Can 3D models be used for Geological Studies?

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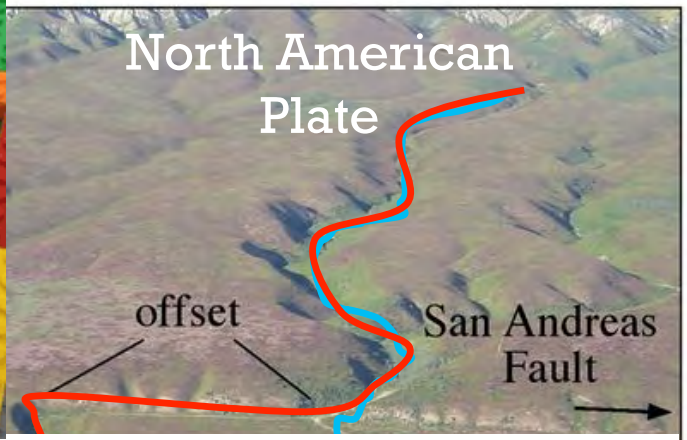
What do geologists do?

- Measure changes in landscape
- Find ages of rocks
- Forecast earthquakes



$$\frac{\text{Fault offset}}{\text{age}} = \text{fault slip rate (speed)}$$

~100 m

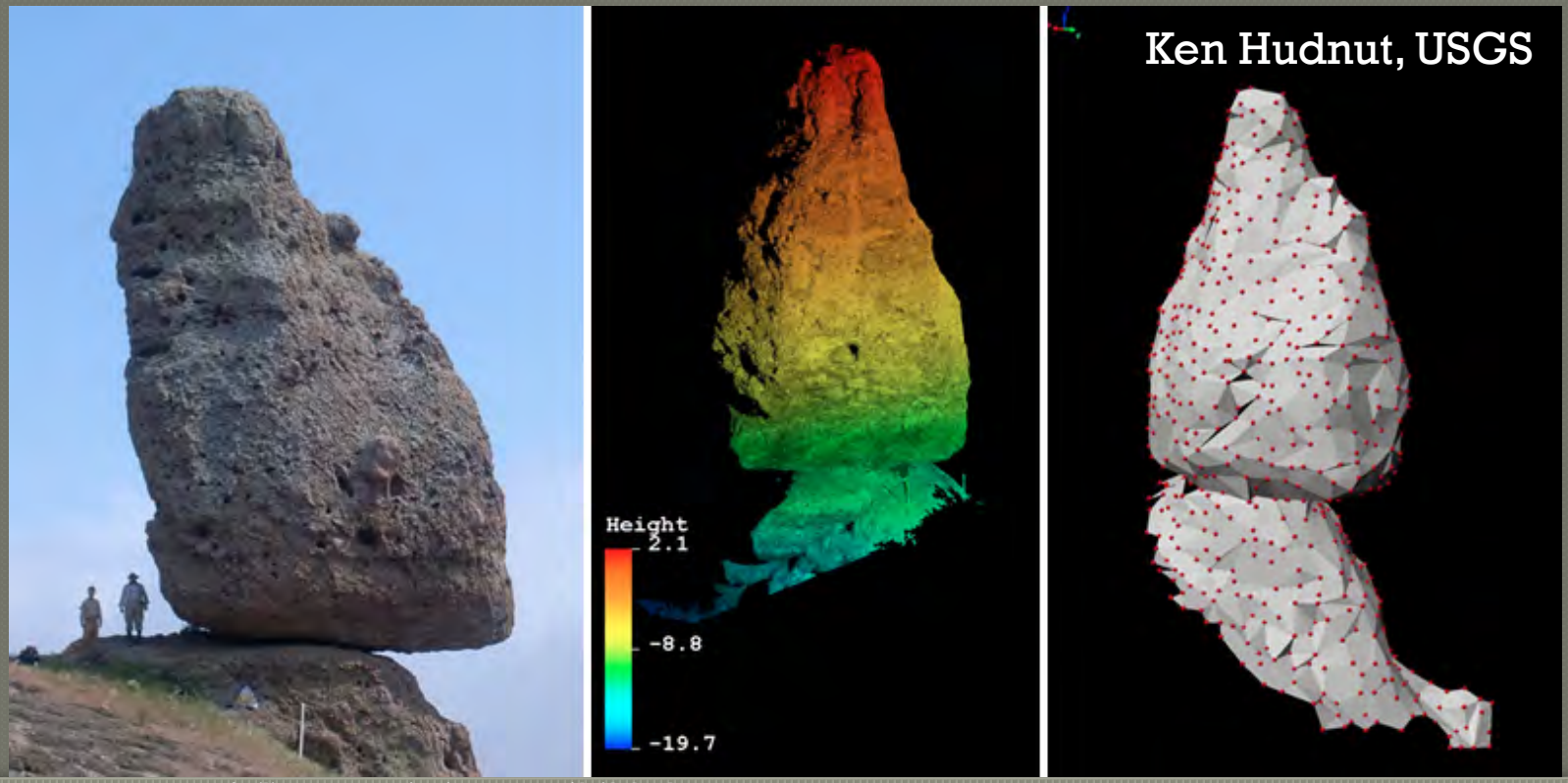
Wallace Creek

Photograph copyright by David Lynch. http://epod.usra.edu/blog/2006/12/aerial-photo-of-wallace-creek-and-san-andreas-fault.html

Animation by Luca Malatesta from the Caltech Tectonics Observatory

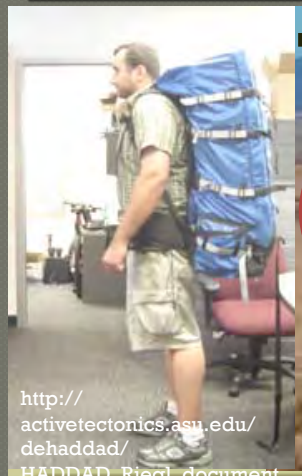
What do geologists do?

- Precariously Balanced Rocks (PBRs) using Terrestrial Laser Scanning
- Link to fault activity beneath Los Angeles



facility.unavco.org/project_support/tls/tls.html

What tools do geologists use?



http://activetectonics.asu.edu/dehaddad/HADDAD_Riegl_documentation.pdf

Terrestrial LiDAR

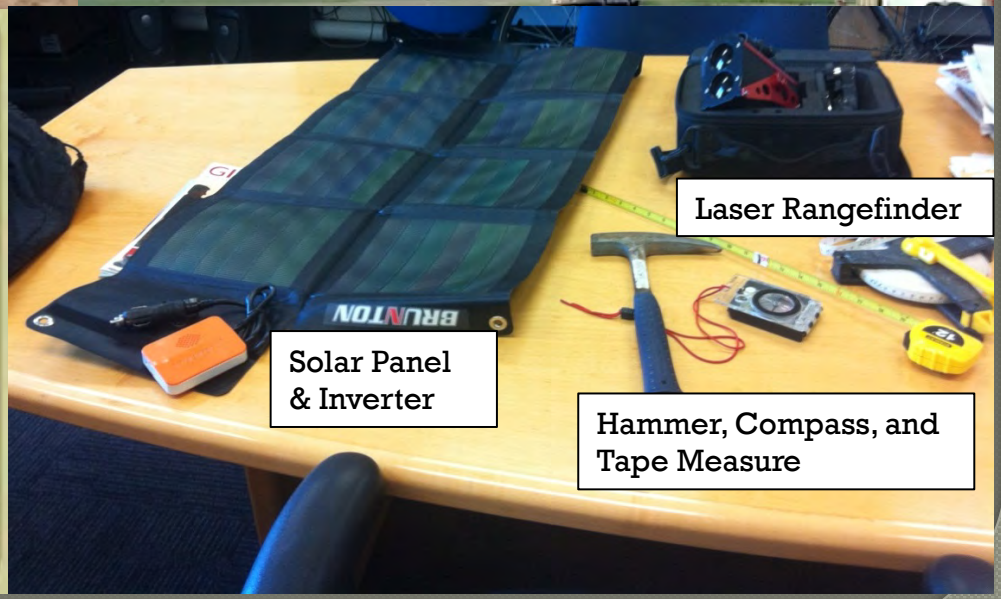
http://sgst.wr.usgs.gov/dunes/files/2011/07/GB_LiDAR_2-300x218.jpg

