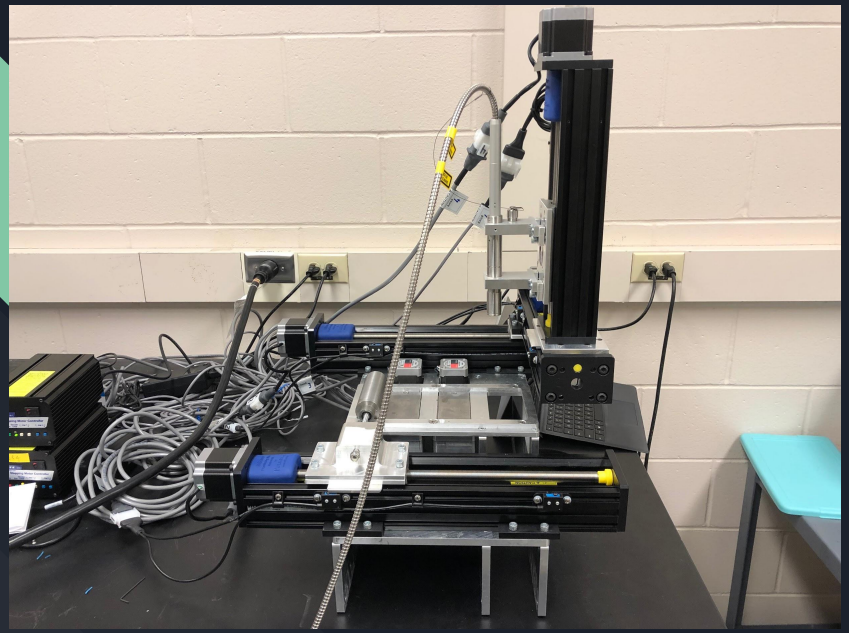
3D Metal Printer

SDMAY19-03



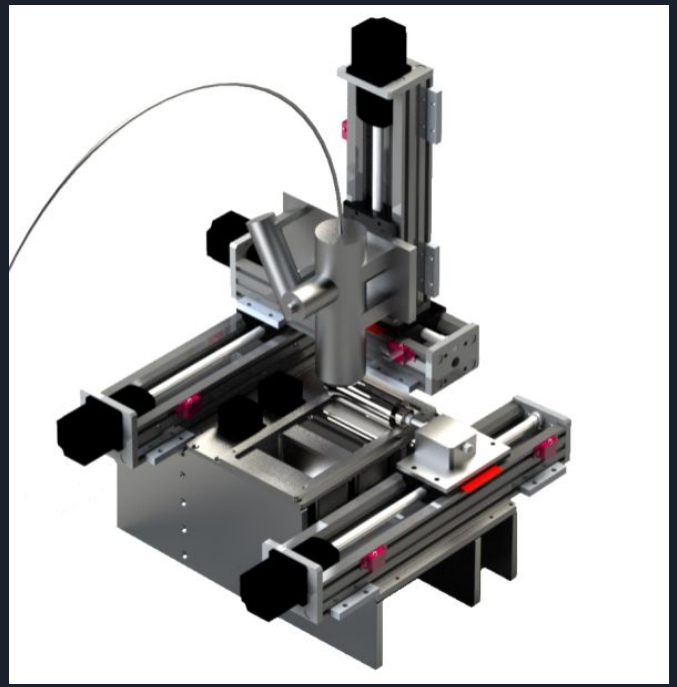
Client and Faculty Advisor: Dr. Timothy Bigelow
Members: Alvin Rymash, Ariel Rizhsky-Yakobson, Armand Hernandez, Jacob Gosse, Thomas Waters

