

Insulation Cutting and Measuring Module Design Release

Team Insulation Station



Objective

- Design and build a module that scans a work order, determines the desired length, measures insulation to that length, and cuts it with minimal human input required.



Value Proposition

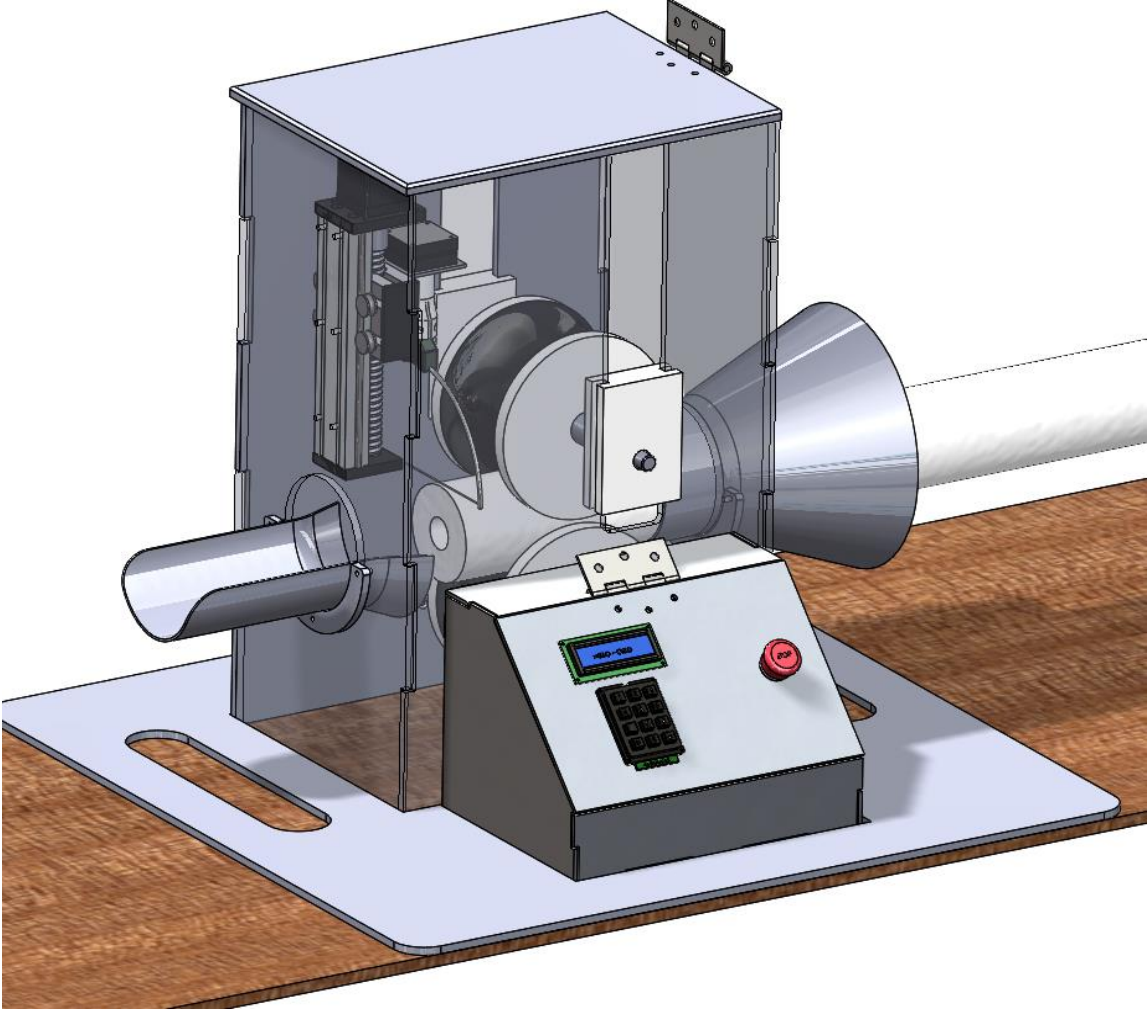
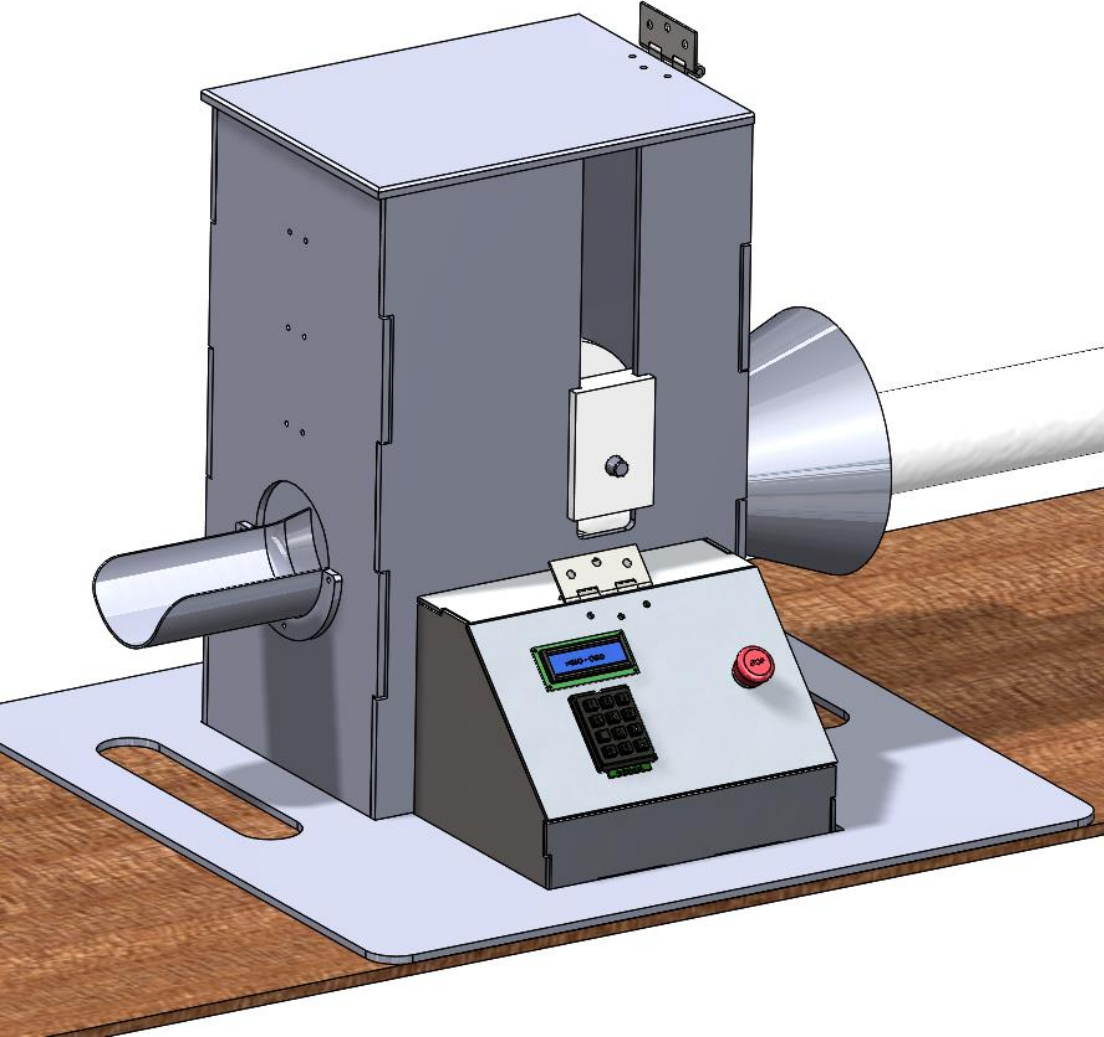
This project will add value to the Boeing Tubing, Duct and Reservoir Center (TDRC) by:

- Minimizing human error involved in cutting insulation
- Reducing cost of measuring and cutting insulation
- Minimizing time spent measuring and cutting job order

