Tim Hitchins
GEOG 593
Final Project Abstract

Title:
Volume Calculation & Weight Estimation of an Immovable Urban Terrain Object
A DIY Application of Structure from Motion – Photogrammetric Multi-View Stereo

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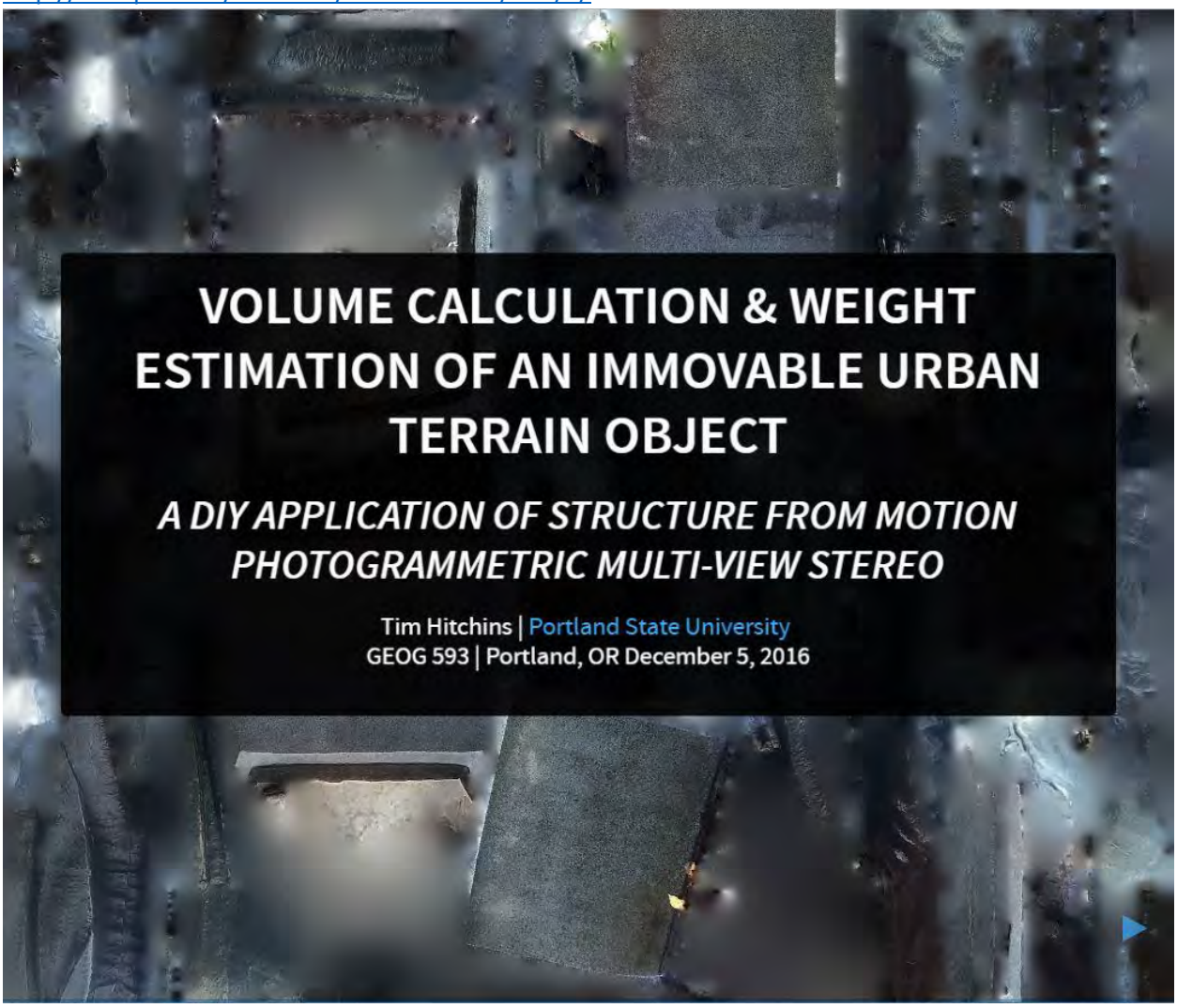
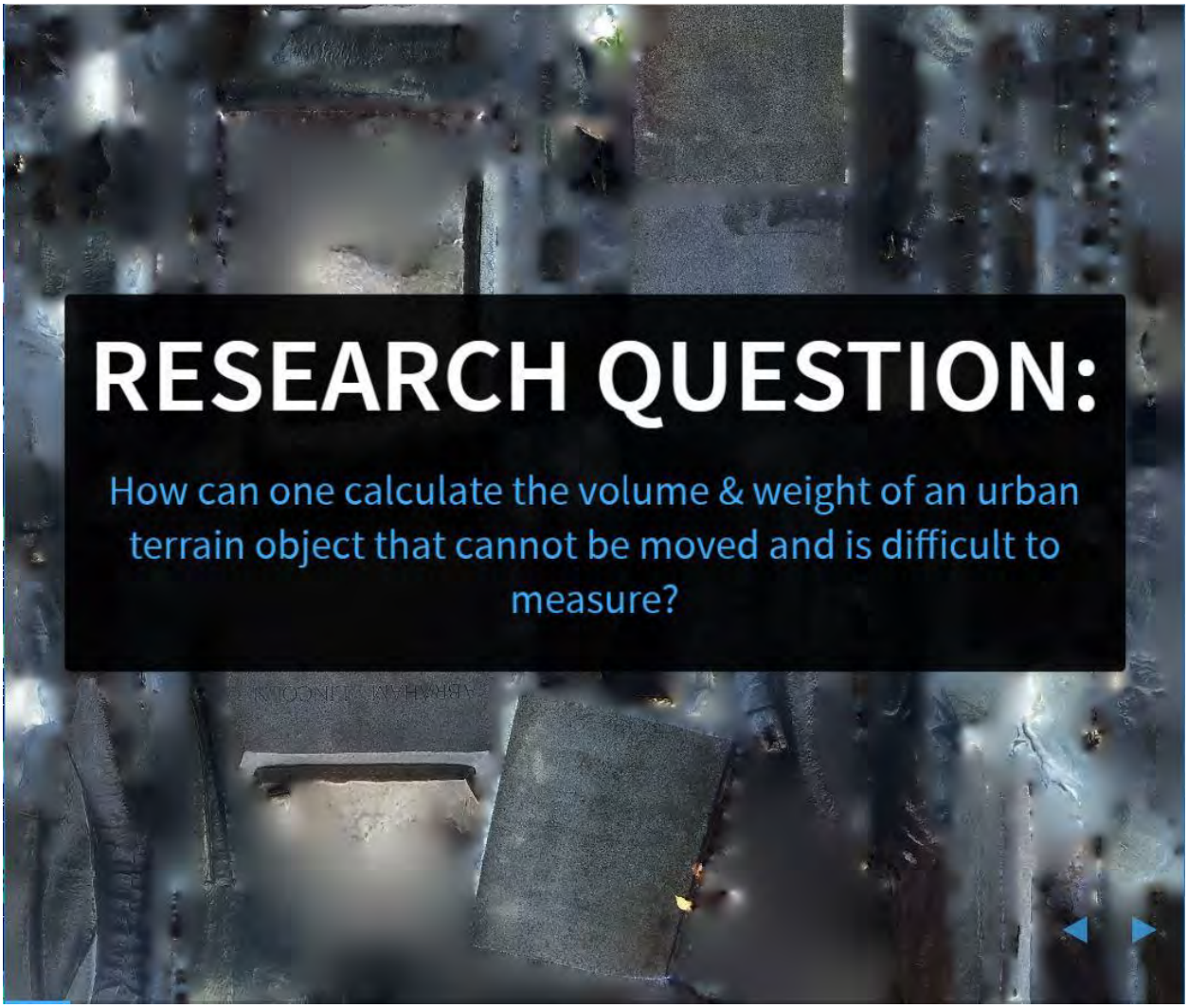
Abstract:
Immovable urban terrain objects are difficult to measure for volume and weight. Such calculations may require a manual workflow calling for large, expensive equipment and a crew of people. So how can a citizen scientist without many resources, cheaply and effectively calculate the volume and estimate the weight of such an object? This project answers that question using photogrammetric multi-view stereo (structure form motion) techniques to build a 3D model of the Abraham Lincoln sculpture, located in Portland, OR's South Park Blocks. The researcher uses his personal 12 Megapixel cellphone camera to collect 55 photographs from positions on the ground and in the air, using an aerial pole developed by Public Lab. The photographs are edited and processed in Agisoft's PhotoScan software, where a dense 3D point cloud is generated and transformed into a textured mesh- one that is then measured for volume and weight. The researcher discovers that low-budget data capture techniques, as well as atmospheric lighting, degrade the quality of the final output 3D model. Areas not well-represented in the photos or obstructed by atmospheric light, require some post processing to restore. Ground control points are also simulated as a method to georeference the model. Despite these challenges to data accuracy and integrity however, the final model appears realistic and is approximated to a volume of 1.9 m^3 and a weight of 9,200 kg (about the weight of an elephant).

