SDMAY19-03: 3D Metal Printer Phase II

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Project Requirements

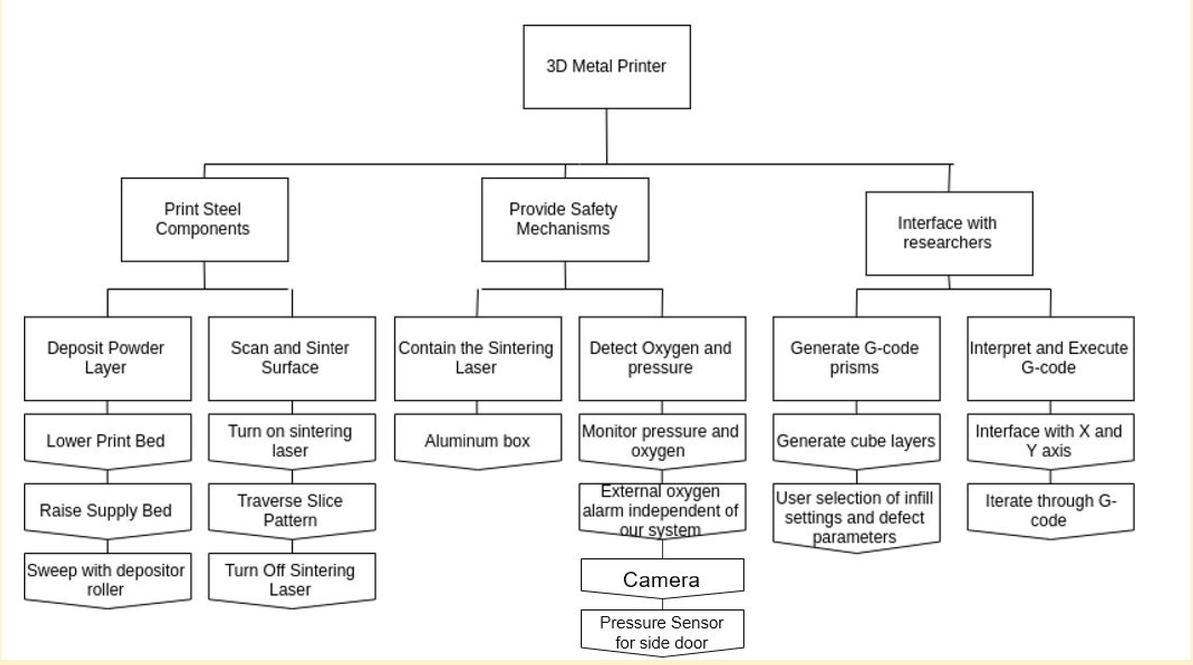
Functional

- Have a powder bed that moves up to deposit a new layer of powder, a print bed that moves down after each layer is sintered by the laser, a roller to deposit powder from powder to print bed
- Enclosed in vacuum sealed chamber filled with nitrogen gas
- Lasers shall be able to be adjusted to any point using servo control system
- Pressure, oxygen, and temperature sensor to check for safety hazards
- Camera to provide eyesight in the sealed chamber to visually see if there are any problems

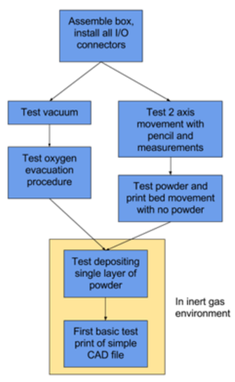
Non-Functional

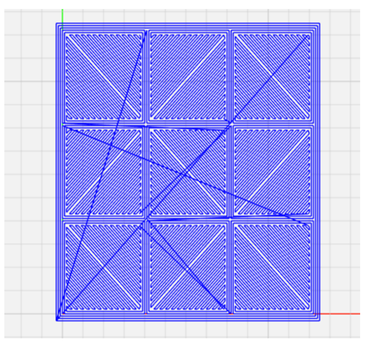
- Vacuum chamber should use space efficiently
- Code should be well documented and understandable
- Printer will be calibrated for most efficient print speed

Concept Diagram



Testing and Evaluation





The bottom figure represents the testing of the laser movement. This testing was accomplished by attaching a pen at the location of the laser mount and moving the motors along a piece of paper. Our future testing plan is shown in the top figure. This figure shows the testing phase of how we will implement the printer in testing inside the vacuum sealed chamber. The vacuum sealed chamber is not approved yet for use, so we do not have access to use the main laser for testing.