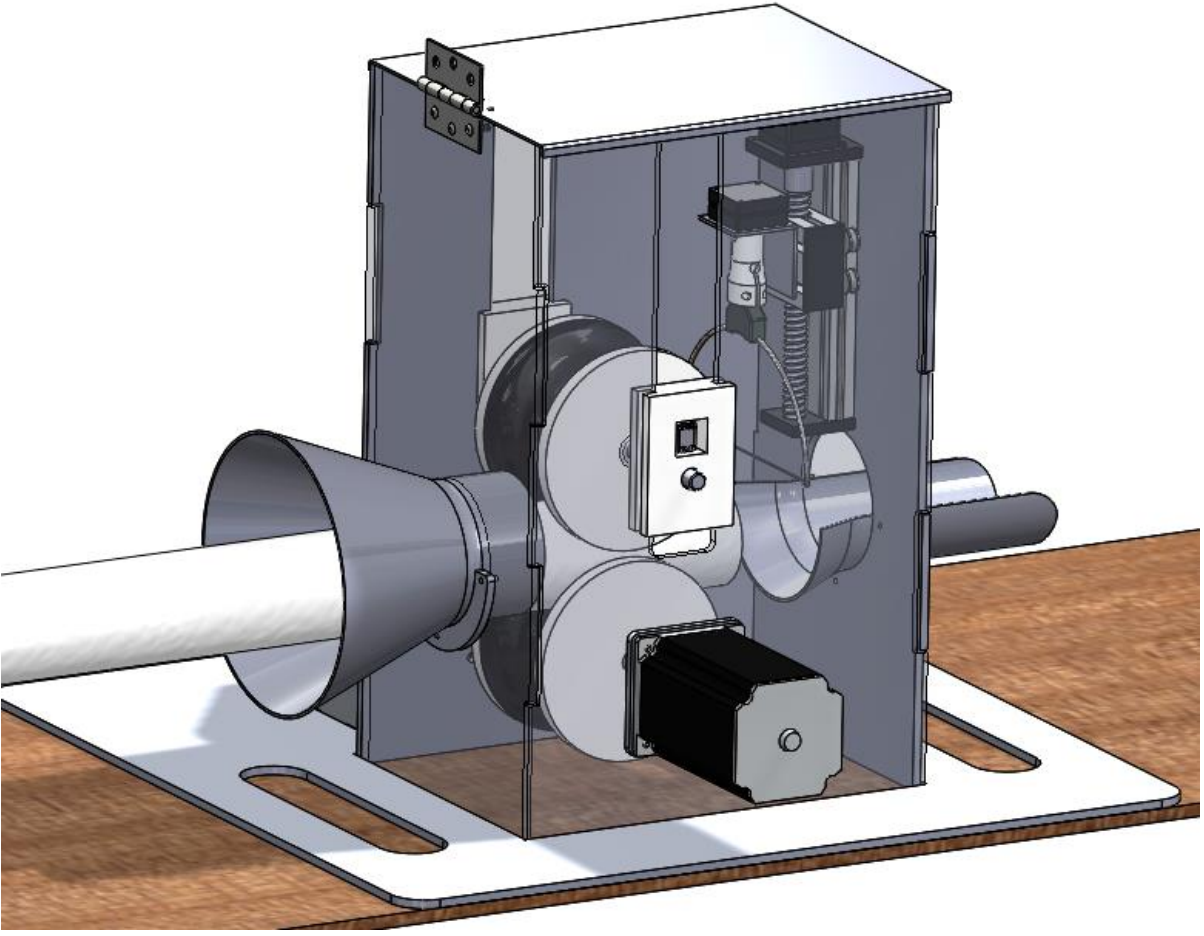
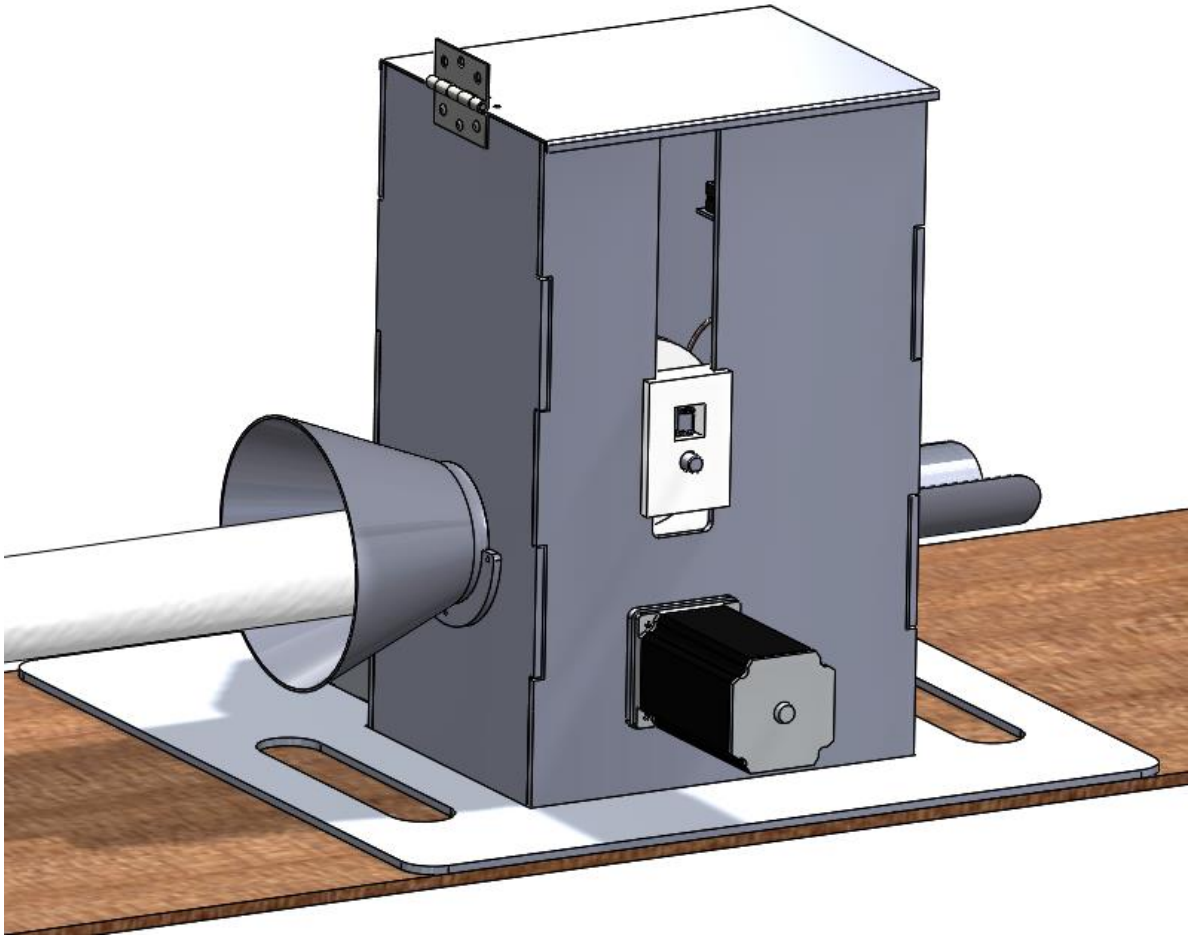
Product Requirements

- This system should take less time than the current method of cutting
- The cutter may not alter the insulation's integrity
- Measure the insulation within +/- 0.270" tolerance