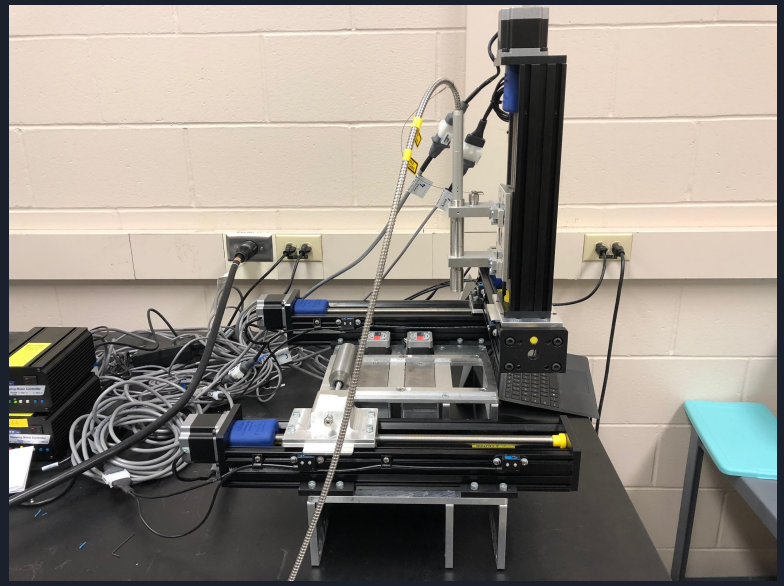
Contributions of each team member

Thomas Waters - Engineering lead, Embedded systems
Arik Rizhsky - Embedded Systems
Armand Hernandez- 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





1. Requirements

Functional Requirements

- 3 lasers
  - 1064 nm 200 W melt laser
  - Ultrasound laser
  - 1550 nm laser interferometer
- 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
- Pressure, temperature, and oxygen sensors placed in vacuum chamber for monitoring and safety hazards

Non-functional requirements

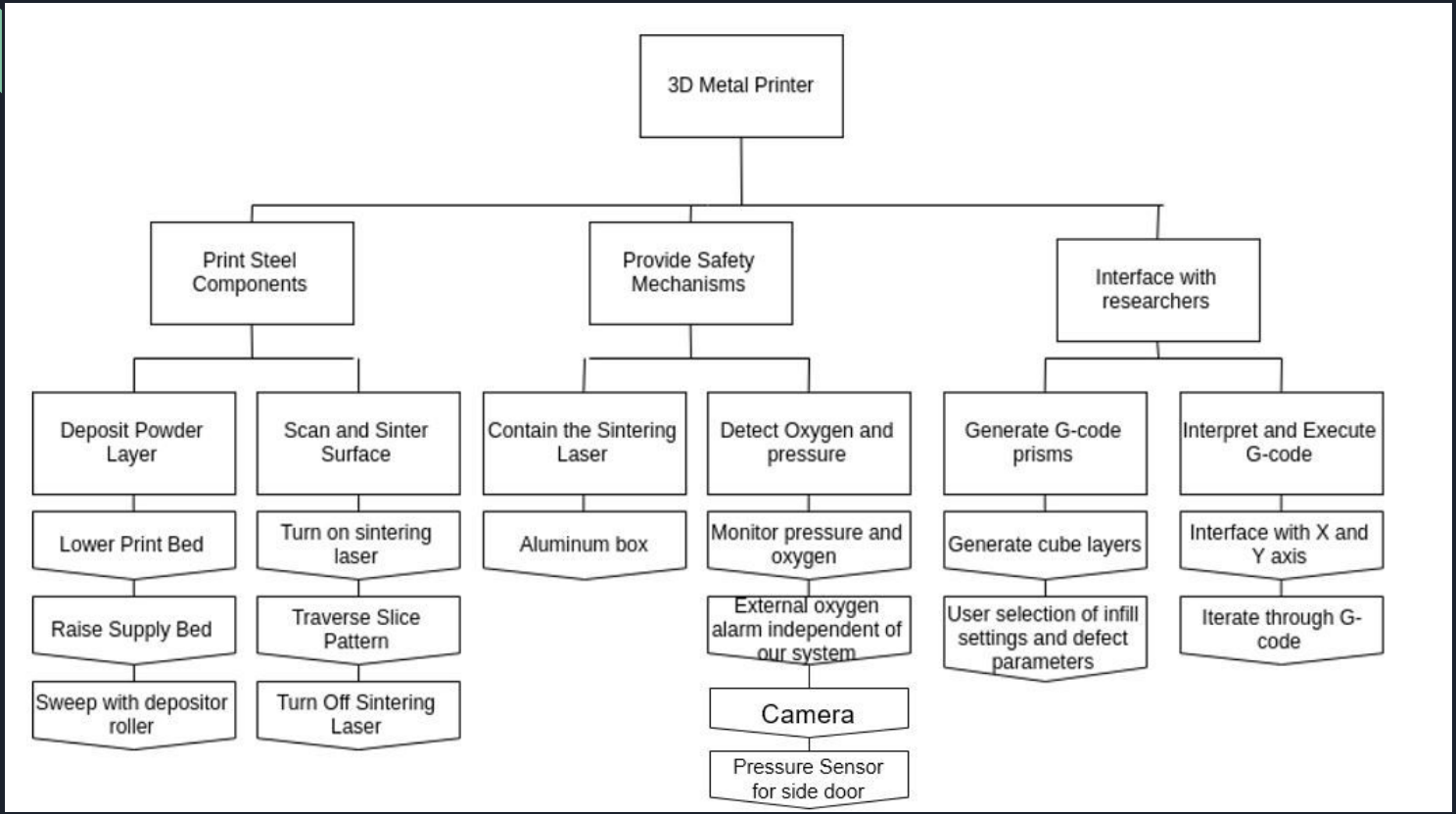
- Print speed
- Size of the vacuum chamber
- Modifiable code
  - well documented and understandable to allow future users to edit easily

