
Bentley Institute
The Year in
YII
INFRASTRUCTURE
2019 Conference
Advancing BIM through Digital Twins
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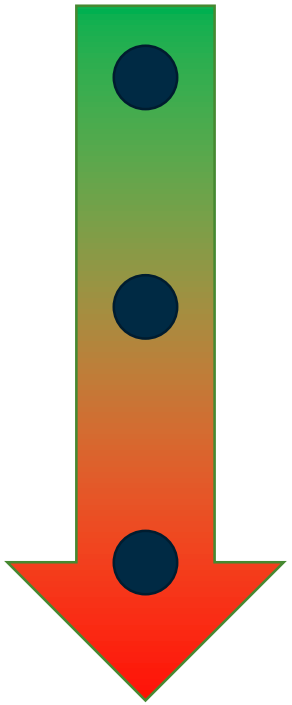
Master the Art of Complex and Challenging Reality Data Acquisitions

Arnaud Durante, Product Manager, iTwin Services - Reality Modeling

ContextCapture

ContextCapture technology and input data



High quality acquisition

- High degree of automation
- Quality results

Low quality acquisition

- Extensive manual work to make it successful
- Final result of lower quality

Poor acquisition

- Processing fails

To reduce costs and risks take care during the data acquisition phase

- ContextCapture technology is **robust** when data acquisition is **thorough.**
- Complex sites increase the risk of failure as data acquisition automation and systemization is difficult.
- Mitigate risks with correct project management.

Terrestrial scale project

Stage 1: Mission planning

- Is the site accessible?
- What are its rough dimensions?
- What is my exact area of interest?
- What would be the right camera choice?

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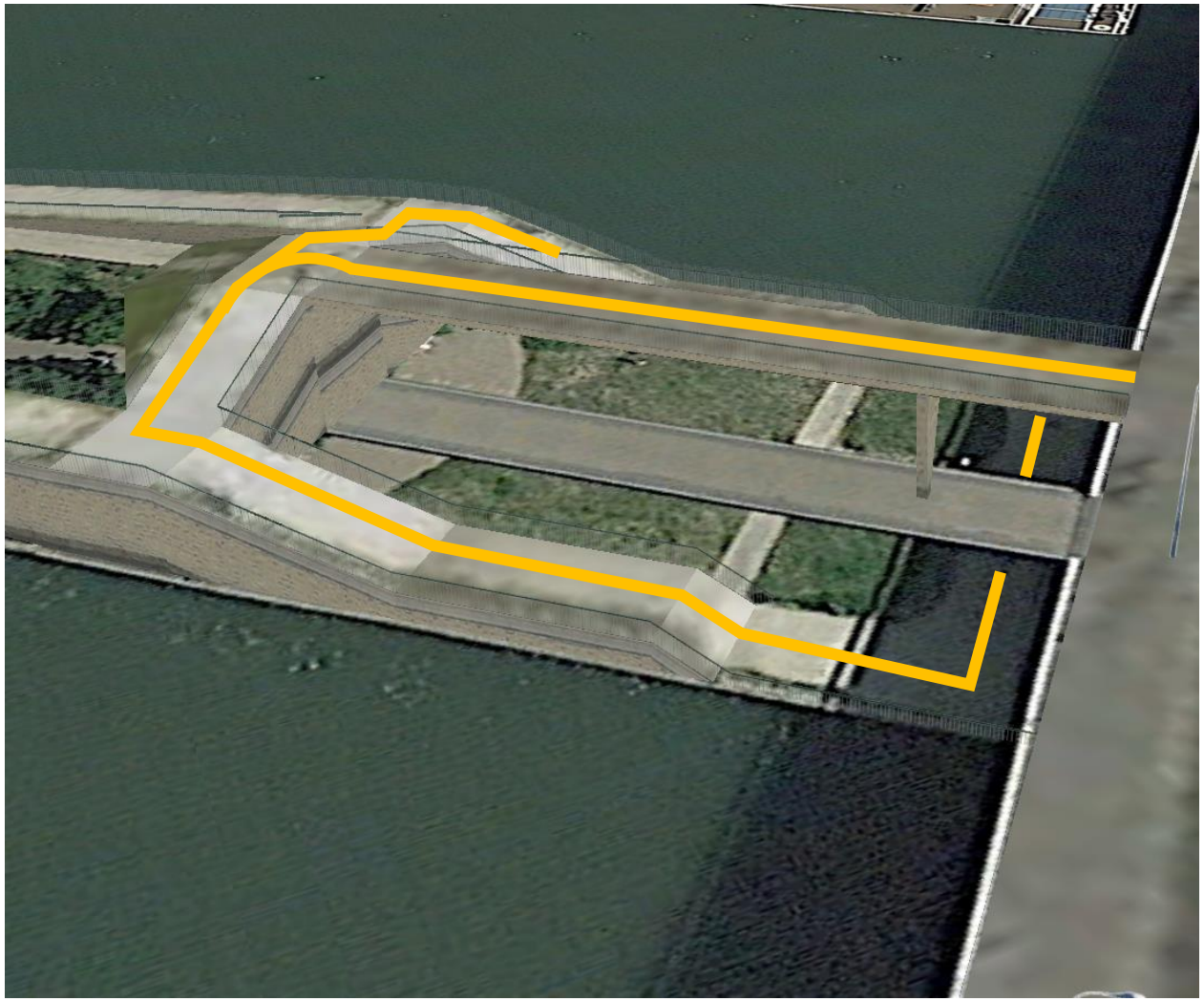
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image IBCAO

Google Earth

Terrestrial scale project

Stage 1: Mission planning

- Site will be accessible from north and free of vehicles
- The site is around 1200sqm and the central part is key
- An estimation of 500-800 images will be required to achieve the mission
- Structure seems high but we should not face backspace issues



Terrestrial scale project

Stage 2: On-site review

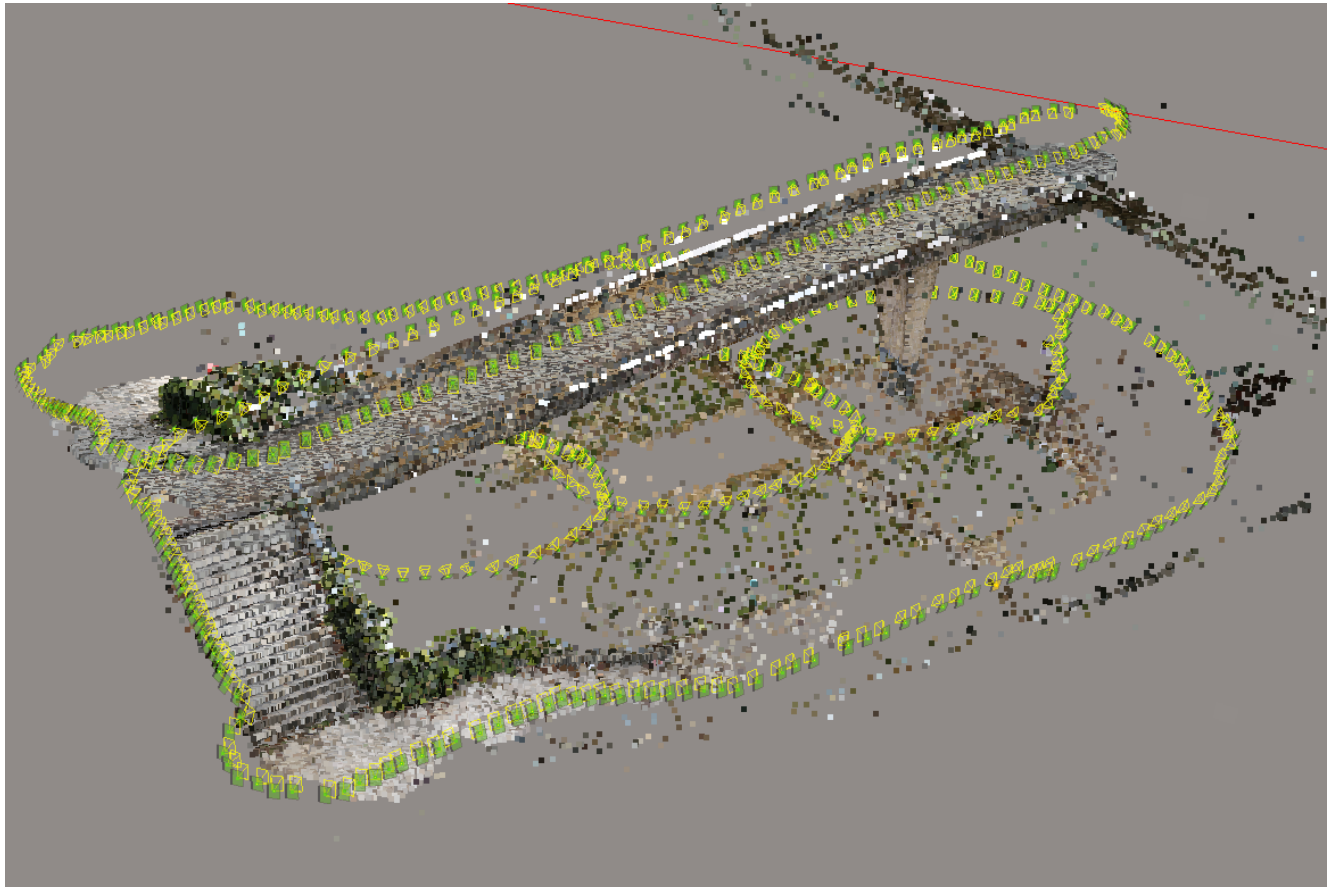
- First global site visit
- Define exact capture path
- Identify potential difficulties
- Determine exact ground control points or scale constraints position
- Camera settings testing

