Next Generation 3D Printer

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Novakinetics Aerosystems

Overview

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- Objectives
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Introduction

- Client: Novakinetics
  - Aerospace composite parts
  - Parts are made with molds
- What can be done to decrease production time, while maintaining product quality?

Novakinetics.com

Novakinetics.com

Needs and Project Goal

- Needs Statement
  - Novakinetic’s lead time for composite parts is currently too long and for a more efficient manufacturing process
- Project Goal
  - Develop a large scale 3D printer that can be used to speed up the manufacturing process at Novakinetics

3D Printing

- Fused Deposition Modeling (FDM)
- Objects are built layer by layer
- Common materials used
    - Acrylonitrile Butadiene Styrene (ABS)
    - Polylactic Acid (PLA)

fundable.com

thingiverse.com

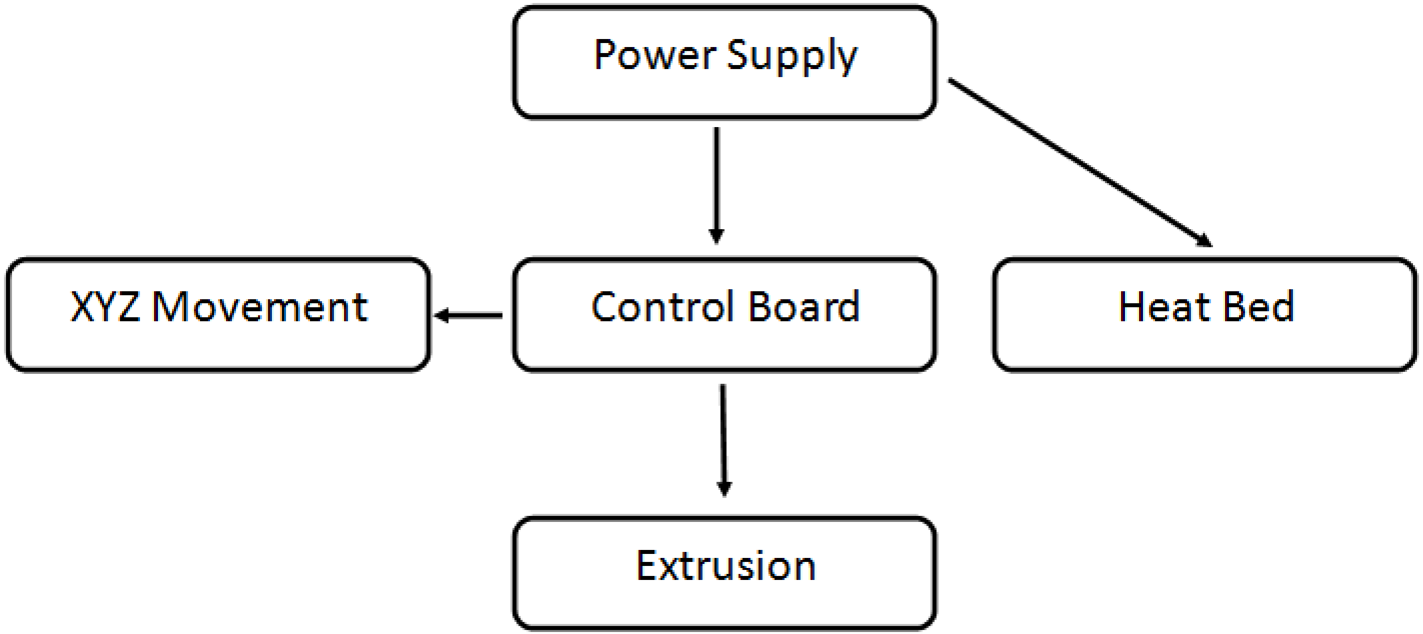
Objectives

OBJECTIVE	MEASUREMENT	UNITS
Fast Print Speed	Filament / Time	mm/s
Accuracy	Length	mm
Maintenance	Time	Hours/Week
Safe to Operate	OSHA	Unitless
Ease of Use	Time to Proficiency	Hours
Economic	Cost	US Dollars

Constraints

- Part thickness $\geq$ 1.25mm
- Surface dimension tolerance of ±0.8mm
- Resolution < 0.5mm
- Print volume $\geq$ 0.216m^3 (0.6m x 0.6m x 0.6m)
- Power use $\leq$ 480V, 200A