Implementation and Technology

Hardware

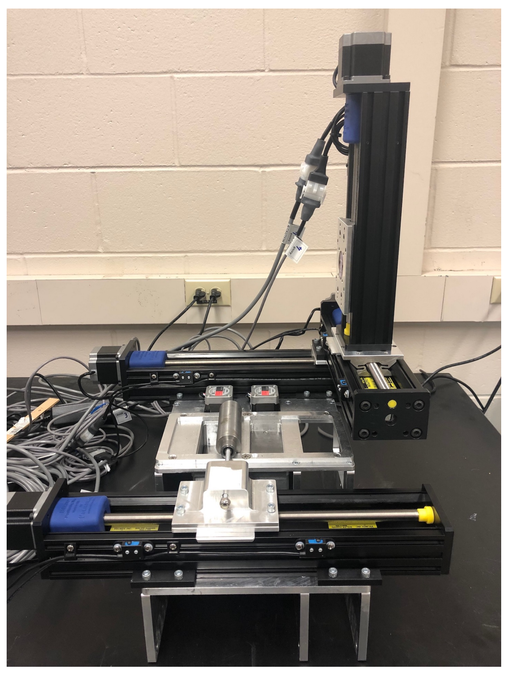
- 6x Velmex Stepper Motor
- 1064 nm 200 W Melt Laser
- 1064 nm Ultrasound Laser
- 1550 nm Laser Inferometer
- Temperature, Pressure, and Oxygen Sensors

Software

- Velmex Motors: vxm
- Lasers and motor code conversion: gcode
- CAD file conversion: C#

Project Summary

The goal of this project is to create a 3D printer which uses lasers to complete a process called Additive Manufacturing. This process is done by laying out a small layer of powder, melting it in the required shape, and repeating the process until a part is built. We were also tasked with monitoring the creation of these parts and ensuring that there are no defects.



Accomplishments and Future Endeavers

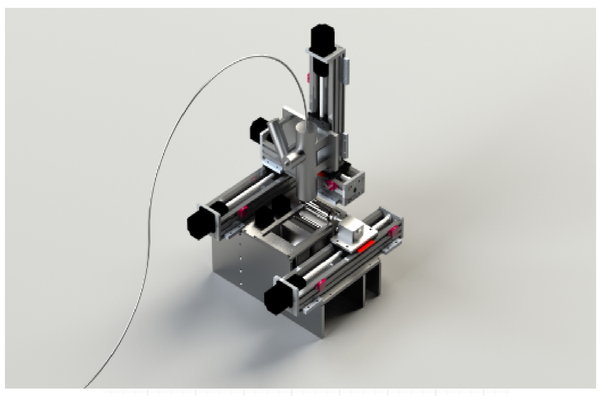
Accomplishments

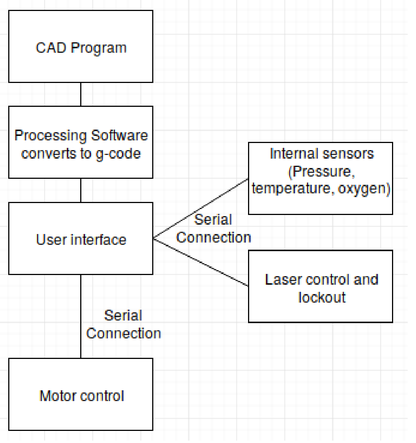
- Added two new sensors into the control systems
- Vacuum sealed chamber is completed enough for testing, but needs to be checked off by EH&S
- Print bed roller is completed enough for testing with the guide laser
- Overall, the printer is ready to be tested with the guide laser. This would entail the testing of how the laser would operate on a piece of paper.

Future Endeavors

- Fully test in printing a basic shape object
- Create a designed object from a CAD file

Design Process





Pictured above is the CAD rendering of the final printer along with a basic block diagram of the software design. There are three motors to move the laser itself, along with one motor to roll out layers of powder. There are also two motors to control the print and powder beds, which lower and raise respectively to allow for powder rolling. The laser itself is mounted using two brackets. The serial connections have been wired through specially-made holes in the vacuum chamber to ensure that the vacuum seal's integrity is preserved.

Standards

- 1100-2005 - IEEE Recommended Practice for Powering and Grounding Electronic Equipment
- 299-2006 - IEEE Standard Method for Measuring Effectiveness of Electromagnetic Shielding Enclosures
- ISO/ASTM 52900:2015 - Additive manufacturing -- General principles -- Terminology
- ISO/ASTM 52910:2018 - Additive manufacturing -- Design -- Requirements, guidelines and recommendations