Field notes

Terrestrial scale project

Stage 3: Imagery capture

- Follow main capture path and close the loop
- Check primary capture is robust and with no breaks. **Images displayed at speed will appear like a movie.**
- Focus on key areas: in this instance, the under-part of the bridge

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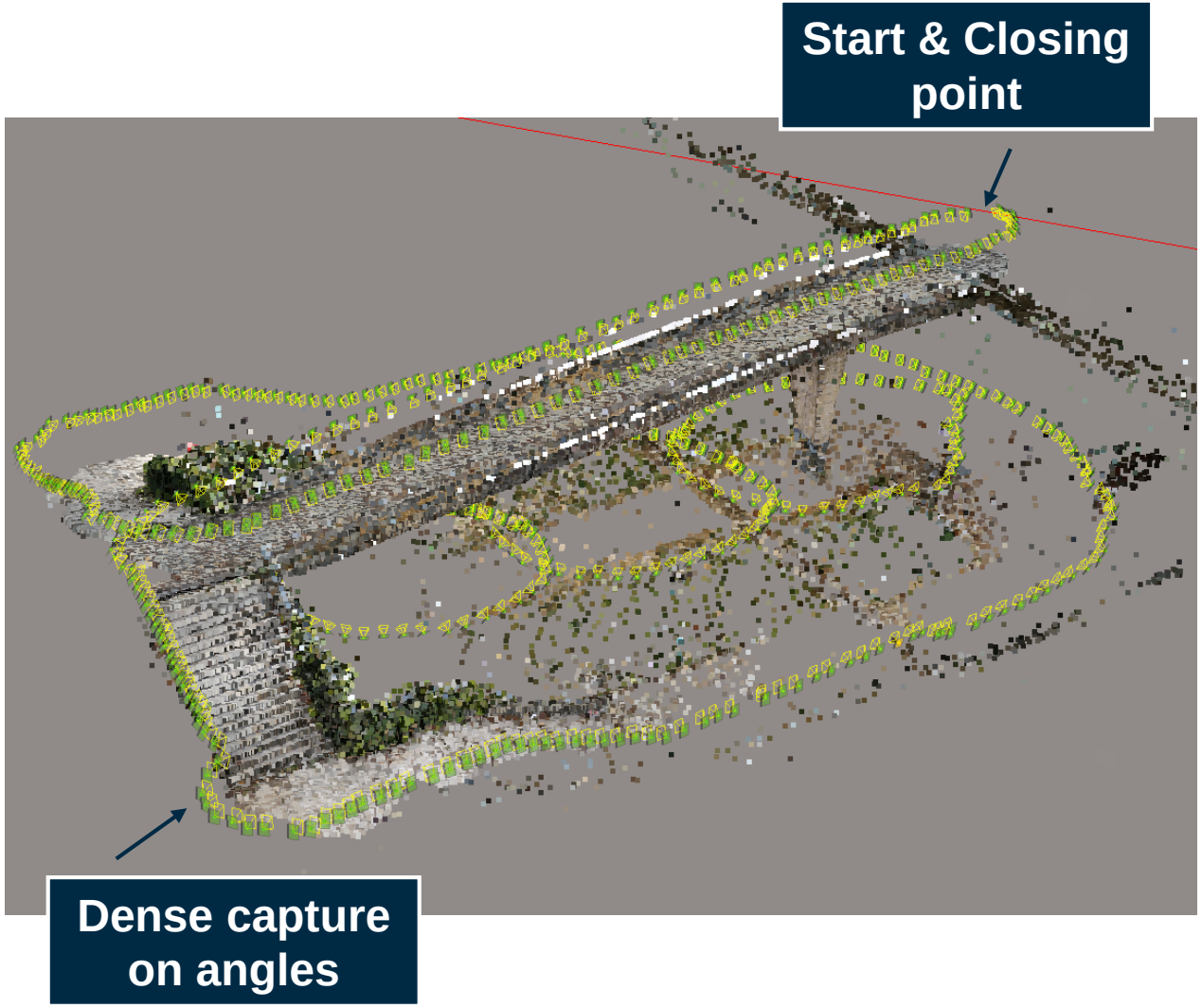
Terrestrial scale project

Stage 3: Imagery capture

- Before leaving the site, validate the checklist:
  - Main capture path is robust
  - Focus areas are good and linked to main capture path
  - All geo-registration and measurement information has been collected
  - Do not forget any materials on-site
- Basic principle reminder:
  Going back on-site is expensive
  If in doubt, capture additional pictures



Terrestrial scale project

Stage 4: Processing

- Copy images to your workstation
- Import images and calibration report
- Define optional positioning constraints: GCPs, scale, etc.
- Submit aerotriangulation to ContextCapture desktop or ContextCapture Cloud Processing Service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Terrestrial scale project

Stage 5: Mission closure

- Review time spent on:
  - Capture
  - Automatic processing
  - Manual processing
- The importance of planning and preparation stages will be clear
- Reviewing helps accurately define the time and associated costs for planning further missions

Processing stage		Processing time
Capture	1- Planification	30min
	2- Global tour	10min
	3- Image shooting	60min
Processing	1- Manual processing	5min
	2- Automatic processing	240min
Summary	Project analysis	20min
TOTAL		**6h05min**

Terrestrial scale project

Well managed capture

Processing stage		Processing time
Capture	1- Planification	30min
	2- Global tour	10min
	3- Image shooting	60min
Processing	1- Manual processing	5min
	2- Automatic processing	240min
Summary	Project analysis	20min
TOTAL		**6h05min**

Poorly managed capture

Processing time
0min
0min
40min
60min
480min
20min
10h00min

Drone capture project

Mission purpose

- Produce a reality mesh of Microsoft Redmond site
- Expected accuracy
  - Global site: <5cm
- Merge reality mesh with existing lower resolution mesh (larger extents)
- Drone and GCPs approach will be the best choice


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Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google Earth

Drone capture project

Stage 1: Mission planning from the office

- Define area of take-off and landing and obtain flight clearances
- Identify access to site
- Define drone flight path and GCPs positions for the global area
  - Choose the hardware
  - Define flight height considering <5cm accuracy expectation

