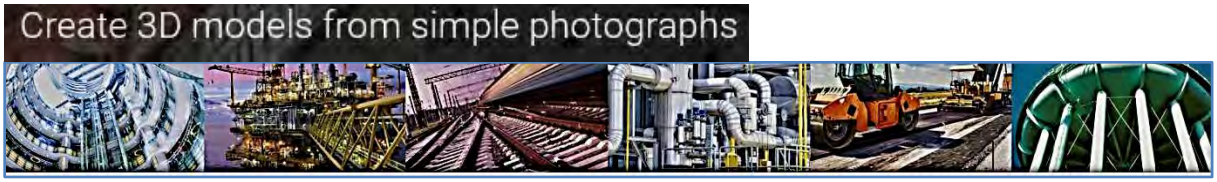
Reality Modeling

ContextCapture®

Software to Automatically Generate Detailed 3D Models from Photographs

Quick Start Guide



Who Should Read This Guide

New Users - This guide provides a reference for administrators and users who are installing and running ContextCapture for the first time.

Contents

About This Guide

This guide provides important installation information to get gets you started with ContextCapture, including:

- System requirements
- Installation instructions
- About ContextCapture
- The acquisition basics

- Systematic simplified workflow

System Requirements

ContextCapture is a processing application that uses computer resources intensively.
These recommendations address the main PC components.
If you need to build more-complex architecture, contact Bentley support at +1 610 458 5000.

Hardware	Recommended
OS: Operating System	Windows 10 (64-bit) Windows 8 (64-bit) Windows 7 (64 bit) Windows Vista (64-bit) Windows XP (64-bit)
The fastest CPUs would be the Intel processors with the most number of cores and the fastest speed possible	
CPU: Central Processing Unit	Intel Core I7-4770 Intel Core I7-5820K Intel Core I7-6900K
Using gaming graphics cards is recommended. Though ContextCapture can use Intel and AMD graphics cards, NVidia GPUs are recommended.	
GPU: Graphics Processing Unit	Nvidia GeForce GTX 1060 Nvidia GeForce GTX 1080 Nvidia TITAN X Pascal
A minimum of 32 GB of RAM is needed, but a 64 GB is required when processing several thousand photos.	
RAM: Random-Access Memory	32GB of RAM 64GB of RAM 128+ GB of RAM (Requires Xeon processors. Only necessary when processing ultra-large blocks of photos.)
Hard Disk(s)	
When processing large projects, installing ContextCapture on a SSD drive with the project files stored on a large HDD with fast read and write access (for example, Western Digital HDD 6Tb WD6001FZWX) is recommended.	
About the Network	
ContextCapture capabilities' work in a network environment to distribute tasks on different processing machines. An efficient network that avoids bottlenecks and ensures fast data transfer is recommended.	

Installation Instructions

ContextCapture does not require administrator rights to operate. However, you must have administrator rights to install the application.

Once the installer is downloaded, double-click on the downloaded package cnctp040400351en.exe, and follow the installation instructions.
You are using an evaluation license of ContextCapture. Your license is valid for a 30-day Period, and watermarks will be applied to the texture of all produced 3D models.
Please read carefully the End User License Agreement in the ContextCapture installation directory: C:\Program Files\Bentley\ContextCapture Center \ eula.pdf.

The desktop displays three icons representing each of the three modules: 1. Acute3D Viewer, 2. ContextCapture Engine, and 3. ContextCapture Master.

ContextCapture has a master module and an engine module.
The **master** module provides a graphical user interface to define input data, processing settings, submit processing tasks, monitor progress, and visualize results.
The **engine** module runs on a computer in the background, without user interaction, and performs the computationally intensive algorithms.

Remote Desktop Connection

ContextCapture Engine does not work through a Microsoft Remote Desktop Connection because in this type of environment hardware acceleration is disabled. However, you can use VNC or a remote administration software such as TeamViewer.

Windows Session

Switching the Windows User account while ContextCapture Engine is running will cause running computations to fail. In this scenario hardware acceleration is disabled when the user is not connected.

Regarding ContextCapture Dataset

Please download the **ContextCaptureDataset.zip** file and extract the datasets and data acquisition guide before continuing.

About ContextCapture

ContextCapture is developed by Bentley Systems, a leading global provider of comprehensive software solutions for *advancing* infrastructure.

ContextCapture allows you to automatically generate high-resolution 3D models from simple photographs or from point clouds, without any human intervention, with any digital camera, including a smartphone. Mount cameras on a drone or use a helicopter with a dedicated multi-directional acquisition system to capture aerial views of a city or structure.

ContextCapture Principle

1. ContextCapture takes as input a set of digital photographs of a static subject, taken from different viewpoints. It also imports frames from video files and point-cloud file formats.

2. Various additional input data can be provided: camera properties (focal length, sensor size, principal point, lens distortion), positions of photos (for example, GPS), rotations of photos (for example, INS), and control points.
3. Without manual intervention, and within a few minutes/hours of computation time depending on the size of the input data, ContextCapture outputs a high resolution textured triangular mesh.

4. The output 3D mesh constitutes an accurate visual and geometric approximation of the parts of the subject adequately covered by input photographs.

Benefits: Modeling in a rich 3D environment that captures all details helps us to:

- Accelerate the design process (not starting from a blank canvas)
- Make better decisions (using detailed existing conditions as context)
- Use geographically located 3D models

Reality modeling technology using ContextCapture is fast, comprehensive, and accurate.

The Acquisition Basics

Great Models Require Good Data Capture

ContextCapture automatically converts photos into a 3D model, meaning that the quality of the input dataset has a deep impact on the output 3D model that is generated.

To get the best results using ContextCapture, we recommend:

- A constant focal length during the acquisition: zoom "with your feet"
- Ambient, constant, and homogeneous lighting

You should avoid:

- Blurry photos: use adapted settings, and possibly a tripod under low lighting conditions
- Flash light
- Optical stabilization

Never use:

- A digital zoom
- Any resizing/cropping/rotation of the input photos.

When capturing video, the following formats are recommended:

- Audio Video Interleave (AVI)
- MPEG-1/MPEG-2 (MPG)
- MPEG-4 (MP4)
- Windows Media Video (WMV)
- QuickTime (MOV)

This section includes useful information on how to take photos to obtain optimal results with ContextCapture.

Capturing Tips - Basic Recommendations

- Use a suitable camera
- Shoot under natural light, cloudy weather (limit the shadows influence)
- Use a constant focal length during the acquisition

Camera models

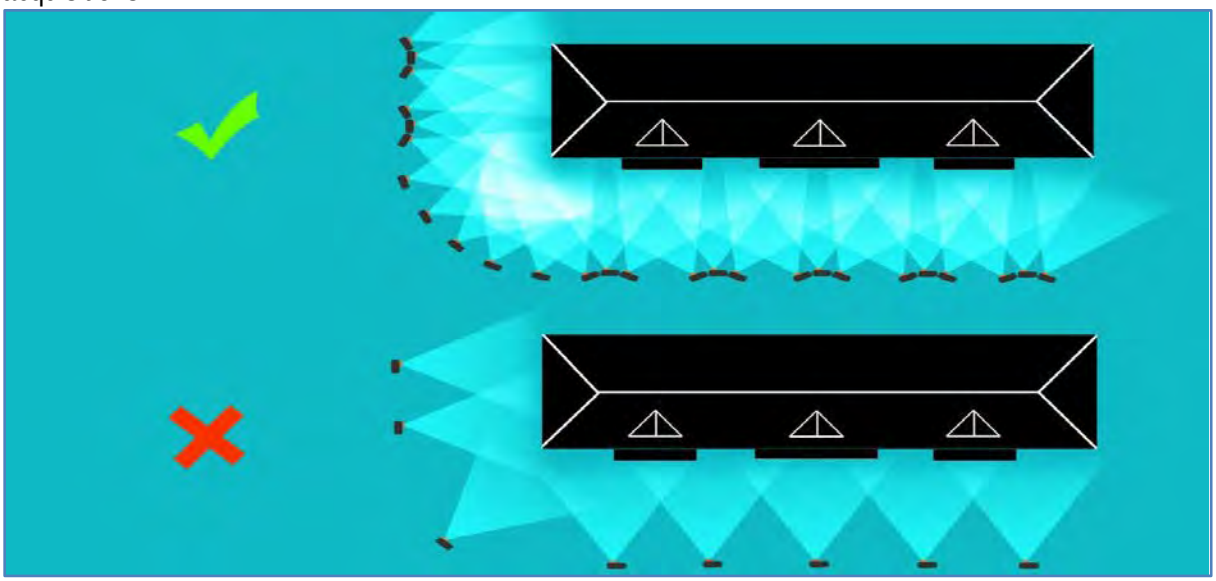
ContextCapture supports a wide range of cameras: mobile phone, compact digital, DSLR, photogrammetric, and multi-camera systems. It can process still photographs or extracted video frames from digital video cameras. Any brand of camera/lens is recommended for ContextCapture, but the quality of the 3D model depends on the photo quality and geometric precision. For optimal results, use a camera with a large sensor, and a good-quality lens, such as a DSLR camera with a fixed lens.

If you are unsure of your camera's specifications, you can consult your camera owner's manual or the Digital Photography Review website: http://www.dpreview.com/products.

Overlap

Each part of the subject should be photographed from at least three distinct – but not radically different – viewpoints and should be less than 15 degrees apart. A minimum of 50 percent overlap is required, but a 70 percent overlap is recommended.

For aerial photography, a longitudinal overlap of 80 percent and lateral overlap of 50 percent or more are recommended. To achieve best results, acquire both vertical and oblique photographs. ContextCapture is remarkably robust for unstructured acquisition. You may, however, prepare a flight plan for more systematic acquisitions.



Note: Remember that the photo is at the basis of all the computation. With reasonable care and practice, you will generate amazing 3D models. The quality of the 3D reconstruction is dependent on the quality and the spatial sampling of your photos. Please refer to Acquisition_Guide_V4_Bentley.pdf for the Acquisition Techniques.

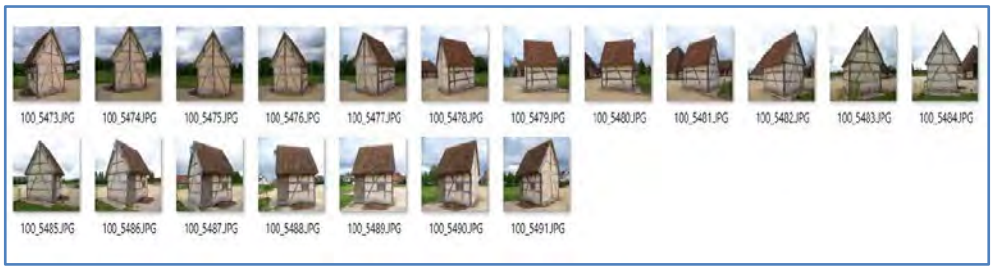
Systematic simplified Workflow

There are two main ContextCapture modules - ContextCapture Master and ContextCapture Engine. They follow a master-worker pattern:

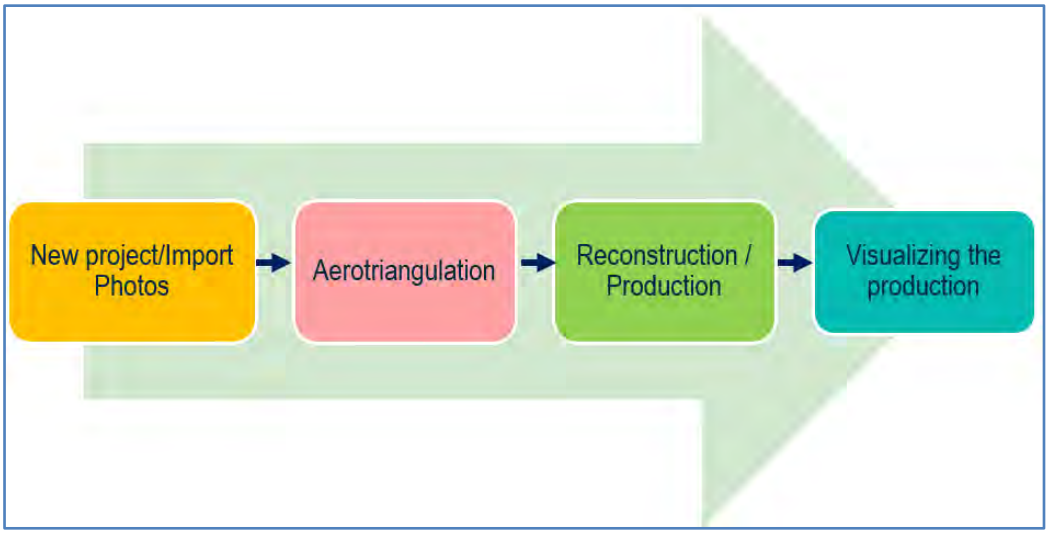
a. Launch ContextCapture Engine
b. Launch ContextCapture Master

Workflow 1: Using Photographs to create a 3D Reality Model

c. Copy the Sample Photographs – Dataset Name: **Barn** (19 Photos) to a desired Location