Aerial

http://www.milehicopters.com/lidar/

GPS

http://www.monasheesurveying.com/images/gps.jpg



Solar Panel & Inverter

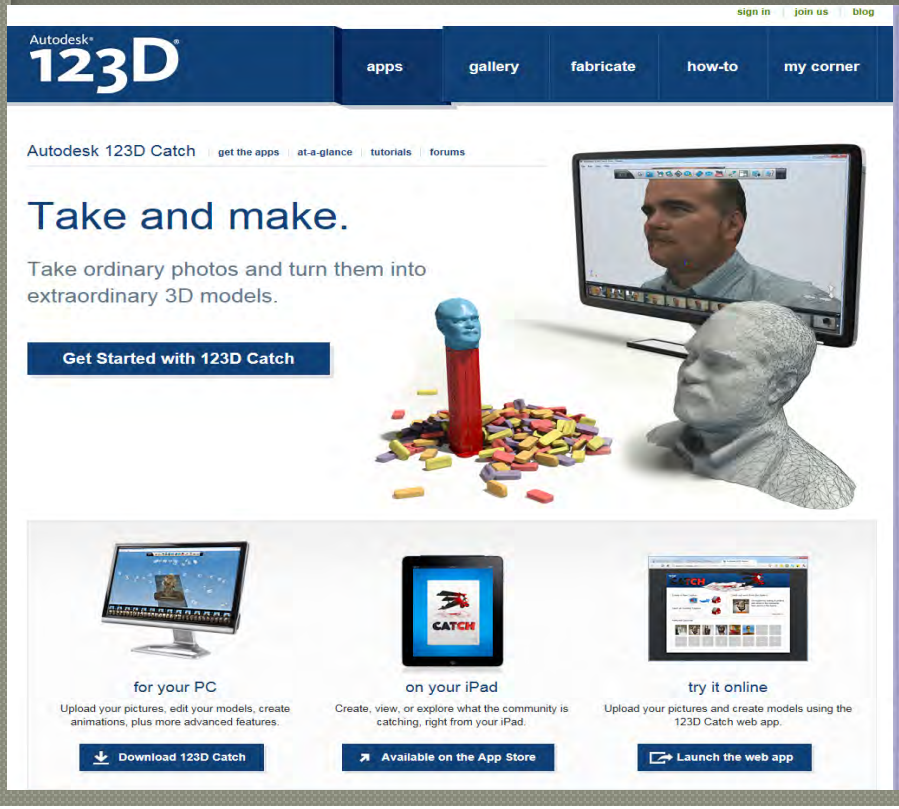
Laser Rangefinder

Hammer, Compass, and Tape Measure

Customs

Emergence of new software

- Modeling software used by engineers to design
- New free programs
  - Opportunity to experiment with possible applications



What if all you needed in the field

was a camera?

Can software be used to convert pictures into 3D models useful to geologists?

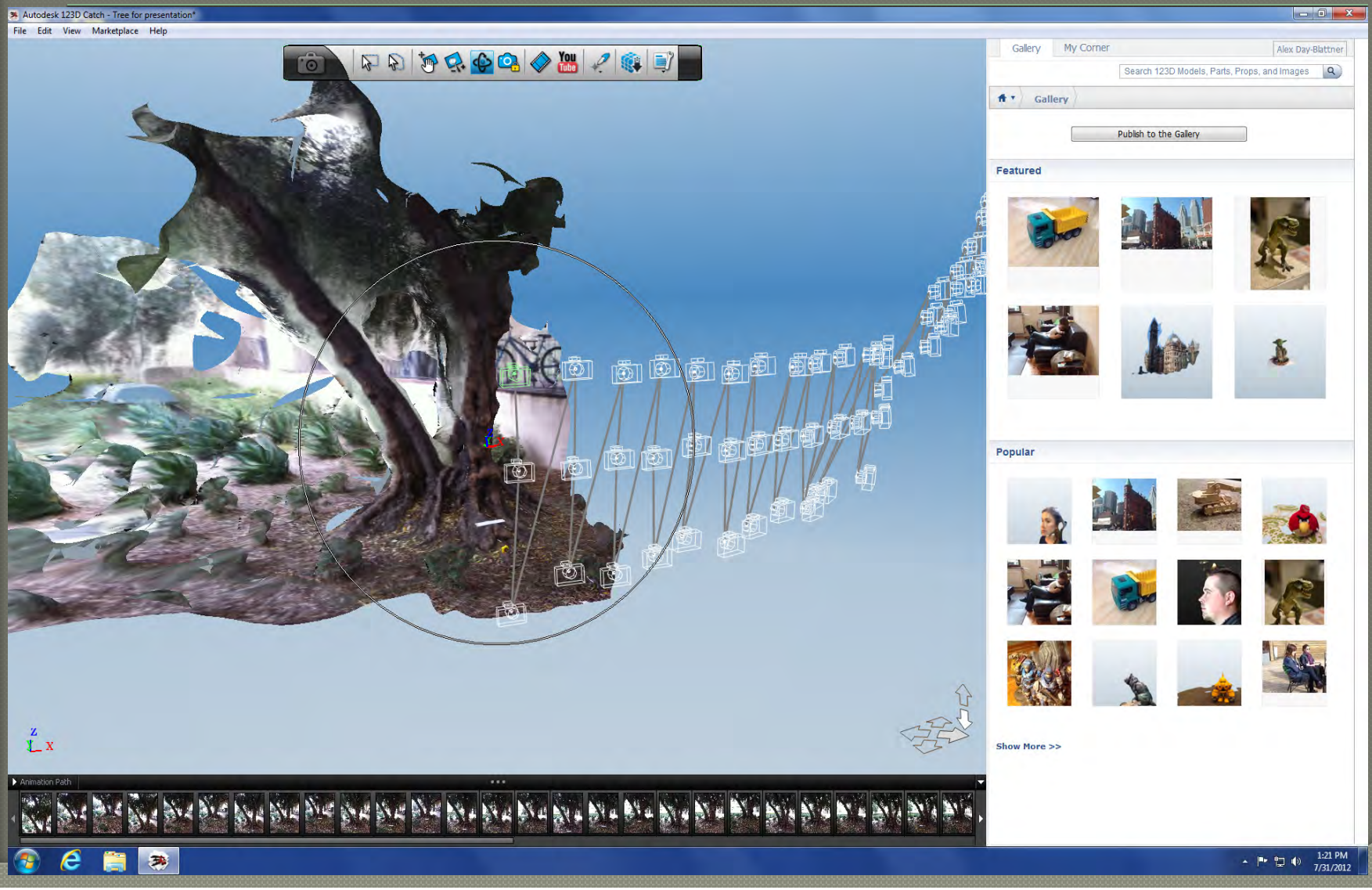
- Can we do it?
- If so, what is the best strategy?
  - Start small and work up to geological scale
  - Incorporate findings into new models
  - Develop a procedure for geologists to follow to produce successful models