Drone capture project

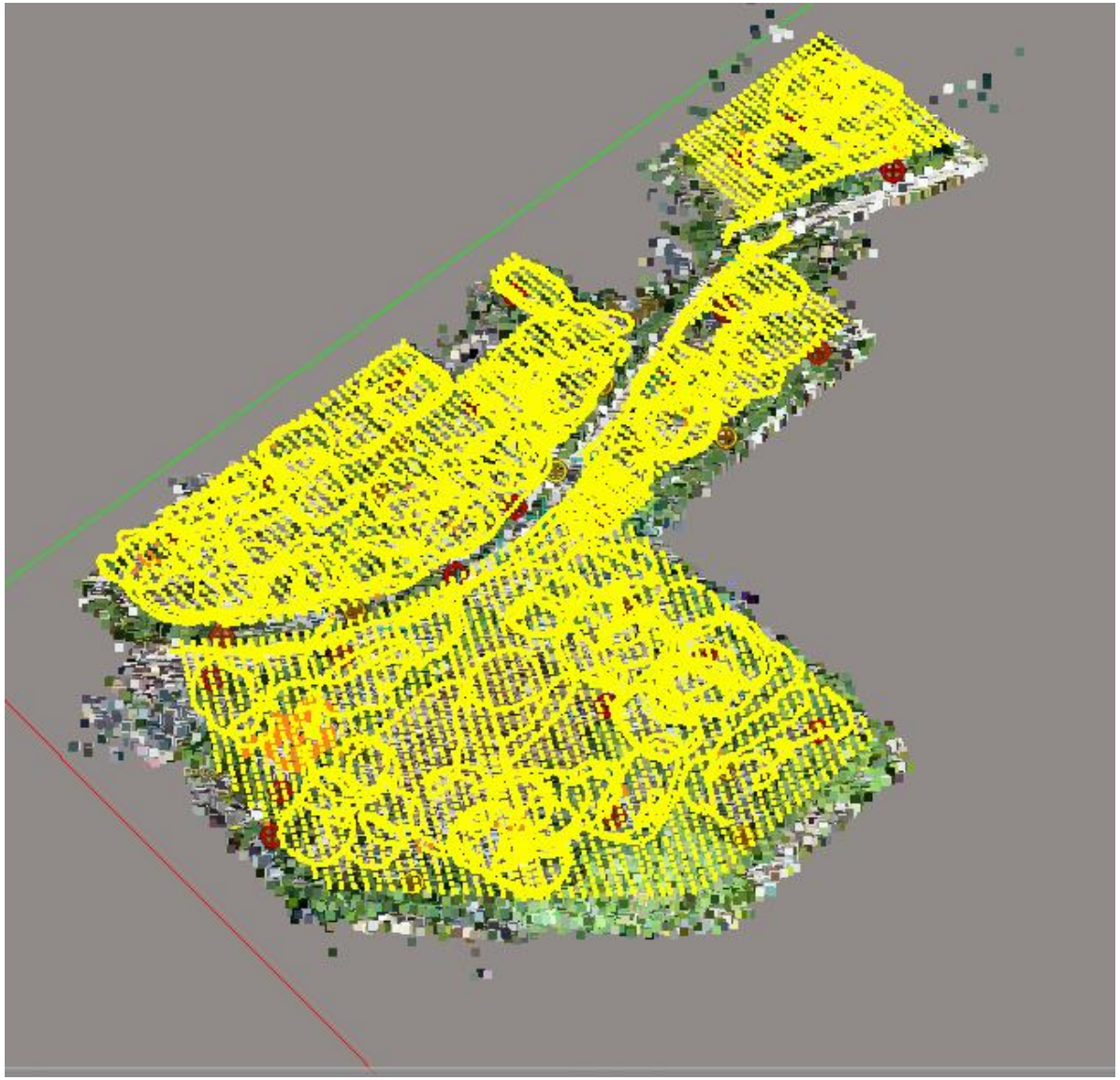
Stage 2: On-site review

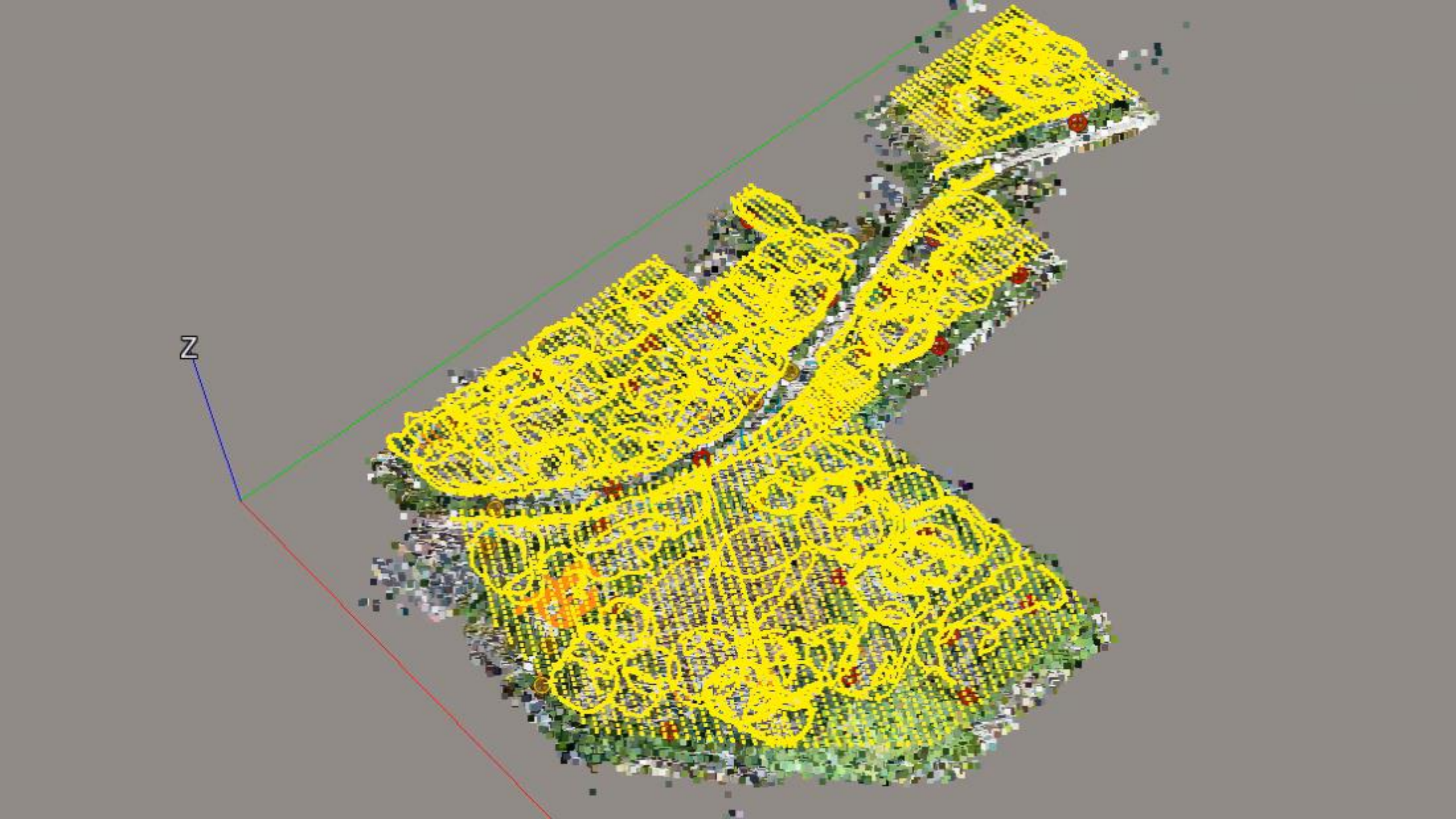
- Check planned take-off and landing sites
- Check for potential obstacles that could not be foreseen prior to capture
- Set and survey targets for ground control points

Drone capture project

Stage 3: Imagery capture

- Execute vertical and oblique predefined flight plan
- Fly at constant height
- Avoid flying over the highway

