Spring 2015

Senior Design: KONG Toy Instruction-Manual Insertion

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SENIOR DESIGN: KONG TOY INSTRUCTION-MANUAL INSERTION

FOR WEAVER INDUSTRIES

GROUP MEMBERS: ASHLEY CUTHBERT, RACHAEL INNOCENZI, MARIANNA SMITH

PROJECT ADVISOR: DR. JERRY DRUMMOND

May 1, 2015

Overview

Introduction

Problem Definition

Design Description

Evaluation

Recommendations

Introduction

WEAVER INDUSTRIES

Founded in 1971 as a non-profit organization.

Provides vocational training and employment opportunities for individuals with developmental disabilities.

The Cuyahoga Falls Facility

- Packages dog chew toys for Kong Company
- 6 million+ Kong toys manually packaged at this facility per year

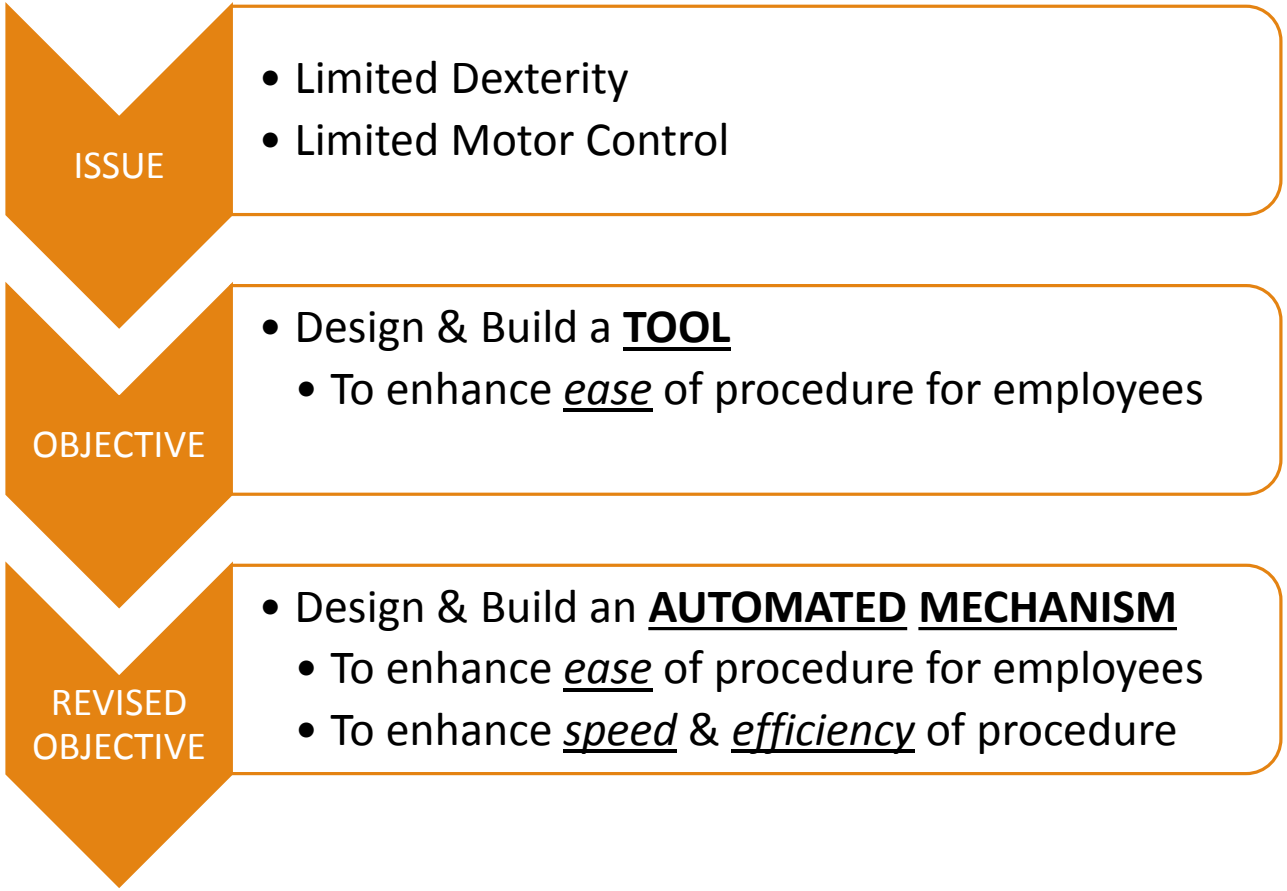
Problem Definition

Current Packaging Method

- Instruction manuals are inserted into the cardstock by hand before the toys are packaged (Figure 1).

