3D Metal Printer

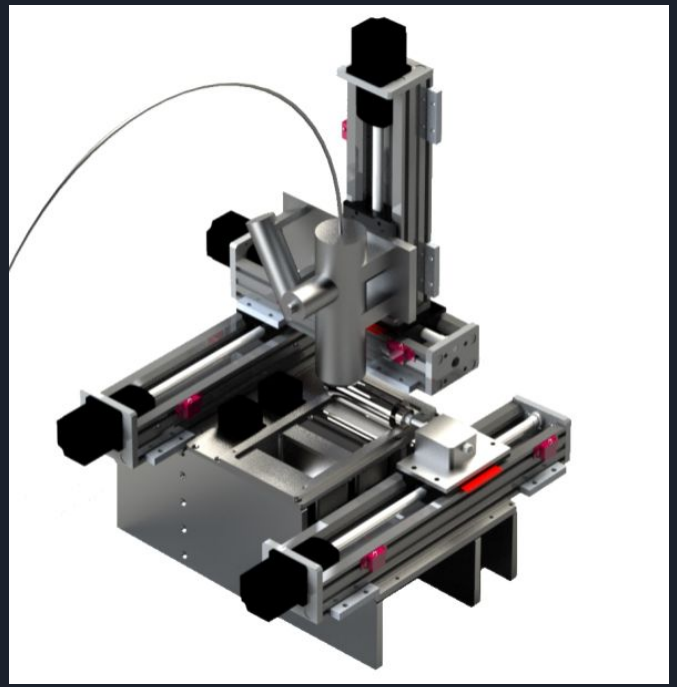
SDMAY19-03

Contributions of each team member

Thomas Waters - Engineering lead, Embedded systems
Arik Rizhsky - Embedded Systems
Armand Hernandez- Software design and integration
Carter Cahill - Software design and integration
Jacob Gosse - Sensor integration, wiring/connectors
Alvin Rymash - Sensor integration, wiring/connectors

Problem Statement

To design and build an affordable 3D metal printer for NDE research



Functional Requirements

3 lasers
1064 nm 200 W melt laser
1064 nm ultrasound laser
1550 nm laser interferometer
Blade/roller to deposit powder from powder bed to print bed
Powder bed which moves up in order to deposit a new layer of powder
Print bed which moves down after each layer is sintered by the laser
Collection bin which collects excess powder not deposited on the print bed
Any place with powder must be enclosed in a sealed chamber which can withstand a vacuum and be filled with nitrogen or argon gas

Non-Functional Requirements

- Build Speed
- Chamber size
- Modifiable code

Technical Constraints

- Many moving pieces to be placed in a sealed, environmentally controlled chamber
- Environmental hazards such as dust interfering in the closed environment
- Monitoring constraints, as the system needs to be closed.
  Potential solutions:
  - Window
  - Camera
  - Mirror

Market Survey (what makes the project unique)

- Build Time Process Monitoring
  - NDE(Non Destructive Evaluation) can be used as a per slice monitoring technique
- Commercial 3D Metal Printers
  - Some use a recoater instead of a roller to apply next layer of powder
- Additive Manufacturing Software
  - Most Software available is only for plastic printing.