Key Words:
Structure from Motion, photogrammetry, ground control points, citizen science, 3D model, mesh, pole mapping, volume calculation

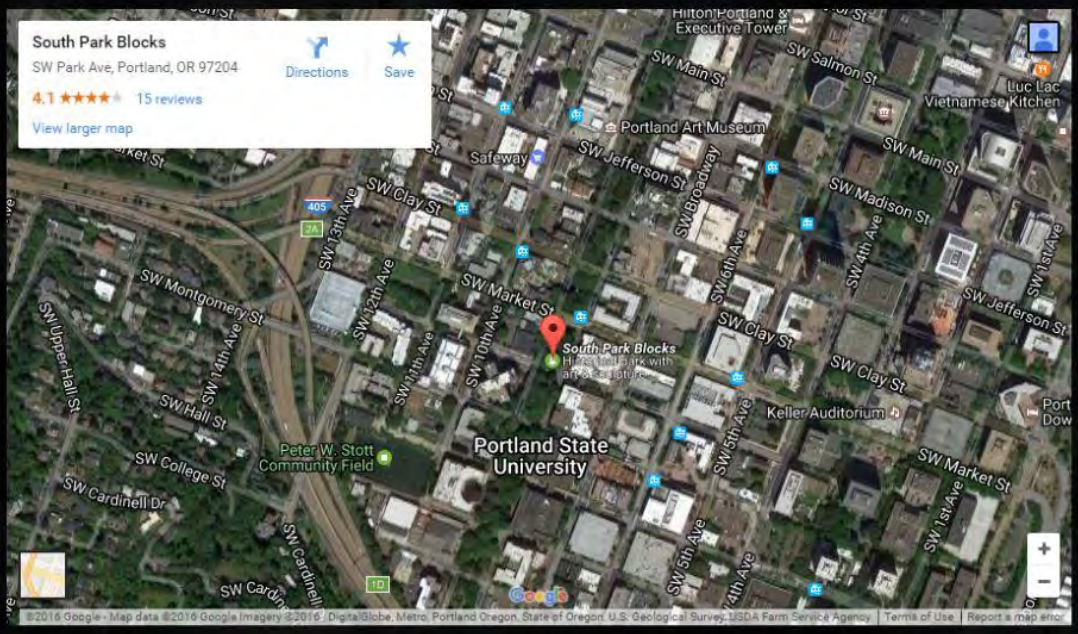
Slides:
http://web.pdx.edu/~hitchins/Presentations/Abe/index.html#/

The web link to this presentation can be found here:
http://web.pdx.edu/~hitchins/Presentations/Abe/#/




RESEARCH QUESTION:
How can one calculate the volume & weight of an urban terrain object that cannot be moved and is difficult to measure?

