Rapid generation of 3D GIS content from reality capture data sources

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Purpose

Why do we want 3D GIS content?

A picture is worth a thousand words, and more, if you can navigate it in 3D

Visualization:

a) Key to demonstrating capability when pursuing work
b) Powerful for communicating ideas, information and progress among project team members
c) Effective in revealing completed results to clients

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Reality capture:

- Current state of an object of interest and its environment (‘as is’ conditions)
- Rapid, detailed, cost effective
- Broadly accessible
- Better than ‘as-built’ drawings, traditional survey, manual measurements and photographs

Users can consume 3D content via widely available GIS platforms

Methods

Hardware, Software and Workflow

Hardware, Software and Workflow

Capturing Reality

Laser scanner or other point cloud generating device

Hardware, Software and Workflow

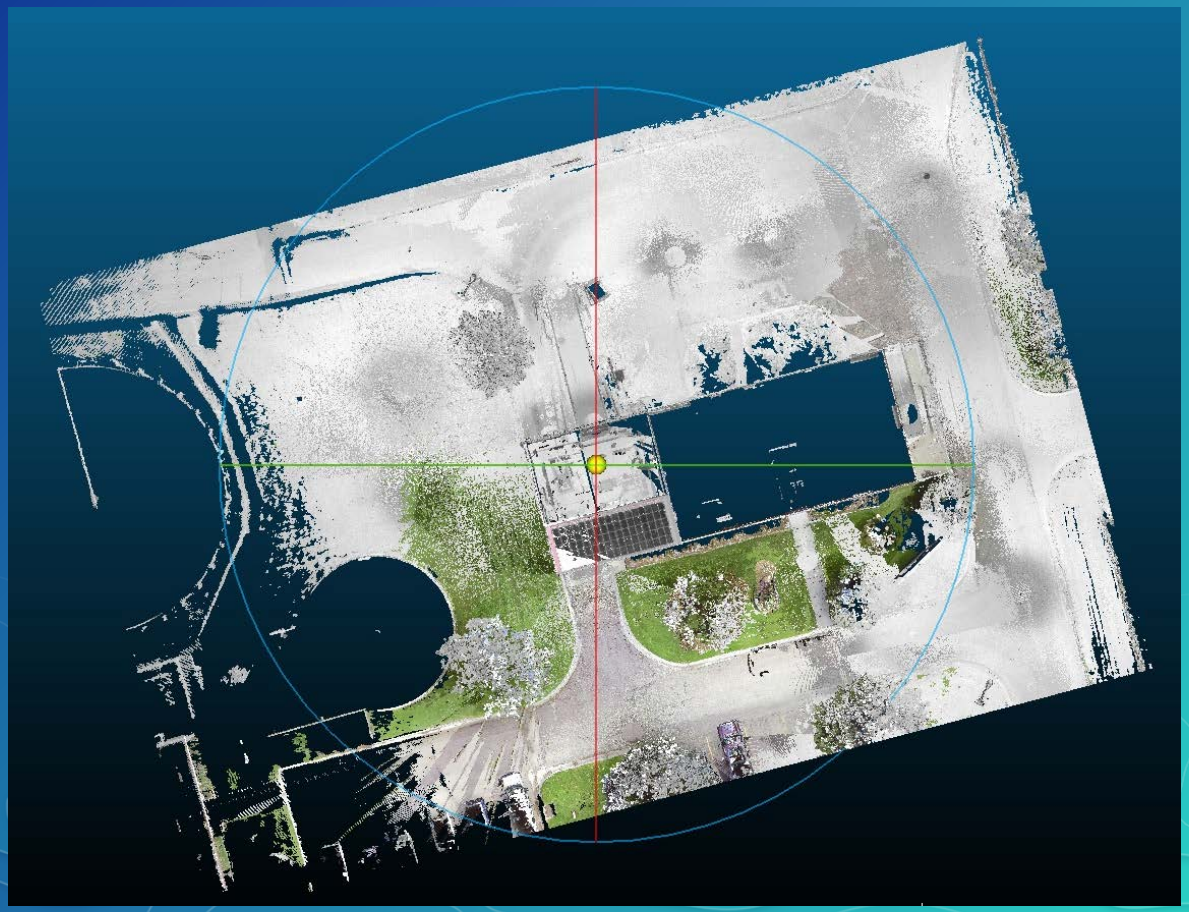
Software

Scan alignment: Scene, ReCap, CloudCompare (fls, e57, others)
Segmentation and clean-up: CloudCompare (e57, ply)
Surface meshing: Meshlab (ply, dae)
Modeling: SketchUp (dae, skp)

Hardware, Software and Workflow

Reality Capture Modeling Workflow

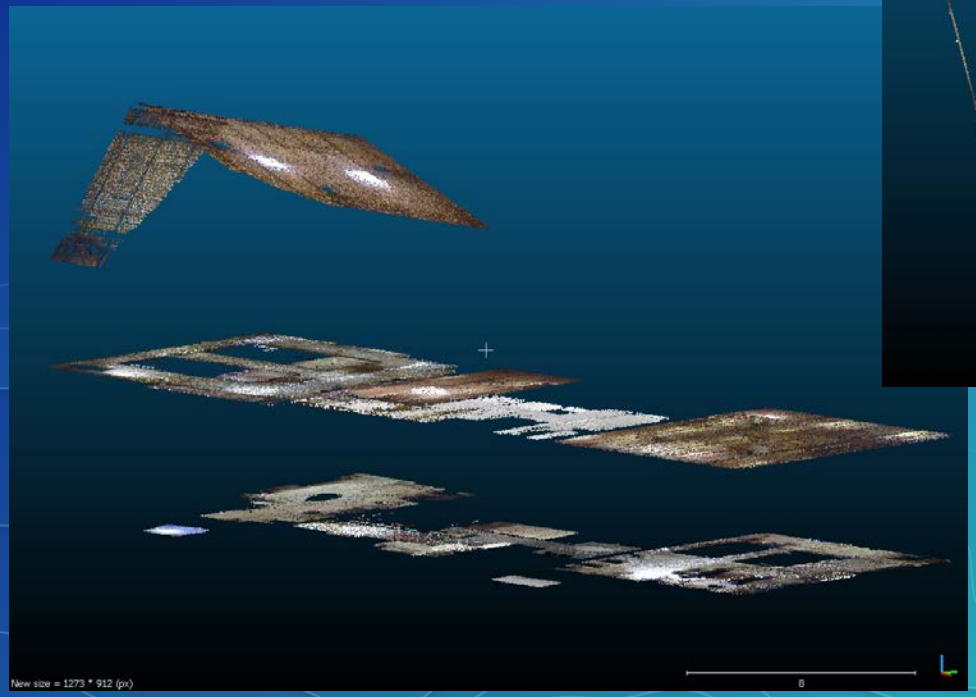
1. Scan site (experience goes a long way)
2. Align scans: generally completed as part of the scan process by scanning technician
3. Create unified point cloud