Potential Risks & Mitigation

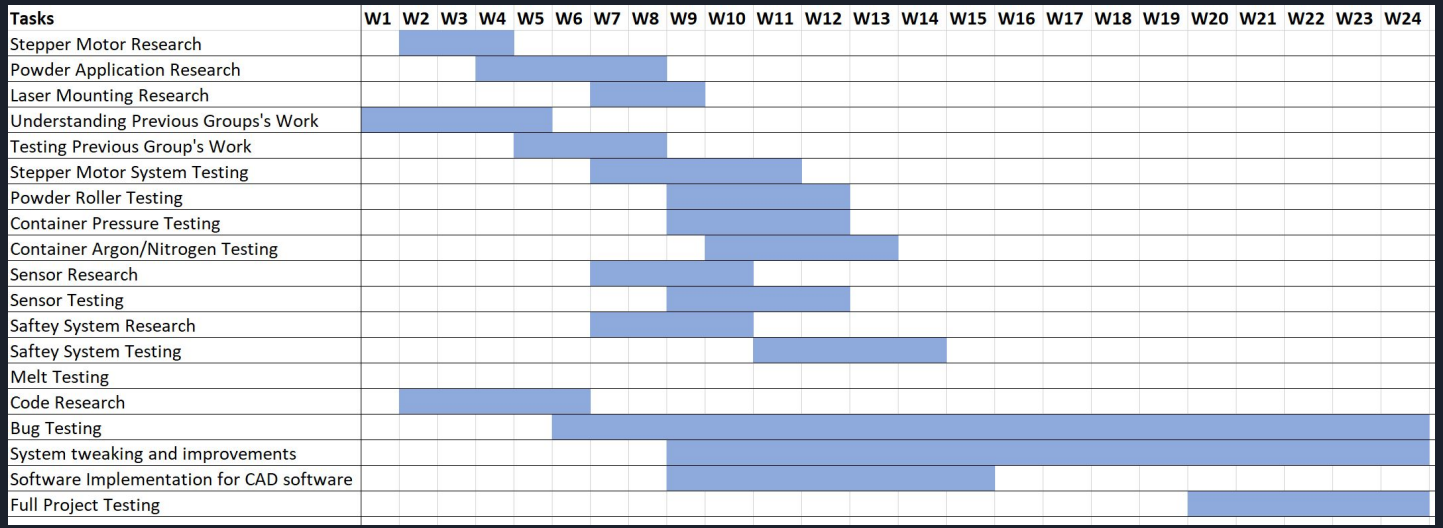
- Potential laser injuries/Burns
  - Closed Environment
  - Remotely operating laser
  - No direct eye contact
- Volatile Metal Powder
  - Vacuum
  - Nitrogen-rich environment

Resource/Cost Estimate

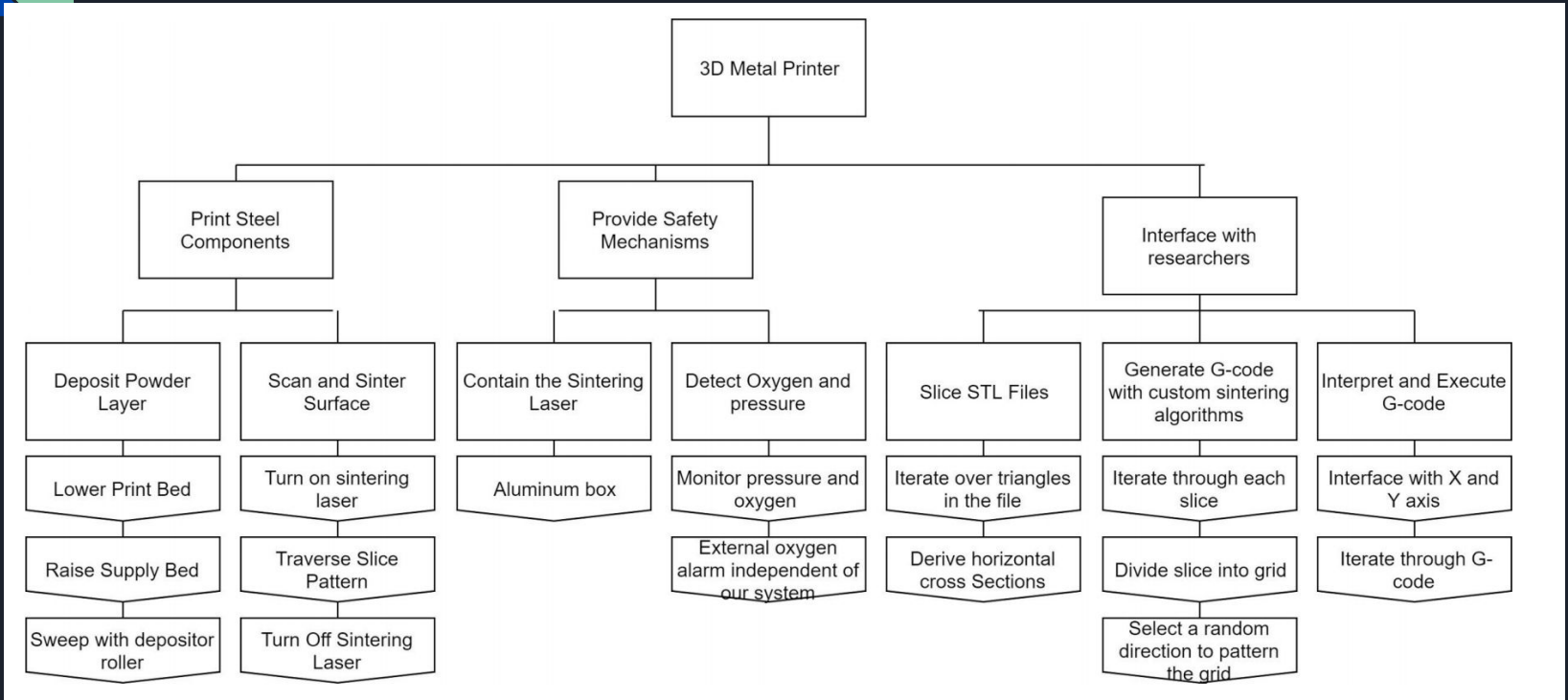
- Previous group cost: $21,286
  - Stepper motors
  - Lasers
  - Sensors
- Our cost: ~$400
  - Camera
  - Contact sensor
  - Laser lens