Functional Diagram



Criteria of Functions

Power Supply

1. Ease of Implementation
2. 120V-240V
3. Cost

Extruder

1. Temperature
2. Nozzle Size
3. Reliability

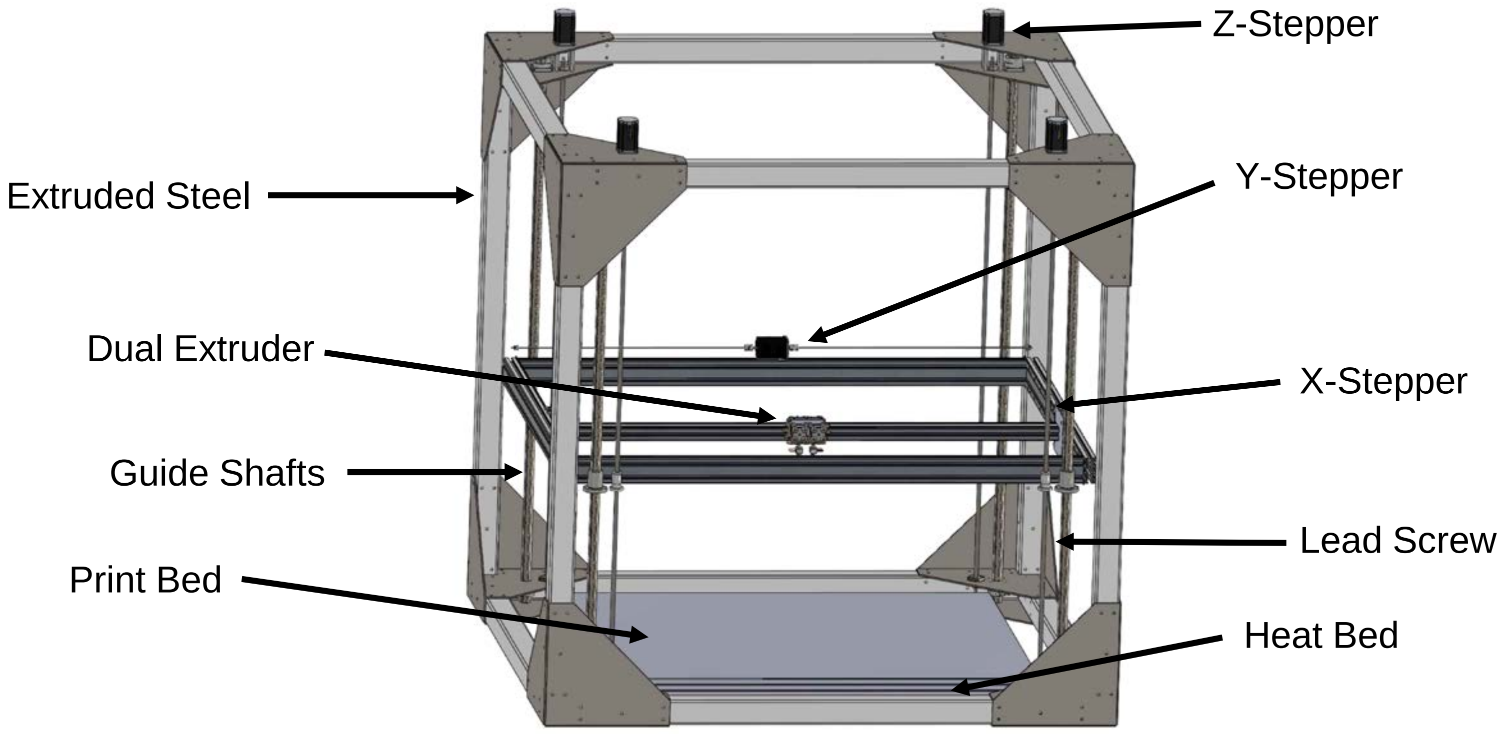
Control Board

1. Open Source
2. Multiple Motor Drivers
3. Modular

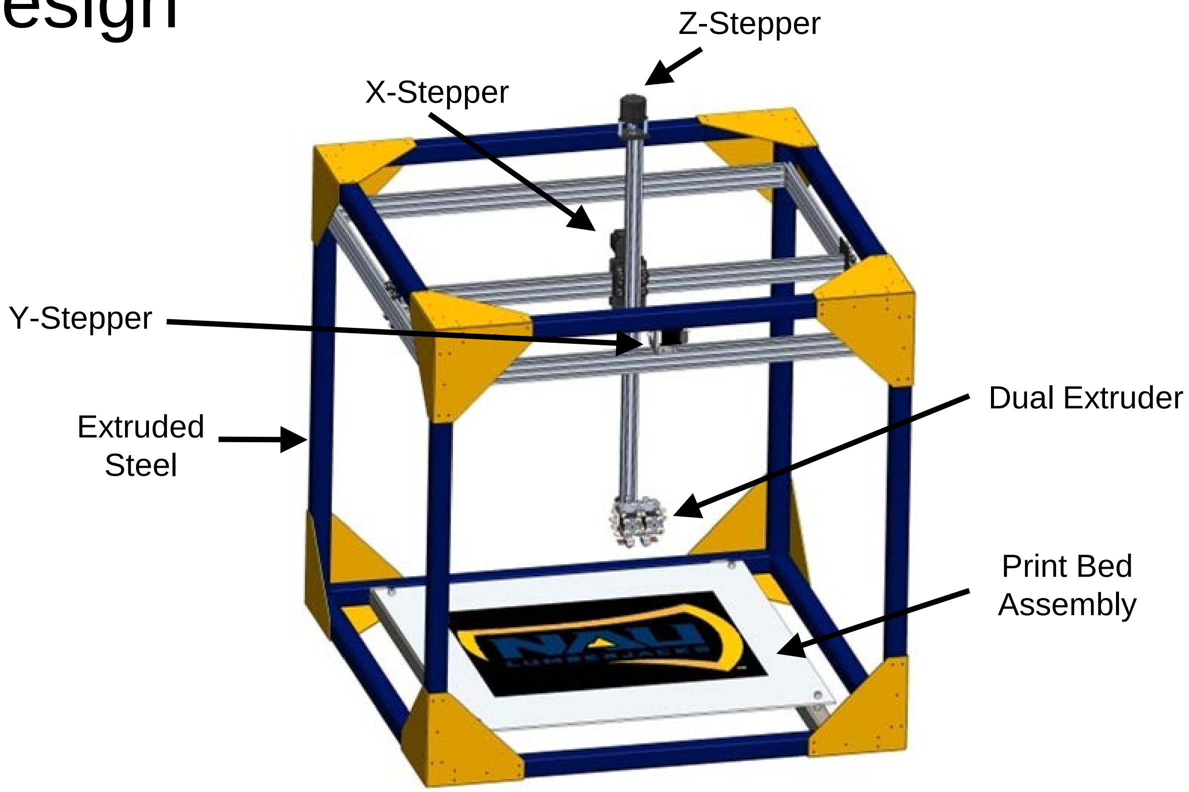
XYZ Movement

1. Torque
2. Resolution
