

# PhotoMesh

Version 7.5

# Datasheet

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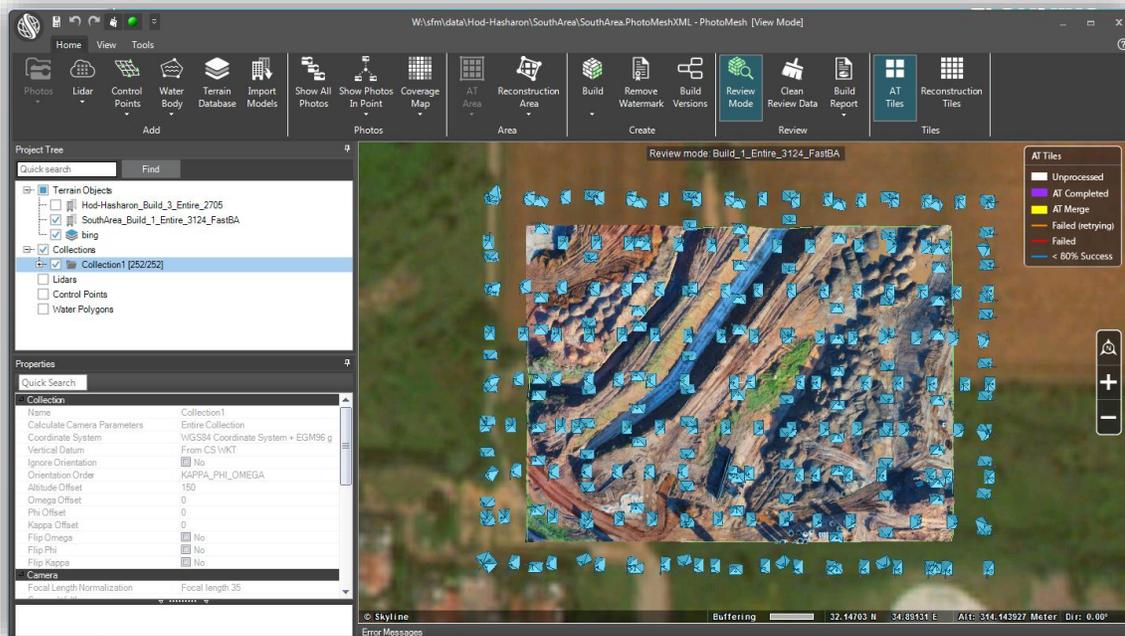
## OVERVIEW

Skyline's PhotoMesh fully automates the generation of high-resolution, textured, 3D mesh models from standard photographs and videos, offering a significant reduction in cost and time compared to traditional modeling methods.

PhotoMesh's breakthrough technology is based on the highest-performance photogrammetry, computer vision, and computational geometry algorithms. Combining any number of photographs, in a wide range of formats and resolutions, PhotoMesh generates highly-detailed 3D models that can be viewed and queried using TerraExplorer or other 3D, GIS products.

PhotoMesh employs elaborate tiling mechanisms to efficiently handle projects with even hundreds of thousands of photos. Running on standard hardware, PhotoMesh can also exploit computer clusters and cloud computing to accelerate database creation.

A single project can run simultaneously on hundreds of fuser machines, each processing different build steps and communicating with PhotoMesh Manager.



## PRODUCT HIGHLIGHTS

### **High Quality**

PhotoMesh generates a full-3D mesh model that faithfully reproduces even small-scale details such as cars, trees, fences, and walls - all with advanced color balancing and high-quality texturing.

### **Cost and Time Efficient**

PhotoMesh offers a significant reduction in cost and time when compared with traditional modeling methods. Reconstructions that would generally take weeks using manual modeling methods can be completed in mere hours using PhotoMesh.

### **Scalability**

PhotoMesh efficiently handles even hundreds of thousands of photos using an elaborate tiling mechanism. PhotoMesh exploits multi-computer architecture (fusers) to further accelerate database creation, running a single project simultaneously on hundreds of machines.