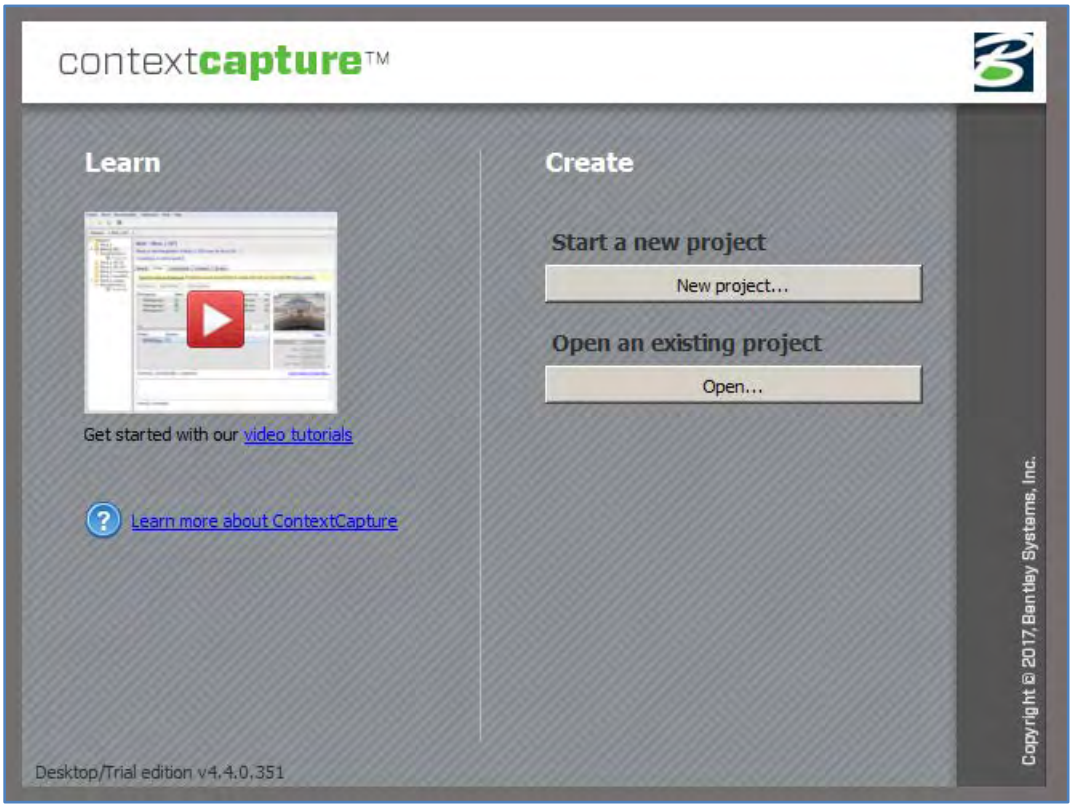


d. Pictured are the steps required to produce a 3D reality model.

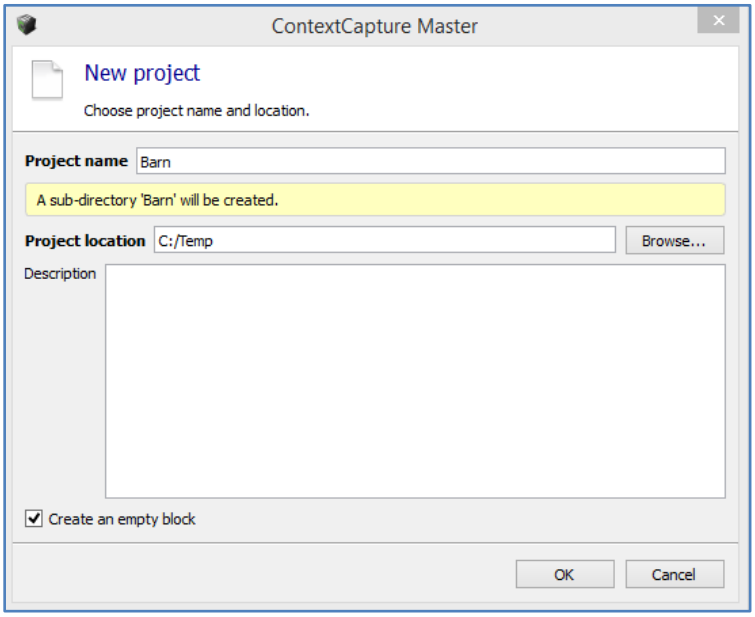


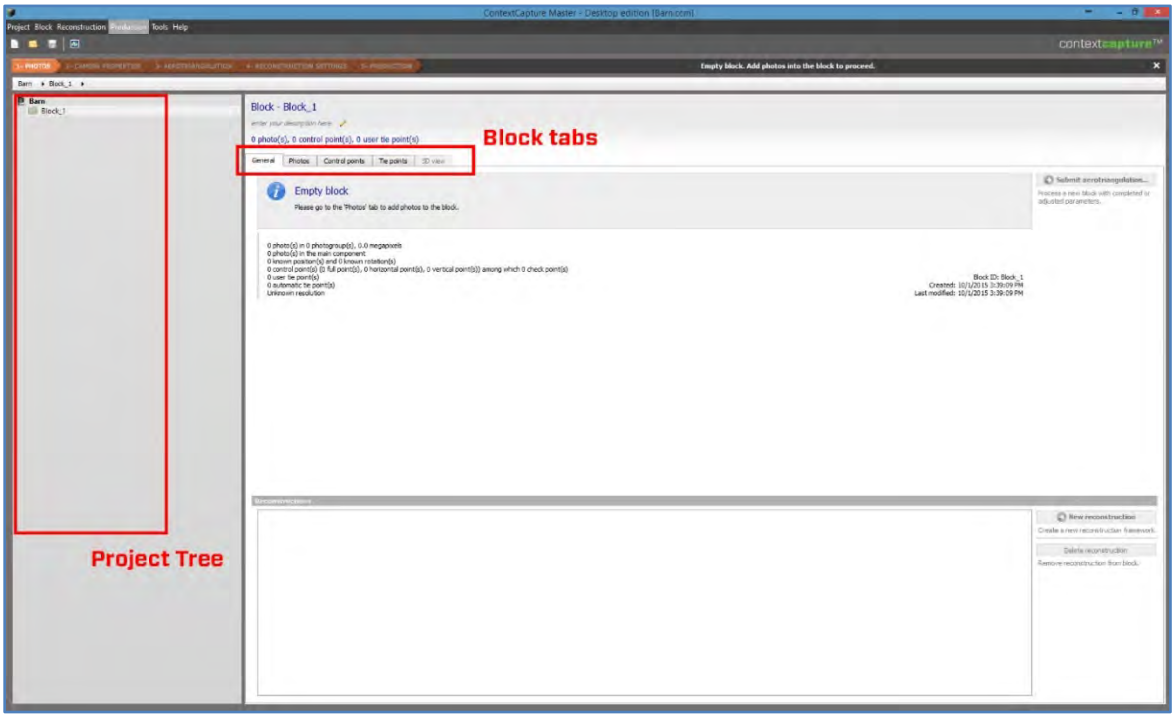
Creating a new project

1. Launch ContextCapture Master



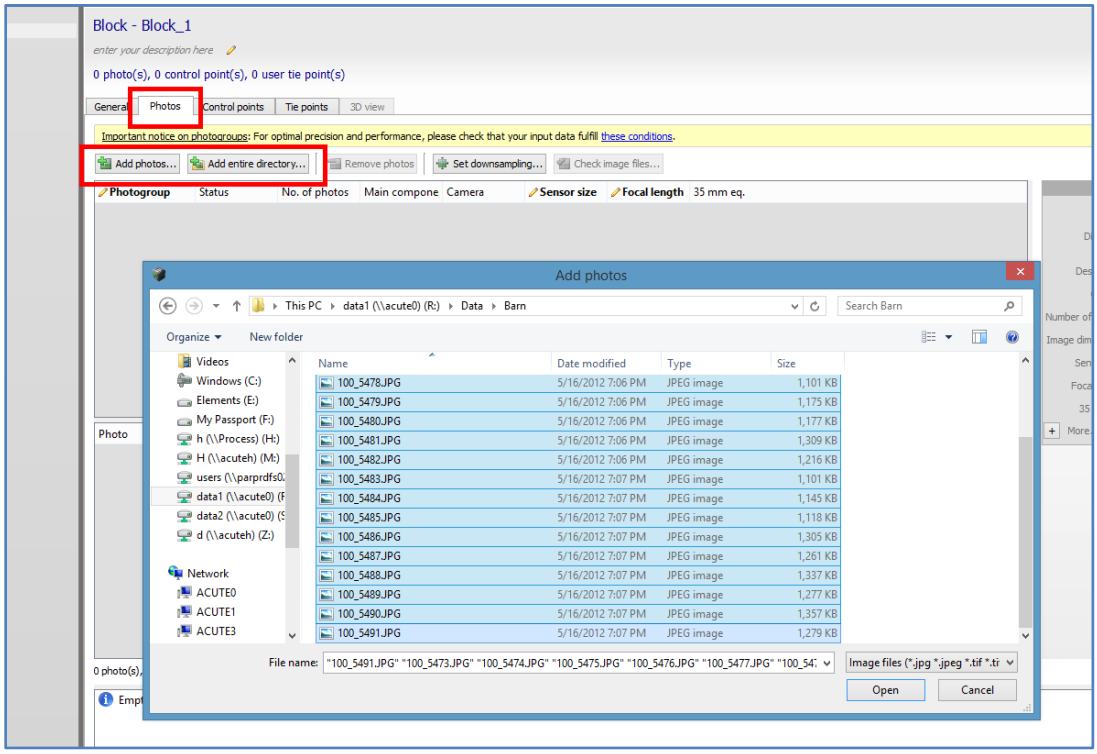
2. Enter name and location of the project.



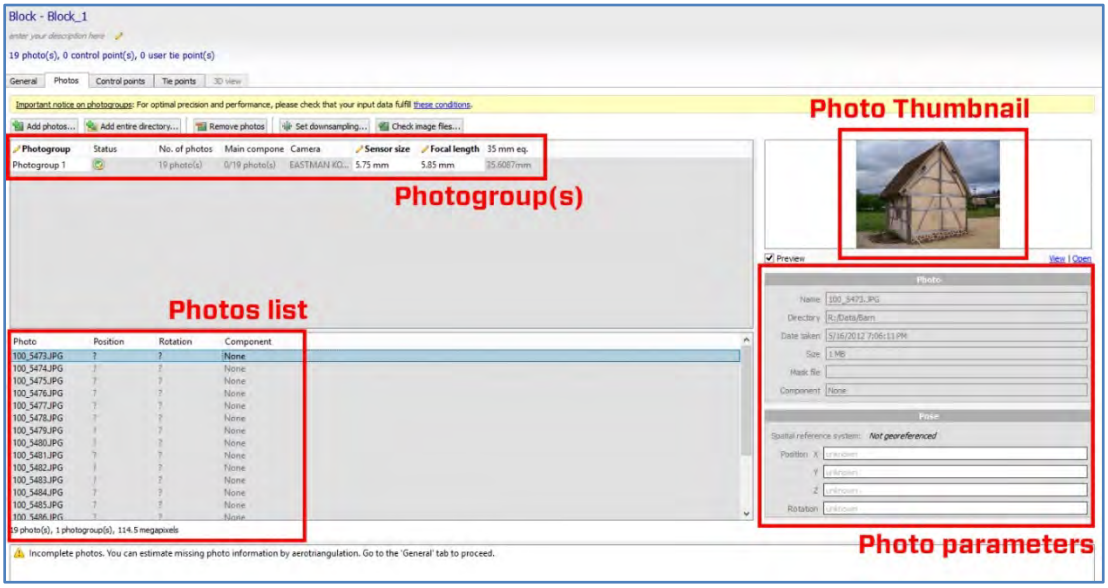


Importing your data

3. Open the photo tab and browse your photo dataset using “Add photos” or “Add entire directory.”



4. The photos have been imported in a photogroup. The camera sensor size and focal length have been extracted from the EXIF info and from the ContextCapture camera database.



(Optional) scale, axis, or plan constraints setting

Without geo-referencing information, the resulting model cannot be scaled or correctly oriented. (ContextCapture will try to find the vertical of your scene when information is unavailable, but it is not always successful.)

The user can add scale and axis constraints before the AT (aerotriangulation)process to scale and rotate the block.

