Learning Objectives

- Learn about Cultural Heritage complexes.
- Learn how to merge different kinds of captured data, such as aerial scans, terrestrial laser scans, and ground structure-from-motion (SfM).
- Learn the best-practice workflow and process.
- Learn how to create 3D/2D models of cultural heritage buildings.

Description

In this class, we will discuss a workflow to document and record cultural heritage sites using 3D data capture and Autodesk software. We will discuss integrated surveying techniques and software, including AutoCAD software, ReCap software, and 3ds Max software, used to document these sites for the next generations. Case studies will address the challenges of integrating aerial scans, terrestrial laser scans, and ground structure-from-motion photography, including working in confined spaces. We will also highlight the value of the data products for managing these important sites. FalconViz will share how the advancement of acquisition and scanning techniques is leading to new ways of fully documenting cultural heritage sites, rather than 2D hand sketching and standard photographing.

Speaker(s)

Ahmad Hasanat is a Cultural Heritage Specialist. He got his degree in Computational Archaeology and surveying, he is a professional photographer and CAD modeler. He has over eight years of experience in these different fields. And having very good experience with different sectors of technology such as terrestrial laser scanning, UAV's surveying methods, and ground structure from motion SfM photography. He is working for FalconVIZ as Data processing manager for Cultural Heritage Documentations.

ahmad.hasanat@falconviz.com
Dr. Neil Smith’s research over the past fifteen years has been in computational cultural heritage and archaeology. As a research scientist at the Visual Computing Center in KAUST, his research interests focus on the merging of computational science with a variety of domain driven research topics including disciplines such as archaeology, cultural heritage, digital humanities, geophysics, marine science, and urban reconstruction. Current research has focused on novel computer vision solutions that incorporate geographic information systems, scientific visualization, informatics, and simulation. In particular, recent research at VCC has led to the development of non-invasive remote sensing techniques (e.g. SfM, LiDAR) including aerial based scanning techniques using unmanned multi-rotor copters mounted with imaging sensors.

neil.smith@falconviz.com

Dr. Mohamed Shalaby, Education: PhD in Technical Mathematics, Johannes Kepler University, Austria. Past Experience: Senior Research Scientist in the Visual Computing Center at KAUST. Software Developer in RISC Software GmbH, Austria. Postdoctoral fellow in Applied Geometry Institute at Johannes Kepler University. 20+ years in research, software development, teaching, research and industrial collaboration management. Core Expertise & Contribution: Dr. Shalaby is a Falconviz founder. He has served as VP Business Development since early 2013. Since then, he is utilizing his industrial network to build key customer relationships and improve FalconViz’s market position and achieve financial growth. In addition, he works in identifying business opportunities by locating business deals; discovering and exploring opportunities. Dr. Shalaby is also co-inventor of FalconViz IP.

Mohamed.shalaby@falconviz.com
# Table of Contents

Introduction to the cultural heritage ......................................................................................................................... 4

Acquisition: 3D Scanning of Samhan ................................................................................................................................. 5

Processing and Quality Control ........................................................................................................................................ 5

Working with Recap .......................................................................................................................................................... 7
  - The Project Screen ..................................................................................................................................................... 7
  - Scan Files ............................................................................................................................................................... 8
  - Scan Project Workflow ............................................................................................................................................. 11
  - Create Project ......................................................................................................................................................... 11
  - Selection Tools ....................................................................................................................................................... 16
  - Window Selection Tool ........................................................................................................................................... 17
  - Fence Selection ....................................................................................................................................................... 18
  - Remove a Selection Area from a Selection Set ......................................................................................................... 20
  - Clear All Selection Sets ......................................................................................................................................... 20
  - Save and Export Projects ....................................................................................................................................... 21

Working with AutoCAD Civil 3D ..................................................................................................................................... 22
  - Project Workflow in AutoCAD Civil 3D .................................................................................................................... 22
  - Inserting your Point Cloud into Civil 3D ................................................................................................................ 22
  - Adjusting the Point Cloud data inside to start drafting ......................................................................................... 25
  - Adding Dimensions and Levels .......................................................................................................................... 28
  - Hatching ............................................................................................................................................................... 31
  - Creating a Title-block and plotting your drawing .................................................................................................. 32