Figure 1

Project Scope



Design Requirements

1. Adjustable for different size packaging
2. Automate manual insertion process
3. Increase current production rates per employee
4. Minimize cost to manufacture
5. Protect employees from pinch points and electrical components

Deliverables

Design Requirement	Importance	Units	Minimum Goal	Ideal Goal	
1. Adjustable for different size packaging	Medium	Inches	*Provided Cardstock Size*	Min: 6.5” x 4”	Max: 9.5” x 6”
2. Automate manual insertion process	High	Pass / Fail	Activated manual insertion by push-button, manual removal of cardstock.	Activated insertion by push-button and removal of cardstock.	
3. Increase current production rates per employee	High	Manuals / Min	7.7	10	
4. Minimized cost to manufacture	High	Dollars	Within $500 Budget	Less than $250	
5. Employees protected from pinch points and electrical components	High	Pass / Fail	Electrical components are covered, wedge mechanism is covered and e-stop is in place.	Component is completely sealed and only needs to be opened to re-fill manuals and cardstock packaging.	

Design Description

DESIGN #1

PROS:

- Manual
- Use of only (1) hand
- Holds *multiple* cardstock

CONS:

- *Not automated*
- Does *not* hold *multiple* instruction manuals

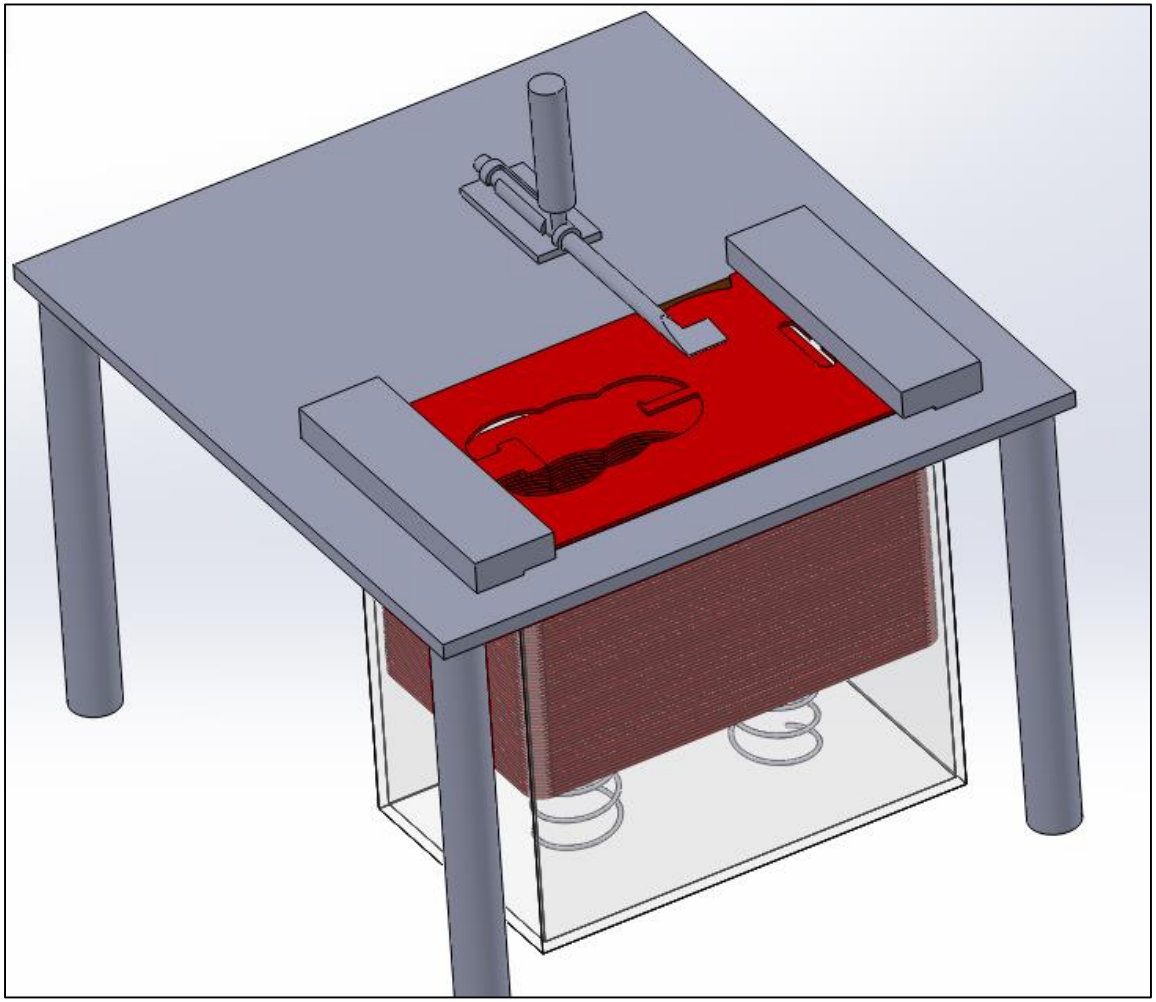


Figure 1

The operator would manually slide the arm into the cardstock and open the cardstock via rotation of the tapered flag on the end of the tool.

DESIGN #2

PROS:

- *Automated*
- Use of (1) hand
- Holds *multiple* cardstock
- Holds *multiple* instruction manuals

CONS:

- Slider mechanism *more complicated* to design
- *Reduced* ease of *speed variability*

