes the complete drawing stored in MDT-PointCloud. This represents the deletion of all the layers in the layer management dialog box.

Delete

Activities conducted on drawings, layers and entities stored in MDT-PointCloud have no effect on those of the CAD system and vice-versa. This means that if layers are sent from MDT to MDT-PointCloud and are later deleted from one of the applications, they will still exist in the other.

It is not possible to delete or control the visibility of items in MDT-PointCloud on an individual basis, the only way being to delete the layer in which the said entity is filed. This requires the user to send items in a correct manner in order to prevent the presence of undesired items in MDT-PointCloud drawing layers.

## 12. CUSTOMISATION

The application features a settings dialog box which enables users to define their preferences in relation to specific aspects of the application. This dialog box is accessed via the “Configuration” button in the lower part of the start menu, or the configuration button in the “Options” group in the “Home” tab on the Ribbon.



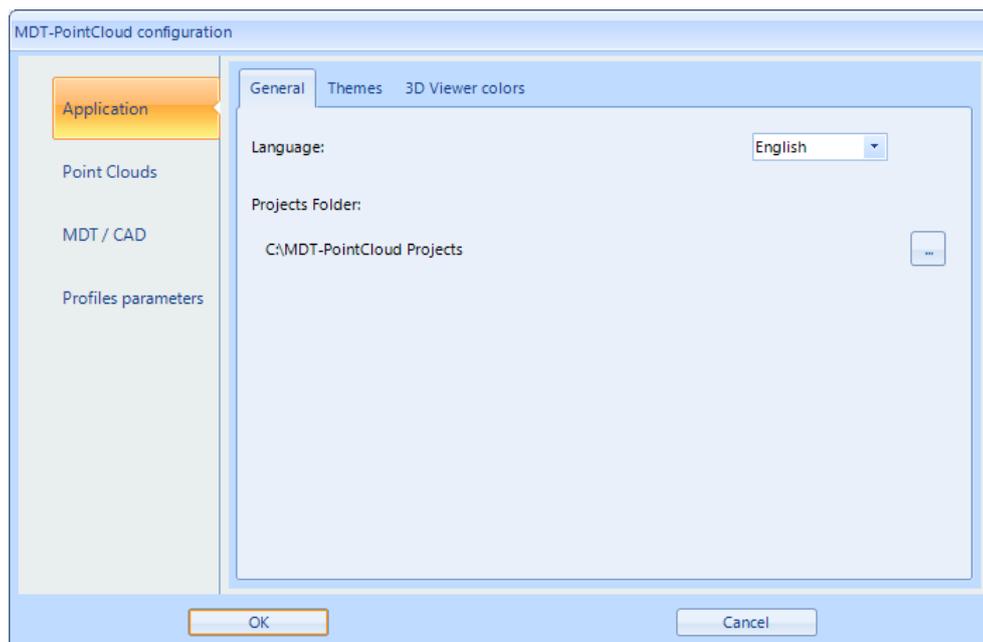
Shows the configuration dialog box, which enables users to define their preferences.

Configuration

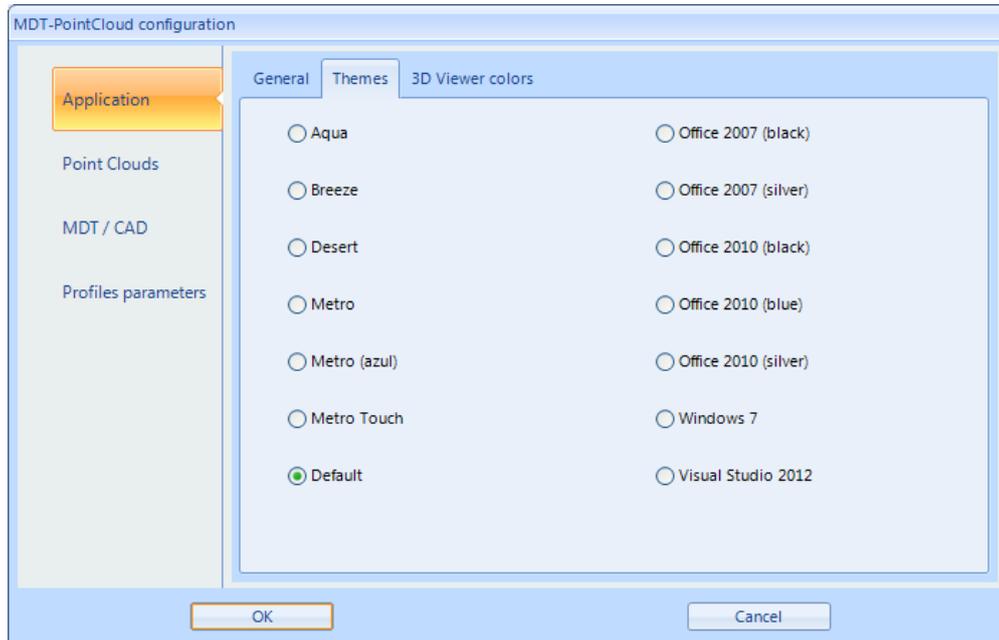
As a means of facilitating its use, the configuration dialog box is divided into four segments located on the left-hand side, whereby each segment is divided into sub-segments located on the right-hand side.