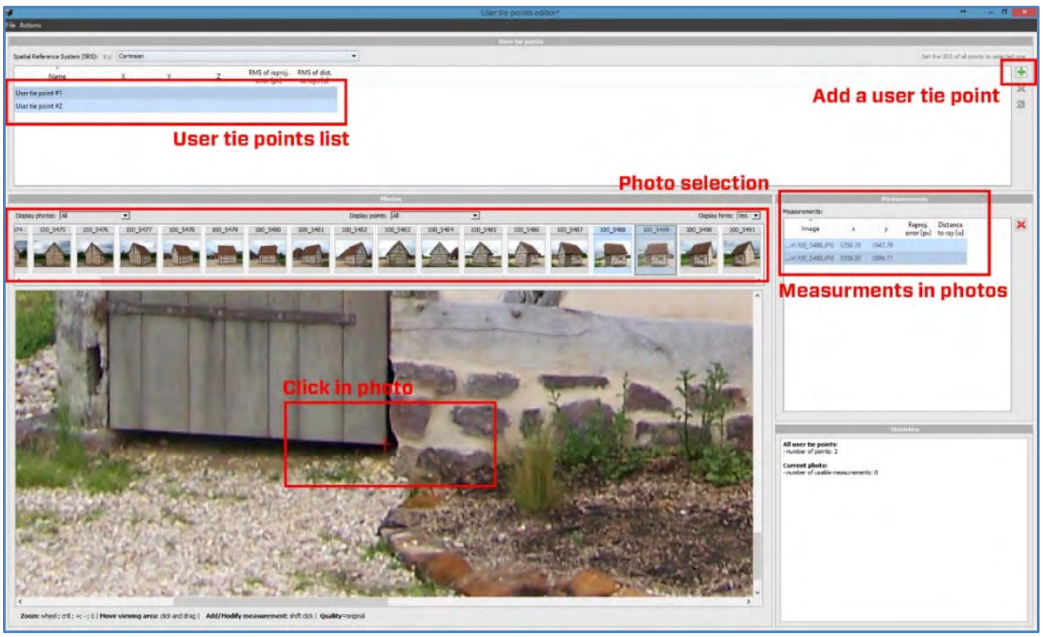
5. To do so, open the **Tie Points** tab.


Block - Block_1
enter your description here
19 photo(s), 0 control point(s), 0 user tie point(s)
General
Photos
Control point
Tie points
Tie points
0 user tie point(s).
Edit user tie points...
0 automatic tie point(s).
View automatic tie points...
Positioning constraints
0 positioning constraint(s).
Positioning constraints are position/orientation/scale priors based on user tie points. They are used to perform a coarse rigid registration of the block during aerotriangulation. You can set the origin and/or the scale and/or the orientation (either an axis or a plane).
Type
Definition

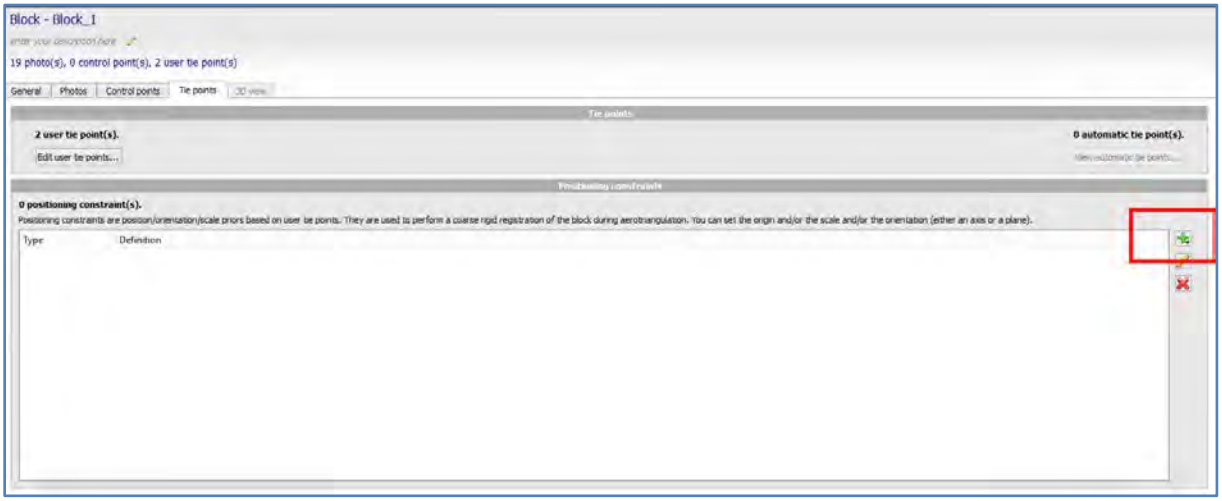
6. Click on Edit user tie points to open the User Tie-point Editor

To define a scale or an axis constraint, you will need to create two user tie points.

7. To create a user tie point, click on the green cross at the upper right-hand corner.
8. Highlight your tie point and pick the photos you want to measure. Click your points in at least two photos.

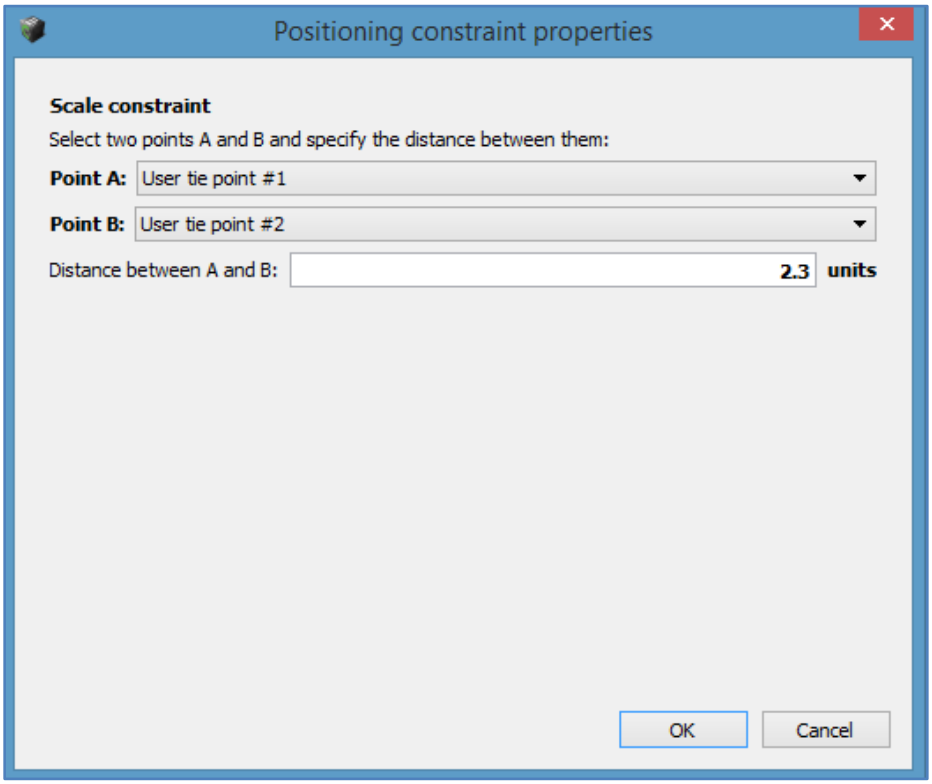


9. Once your two points are correctly selected in the photos, *save* and *close*.
10. To define a new constraint using these tie points, from the Positioning Constraints panel click on the green cross in the Tie Points tab.



To set a scale constraint choose “add scale constraint.”

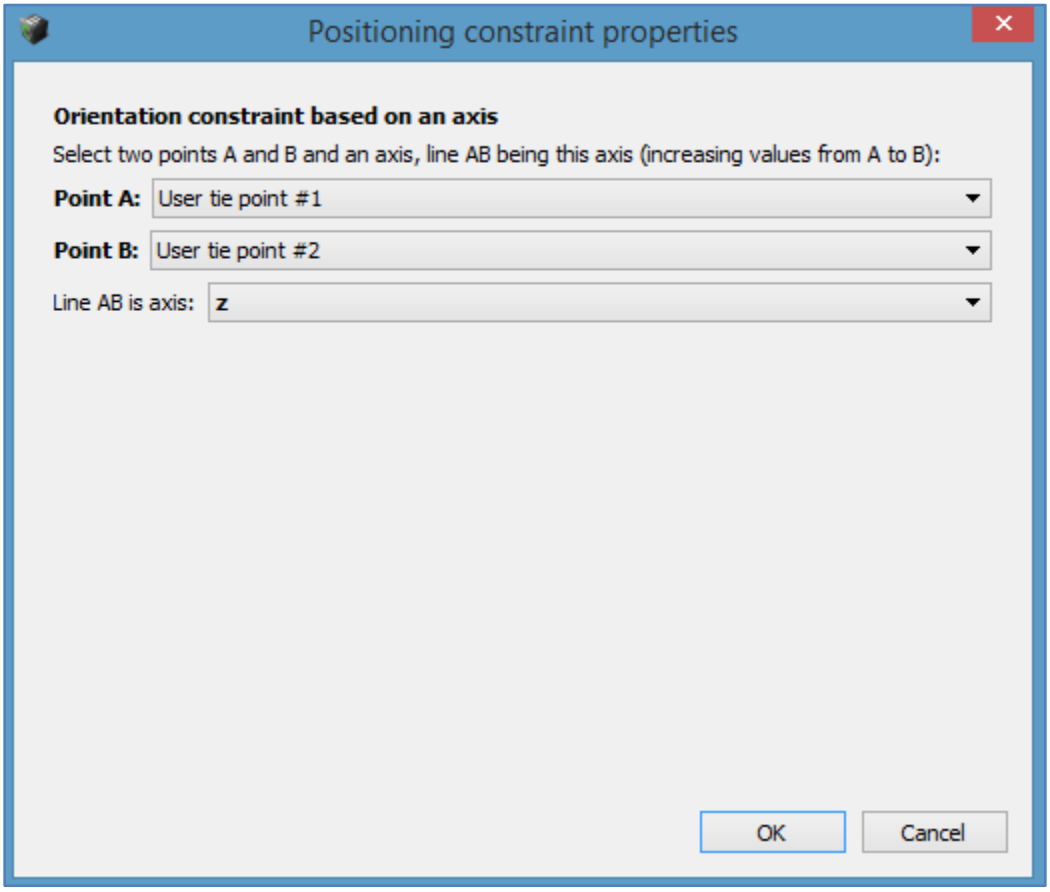
11. Select the two tie points that will be used to define the scale constraint and define the distance between the two tie points.

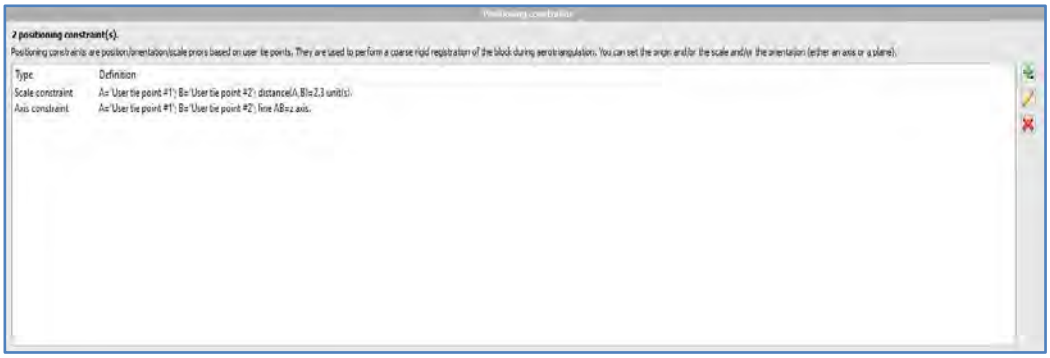


12. Click on *OK* to save the scale constraint.

You can add different constraints (axis and plan) using the same tie points or by adding other user tie points.

