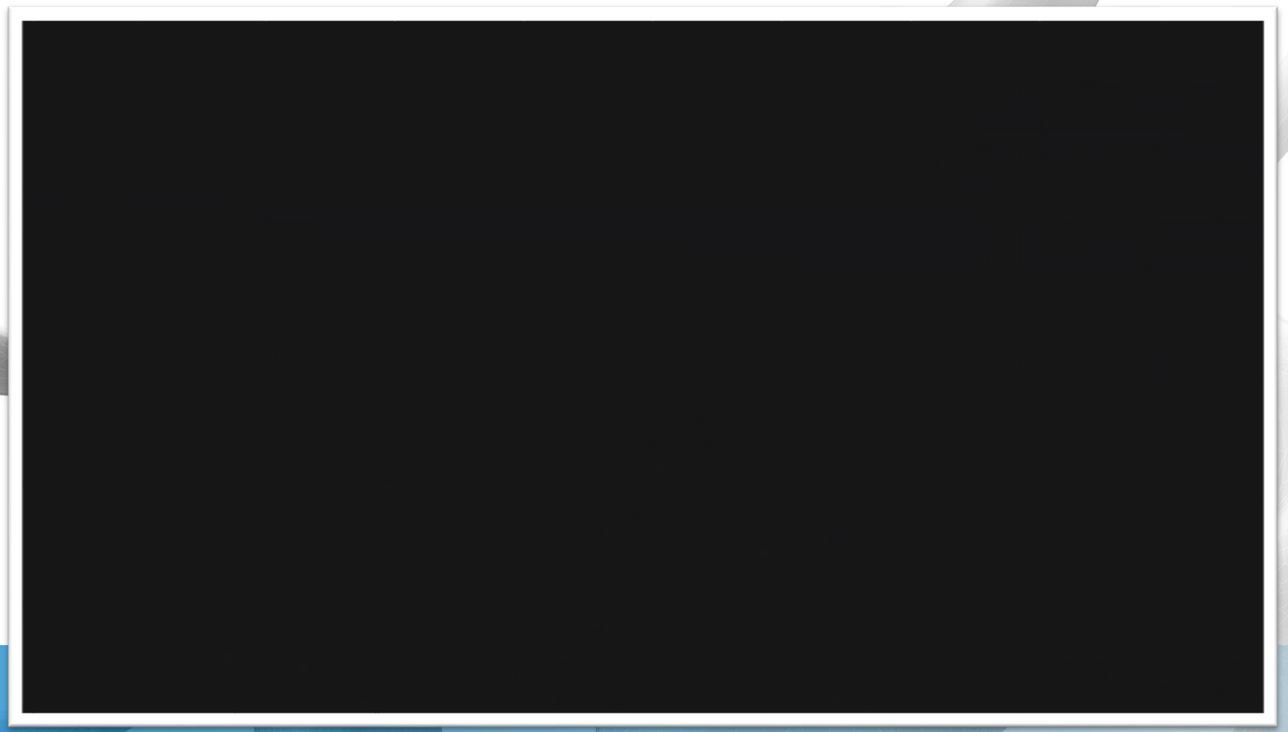


# Photogrammetry—Making Point Cloud Magic from Drones and Photos

Rob Clark

Principal Technical Consultant, Excitech Ltd

Mike Turpin

Company BIM Manager, Capita (Real Estate & Infrastructure)

# The Brief

# Todays Agenda

- **Signing up for Autodesk Recap 360**
  - Account Log in - **Hand's on!**
- **Why Photogrammetry?**
- **Setting Up – Hand's on!**
  - Uploading
  - Setting up a project
  - Scaling
  - Photo matching (registration)
  - Coordinates
  - Textures, Cropping and NADIR
  - Processing formats and download
  - Viewing and publishing (sharing)
- **Using Photogrammetry**
  - A real world example, the Shanklin Lift Bridge
  - The outputs
- **Autodesk Recap Pro - Hand's on!**
  - Acesss
  - Navigation of the point cloud
  - Limit Boxes
  - View States and Regions
  - Measurement tools
  - Creating Regions
- **Autodesk Revit - Hand's on!**
  - Linking RCS
  - Photo to BIM
  - Visibility Control
- **Conclusion**
  - Accuracy
  - Site Access, inc. No Fly Zones
  - Photogrammetry Tips and Tricks
  - Recap Tips and Tricks
  - Administration of Autodesk Cloud Credits (summary)
- **Questions**

# Learning Objectives

At the end of this class, you will be able to;

- Create a point cloud (and other outputs) using Autodesk Recap 360 from photos
- Use the registration tools in Autodesk Recap 360
- Navigation and using Autodesk Recap Pro
- Use the measuring tools in Autodesk Recap Pro
- Import the RCS to other products in the Autodesk portfolio (example, Revit)
- Basic Photo to BIM within Autodesk Revit

# Format of this session

- This is a “Show and then Do” lab.
- Instructions are shown on screen.
- Datasets are provided and preloaded to machine or supplied Autodesk account.
- How to videos are also on your machine.

# Software

We will be using the following software

- Autodesk Recap 360 (online service – **an account is provided***)
- Autodesk Recap Pro (desktop software)
- Autodesk Revit

* Do not use your own Autodesk Online account!  It does not contain the dataset. (Also, you will use your own credits)

# Example


ANNOYING
ORANGE

# Lab – Instructions *Example* Slide

***Step xx to xx***
***Title of this section***

1. Turn on computer
2. Take supplied crowbar
3. Apply to computer


| | |
|---|---|
| Time | 1 minute |
| Files | C:\Datasets\TBC |
| Software | Autodesk Recap 360 |
| Help | “00. Test Video.wmv” or ask an assistant |
| Jump On | Click the link in folder named “S6” |

**Time Left :**

# Part 1
# Logging into Autodesk Recap 360


Google
Chrome

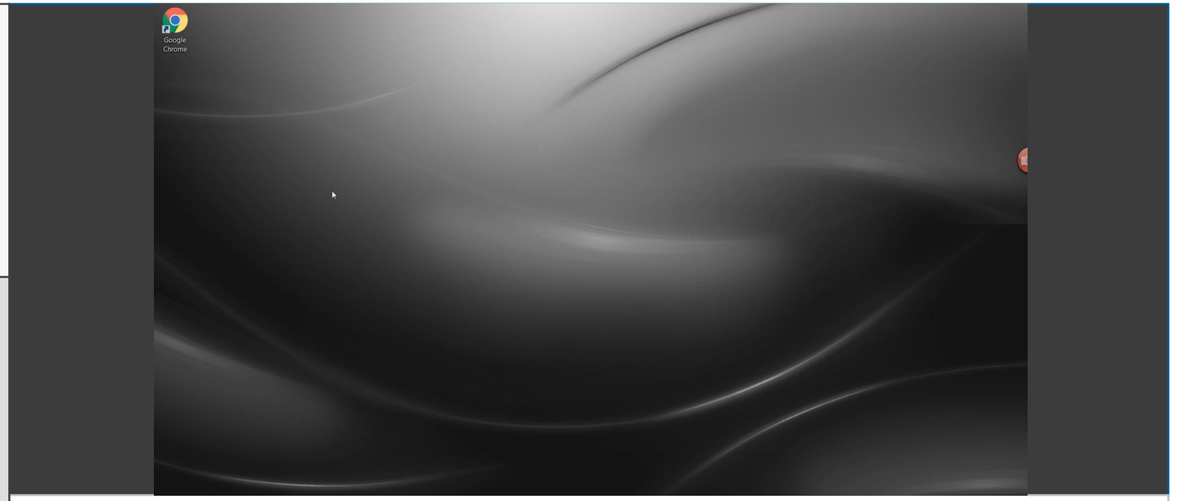
# *Login to the Autodesk Recap 360 Service*

1. Open up a web browser.

2. In the address bar,
   https://recap360.autodesk.com/

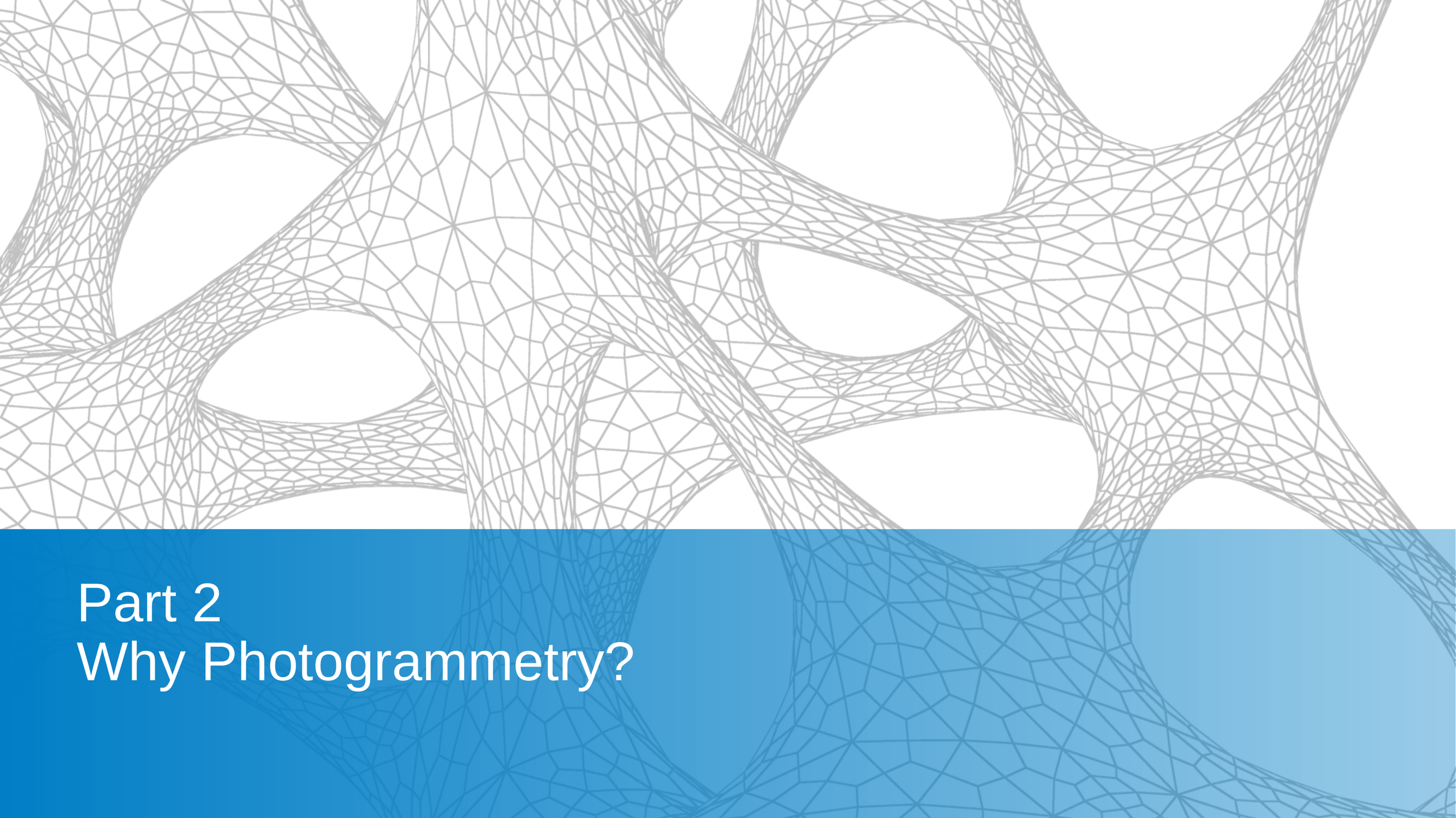
3. Enter the supplied login credentials
   Username: AU-??@autodesk.com
   Password: Autodesk1

***We have uploaded the files for you. Use the login credentials supplied, not your personal account.***




| | |
|---|---|
| Time | 2 minutes |
| Files | |
| Software | Autodesk Recap 360 |
| Help | “Recap – Login.wmv” or ask an assistant |
| Jump On | No jump on available |

**Time Left :**



# Part 2
# Why Photogrammetry?


# What is?...

…the material of…

…the width of…

…the volume of…

…the colour of…

…the maximum…

…the area of…

…the length of…

…the shape of…

…the minimum…

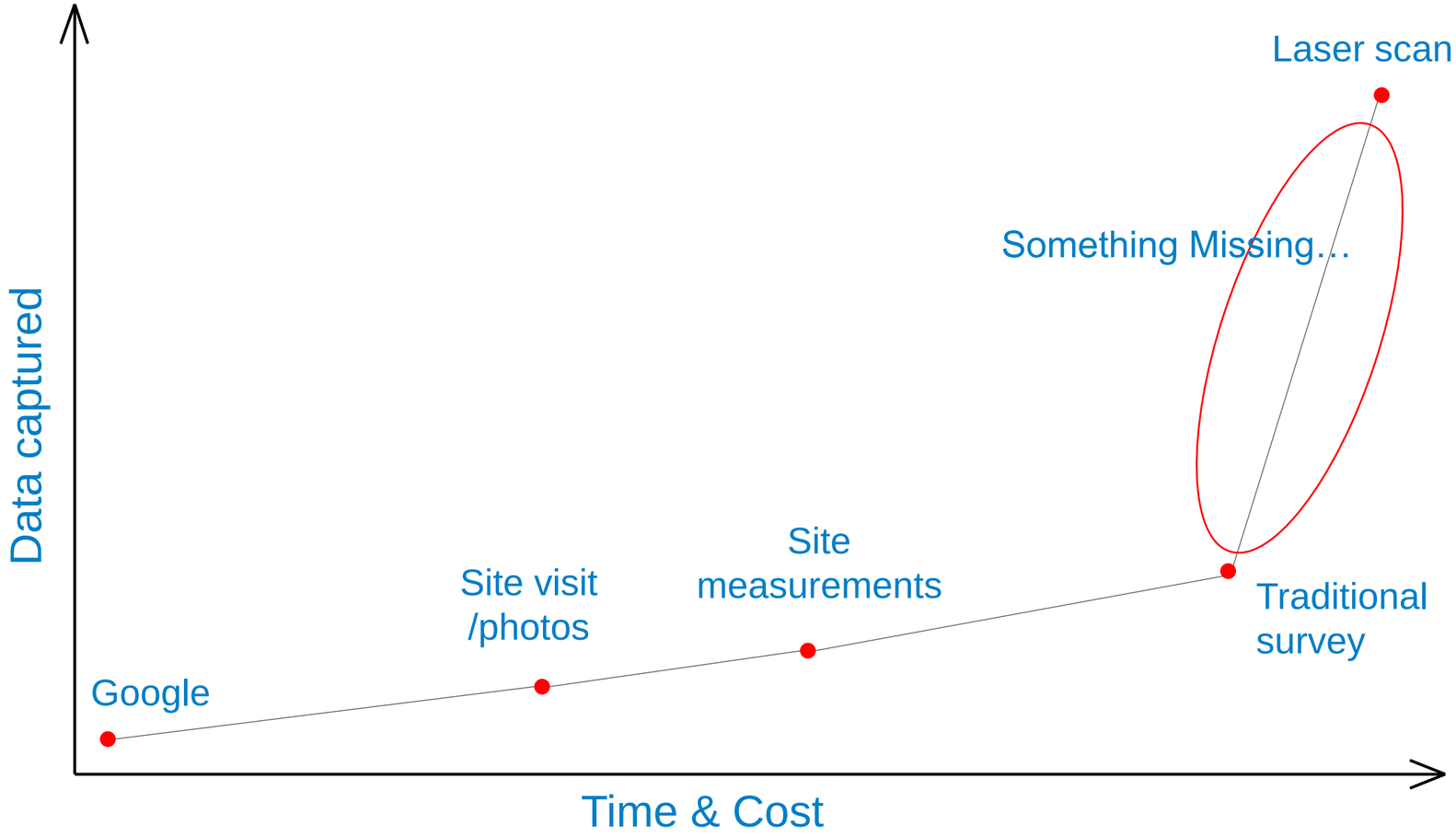
…the height of…

…the distance between…

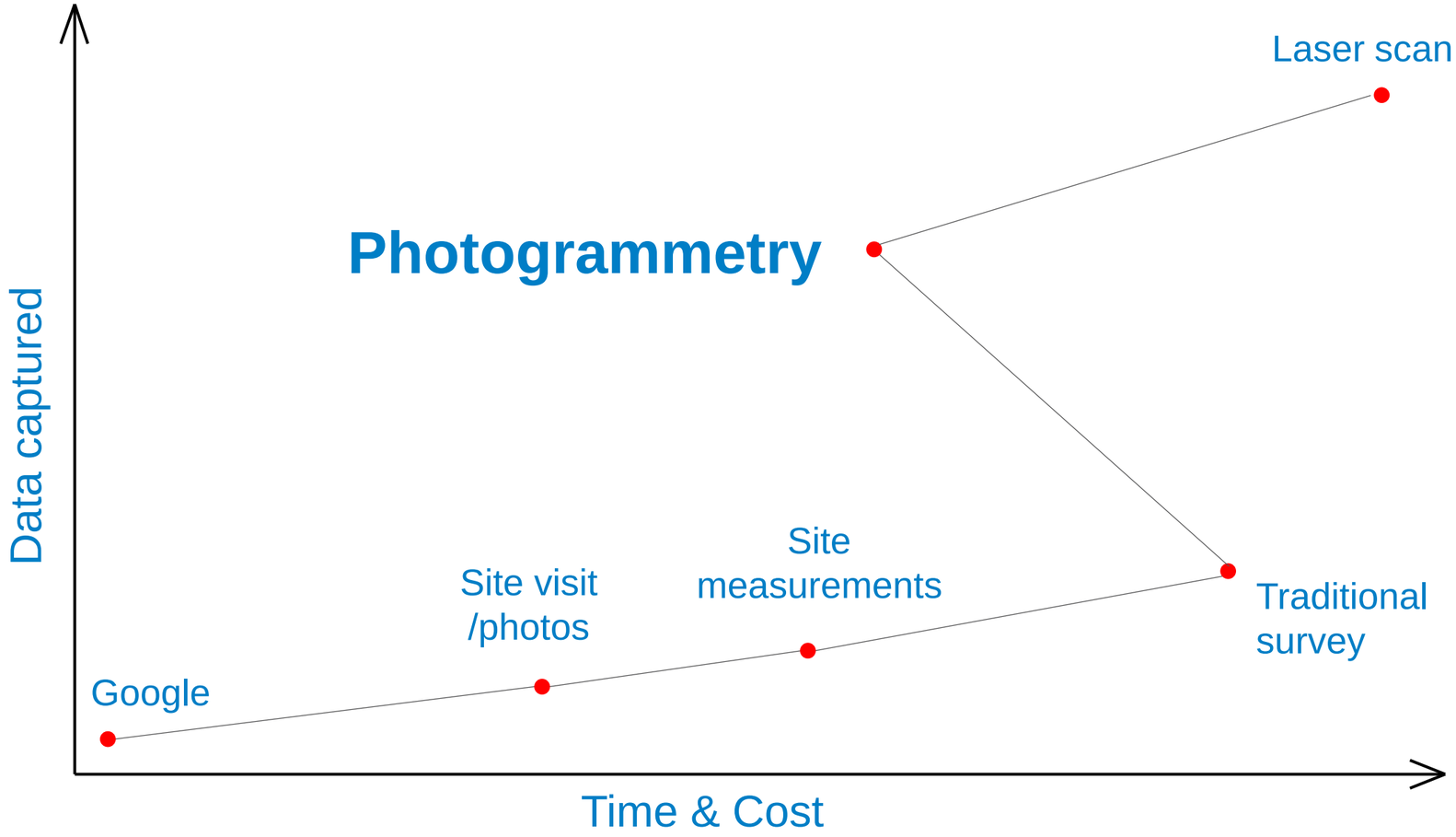
# What if?...

