

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:
 - \circ Window
 - Camera
 - Mirror

• Bu

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

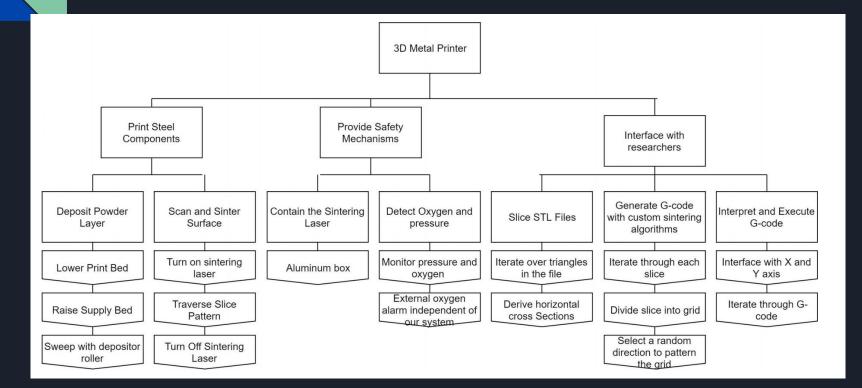
- Previous group cost: \$21,286
 - Stepper motors
 - \circ Lasers
 - \circ Sensors
- Our cost: ~\$400
 - Camera
 - Contact sensor
 - Laser lens

Milestones and Schedule

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

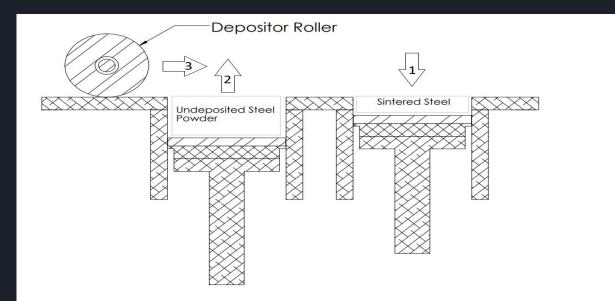
Tasks	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21	W22	W23	W24
Stepper Motor Research									-															
Powder Application Research																								
Laser Mounting Research																								
Understanding Previous Groups's Work																								
Testing Previous Group's Work																								
Stepper Motor System Testing																								
Powder Roller Testing																								
Container Pressure Testing																								
Container Argon/Nitrogen Testing																								
Sensor Research																								
Sensor Testing																								
Saftey System Research											_													
Saftey System Testing																								
Melt Testing																								
Code Research																								
Bug Testing																								
System tweaking and improvements																								
Software Implementation for CAD software																								
Full Project Testing																								

Functional Decomposition





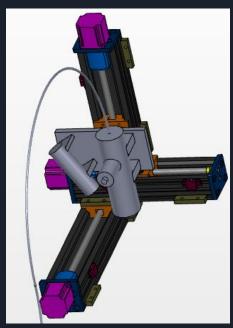
Detailed Design: Depositing Powder





Detailed Design: Sintering Assembly

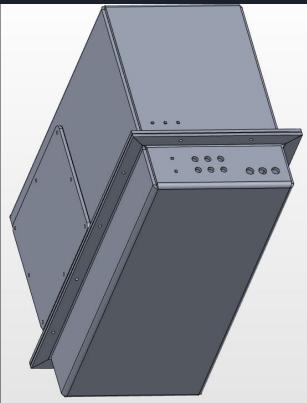
- Attached to three Velmex stepper slide motors
- Random movement
 - Sinters in small, ~1cm squares
 - Avoids overheating





Detailed Design: Vacuum Chamber

- Holes for wires
 - Sensors
 - Cameras
 - \circ 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#

III 3D Metal Printer	-		×
30 METAL P	RINT		R
Cube generator	G-Code I	nterprete	r

CubeGeneratorWindow	- 0	×	MainWindow	-	×
	pot size:		Team 3 3D Metal Printer		
Layer th	Height:		Import a .stl file, slice, and then print.		
Number of perimeter lines	s (layer):		Browse File Location		
Hatch direction alternation:		*	Slice		
Infill squa			Print		
Number of perimeter line			Clear		
Number of infill squ Number of infill squ					
Infill square order:		~			
Defect size (x, y, z):		Defect?			
Defect location (x, y, z):	distance unit	rs in mm			
Close	_	gCode			

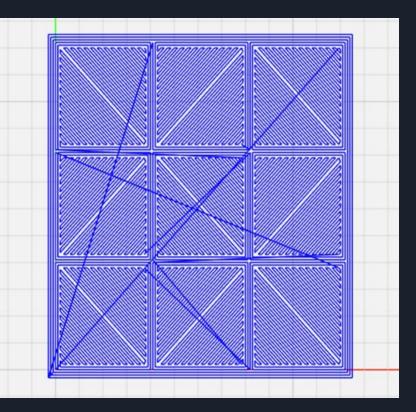
Hardware/Software/Technology Platforms used

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



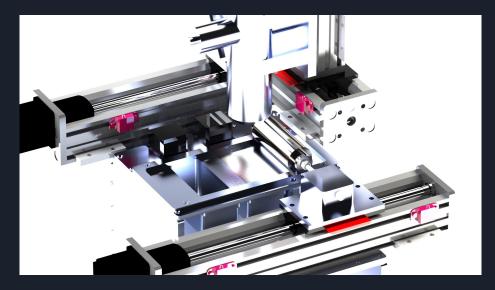
Test Plan

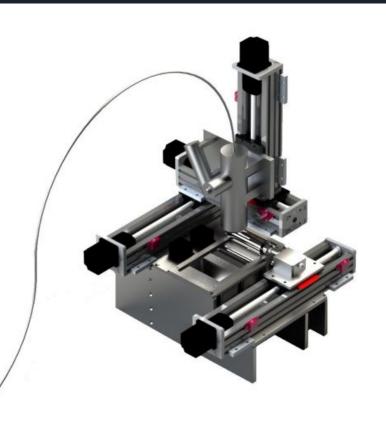
- Interface testing
 - Sensor readings
 - Current status
- Functional testing
 - \circ 2D Box (Complete)
 - 3D Cube
 - Other basic shapes
 - CAD Files
- Non-Functional testing
 - \circ Speed
 - Ease of use



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