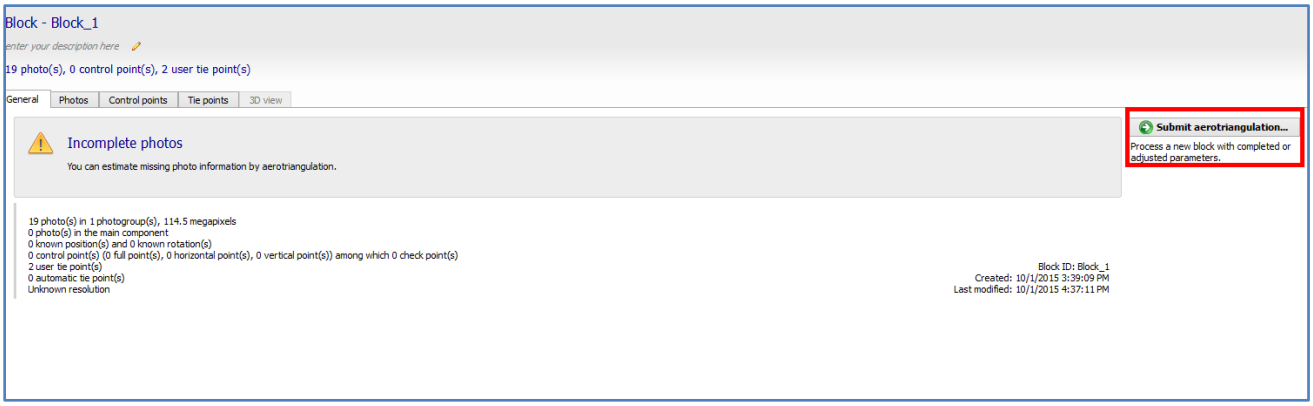
13. Adding an axis constraint:



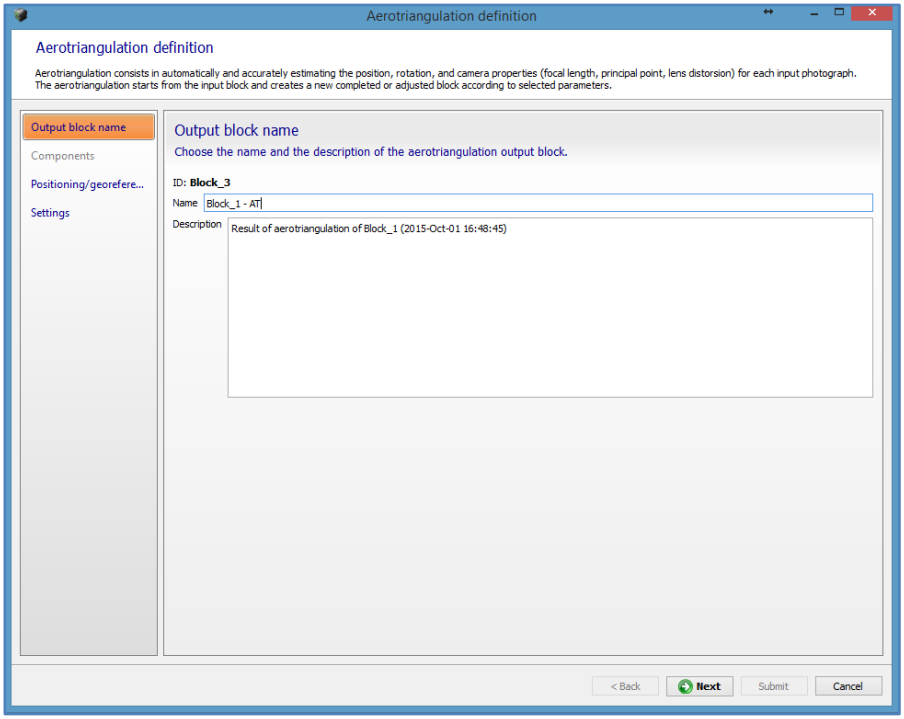


Processing the aerotriangulation

14. Return to the **General** tab, and select *Submit aerotriangulation*.

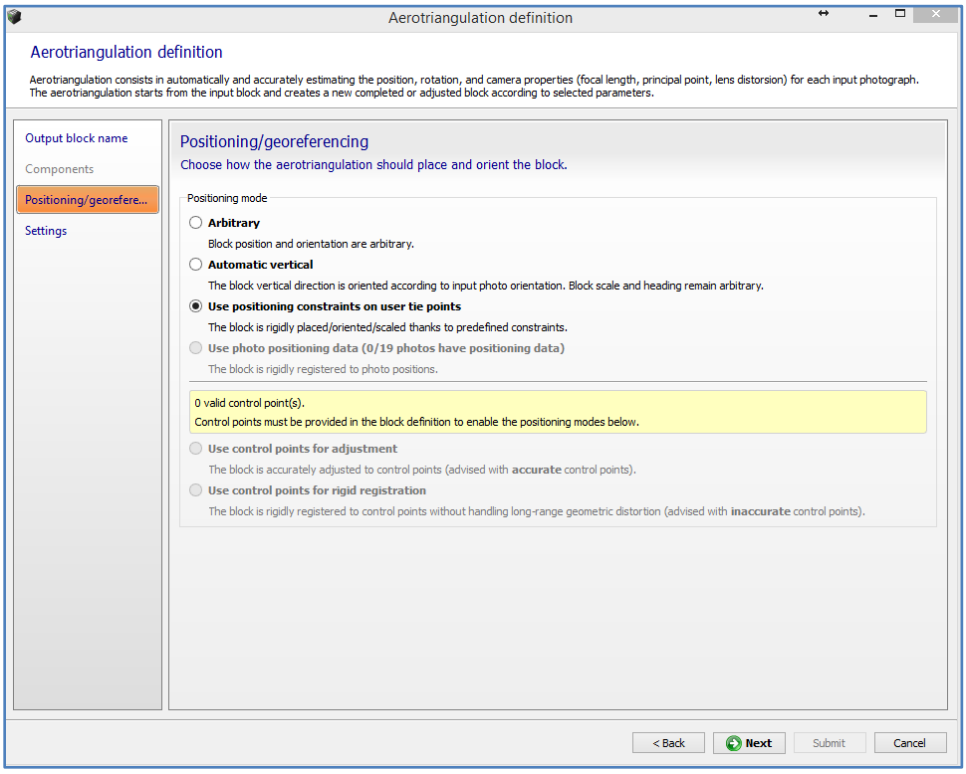


15. The aerotriangulation definition window will pop up.

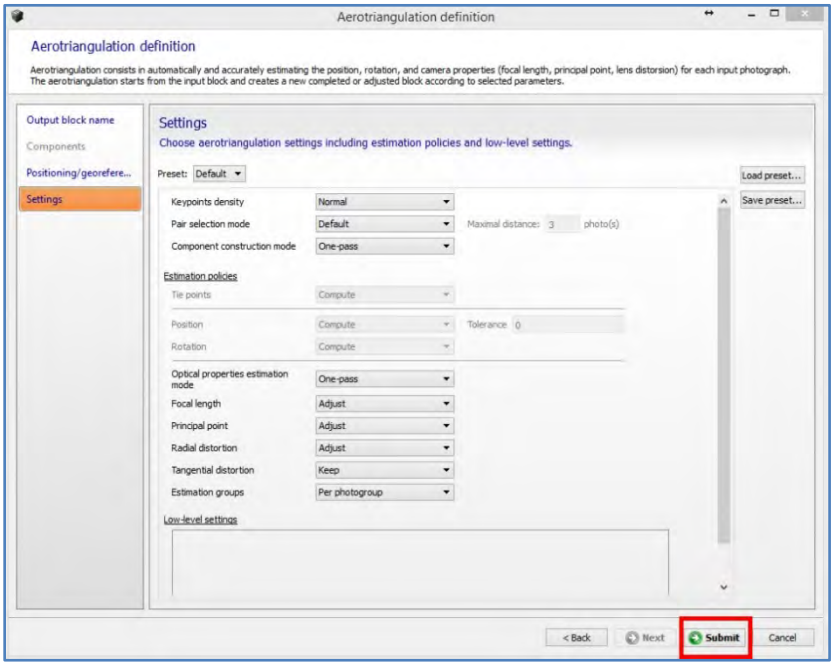


Change or leave the default name for the new block that will be created.

16. In the **positioning/georeferencing page**, select the mode you want to use. If you have defined tie point constraint "**use positioning constraint on user tie points**." Otherwise, choose "**automatic vertical**" to let the software try to determine automatically the Z axis of the scene. (Warning: your model will not be scaled using this mode.)

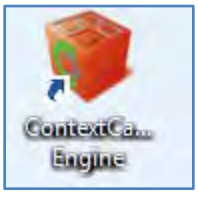


17. In the settings page, leave the default settings and press submit.

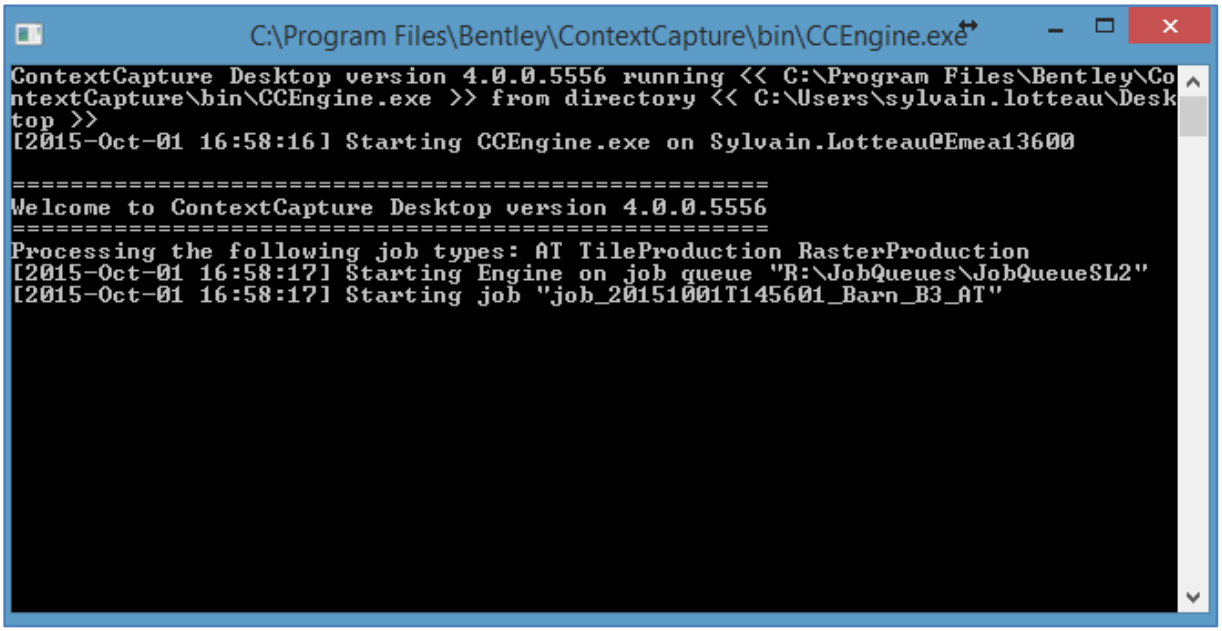


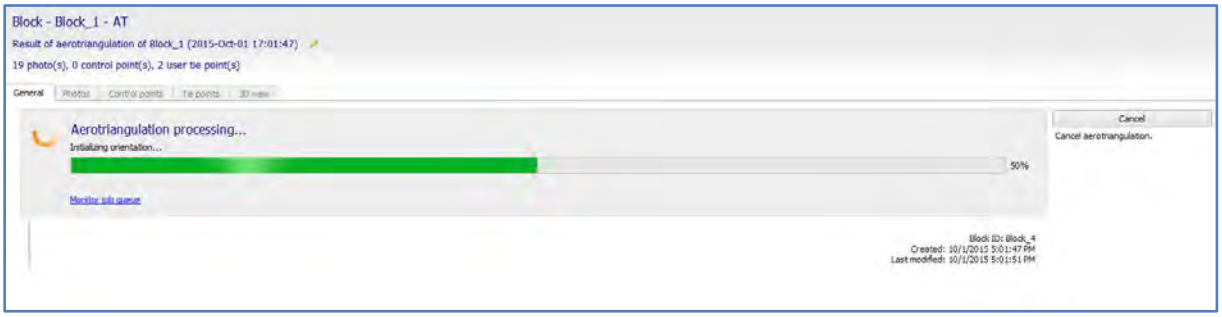
18. The AT is now pending and ContextCapture Master is waiting for the Engine to process the job.