Working in 3D Max .......................................................................................................................................................... 34
  - Importing Point cloud inside 3ds max .................................................................................................................... 34
  - 3D modeling ......................................................................................................................................................... 39
  - Tips and Tricks for Modeling in 3ds max ................................................................................................................ 45
Introduction to the cultural heritage

Cultural Heritage is an expression of the ways of living developed by a community and passed on from generation to generation, including customs, practices, places, objects, artistic expressions and values. Cultural Heritage is often expressed as either Intangible or Tangible Cultural Heritage (ICOMOS, 2002).

Cultural Heritage types:

Cultural Heritage can be distinguished in:

- Built Environment (Buildings, Townscapes, Archaeological remains)
- Natural Environment (Rural landscapes, Coasts and shorelines, Agricultural heritage)
- Artifacts (Books & Documents, Bones, Objects, Pictures)

In this part we are going to talk about built environment complexes such as buildings and ruins, and we also will take an example of document an archeological park located in Saudi Arabia called Samhan site. This park is about 23,500 m².

Figure 01: An orthophoto shows the whole area of Samhan archaeological Park.
Acquisition: 3D Scanning of Samhan

The As-built laser scan survey of Samhan Historical site began in the morning. The FalconViz acquisition team arrived on site at 7:30am and began laying out all ground control and Laser Scan Markers throughout the exterior of the buildings and collapsed areas. The team consisted of 4 members. After establishing permanent ground control, laser scanning began starting from the Mosque area and moving through the southern end of the site. A total of 19 laser scans conducted over 3 days were required to scan the exterior of all exposed buildings. From November 12-17 Interior laser scanning and image documentation was conducted for all houses with closed interiors.

During this period all rooms within the buildings that could be safely accessed were scanned and recorded. Most stairwells were captured and where safe the team captured imagery of upper floors and roofs. Rooms or small buildings that were pitch dark were captured successfully by laser and the intensity value was used for visual representation of these areas.

After one week, the team returned to Samhan Historical site to conduct the Aerial Survey after receiving permissions from MOI and GACA. The GCPs were recorded with RTK GPS with RMS error of ±5mm. In the next day the aerial scanning commenced at the site. A total of 8 scans were conducted throughout the day to capture the entire exterior of the buildings.

Again about acquisition, we captured this project using three different ways to acquire the data, first one was aerial scanning using drones, second way was ground structure from motion SfM a part of photogrammetry technology, and last one was scanning using terrestrial laser scanner (Leica C10 and P20)

Processing and Quality Control

After finished acquisition, Processing of the Aerial scans begun. After processing completed, the Aerial scan was combined with LiDAR scan with registration error below 1cm. The LiDAR and aerial used the same ground control for global positions in UTM 38N WGS84. The ground control was established on the provided benchmark located at the site. After quality assurance was achieved by the geomatics team, the FalconViz CAD team was then provided the final master plan Point Cloud which integrates Aerial+Terrestrial SfM photo imagery with Laser Scan. The final total size of the entire project is > 5 Billion points which includes all exterior and interior scans integrated together.
Table 1: Aerial Photogrammetric Scanning of Samhan

<table>
<thead>
<tr>
<th>Camera Model</th>
<th>Calibrated Nex-7 19mm 6000x4000 (24MP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAV Model</td>
<td>FalconViz FH850</td>
</tr>
<tr>
<td>Average Ground Sampling Distance</td>
<td>0.65cm</td>
</tr>
<tr>
<td>Area Covered</td>
<td>23,300 m²</td>
</tr>
<tr>
<td>Images Captured</td>
<td>2,198</td>
</tr>
<tr>
<td>Ground Control Points</td>
<td>19</td>
</tr>
<tr>
<td>Projection</td>
<td>UTM 38N WGS84</td>
</tr>
<tr>
<td>GCP RMS Error to Point Cloud</td>
<td>X: 0.008 Y: 0.008 Z: 0.010</td>
</tr>
<tr>
<td>Aerial Point Cloud Points</td>
<td>130,885,779</td>
</tr>
<tr>
<td>3D Mesh</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 2: LiDAR Survey Report of Samhan