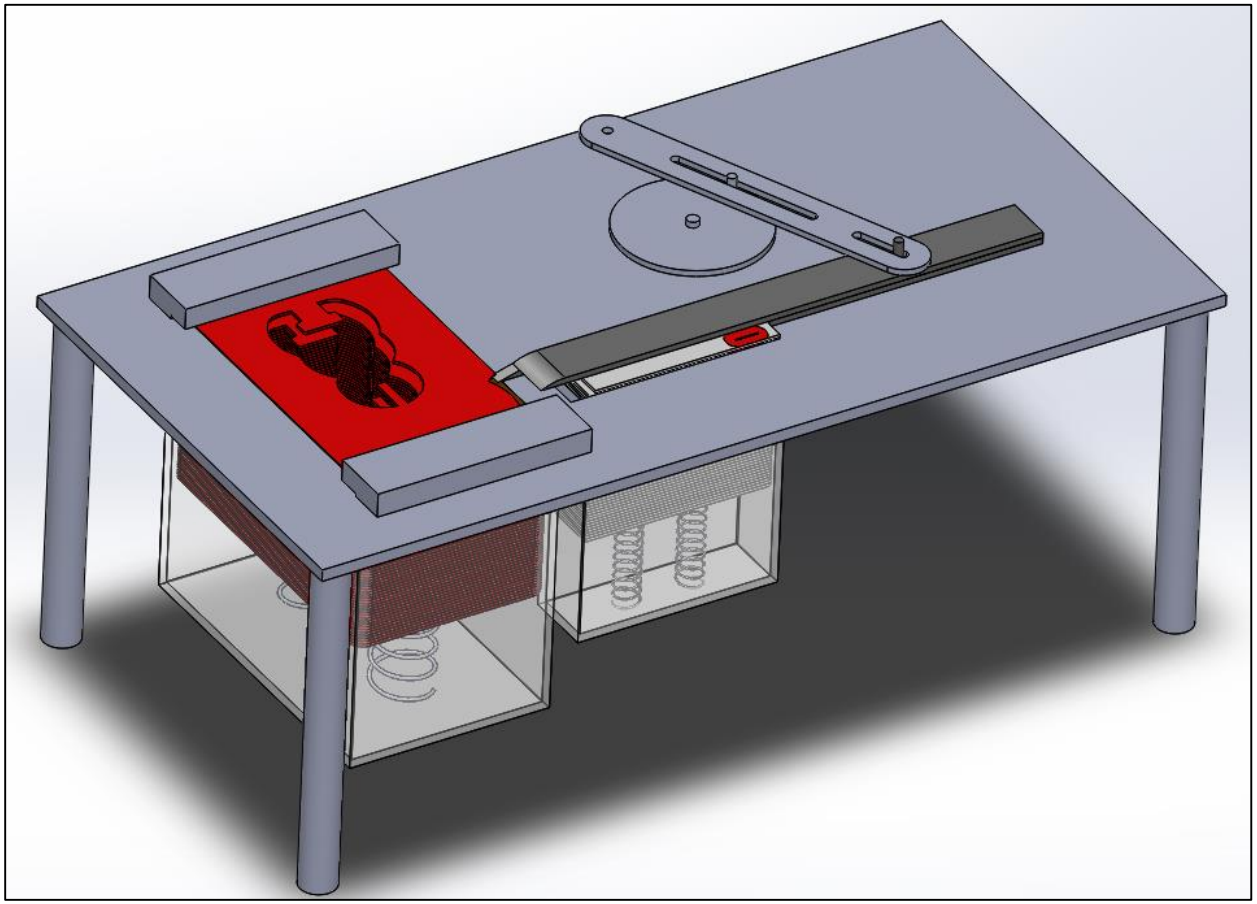


Figure 2

The operator would press a button that causes one rotation of the wheel to insert one instruction manual. The operator then removes the “stuffed” cardstock and begins the process again.

DESIGN #3

PROS:

- *Automated*
- Use of (1) hand
- Holds *multiple* cardstock
- Holds *multiple* instruction manuals
- Enhanced *speed variability*

SELECTED FOR BUILD

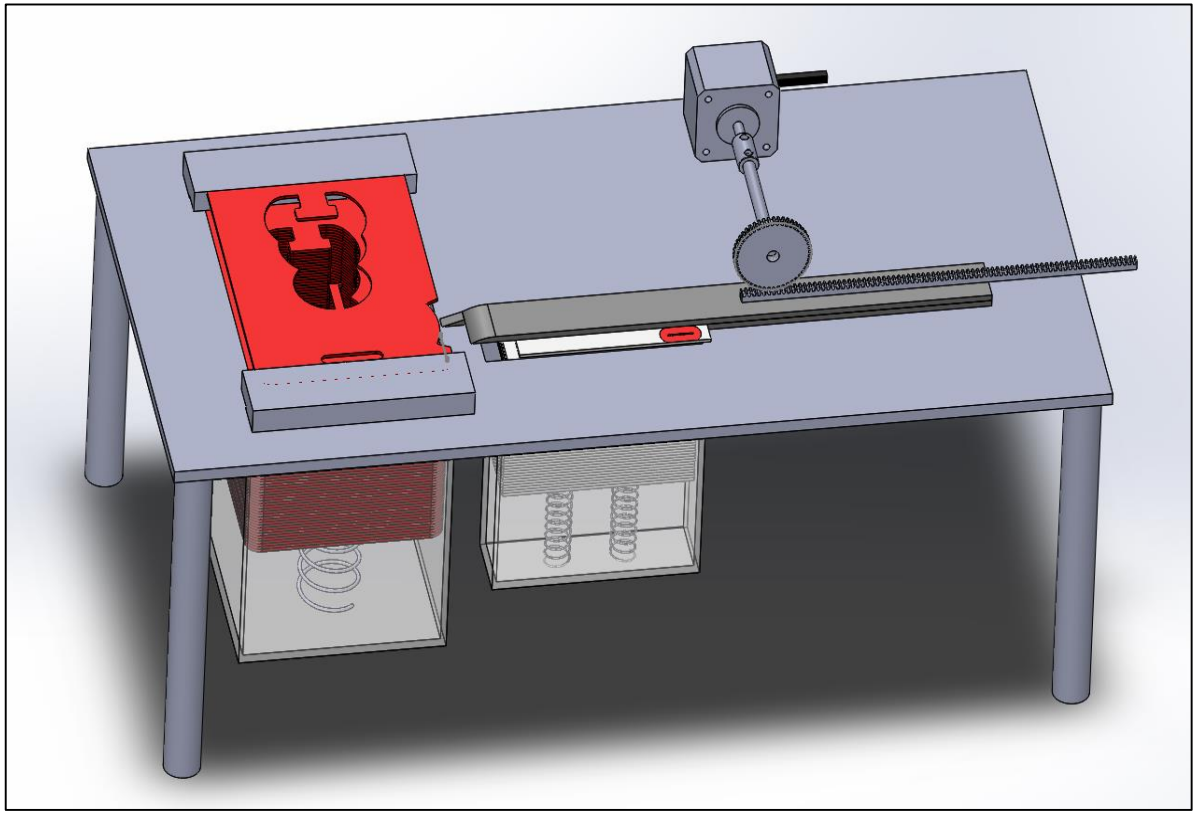


Figure 3

This design utilizes a rack & pinion set-up above the work bench.