3. Rotations Per Minute (RPM)

Preliminary Design

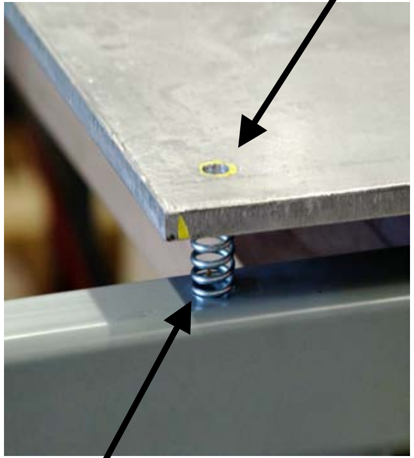


Final Design

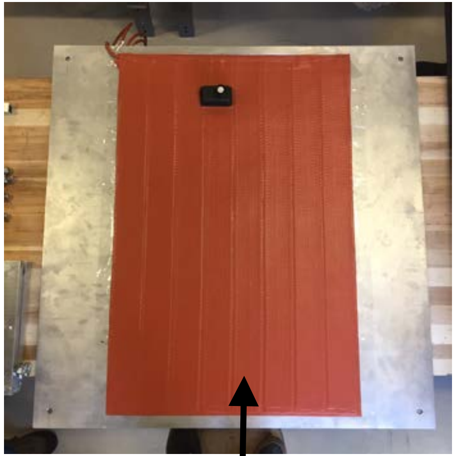


The Print Bed

½ inch holes



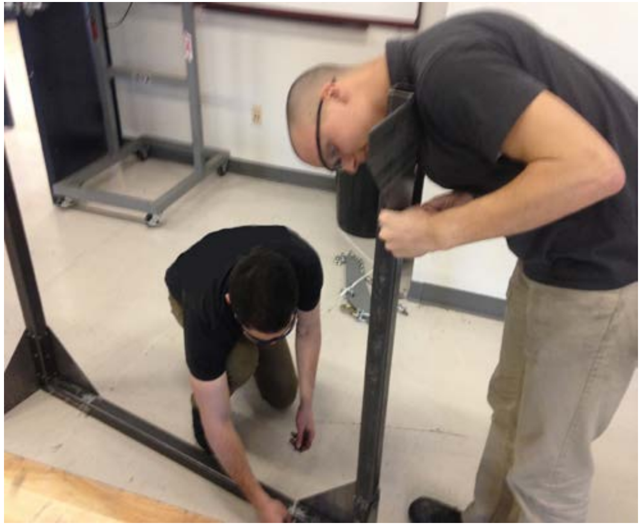
Compression
Springs



24 x 36 inch Heat Bed

38 x 38 x ⅜ inch
6061 Aluminum

The Frame

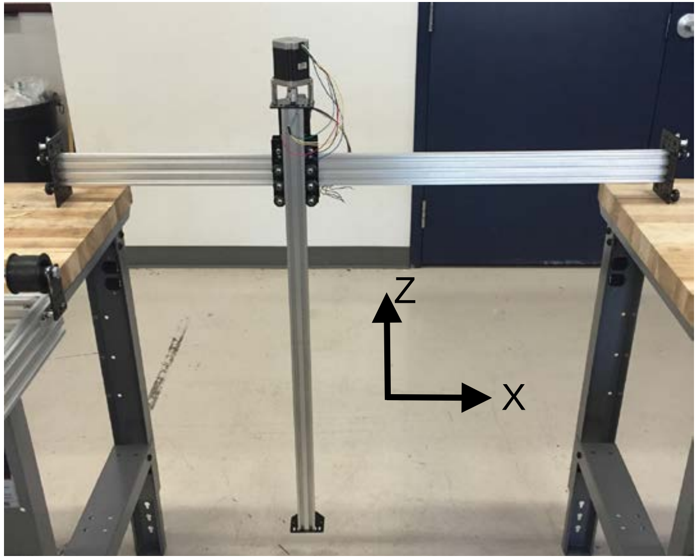


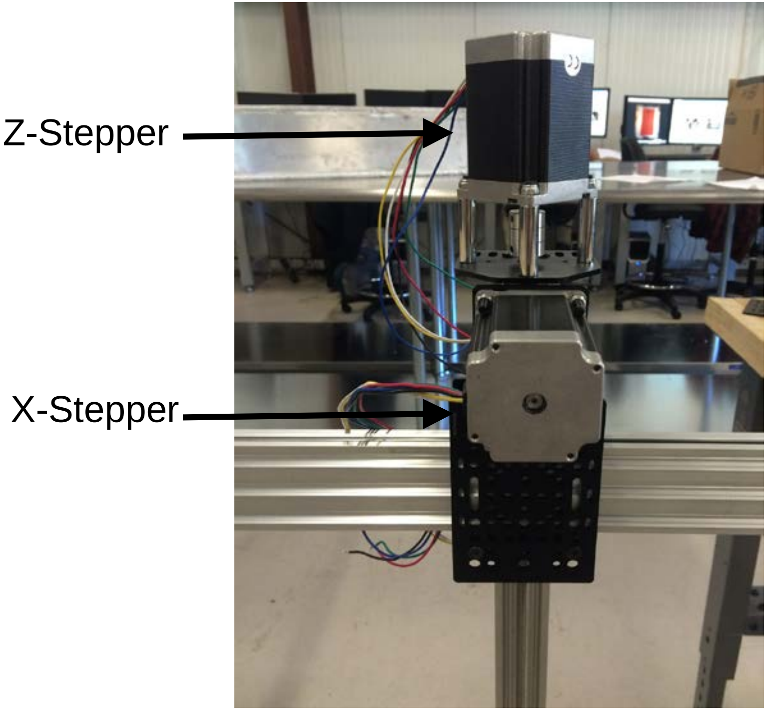