# …we knew everything?

# What are the options for collecting data?

# What are the options for collecting data?

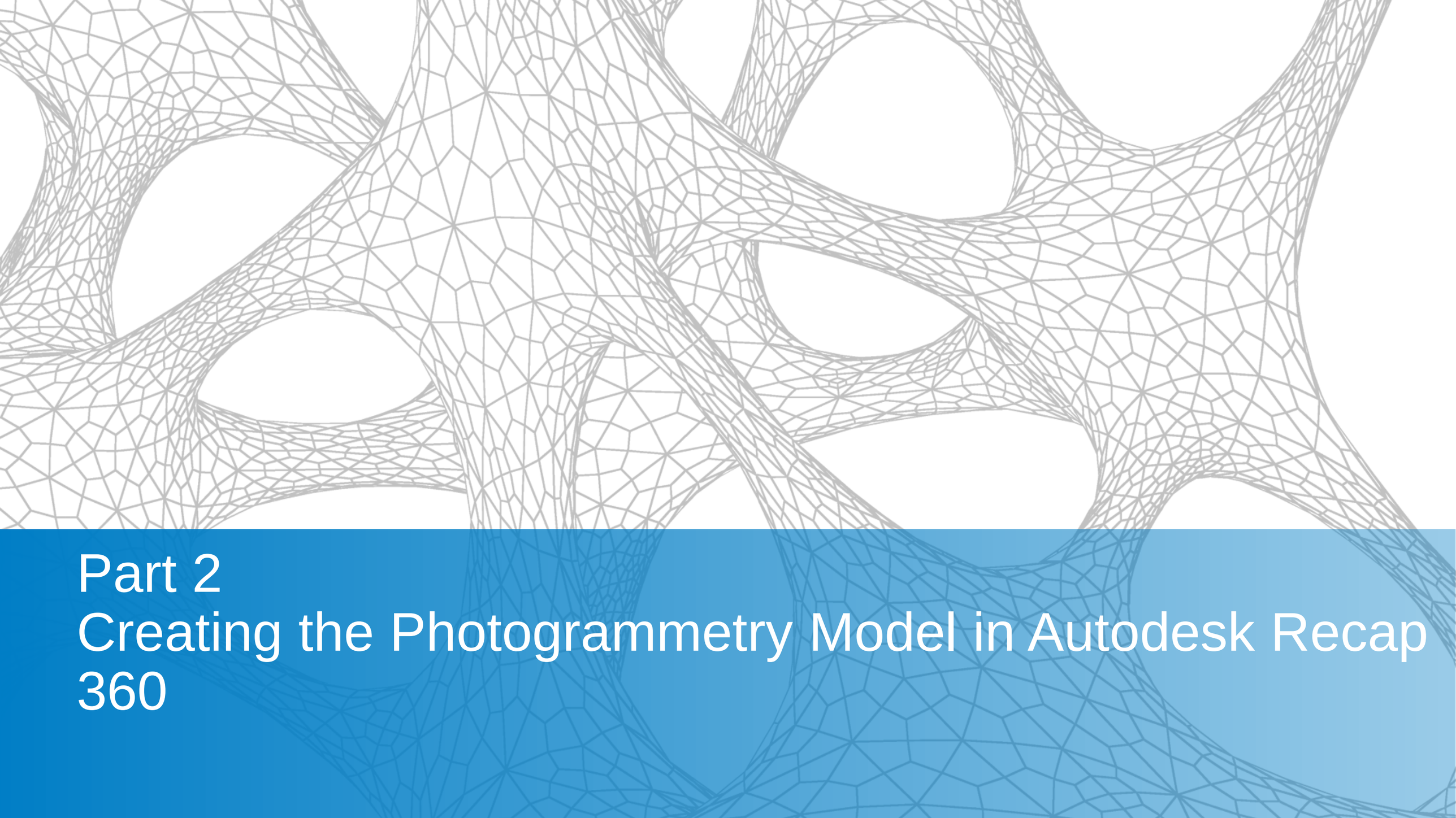



# What is Photogrammetry?

**Google Definition**

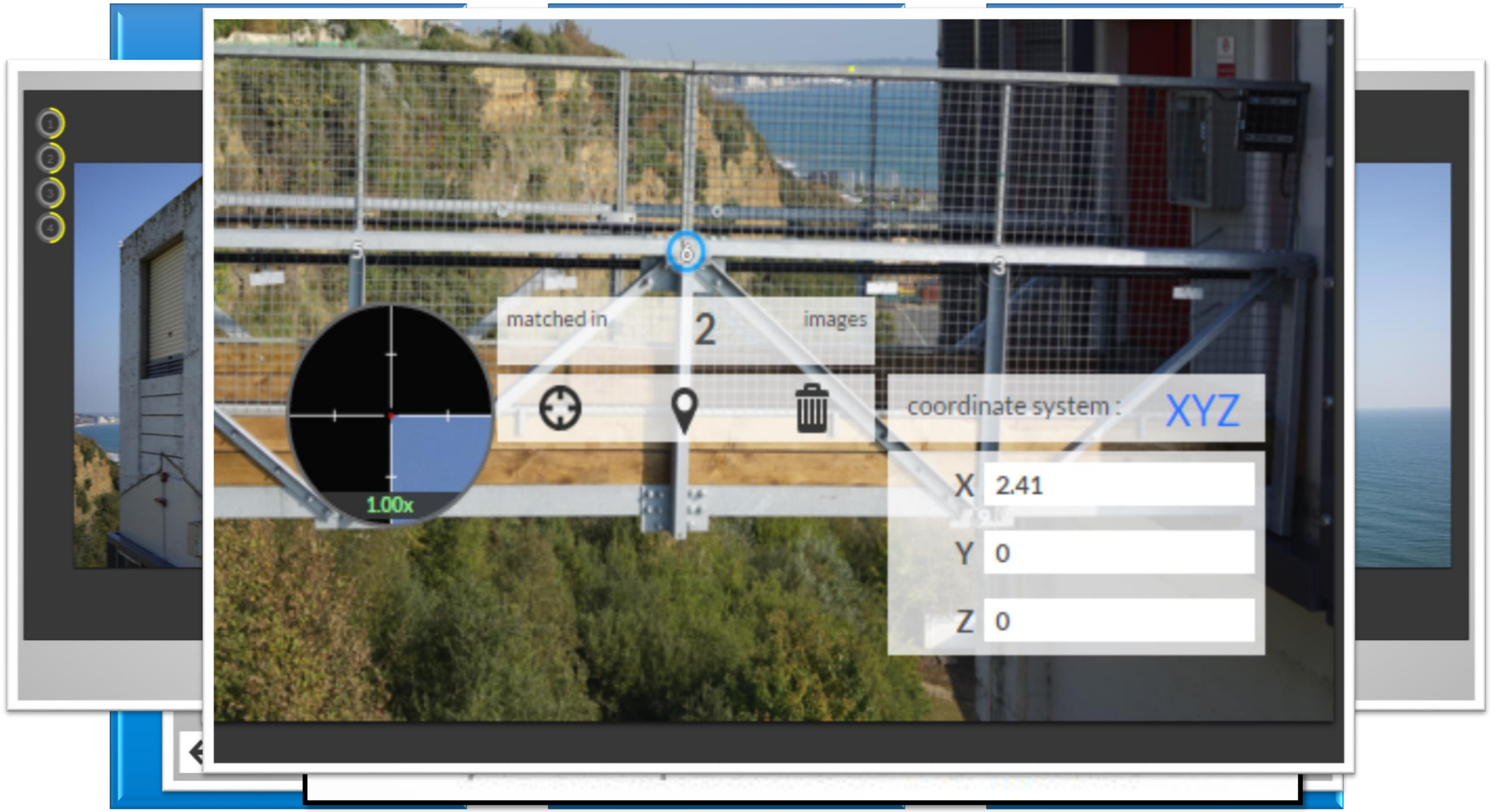
***“The use of photography in surveying and mapping to ascertain measurements between objects”***

**Simply put, in theory we should be able to take lots of photographs of an item from many different points of view and by ensuring that we have overlap between these photos we can create common points of reference.**



# Part 2
# Creating the Photogrammetry Model in Autodesk Recap 360

# Autodesk Recap 360 - Process




*The experiences presented here are as experienced on this project only.*
*The issues could be novice user error, temporary or to do with our hardware.*

ReCap

https://recap360.autodesk.com

AUTODESK® RECAP®

Robert

all photo scan

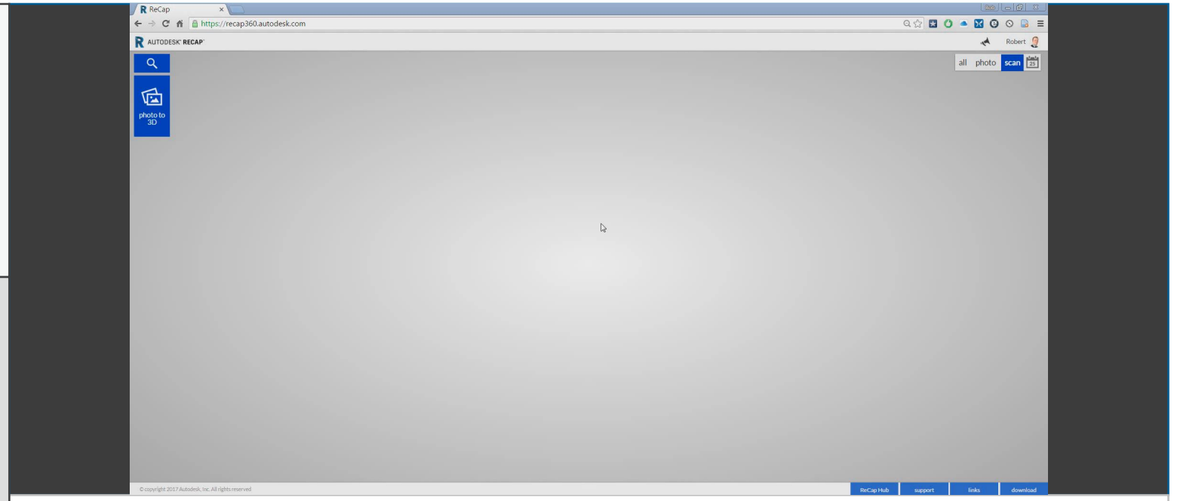
photo to 3D



ReCap Hub support links download

# *Select the photos from A360 Drive*

1. Ensure that the interface is set to either “All” or “Photo”
2. Click on Photo to 3D
3. Select “Browse from A360 Drive”
4. Select Photogrammetry then AU LDN Dataset 2
5. Highlight the top photo and scroll to the bottom of the list. Hold down the SHIFT key and select the bottom photo. This selects all photos. Press Select




| | |
|---|---|
| Time | 2 minutes |
| Files | AU LND Dataset 2 - Preloaded to A360 |
| Software | Autodesk Recap 360 |
| Help | “Recap – Login.wmv” or ask an assistant |
| Jump On | No jump on available |

**Time Left :**

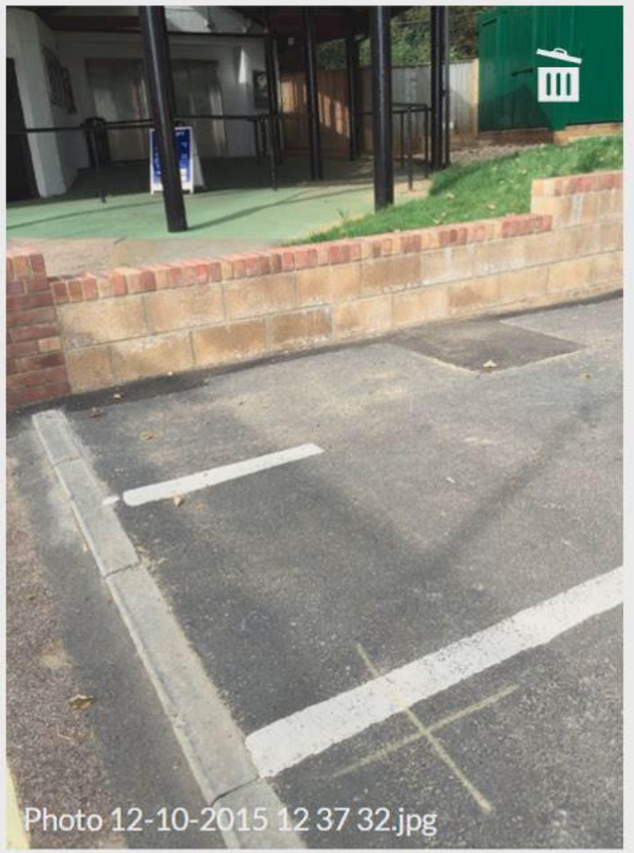
ReCap

Secure | https://recap360.autodesk.com

AUTODESK® RECAP™

Adsk

add photos | tiled view | survey settings



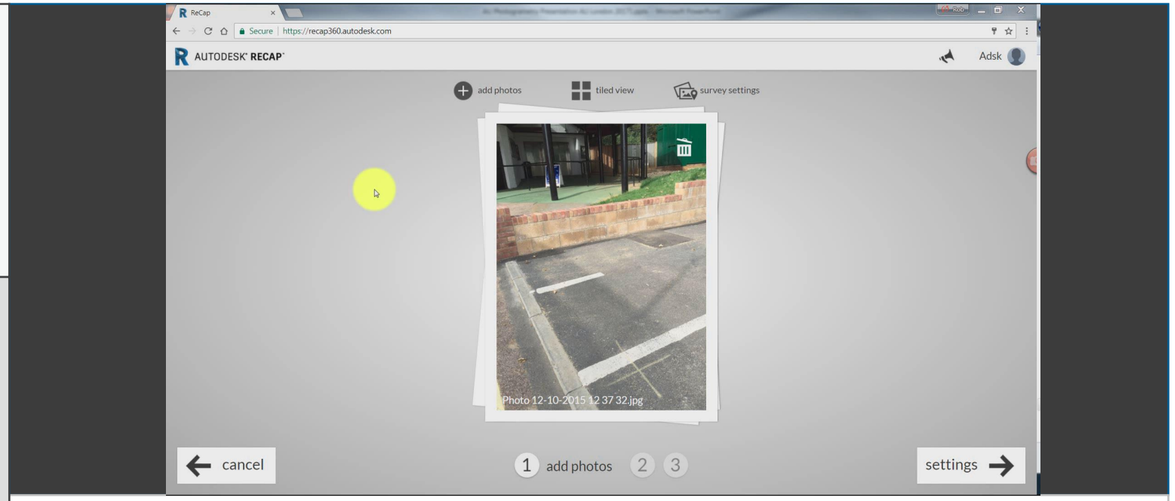

cancel

1 add photos 2 3

settings

# *Set the Scale*

1. Click on Survey Settings
2. Choose Set Scale and choose the top left hand photo in the left plane
3. Use your mouse wheel to zoom into a facing brick.  Do not use edge bricks
4. Choose a photo in the right hand plane where you can see the same brick but from a different angle.
5. In the first (left) picture, click on the left side of the brick
6. In the second (right) picture, click on the left side of the same brick




| | |
|---|---|
| Time | 3 minutes |
| Files | AU LDN Dataset 2 |
| Software | Autodesk Recap 360 |
| Help | “Scale 1.wmv” or ask an assistant |
| Jump On | No jump on |

