3D Printing Procedures and Applications in Outreach and Field Support

August 3, 2017 Poster Session Jodi Schoonover[1], Dylan Blanchard[1], Marianne Okal[2], Christopher Crosby[2]
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Introduction

The realm of 3D printing has seen many evolutions since its invention in 1983. Beginning as an expensive, unreliable tool, improvements to 3D printers have made it affordable and dependable, two traits that are paramount to its success. The technology is more accessible than at any previous point allowing for a wide variety of users extending from novices to experts.

The Prusa i3 MK2S uses a technology called fused deposition modeling (FDM), also referred to as fused filament fabrication (FFF). FDM is an additive process contrasting the subtractive process used in most manufacturing. This allows for less waste and also an inexpensive alternative to rapid prototyping. The ability to make singular prints on a small scale has proven useful in a myriad of practices.

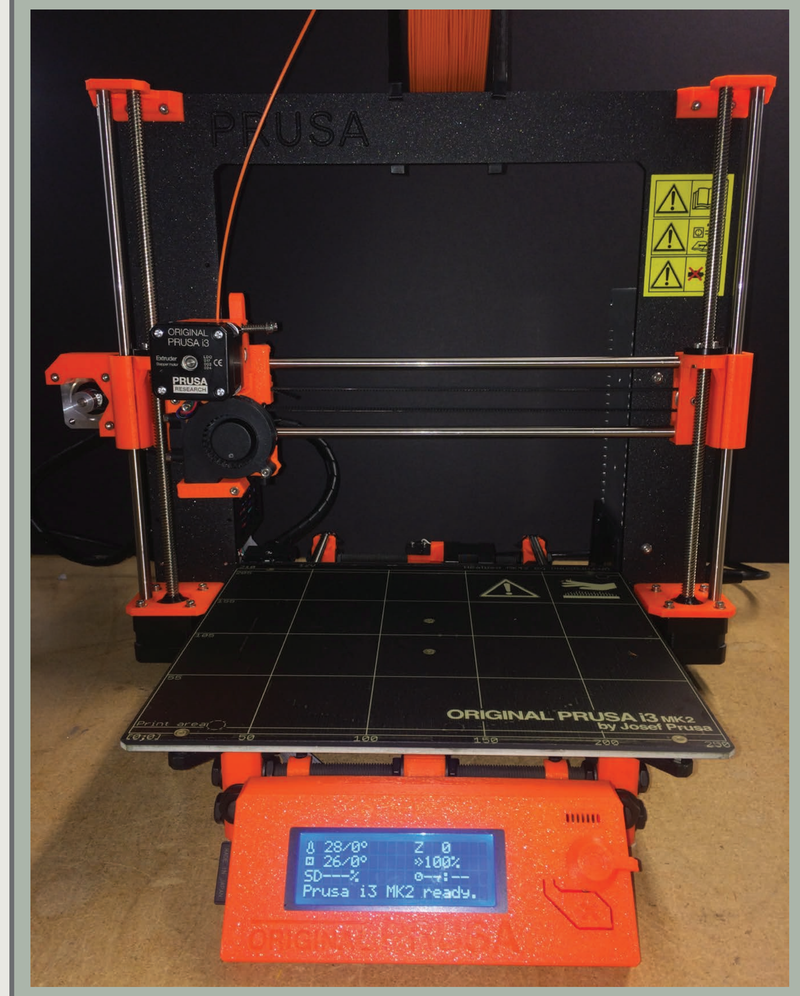

Figure 1: The Prusa i3 MK2 post assembly.

Outreach

Figure 14: Printed Cephalopod Mollusk fossil published by Geofablab in Thingiverse.

3D printing's full potential lies in its ability to make abstract concepts tangible. The technology's philosophy is to open-source information. Repositories like the website "Thingiverse" exist to distribute designs under Creative Commons licenses. A 3D printed fossil from Thingiverse is seen on the left.