High-level requirements

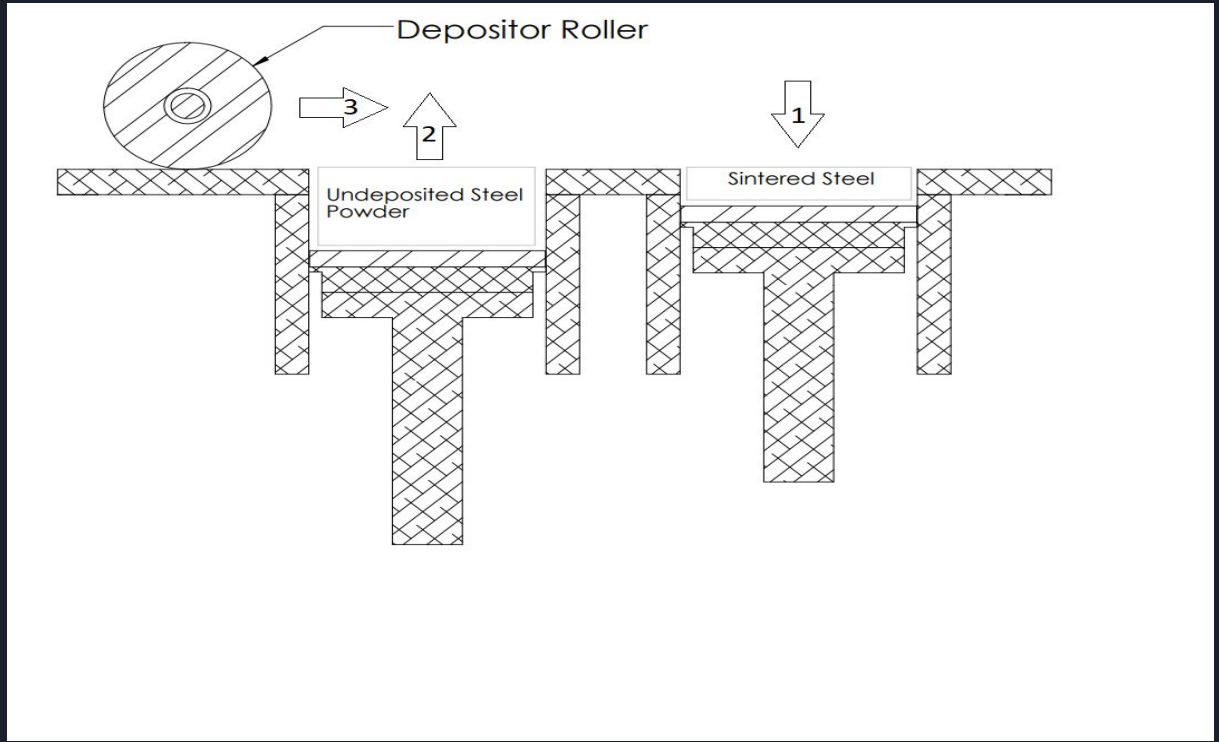
- Many moving pieces to be placed in a sealed, environmentally controlled chamber
- Environmental hazards such as dust interfering in the closed environment
- Monitoring constraints, as the system needs to be closed.
  Potential solutions:
  - Window
  - Camera
  - Mirror