From 2D to 3D using 123D Catch

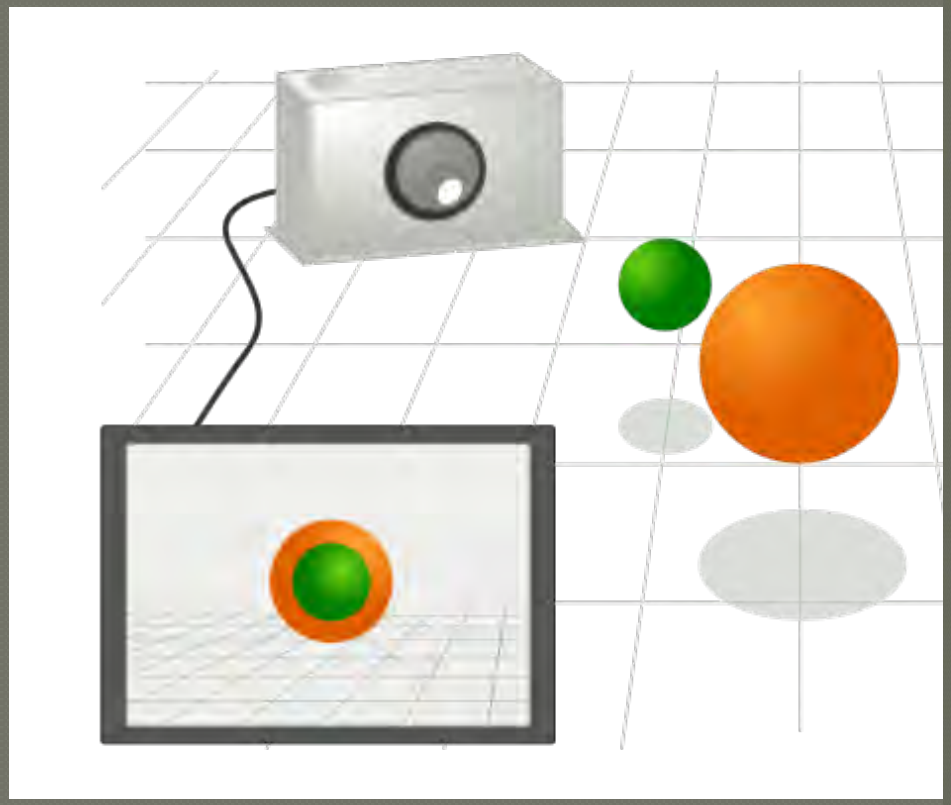
Input: 53 pictures

Output: 3D model

Getting started with 123D Catch



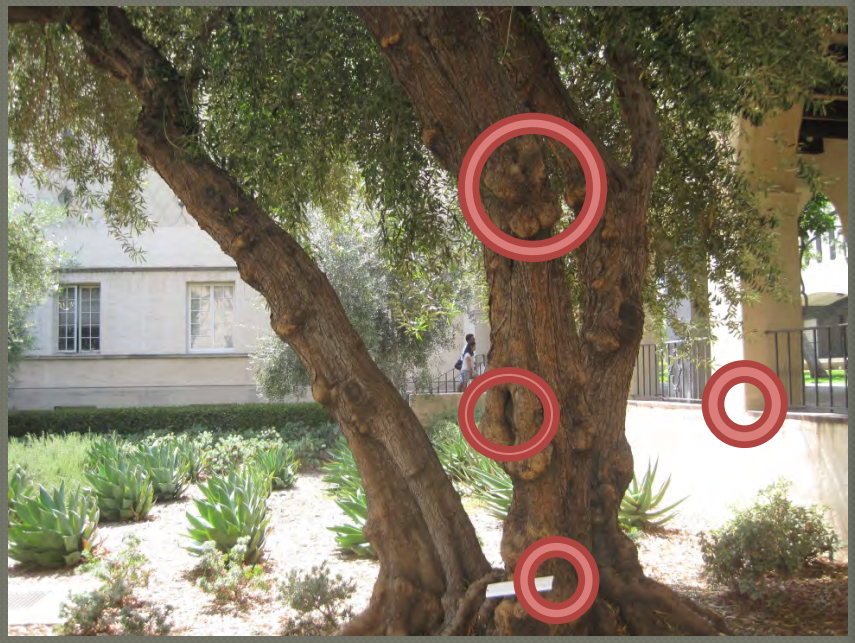
Two perspectives



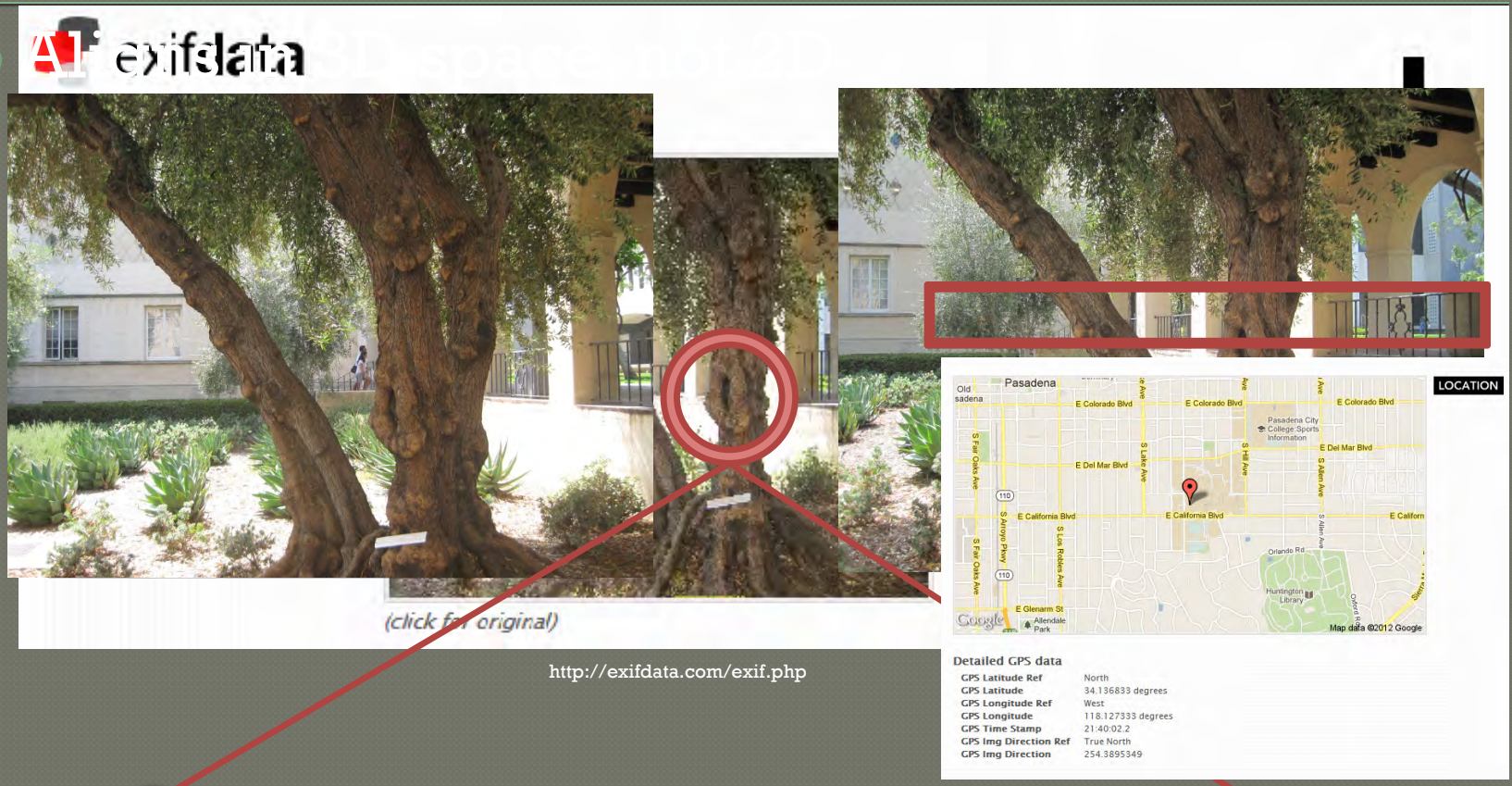
http://upload.wikimedia.org/wikipedia/commons/7/7c/Aufnahme_mit_zwei_Kameras.svg