Milestones and Schedule

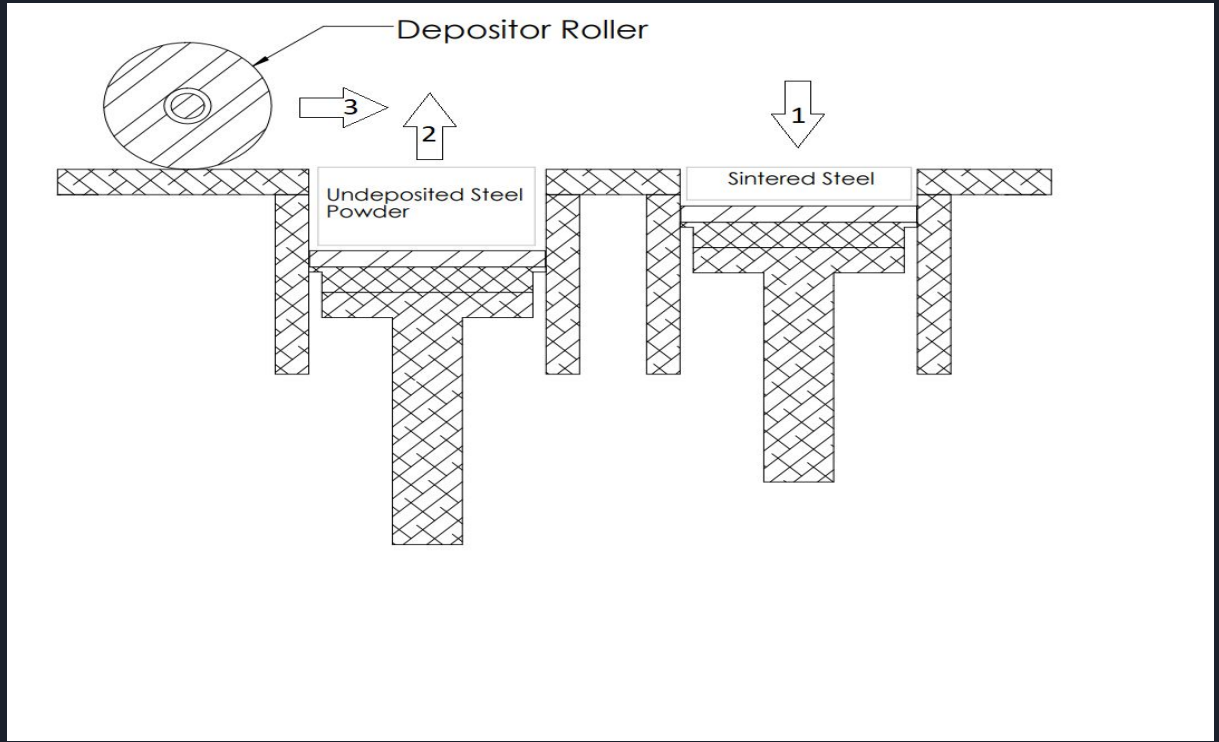
- Roller/print beds
- Vacuum chamber
- Metal powder
- Laser sintering
- 3D Cube
- CAD file -> object