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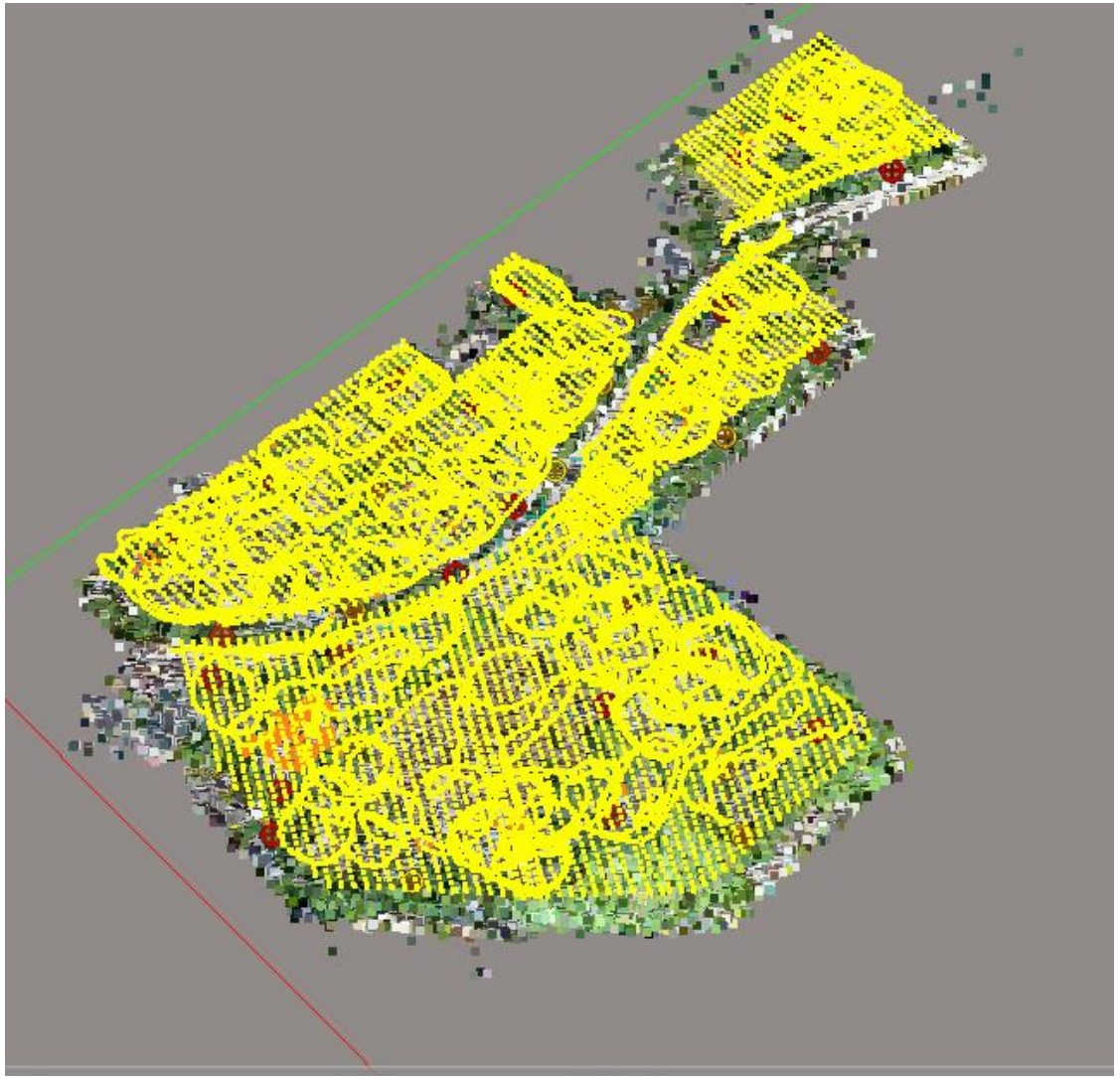
Drone capture project

Stage 4: Processing

- Copy your images to your workstation
- Import images and ground control points
- Register GCPs
- Submit aerotriangulation to ContextCapture or ContextCapture Cloud Processing Service



Terrestrial scale project

Stage 5: Mission closure

- Review time spent on:
  - Capture
  - Automatic processing
  - Manual processing
- The importance of planning and preparation stages will be clear
- Reviewing helps accurately define the time and associated costs for planning further missions

Processing stage		Processing time
Capture	1- Planification	1h
	2- On-site checking	10min
	3- Image shooting	8h00min
Processing	1- Manual processing	45min
	2- Automatic processing	20days 0h 0min
Summary	Project analysis	20min
TOTAL		**20d 10h 15min**

Drone capture project

Well managed capture

Processing stage		Processing time
Capture	1- Planification	1h
	2- On-site checking	10min
	3- Image shooting	8h00min
Processing	1- Manual processing	45min
	2- Automatic processing	20d 0h 0min
Summary	Project analysis	20min
TOTAL		**20d 10h 15min**

Poorly managed capture

Processing time
0min
0min
6h 00min
20h 00min
30d 0h 0min
20min
31d 2h 20min

Complex hybrid capture

Mission purpose

- Get a reality mesh of Cambridge university campus
- Expected accuracy
  - Global site: 2cm
  - Point of interest: <5mm
- Point of interest is a single building requiring indoors & outdoors imagery
- Full hybrid combination will be the best approach

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Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image IBCAO

Google Earth

Complex hybrid capture

Stage 1: Mission planning from the office

- Define area of take-off and landing and obtain flight clearances
- Identify access to main site and building of interest
- Define drone flight path and GCPs positions for the global area
  - Choose the hardware
  - Define flight height considering 2cm accuracy expectation
- Estimate time and resources required, both personnel and equipment

Site	Description	Value
Main site	**Area**	556.000sqm
	Expected accuracy	2cm
	Flight plan	Oblique + Nadir Grid
	Number of pictures	1400
	Estimated capture time	2h
	Equipment & staff	2 operators
		1 Sirius Drone
		1 camera
		1 Total station
Focus building	**Area**	5.300sqm
	Expected accuracy	<0.5cm
	Number of pictures (outdoor)	2000
	Number of scan stations (outdoor)	6
	Estimated capture time	Outdoor: 4h
		Indoor (rough at this stage): 4h
	Equipment and staff	2 operators
		1 Laserscan
		1 camera

Complex hybrid capture

Stage 2: On-site review – Global capture

- Check planned take-off and landing sites
- Check for potential obstacles that could not be foreseen prior to capture
- Set targets for ground control points

Complex hybrid capture

Stage 2: On-site review – Building image capture - Outdoors

- First building site visit
- Define exact capture path
- Identify potential difficulties
- Camera settings testing

Complex hybrid capture

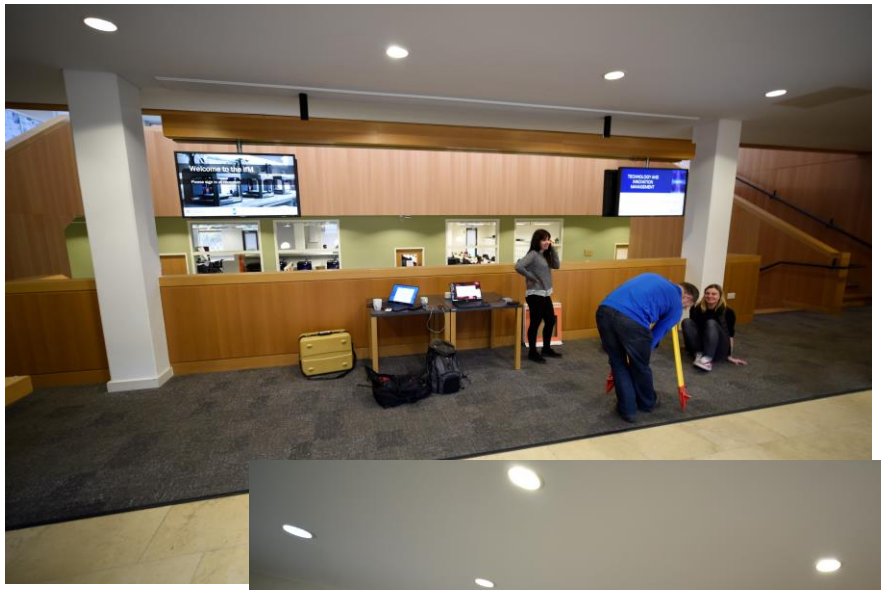
Stage 2: On-site review – Building image capture - Indoors