Finding corresponding points between pictures

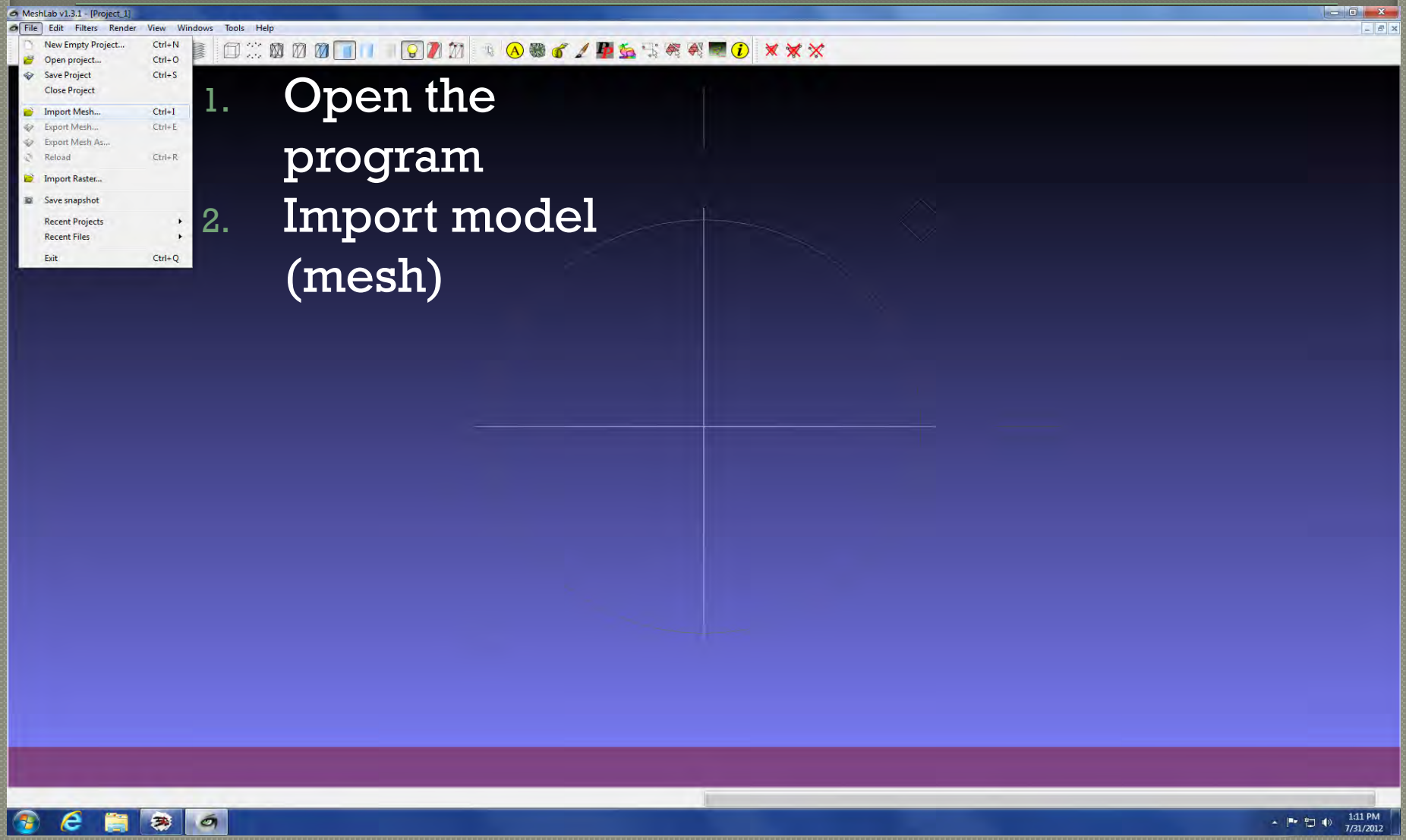
- Seeing a tree from two angles



123D Catch matches pixels & triangulates camera position

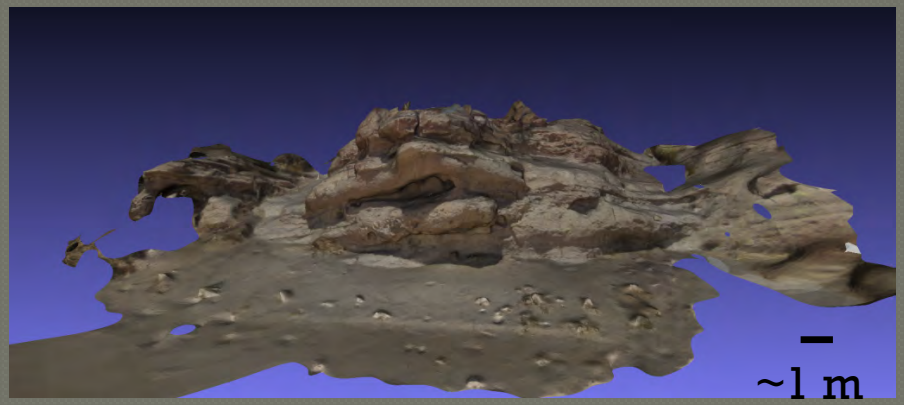


Getting started with Meshlab

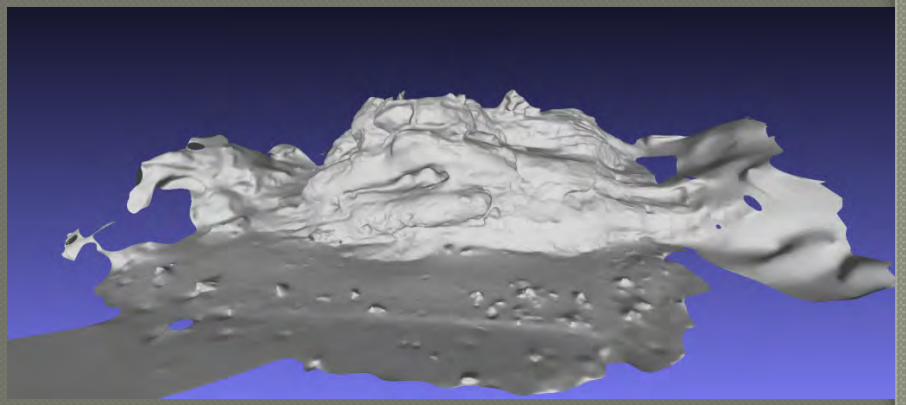


1. Open the program
2. Import model (mesh)

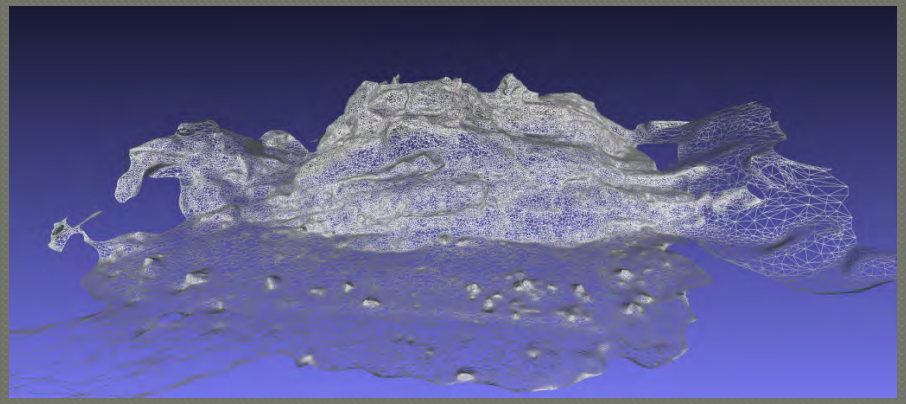
Visualizing models using Meshlab



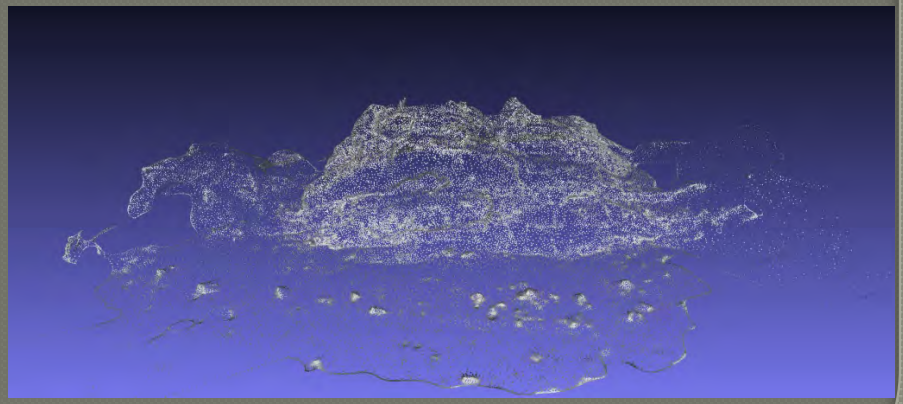
3D Textured Model



3D Texture-less Model



3D Mesh



3D Point Cloud

140 pictures

Getting started making models

- What we were told:
  - Do not use flash
  - Start with small objects
  - Look for varied textures
  - Take pictures from a wide range of angles