Gusset Plate

2”x2”x1/8”
Steel Square Tubing

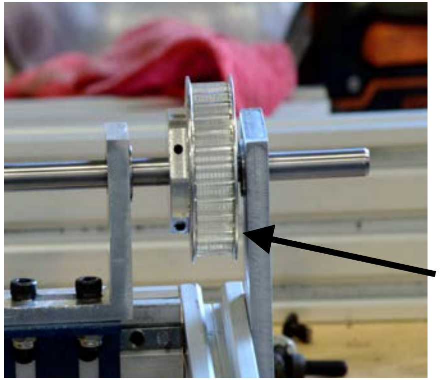
4” Polyurethane Casters

The Gantry

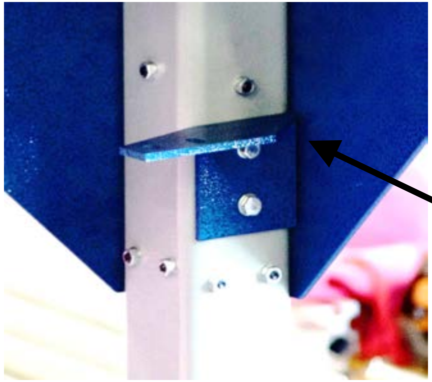




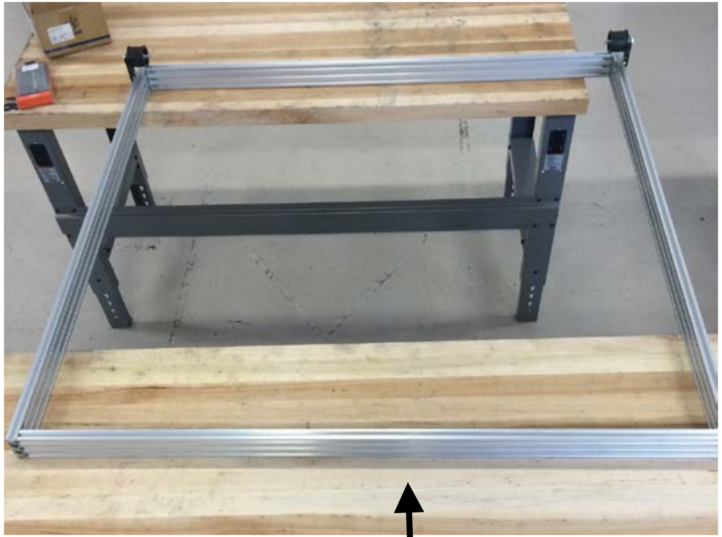
The Gantry



Pulley

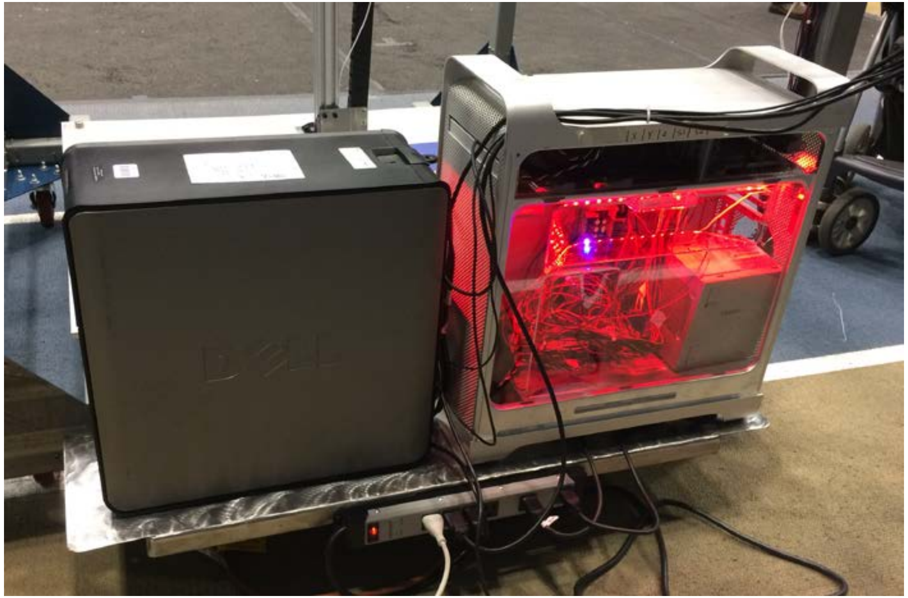


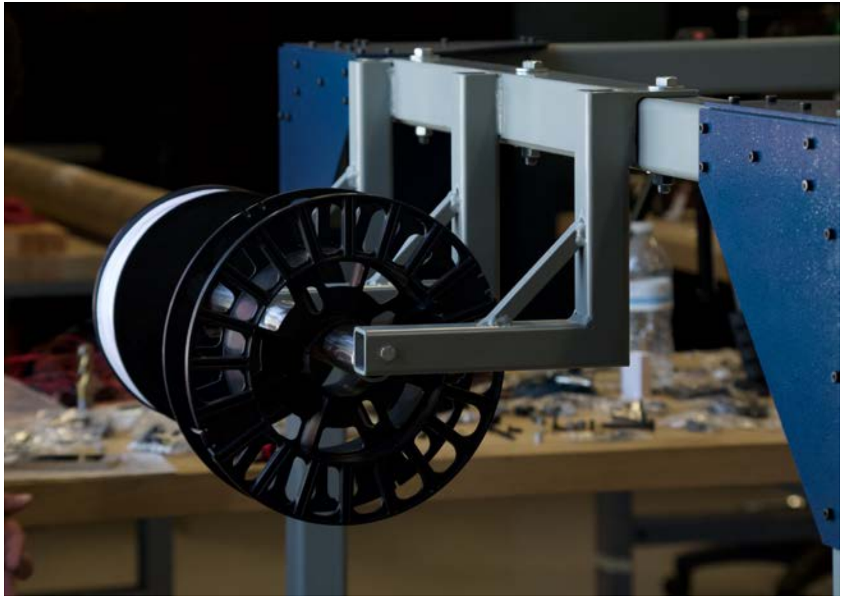
Gantry Support Bracket