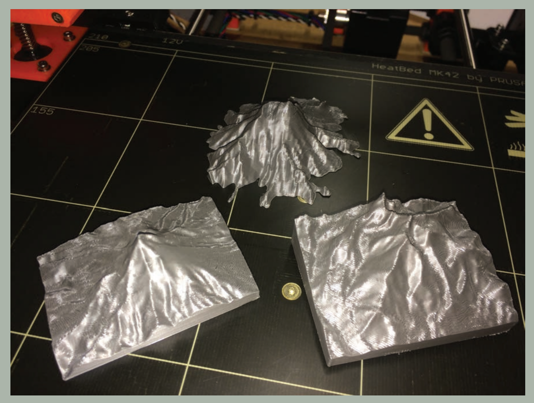

Figure 15: Mt Hood created from Terrain2STL, Mt Pelee created from Thingiverse, Longs Peak created from OpenTopography.

Figure 16: Marianne Okal discussing the Garwood Valley project in Antartica, aided by the 3D print, with Dylan Blanchard and Jodi Schoonover.

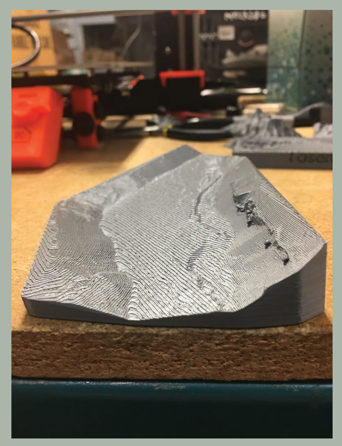

Figure 17: A profile view of Garwood Valley, Antarctica, created from TLS data.

However, with a tangible example of a fault slip in their hands, the disconnect can be bridged and an interest fostered. With new innovations and competition continually driving down the cost of 3D printers, the ability for educators to design lessons around them grows in tandem. These designs not only include basic toys and tools, but models of fossils, volcanoes, fault lines, car engines, and shaking tables for earthquake simulations. A student that was uninterested in subjects like seismology may have only been so because he or she could not connect to a textbook or lecture about the science.

Assembly and Calibration

The official Prusa manual was primarily used as a guide during assembly.

Assembly problems included:
- Misaligned pulley on Y-axis
- Dislodged nut in printer extruder
- Loose LCD cable

Resolutions included:
- Realignment of Y-idler
- Deconstructing and rebuilding extruder
- Reinsertion of motherboard cables

Calibration problems included:
- Gyration of X-axis belt
- Imbalance of Y-axis
- Misalignment of Z-axis

Resolutions included:
- Realignment of X-axis belt motor guide
- Applied torsion to Y-axis
- Adjustment of P.I.N.D.A. probe

Figure 2: The Prusa i3 MK2 during assembly showing completed y-axis.

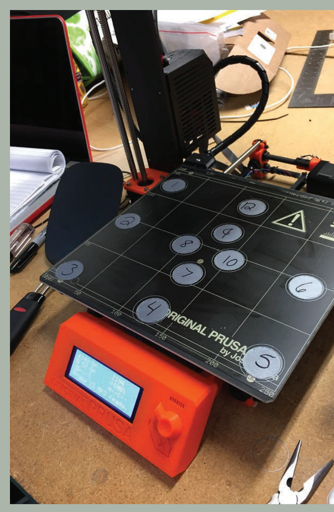

Figure 3: Calibration of the z-axis across entire heat bed.

Figure 4: Dylan Blanchard and Jodi Schoonover working on the 3D printer during its operation.

Field Support

In preparation for the total solar eclipse next month, researchers at MIT will be using UNAVCO campaign boxes to improve understanding of such events. During the eclipse, roughly ten boxes will be monitoring possible disturbances in the ionosphere. The goal is to better understand these disturbances and how they vary from different positions on Earth.

To provide these campaign boxes to the primary investigator, UNAVCO has relied on proprietary designs for these boxes. Previously, because the manufacturer did not sell individual parts, a brand new box was required for replacements. For a simple wire cap (the most fragile part of the system), this was a $100 fix. However, the 3D printer has allowed UNAVCO to acquire new parts at a fraction of this cost. A recreation of the cap was created, printed, and performs identical to the original part while also reducing waste.

Figure 18: A campaign box using printed caps to attach to a solar panel.

Figure 19: Left, one of the basic caps printed for the campaign boxes. Right, a cap with power connections designed to interface with solar panels.

Software Workflows

OpenTopography Data to 3D Model[1]

1.