2. System Design and Development

Concept Diagram

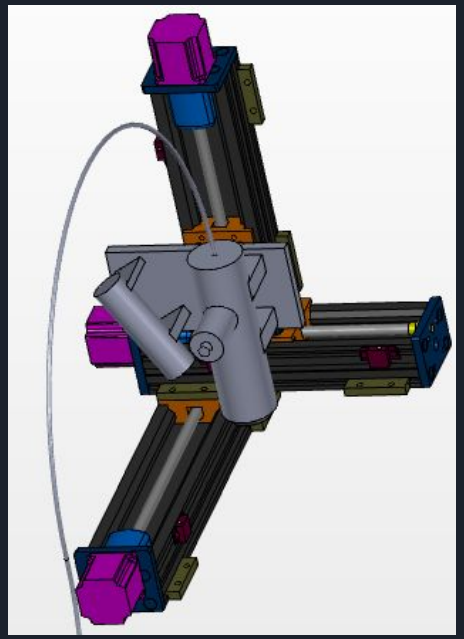


Detailed Design: Depositing Powder



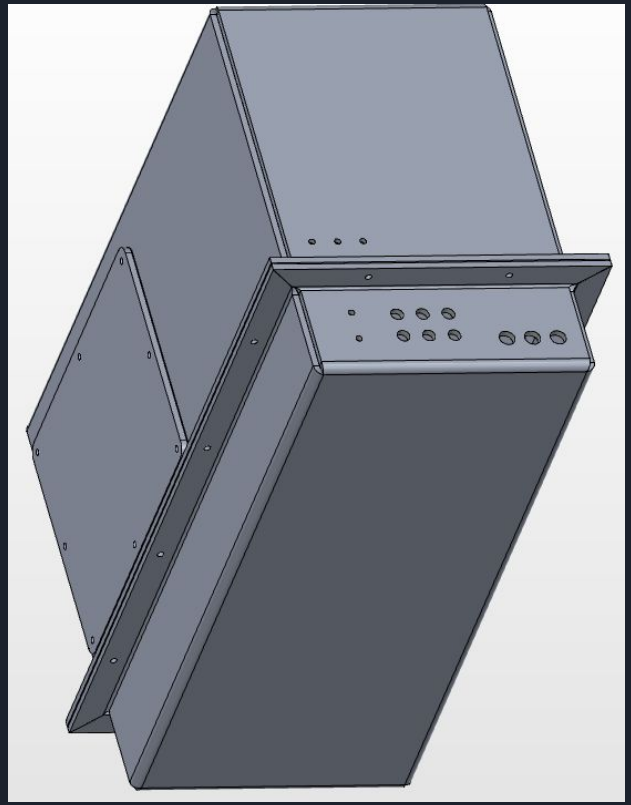
Detailed Design: Sintering Assembly

- 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

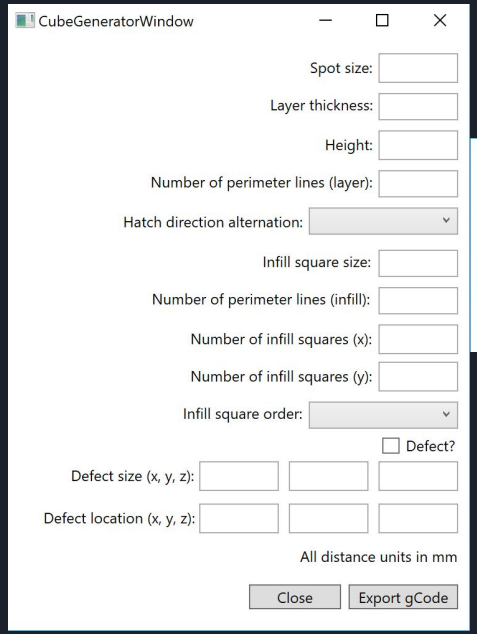


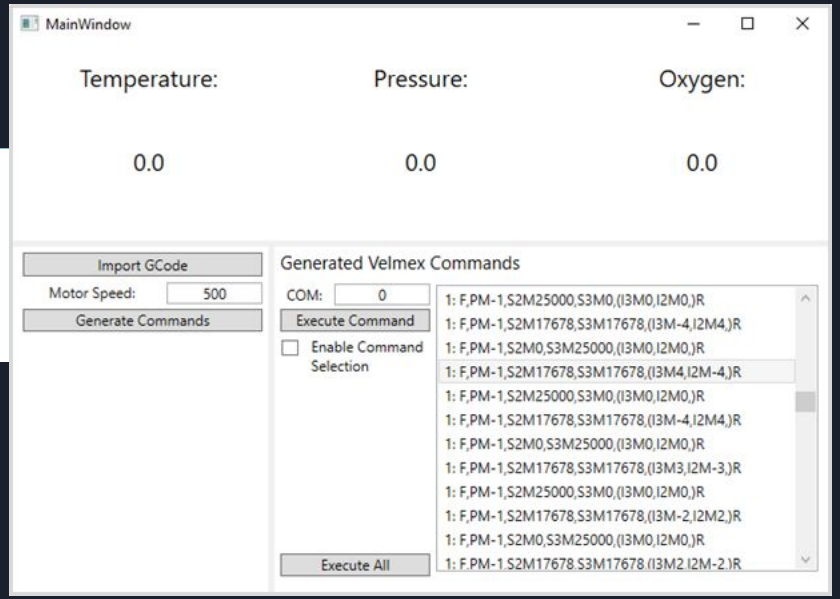
Detailed Design: Sensor Integration