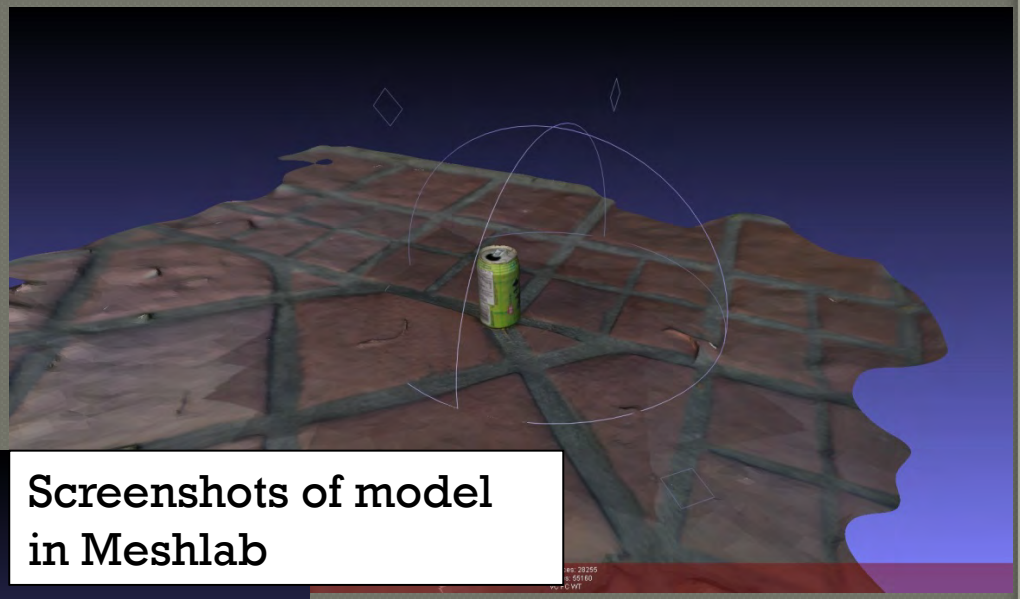
Getting started making models

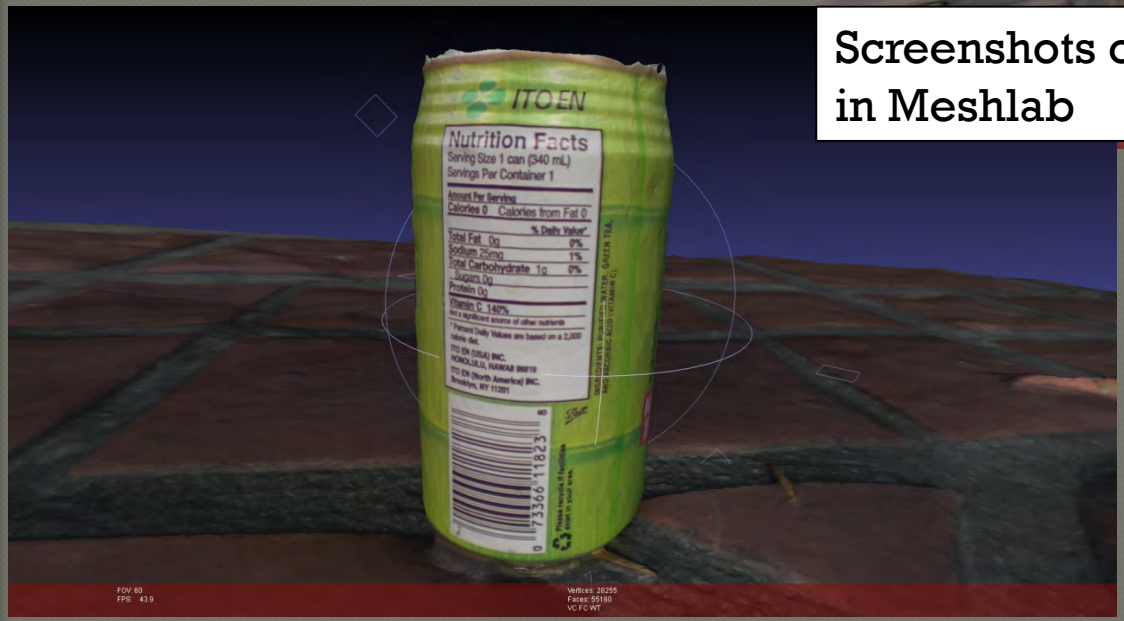
- Questions that needed answers:
  - How many pictures are needed?
  - Where to take the pictures from?
  - How much overlap between pictures?
  - Can you make measurements from the models?
  - Can GPS coordinates be assigned to the model?

- **Q:** Can 123D Catch and Meshlab be used to create 3D models for geological research?

Highly detailed model

- 33 Pictures
- 2 concentric circular paths





Screenshots of model in Meshlab

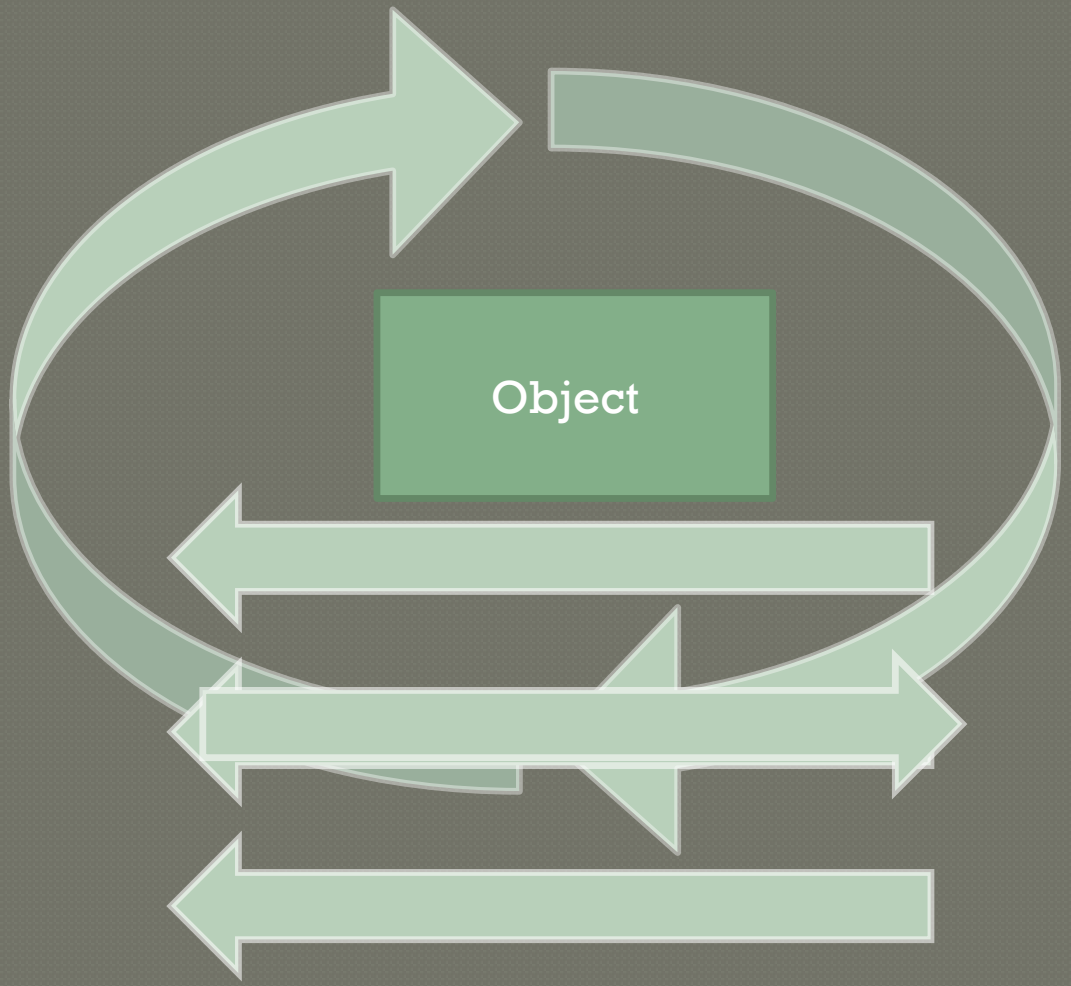
Best path for pictures is from the outside facing in