<table>
<thead>
<tr>
<th>LiDAR Models</th>
<th>Leica C10 &amp; Leica P20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Resolution</td>
<td>5mm @ 10m</td>
</tr>
<tr>
<td>Area Covered</td>
<td>10,000 m²</td>
</tr>
<tr>
<td>Scans Conducted</td>
<td>117</td>
</tr>
<tr>
<td>Ground Control Points</td>
<td>19</td>
</tr>
<tr>
<td>Vertical Marker Controls</td>
<td>260</td>
</tr>
<tr>
<td>RMS Error range</td>
<td>X: 0.008 Y: 0.008 Z: 0.013</td>
</tr>
<tr>
<td>Registration Error</td>
<td>X: 0.010 Y: 0.010 Z: 0.010</td>
</tr>
<tr>
<td>Total Combined Point Cloud Points</td>
<td>&gt;2.5B</td>
</tr>
<tr>
<td>3D Mesh</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Figure 02: Tables show some information about the project.
Figure 03: LiDAR Point Cloud Alignment Error Histogram for all registered scans.

<table>
<thead>
<tr>
<th>Software</th>
<th>File format</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclone (C10,P20)</td>
<td>.las, pts formats</td>
<td>All the laser scans has been processed in its own software.</td>
</tr>
<tr>
<td>Pix4D</td>
<td>.las format</td>
<td>Process all the aerial scans together.</td>
</tr>
<tr>
<td>Agisoft photoscan</td>
<td>.las format</td>
<td>Process all the ground SFM data.</td>
</tr>
</tbody>
</table>

**Working with Recap**

You will start importing data, which automatically triggers the indexing process. Indexing time can range from a few minutes to a few hours, depending on the number and size of the files you import. You can start working on the point cloud scene as soon as the first file has been indexed.

**The Project Screen**

To get going with ReCap you’ll want to understand a little bit about the data you’ll be viewing and creating within the application. Autodesk ReCap lets you view and manipulate point cloud data from a number of sources. These include Project files which reference a large subset of indexed files, as well as unified scan documents that are stand-alone.
**Figure 04**: The initial screen of the Recap once you load it up, here we can understand some of the UI that will show up.

**Scan Files**

A point cloud typically contains information from multiple scan files. After the imported scan files have been indexed you will be working with the aggregate point cloud and not the individual scan files. For example, scan regions, which are used to organize and filter the content of the point cloud, often extend across the boundaries of the original scan files.

A point cloud project file (RCP) is a relatively small file that references the point cloud laser scan files, but does not contain them. In order to use a project file in scan projects, the RCS files must be available.

You can also export scan files in the project as a single RCP/RCS, E57, PTS, or PCG file. Because this process packages all of the information in the project, these files can be quite large.

<table>
<thead>
<tr>
<th>File type</th>
<th>Description</th>
<th>Use by</th>
<th>Create by</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCP/RCS</td>
<td>A project file that points to indexed point clouds, and includes information such as Scan</td>
<td>Creating a new project that acts as an access point to the point cloud. The file folders that</td>
<td>Saving a group of files that have been imported.</td>
</tr>
<tr>
<td>Regions that you have defined and other settings that you have used to analyze the data.</td>
<td>contain the individual indexed files must also be accessible.</td>
<td><strong>E57, PTS, PCG, LAS</strong></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>A single scan file that combines information from the files in the project.</td>
<td>Opening a package file that can be shared with products that cannot read RCS or RCP formats.</td>
<td>Exporting a group of files that have been imported.</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 04:** Table shows the files types which works in Recap.

For this project we have three different kind of data. All point clouds are registered to the laser scans based on the GCPs which capture by our team.

**Figure 05:** 3D laser captured points cloud.

**Figure 06:** 3D Aerial scan point cloud using drones.
**Figure 07:** 3D SfM structure from motion - ground scan.

**Figure 08:** The main work space window of the Recap.
Scan Project Workflow

Every scan project need to follow up with different steps to create the point cloud, and here is the workflow of any project in Recap.