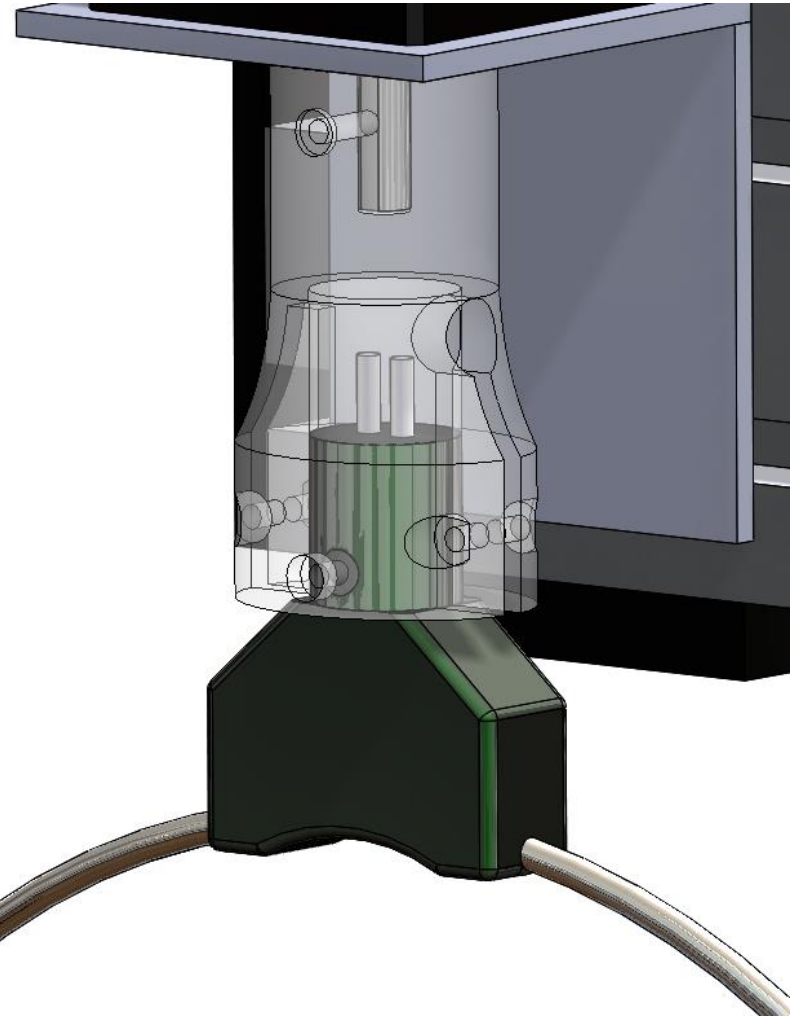
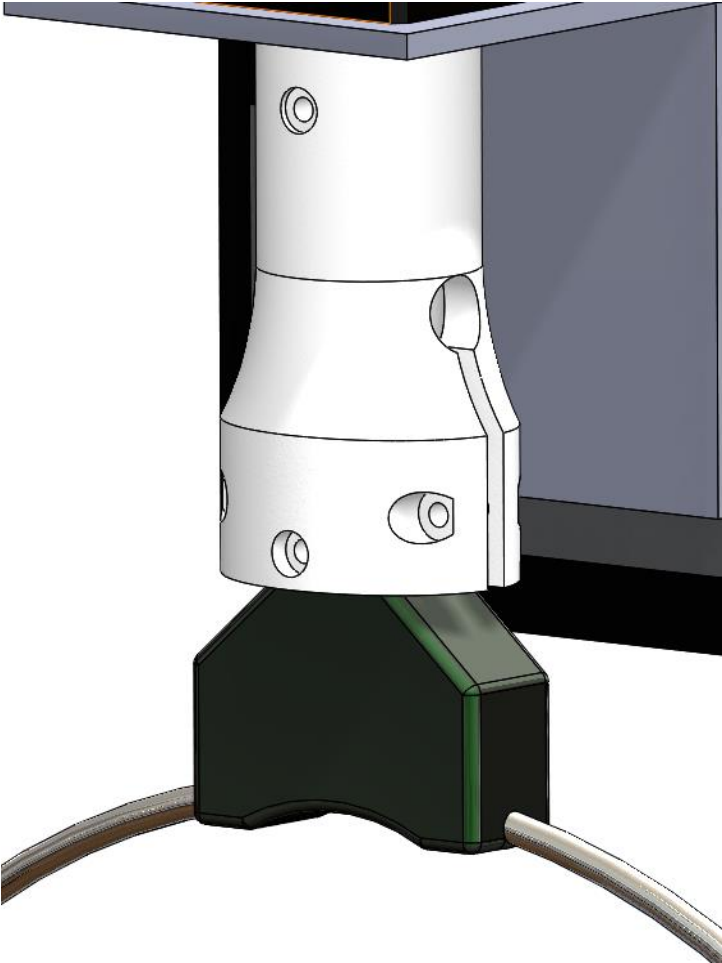
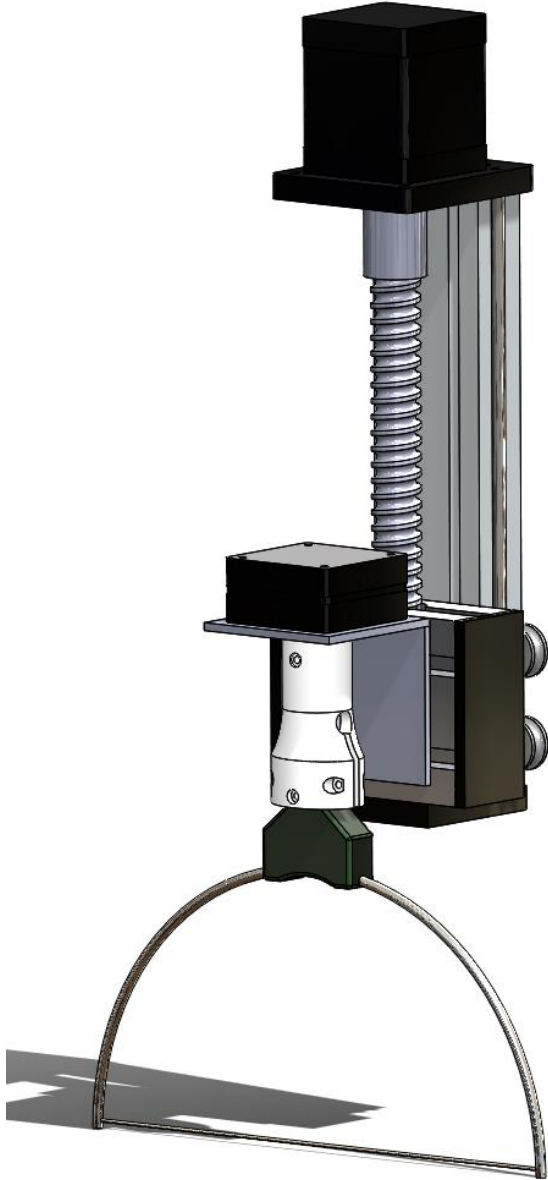
Total System Drawing



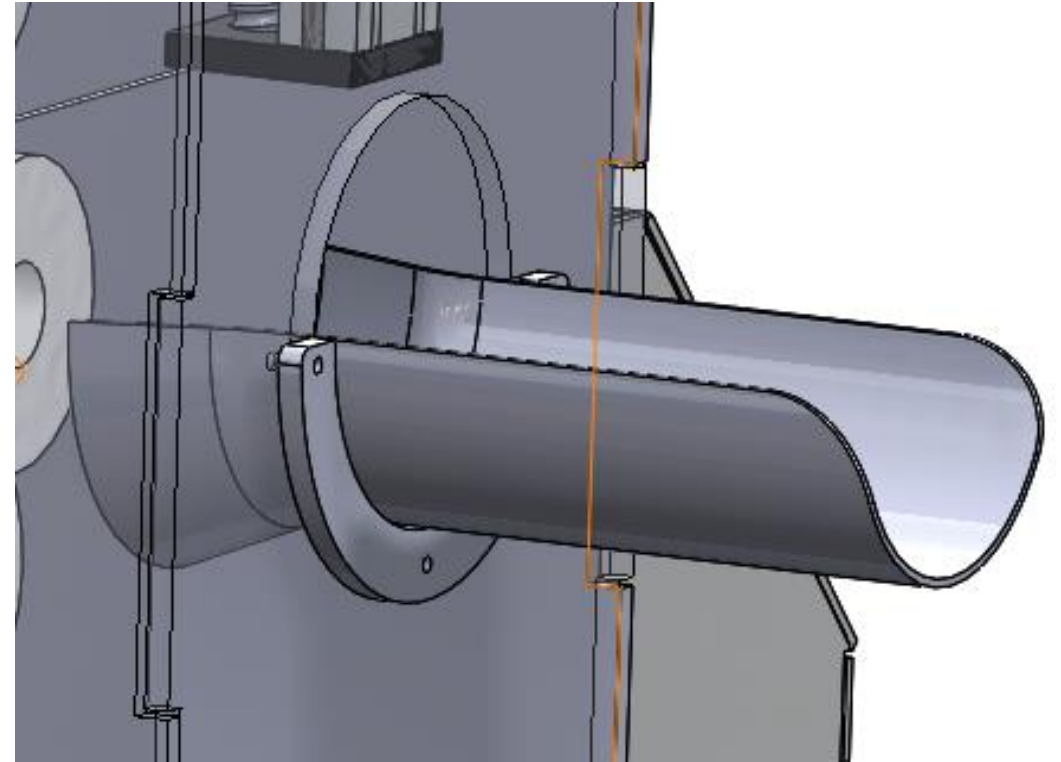
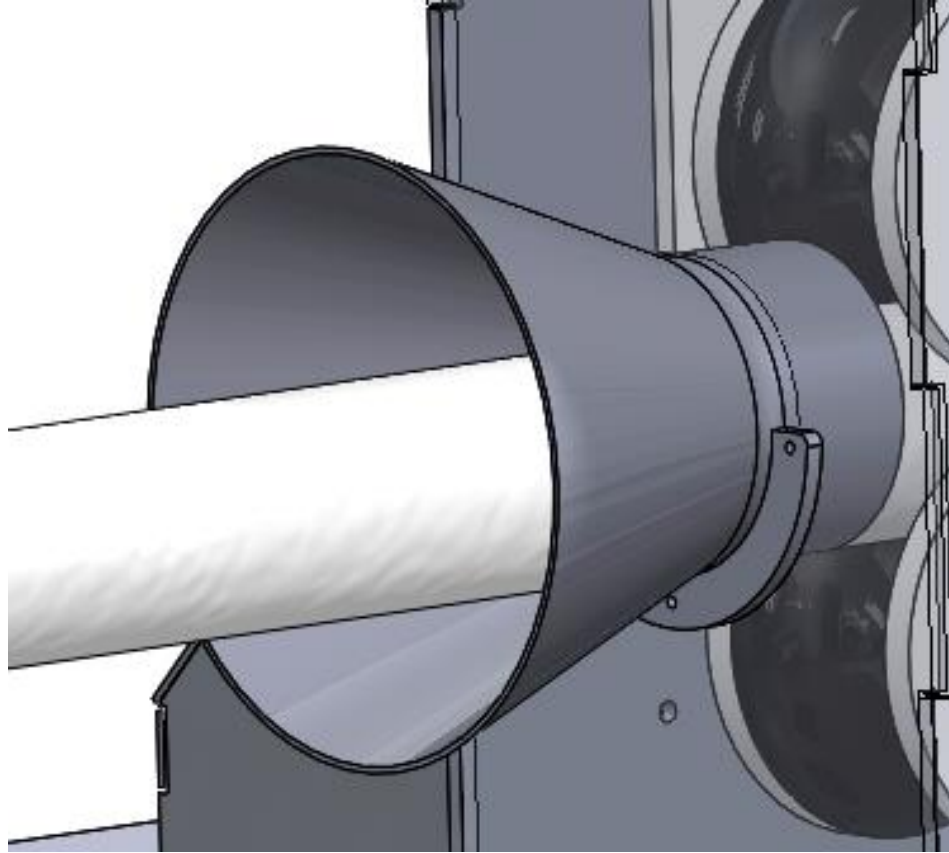
Alternative Views