Hardware, Software and Workflow

Reality Capture Modeling Workflow

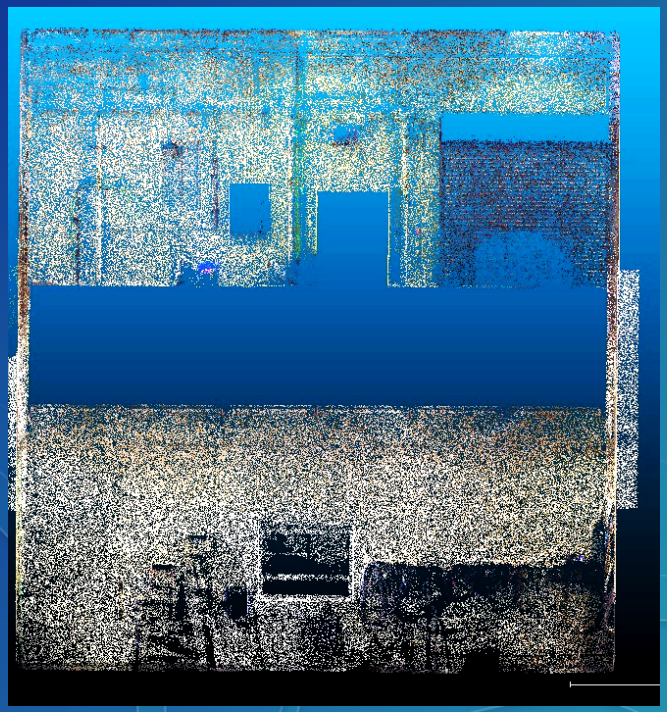
4. Segment data into logical groups (e.g. interior walls by room/floor, ceilings/floors, roof, exterior walls, surrounding site) using CloudCompare (v2.8.1)

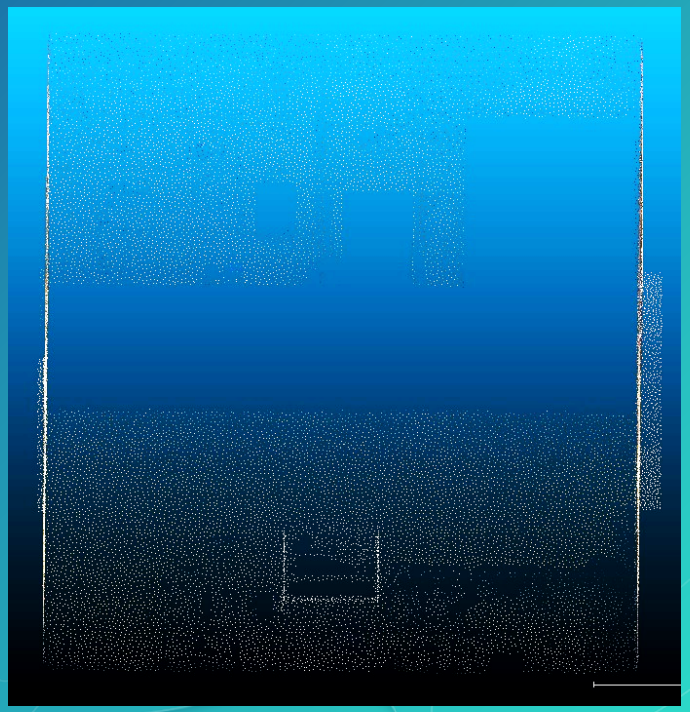


Hardware, Software and Workflow

Reality Capture Modeling Workflow

5. Clean and decimate data:
    a. Remove noise and extraneous data
    b. Reduce data density and generate uniform sample (minimum distance sample)





Hardware, Software and Workflow

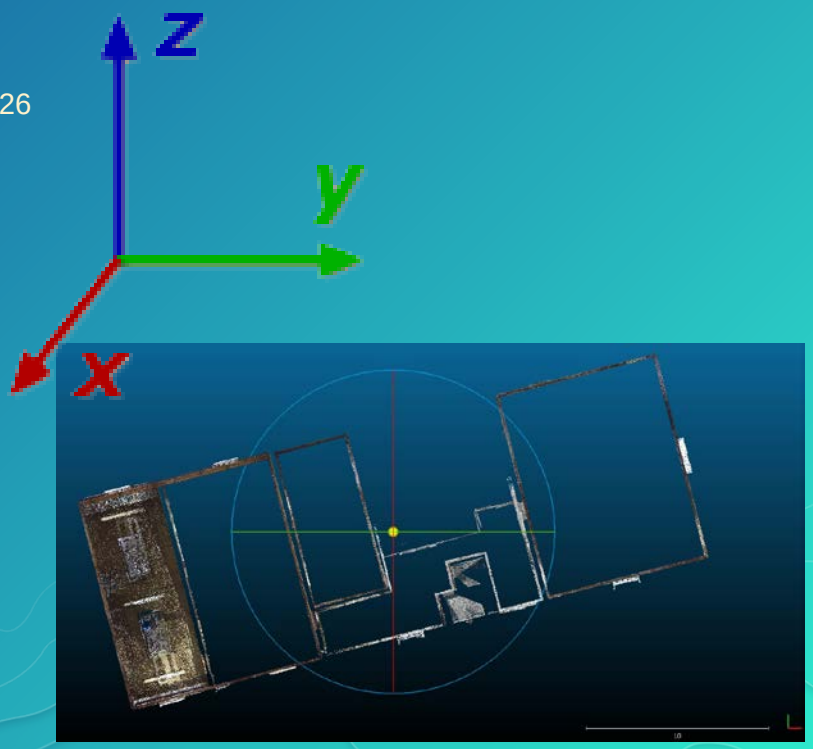
Reality Capture Modeling Workflow

6. Transform data for easier use in modeling (z axis is different in modeling program), export to *.ply

Initial rotation and translation:

0.968104720116 0.250545799732 0.000000000000 5.744572162628
-0.250545799732 0.968104720116 0.000000000000 -14.400389671326
0.000000000000 0.000000000000 1.000000000000 0.000000000000
0.000000000000 0.000000000000 0.000000000000 1.000000000000