- 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#

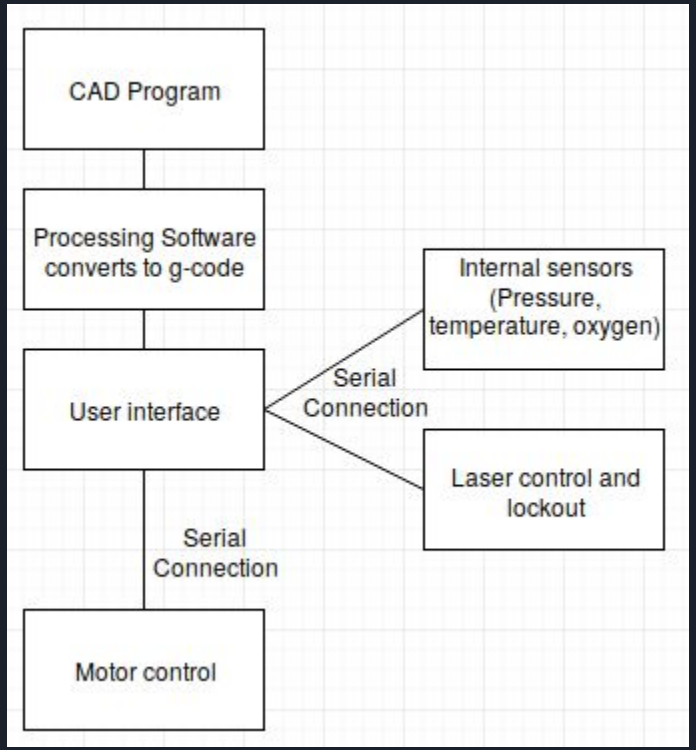




Hardware/Software/Technology Platforms used

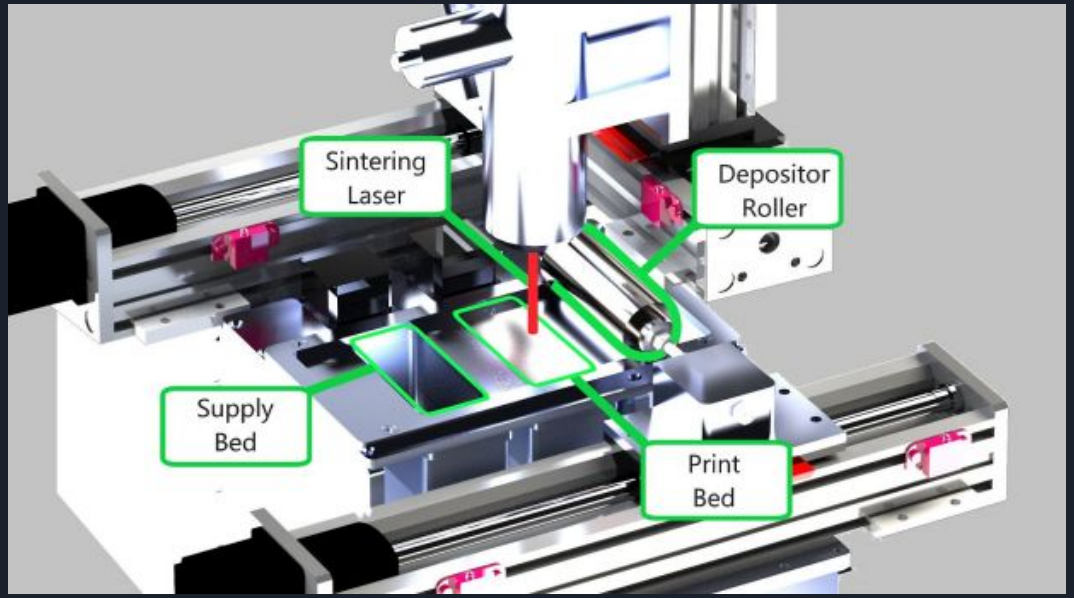
- GUI software - C#, Visual Studio, STL file input, g-code
- Stepper motor controllers - Velmex hardware, serial commands
- Sensor integration - Arduino
- CAD software - Solidworks, GrabCAD
- Slicer software- Slic3r