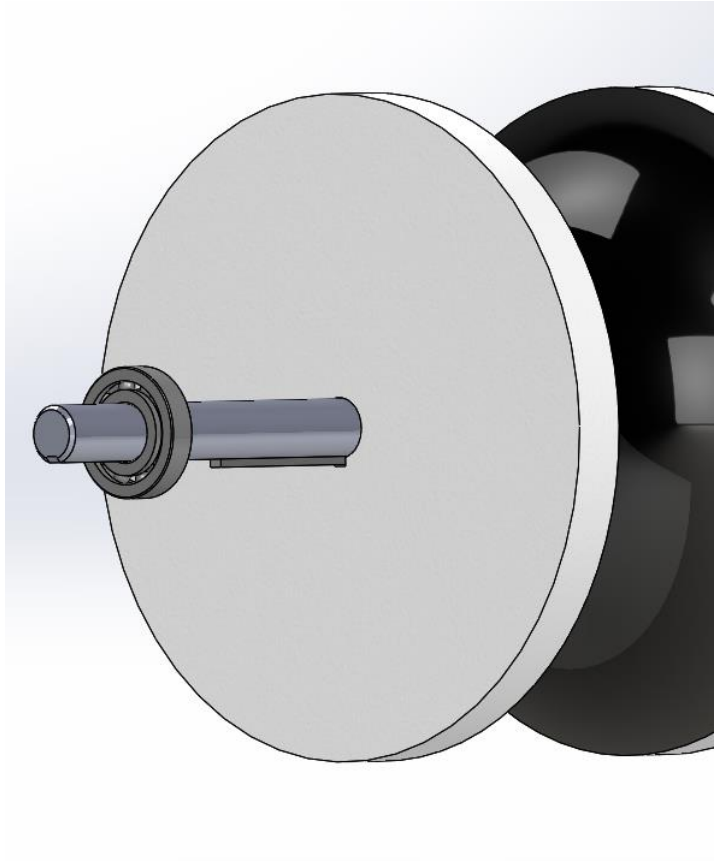
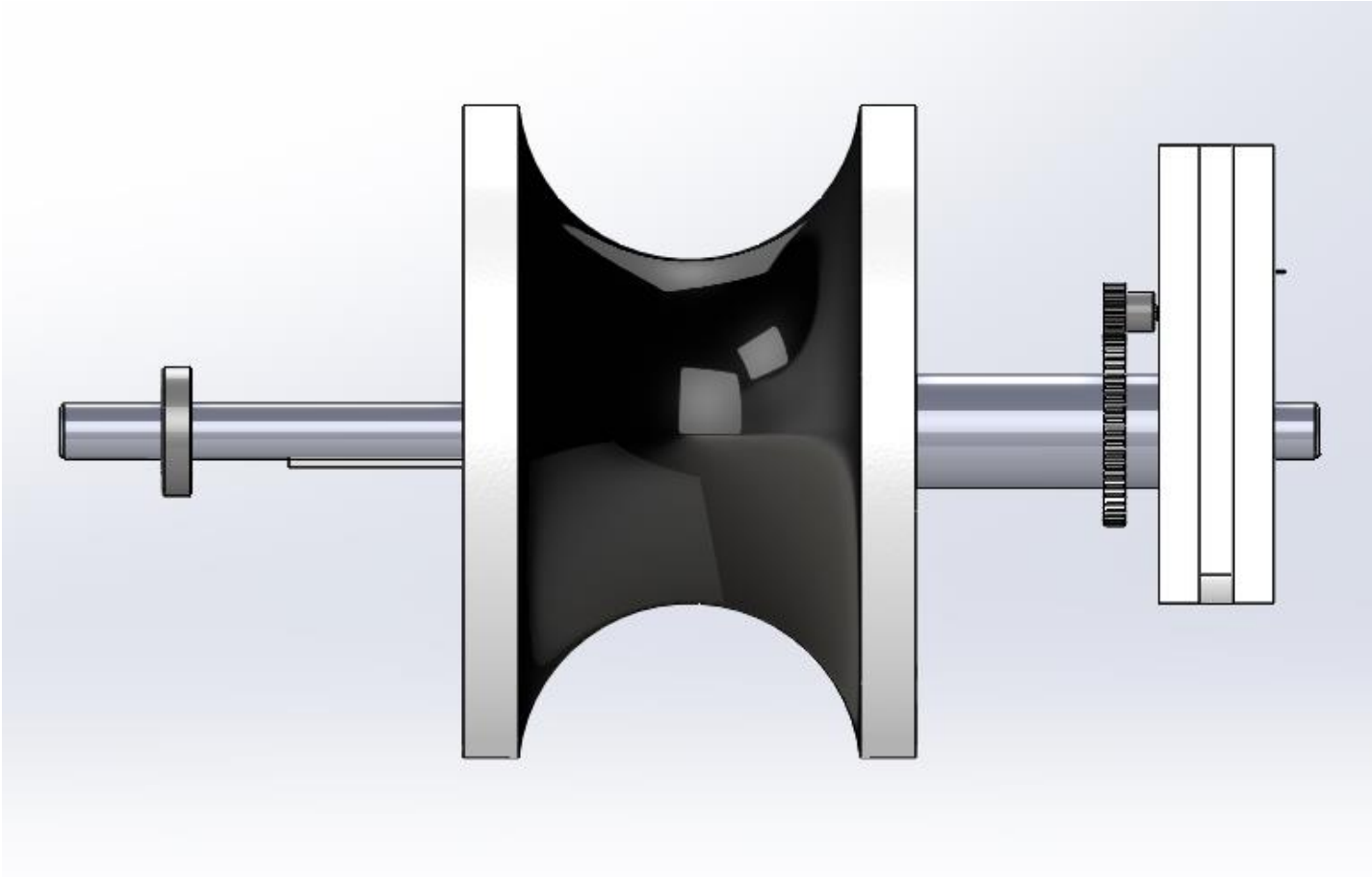
Cutter Assembly

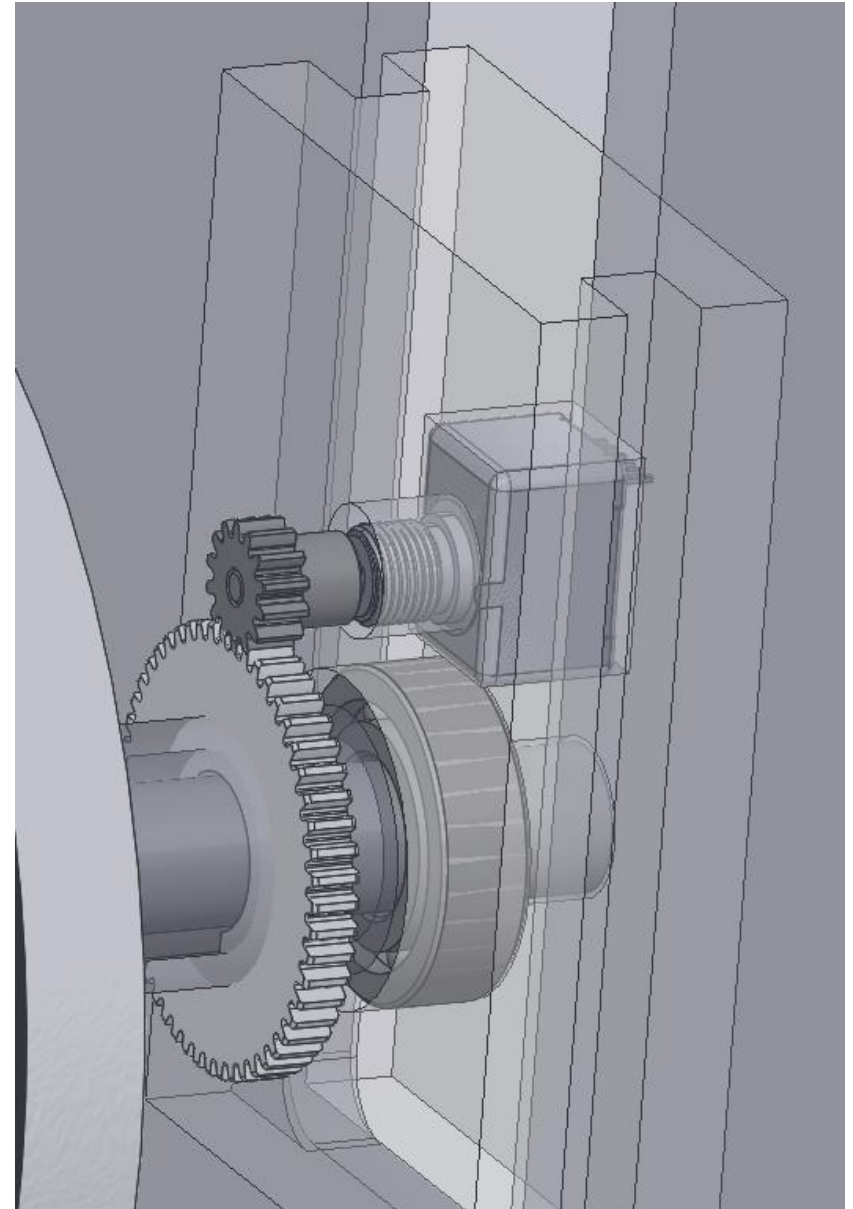
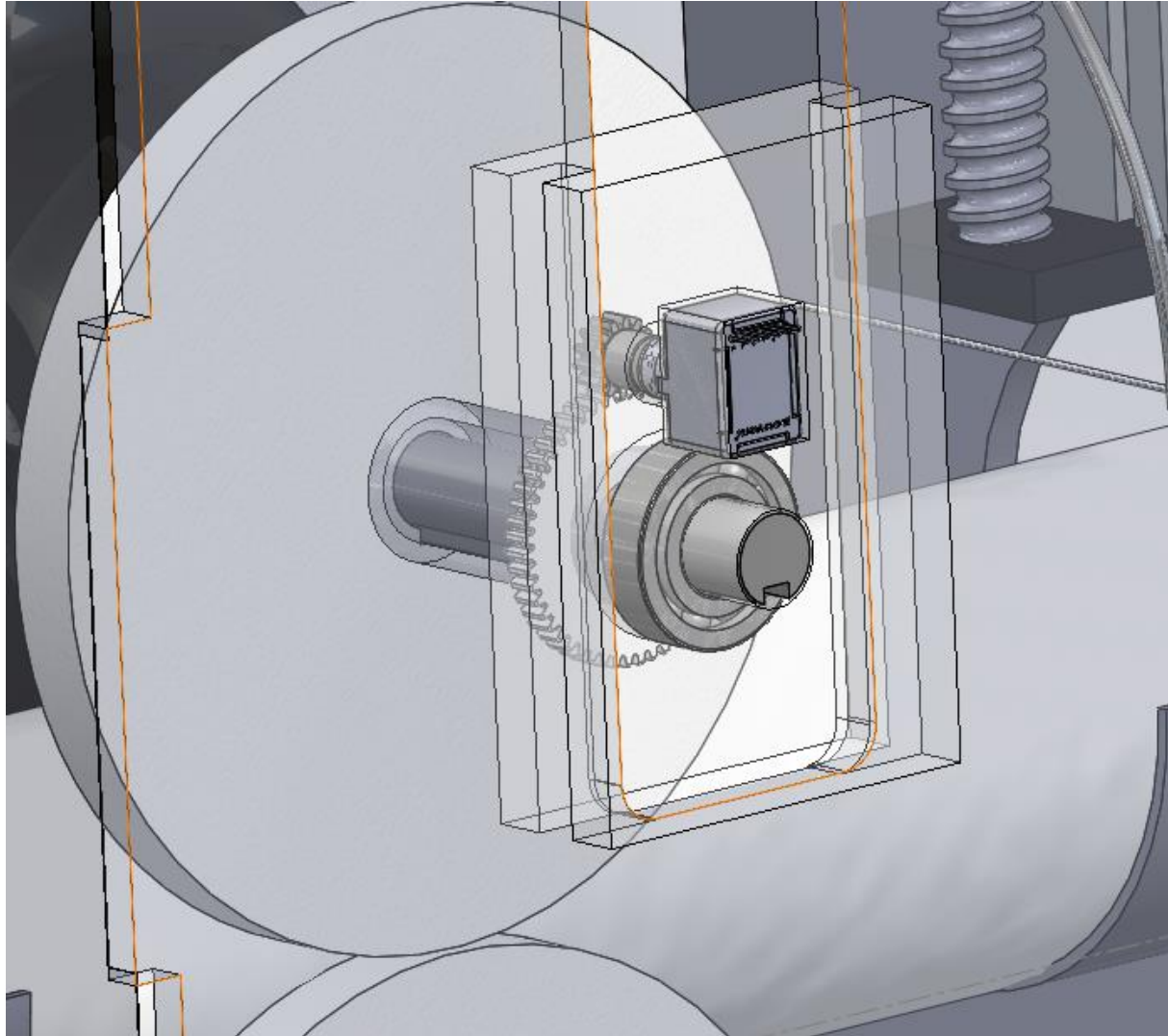