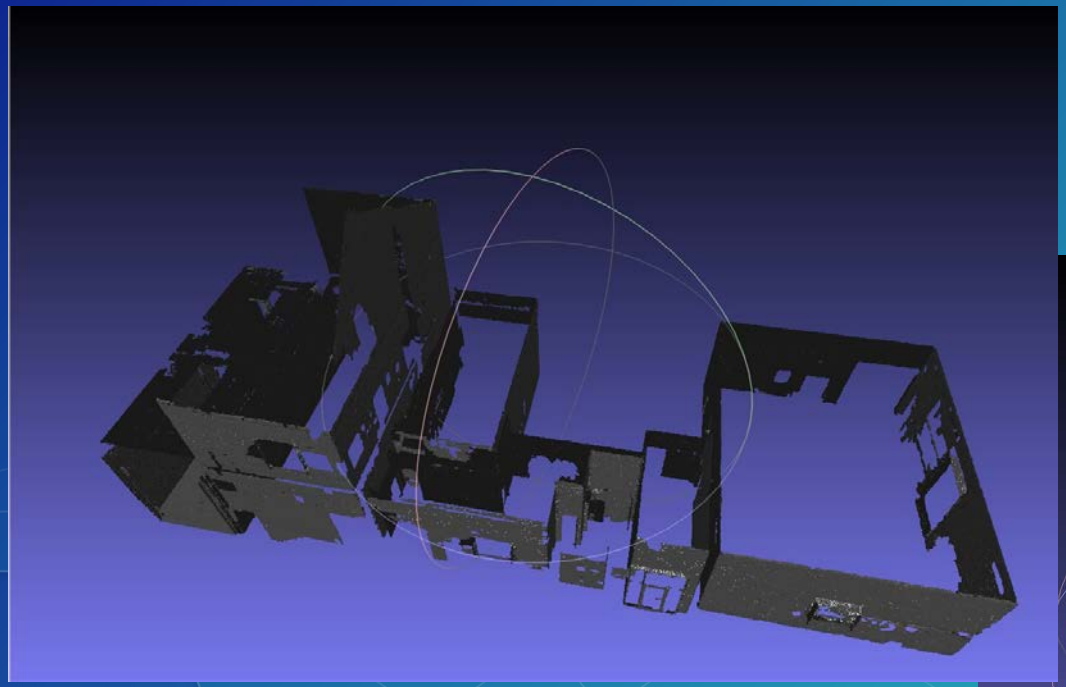
Secondary rotation (to fix axis transposition in Sketchup):
1 0 0 0
0 0 1 0
0 -1 0 0
0 0 0 1