**Time Left :**

ReCap

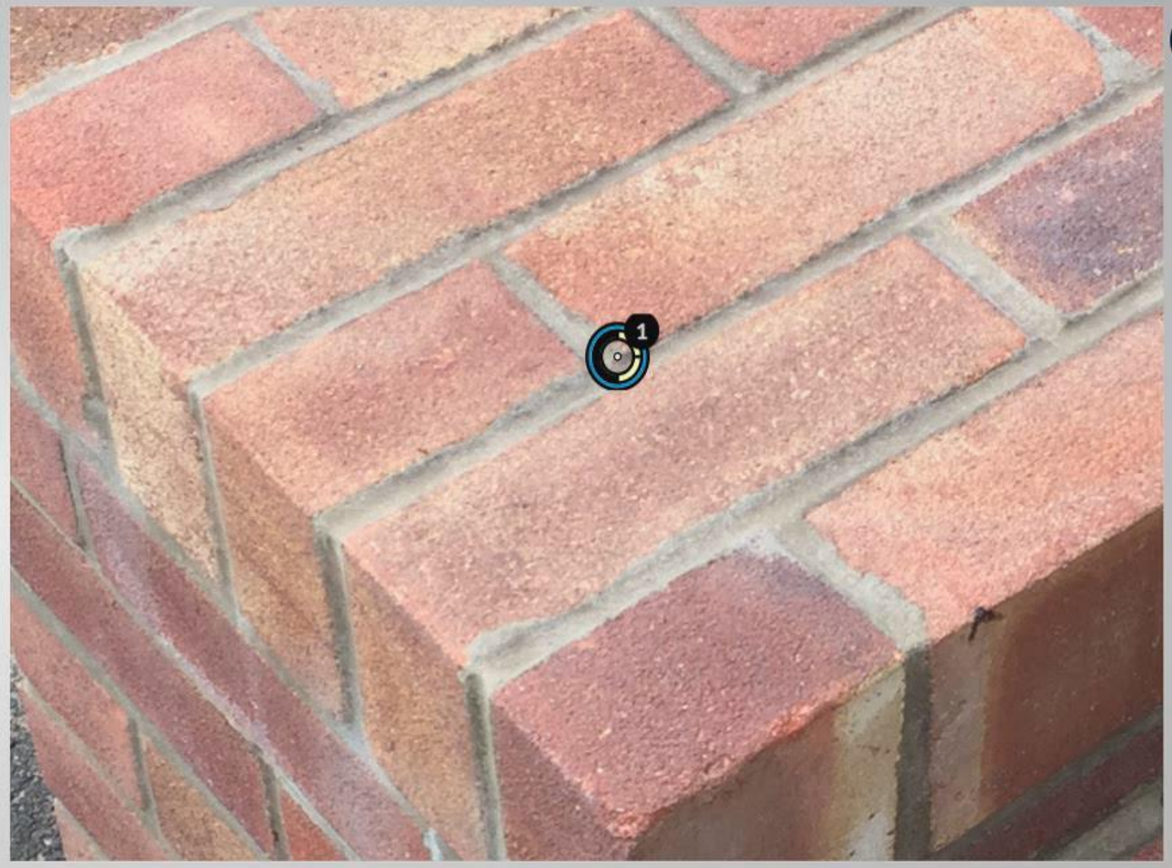
Secure | https://recap360.autodesk.com

AUTODESK® RECAP®

Adsk

click a point on the image to set a registration point

click a point on the image to set a registration point



select second point

choose a different photo

cancel scale

choose a different photo

photos

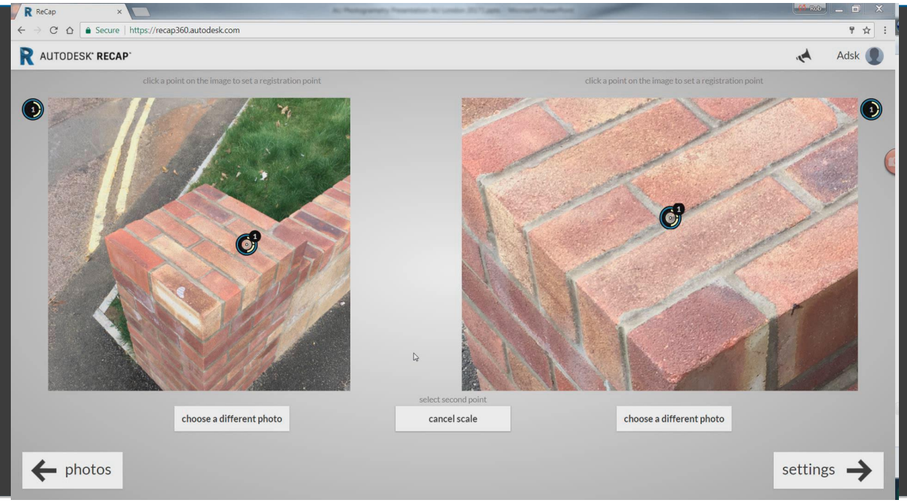
settings

# *Set the Scale*

1. In the first picture, click on the right hand side of the brick

2. In the second picture, click on the right hand side of the same brick

3. Enter a dimension of 0.215.  (This is 215 millimetres in meters. For Inches, enter 8.46)




| | |
|---|---|
| Time | 2 minutes |
| Files | AU LDN Dataset 2 |
| Software | Autodesk Recap 360 |
| Help | “Scale 2.wmv” or ask an assistant |
| Jump On | No jump on |

**Time Left :**

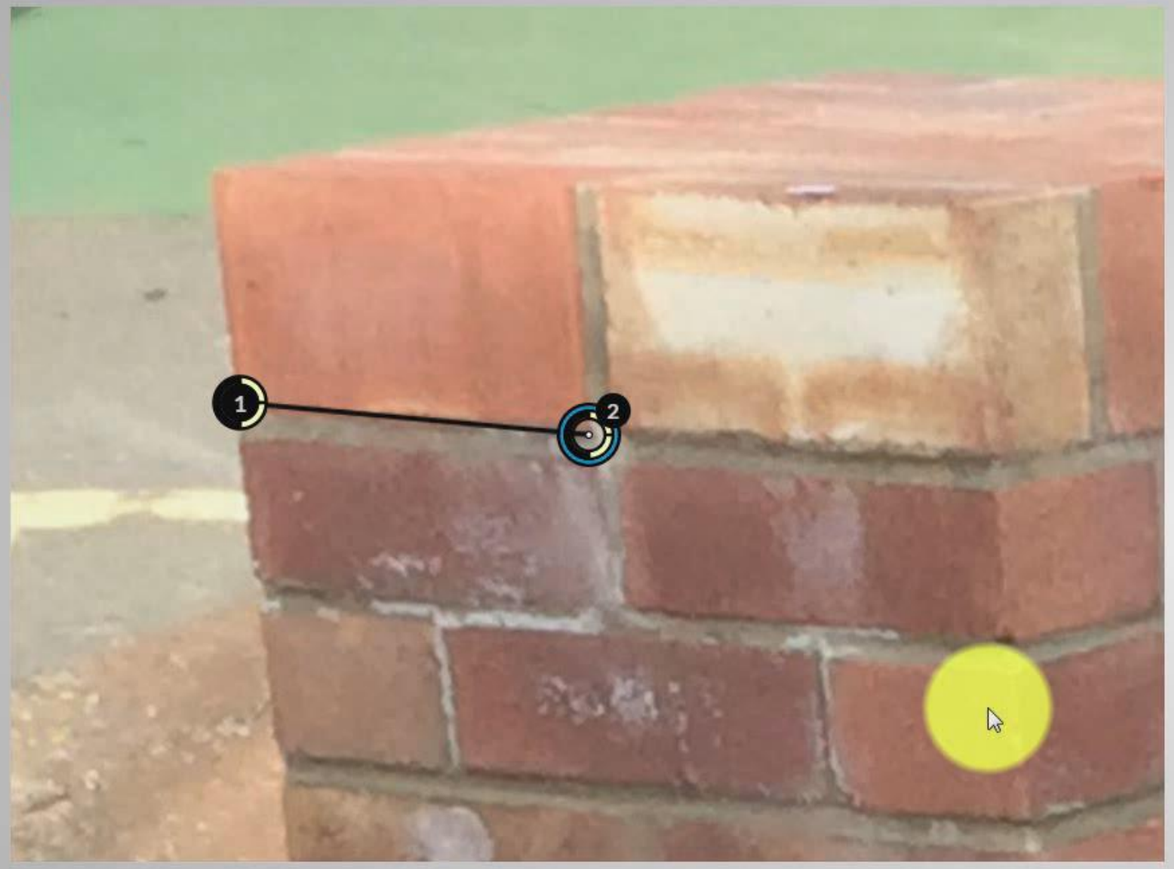
ReCap

Secure | https://recap360.autodesk.com

AUTODESK® RECAP®

Robert

click a point on the image to set a registration point




click a point on the image to set a registration point


choose a different photo

delete scale

1 0.215m 2

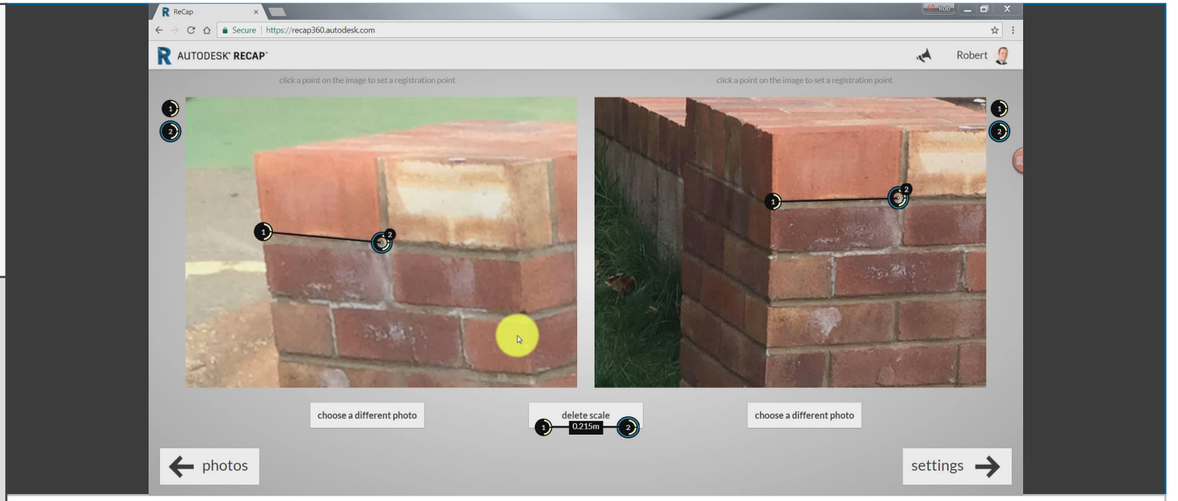
choose a different photo

photos

settings

# *Registration*

1. In the first picture, select a surface (not corner!) of another brick
2. In the second picture, select the same surface.
3. Select “choose a different photo” on the first photo and the second photo, and choose two new photos ensuring that at least one surface is visible in both photos.
4. Repeat this process several times




| | |
|---|---|
| Time | 3 minutes |
| Files | AU LDN Dataset 2 |
| Software | Autodesk Recap 360 |
| Help | “Recap 360 Registration.wmv” or ask |
| Jump On | No jump on |

**Time Left :**

ReCap

Secure | https://recap360.autodesk.com

AUTODESK® RECAP®

Robert

choose your first photo to register

...now choose a second photo to register to it

Unstitched

Photo 12-10-2015

delete scale

1 0.215m 2

photos

settings

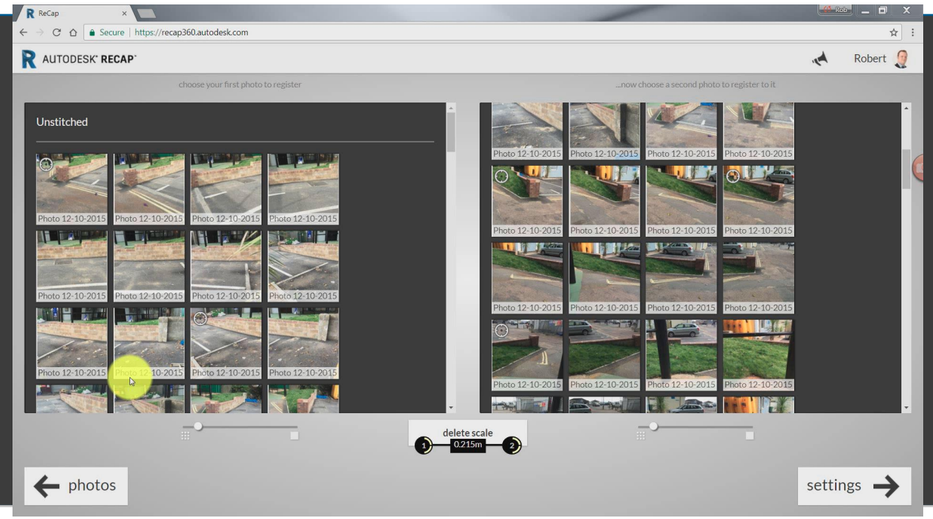
# *Insert Coordinates*

1. Find a photo that shows the top right hand corner of the front of the wall

2. Place a point on the top right hand corner of the front of the wall and click on the coordinate button

| | |
|---|---|
| **X** | 458589 |
| **Y** | 81473 |
| **Z** | 24.4 |

3. Click “Settings”




| | |
|---|---|
| Time | 2 minutes |
| Files | AU LDN Dataset 2 |
| Software | Autodesk Recap 360 |
| Help | “Coordinates.wmv” or ask an assistant |
| Jump On | No jump on |

**Time Left :**

ReCap

Secure | https://recap360.autodesk.com

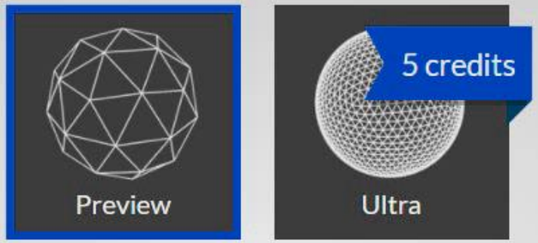
AUTODESK® RECAP®

Robert

new project name

## quality

choose the quality of the mesh you want to create




## smart cropping off

crop out unnecessary graphics behind the camera positions

## nadir optimization off

enable this with nadir photography for advanced optimization
add a geographical reference (EXIF GPS data) for further accuracy

## OBJ,RCM format

select the file formats you would like to output

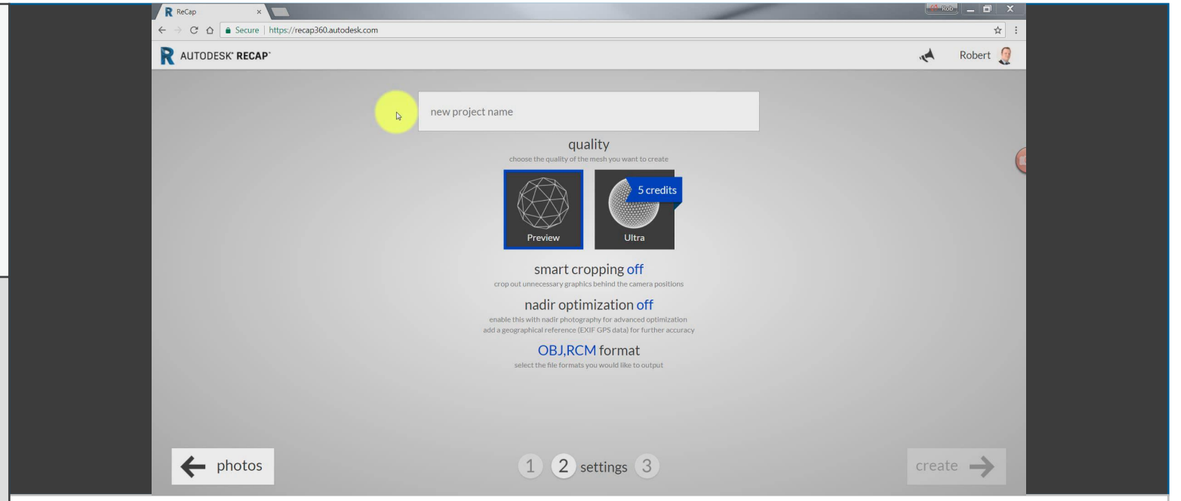
photos

1 2 settings 3

create

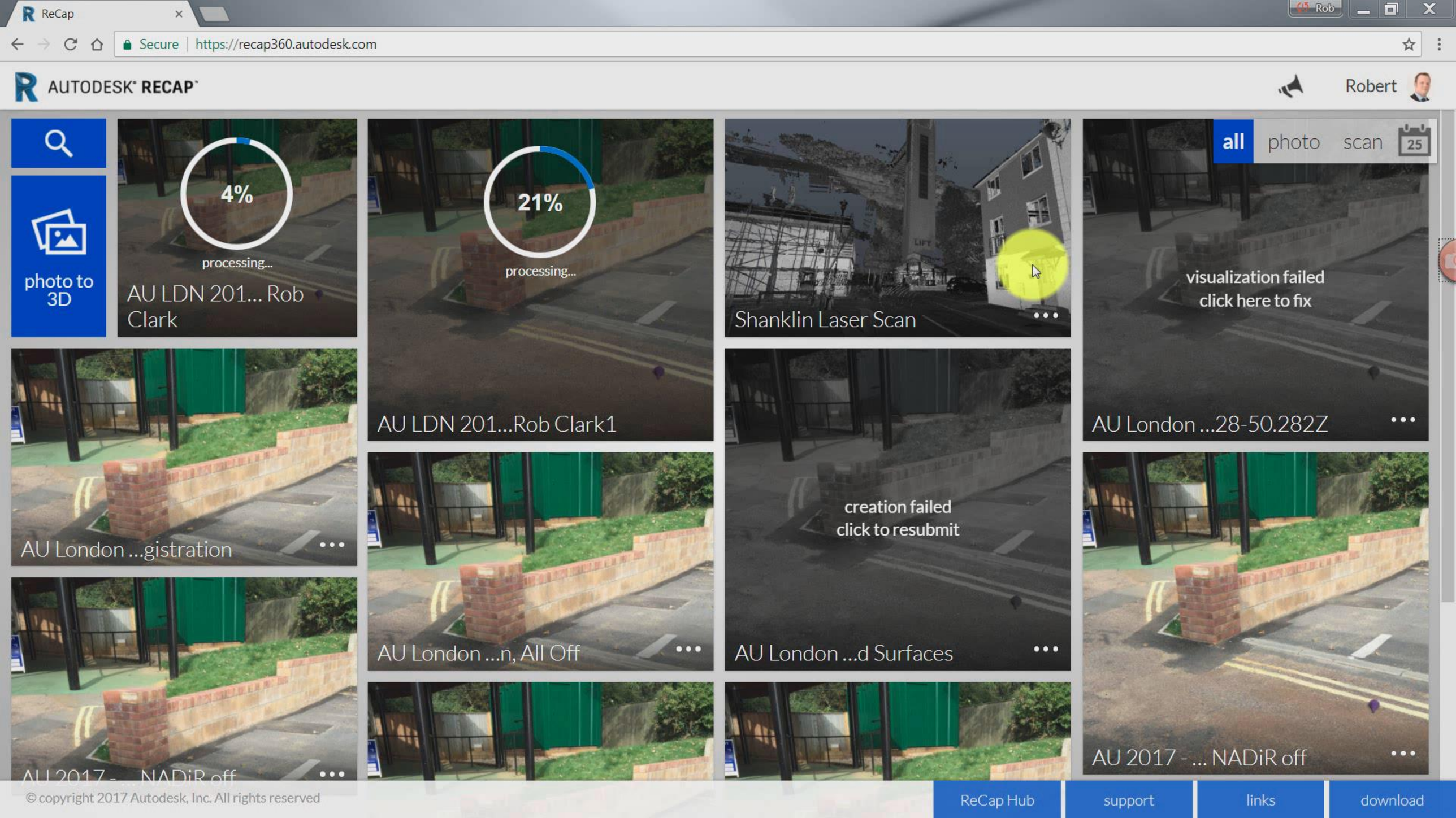
# *Submit the model*

1. Enter the project name as “AU LDN 2017 –Brick Wall Example - *your name*”. For example, “AU LDN 2017 – Brick Wall Example – Rob Clark”
2. Select Ultra
3. Turn off Smart Cropping and Smart Texture
4. Turn on Nadir Optimisation.
5. Turn on all the available formats
6. Here we go! Click on Create