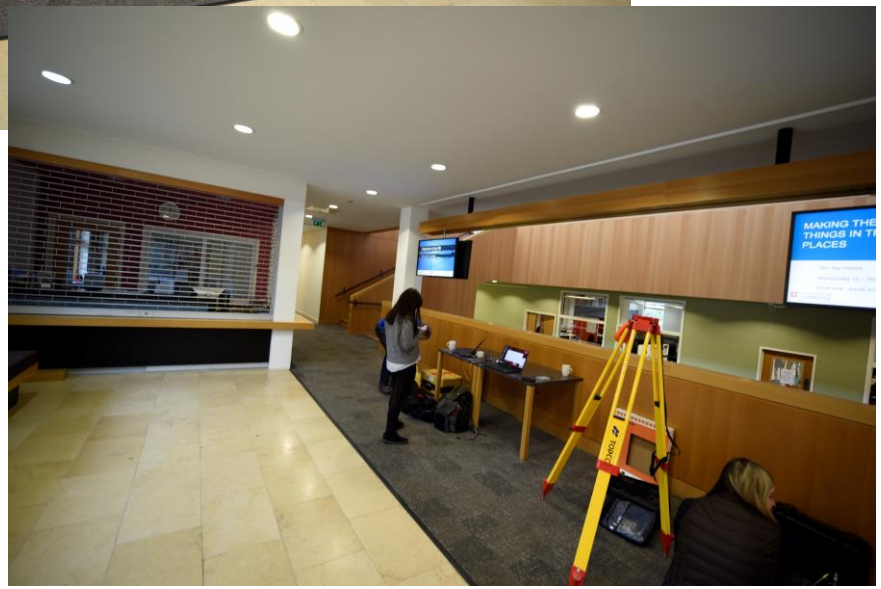
- First indoor site visit
- Define exact capture path
- Identify potential difficulties
  - Shiny surfaces
  - Angles
  - Entrances

Complex hybrid capture

Stage 2: On-site review – Building laserscan capture - Indoors

- Define scanner positions to cover the entire area
- Make sure laserscanning activity will not interfere with imagery capture

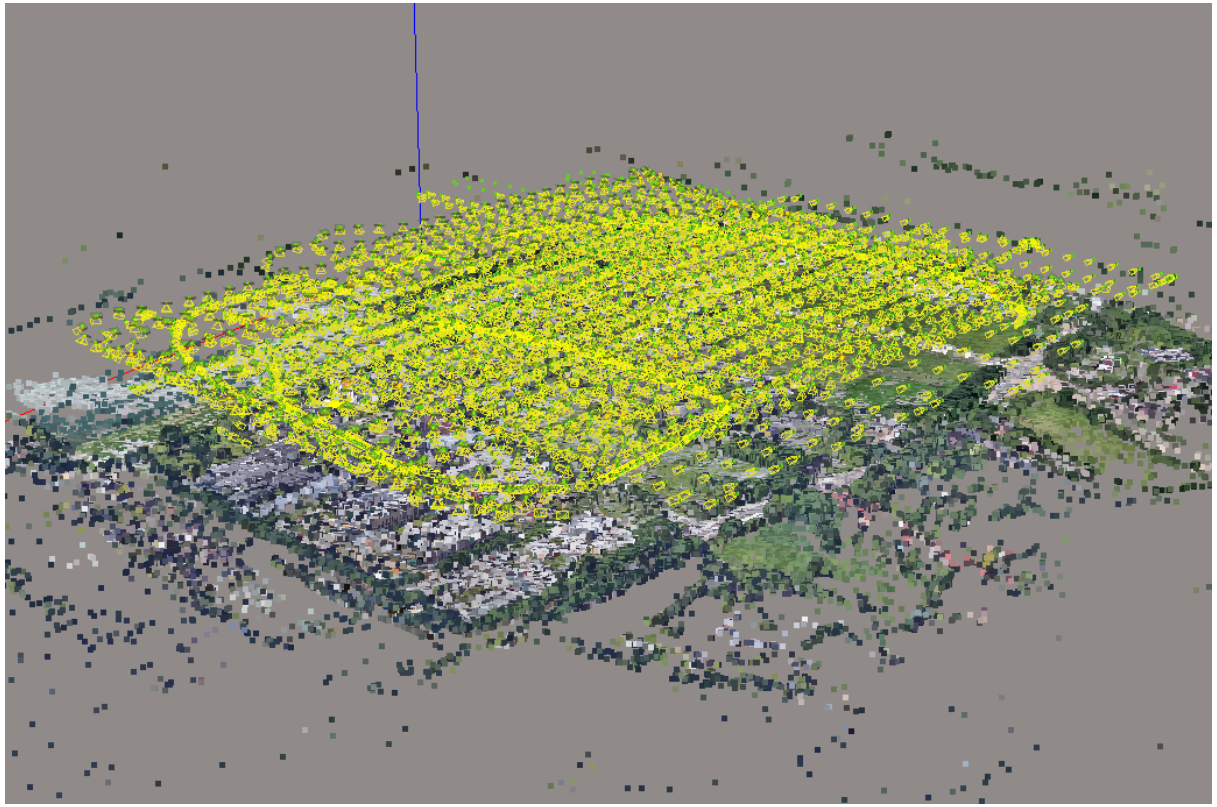




Complex hybrid capture

Stage 3: Imagery capture – Global capture

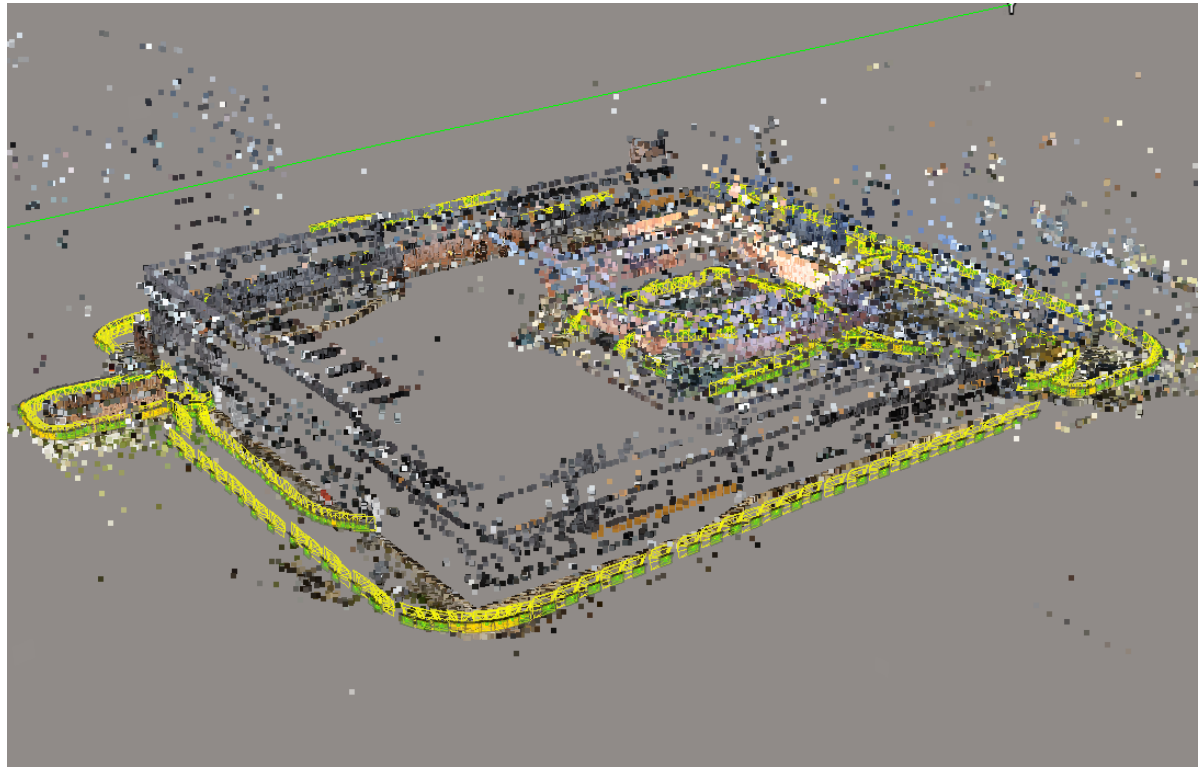
- Execute pre-defined flight plan
- Make sure to set GCPs before flying
- Fly at constant height