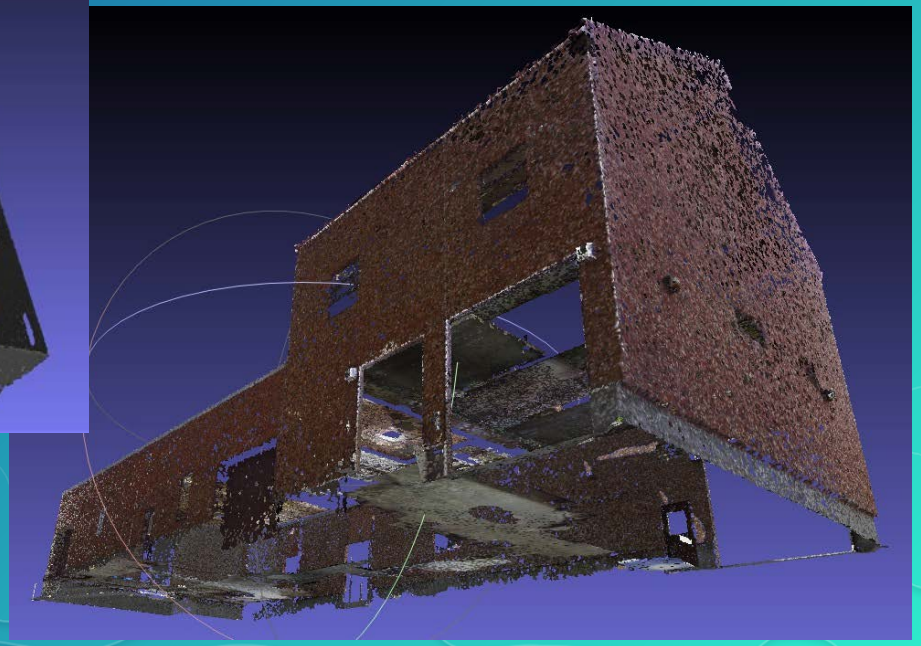


Hardware, Software and Workflow

Reality Capture Modeling Workflow

7. Mesh point cloud to create surfaces (ball pivoting, Meshlab v1.3 beta), export to collada file format (*.dae)

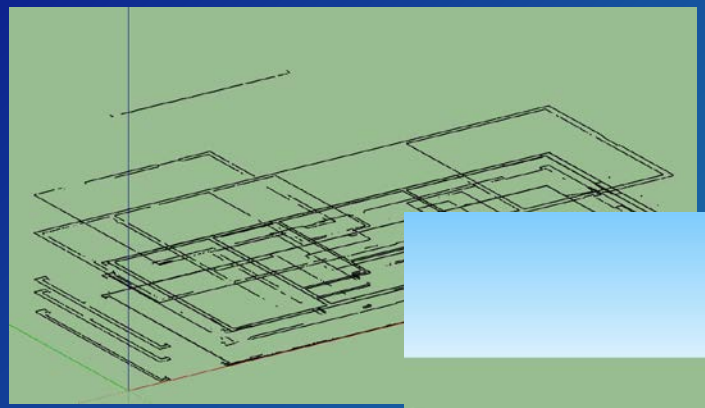


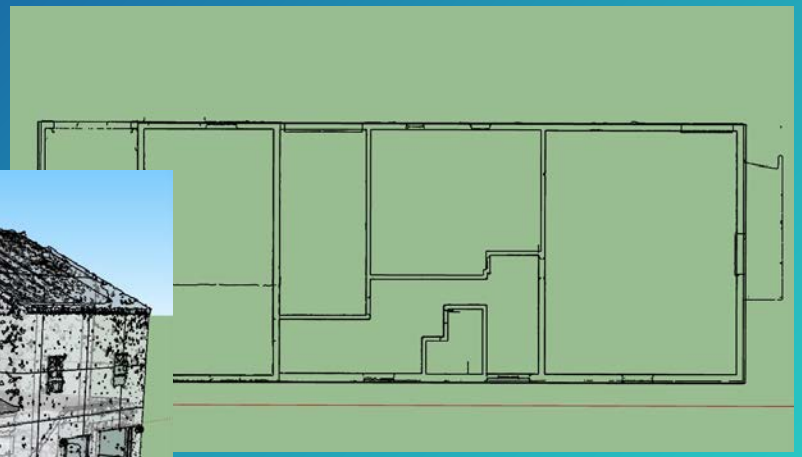


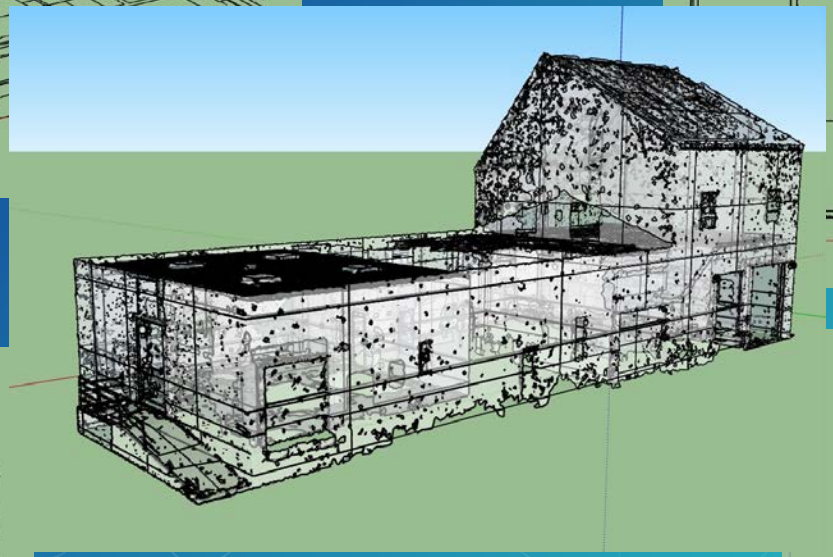
Hardware, Software and Workflow

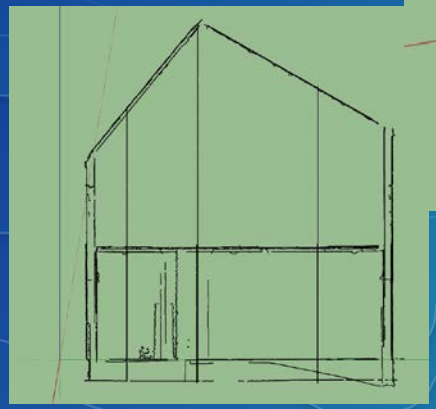
Reality Capture Modeling Workflow

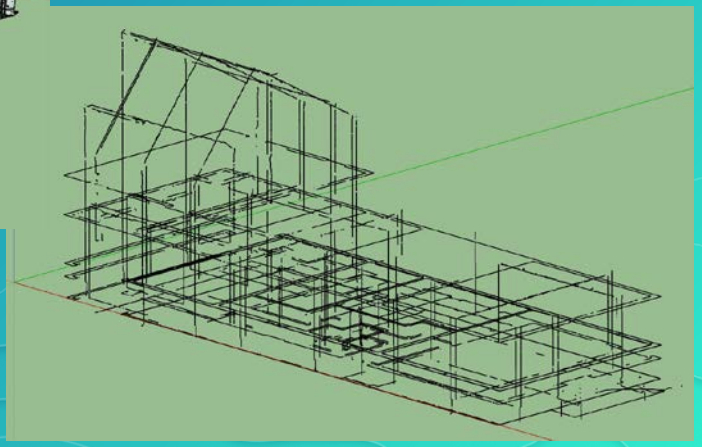
8. Import mesh files to modeling software, create cross sections as needed (vertical, horizontal or oblique) in Sketchup (v2017)