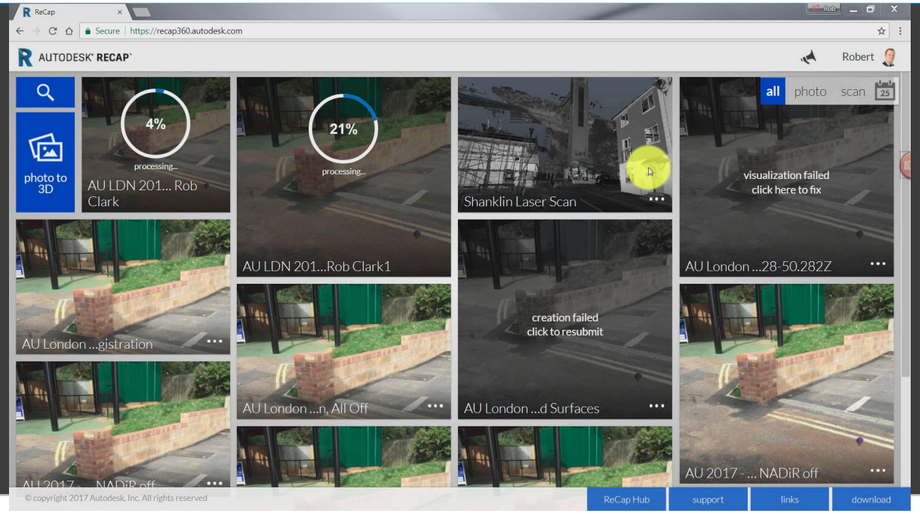

| | |
|---|---|
| Time | 2 minutes |
| Files | AU LDN Dataset 2 |
| Software | Autodesk Recap 360 |
| Help | “Submit Photo Model.wmv” or ask. |
| Jump On | No jump on |

**Time Left :**


ReCap
Secure
https://recap360.autodesk.com
AUTODESK RECAP
Robert
photo to 3D
4%
processing...
AU LDN 201... Rob Clark
21%
processing...
AU LDN 201...Rob Clark1
Shanklin Laser Scan
all
photo
scan
25
visualization failed
click here to fix
AU London ...28-50.282Z
AU London ...gistration
AU London ...n, All Off
creation failed
click to resubmit
AU London ...d Surfaces
AU 2017 - ... NADiR off
© copyright 2017 Autodesk, Inc. All rights reserved
ReCap Hub
support
links
download

# *Publish and Navigation*

1. Select AU LDN Dataset 3 - Brick Wall Capture - PreLoaded
2. Select View Downloads.  **No need to download anything**
3. Select Edit and invite friends, view the public link
4. Select Publish to Publish to the Autodesk Gallery
5. Open 3D Model to view model online




| | |
|---|---|
| Time | 4 minutes |
| Files | AU LDN Dataset 3 (on Recap 360) |
| Software | Autodesk Recap 360 |
| Help | “Recap Online - Publish and Basic Nav. |
| Jump On | AU LDN Dataset 3 - Brick Wall Capture - PreLoaded |

**Time Left :**

# Part 3 - Capturing Our Site!

# Our site – Shanklin, I.O.W.



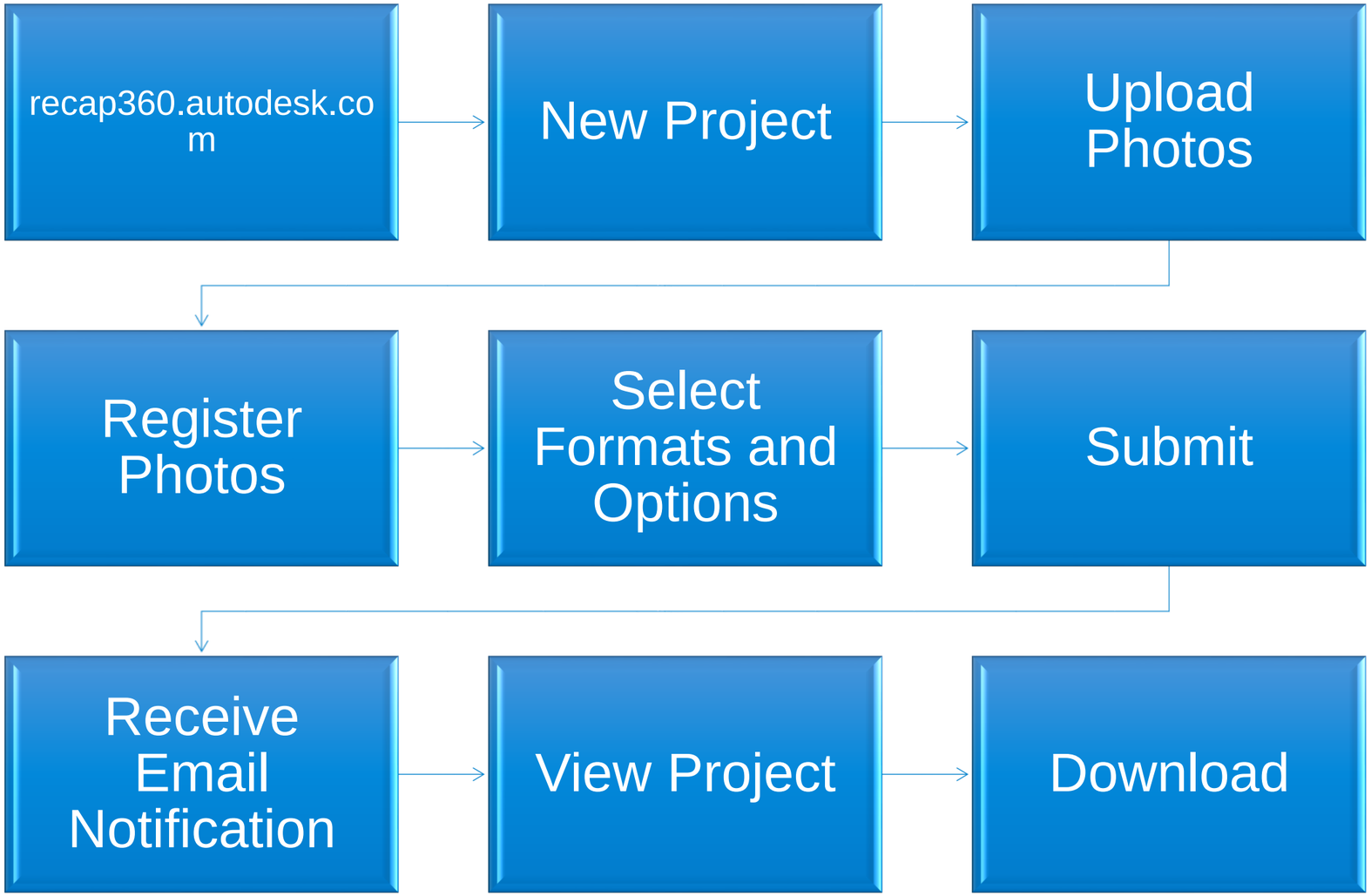
It can operate in wind speeds up to 15 meters per second, 15 m/s is about 33 miles per hour which on the Beaufort scale is a “Strong Breeze” to “Moderate Gale”.

We were on the coast and had winds ranging between 0.2 meters per second and 4.7 meters per second.

- Topcon Falcon 8 by Ascending Technologies flown by Resource Group
- Sony 7 Aplha R camera (36 mega pixel) modified for the Falcon
- V Shape – can point its camera up and down
- Its suitable for photographing spaces up to 35 hectares, or about 0.14 square miles.
  So not huge spaces

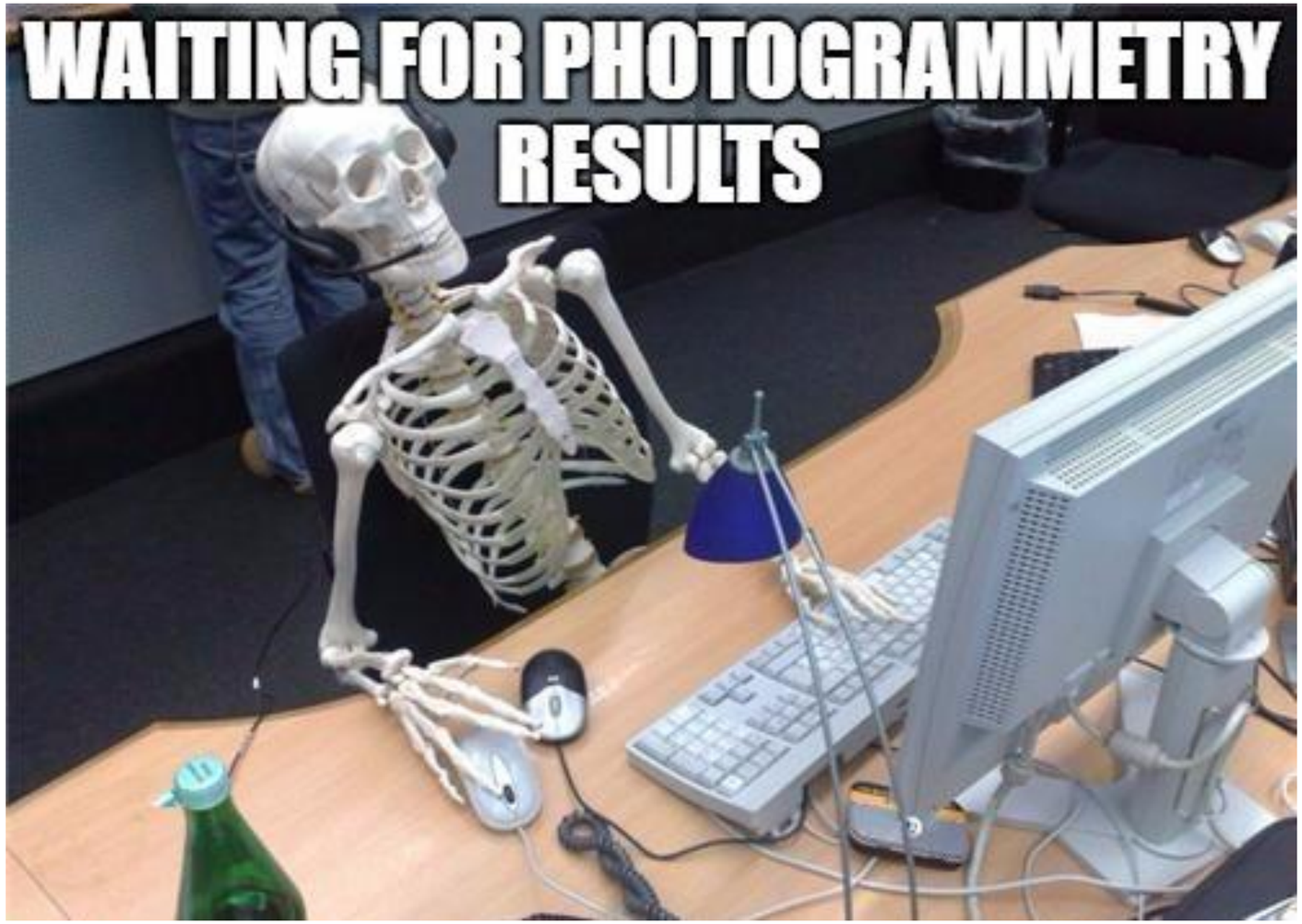
# Step 1 – Take lots of photos

# Step 2 – Set up the model




*The experiences presented here are as experienced on this project only.*
*The issues could be novice user error, temporary or to do with our hardware.*

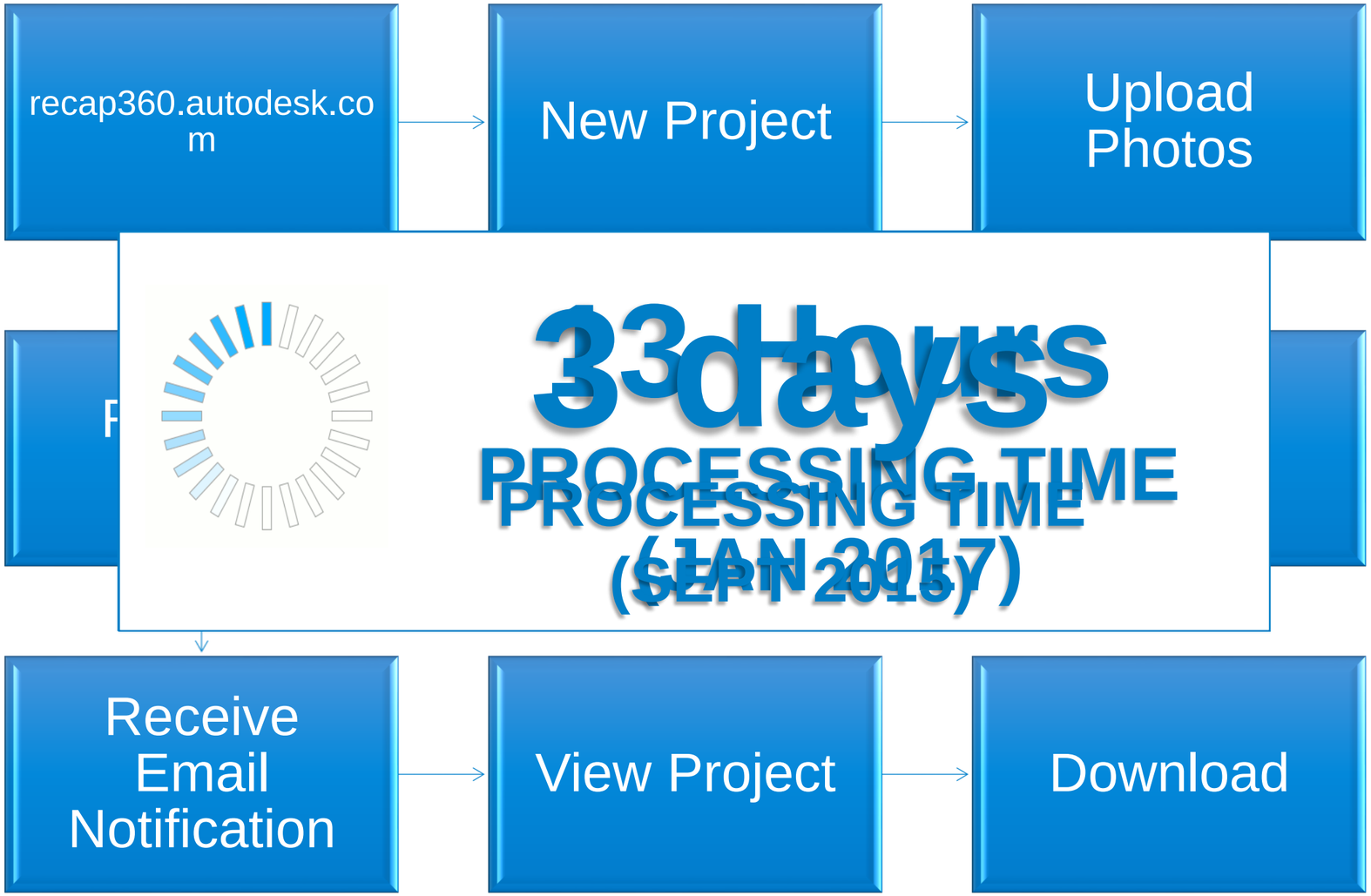
# Step 3 – Process photos





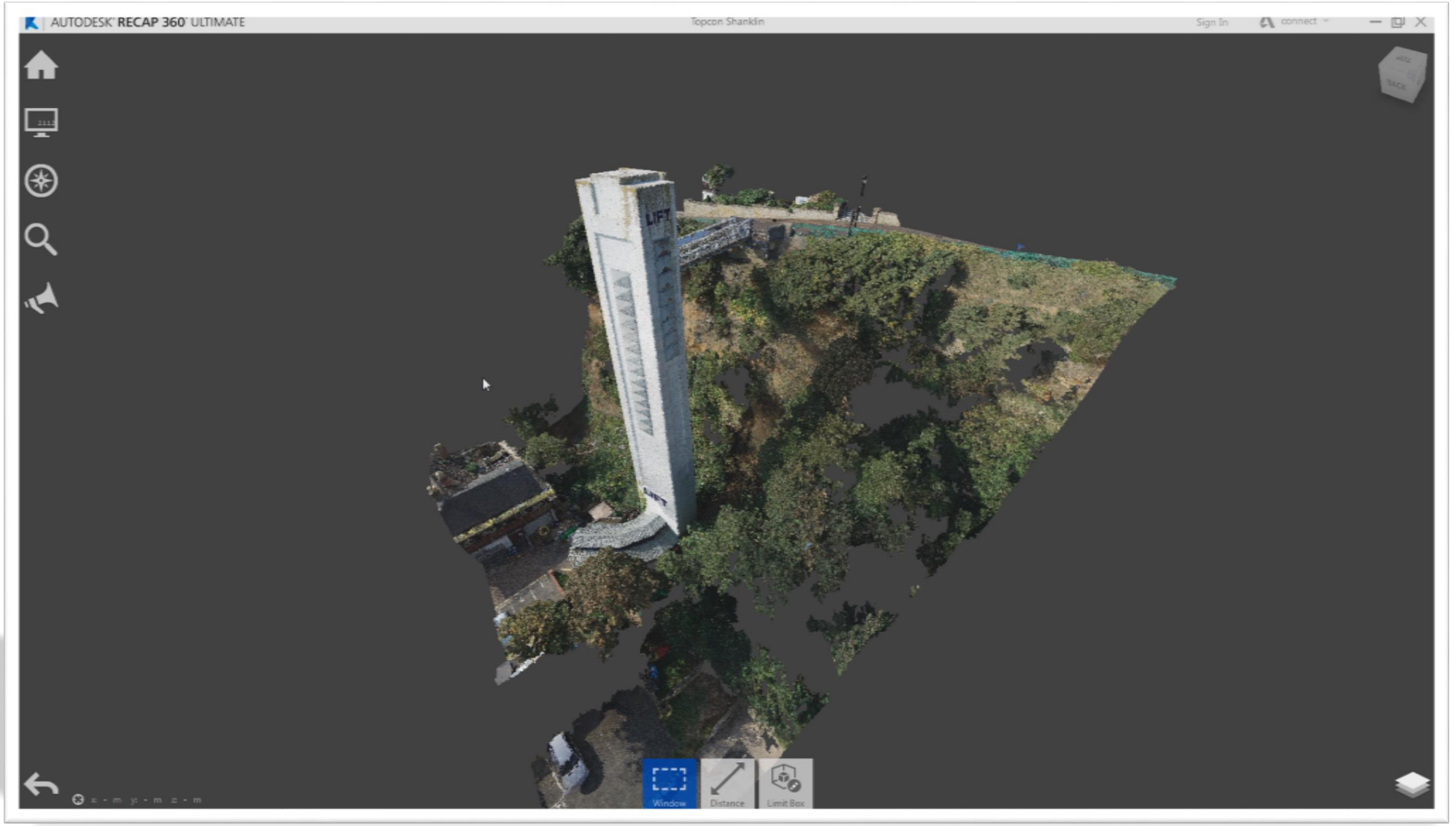
*The experiences presented here are as experienced on this project only.*
*The issues could be novice user error, temporary or to do with our hardware.*