### **Output Formats**

PhotoMesh's result can be exported to various multi-resolution 3D model formats (3DML, I3S, Cesium 3D Tiles, OSGB, DAE, OBJ), raster formats (Orthophoto, DSM, DTM) and point clouds (LAS), ensuring full interoperability with 2D/3D GIS solutions.

### **High Performance**

PhotoMesh can run its efficient algorithms fluidly on standard GPUs, or exploit multi-core and multi-computer processing to further accelerate database creation. A single project can run simultaneously on hundreds of fuser machines, processing tens of km<sup>2</sup> per day.

### **Source Image Flexibility**

PhotoMesh supports most standard image formats (Jpg, Tiff, hyperspectral, etc.), Lidar and video files, generating complete, true 3D mesh models from professional or drone-captured standard, unordered oblique, nadir, and ground photos.

### **Efficient Management**

PhotoMesh Manager provides comprehensive information on the progress of each build step and the active fusers, highlighting tiles with errors, and allows the viewing of intermediate data while the build is in progress.

### **Intuitive GUI**

PhotoMesh provides powerful visualization capabilities and tools, including photo projection on the terrain and project preview, which facilitate accurate evaluation and adjustment of photo and camera parameters.

## DATA COLLECTION

### Supported Inputs

- Standard image formats (Jpg, Tiff, etc.)
- Photos with hyperspectral bands (NIR)
- Video files (most formats)
- Lidar (LAS, E57)
- Photos without positioning (GPS) information
- Photos without orientation information

### Camera & Resolution

- Aerial and terrestrial collections
- Supports large frame sensors (200+ megapixels)
- Processing of photos with different resolutions and focal lengths

### External AT

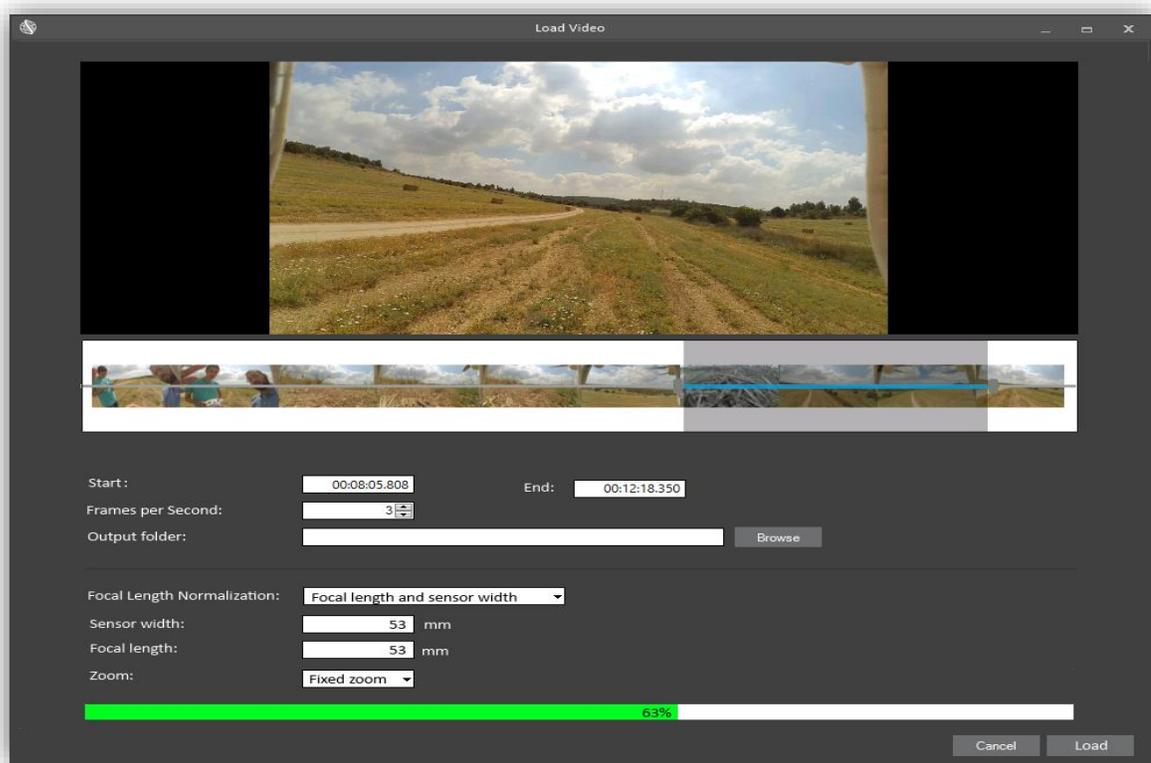
PhotoMesh can use inputted camera positioning and orientation information and camera parameters (including focal length, principal point and radial/tangential distortion) for collections captured by professional systems as the initial starting point for the aerotriangulation process:

- Skip the aerotriangulation step – accelerates processing time
- Can improve geographic positioning and quality
- Supports most standard systems - Bingo, Inpho, VisionMap, Stellacore, and others

## Video

PhotoMesh can extract individual frames from Full Motion Video (FMV) and save them as photo files:

- All common video formats supported
- Frames automatically extracted and added to project
- Preview option
- Set Start/End times for video frame extraction



## Lidar

PhotoMesh supports laser based collection system (point cloud) to improve the 3D model integrity and accuracy:

- Aerial and terrestrial collections
- Supported Lidar formats include: LAS and E57
- Manually match Lidar point clouds and photos using GCP editing tool
- Lidar data can be loaded together with a trajectory file that provides information about the scanner's position while capturing the point cloud to improve the reconstruction of the model
- Preview Lidar data in PM
- Use Lidar color for texturing areas not covered by photos



## OUTPUT FORMATS

- 3DML database
- OSGB
- OBJ files (including LOD models)
- DAE files
- ESRI i3s / SPK
- Cesium 3D Tiles (B3DM)
- LAS (point cloud)
- True orthophoto (multi-band)
- DSM elevation models
- DTM elevation models

## PERFORMANCE AND SCALABILITY

### Standard, Low Cost Hardware

- Utilizes multi-core architecture
- 16-32 GB RAM
- Dedicated GPU not required

### Processing Capabilities

- Processes around 10 gigapixels per day and per PhotoMesh fuser (8 cores) on average
- Handles very large data sets
  - Divide project into large aerotriangulation (AT) tiles
  - Divide each AT tile into small reconstruction tiles

### Scalable Architecture

- Designed for computer clusters and for private/commercial clouds
- Multi-computer architecture (PhotoMesh fusers)
- Single project can run simultaneously on hundreds of fuser machines

### Amazon Web Services (AWS)

PhotoMesh allows working with Amazon Web Services to scale project production up and down based on resource needs. AWS virtual fuser machines (i.e., spot instances) can be dynamically launched whenever there are unassigned pending fuser tasks, to further accelerate model creation. PhotoMesh Build Manager continuously monitors the fusers' progress and status and the processing requirements of the current step, adding and terminating AWS fusers as required.

- Launch AWS instances on demand
- Optimization algorithm for best value-for-money

## QUALITY

PhotoMesh generates a full-3D mesh model with advanced color balancing and high-quality texturing.