Functional Decomposition

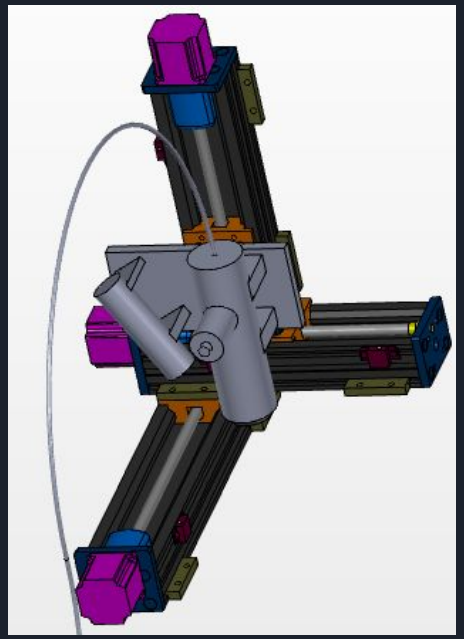


Detailed Design: Depositing Powder



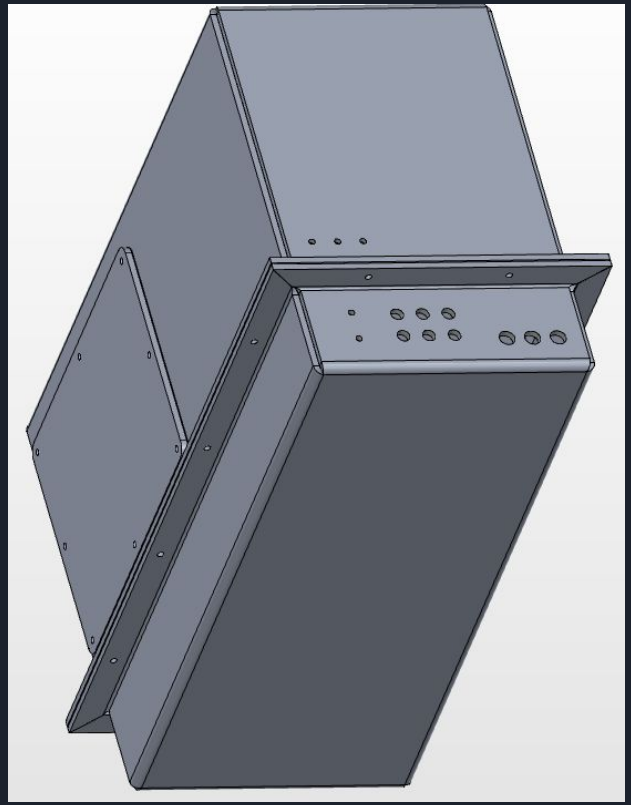
Detailed Design: Sintering Assembly

- Attached to three Velmex stepper slide motors
- Random movement
  - Sinters in small, ~1cm squares
  - Avoids overheating