Figure 09: A map shown the workflow of any project inside Recap.

Create Project

Project creation is split into several steps designed to help you get your scan data merged correctly into a point cloud: Import, Registration, and Index.

To start, hit the "scan project" button located on the home screen:
Figure 10: The main work space window of the Recap.

You will be next be prompted to name your project, and provide the scan files you intend to combine into a point cloud.

Figure 11: The window of naming the project.
Figure 12: Select your file to import, you can drag files or folder there.

The files can be either traditional scans from a fixed location (structured files), scans from multiple locations, such as those produced by a UAV (unstructured files), or a mixture of both. The scan data type will be reflected by a badge on the individual scan thumbnail:

Figure 13: the differences between structured data and unstructured data.

Once the desired files are selected, import options are presented. These allow you to define several settings that affect the result of the import.
Figure 14: Sittings panel you can use some filter to control the distance between the points.

Advance sitting is important because from there we can change the coordinate system, and in the case we use UTM-38N because that was the location out the project we talk about in the beginning.

Import may take a few minutes, depending on your number of scans and density of their data. The import progress is displayed on each scan's individual progress wheel.
Figure 15: After creating your project this what will you see. You need to click on Import your file to bring it inside Recap.

Figure 16: After importing your files, you need to index the whole point cloud files in Recap.
Figure 17: Once your indexing project done you can launch it in Recap.

Selection Tools

For the selection tools there are several kind of selection, free window, fence, and plane selection.

Figure 18: Selection tools.
Window Selection Tool

The Window selection tool selects a rectangular area within the diagonal corners that you specify, and is the default tool in ReCap. The selection area extrudes from the current view into 3D space to include points beyond those that fall within the 2D rectangle. In the example, the selection includes the back tower of the building, which might not have been the intended result.

This method is best used when defining a rectangular Scan Region or clipping area.

- Position the point cloud so several points on the plane you want to select are visible.
- On the Contextual tile menu, hover over the toolbar and click Window.
- In the point cloud, drag to define the diagonal corners of the rectangular selection area you want to define.
- To "remove" the entire area inside or outside the Window selection boundaries, click the Clip Inside or Clip Outside tool.
Fence Selection

Figure 20: Fence selection tool illustration.

The Fence selection tool selects an area that is bounded by the points you select. This is a good way to select an irregular area. Like Window selection, the Fence selection area extrudes into 3D space to include points beyond those that fall within the 2D rectangle that you specify.

Use this method to define the boundaries of an irregular Scan Region or clipping area.

- Position the point cloud so several points on the plane you want to select are visible.
- On the Contextual tile menu, hover over the Selection Tool and click Fence.
- In the point cloud, click locations to define each corner of the boundary that you want to define.
- Continue clicking locations until all points that you want to select are enclosed.
- To remove the most recent click location, press Backspace.
- To complete the selection, double-click or press Enter.
- To remove the entire area inside or outside the Fence selection boundaries, click the Clip Inside or Clip Outside tool.
Plane Selection

Figure 21: Plane selection tool illustration.

The Plane selection tool selects areas that are on the same plane. You click three or more locations. The selected area includes any points that are on the same plane as the points you selected.

Use this method to define a planar Scan Region or clipping area.

- Position the point cloud so several points on the plane you want to select are visible.
- On the Contextual tile menu, hover over the Selection Tool and click Plane.
- To set the depth of the planar selection, on the Contextual tile menu, drag the slider or enter a value.
- In the point cloud, click three or more locations that lie on the plane you want to select.
- To remove the most recent click location, press Backspace.
- To complete the selection press Enter.
- To remove the entire area inside or outside the Plane selection boundaries, click the Clip Inside or Clip Outside tool.
Add to a Selection Sets

**Figure 22:** Select different areas and adding them to the main selection set.

To define a new selection area when other areas are selected, the previous areas are cleared by default. Follow this procedure to add the new selection to selected areas you have already defined.

- Press Shift as you use a Selection tool.
- You will see a + attach to the drawing arrow.
- Define a new selection area.
- Release Shift when you are through defining the additional area.