Gutters

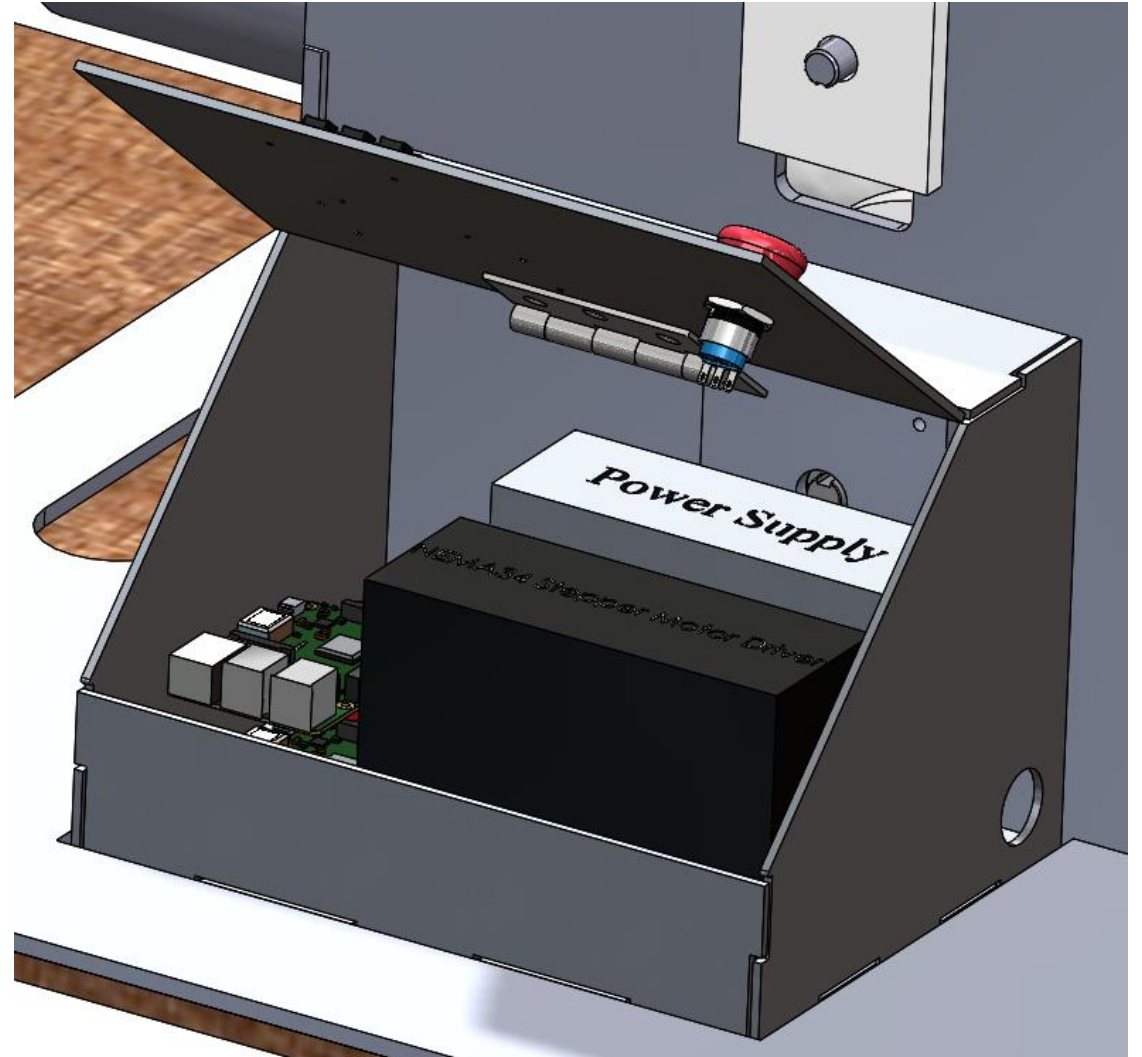
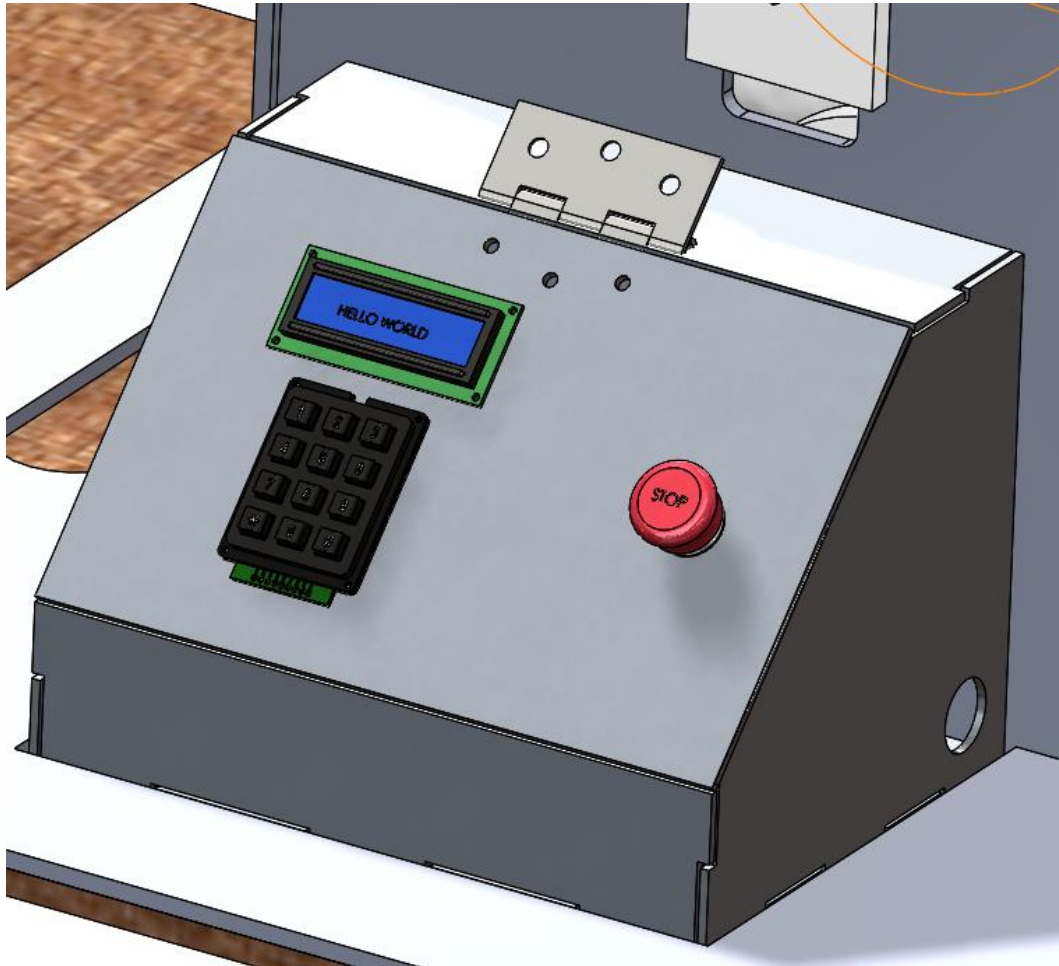