Gantry X & Y Frame

Computer Shelf and Filament Holder





Electronics: Programming

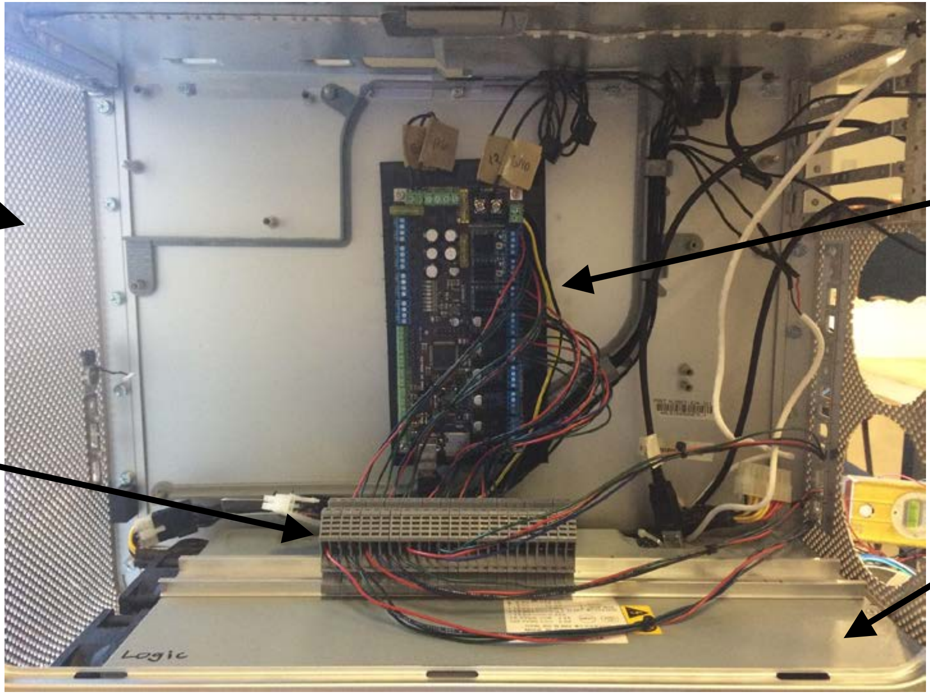
- Repetier Host installed on control PC
- Repetier Firmware Installed on Azteeg X3 Pro
- Calibration
  - Calculated Steps/mm for X&Y axis

$$\frac{\text{steps}}{\text{mm}} = \frac{\text{motor steps per rev} * \text{driver microstep}}{\text{belt pitch} * \text{pulley number of teeth}}$$

  - Calculated Steps/mm for Z axis

$$\frac{\text{steps}}{\text{mm}} = \frac{\text{motor steps per rev} * \text{driver microstep}}{\text{thread pitch}}$$

Electronics: Control System



G5 Apple Case

Azteeg X3-Pro

Terminal Block

12V 14-Amp Power Supply

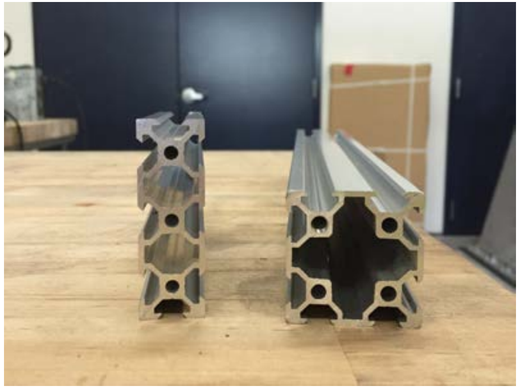
Design Modifications:

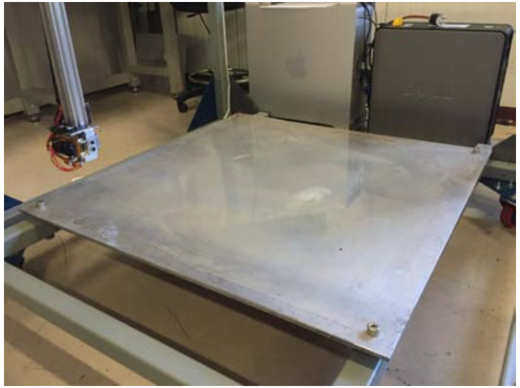
Address Vibrations

Increase torque resistance by changing the x-axis bar cross section from 20mm x 60mm to 40mm x 40mm

Address Warped Print Bed

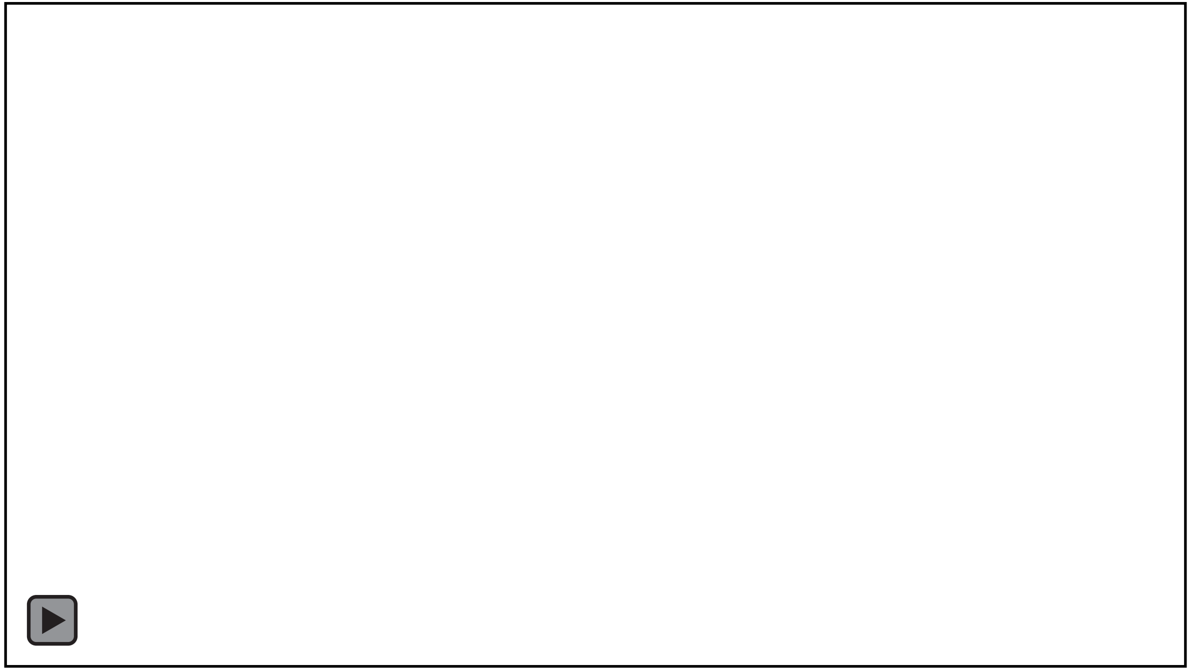
Increase surface flatness by adding thermally stable epoxy to self level the print bed