Complex hybrid capture

Stage 3: Imagery capture - Building image capture - Outdoors

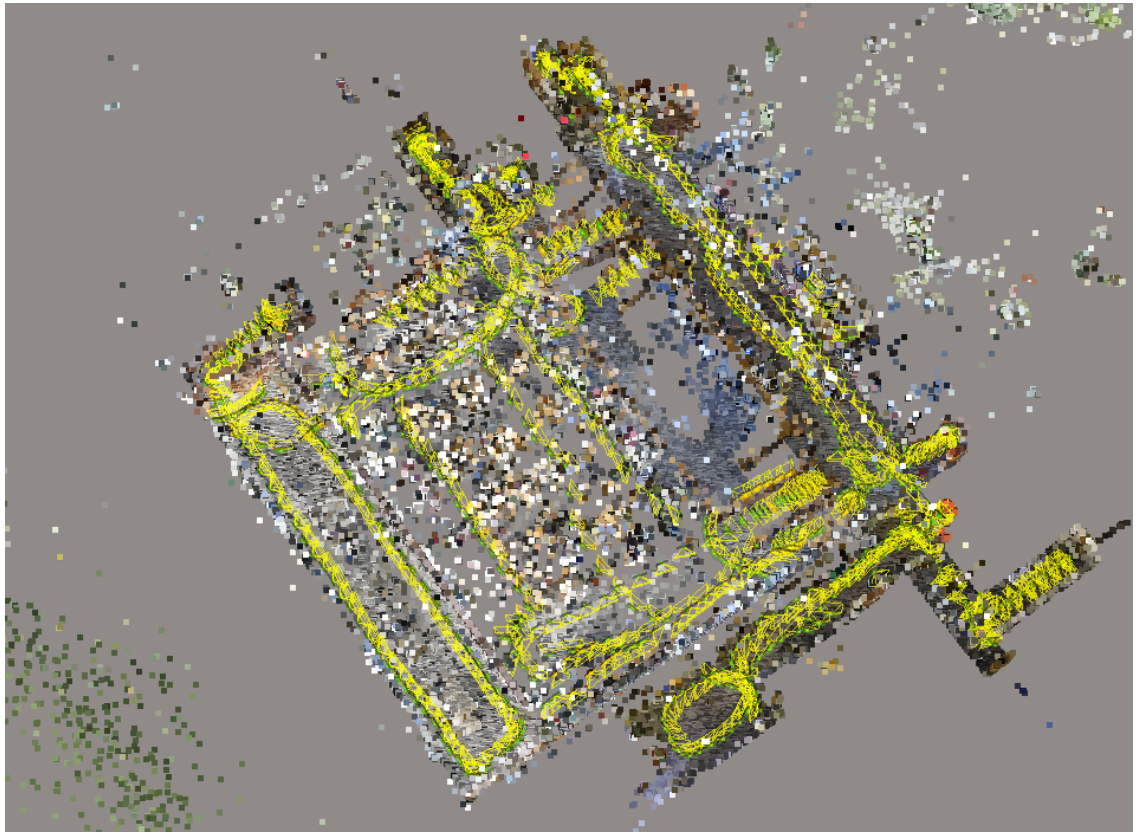
- Follow main capture path and close the loop
- Check primary capture is robust and with no breaks. **Images displayed at speed will appear like a movie**
- In a 2nd time stitch areas of interest to main canvas



Complex hybrid capture

Stage 3: Imagery capture - Building image capture - Indoors

- Follow main capture path and close the loop
- **To ensure automatic stitching with outdoors section, take extra care with the entrances**
- Pay attention to light condition changes and how images shot in automatic mode can be affected



Complex hybrid capture

Stage 3: Imagery capture - Building image capture - Indoors

- Follow main capture path and close the loop
- **To ensure automatic stitching with outdoors section, take extra care with the entrances**
- Pay attention to light condition changes and how images shot in automatic mode can be affected

Complex hybrid capture

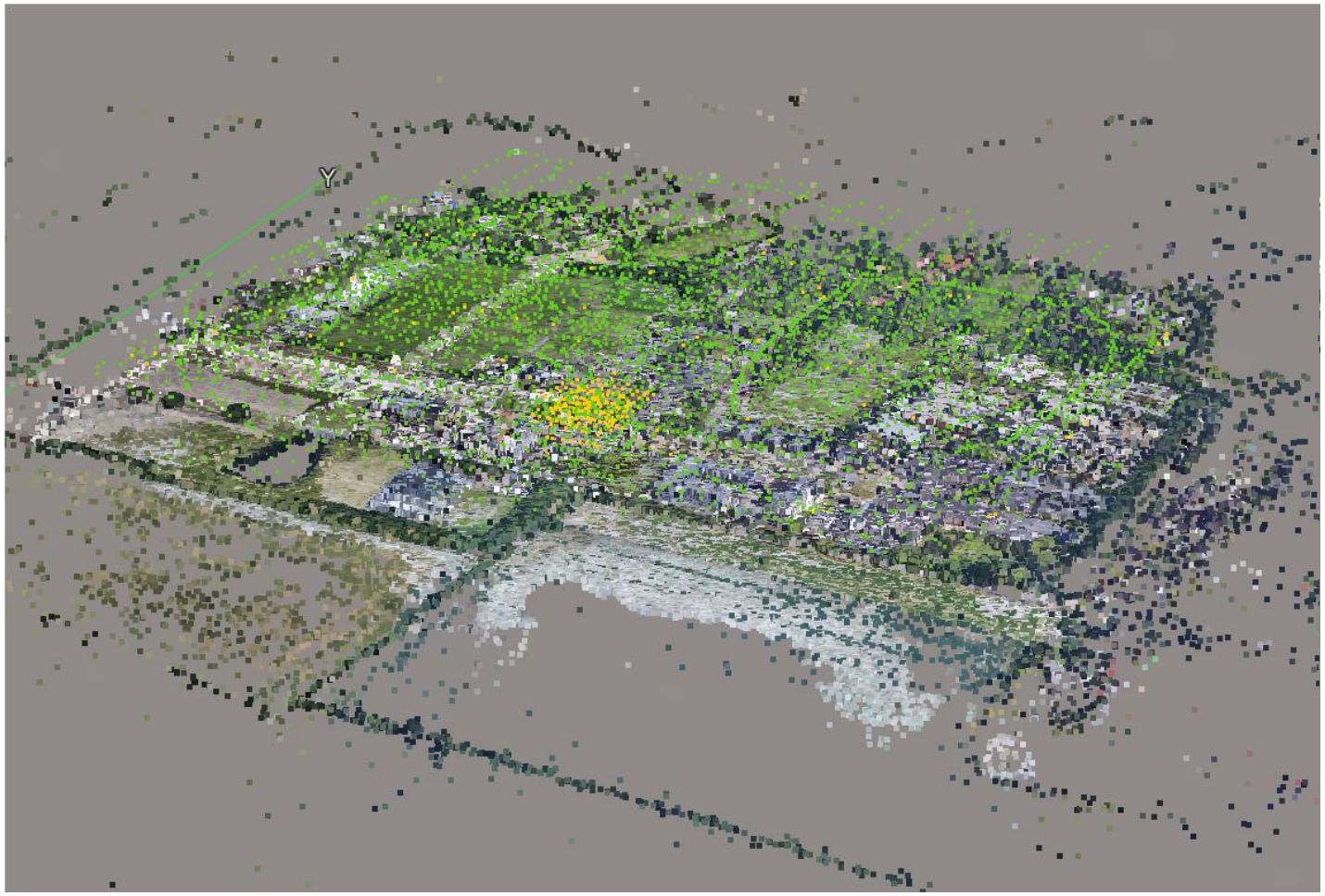
Stage 3: Imagery capture - Building laserscan capture - Indoors