AREA OF STUDY: AERIAL VIEW



AREA OF STUDY: STREET VIEW


DIY METHODS AND WORKFLOW:
UTILIZE ACCESSIBLE TOOLS
• capture photos with my broken 12 MP phone
• use pole and interval photo app for "aerial" photos
• collect GCP with Trimbe Juno
• use PhotoScan free license x2 to create 3D model
• calculate volume and weight from closed mesh
• Limitations?

TOOLS

PhotoScan

3D Modeling and Mapping

Agisoft

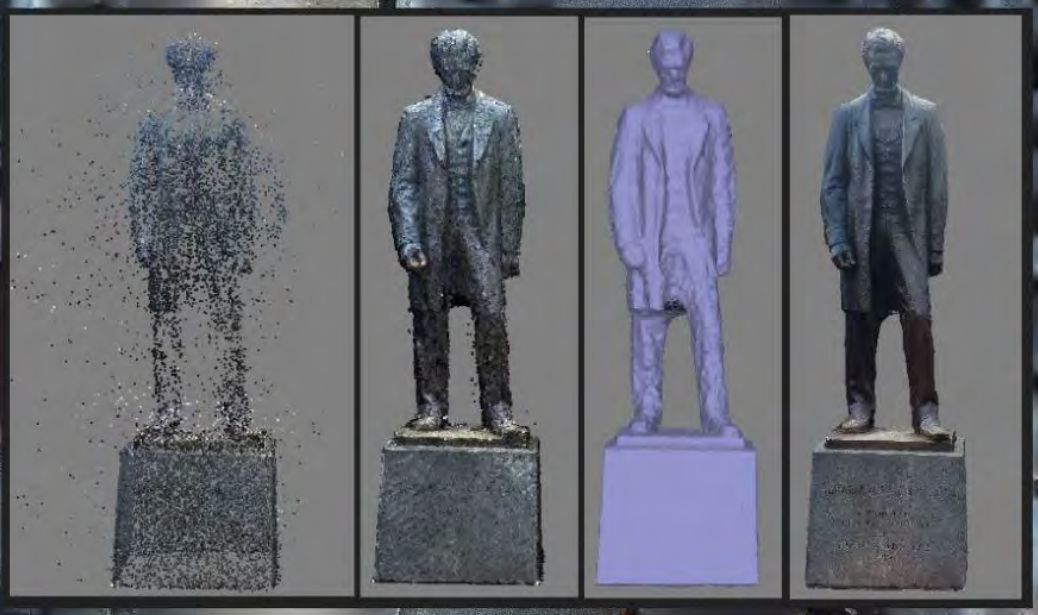
PHOTOS FROM THE GROUND

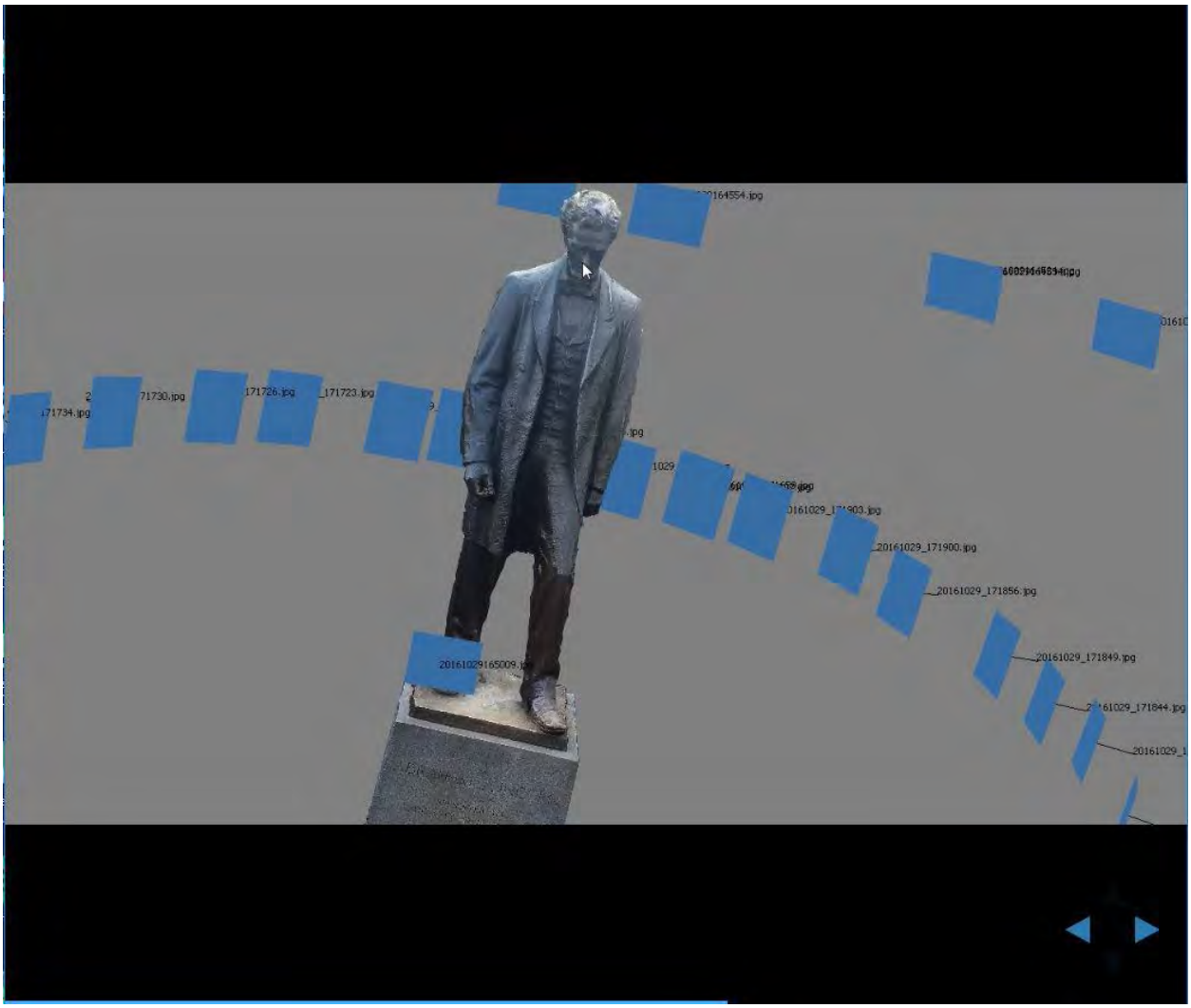
PHOTOS FROM THE POLE

QUALITY OF DATA CAPTURE

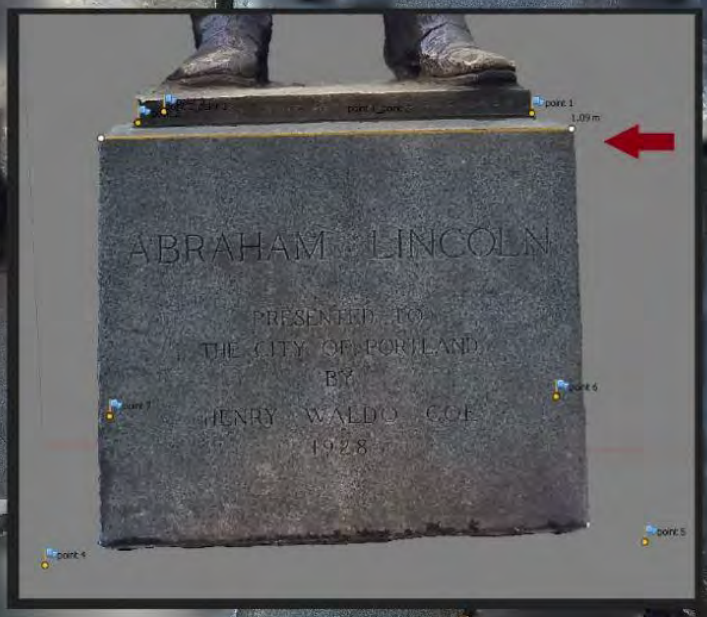
MASKING OUT NOISE

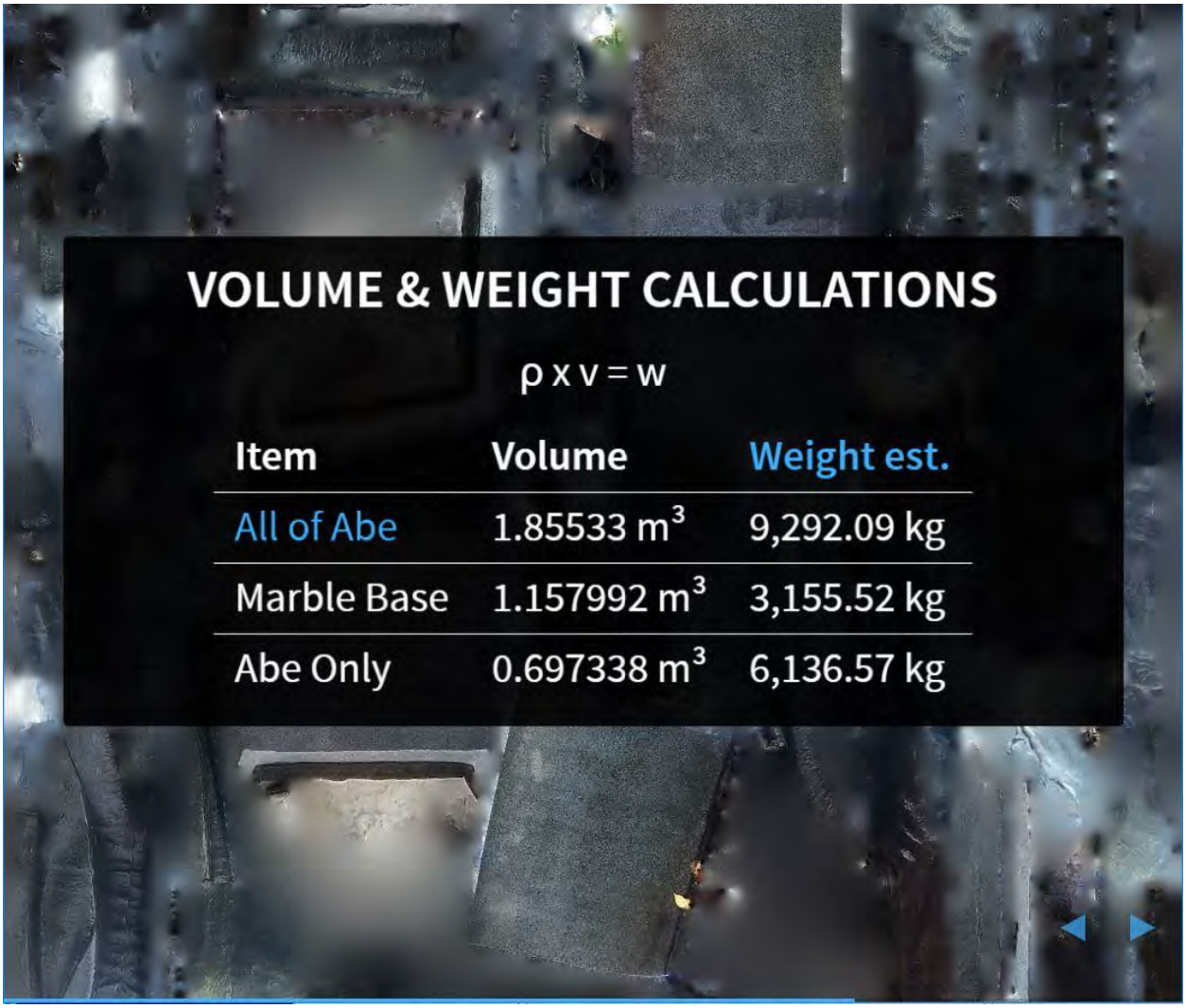
STRUCTURE FROM MOTION WORKFLOW



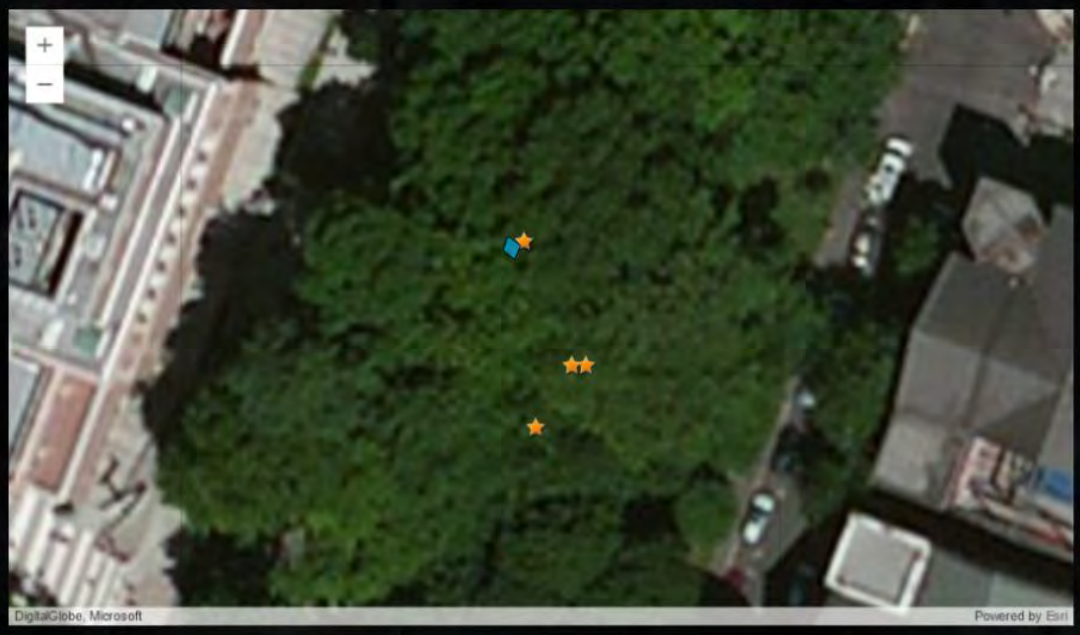