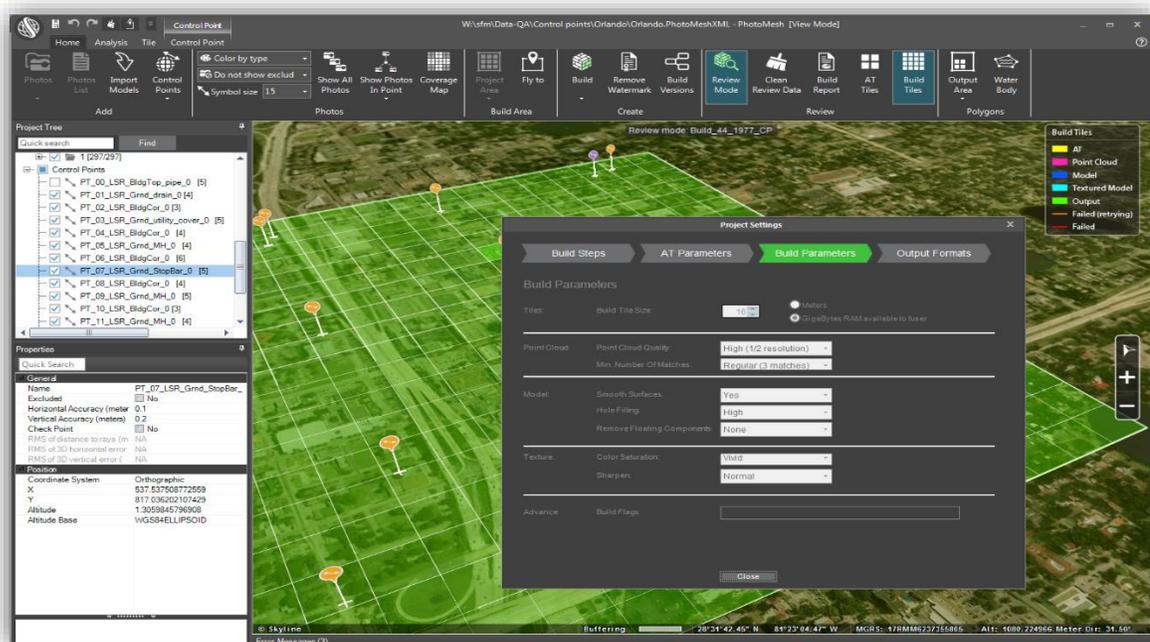
- High quality 3D edge mechanism
- Enhanced reconstruction of small scale objects like poles, fences and thin walls
- Improved texturing algorithm for a crisper, cleaner look



# COMPONENTS

The PhotoMesh application is composed of three components:

- **PhotoMesh Editor** – The main PhotoMesh working area for various workflow actions such as preparing, submitting for processing, monitoring, and reviewing the build.
  - Defines camera sets and camera properties
  - Defines project area and build properties
  - Defines control points
  - During build - view and analyze tile models
- **PhotoMesh Fuser** – Worker component of PhotoMesh which allows you to share the workload between several computers on the same network. The master computer, equipped with PhotoMesh fuser, utilizes the computing power of the network's client computers by connecting to PhotoMesh fusers on the client machines.
  - Performs image pre-processing, AT and reconstructions on tiles
- **PhotoMesh Build Manager** – Manager application that is responsible for managing the build process and PhotoMesh fusers. PhotoMesh Build Manager keeps track of all build tasks and fusers, distributing tasks among the fusers and assigning new tasks as fusers complete their tasks and become available. During the build process, PhotoMesh Build Manager monitors the build and provides the user with detailed information about the build's progress.
  - Manages build process - tiles and steps
  - Manages fusers



## WORKFLOW

PhotoMesh converts standard 2D photographs into high-resolution, textured, 3D mesh models in a streamlined, step-by-step process:

- [Step 1: Imagery Acquisition](#)
- [Step 2: Loading Photos and Other Input Sources and Preparing the Project](#)
- [Step 3: Managing Local and AWS Fusers](#)
- [Step 4: Building the Model](#)
- [Step 5: Managing and Reviewing the Build](#)

### Step 1: Imagery Acquisition

All visible surfaces of the intended object or scene must be photographed from multiple overlapping viewpoints. The accuracy of the resulting 3D mesh model is affected by several factors including: input image resolution and quality, lens distortion, overlapping ratio, directionality, and lighting. While PhotoMesh optimizes the accuracy of the 3D mesh model by selecting the best photos for an area, each factor can affect the overall output or cause varying levels of accuracy and quality in different areas of a project.