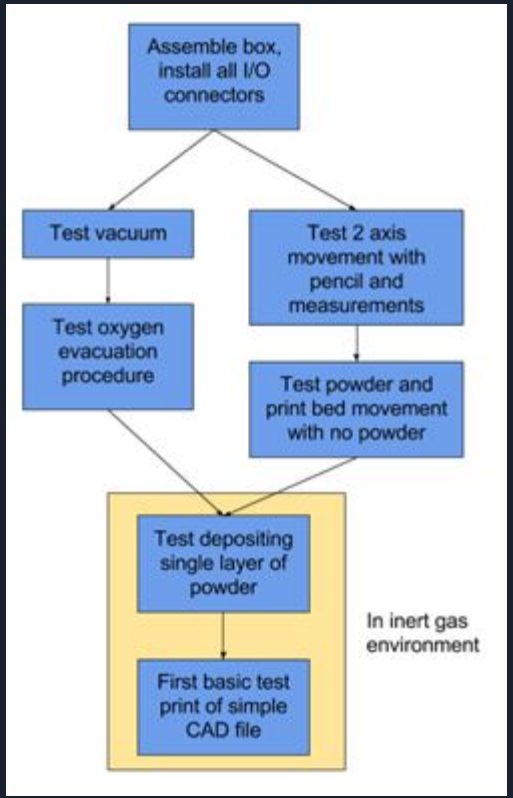
Architectural Diagram, Design Block diagram