- Set-up laserscan on pre-defined positions during initial tour
- Run acquisition

Complex hybrid capture

Stage 4: Processing

- Import laserscan
- Import and align drone images on GCPs
- Align ground and indoor images and fit to pointcloud
- Run 3D reconstruction



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Complex hybrid capture

Stage 5: Mission closure

- Review time spent on:
  - Capture
  - Automatic processing
  - Manual processing
- The importance of planning and preparation stages will be clear
- Reviewing helps accurately define the time and associated costs for planning further missions

Processing Stage		Processing time
Capture	1- Planification	1h
	2- Focus building tour	30min
	3- Image shooting	2h + 4h
	4 – Laserscan shooting	4h
Processing	1- Manual processing	1h
	2- Automatic processing	6d 1h
Summary	Project analysis	20min
TOTAL		**6d 13h 50min**

Complex hybrid capture

Well managed capture

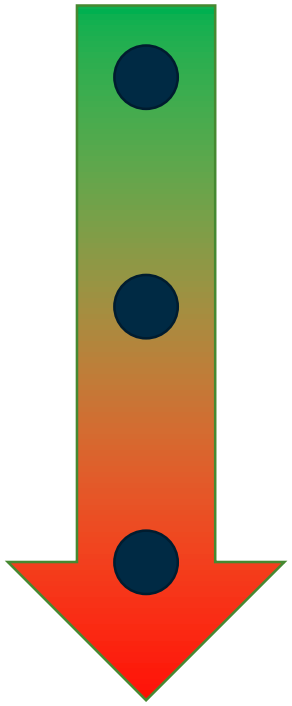
Processing stage		Processing time
Capture	1- Planification	1h
	2- Focus building tour	30min
	3- Image shooting	2h + 8h
	4 – Laserscan shooting	4h
Processing	1- Manual processing	1h
	2- Automatic processing	6d 1h
Summary	Project analysis	20min
TOTAL		**6d 15h 50min**

Badly managed capture

Processing time
0min
0min
2h + 6h
2h
16h
11d 2h
20min
12d 2h 20min

Conclusion

- Only a robust capture will lead to a consistent reality mesh
- Time spent on mission planning and imagery capture is never wasted
- Time invested at mission planning, on-site review and capture stage **can reduce processing time and related costs by 80%**