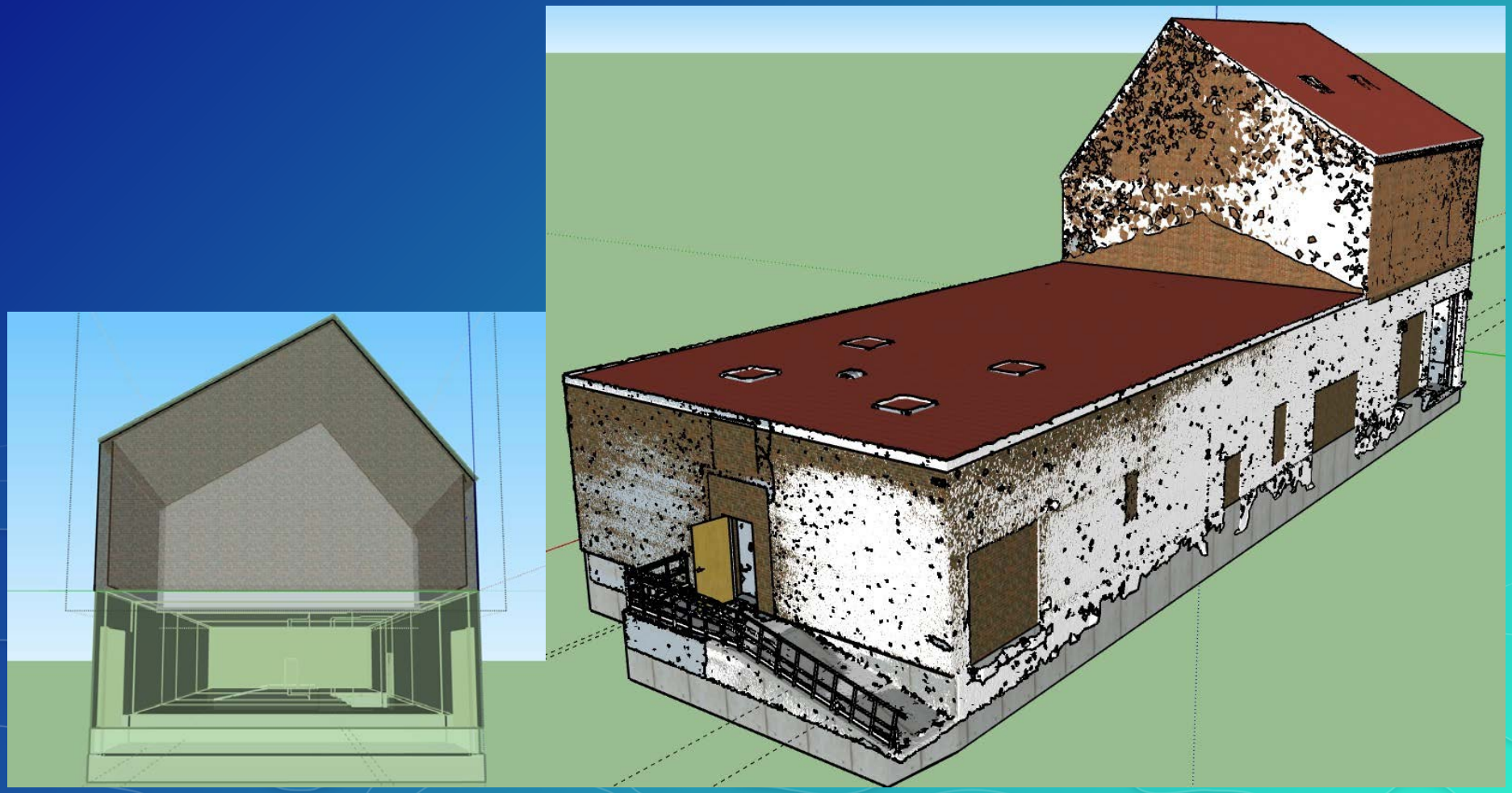


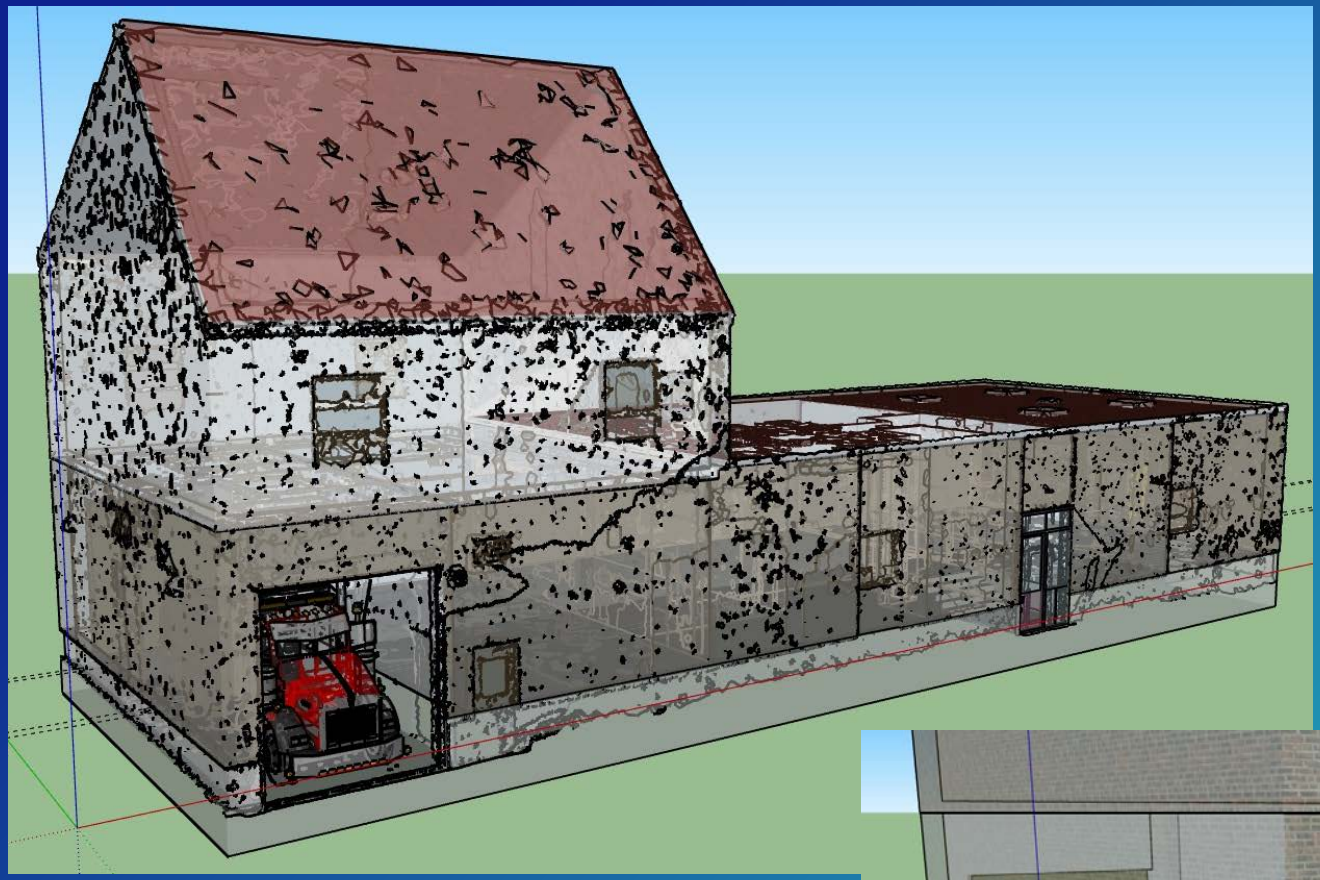


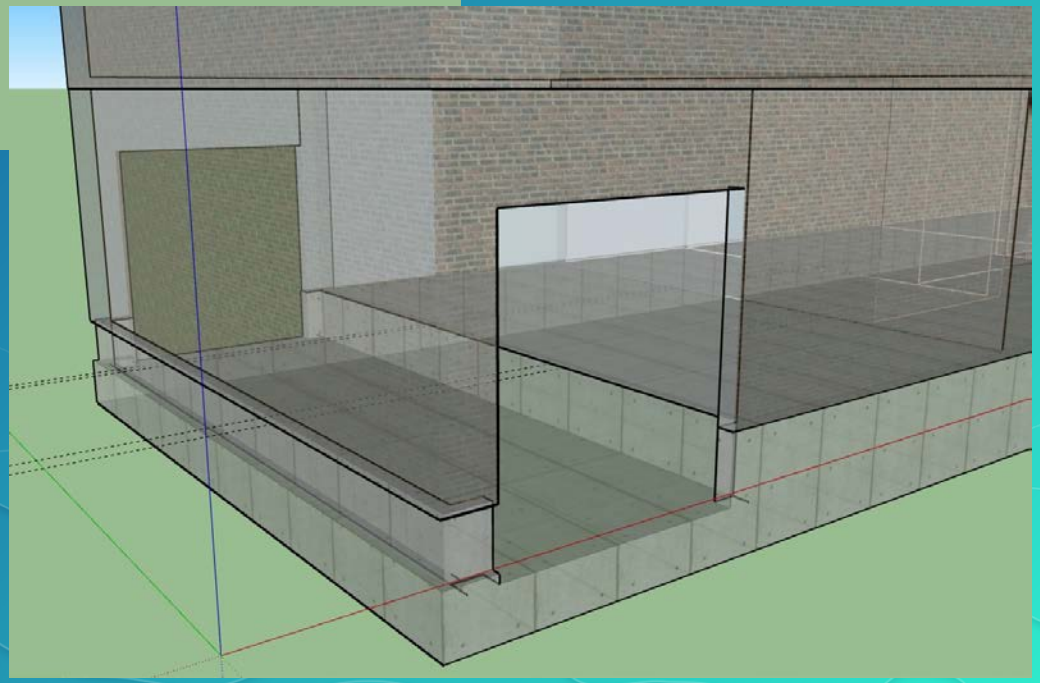
Hardware, Software and Workflow

Reality Capture Modeling Workflow

9. Generate finished 3D model surfaces based on reality capture based surfaces







Hardware, Software and Workflow

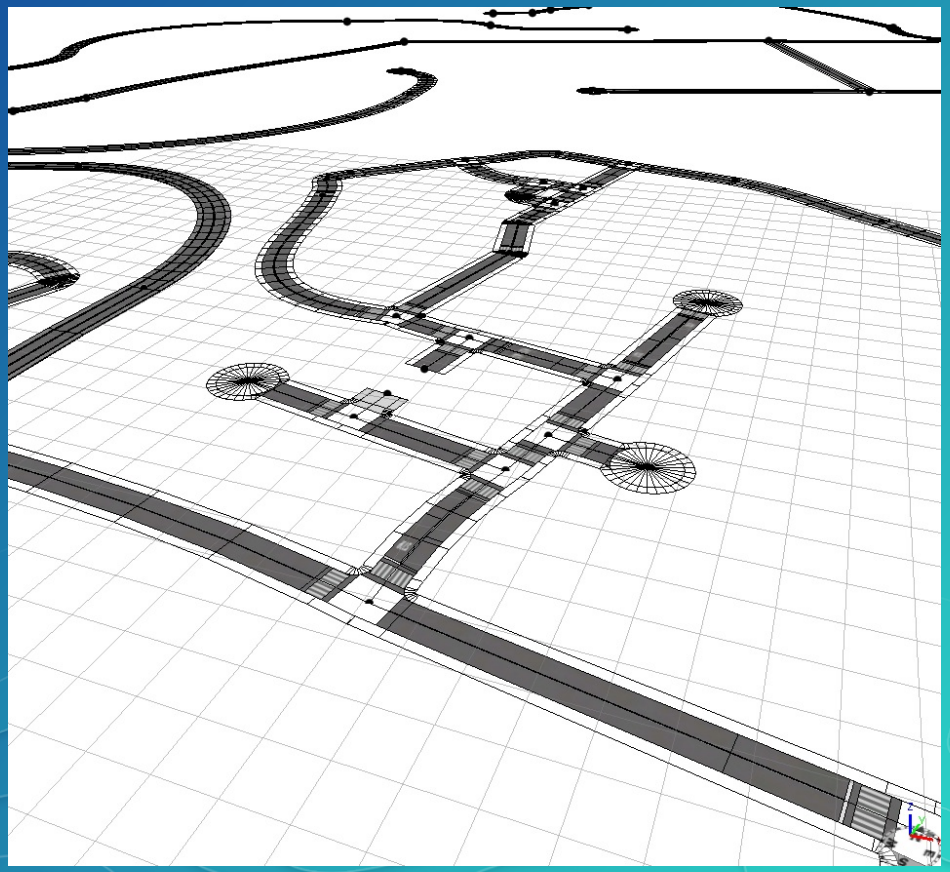
Reality Capture Modeling Workflow