Ground resolution = 5cm per pixel – Orlando USA



Ground resolution = 1 cm per pixel – Tel Aviv (drone)



Ground resolution = 3 cm per pixel - Frederick



Ground resolution = 7cm per pixel – Enfield England (Midas)

## Step 2: Loading Photos and Other Input Sources and Preparing the Project

Photos and other input sources are loaded into a project using any of the following methods:

- Load photo files from disk.
- Load an Excel/XML file with a list of photos, their file paths, and all photo and photo collection information.
- Load a PhotoMesh project. When a PhotoMesh project (.PhotoMeshXML) is loaded into a second project, only the project's photos and photo and collection parameters are loaded.
- Load a video from which PhotoMesh extracts individual image frames.
- Import photos of different data types (e.g., Inpho, Bingo, Stellacore) into the project with their metadata (e.g., sensor width, focal length, and aerotriangulation data). When AT results are imported, the AT step of the build process can be skipped.
- Load Lidar data in either .las or .e57 formats into a PhotoMesh project, integrating it with project photos to supplement project data and increase model accuracy.

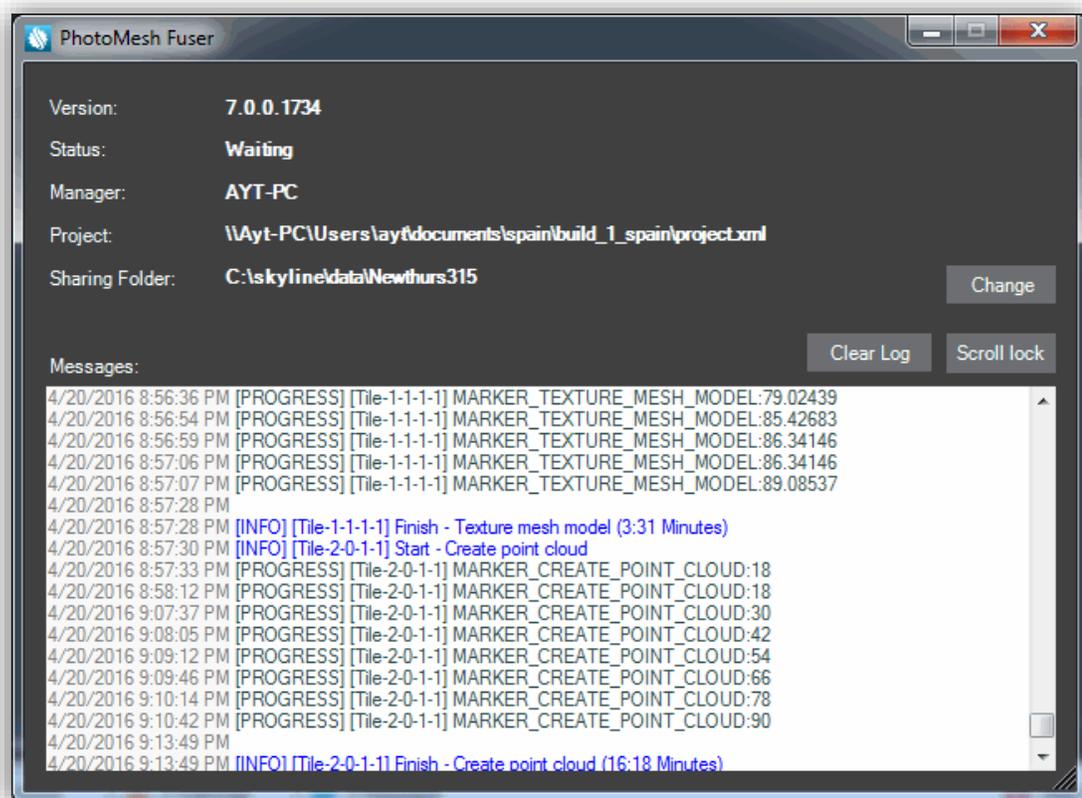
After photos have been loaded, do any of the following to prepare the project for the build:

- Modify photo and photo collection properties
- Verify that the camera symbols generate the expected cluster form
- Project photos on the terrain to see if they fit the terrain imagery or to better understand their position
- Show Lidars on the terrain to see if they fit the terrain imagery or to better understand their position
- Associate a Lidar with its trajectory data that provides information about the scanner's position while capturing the point cloud
- Improve the accuracy of the model's position by creating ground control points that associate real-world X, Y, Z coordinates with corresponding locations (in pixels) in photos
- Establish a correspondence between project photos and improve aerotriangulation results by creating tie points in the same physical point in three or more photos
- View photos in the photo viewer
- Import or draw water body polygons to generate a flat surface with correct texturing over user-defined water bodies
- Display the coverage map to identify which areas of the project have sufficient coverage and which require more
- Create a subset AT area in which to validate camera parameters and project settings
- Set a reconstruction area

### Step 3: Managing Local and AWS Fusers

Fusers allow you to share the demanding workload involved in processing the different build steps (data preparation, AT, point cloud, mesh model, texture, 3DML/other outputs) between several computers on the same local network. The master computer utilizes the computing power of the network's client computers by connecting to PhotoMesh fusers on the client machines. The fusers communicate (deposit and collect pending tasks, and share information about fuser availability, status and progress) with PM Manager via the working folder.

PhotoMesh can also work with Amazon Web Services (AWS), adding and terminating virtual fuser machines, to scale a project up and down based on resource needs.

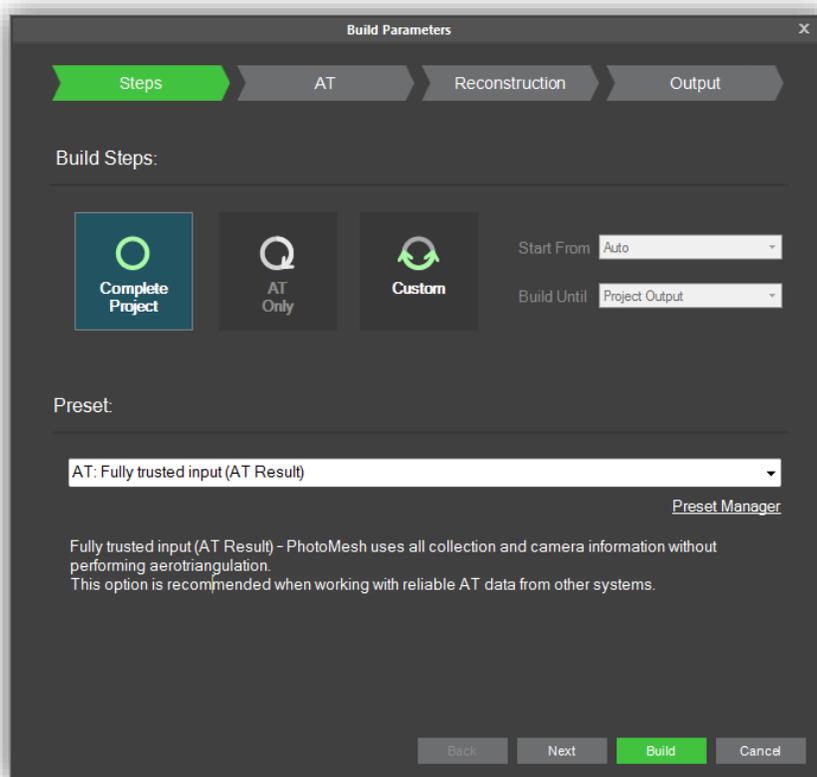


## Step 4: Building the Model

After all photos are added to the project and all properties are set as required, you can launch PhotoMesh Build Manager to begin the build process. The build process provides flexibility both with regard to the area of the project being built (entire or selected area) and the build steps that are to be performed. Build parameter presets make it easy to automatically set the required parameters to generate the optimum output for the project's data as well as to share user-defined build settings between projects.