19. Make sure that the **ContextCapture Engine** is launched from the desktop icon.

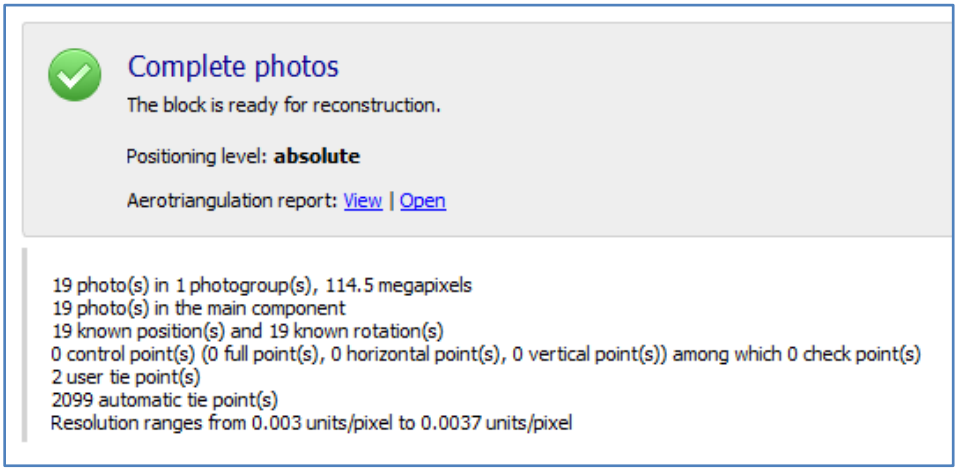


20. A command window will appear and the Engine will start processing the job.

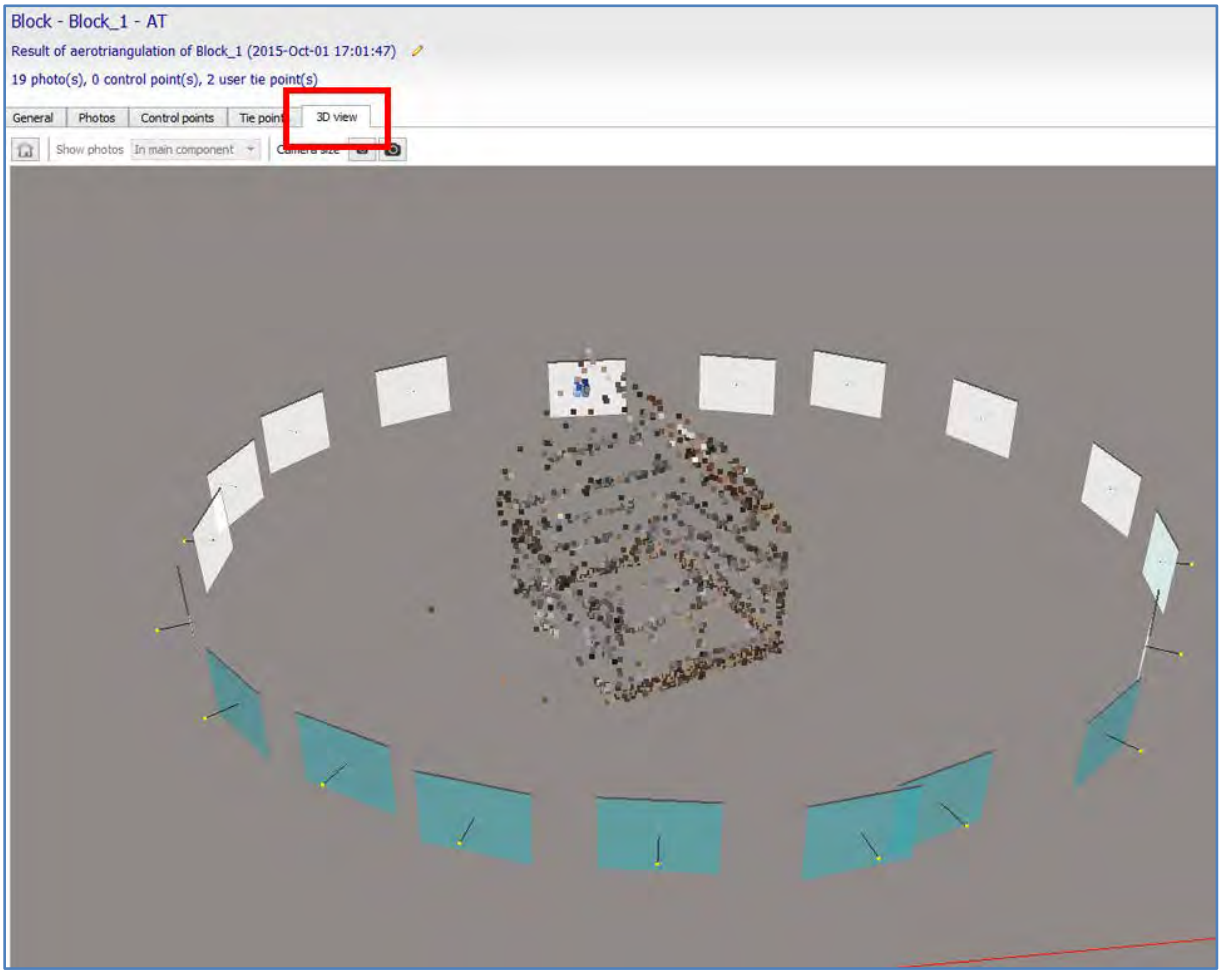




21. Once the AT is done the status becomes “Complete photos”



22. Click the **3D view** tab to check the position of the photos.



The displayed points are the automatic tie-points used by ContextCapture to link the photos together.

JobQueue Issues

Note: You may encounter problems when submitting your jobs. This might be the result of the JobQueue not being accessible because of permission issues, (**"fail to submit aerotriangulation"**) or the Engine module may be listening to the wrong JobQueue ("warning: there is no engine currently listening to the JobQueue").

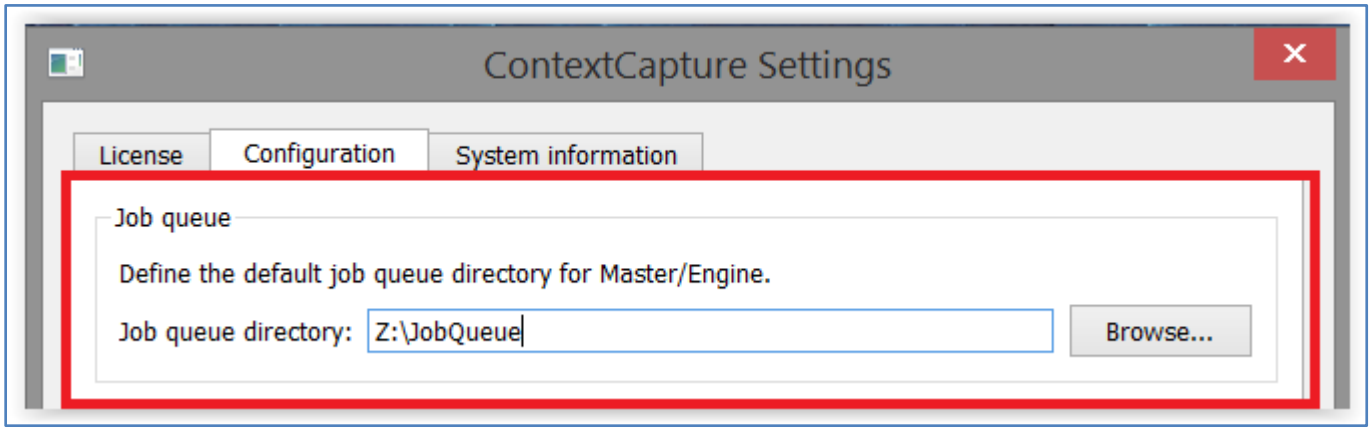
If you are experiencing these issues, please **reset the JobQueue** to a directory where you have read and write access (typically the "My Documents" folder is OK).

Changing the JobQueue

Launch ContextCapture Settings

("C:\Program Files\Bentley\ContextCapture\bin\CCsettings.exe").

Go to the "Configuration" tab and browse your new JobQueue.

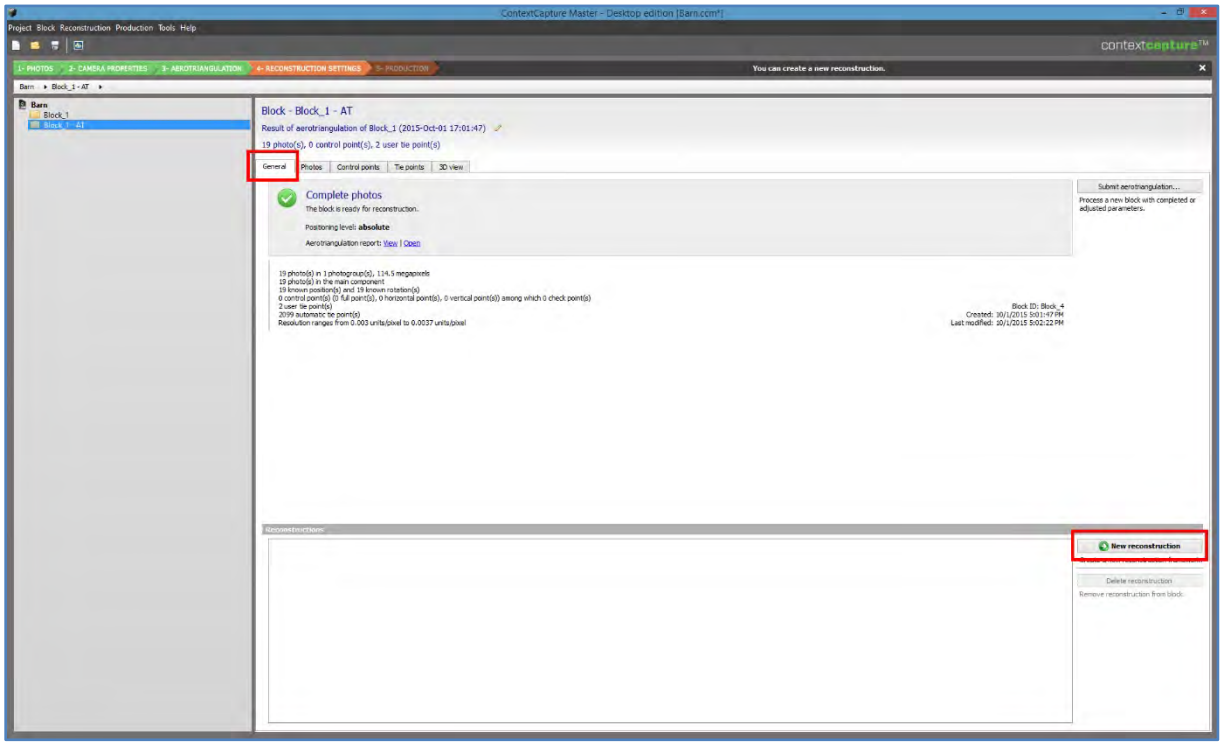


23. Once this step (JobQueue) is completed, submit the aerotriangulation again to complete the 3D view of the photographs.

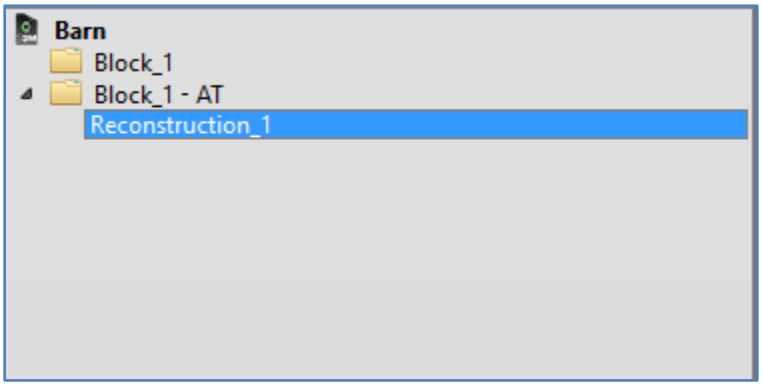
Creating a new reconstruction

A reconstruction item manages a 3D reconstruction framework (spatial reference system, region-of-interest, tiling, constraints, retouching and processing settings). Based on the reconstruction item, one or several productions can be launched.

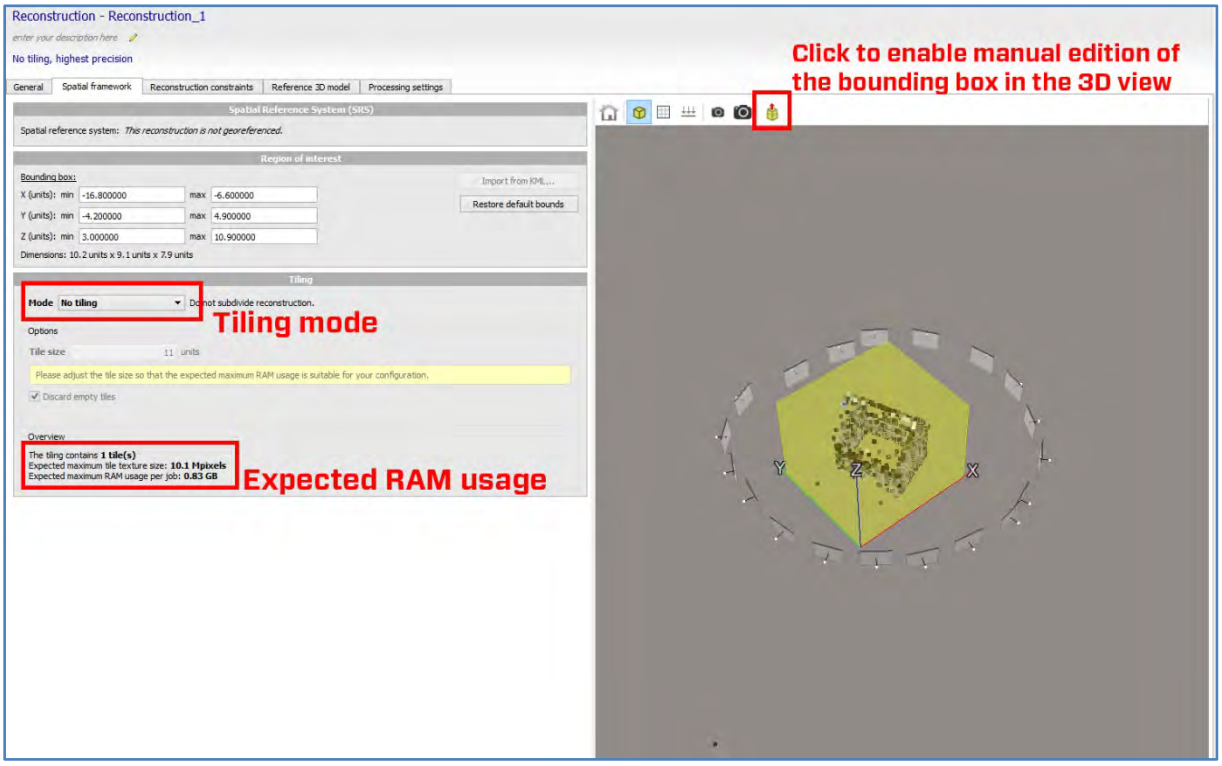
24. To create a reconstruction, return to the general tab and click **"Create reconstruction."**