### Application

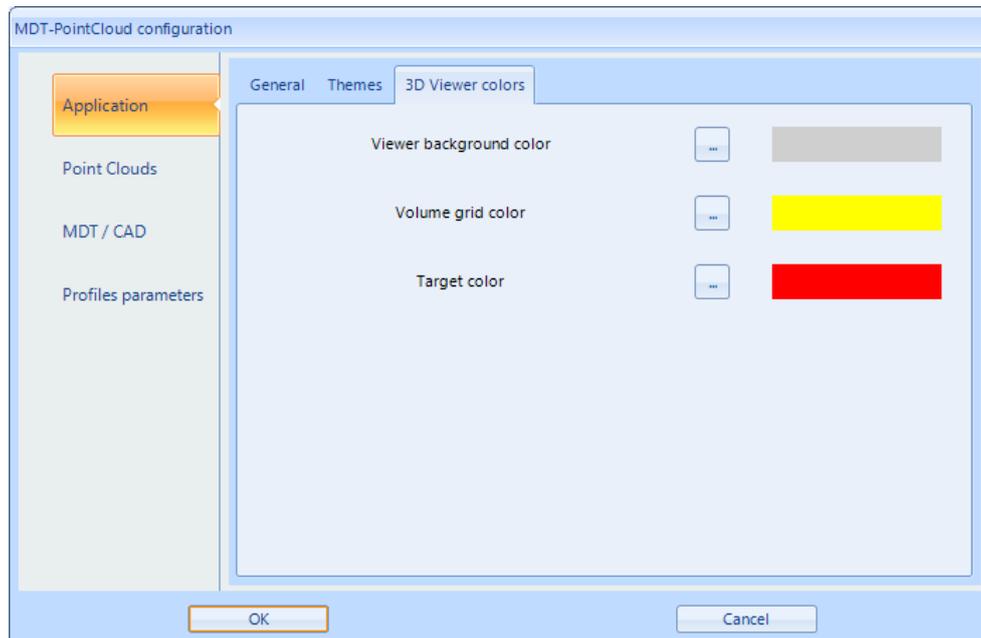
With regard to the application, the user may define the language and the folder to be used for creating the projects by default, the theme of the application (colours and shapes of the windows and their elements) and the colours of the basic elements of the view window.



The user should click on the “...” button and select the desired folder in order to change the project default folder.



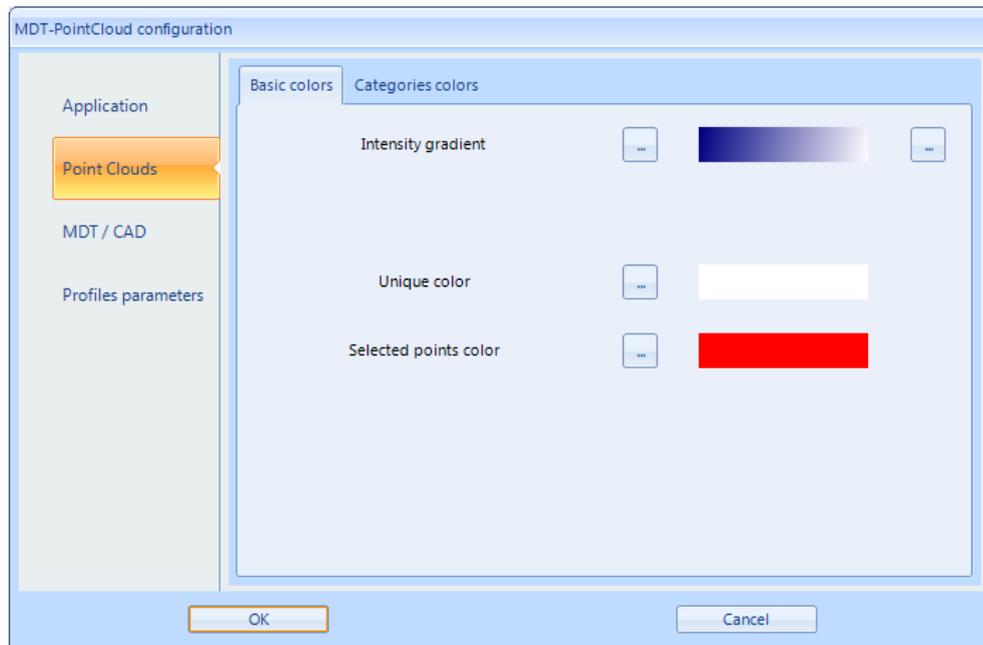
There are nine different themes for the windows of this application. The user may select a new theme from the list in the dialog box.