DESIGN #3

PROS:

- *Automated*
- Use of (1) hand
- Holds *multiple* cardstock
- Holds *multiple* instruction manuals
- Enhanced *speed variability*

SELECTED FOR BUILD

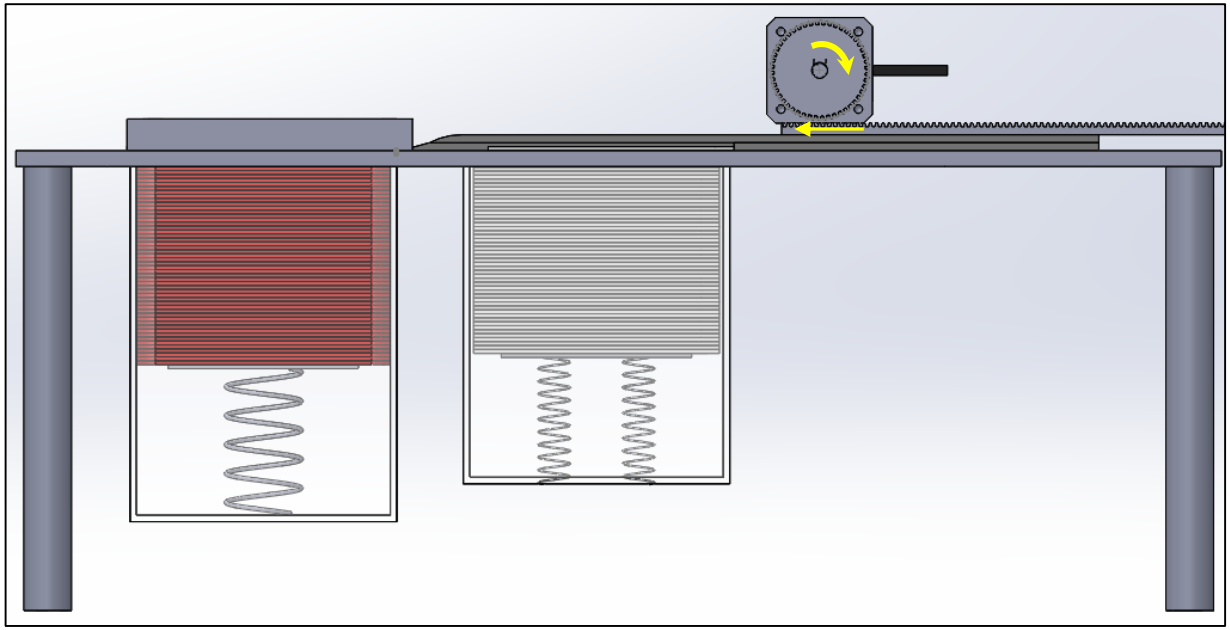


Figure 4

This design utilizes a rack & pinion set-up above the work bench.

DESIGN #3

PROS:

- *Automated*
- Use of (1) hand
- Holds *multiple* cardstock
- Holds *multiple* instruction manuals
- Enhanced *speed variability*