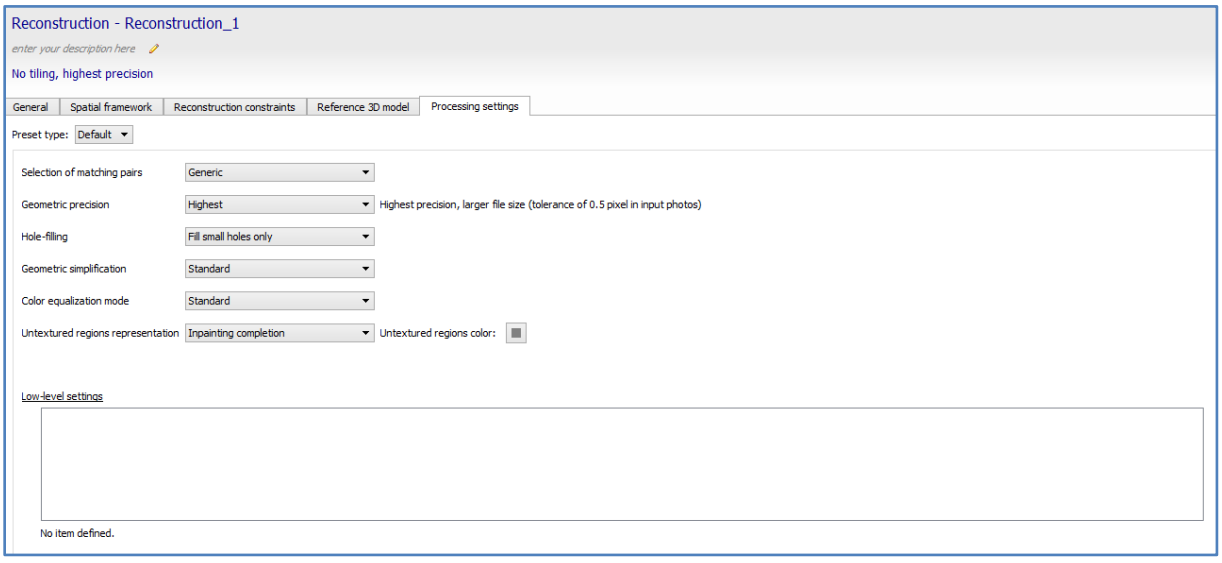
25. A new **reconstruction** is created in your block. Several reconstructions can be created, with different settings.



26. Go to the "Spatial framework" tab to setup the bounding box and tiling (if needed).

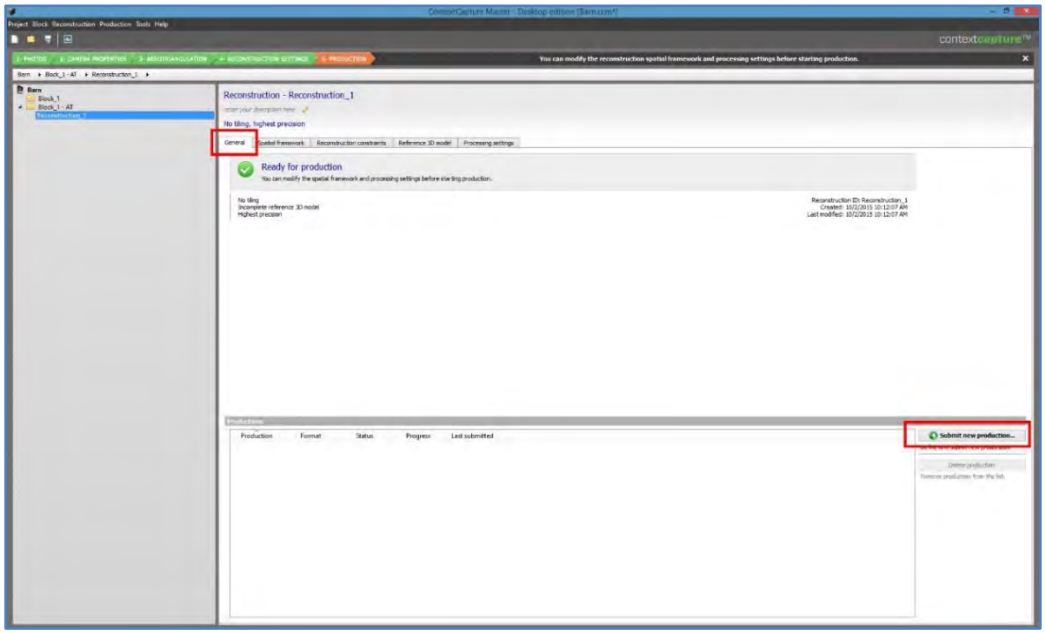


27. To change processing settings, click "processing settings."

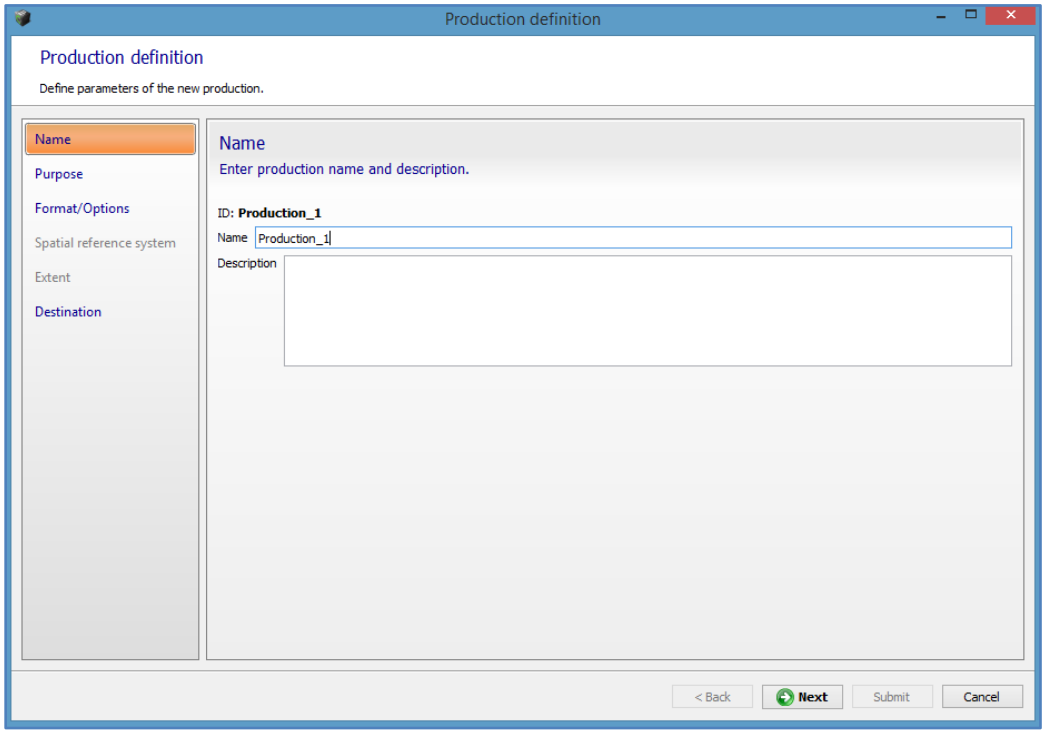


28. Once your reconstruction framework is setup, return to the **general** tab to submit a new production.

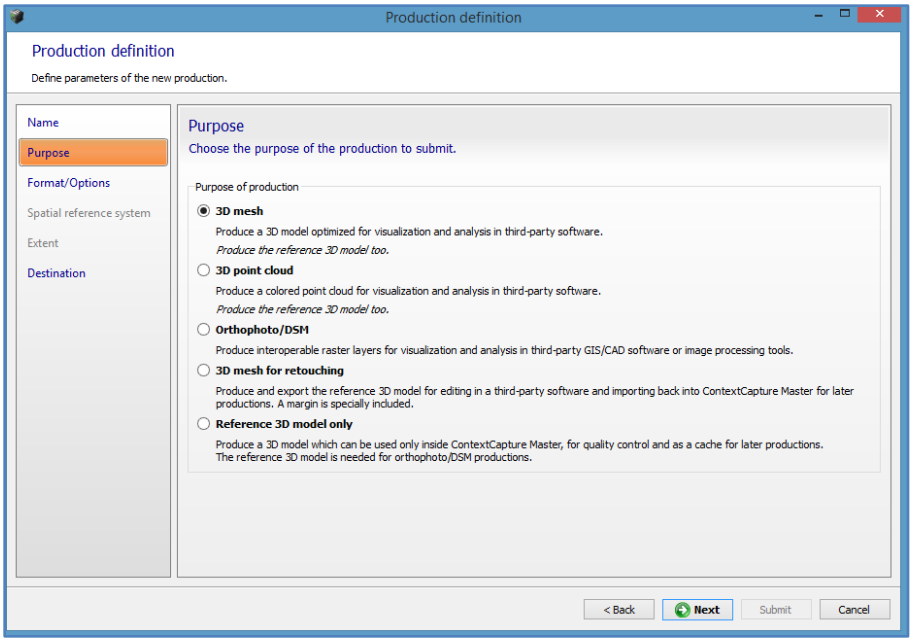
Submitting a new production



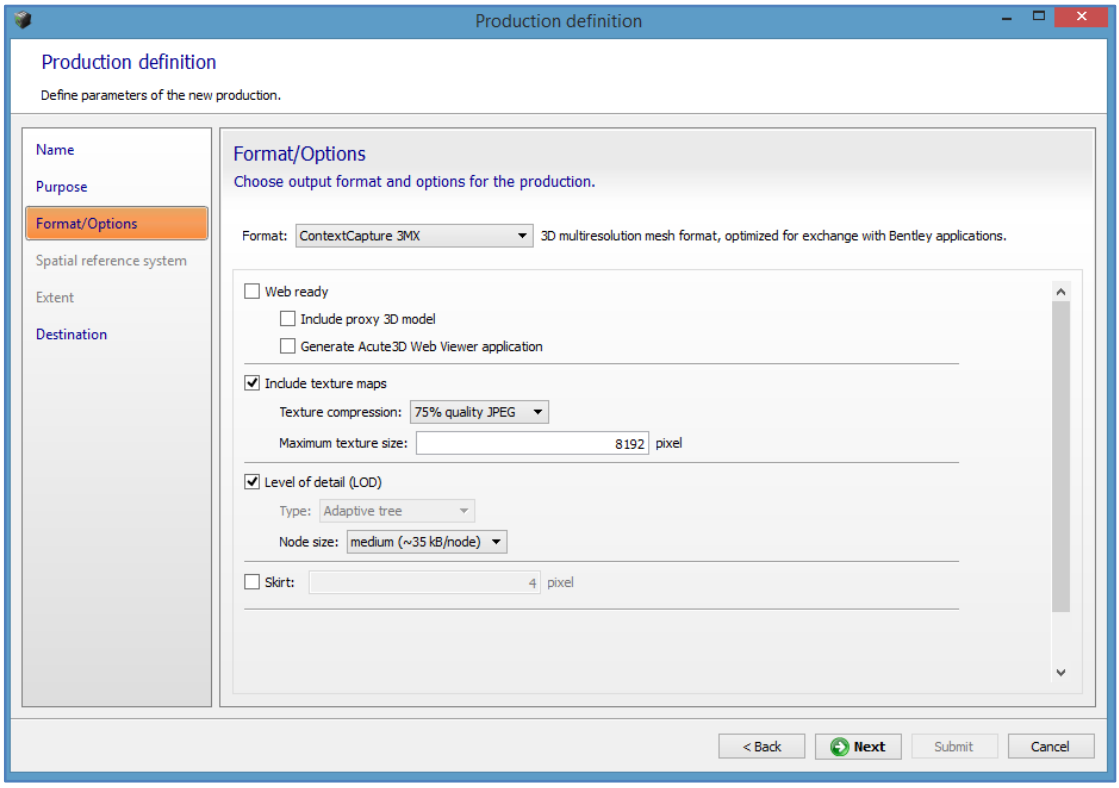
29. The production definition window is displayed.