High quality acquisition

- High degree of automation
- Quality results

Low quality acquisition

- Extensive manual work to make it successful
- Final result of lower quality

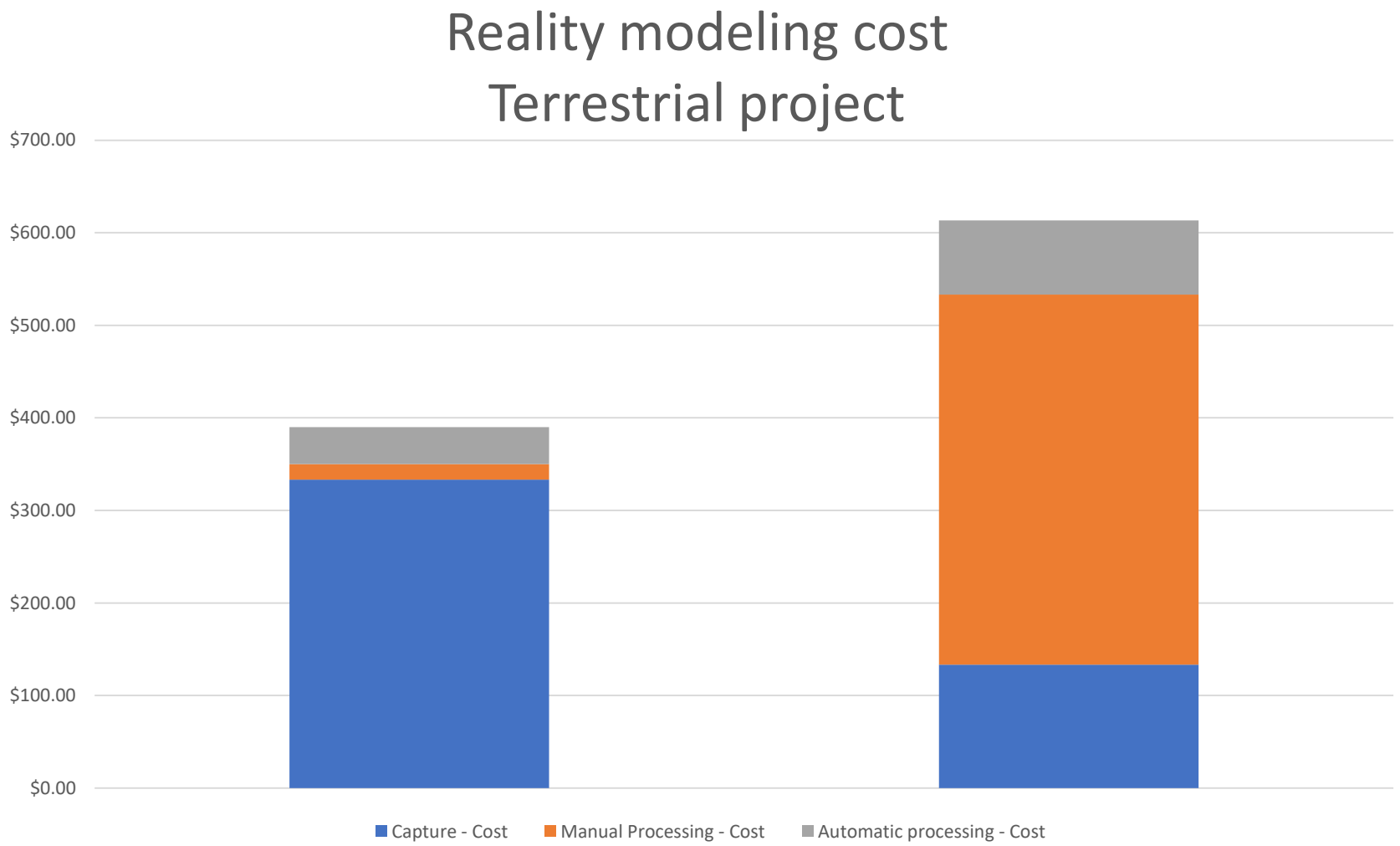
Poor acquisition

- Processing fails

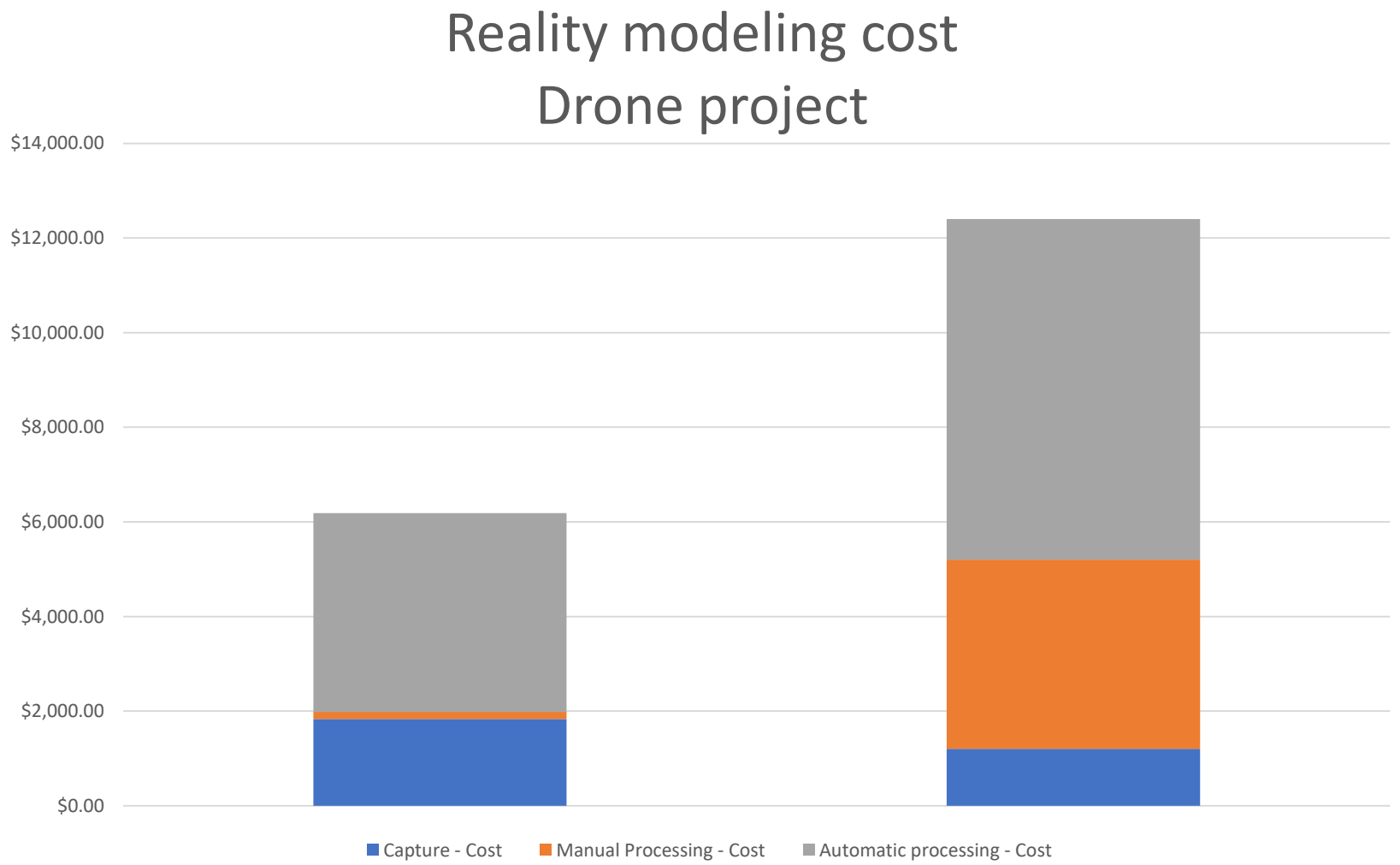
Conclusion

	Stage	Terrestrial - Good	Terrestrial - bad	Drone - Good	Drone - bad	Hybrid good	Hybrid bad
Capture	Planification	0:30:00	0:00:00	1:00:00	0:00:00	1:00:00	0:00:00
	On-site review	0:10:00	0:00:00	0:10:00	0:00:00	0:30:00	0:00:00
	Image capture	1:00:00	0:40:00	8:00:00	6:00:00	10:00:00	8:00:00
	Laserscan shooting	0:00:00	0:00:00	0:00:00	0:00:00	4:00:00	2:00:00
Processing	Manual processing	0:05:00	2:00:00	0:45:00	20:00:00	1:00:00	16:00:00
	Automatic processing	4:00:00	8:00:00	420:00:00	720:00:00	145:00:00	267:00:00
Project Review	Analysis	0:20:00	0:20:00	0:20:00	0:20:00	0:20:00	0:20:00
TOTAL		**6:05:00**	**11:00:00**	**430:15:00**	**746:20:00**	**161:50:00**	**293:20:00**
Capture		1:40:00	0:40:00	9:10:00	6:00:00	15:30:00	10:00:00
Manual Processing		0:05:00	2:00:00	0:45:00	20:00:00	1:00:00	16:00:00
Automatic processing		4:00:00	8:00:00	420:00:00	720:00:00	145:00:00	267:00:00
Capture - Cost		$333.33	$133.33	$1,833.33	$1,200.00	$3,100.00	$2,000.00
Manual Processing - Cost		$16.67	$400.00	$150.00	$4,000.00	$200.00	$3,200.00
Automatic processing - Cost		$40.00	$80.00	$4,200.00	$7,200.00	$1,450.00	$2,670.00
TOTAL COST		**$390.00**	**$613.33**	**$6,183.33**	**$12,400.00**	**$4,750.00**	**$7,870.00**
1h cost involving operator	**$200.00**						
1h cost of automatic processing	**$10.00**						

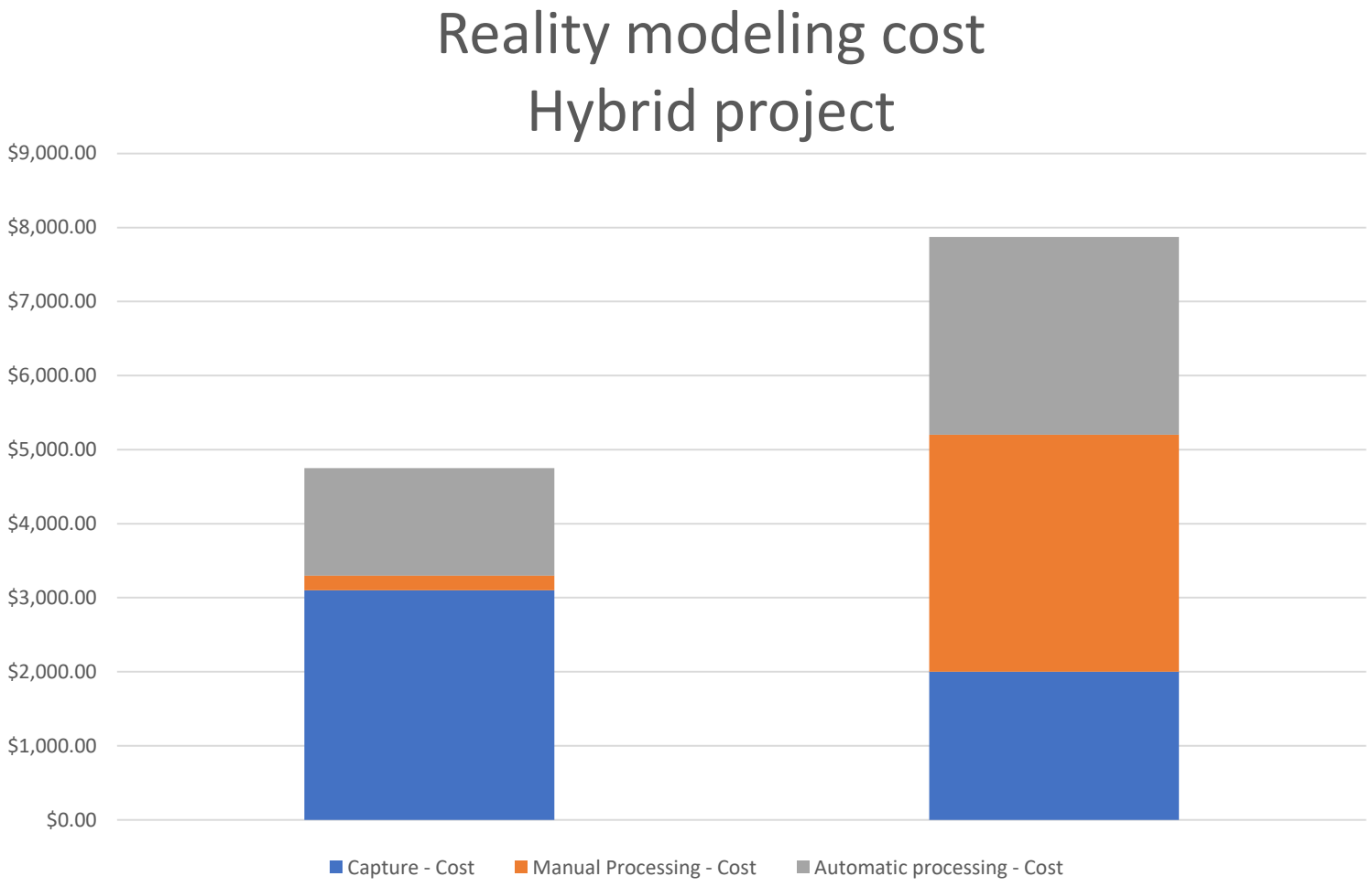
Conclusion



Conclusion



Conclusion



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For more information, please visit:

www.Bentley.com/ContextCapture

Visit the Reality Modeling team at the demo pod in the Technology Pavilion!

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