- Quad N Mudd – from inside-out vs. a rock pictured from outside-in

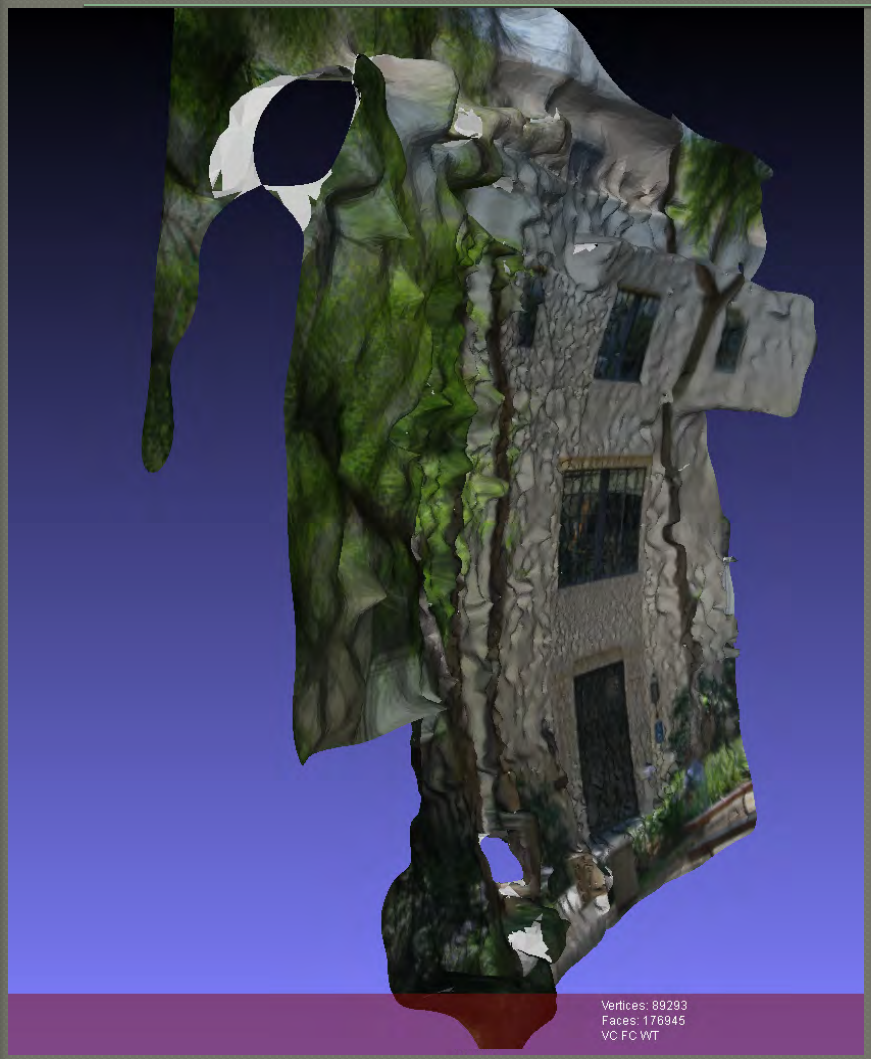
56 pictures

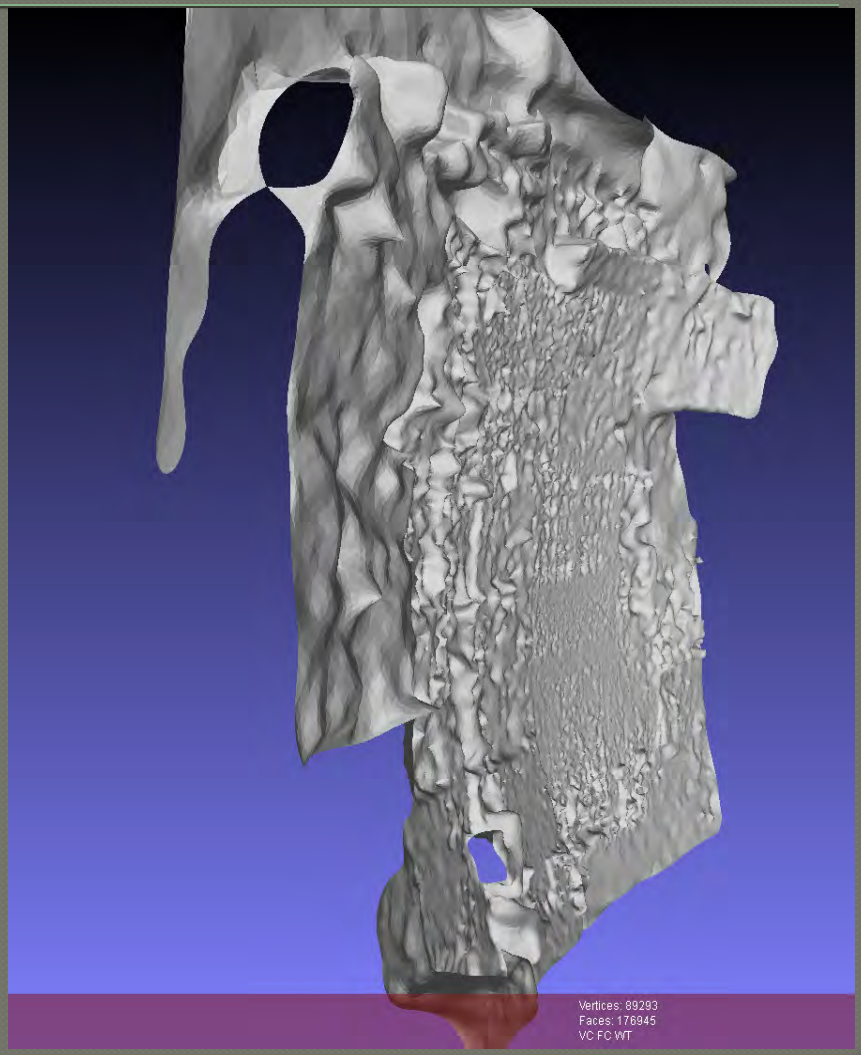
36 pictures

Best path - continuous



Moving to take pictures is necessary





35 pictures

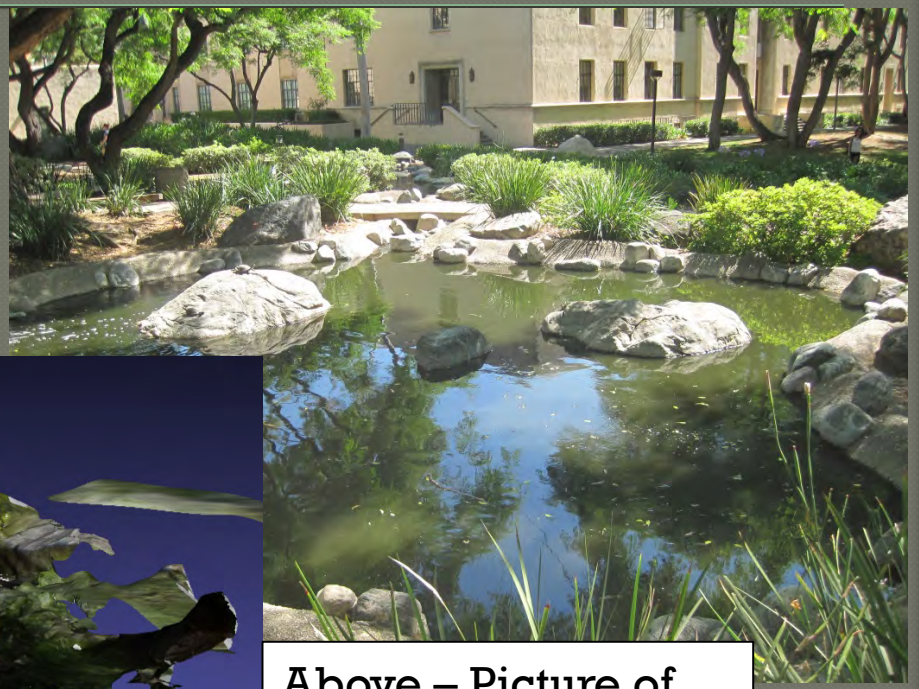
Symmetry confuses 123D Catch

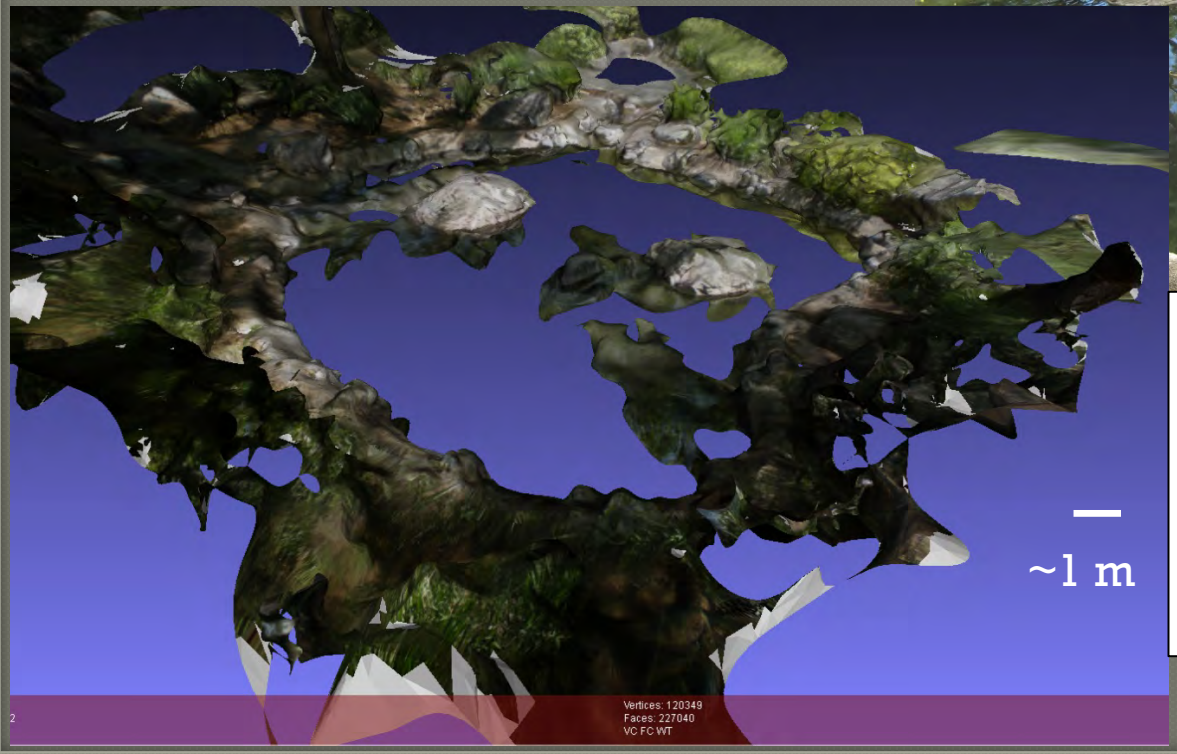
- Pictures taken in "best path" order
- Complete information about all sides provided
- 123D Catch used symmetrical features to generate the model.
- Not a problem for geologists