Any combination of selection tool boundaries can coexist as a cohesive selection. Scan Regions and Clipping will function as normal, regardless of your quantity and variety of selections.

**Remove a Selection Area from a Selection Set**

You can only use this method for the most recently created selection set or Scan Region. To remove a selected area from a selection set you are creating, use the following simple method:

- Press Alt+click the selection area that you want to remove from the set.

**Clear All Selection Sets**

Use this method to remove all selection sets you have created.

- On the Contextual tile menu, click Clear.
Save and Export Projects

You can save and export your scan projects from ReCap's desktop application easily through the software itself.

To save your project, first it will save your changes on the original RCP format:

- You go to Home button.
- Click on the Save icon.

To export your project:

- You go to Home button.
- Click on Export button. You can choose what format you want to export. There are several formats such as PTS and RCS formats.

Figure 23: Clear button place.

Figure 24: Save and export buttons.
Working with AutoCAD Civil 3D

Project Workflow in AutoCAD Civil 3D

There are some steps we usually go through to start creating 2D plans in AutoCAD civil 3D.

1. **Inserting your Point Cloud into Civil3D**
2. **Adjusting the Point Cloud data inside to start drafting**
3. **How to create 2D CAD plans from PCD**
4. **Adding Dimensions and Annotations**
5. **Hatching**
6. **Creating a Title-block and plotting your drawing**

**Inserting your Point Cloud into Civil3D**

![Main screen of the AutoCAD Civil 3D.](image)

**Figure 25:** Main screen of the AutoCAD Civil 3D.
Load up AutoCAD Civil 3D, then click on the *Start Drawing* once you open it, first you need to delete all the default layers.

- To delete these layers you need to type `LAYDEL` in the command line.

**Figure 26:** Layers panel in AutoCAD Civil 3D.

- Then type N or click on Name in the command line to open up a window to choose the layers you want to delete them.

```
LAYDEL Select object on layer to delete or [Name]:
```

- You will see a window has all the layers, select them all then click *ok*, after that it will show another window click *Delete Layers*

**Figure 27:** Layers deleting window.
To start attaching your point cloud in civil 3D. First go to Insert → Point Cloud tab → Attach.

**Figure 28:** how to find out the button to attach the point cloud.

- After clicking on attach button, a select point cloud file window just show up, then navigate to the point cloud file you want to import. After that double click on your file or click on Open.

**Figure 29:** Select point cloud location window.
At this stage another window will show up called *Attach Point cloud* window, this is like an insertion dialog box says where you want to insert your points or scale them. We usually keep the default settings as it is and click *OK*.

![Figure 30: This is how your Point cloud will appear inside AutoCAD civil 3D.](image)

**Adjusting the Point Cloud data inside to start drafting**

Click on the point cloud to view its properties and adjust any settings needed.

**Note:** Sometime we attaching a point cloud has several scans or locations, in this case we can load up a *Point Cloud Manager* dialog box which could help to switch between the scans themselves. To turn on this dialog box you need to type `POINTCLOUDMANAGER` in the command line and to turn it off type `POINTCLOUDMANAGERCLOSE`.

![Figure 31: Point cloud manager dialog box.](image)

**Note:** I always prefer to create a layer and name it as *Pointcloud*, then just copy the point cloud you inserted to it because this could help while you are working on your project.
Figure 32: Layer properties manager dialog box.

Figure 33: This is how your Point cloud will appear inside AutoCAD civil 3D.

Figure 34: Point cloud properties inside AutoCAD civil 3D.

Note: We need to understand that these options are here in this Point cloud properties panel because this can help us a lot while we working with big point cloud data sets. We can control Point Size (this could help to close the small areas between points when I plot my data as final output). Level of Detail (This helps computer to process it fast and render it easy while you work on it). Transparency (This option can help to see through the point cloud) Scan Colors (this can help to see the Elevation, Scan location, and Normal) Cropping option (this can help crop some area to work on it and that could make your computer fast). Section could help to make slices on the point cloud to draw on it.

- To begin drafting a 2D plan, you must first slice your point cloud using the section plane.
Figure 35: Point cloud section plane button.

Once you create your section plane, you can go ahead and click on it, then you will see a *Section properties* dialog box.