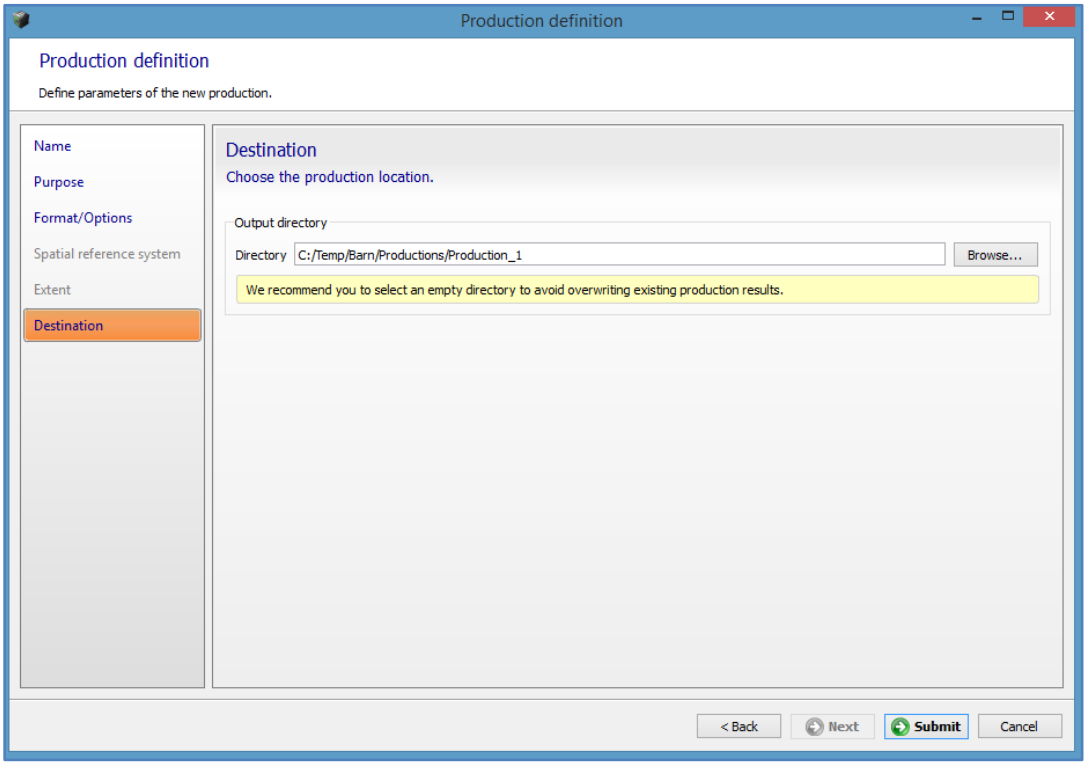
30. In the purpose page, choose the **purpose** of your production.



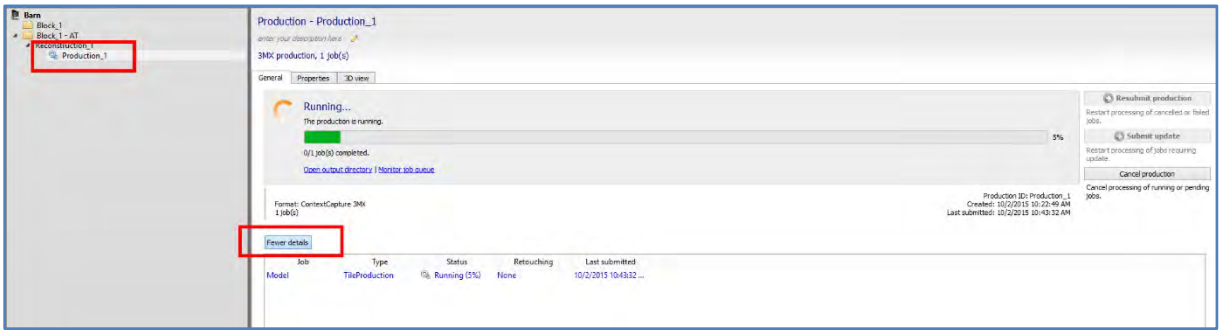
31. In the Format/Options page, choose the **format/options** for the specific purpose.



32. Select the destination folder and click "submit."

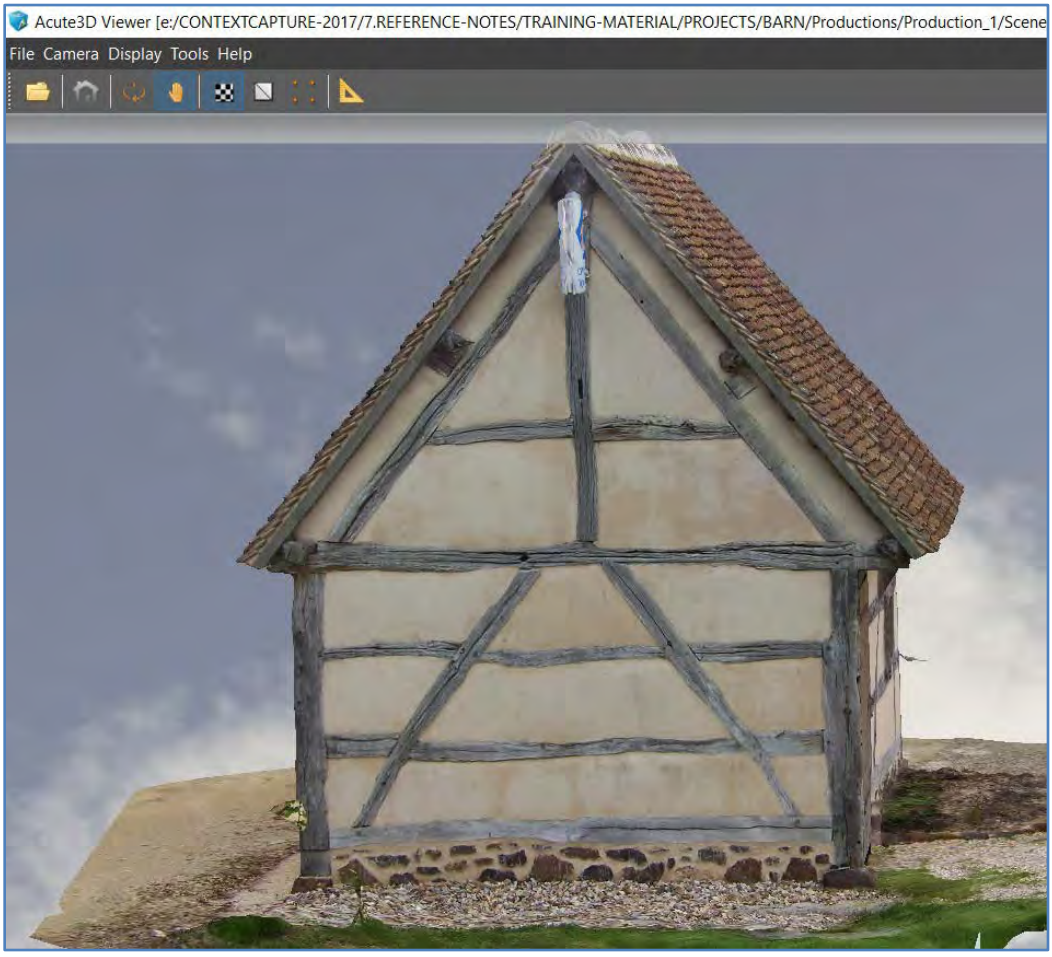


33. Select your production in the project tree to see the progress of the process, until it is completed.



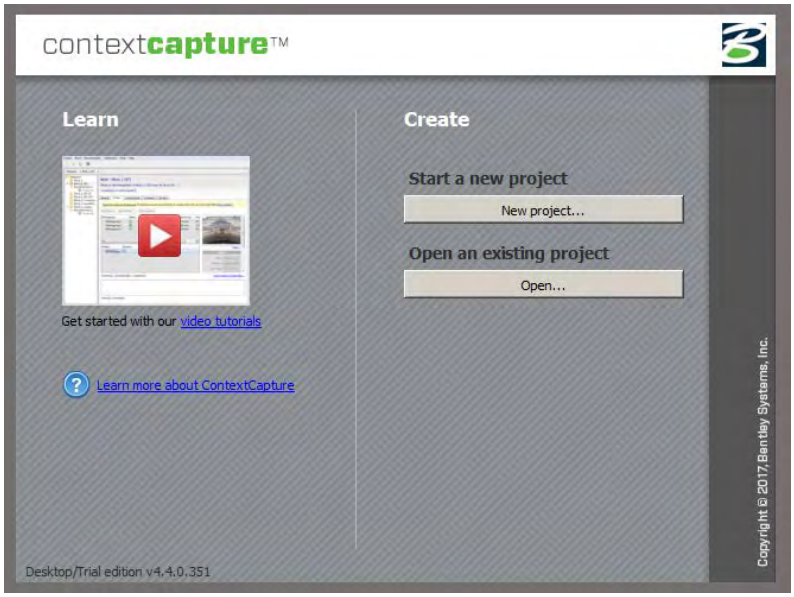
Visualizing the production

34. Launch **Acute3D viewer** or visualize the 3D model in the 3D view tab (only works for S3C 3MX and single-tile OBJs).