BUILT

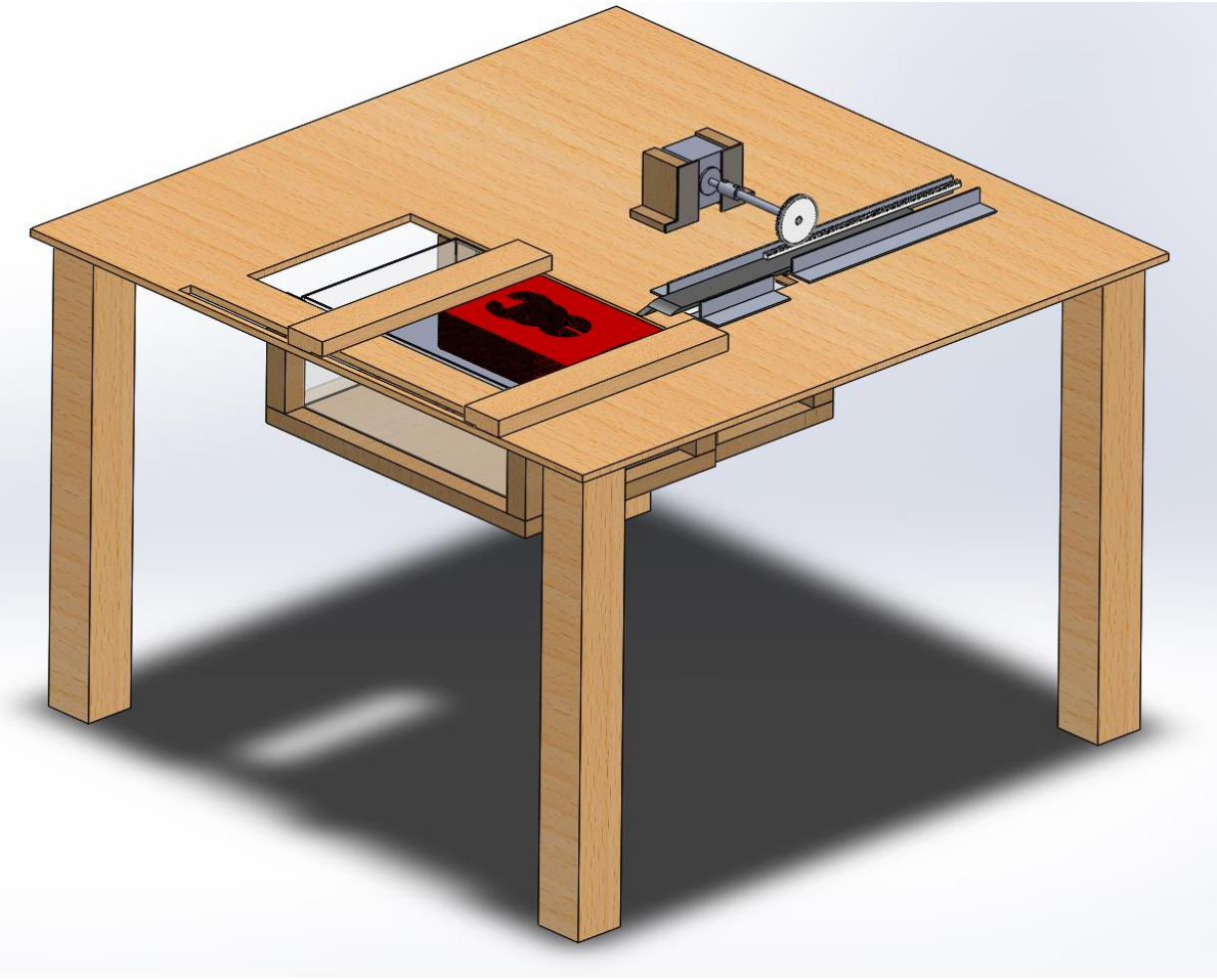
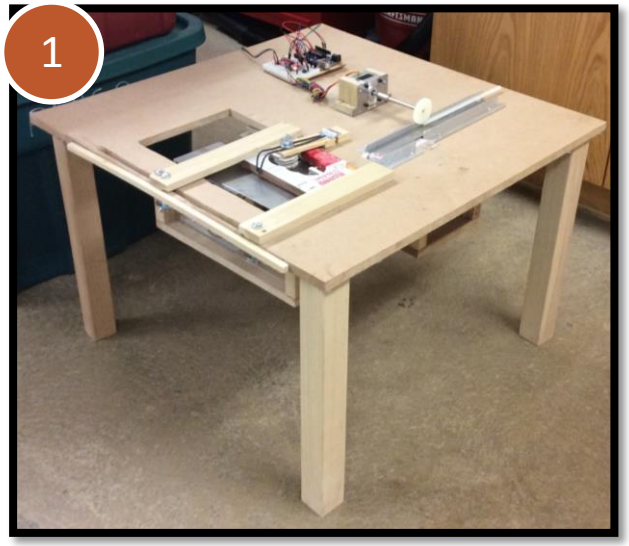
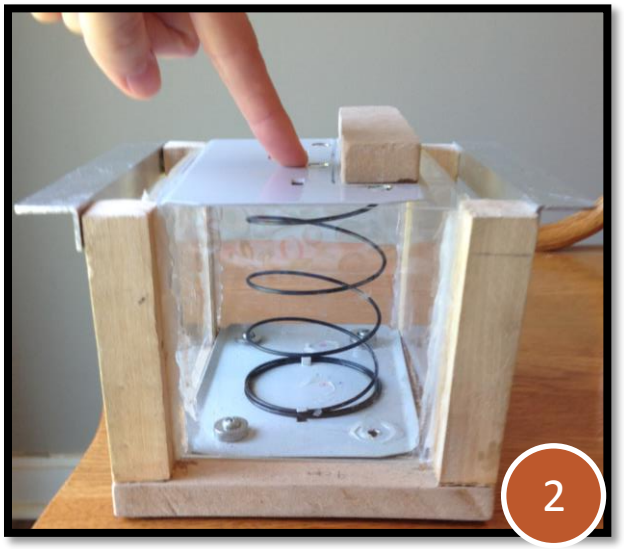


