CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)
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Project Number
S0302

Project Title
Does the Direction of a 3D-Print Matter?

Abstract

Objectives/Goals
3D-printing is a form of additive manufacturing where materials are added layer by layer to create a three-dimensional object. If the orientation an object is 3D-printed at changes the object's strength, the 0° (horizontally printed) piece is expected to be strongest and the 90° (vertically printed) piece is expected to be the weakest.

Methods/Materials
3D hexagonal prism models oriented at three different directions were created using CAD based programs (SketchUp, MeshLab, Axon, and Pleasant3D). The files containing the G-code were then transferred using an SD card to a Bits for Bytes 3D-printer. Using PLA filament, the hexagonal prisms were 3D-printed. From there, the prisms were broken in a homemade cantilever system, with a bucket tied to a fixed point on the pieces of plastic. Rocks were used as weights and placed into the bucket until the pieces of plastic broke. After the plastic hexagonal prisms broke, the total rock mass was recorded.

Results
For the first round of trials, the standard deviation was 0.782 for the 0° prisms, 1.671 for the 45°, and 0.948 for the 90°. As improvements in the prints were made, the second round had a 0.0912 standard deviation for the 0°, 0.308 for the 45°, and 0.315 for the 90°. The 0° prisms were able to hold up to an overall average of 6.765 Kg. The 45° prisms were, on average, 24% weaker than the 0° (being able to hold up to an average of 5.154 Kg), took 507% more time to print, and 483% more material. On average, the 90° prisms were 32% weaker than the 0°, took 297% more time to print than the 0°, and 250% more material.

Conclusions/Discussion
The data supported the hypothesis: the 0° prisms were the strongest and the 90° prisms were the weakest. The 0° prisms were the best in all other aspects, as well: took less time to print, used less material, and were the most consistent in strength variance. This information can be used to help print creations such as 3D-printed houses, prosthetics, replacement organs and bones, and other products. Knowing which direction is strongest to print will improve the safety, manufacturing, design, and economics of the product by not making as many prints and, thus, wasting less time, money, and material.

Summary Statement
The orientation of a 3D-printed object changes the relative strength of the object, production time, and material consumption.

Help Received
Father provided his 3D-printer and printer materials.