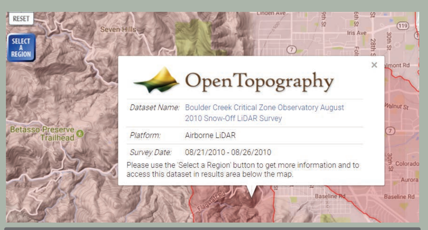

Figure 5: Open-Source repository for LiDAR data.

2.

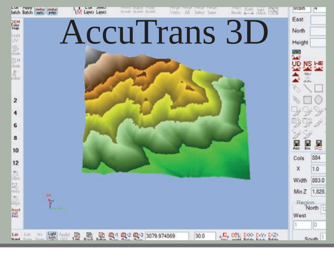

Figure 6: LiDAR data of the Boulder Flatirons from Open Topography imported into AccuTrans.

3.

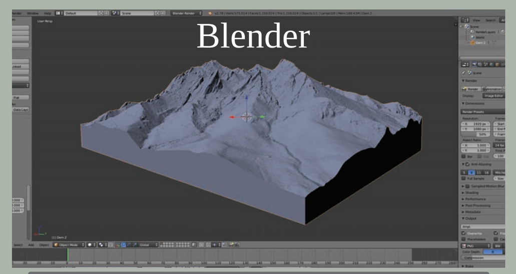

Figure 7: Completed model of the Boulder Flatirons in Blender.

4.

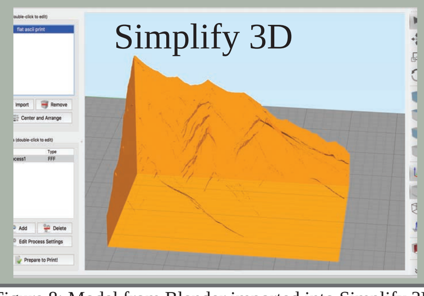

Figure 8: Model from Blender imported into Simplify 3D to create printable file.

LiDAR Data to 3D Model[2]

1.

Figure 9: A tool used to covert data from ellipsoid to geoid coordinates.

2.

Figure 10: Visualization of a LiDAR point cloud in RiSCAN showing outline of Garwood Valley in Antarctica.

3.

Figure 11: Mesh has been applied to the point cloud in CloudCompare.

4.

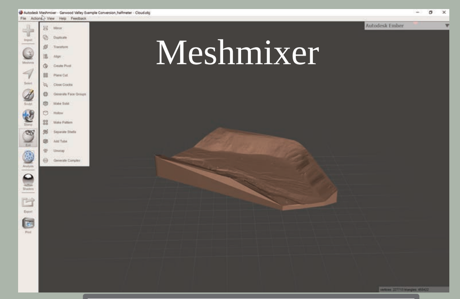

Figure 12: Completed model of Garwood Valley in Meshmixer.

5.

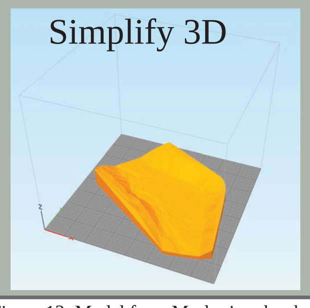

Figure 13: Model from Meshmixer has been imported into Simplify3D to create printable files.

Conclusion

With versatility and a low cost-of-entry, a 3D printer proves to be a worthwhile tool in the geodesist's toolkit. The technology has sufficiently advanced to the point where even basic printers have incredible accuracy. Seemingly simple ideas, like our cap design, directly enhance our ability to collect data. In addition, complex scientific topics can be made accessible by 3D printers, inspiring young minds to pursue STEM careers. Our experimentation and research with UNAVCO's printer has lead to the creation of operations manuals for their employees. These manuals are imagined to allow anyone to use the printer to realize his or her vision for useful field tools and educational material.

Acknowledgements

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[1]The "OpenTopography Data to 3D Model" workflow was derived from "Make 3D Printed Topo Maps of Anywhere" by Shapespeare, licensed under CC BY-NC-SA 2.5.

http://www.instructables.com/id/Make-3d-Printed-Topo-Maps-of-Anywhere/
https://creativecommons.org/licenses/by-nc-sa/2.5/legalcode

[2]The "LiDAR Data to 3D Model" workflow was partially derived from "Steps to Create a 3D Print from LiDAR Data" by Jozi Pearson.

https://drive.google.com/file/d/0Bx-eHELfVjfhbnpkUkxoTGpTT1U/view