# Autodesk Recap 360 - Process




*The experiences presented here are as experienced on this project only.*
*The issues could be novice user error, temporary or to do with our hardware.*

# The Result



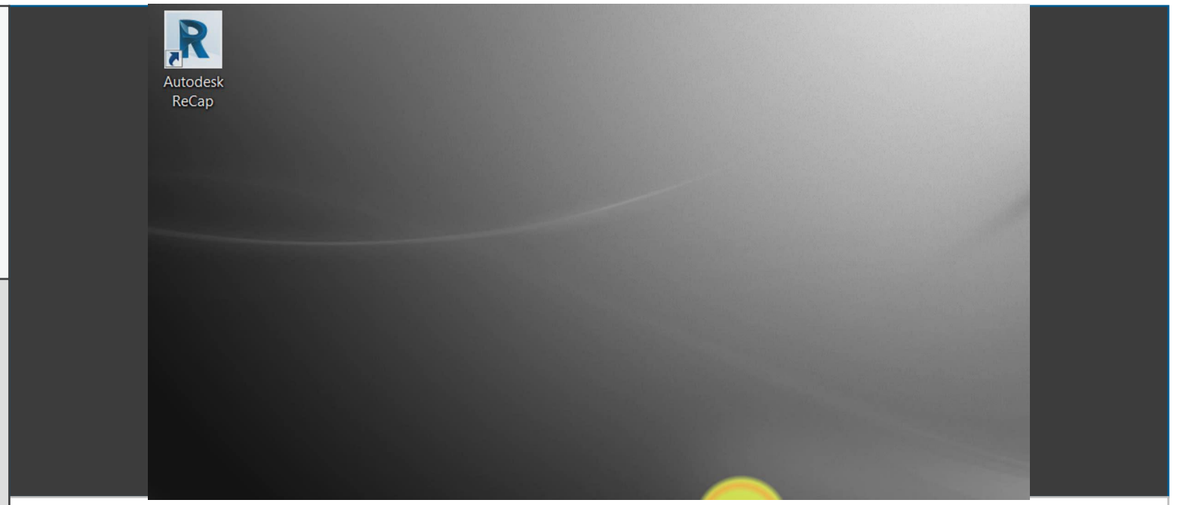

*The experiences presented here are as experienced on this project only.*
*The issues could be novice user error, temporary or to do with our hardware.*

# Part 4
# Working with the point cloud in Autodesk Recap Pro


Autodesk
ReCap

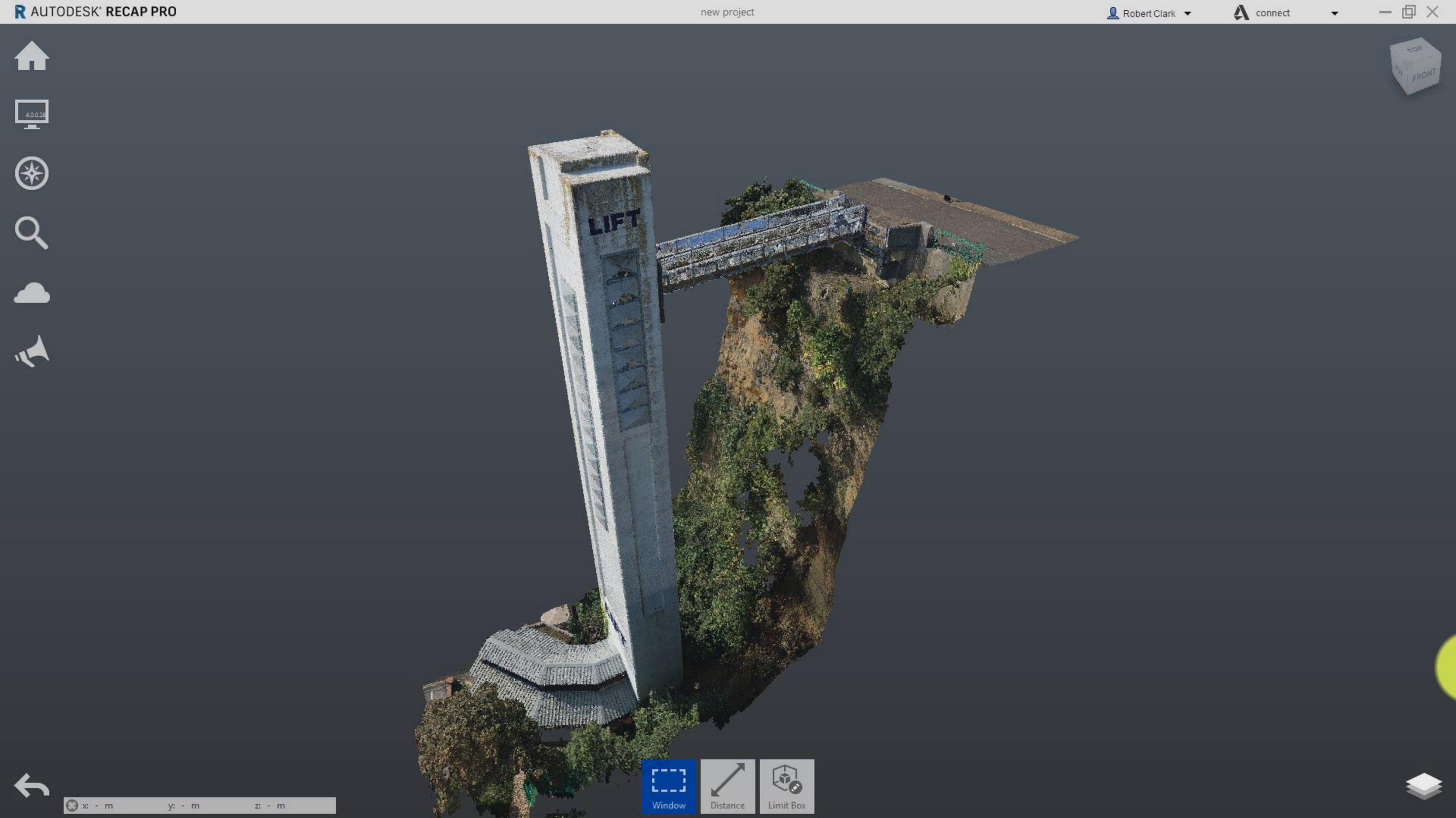
## *Open Recap and Open RCP*

1. Double click Recap on the desktop
2. Click on Open
3. Double click AU LDN Dataset 5 - Shankin Recap.rcp
4. Click on Project Navigator 
5. Choose View States to navigate the model




| | |
|---|---|
| Time | 3 minutes |
| Files | C:\Datasets\ |
| Software | Autodesk Recap Pro |
| Help | “Recap Pro Open.wmv” or ask |
| Jump On | AU LDN Dataset 5 - Shankin Recap.rcp |

**Time Left :**


AUTODESK RECAP PRO
new project
Robert Clark
connect
LIFT
TOP
FRONT
Window
Distance
Limit Box
x: - m
y: - m
z: - m

## *Recap Pro Navigation*

1. Go to the Navigation button

2. Try Window, Pan, Orbit, Look and Fly

Tips

- Click on points first to set a pivot
- Use the mouse wheel to speed up and slow down fly
- Use the View States to return to Top Iso if lost


| | |
|---|---|
| Time | 4 minutes |
| Files | C:\Datasets\ |
| Software | Autodesk Recap Pro |
| Help | “Recap Pro – Navigation.wmv” or ask |
| Jump On | AU LDN Dataset 5 - Shankin Recap.rcp |

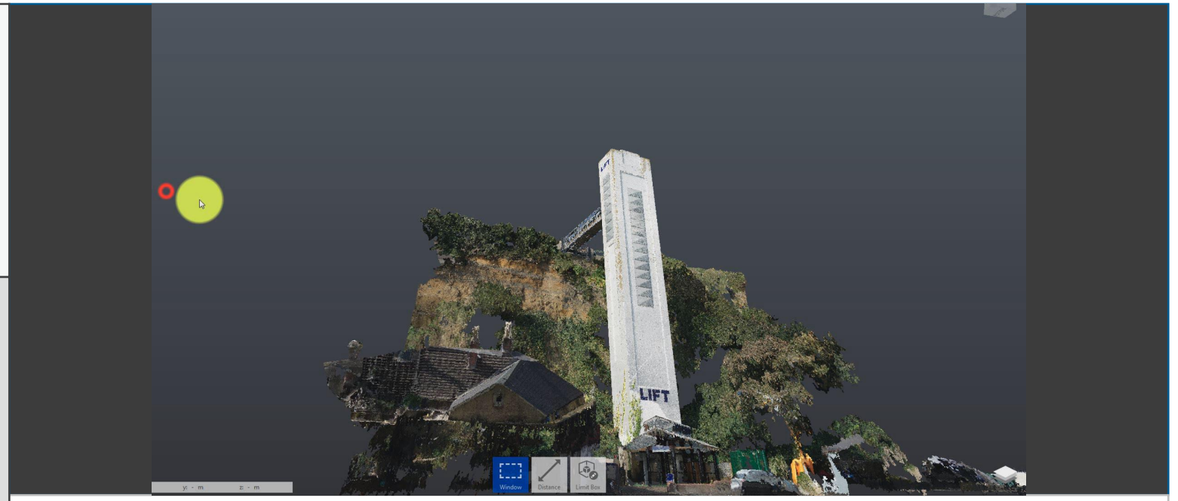
**Time Left :**


LIFT
Window
Distance
Limit Box
y: - m
z: - m

## *Recap Pro Measure*

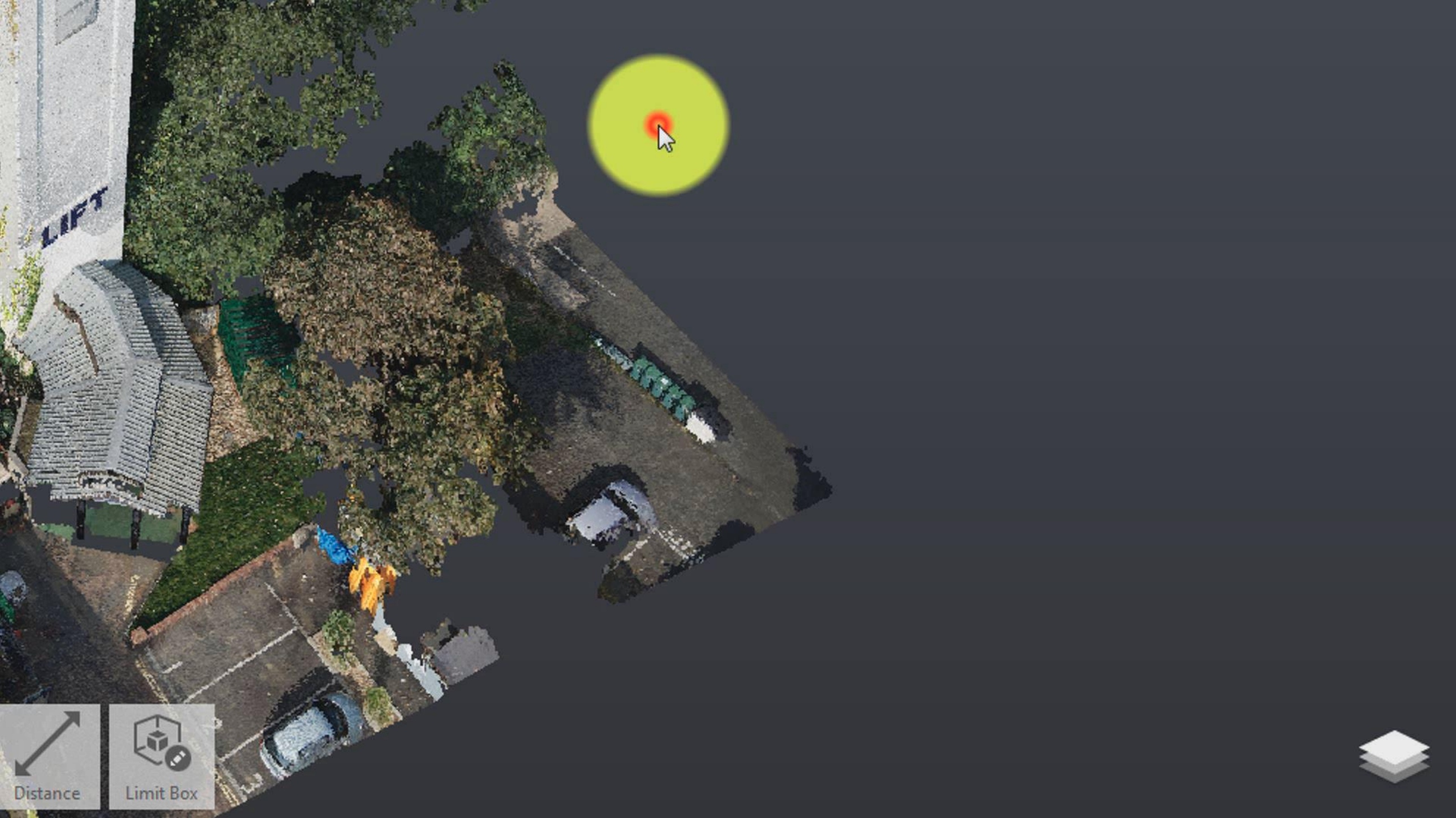
1. Click the Distance Tool 

2. Click the Ortho Tool and lock the Z axis
3. Click the surface at the top of the building
4. Click the car park surface
5. Click Distance and lock the X ortho
6. Measure across the top, adjusting the dimension nodes if necessary



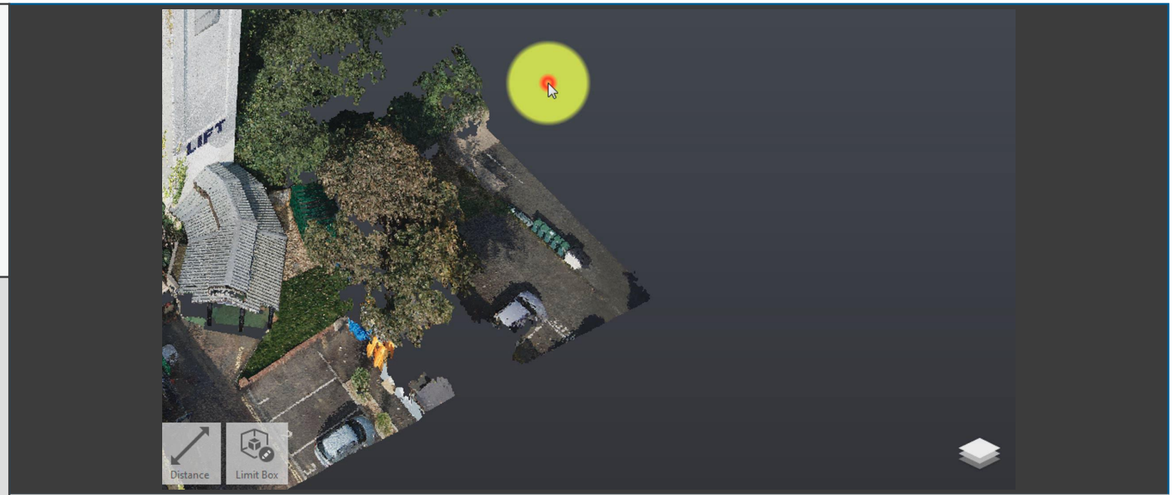

| | |
|---|---|
| Time | 3 minutes |
| Files | C:\Datasets\ |
| Software | Autodesk Recap Pro |
| Help | “Recap Pro Measure.wmv” or ask |
| Jump On | AU LDN Dataset 5 – Shanklin.rcs |