Figure 36: Point cloud section plane.

Figure 37: Point cloud section plane option dialog box.

Make sure to draw any other details you can see in the plan, pay attention to openings [doors & windows], and draw your columns as well. To also be able to view your lines properly, make sure your 2D drawing is above the side point cloud for better visualization.
To view your point cloud more clearly, when you click on your section plane, choose slice to slit it from the bottom as well.

After adjusting your section plane, you can now draft your 2D using Polylines (PL on the keyboard then C to close it). Go to Top view and start drawing your walls.

Figure 37: Drawing 2D polylines on the point cloud.

Adding Dimensions and Levels

After drafting the plan from point cloud, we will go ahead and start adding dimensions and annotations.

Start by managing the dimension style from Annotate. Click Modify and specify your desired settings. After finishing up, go ahead and begin adding your dimensions. OR you can start to place your dimensions then you can bring any other old dimension from any old project then use Match Properties tool this could make it easy.
Next we will add the spot elevation levels to our plan. In my company FalconViz, we have created a tool to help us add the spot elevations on the point cloud. Here’s how to use this tool.

- You will first load this tool from the following folder by typing `NETLOAD` in the command tool bar.

**Figure 38:** Annotate dialog box.

**Figure 39:** Load up the spot elevation tool window.
• Adjust the settings by typing **FAVZPOTELE_SETTINGS...** this will open this window below.

![FalconViz Tools Settings](image)

**Figure 40:** Falconviz tool settings window.

• Next, you will type the following command to finally start adding your spot elevations. **FAVZPOTELE_POINT**

![FAVZPOTELE_POINT](image)
Hatching

- To hatch the walls, press H for shortcut and choose Hatch from the menu.

- Press on the hatch pattern and then select the internal points within your wall. Make sure you have your wall zoomed out to appear in full view for hatching to work.

- Make any necessarily adjustments needed using the properties tab.

Note: If you encountered problems with solid hatching [not visible]. Make sure your FILLMODE variable is set to 1. If problem still occurs, type SHADEMODE and set it to Shaded.
Creating a Title-block and plotting your drawing

- Last thing we would need to do is to plot our drawing and publish a HQ PDF. We need to create a title-block sheet.
- You can now begin by filling in the information of your project.

![Sample title block]

**Figure 41:** Sample of the title block we need to insert for our project.

There is a file .DWT we need to drag it and drop it in the working space then we will see the file there, we just need to adjust some information there.

Now we will begin plotting our drawing for a PDF file outcome.

- Go to plot by right-clicking on the layout tab.
- Choose from plotter, AutoCAD PDF.
These are the settings that we will be using. Go to preview to make sure everything looks accurate before plotting.

Figure 42: Your final plotted PDF file.
Working in 3D Max

3Ds max allows you to import a point cloud model and work with it in order to build a geometric model or scene based on the point.

In this chapter we will talk about how to add point cloud inside 3d max and how to model on it using editable poly modifier after drawing 2D plan based on the point cloud.

Importing Point cloud inside 3D max:

- To import point cloud we go to Create panel > Geometry > Point Cloud Objects > Object Type rollout > PointCloud

Figure 43: Create panel window.
Click on the **Point cloud button**, after that click on the center of the working space to place out the point cloud, initially, you would not see anything, at this point in the **command panel** click on the **Modify tab** but be careful to not deselect the **Point Cloud object**.

![Point Cloud window and Center of the working space](image)

**Figure 44**: Point cloud window and Center of the working space. Center of the scene.

- In the **Modify panel point cloud source rollout** click **Load Point Cloud**. Then navigate to the point cloud file you want to import. After that double click on your file.
Figure 45: Select point cloud file to import window.

In 3ds max it may take a couple minute to process the file, once the file has been imported click zoom extents all in the viewport navigation tools.

Important Note: sometime when you upload Point cloud in 3D max, it could come in as a lines or not showing up or just disappear. This problem happens because most of the point clouds are georeferenced to a coordinate system. To fix this problem you need to reset the orientation of the coordinate system of your project. To do this you need to go to Recap and reset it there. After that it should come east in the center of the working space.
**Figure 46:** Screenshots show the problem we were talking about above.