Figure 5

Table

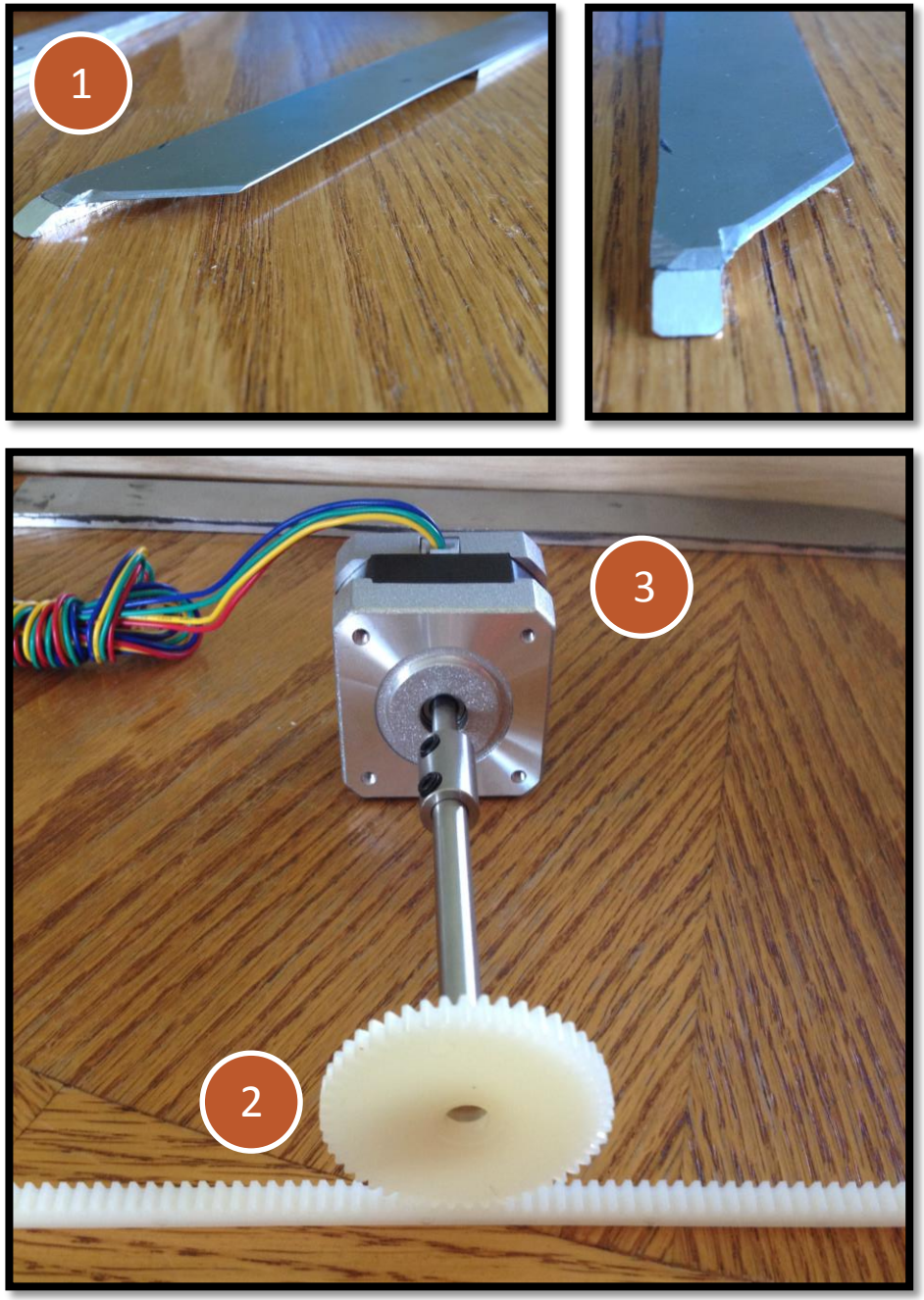
1. Table Stand
2. Instruction Manual Box
3. Packaging Cardstock Box