**Time Left :**


LIFT
Distance
Limit Box

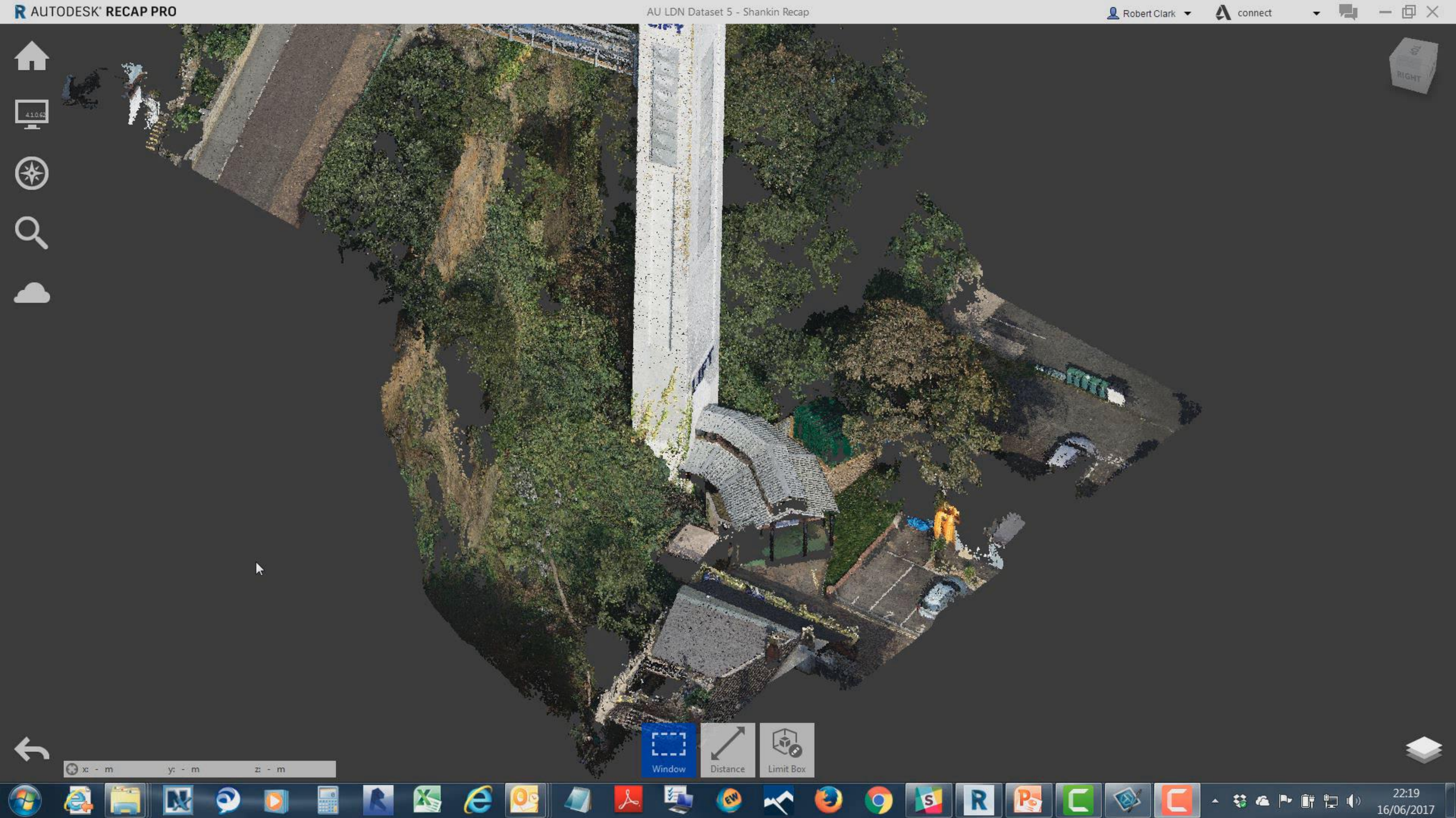
## *Recap Pro Limit Box*

1. Select Limit Box
2. Pull in the sides
3. Click confirm



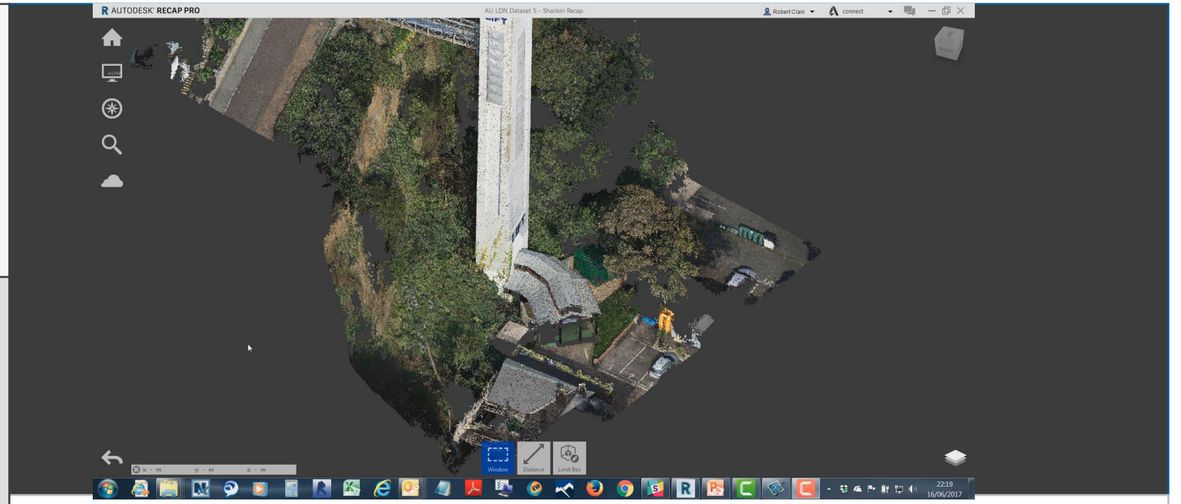

| | |
|---|---|
| Time | 2 minutes |
| Files | C:\Datasets\ |
| Software | Autodesk Recap Pro |
| Help | “Recap - Limit Box.wmv” or ask |
| Jump On | AU LDN Dataset 5 – Shanklin.rcs |

**Time Left :**


AUTODESK RECAP PRO
AU LDN Dataset 5 - Shankin Recap
Robert Clark
connect
RIGHT
Window
Distance
Limit Box
x: - m
y: - m
z: - m
22:19
16/06/2017

# *Recap Pro Regions*

1. Click on Project Navigator 
2. Expand Scan Regions
3. Click the + and call the new region, “Entrance”
4. Select Fence, draw a fence around the entrance canopy
5. Select Region and then Entrance
6. Turn off the Region in the Project Navigator


| | |
|---|---|
| Time | 3 minutes |
| Files | C:\Datasets\ |
| Software | Autodesk Recap Pro |
| Help | “Recap Pro - Regions.wmv” or ask |
| Jump On | AU LDN Dataset 5 – Shanklin.rcs |

**Time Left :**

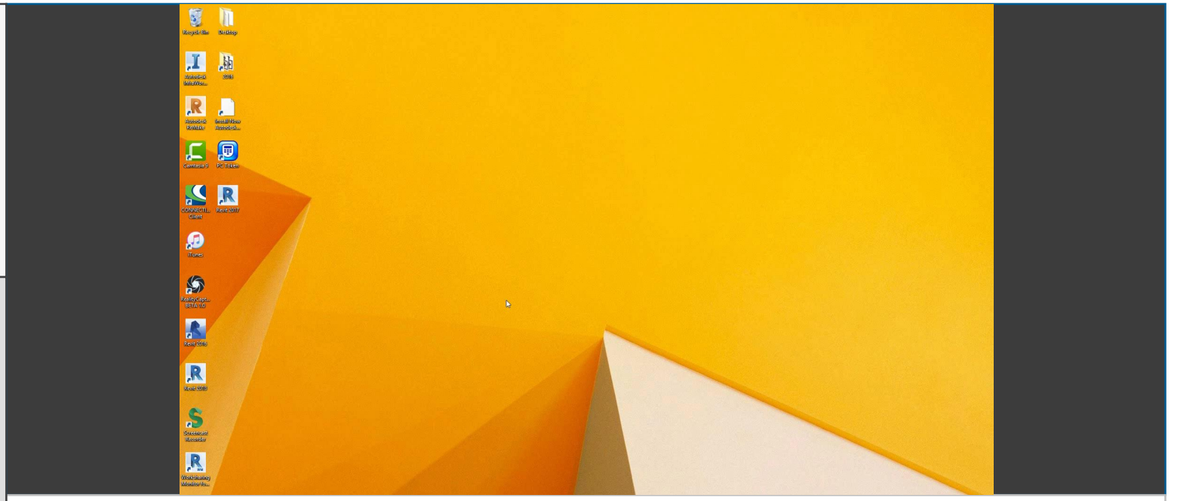
# Part 5
# Revit modelling from photogrammetry


Recycle Bin
Desktop
Autodesk InfraWor...
2016
Autodesk ReMake
Install Now Autodesk...
Camtasia 9
PC Token
CONNECTI... Client
Revit 2017
iTunes
RealityCapt... BETA 1.0
Revit 2016
Revit 2018
Screencast Recorder
Worksharing Monitor fo...

# Point Clouds inside Revit

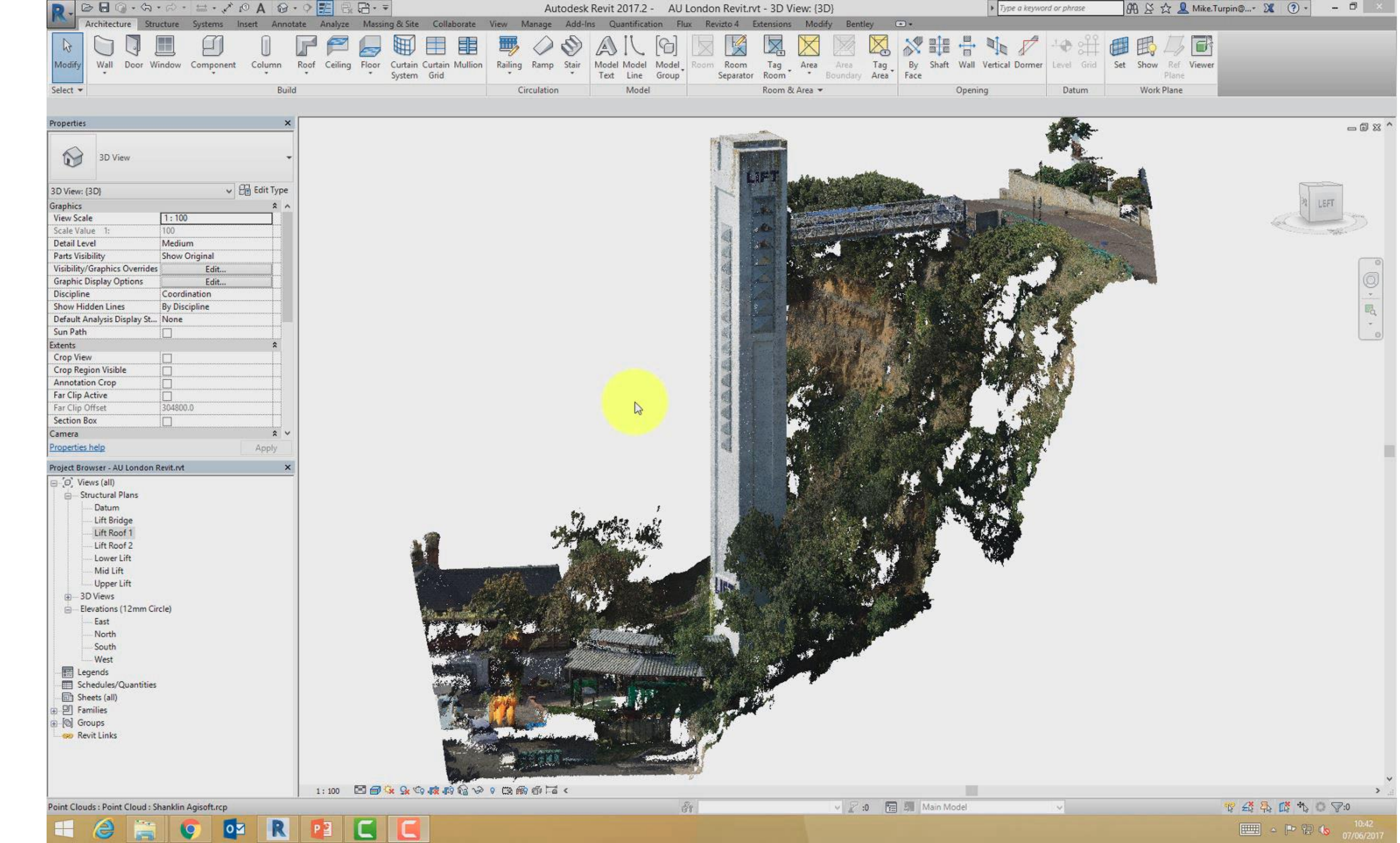
***Open Revit Dataset***

1. Open Revit 2018 software
2. Click “Open”
3. Navigate to the Datasets folder
4. Open “AU - LDN Dataset 6 -  Revit.rvt” file
5. Revit point cloud inside Revit 3D view



| | |
|---|---|
| Time | 3 minutes |
| Files | C:\Datasets |
| Software | Autodesk Revit |
| Help | “Video1.wmv” or ask an assistant |
| Jump On | AU - LDN Dataset 6 -  Revit.rvt |

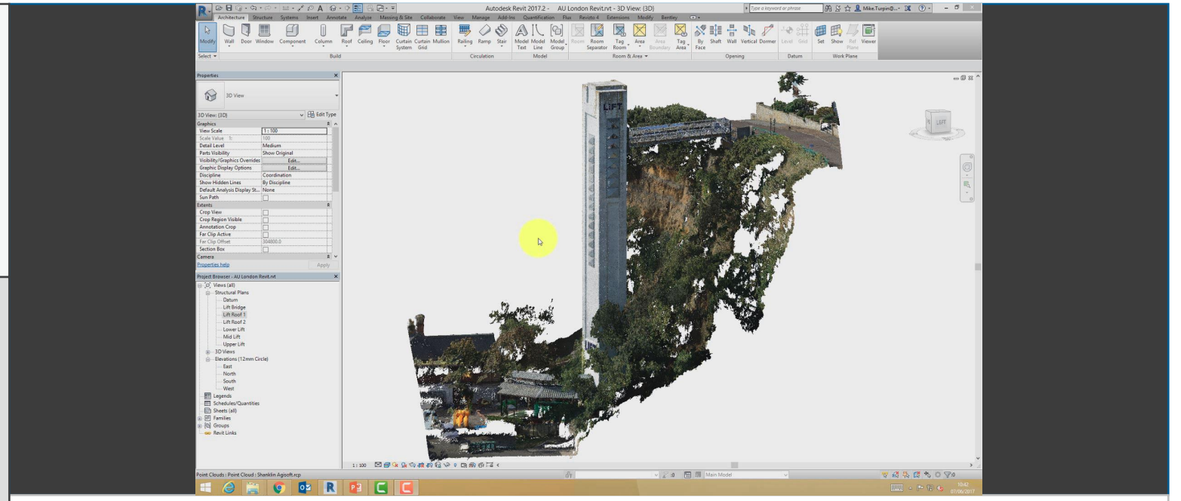
**Time Left :**


Autodesk Revit 2017.2 - AU London Revit.rvt - 3D View: {3D}
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Quantification
Flux
Revizto 4
Extensions
Modify
Bentley
Modify
Wall
Door
Window
Component
Column
Roof
Ceiling
Floor
Curtain System
Curtain Grid
Mullion
Railing
Ramp
Stair
Model Text
Model Line
Model Group
Room
Room Separator
Tag Room
Area
Area Boundary
Tag Area
By Face
Shaft
Wall
Vertical
Dormer
Level
Grid
Set
Show
Ref Plane
Viewer
Select
Build
Circulation
Model
Room & Area
Opening
Datum
Work Plane
Properties
3D View
3D View: {3D}
Edit Type
Graphics
View Scale
1 : 100
Scale Value 1:
100
Detail Level
Medium
Parts Visibility
Show Original
Visibility/Graphics Overrides
Edit...
Graphic Display Options
Edit...
Discipline
Coordination
Show Hidden Lines
By Discipline
Default Analysis Display St...
None
Sun Path
Extents
Crop View
Crop Region Visible
Annotation Crop
Far Clip Active
Far Clip Offset
304800.0
Section Box
Camera
Properties help
Apply
Project Browser - AU London Revit.rvt
Views (all)
Structural Plans
Datum
Lift Bridge
Lift Roof 1
Lift Roof 2
Lower Lift
Mid Lift
Upper Lift
3D Views
Elevations (12mm Circle)
East
North
South
West
Legends
Schedules/Quantities
Sheets (all)
Families
Groups
Revit Links
LIFT
LEFT
1 : 100
Point Clouds : Point Cloud : Shanklin Agisoft.rcp
Main Model
10:42
07/06/2017

# Modelling to Point Clouds

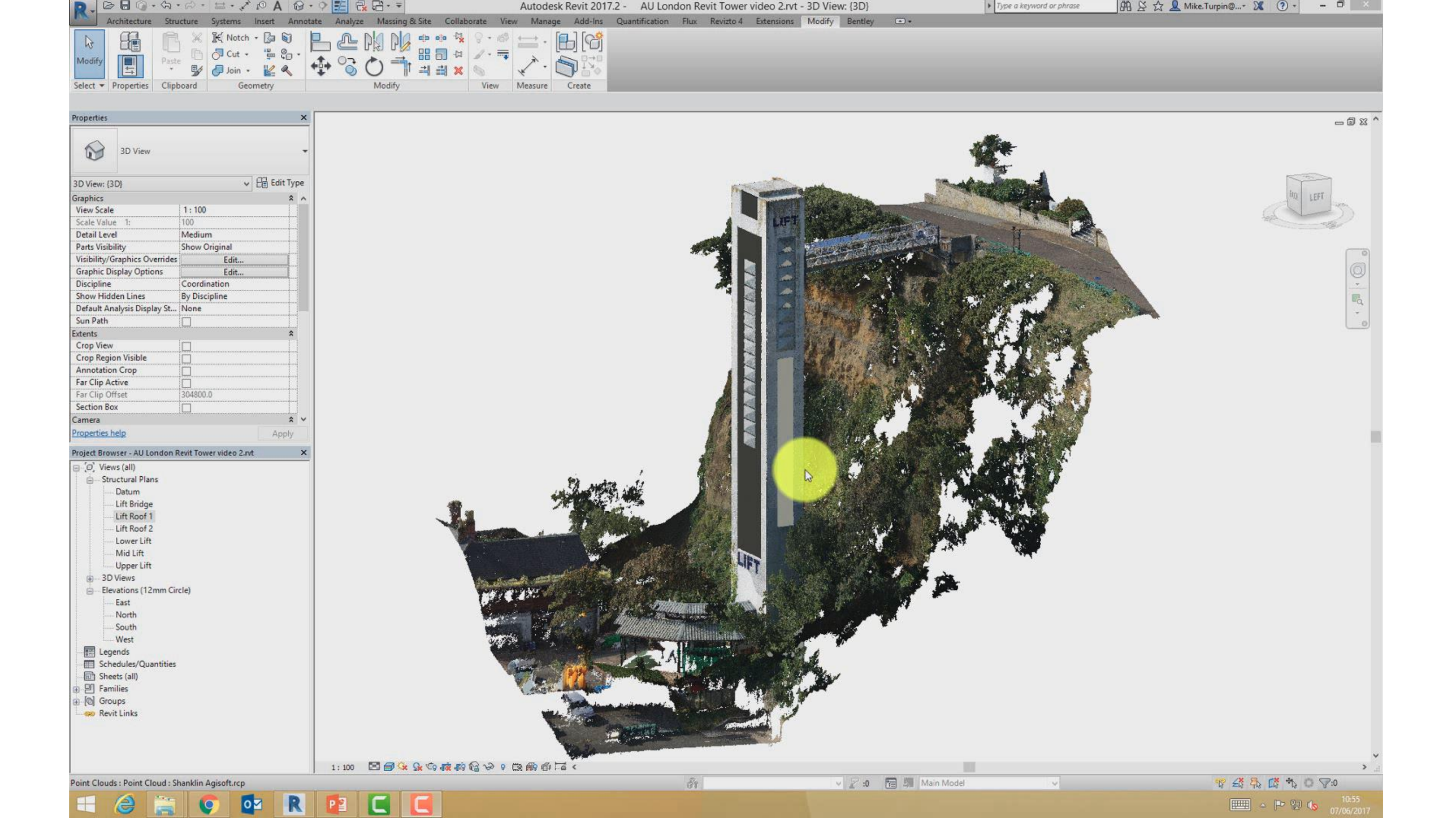
***Model lift walls***

1. Open “North” Elevation view to review levels
2. Open “Mid Lift” Floor Plan
3. Using the “Wall” tool model the 4 walls between the “Datum” Level and “Lift Roof 1” Level
4. Check wall in other floor plans, modify position using the arrow keys if needed
5. In “Lift Roof 2” Level model the lift roof using the “Roof” tool



| | |
|---|---|
| Time | 4 minutes |
| Files | C:\Datasets\ |
| Software | Autodesk Revit |
| Help | “Video2.wmv” or ask an assistant |
| Jump On | AU LDN Dataset 6 Jumpon 1 Revit.rvt |