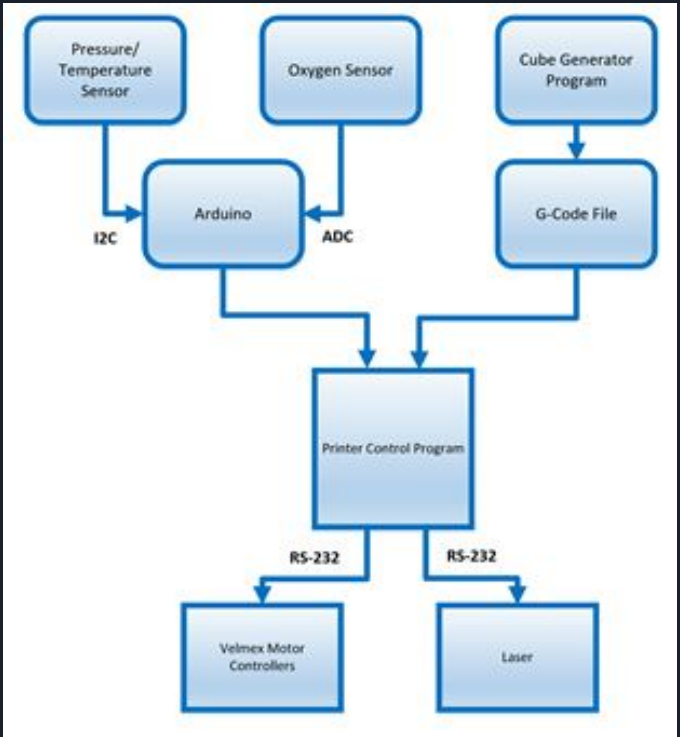
3. Implementation

Implementation Diagrams





Sensor Implementation



4. Testing

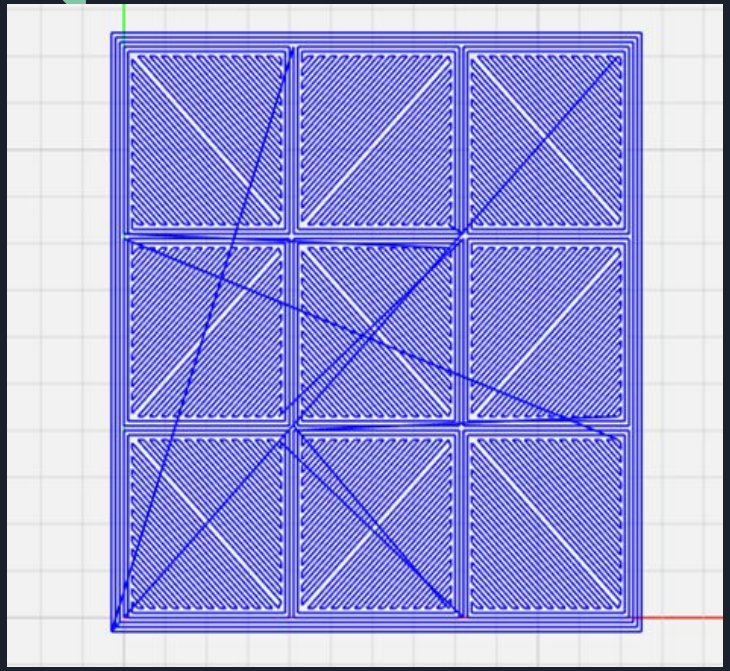
Test-Plan

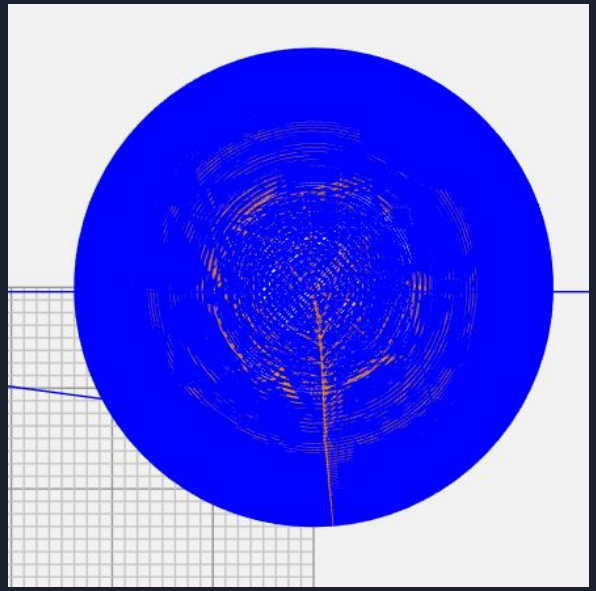
- Interface testing
  - Sensor readings
  - Current status
- Functional testing
  - 2D Box (Complete)
  - 3D Cube
  - Other basic shapes
  - CAD Files
- Non-Functional testing
  - Speed
  - Ease of use