20161029_171900.jpg
20161029_171856.jpg
20161029_171849.jpg

SCALING

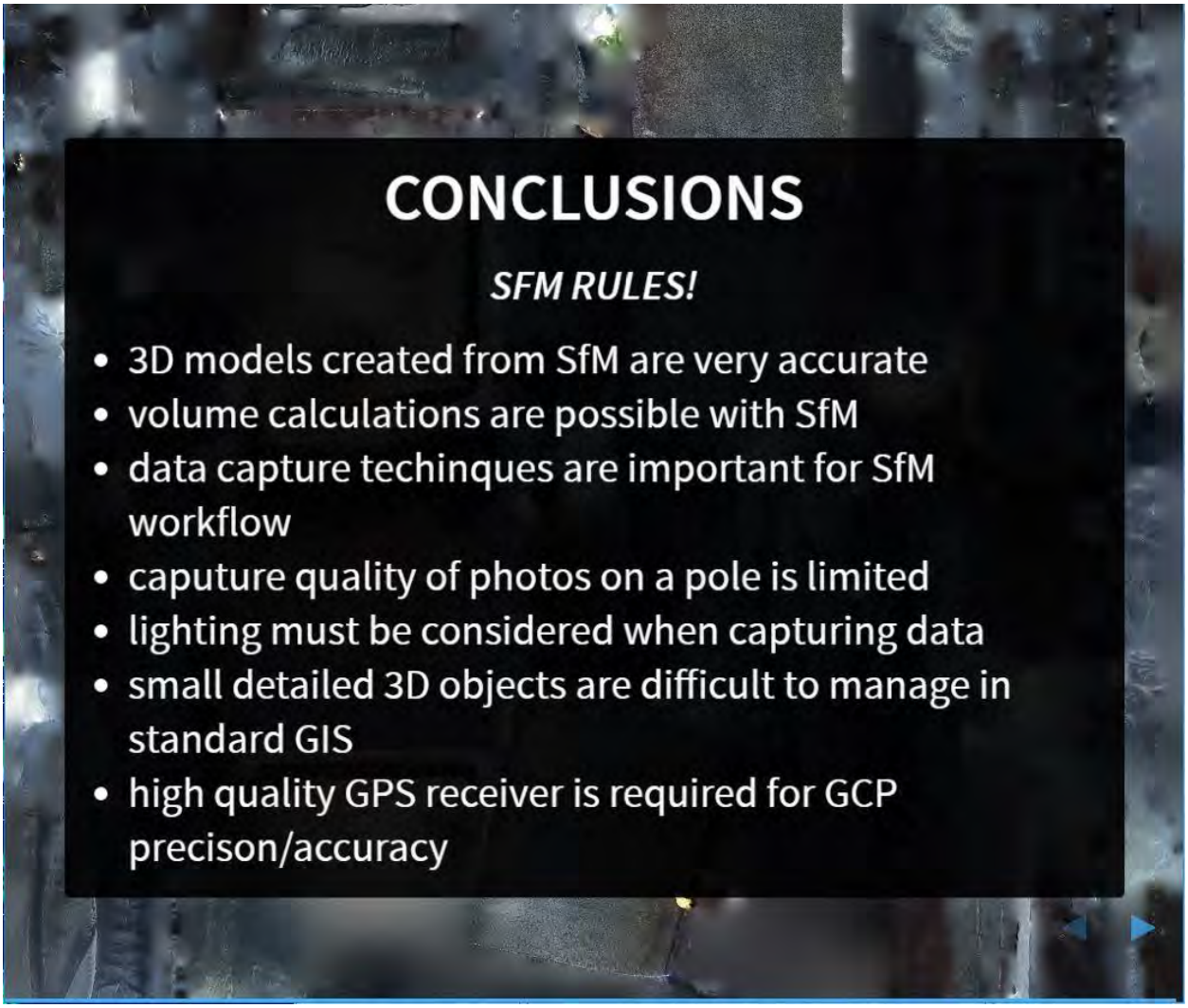

point 1
1.09 m
ABRAHAM LINCOLN
PRESENTED TO
THE CITY OF PORTLAND
BY
HENRY WALDO COE
1928
point 4
point 5
point 6
point 7


VOLUME & WEIGHT CALCULATIONS
ρ x v = w
Item
Volume
Weight est.
All of Abe
1.85533 m3
9,292.09 kg
Marble Base
1.157992 m3
3,155.52 kg
Abe Only
0.697338 m3
6,136.57 kg

GROUND CONTROL LIMITATIONS




PYTHON SAVED ME...
import PhotoScan
import math
T = PhotoScan.Matrix([[R[0,0], R[0,1], R[0,2], C[0]], [R[1,0], R[1,1], R[1,2], C[1]], [R[2,0], R[2,1], R[2,2], C[2]], [0, 0, 0, 1]])
#resulting chunk transformation matrix
chunk.transform.matrix = S * T.inv()


CONCLUSIONS
SFM RULES!
• 3D models created from SfM are very accurate
• volume calculations are possible with SfM
• data capture techinques are important for SfM workflow
• caputure quality of photos on a pole is limited
• lighting must be considered when capturing data
• small detailed 3D objects are difficult to manage in standard GIS
• high quality GPS receiver is required for GCP precison/accuracy


QUESTIONS?