**Figure 47:** Screenshot shows how to reset the origin in Recap.
Figure 48: Point cloud window settings.

- **Color Channel** dropdown list contains five options for coloring the points.

- **Level of Detail Setting** contains the options to adjust the number of the points visible in the viewport.

- **Fixed in Rendering** checkbox allows for an alternate level of detail when rendering a point cloud versus what is shown in the viewport.

- Number of points that are being displayed and the total number of points.

To adjust the limit box open the subject of the point cloud and click the limit box gizmo in the modifier stack, then you can use the Select and Move tool to adjust the box.
3D modeling

3D Point clouds provide a high quality visual model that can be used as the basis for creating 3D geometry within 3ds max.

Once we import the point cloud inside 3ds max, we can go ahead and start modeling based on it.

The best way to start modeling in 3ds max is using the Limit Box to crop out the area you want to model on it because this could make your model easy to work with it.

![Figure 49: limit box option to adjust the point cloud area.](image)

When working with point cloud within 3ds max the standard snaps for geometry are augmented by the ability to snap to the point in the point cloud.

Here we are going to use the two and a half snap capabilities to create a Spline object that matches the outline of the walls. The Spline can then be used to extrude a three dimensional objects.

In order to be able to snap to the point in point cloud right-click the snap toggle button. It will open the grid and snap settings.
Figure 50: Grid and snap settings window.

- Make sure all the snaps are cleared by clicking the *Clear All* button at the bottom of the panel.
- Expand the snap type drop-down list.
- Choose the *point cloud objects*.
- Check point cloud vertex to enable you to snap vertices within the point cloud.

Figure 51: Grid and snap settings window and Point cloud Vertex.

- Click and hold the snap toggle button and choose two and a half from the fly out list.
This will help to draw an object on the world XY plane while allowing you to snap to points that are above the XY plane.

- Click the create tab in the command panel, then change through the shapes option and choose *Line* from the object type panel.

![Create tab and object type's window.](image)

**Figure 52:** Create tab and object type’s window.

- Since the two and a half is enabled, you can begin drawing in the top viewport. To trace your point cloud.
Figure 53: Drawing Splines over the point cloud, place the first point and follow up with the others, then close the spline object.

- Change to the modify panel from the modifier drop list add an *Extrude modifier* to the *line* in the Parameters rollout, then you can set amount to the extruding.

Figure 54: Extrude modifier parameters.
Sometime you need to do some editing on the vertices to make them attached to the point cloud.

- Add Edit Poly modifier on the model you already created, this can give you the ability to do changes over the model. From the modifier drop list add Edit Poly to the Extrude in the Parameters rollout.

![Figure 55: Edit Poly modifier.](image)

After adding Edit Poly modifier, you need to go to Selection parameters, and click on the Vertex to make it editable, then you can click on the Select and Move tool from the tools bar. After that you will be able to adjust the model to fit with the point cloud.

![Figure 56: Edit Poly modifier.](image)
If we are going to model in 3ds max using *Edit Poly* we need to think well about the number of edges we add to the model because that could make the model too high and that will slow our work and it may crash out project. We need to monitor the number of *the poly and verts*, we can press *key number 7* in the keyboard to show us the number poly.

**Figure 57:** modeling based on the point cloud.
Tips and Tricks for Modeling in 3ds max

This is the way how to model cultural heritage building in 3ds max.

- There can be only 2 mistakes when your extruded (spline + extrude modifier) object has an error:
  a) You have overlapping segments in your spline.
  b) the shape is not closed-check where you did not weld the vertexes-
- If you use splines to create shapes, try to use a very small number of vertexes.
- If you convert the vertexes in smooth/ bezier/ bezier-corner you can create very organic and round
- shapes without a too high number of vertexes
- If the transform gizmo disappears, press X to bring it back.
- Press ALT + W to maximize or minimize viewport.
- Use object isolation.
- F3 switches Shaded Display to Wireframe and back.
- F4 switches Shaded viewport to Shaded with Edges and back.
- Save incrementally to keep a record of progress.