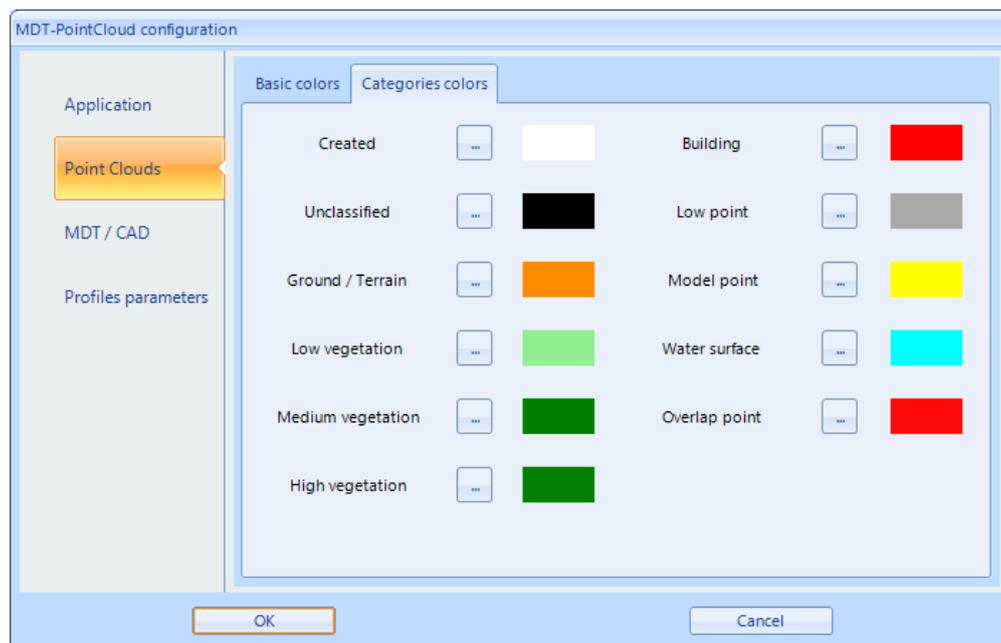
In order to define the background colour, 3D image or point of interest, the user should click on the “...” button and select the desired colour.

## Point clouds

Some of the default values to be used in the different viewings of point clouds may be defined.