10. Place model in real world location adjusting horizontal position, rotation angle and elevation

Hardware, Software and Workflow

Site/Environment Modeling Workflow

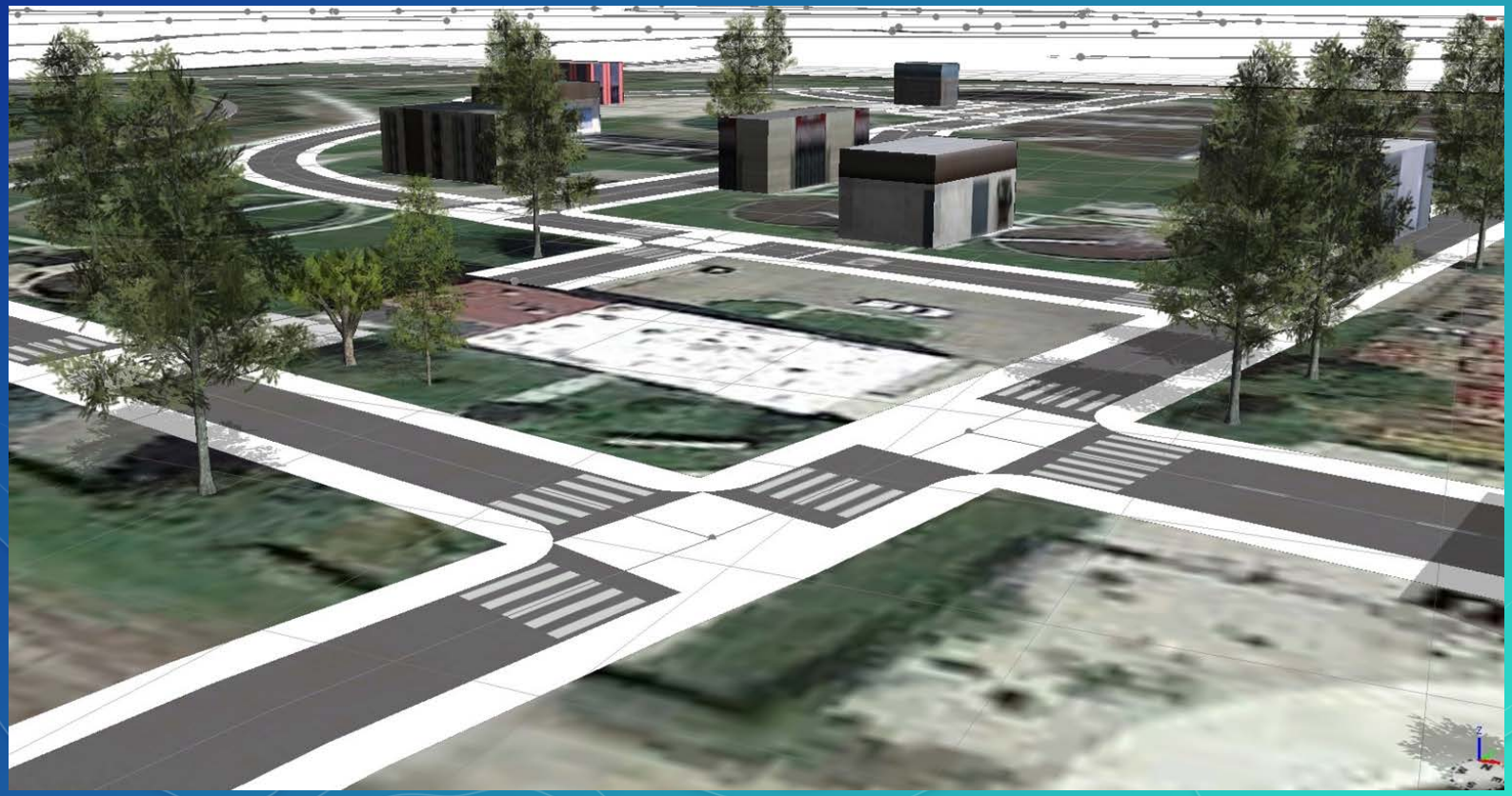
1. Assemble geospatial data for inclusion in site modeling
2. Create empty CityEngine project
3. Import vector data, aerial and elevation data