Unit Testing/ Interface Testing

- Camera
- Barometer
- Gcode
- Velmex commands

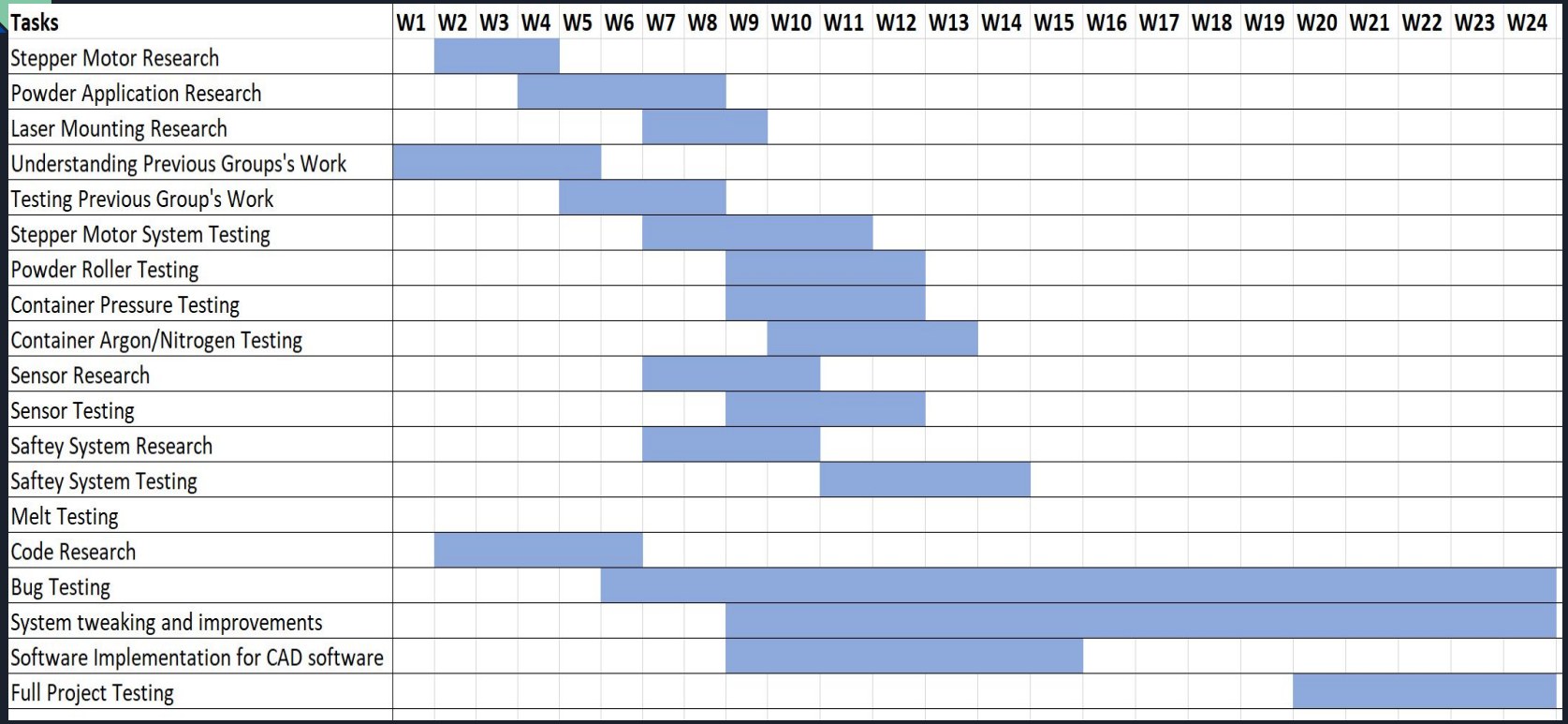
System Integration Testing



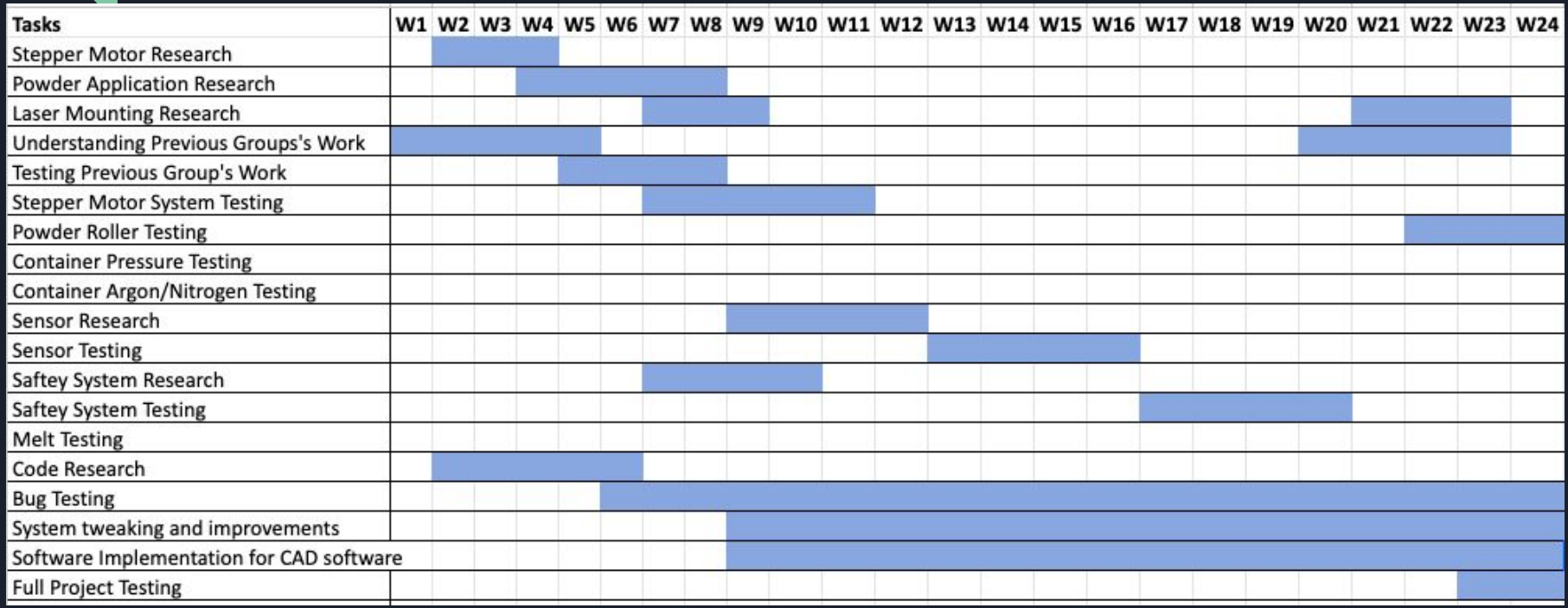


5. Project and risk Management

Proposed Project Schedule



Actual Project Schedule



Risks and Mitigation

- Project lost two mechanical engineers
- Problems with putting the printer together
- The 1064nm 200 W melt laser needed the proper power cable
- Loss of a team member

6. Conclusions/Lessons learned

- Group organization and communication
- Design constraints
- Real-world/Project constraints

Questions?

7. References

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