41 pictures

Measuring from bank to bank

- Water does not show in mesh
- Can still measure bank-to-bank





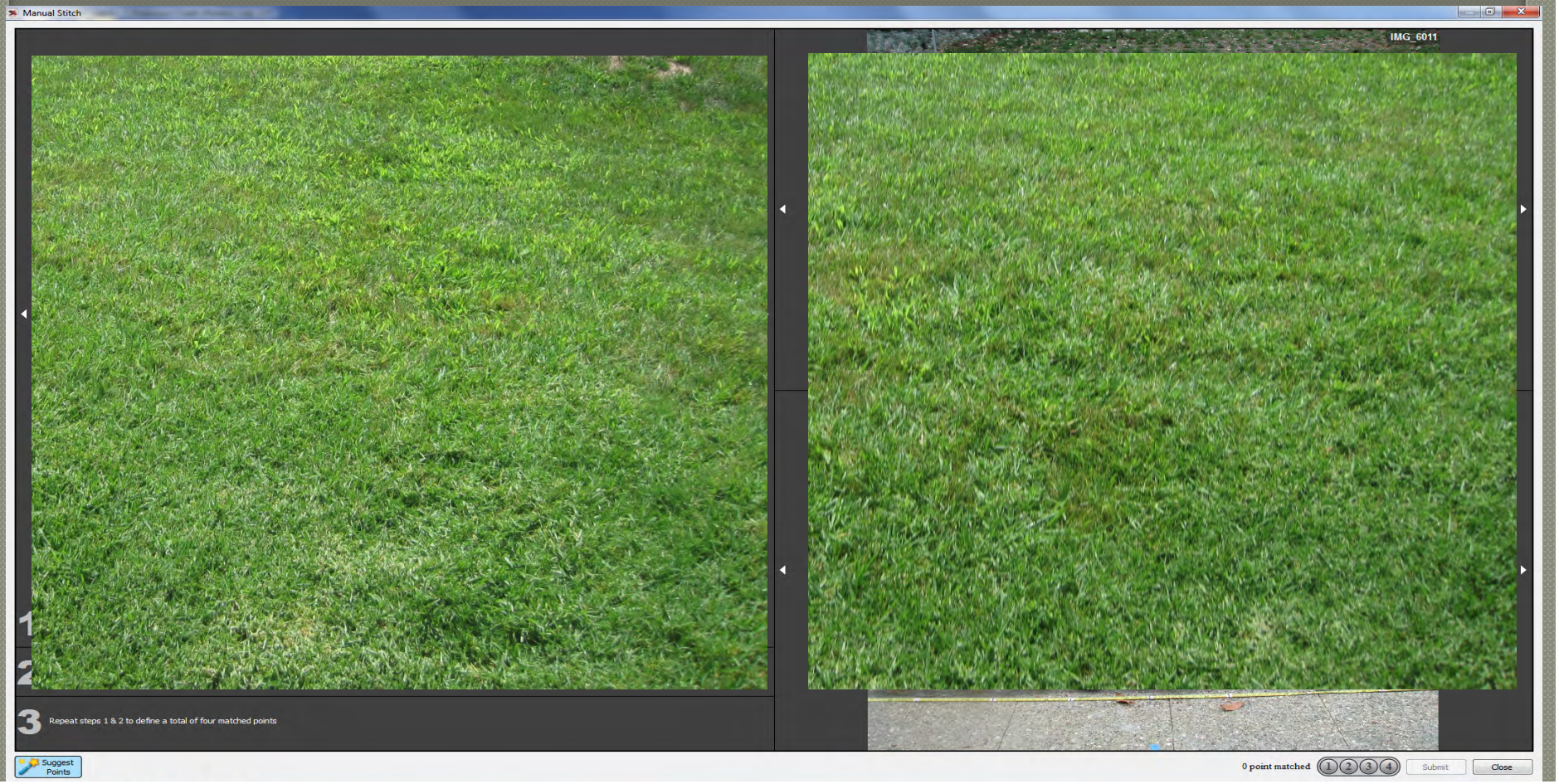
Above – Picture of Turtle Pond

Left - Screenshot of model in Meshlab

46 pictures

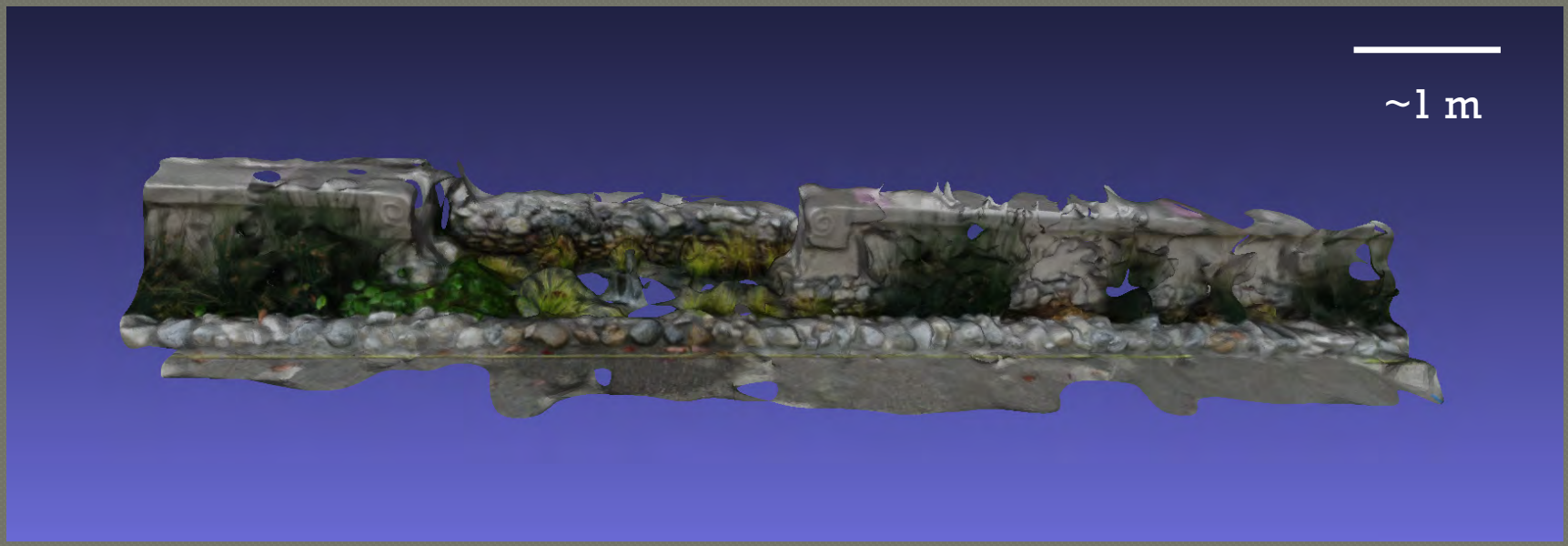
Stitching emphasizes the need to have 4 distinguishing features

- Pictures are left out of models because 123D Catch cannot recognize where it fits in.