Hardware, Software and Workflow

Site/Environment Modeling Workflow

4. Assign procedural modeling rules to feature groups, such as...
    a. Extrude buildings
    b. Assign tree species and height
    c. Customize roadway rules to best approximate reality



Hardware, Software and Workflow

Site/Environment Modeling Workflow

5. Import detailed model from reality capture workflow
6. Port to viewing platforms (online/AGOL, offline CEViewer, Google Earth, others)

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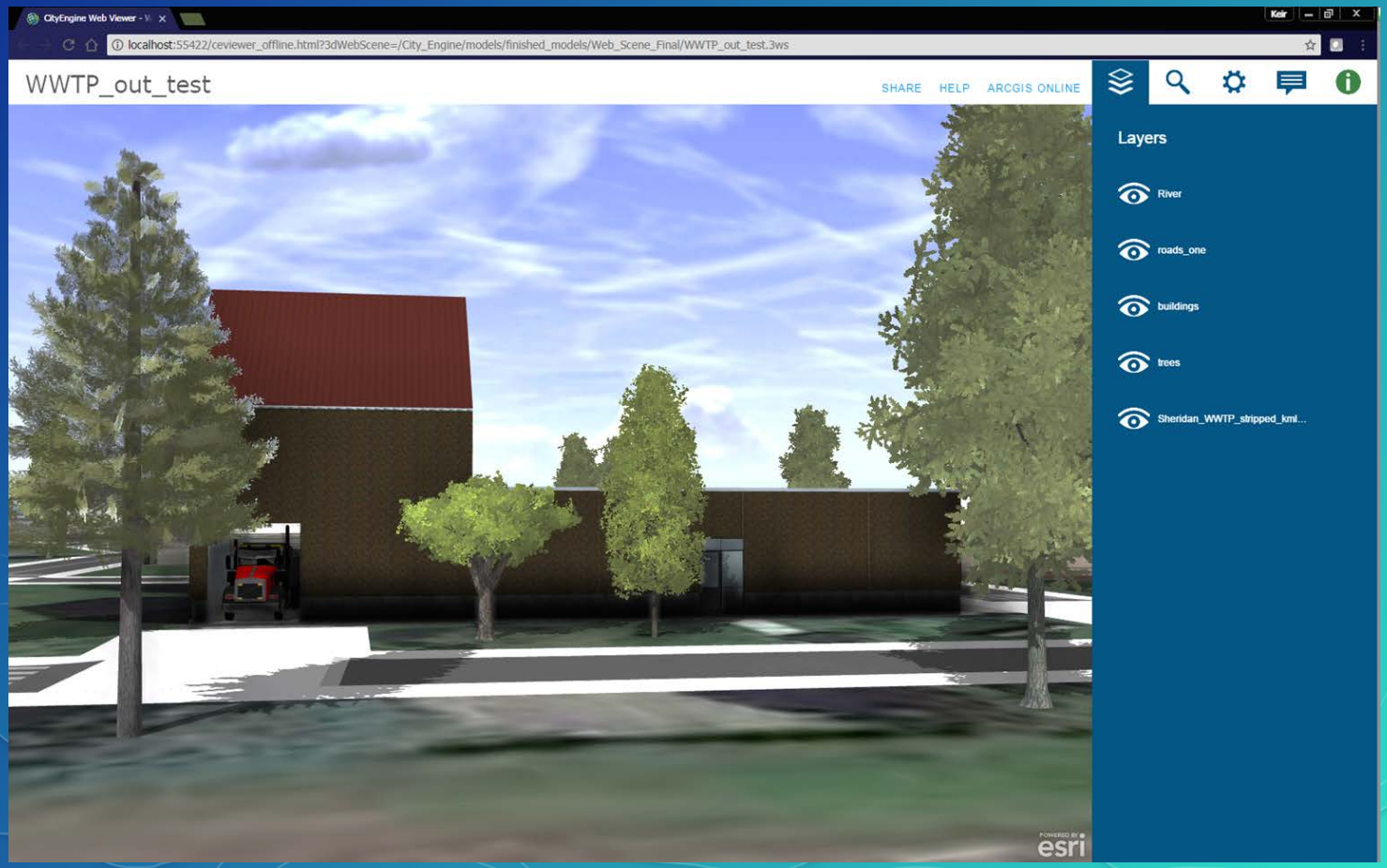
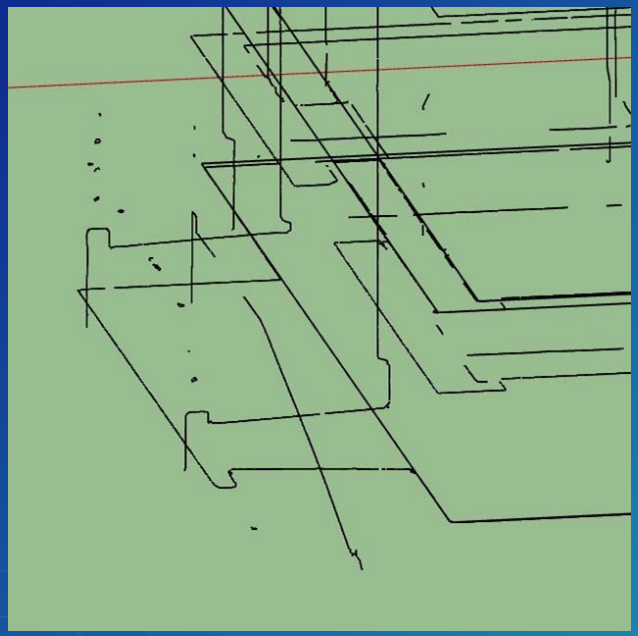