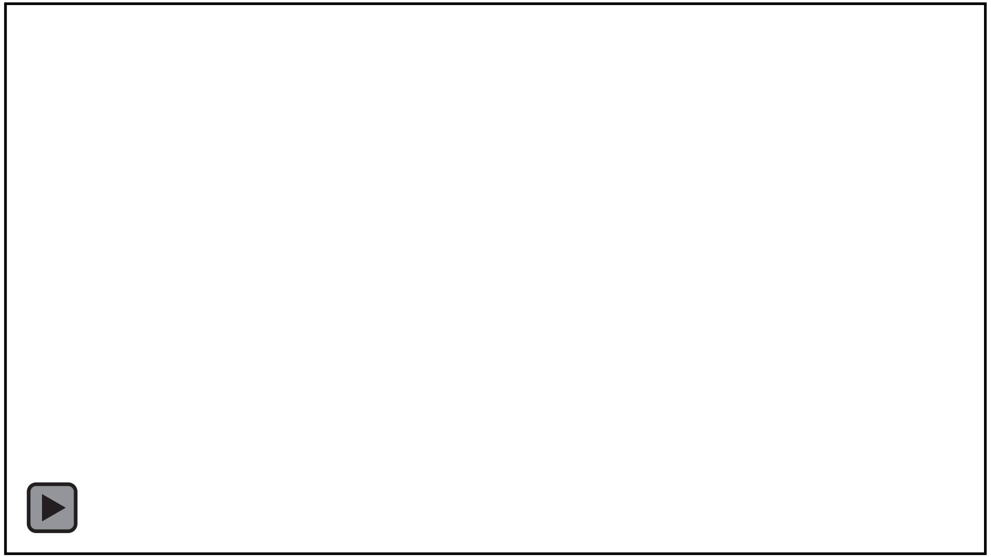


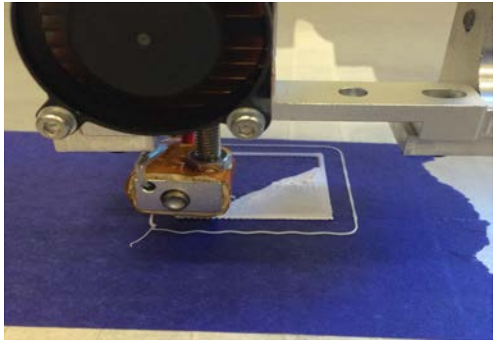
Completed Assembly

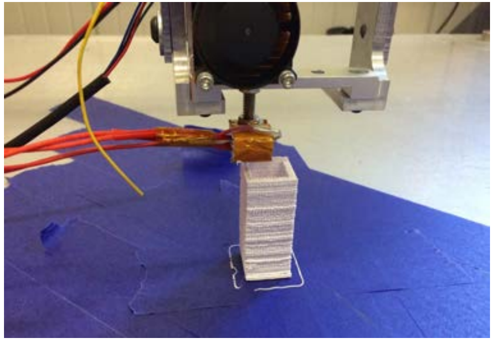
Performance Testing



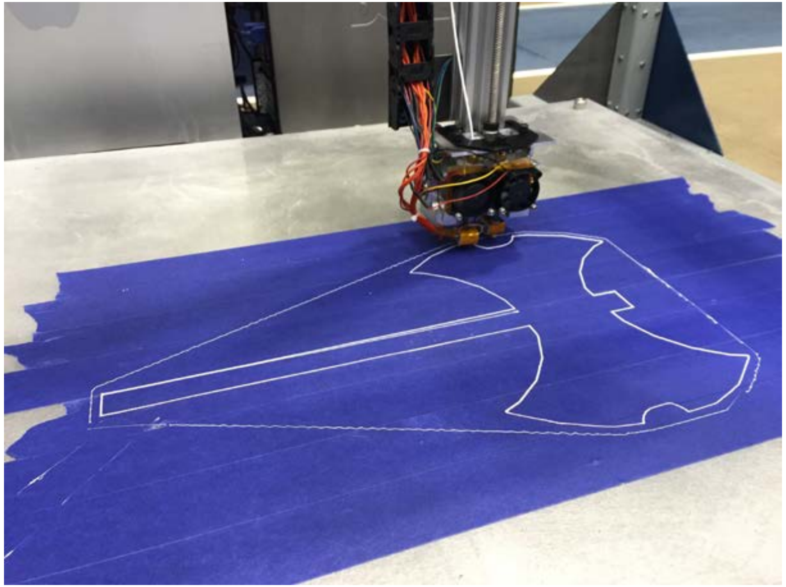
Performance Testing







Performance Testing



Bill of Materials

Section	**Cost**
Frame	$409.08
Gantry	$1098.25
Print Bed	$889.88
Electrical	$754.24
Powder Coating	$300.00
Miscellaneous	$590.21
TOTAL:	$4041.66

Conclusions

- Novakinetics is seeking a new way to manufacture their products
- The team determined that a large scale 3D printer can be used to speed up their manufacturing process
- Individual components of the 3D printer were selected based on research, functional diagrams and relative weight matrices
- With components selected, the team created a CAD model and Bill of Materials(BOM) of the design
- Using the CAD model and B.O.M. parts were ordered and the manufacturing, programming, and assembly process of the 3D printer began

Conclusions

- The manufacturing process of the 3D Printer was broken up into 6 sections: the print bed, frame, gantry, electronics,computer shelf, and filament holder,
- During manufacturing, design modifications included leveling of the print bed and modification of the x-axis bar
- With the 3D printer assembled, performance testing began
- The final cost of the printer came out to $4041.66

Acknowledgements

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Questions?