Detailed Design: Vacuum Chamber

- Holes for wires
  - Sensors
  - Cameras
  - Motors
- Removable panel

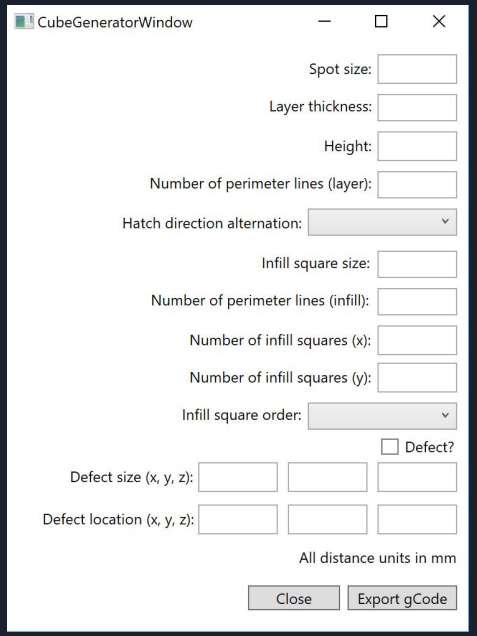


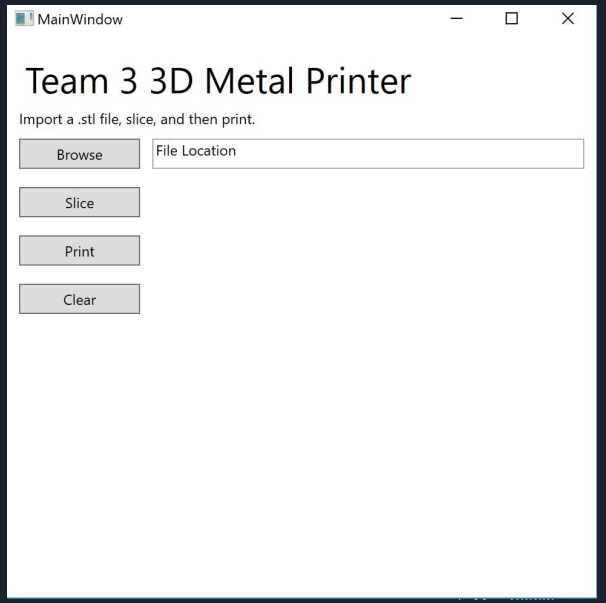
Detailed Design: Sensor Integration

- Internal Oxygen Sensor
  - AMI 2001LC Trace Oxygen Analyzer
- External Oxygen Alarm
  - BW Honeywell Clip 2.0
- Internal Pressure and Temperature Sensor
  - SEEED Studio Grove High Accuracy Barometer
- Camera
  - 700 TVL Waterproof Color Day/Night Camera

Detailed Design: User Interface

- Made in Visual Studio C#



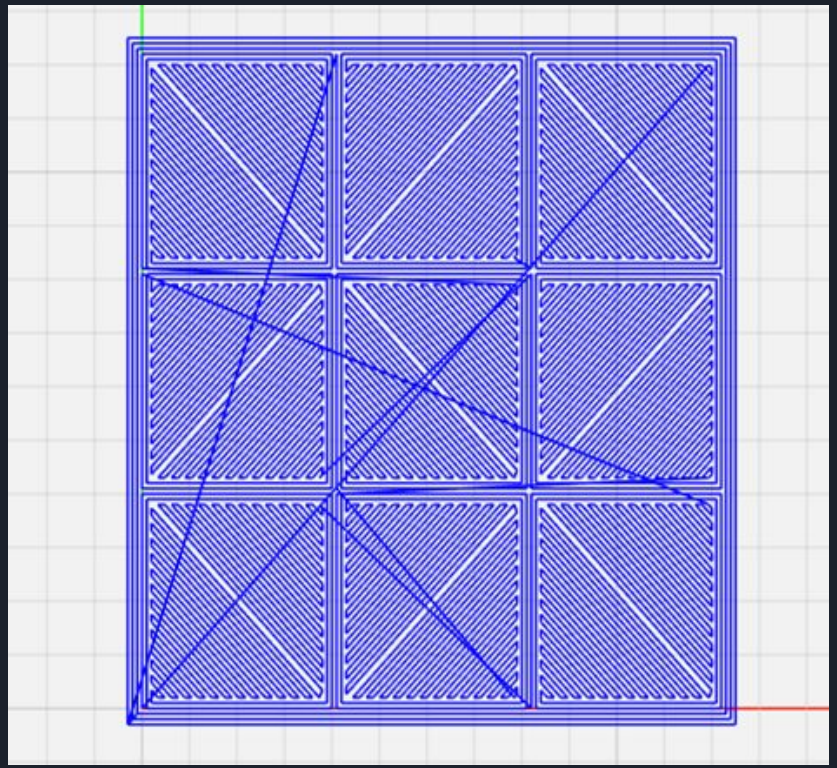


Hardware/Software/Technology Platforms used

- GUI software - C#, Visual Studio, STL file input, g-code
- Stepper motor controllers - Velmex hardware, serial commands
- Sensor integration - Arduino
- CAD software - Solidworks, GrabCAD