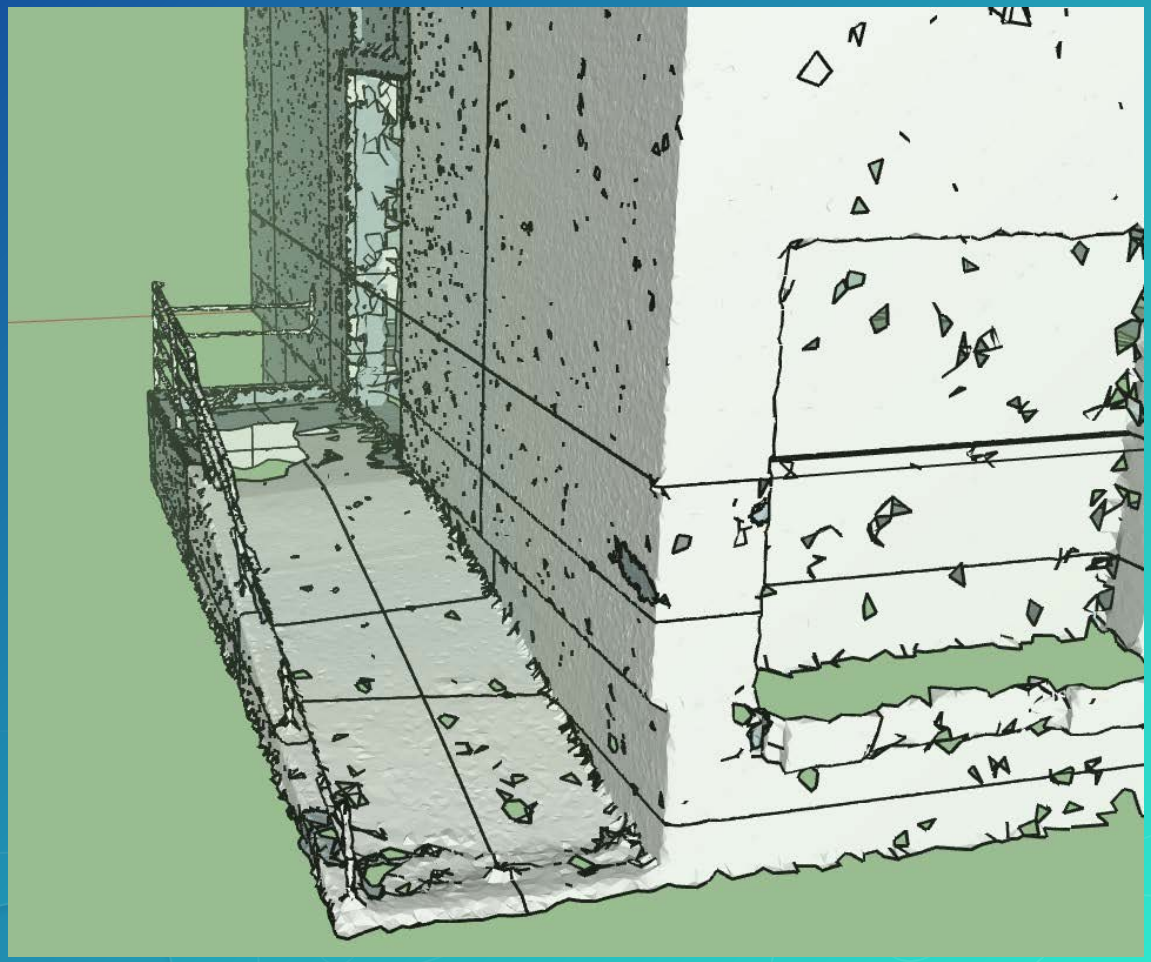
Results

Product, Issues, Recommendations

Reality Captured

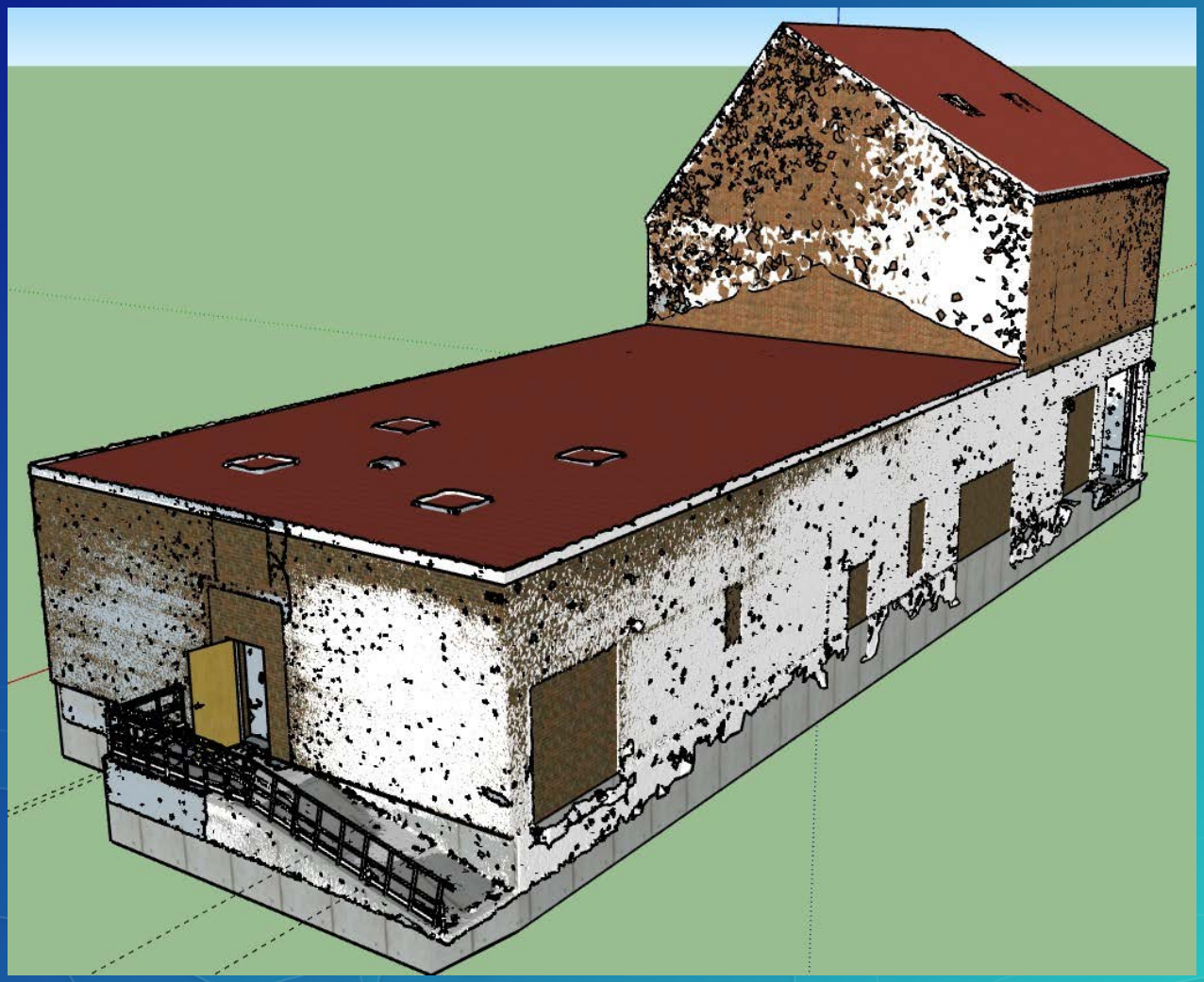
Detail like angled ramp is not lost to generic modeling





Reality Captured

Error tracking possible by comparing mesh with modeled surfaces. Deviation between measured and modeled data revealed in surface difference maps.



Results are portable and accessible

Visualization is at the team's fingertips

ArcGIS Online Link

esri

CityEngine

GIS > 3D

Questions

Acknowledgments

CloudCompare: danielgm.net GNU GPL

MeshLab: meshlab.net, isti.cnr.it (open source)