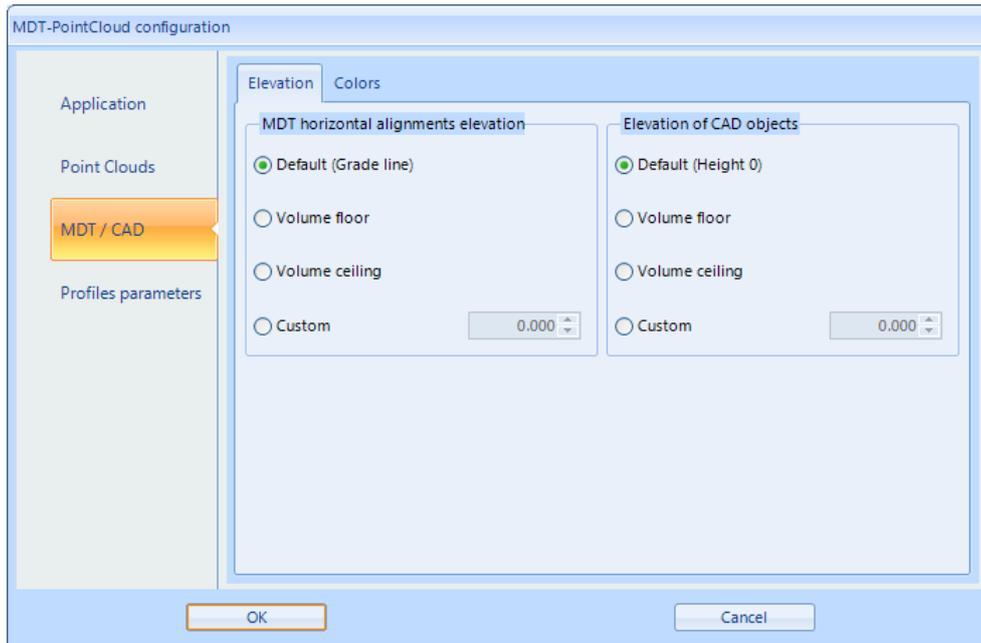
The user may define the two intensity colours, the unique colour and that of the points selected. In any case, selecting a category on the Ribbon will reveal a dialog box to enable the user to change these colours.



It is also possible to define the colours for the LAS/LiDAR categories. As with the other view options, selecting a category will reveal a dialog box to enable the user to change these colours (in addition to its visibility).

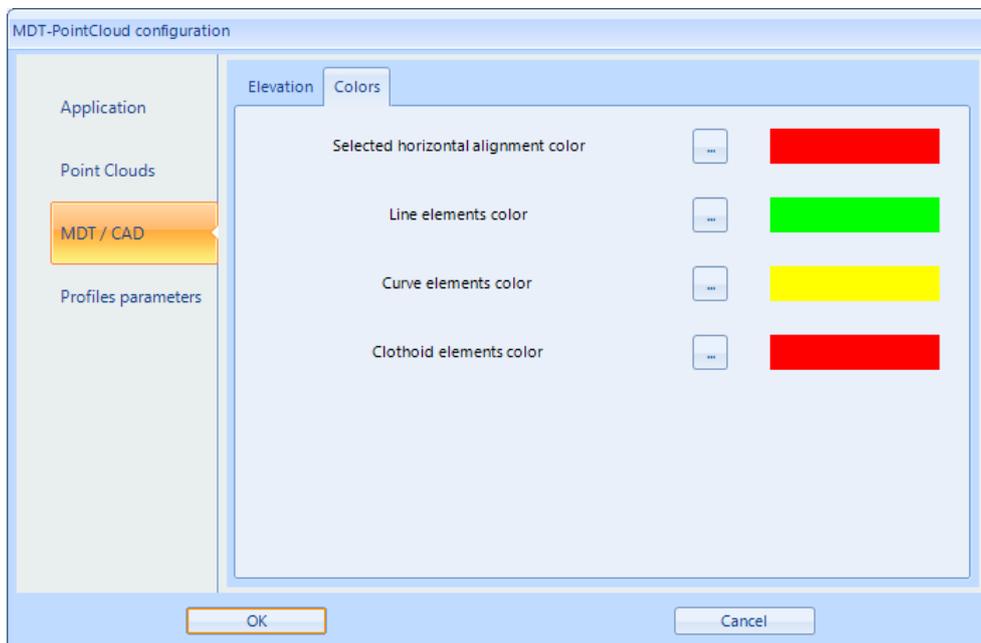
## MDT and CAD

The heights in which the horizontal alignments and elements of the CAD system are displayed may also be set, as well as the colours of the horizontal alignments.



The values in which such elements may be located are:

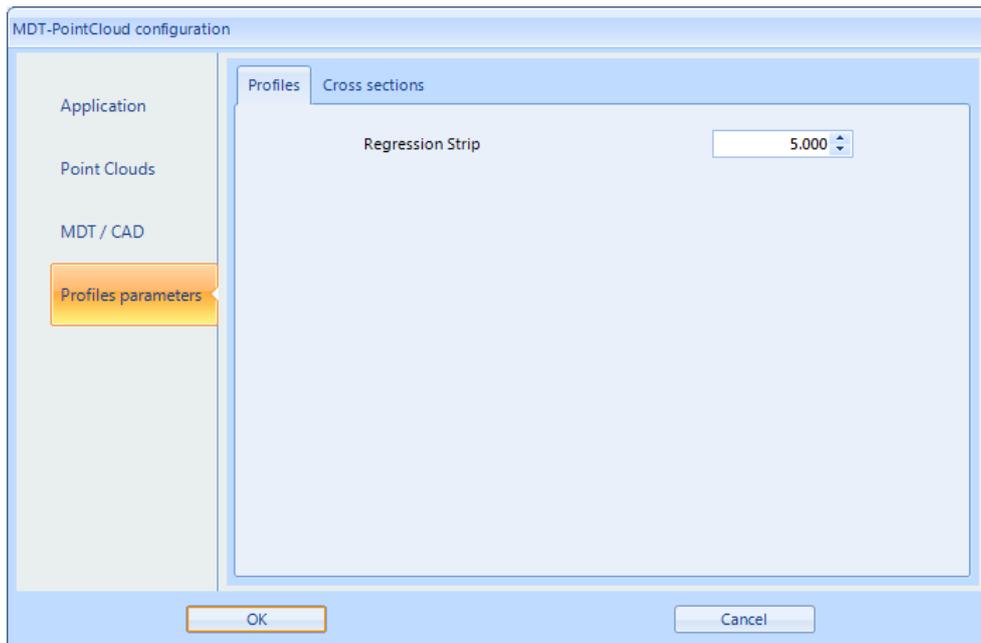
- By grade line or 0.
- Base of the 3D volume (bounding box which contains the point clouds).
- Top of the 3D volume.
- Customised. In accordance with the value specified in the adjacent text box.



The colours used to display the selected horizontal alignments and different elements may also be customised.

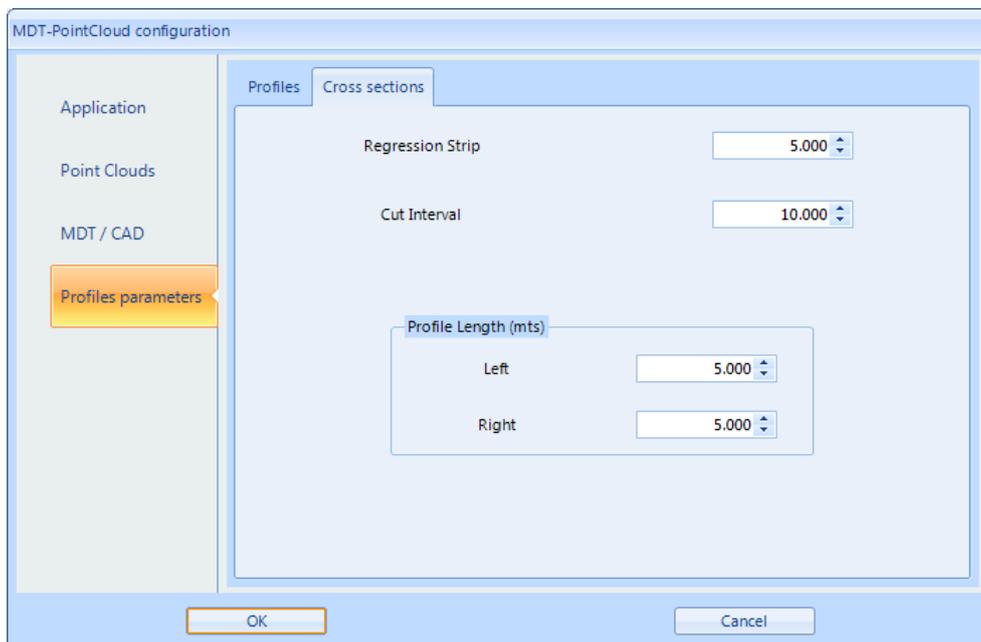
## Profiles

On creating a profile a window will always appear to enable the user to insert the required parameters. This feature provides the user with options to define the default values of these parameters.



The only parameter required for profiles is that of the regression strip. This value is also used for the creation of quick profiles.

With regard to cross sections, the user defines the cut interval and the length to the left and right of the horizontal alignment, in addition to the regression strip.



Clicking on "OK" after having made the desired changes will execute it and update the user interface.

## 13. HELP AND ABOUT....

The “Help” group on the “Home” tab on the MDT-PointCloud Ribbon contains the buttons which provide access to the application’s help and information windows.



This option shows this manual in Windows help format.

Help



This option features the application’s information window.

About



This window supplies the following information:

- Application and version.
- Licence number and customer registration name.
- A list of copyrights in relation to the application and third-party software.

It also provides access to the MDT-PointCloud application user licence documentation.