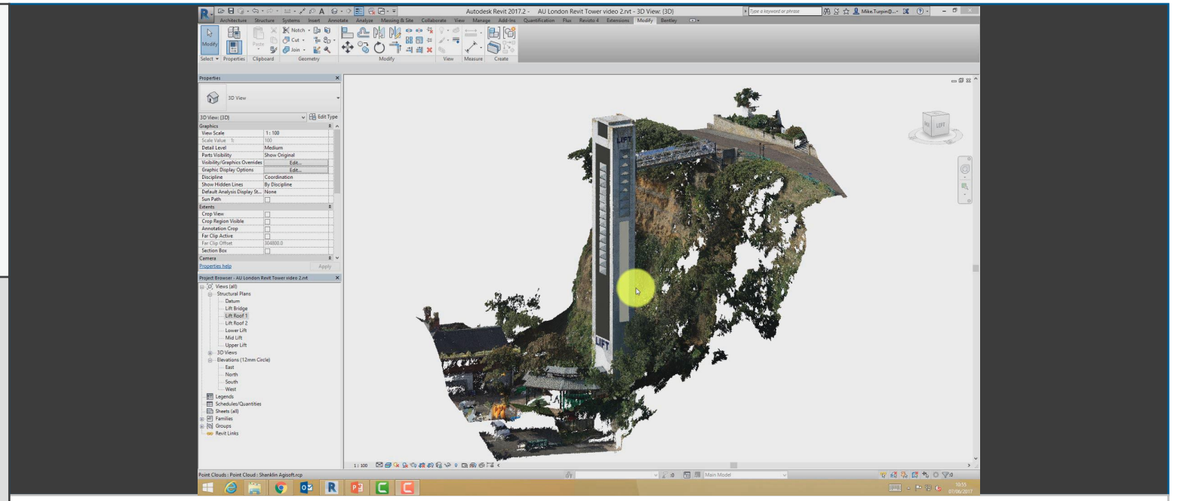
**Time Left :**


Autodesk Revit 2017.2 - AU London Revit Tower video 2.rvt - 3D View: {3D}
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Quantification
Flux
Revizto 4
Extensions
Modify
Bentley
Modify
Select
Properties
Clipboard
Geometry
Notch
Cut
Join
Paste
Modify
View
Measure
Create
Properties
3D View
3D View: {3D}
Edit Type
Graphics
View Scale 1 : 100
Scale Value 1: 100
Detail Level Medium
Parts Visibility Show Original
Visibility/Graphics Overrides Edit...
Graphic Display Options Edit...
Discipline Coordination
Show Hidden Lines By Discipline
Default Analysis Display St... None
Sun Path
Extents
Crop View
Crop Region Visible
Annotation Crop
Far Clip Active
Far Clip Offset 304800.0
Section Box
Camera
Properties help
Apply
Project Browser - AU London Revit Tower video 2.rvt
Views (all)
Structural Plans
Datum
Lift Bridge
Lift Roof 1
Lift Roof 2
Lower Lift
Mid Lift
Upper Lift
3D Views
Elevations (12mm Circle)
East
North
South
West
Legends
Schedules/Quantities
Sheets (all)
Families
Groups
Revit Links
LIFT
LIFT
LEFT
1 : 100
Point Clouds : Point Cloud : Shanklin Agisoft.rcp
Main Model
10:55
07/06/2017

# Controlling Point cloud Visibility

***Turn off lift points & modify bridge points***

1. Open default 3D view
2. In the view properties open “Visibility/Graphic Overrides” (Keyboard Shortcut “VV” or “VG”)
3. Select the “Point Clouds” tab then expand the tree (+)
4. Under “Scan Regions” un-tick the Tower region and override the colour of the Bridge region
   Click “OK” and you should now be able to navigate the model showing the Revit lift instead of the points

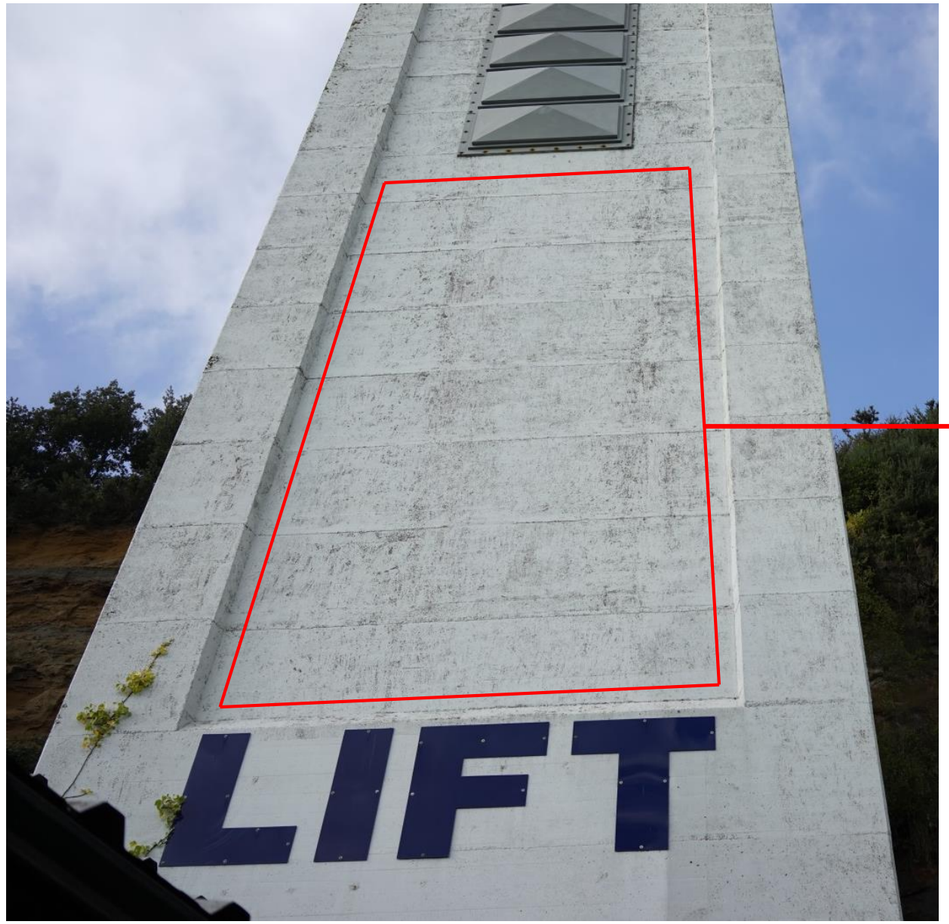


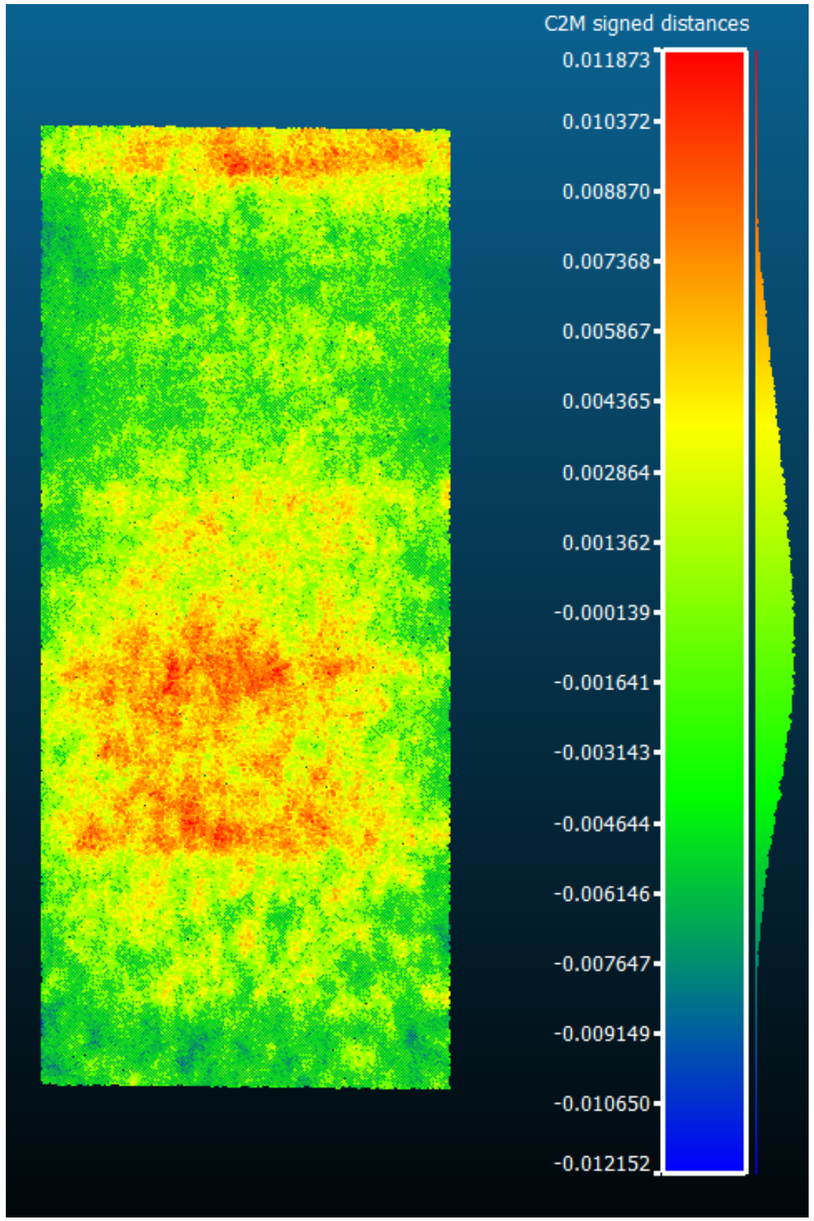
| | |
|---|---|
| Time | 2 minutes |
| Files | C:\Datasets\ |
| Software | Autodesk Revit |
| Help | “Video3.wmv” or ask an assistant |
| Jump On | AU LDN Dataset 6 Jumpon 2 Revit.rvt |

**Time Left :**

# Part 7
# Tips and Tricks and Lessons Learnt

# So what about accuracy?




±12mm (95% points within ±7mm)

*The experiences presented here are as experienced on this project only.*
*The issues could be novice user error, temporary or to do with our hardware.*

# Site Access

Visit
www.skyfleetmodels.com

If in doubt Consult an expert!

## Article 95 - small unmanned surveillance aircraft

(1) The person in charge of a small unmanned surveillance aircraft must not fly the aircraft in any of the circumstances described in paragraph (2) except in accordance with a permission issued by the CAA.

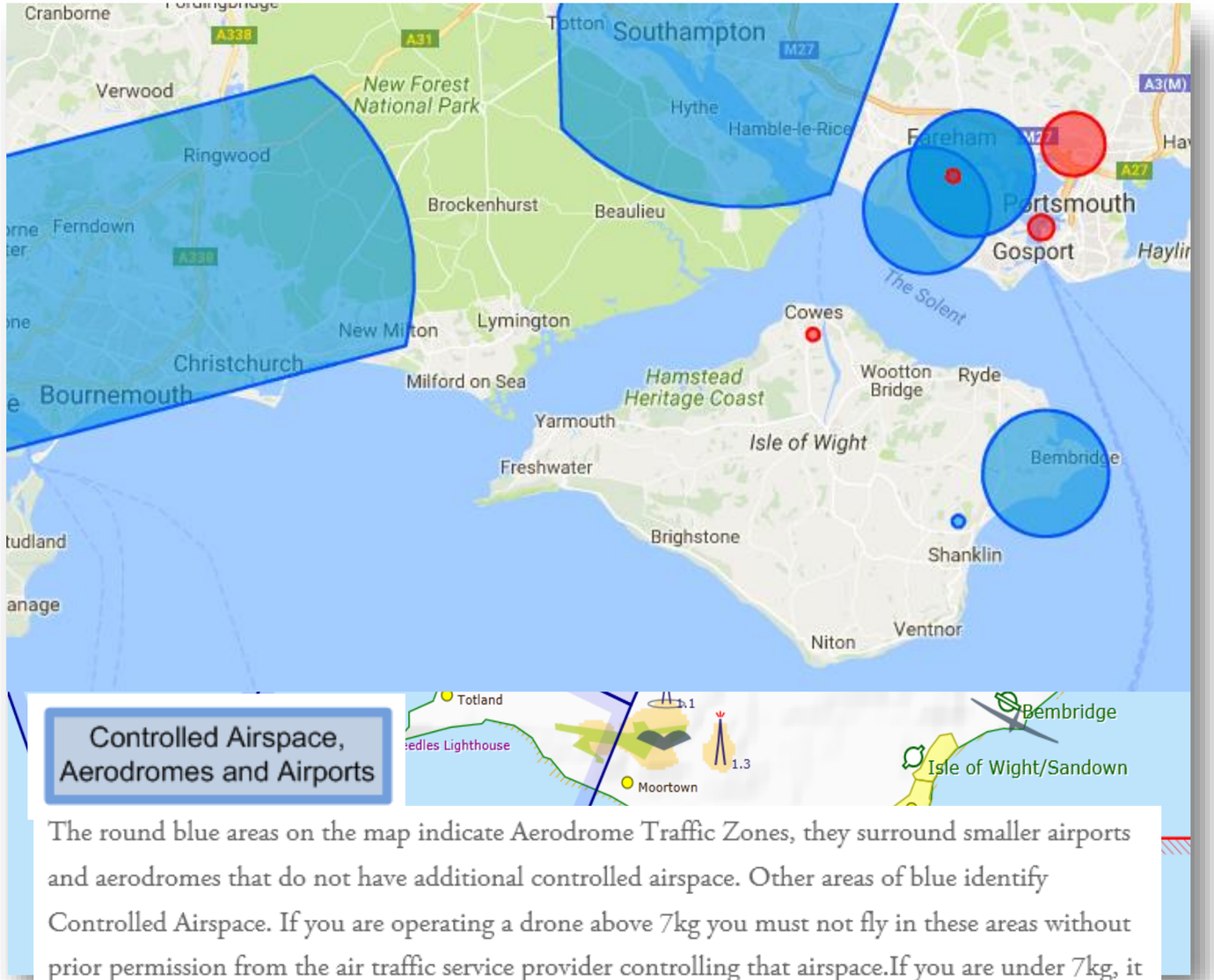
(2) The circumstances referred to in paragraph (1) are:

(a) over or within 150 metres of any congested area;

(b) over or within 150 metres of an organised open-air assembly of more than 1,000 persons;

(c) within 50 metres of any vessel, vehicle or structure which is not under the control of the person in charge of the aircraft;
or
(d) subject to paragraphs (3) and (4), within 50 metres of any person.

(3) Subject to paragraph (4), during take-off or landing, a small unmanned surveillance aircraft must not be flown within 30 metres of any person.




The round blue areas on the map indicate Aerodrome Traffic Zones, they surround smaller airports and aerodromes that do not have additional controlled airspace. Other areas of blue identify Controlled Airspace. If you are operating a drone above 7kg you must not fly in these areas without prior permission from the air traffic service provider controlling that airspace.If you are under 7kg, it is still strongly advised to notify the air traffic service provider of your activity.

# Photogrammetry Tips and Tricks

1. For UAV. Check no fly zones and know the regulations.  Use fully licenced operators.
2. Add markers on site of known measurements.
3. Ensure photos that are taken are a good quality with consistent lighting and in focus.
4. Avoid vibration, shiny or very thin objects, or featureless texture or patterns.
5. Use fast shutter speeds and avoid movement.
6. Aim for minimum 50% overlap, go for 80%, with photos no more than 10 degrees apart.
7. Capture every angle, but try not to repeat photos.  Be systematic, read up on methods.