Top Wheel

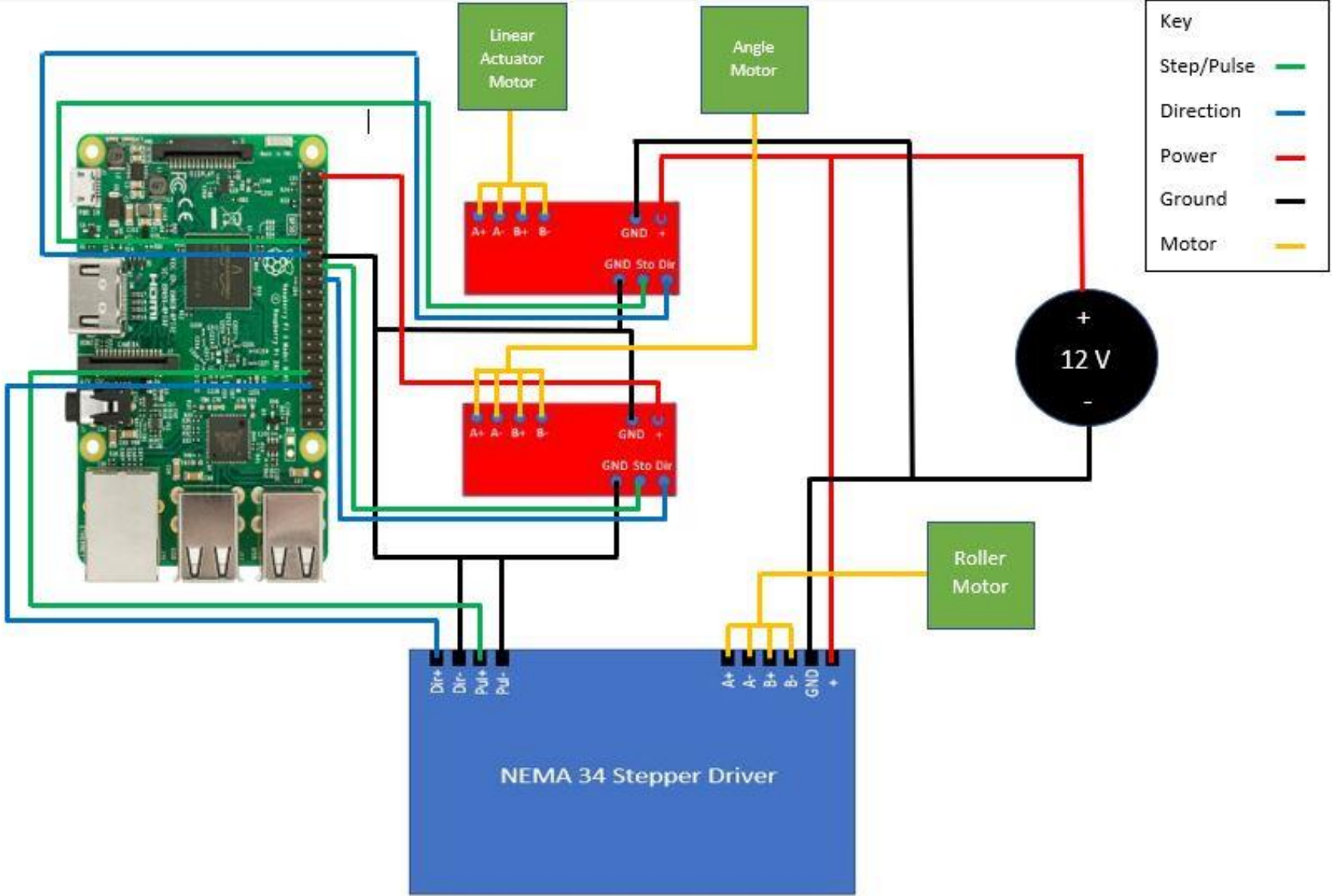




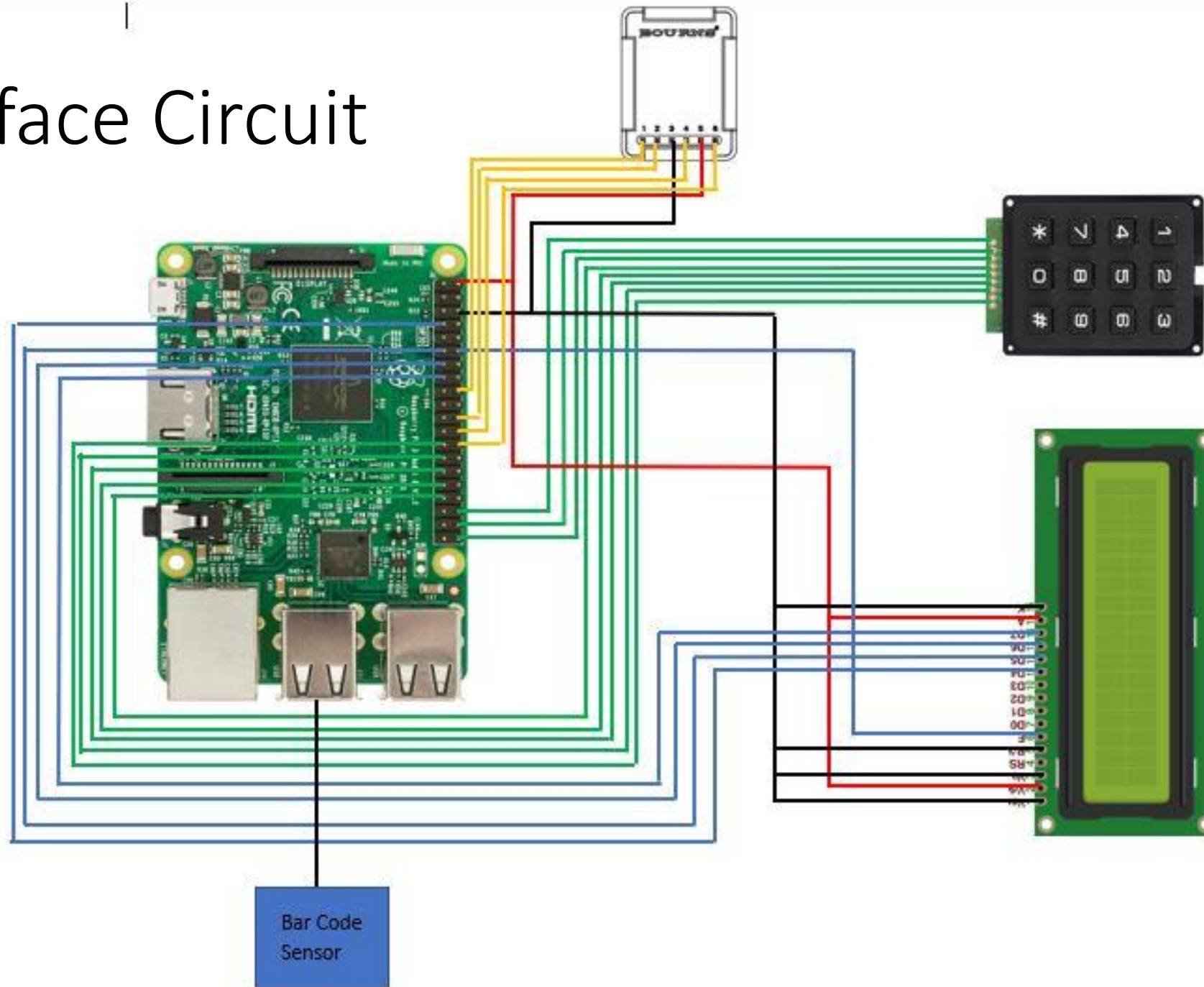
Power Box Assembly



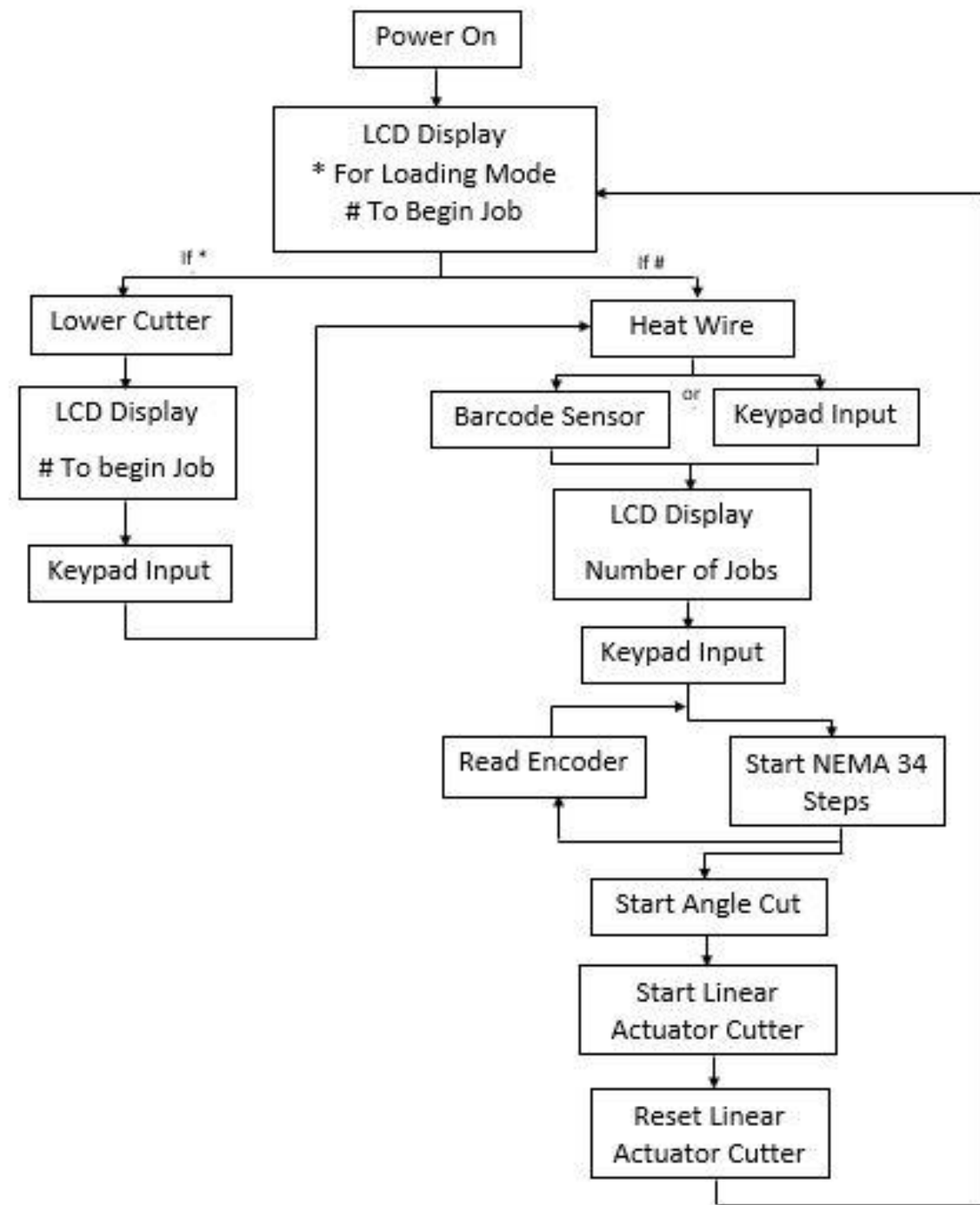
Motor Circuit



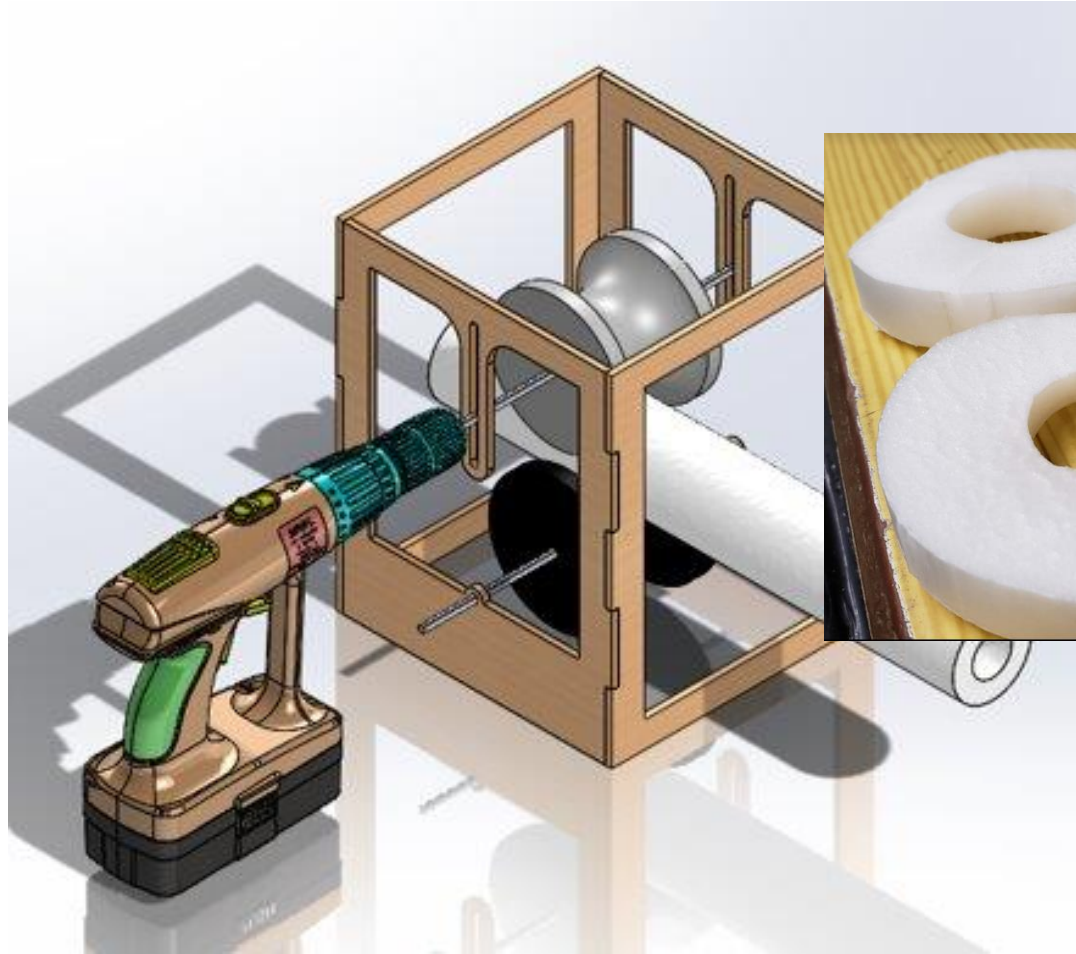
Interface Circuit



Programming Considerations



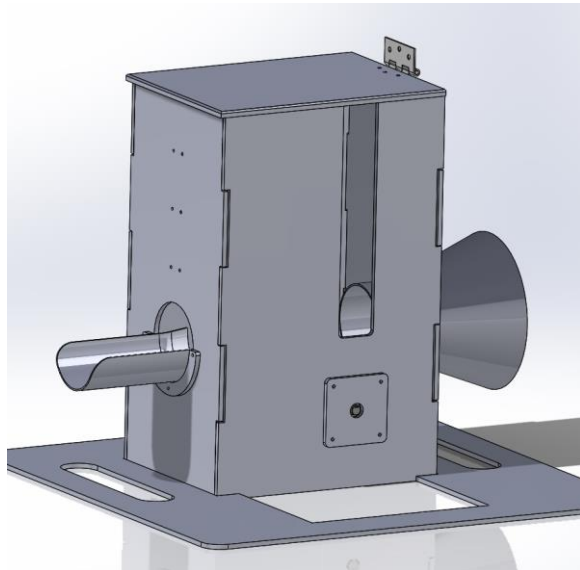
Proof of Concept



Manufacturing Plan

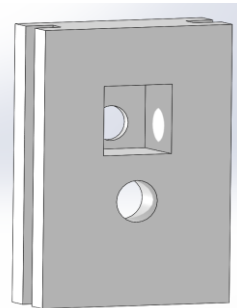
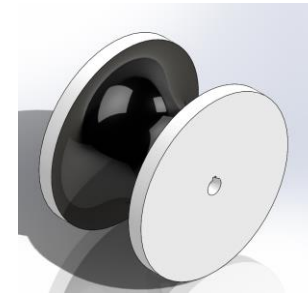
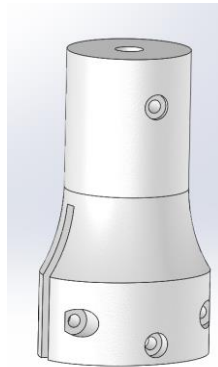
Laser Cut and Weld Together

- 02-00 Gutters
- 03-00 Power Box
- 04-00 Frame
- 05-00 Human Interface



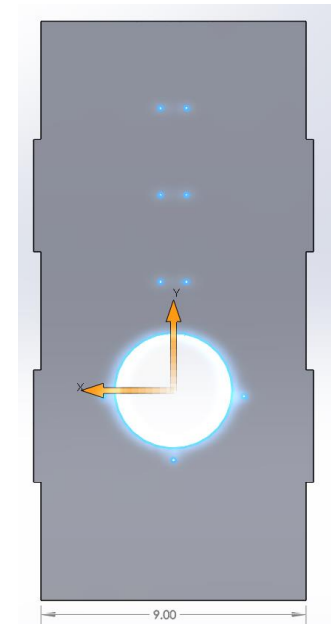
3D Print

- 01-01 Connector
- 04-06 wheels
- 04-07-8 Linear Bearings



Machine

- 01-02 & 01-03 L Plate
 - 04-04 Axle
- Precise Holes on:
- 04-00 Frame



Risk Management

- Sharp metal
 - We have rounded all corners to prevent this being an issue
- Heated Wire
 - Encapsulated in box to prevent hands from touching heated wire
- Rollers
 - Encapsulated in box to prevent hands from getting stuck in rollers
- Other Precautions
 - Emergency stop button has been added to completely stop energy from coming into the system