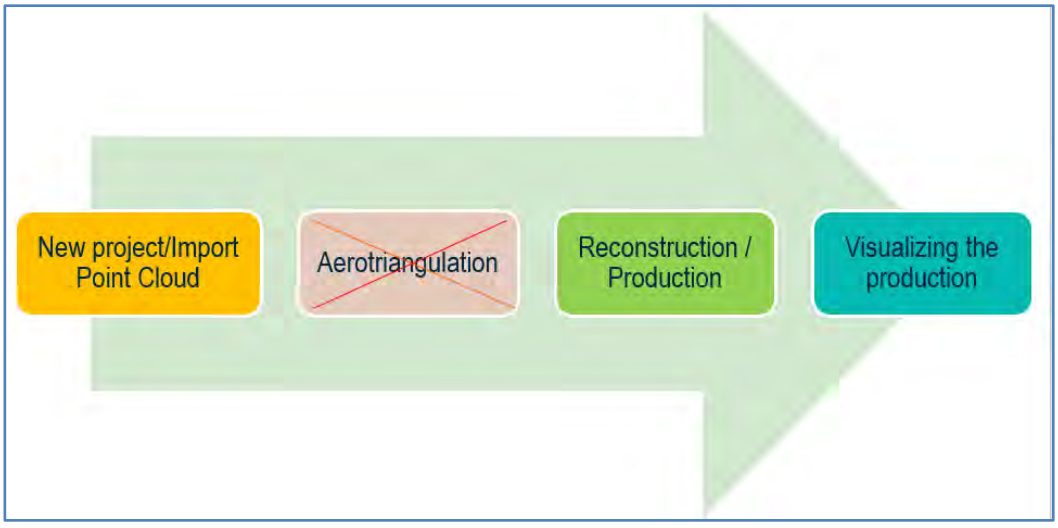


Workflow 2: Using Point-cloud data to Create a 3D Reality Model

1. Copy the Sample – Dataset Name: Point cloud Tuxford_referenced_scan.e57 to a desired location.

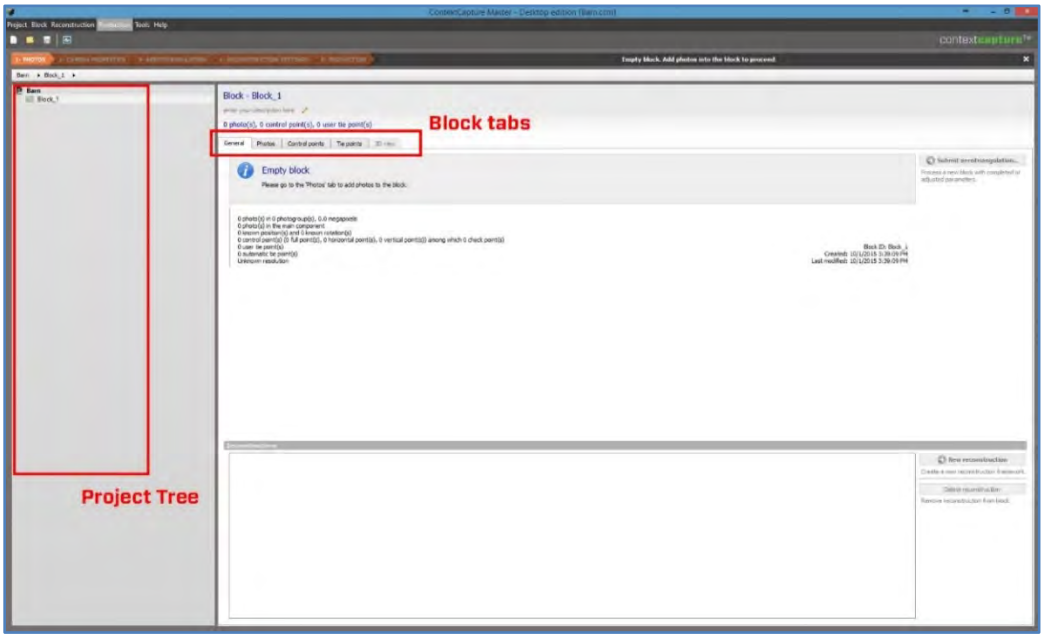


2. Displayed are the steps required to produce a 3D reality model using photos and point-cloud data.



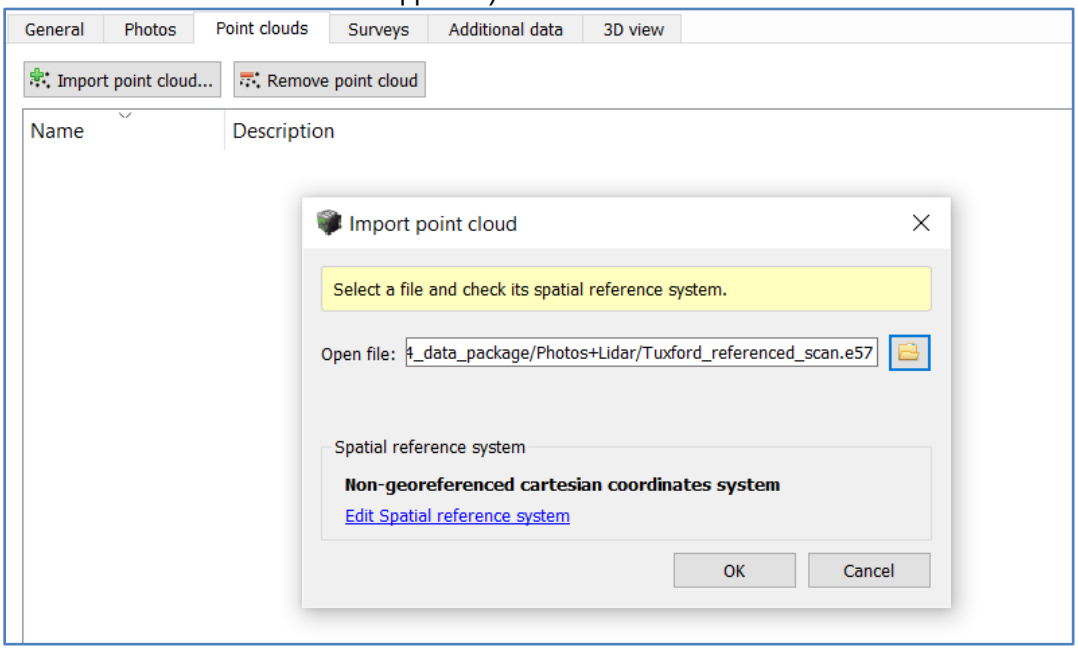
Creating a new project

3. Launch ContextCapture Master
4. Enter name and location of the project

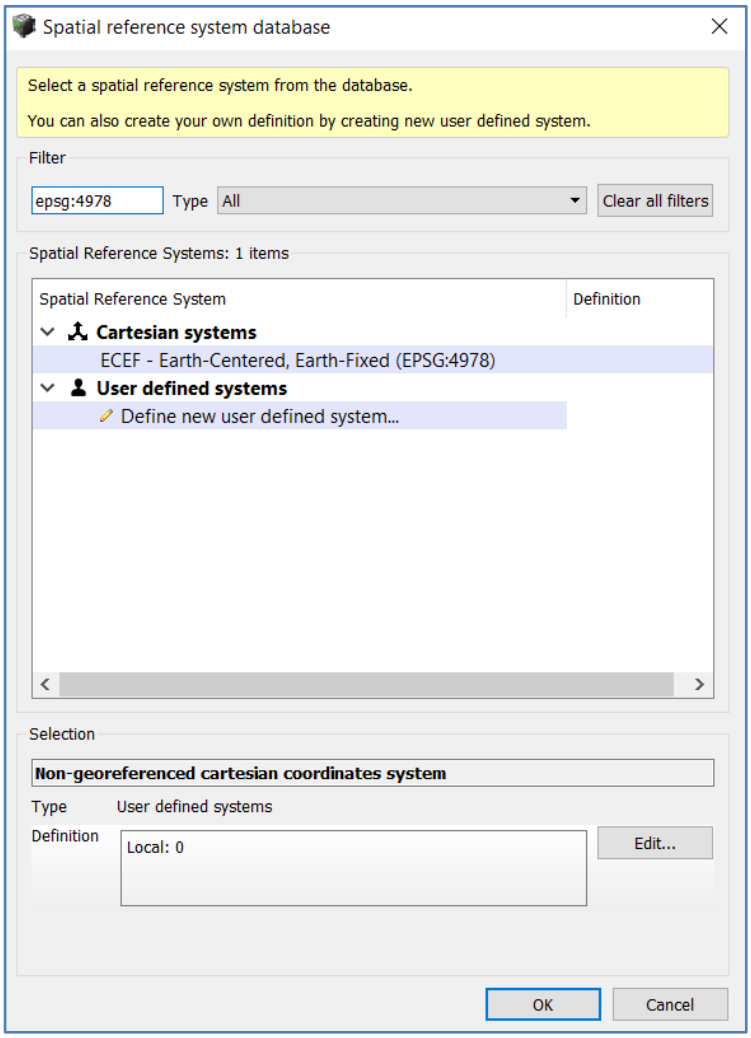


Importing your data

5. Open the **Point clouds** tab and browse to your LiDAR dataset and **Import Point Cloud** (only PTX and E57 file formats are supported).



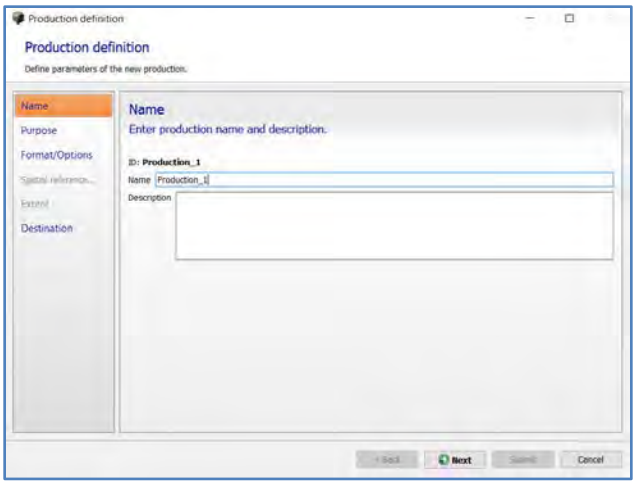
6. Click on “Edit spatial reference system” and select from More “Spatial reference system database”
7. In the filter, search for EPSG:4978

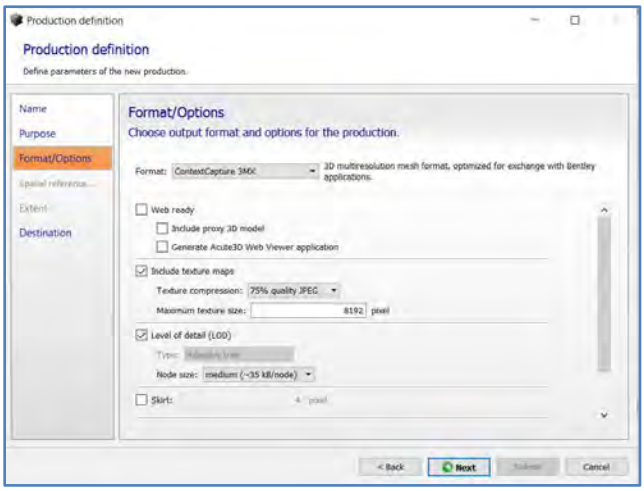


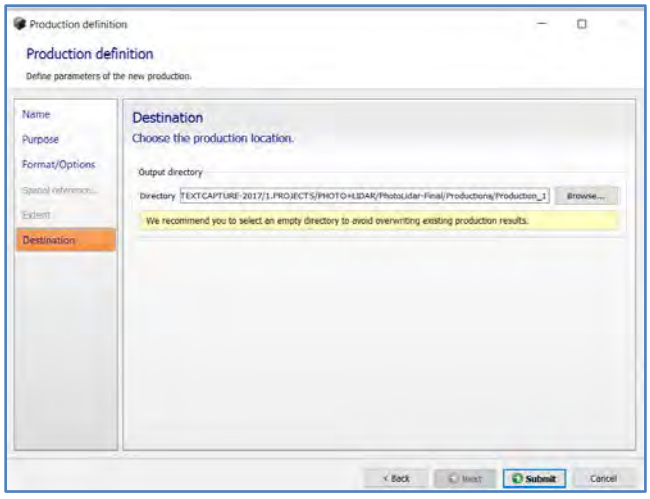
8. Click OK
9. Now, click on the General Tab again and click on “New reconstruction.”

Submit new production

10. Just follow the Production Definition Settings

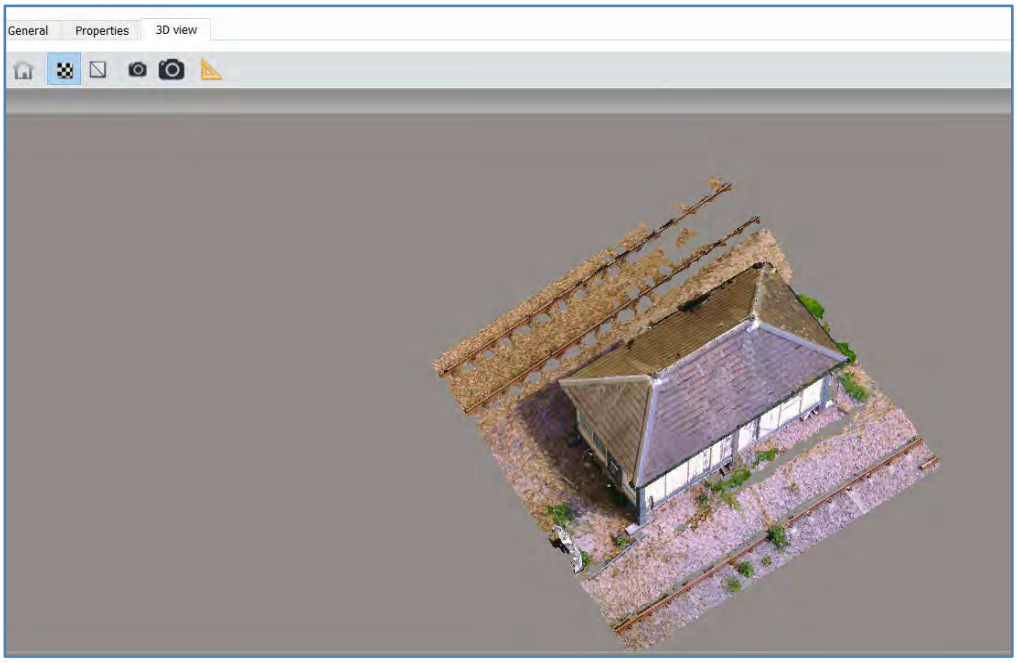






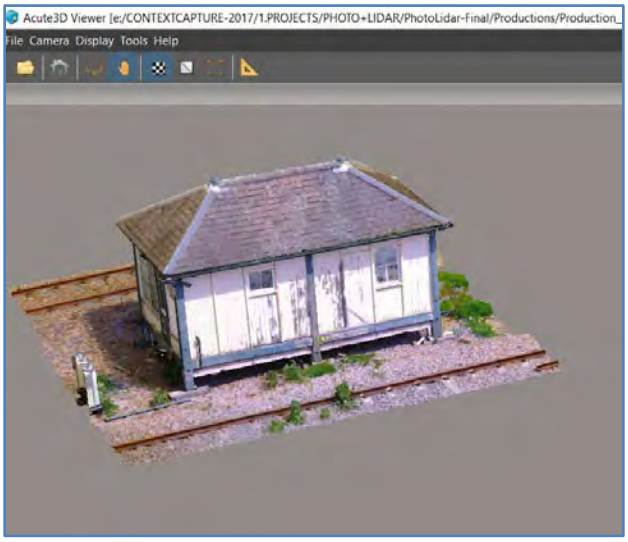
11. Click on "Submit"

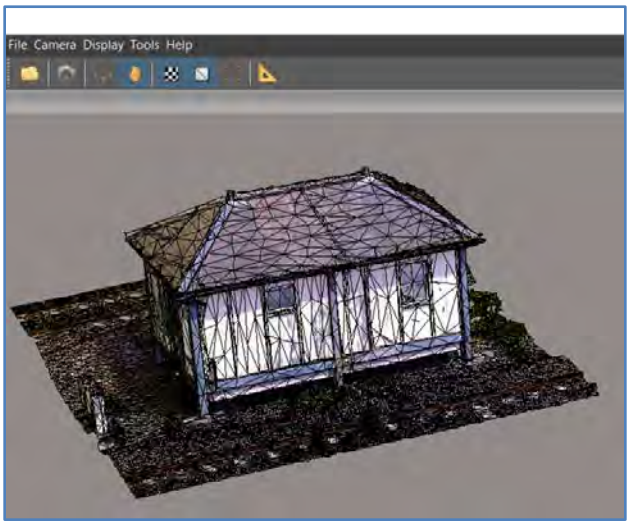
12. Once Completed select the "3D View" tab



Visualizing the production

Launch Acute3D Viewer and open the Output file





Conclusion:

- With ContextCapture, you can quickly produce the most challenging 3D models of existing conditions for infrastructure projects of all types, derived from simple photographs.
- Without the need for expensive, specialized equipment, you can quickly create and use this highly-detailed 3D reality meshes to provide precise real-world context for design, construction, and operations decisions for use throughout the lifecycle of projects.
- You can reliably and quickly produce 3D models of any scale, from objects of a few centimeters to entire cities using ContextCapture.
- There is no limit in the precision of the resulting 3D model, other than the resolution of the input photographs.