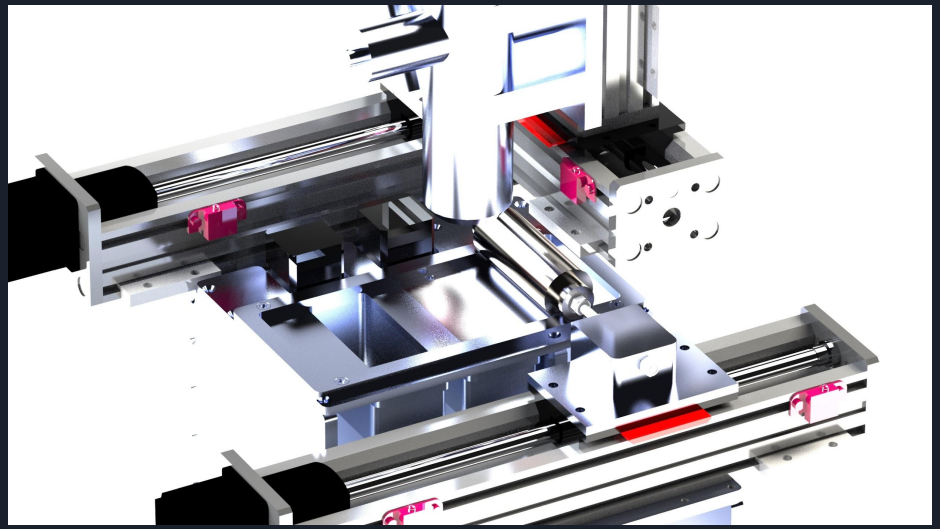
Test Plan

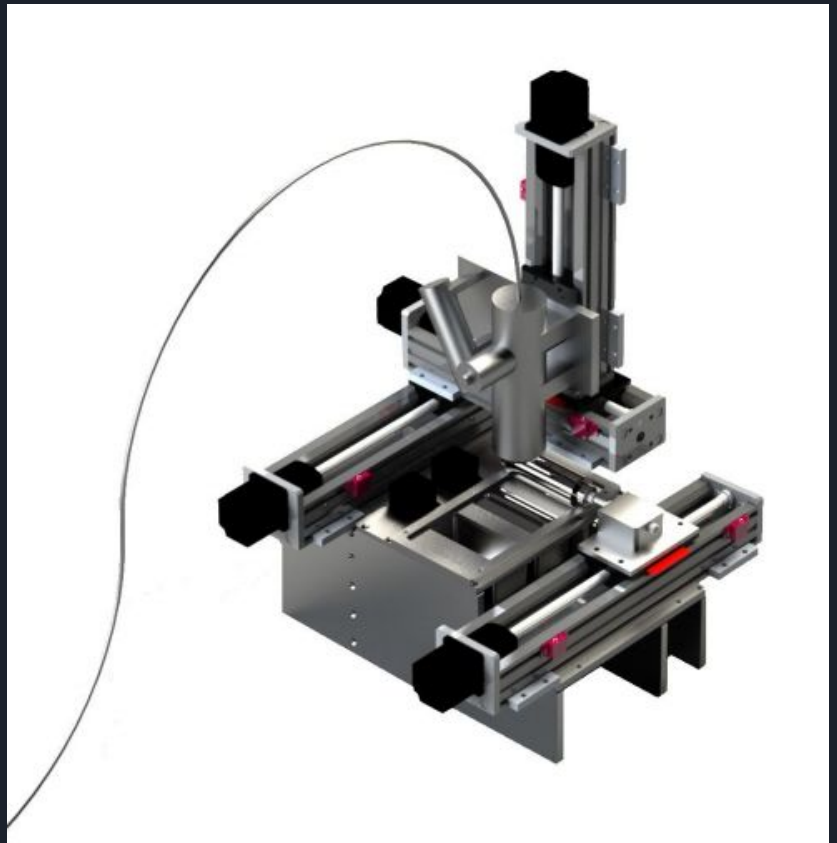
- Interface testing
  - Sensor readings
  - Current status
- Functional testing
  - 2D Box (Complete)
  - 3D Cube
  - Other basic shapes
  - CAD Files
- Non-Functional testing
  - Speed
  - Ease of use



Prototype Implementations

Solidworks CAD renderings of the many parts of the assembly





Current project status

- Motors working with software.
- Theoretically can make 3D cube (cannot use lasers yet).
- Camera purchased.
- Waiting on print bed.
- Waiting on vacuum chamber.

Plans for next Semester

- Attach print bed
- Put assembly inside chamber
- Wire things to accomplish vacuum
- Test cameras and sensors
- Add the Laser
- Test 3D printing capabilities
- Finish CAD slicing file to be able to convert to gcode

Questions