The build process involves the following steps:

- Data Preparation
- Aerotriangulation
- Reconstruction
  - Point Cloud Creation
  - Model Creation
  - Model Texturing
- Project Output - Select all required output formats: 3DML (for loading directly into CityBuilder or TerraExplorer and streaming with SkylineGlobe Server), DAE, OBJ, Cesium, I3S/SPK, OSGB, Orthophoto, DSM, DTM/DEM, and LAS (Point cloud public file format).



## Step 5: Managing and Reviewing the Build

Throughout the build process, you can monitor build progress from PhotoMesh Build Manager and view the build data already created in the PhotoMesh 3D Window. As soon as a build step is completed for a tile, its build data is viewable in the 3D Window, e.g. if aerotriangulation was performed, PhotoMesh can display the calculated camera positions in the 3D Window, and if reconstruction tiles were calculated, they can be displayed in the 3D Window, with each tile colorized according to the build step completed. You can also view point cloud, 3D model, and texture data for one or more tiles once this build step for the selected tile is completed. Build reports are available, as well, with statistical and graphical information about the build process.

After reviewing build data, you can easily rebuild any of the following: the entire project, error tiles, or selected tiles. Alternatively, you can create a new build version with different project steps and different build parameters. You have the option to create a completely new build version or one which copies the AT information from the previous build, thereby accelerating the build process.

Before rebuilding, 3D models can be exported when necessary to external software, such as Autodesk® MeshMixer, to perform certain edits, e.g. to remove a particular building that is being torn down, flatten surfaces and correct certain imperfections such as bumps or irregular surfaces, or edit textures, and then reimported to PhotoMesh.

The screenshot shows the PhotoMesh Build Manager interface with the 'Aerotriangulation' step selected. The interface includes a progress bar at the top with four stages: Data Preparation, Aerotriangulation (active), Reconstruction Tiles (Point Clouds, Model, Texture), and Project Output. Below the progress bar, there are settings for the Working Folder (C:\Users\Working Folder\), a checkbox for 'Automatically use new available fusers' (checked), and a checkbox for 'Automatically launch AWS fuser instances' (unchecked). A table lists the active fuser: DESKTOP-GG4EGGQ(10.100.102.4) running the step 'Create point cloud [Tile-2-4-1-1]' with an elapsed time of 00:08:05. At the bottom, there are buttons for 'Build Report', 'Show Settings', 'Cancel', and 'Build'.

Use	Fuser	Version	Running Step	Step Elapsed Time	Progress	Status
<input checked="" type="checkbox"/>	DESKTOP-GG4EGGQ(10.100.102.4)	7.5.0.3502	Create point cloud [Tile-2-4-1-1]	00:08:05		Online - Working

Task	Last Step	Running Step	Status Description	Progress	Fusers
AT Tile-0-0-1-1	Calculate camera positions				
AT Tile-0-1-1-1	Calculate camera positions				
AT Tile-1-0-1-1	Calculate camera positions				
AT Tile-1-1-1-1	Calculate camera positions				
Build_4_noAT_731_2705	Merge				

## SYSTEM REQUIREMENTS

<b>Operating System</b>	Windows® 7 / 8 / 8.1 / 10 Windows® Server 2012 R2 – 64bit required.
<b>System Memory</b>	16 GB RAM (32 GB recommended). <b>Note:</b> RAM requirements are mostly affected by the number of photos in the AT tile and the reconstruction tile size. <b>See</b> “ <a href="#">Setting AT Parameters</a> ” and “ <a href="#">Setting Reconstruction Parameters</a> ” in the “Building” chapter for more information.
<b>Video Card</b>	1 GB of video memory (2 GB or more recommended). Pixel and vertex shader v3.0.
<b>Processor</b>	4 cores (8 cores recommended). PhotoMesh works best in a multi-core environment and can utilize multiple CPU's and hyper-threaded processors.
<b>Additional Software</b>	.Net Framework 4.6 required.

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