Fine tuning models: Stitching

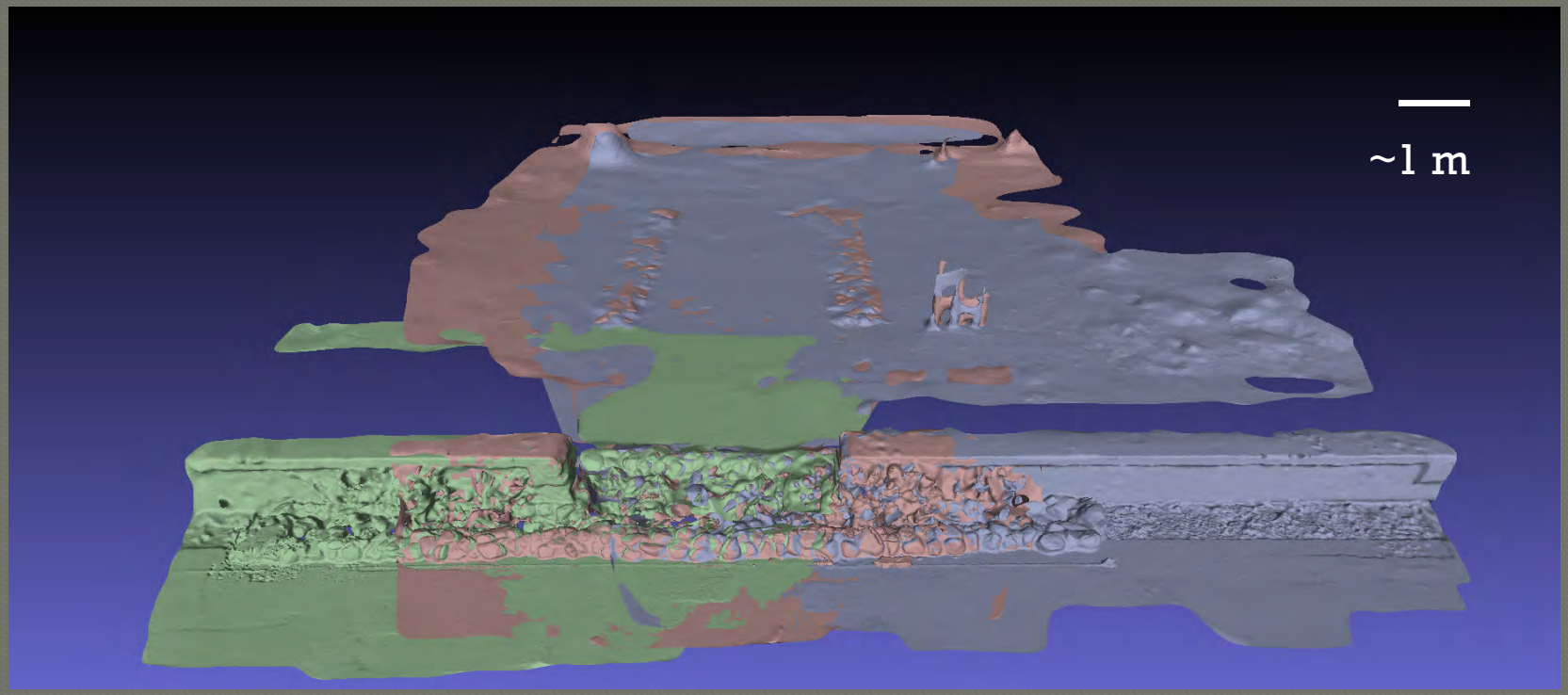
- Can "stitch" pictures into the model by manually matching pixels
  - Time consuming
  - Introduces new errors



102 pictures

Fine tuning meshes: Merging

- For larger projects, merging helps:
  - Reduce picture load per person
  - Reduce processing time

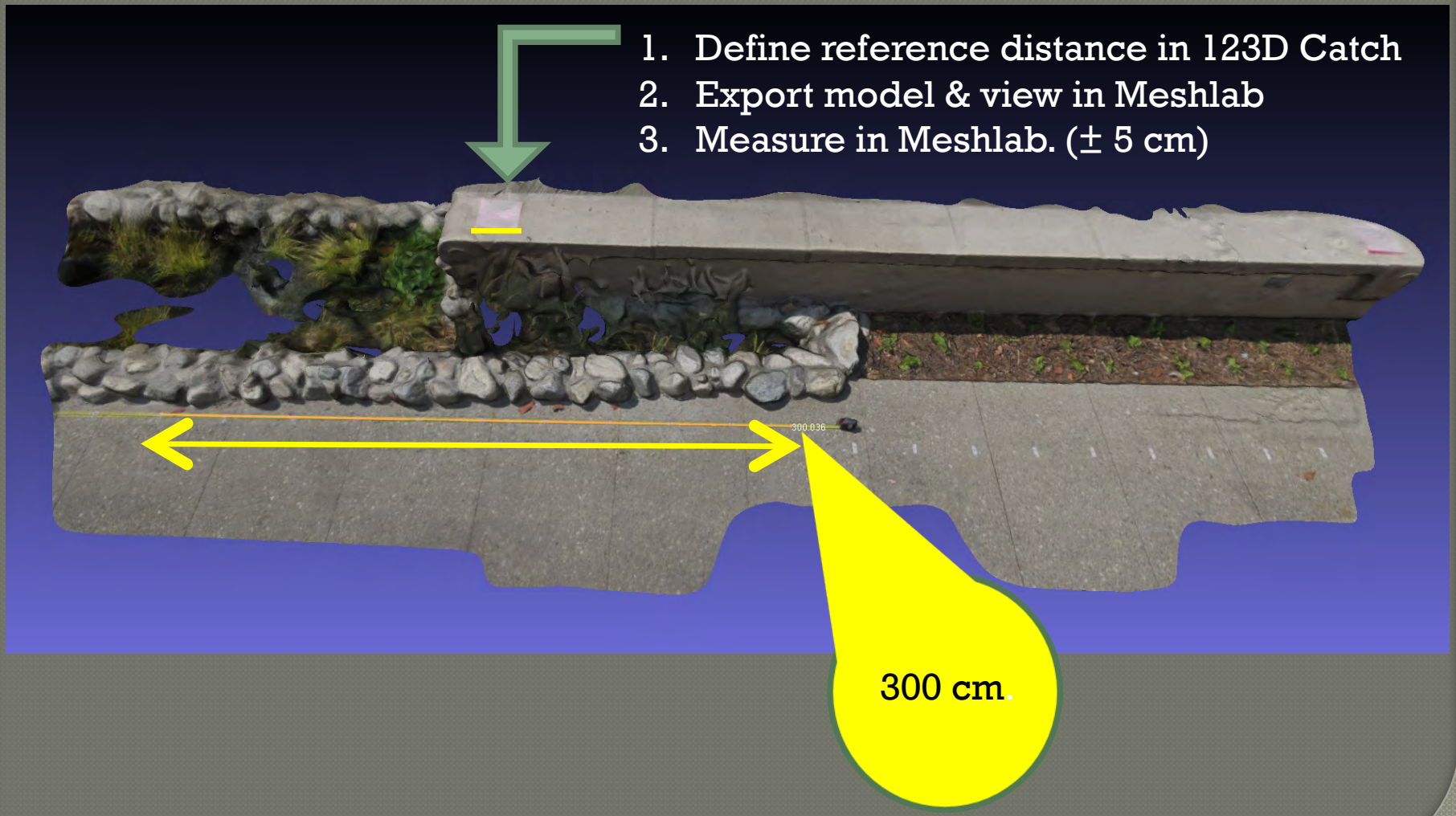


65 pictures 68 pictures 100 pictures

Fine tuning meshes: Merging

- Merging can be used to increase detail.

Measuring in Meshlab



100 pictures

Moving into the field
Vasquez Rocks County Park

Vasquez Rock model

153 pictures

Google Inc. for Google Earth pictures, www.google.com

An almost complete model of a 5 m tall rock at Vasquez Rocks

36 pictures

Conclusions

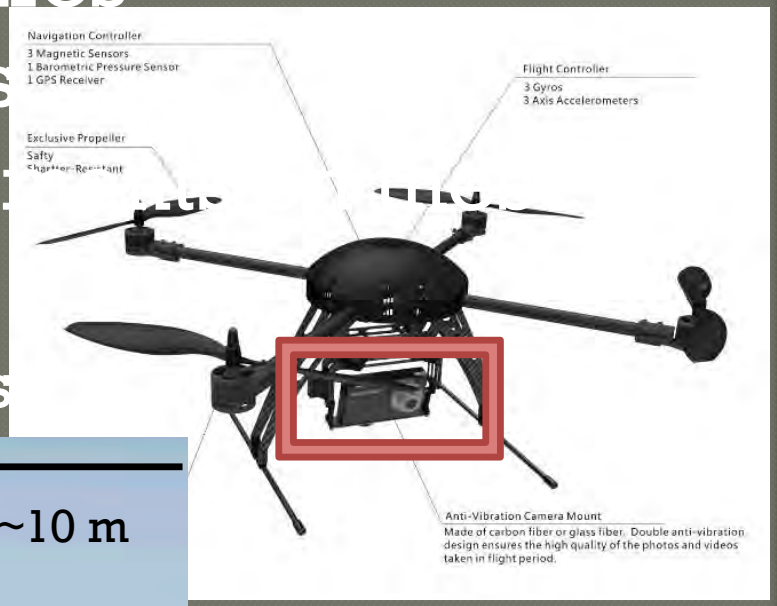
- Yes we can use the free software
  - Different cameras ✔
  - Different users ✔
  - GPS Coordinates ✘
  - Measure features ✔
  - **Geological features** ?

Conclusions

- A General Protocol:
  - No flash
  - Carefully plan photograph pathway (occlusions, vegetation, circular path)
  - 4+ Distinguishing features between every other picture
  - Start far away, move closer for additional detail
  - More photos, can discard later

Future directions

- Incorporate aerial pictures
- Attach GPS Coordinates
- Make detailed measure models
  - Profiles, slopes, and curves



http://www.infmetry.com/wp-content/uploads/2010/08/XAircraft-X650-QuadCopterQuadRotor-cool-photo.jpg

140 pictures

Acknowledgements

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Tectonics Observatory
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