BOM

Capstone Design Combined BOM and Manufacturing Plan

Indented Bill of Materials (BOM)				Manufacturing Plan					Cost		
Part No. or Assy No.	Description	Quantity	Make or Buy?	Source (or Fabrication Location)	Fabrication Technique (if appl.)	Is the Drawing Avail.?	Is Material Avail.?	Who will lead (Name)?	Target Completion Date	Unit Cost (\$)	Extended Cost (\$)
Full Assembly	Measuring and Cutting Module										\$ -
Subassembly 1	Cutter										\$ -
01-01	Bottom Plate	1	free	(apart of servo)	N/A	Yes	Yes			\$ -	\$ -
01-02	Connector	1	Make	Amazon	3d print	Yes	No			\$ -	\$ -
01-03	Cutter L Plate	1	Make	ME shop	weld	Yes	No			\$ 2.00	\$ 2.00
01-04	Lead Screw	1	Buy	McMaster-Carr	N/A	Yes	No			\$ 15.00	\$ 15.00
01-05	Moving Plate	1	free	(apart of servo)	N/A	Yes	Yes			\$ -	\$ -
01-06	Nema 23 (linear actuator)	1	Buy	Amazon	N/A	Yes	Yes			\$ 69.99	\$ 69.99
01-07	Rail	1	free	(apart of servo)	N/A	Yes	Yes			\$ -	\$ -
01-08	Top Plate	1	free	(apart of servo)	N/A	Yes	Yes			\$ -	\$ -
01-09	Tiny Wheel	1	free	(apart of servo)	N/A	Yes	Yes			\$ -	\$ -
01-10	Wire Cutter	1	Buy	Amazon	N/A	Yes	Yes			\$ 23.99	\$ 23.99
01-11	Nema 17 (angle cutter)	1	Buy	Amazon	N/A	Yes	Yes			\$ 10.99	\$ 10.99
Subassembly 2	Gutter										\$ -
02-01	Gutters	2	Make	ME shop	lathe mill	Yes	No			\$ 30.00	\$ 30.00
02-02	Gutter Connection	2	Make	ME shop	weld	Yes	No			\$ -	\$ -
02-03	Gutter Screws		Buy	McMaster-Carr	N/A	Yes	No			\$ 10.00	\$ -
Subassembly 3	Power Box										\$ -
03-01	12V Power Supply	1	Buy	Amazon	N/A	Yes	Yes			\$ 11.99	\$ 11.99
03-02	24V Power Supply	1	Buy	Amazon	N/A	Yes	Yes			\$ 6.99	\$ 6.99
03-03	Outlet Extension Cord	1	Buy	Amazon	N/A	Yes	No			\$ 10.00	\$ 10.00
03-04	Raspberry Pi	2	Buy	Amazon	N/A	Yes	Yes			\$ 59.99	\$ 59.99
03-06	Stepper Driver (Nema 17 and 23)	1	Buy	Amazon	N/A	Yes	Yes			\$ 14.23	\$ 14.23
03-08	Stepper Driver (Nema 34)	1	Buy	Amazon	N/A	Yes	Yes			\$ 65.85	\$ 65.85
03-09	Sheet Metal Box	1	Make	ME shop	weld	Yes	No			\$ 100.00	\$ 100.00
03-10	Surface Hinge	1	Buy	ME shop	weld	Yes	No			\$ 5.00	\$ 5.00
Subassembly 4	Wheels and Frame										\$ -
04-01	Box Sides	2	Make	ME shop	weld	Yes	No			\$ -	\$ -
04-02	Inlet Panel	1	Make	ME shop	weld, saw	Yes	No			\$ -	\$ -
04-03	Outlet Panel	1	Make	ME shop	weld, saw	Yes	No			\$ -	\$ -
04-04	Lid	1	Make	ME shop	weld	Yes	No			\$ 25.00	\$ 25.00
04-05	Bottom Plate	1	Make	ME shop	saw	Yes	No			\$ 25.00	\$ 25.00
04-06	Wheel	2	Make	Amazon	3d print	Yes	Yes			\$ 59.98	\$ 59.98
04-07	Keyed Bottom Shaft	1	Buy	McMaster-Carr	N/A	Yes	No			\$ 15.00	\$ 15.00
04-08	Linear Bearing	2	Make	Amazon	3d print	Yes	No			\$ -	\$ -
04-09	Purchased Part	1	Buy	McMaster-Carr	N/A	Yes	No			\$ -	\$ -
04-10	Ball Bearing	3	Buy	McMaster-Carr	N/A	Yes	No			\$ 32.89	\$ 32.89
04-11	Nema 34	1	Buy	Amazon	N/A	Yes	Yes			\$ 77.50	\$ 77.50
04-12	Keyed Axel	2	Buy	McMaster-Carr	N/A	Yes	No			\$ 15.00	\$ 30.00
04-13	Shaft Key	2	Buy	McMaster-Carr	N/A	Yes	No			\$ 15.00	\$ 30.00
04-14	Spacer	4	Buy	acme plastics	N/A	Yes	No			\$ 30.00	\$ 30.00
04-15	Motor Plate	1	Make	ME shop	weld	Yes	No			\$ -	\$ -
04-16	Bearing Plate	1	Make	ME shop	N/A	Yes	No			\$ -	\$ -
04-17	Shaft Coupling	1	Buy	McMaster-Carr	lathe mill	Yes	No			\$ 20.00	\$ 20.00
04-18	Button Screw		Buy	McMaster-Carr	N/A	Yes	No			\$ 10.00	\$ 10.00
04-19	Surface Hinge	1	Make	ME shop	N/A	Yes	No			\$ 5.00	\$ 5.00
Subassembly 5	Human Interface										\$ -
05-01	Barcode Scanner	1	free	Boeing	N/A	Yes	Yes			\$ -	\$ -
05-02	Scanner Holder	1	free	Boeing	N/A	Yes	Yes			\$ -	\$ -
05-03	Emergency Stop Button Nut		Buy	McMaster-Carr	N/A	Yes	No			\$ 5.00	\$ -
05-04	Emergency Stop Button	1	Buy	Amazon	N/A	Yes	No			\$ 10.00	\$ 10.00
05-05	Keypad	1	Buy	Amazon	N/A	Yes	Yes			\$ 10.34	\$ 10.34
05-06	Front-Back Plate	1	Make	ME shop	weld, saw	Yes	No			\$ -	\$ -
05-07	LCD Screen	1	Buy	Amazon	N/A	Yes	Yes			\$ 5.99	\$ 5.99
Insert more lines as needed...											
										Total BOM Cost	\$ 812.72

Gantt Chart

Key Milestones:

- Boeing Design Review – 2/19
- Machining – 2/24
- Wiring - 3/09
- Component Installation - 3/09
- Testing – 3/16
- Expo – 5/1

PROJECT TITLE	Insulation Station				
	Christmas Break		12/23/19	01/08/20	100%
3.7	Solidworks Modeling	Group	01/08/20	02/19/20	95%
3.7.1	Casing Modeling	Rennie, Ian	01/08/20	01/15/20	100%
3.7.2	Cutter Modeling	Rennie, Ian	01/16/20	01/20/20	100%
3.7.3	Intlet Modeling	Rennie, Kyle	01/20/20	01/24/20	100%
3.7.4	Outlet Modeling	Rennie, Kyle	01/20/20	01/24/20	100%
3.7.5	Roller Modeling	Rennie, Ian	01/27/20	01/31/20	100%
3.7.6	Power Box Modeling	Rennie, Ian	02/03/20	02/07/20	100%
3.7.7	Motors, Encoder Modeling	Rennie, Ian	02/10/20	02/14/20	100%
3.8	Programming	Alyssa	02/05/20	02/25/20	75%
3.8.1	Motor programming	Alyssa	02/05/20	02/12/20	80%
3.8.2	Angle Motor programming	Alyssa	02/13/20	02/18/20	80%
3.8.3	Encoder programming	Alyssa, Kyle	02/18/20	02/25/20	50%
3.9	Modeling Revisions	Group	02/14/20	02/19/20	50%
3.10	Drawings	Group	02/17/20	02/19/20	100%
3.11	Boeing Design Review	Group	02/19/20	02/19/20	0%
3.12	Machining	Group	02/24/20	03/11/20	0%
3.12.1	Cutter Machining	Group	02/24/20	03/11/20	0%
3.12.2	Gutter Machining	Group	02/24/20	03/11/20	0%
3.12.3	Power Box Machining	Group	02/24/20	03/11/20	0%
3.12.4	Wheels and Frame Machining	Group	02/28/20	03/11/20	0%
3.13	Wiring	Group	03/09/20	03/13/20	0%
3.14	Component Installation	Group	03/09/20	03/16/20	0%
4	Validate				
4.1	Design Validation Plan	Alyssa	03/16/20	03/23/20	0%
4.2	Intake Testing	Ian	03/16/20	03/21/20	0%
4.3	Cutting Testing	Rennie	03/17/20	03/21/20	0%
4.4	Casing Testing	Alyssa	03/22/20	03/26/20	0%
4.5	Program Testing	Alyssa	03/27/20	03/31/20	0%
4.6	Measurement Testing	Kyle	04/01/20	04/05/20	0%

Discussion