# Autodesk Recap Tips and Tricks

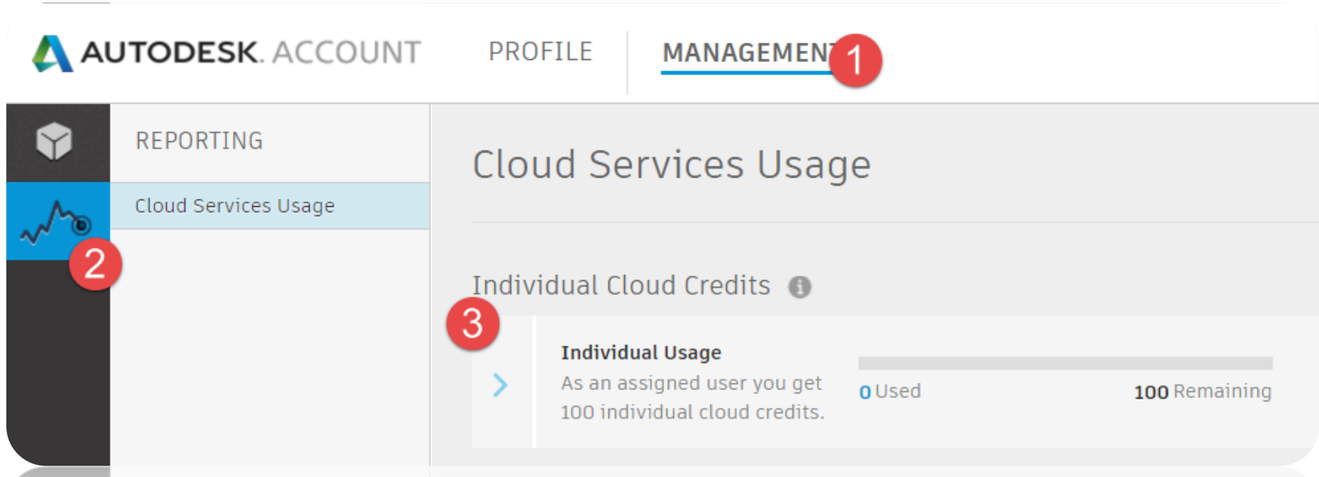
1. Know software limits, like maximum photos. Recap 360 currently has a 250 limit.  Autodesk Remake does not have this limit, but it needs to be processed on very high spec machine.
2. Scale the capture.  Don’t use corners, use inside of surface measurements.
3. Use NADIR if it is available.  It helps with orientation and positioning by using GPS, but scale can still be incorrect.
4. Smart Cropping and Smart Texture, worth trying, but our experience is not great
5. Expect long processing times.  Schedule accordingly.

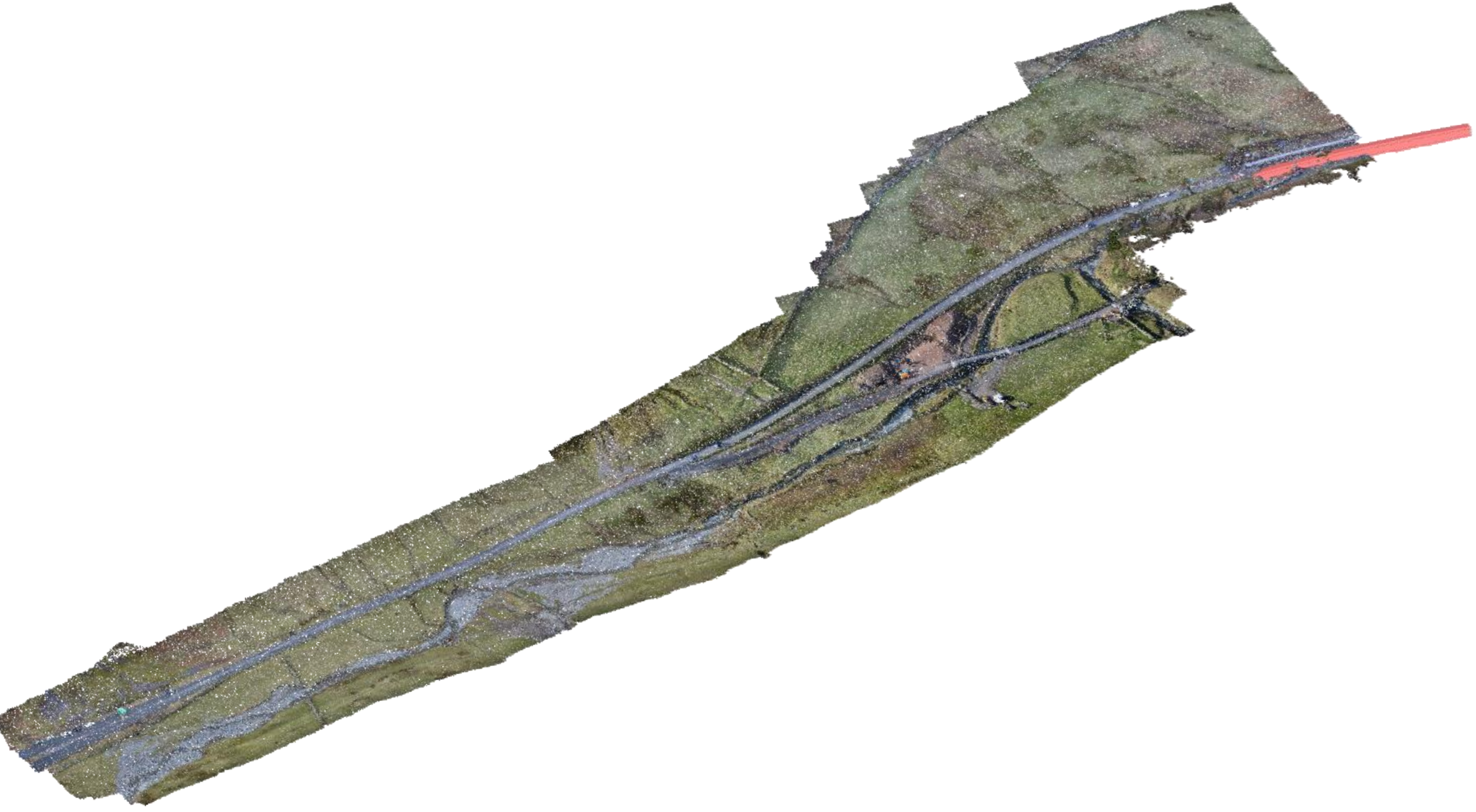
# Account Administration

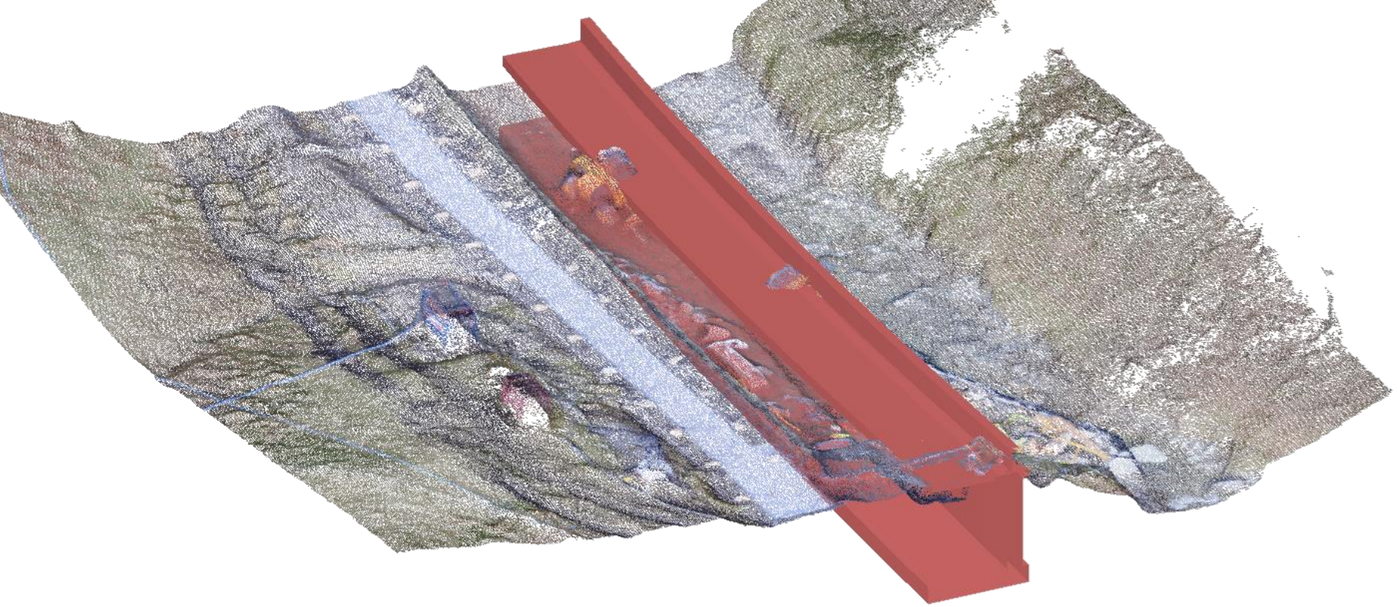
- Autodesk Recap 360 “Ultra” photogrammetry processing costs 5 individual cloud credits.  Most people get 100 credits.

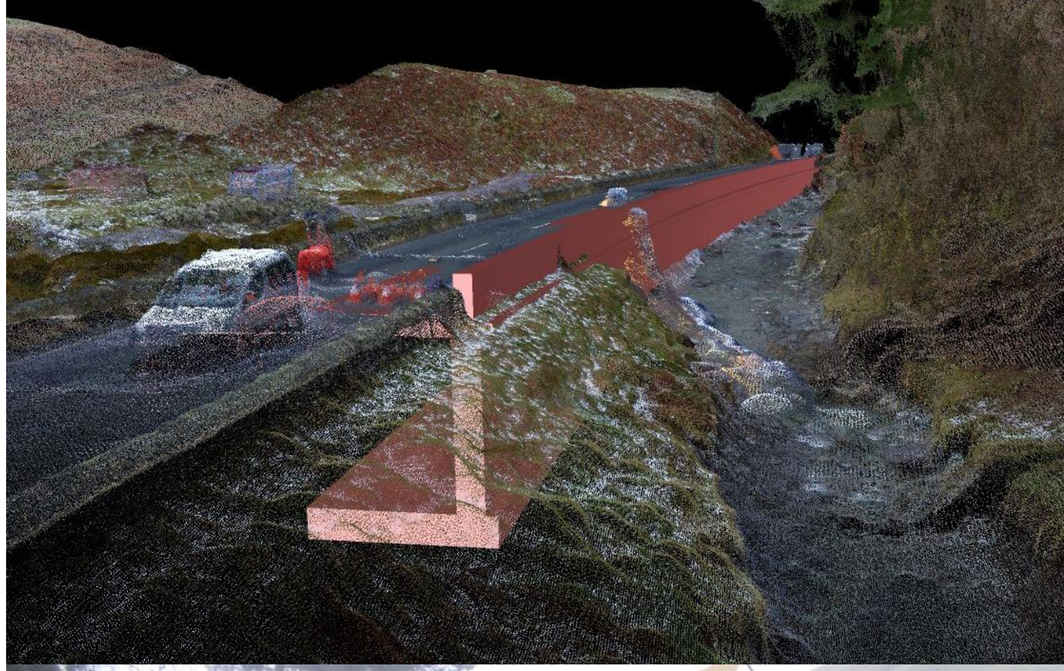
- Resubmits do not cost extra credits, even if you change settings.

- To check your credits, do the following;
  - Go to manage.autodesk.com
  - Click on Management
  - Click on Reporting

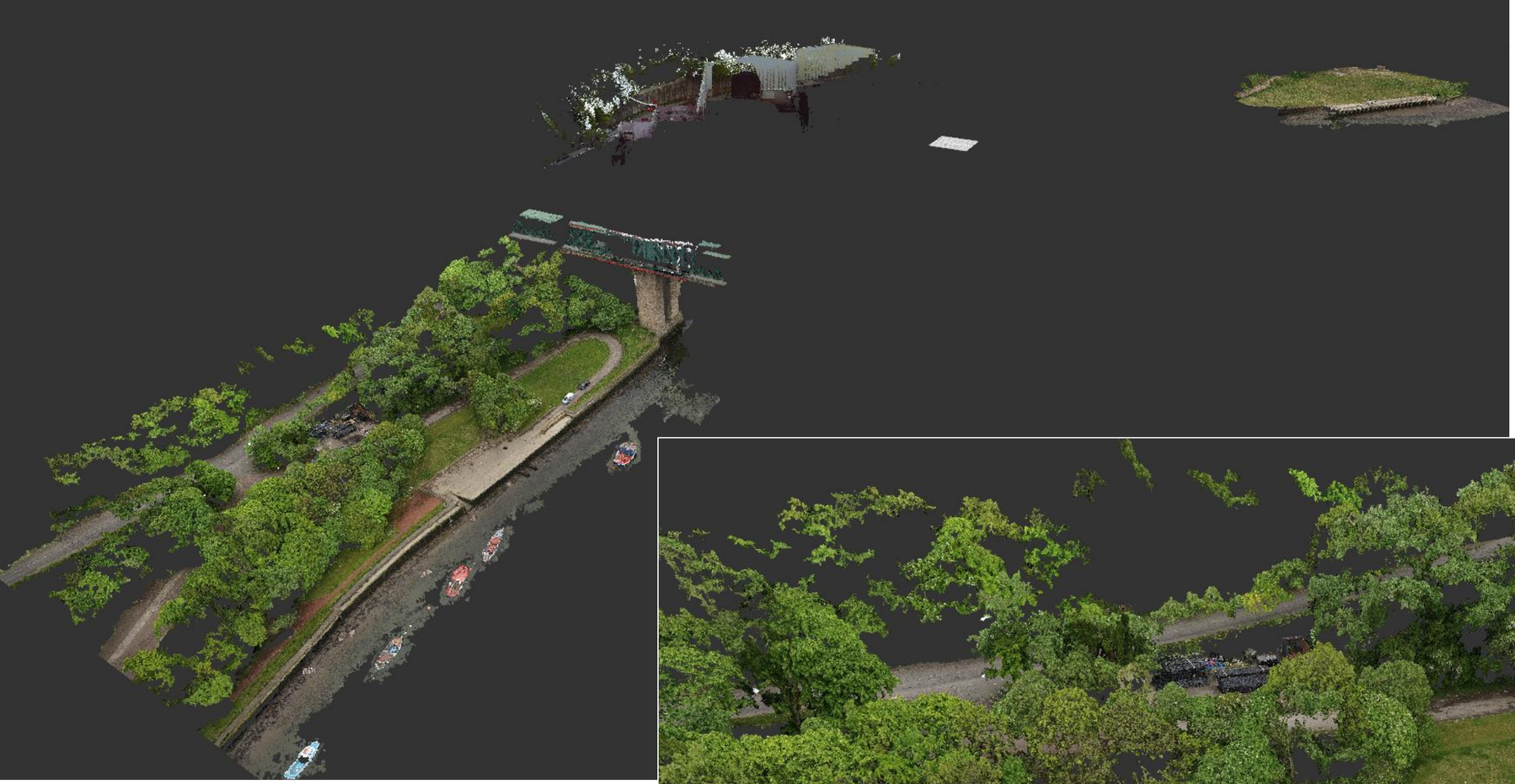


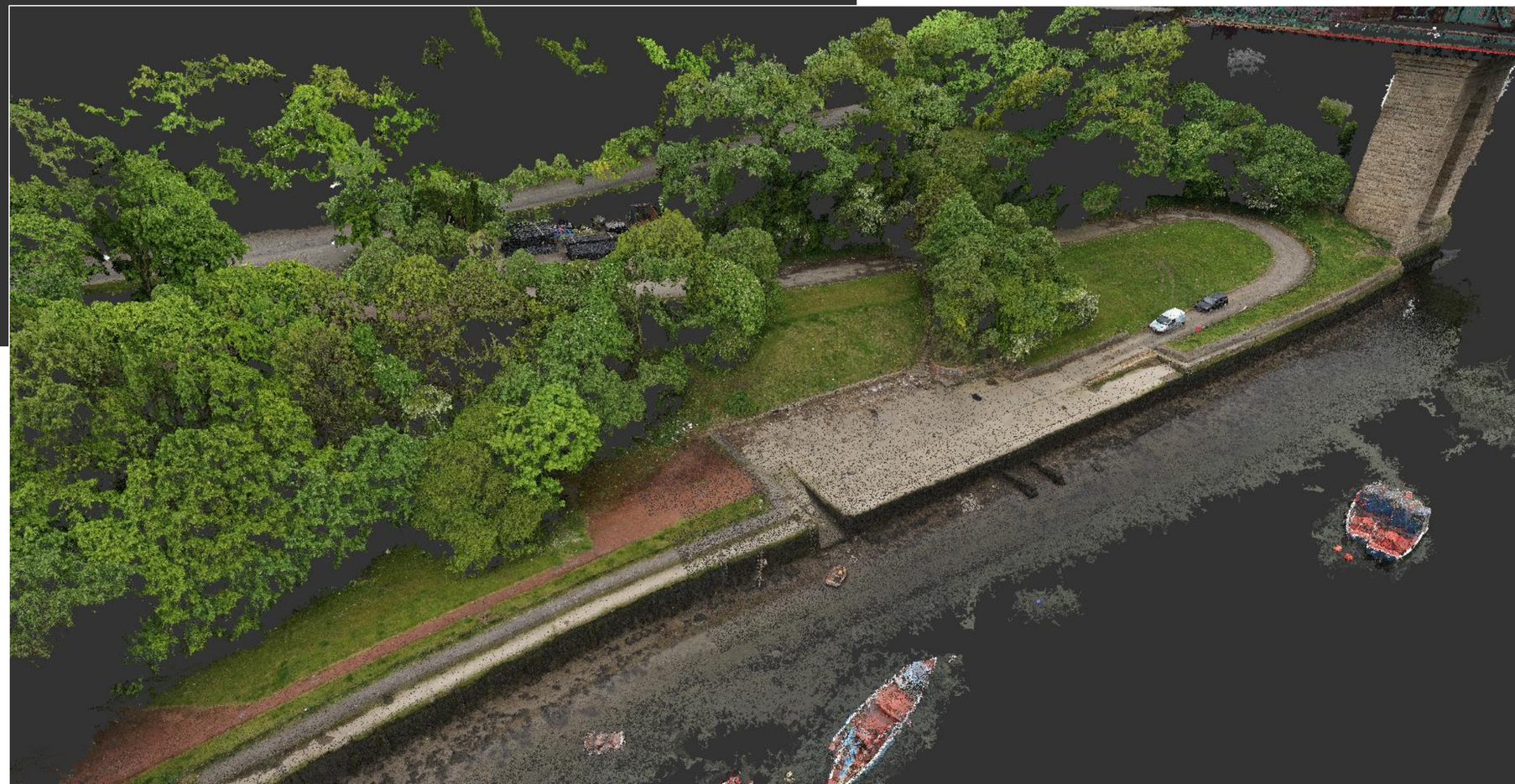







CUBBY





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