Mechanism

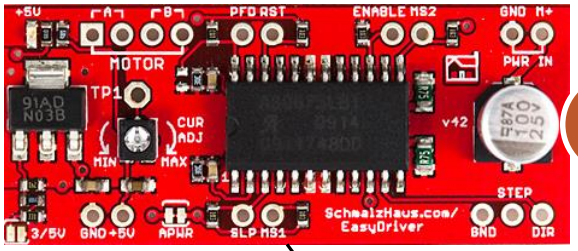
1. Wedge
2. Rack & Pinion
3. Stepper Motor

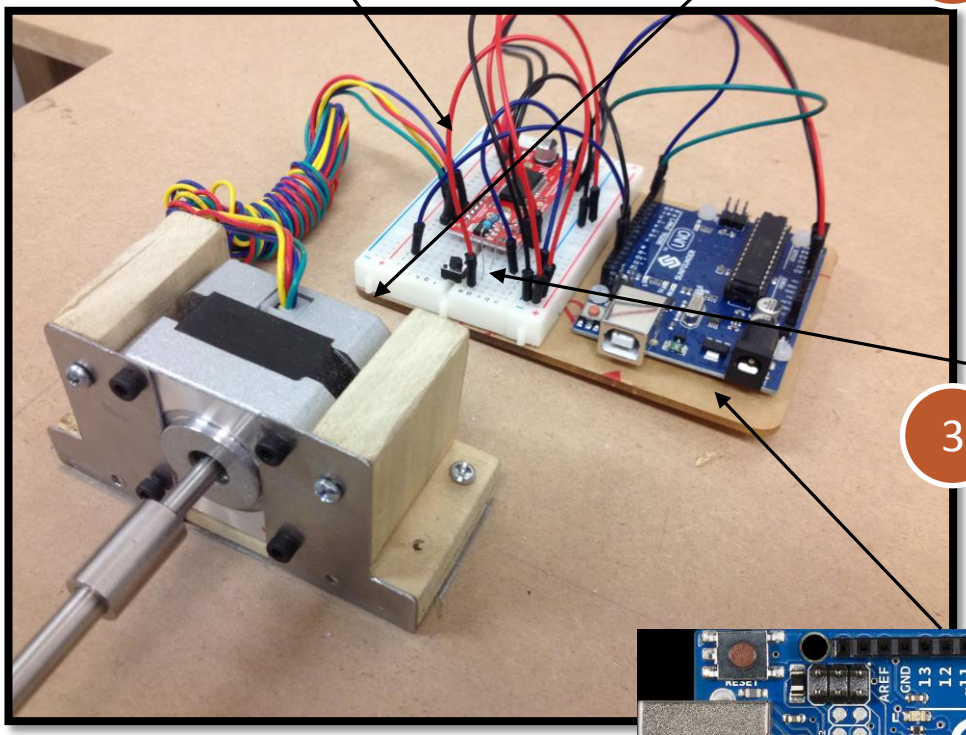


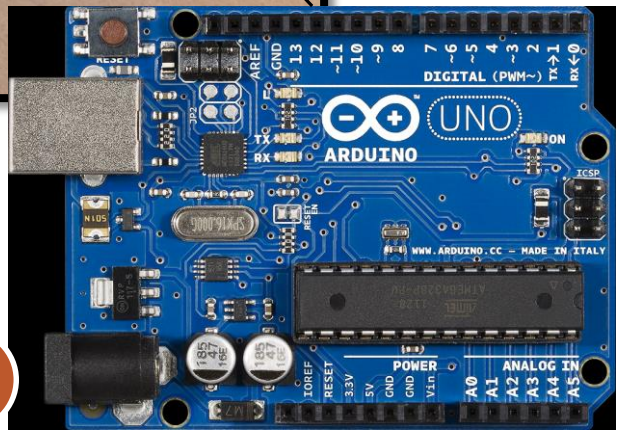
Controls

Hardware

1. Microcontroller
2. Stepper Motor
3. Push-Button
4. Arduino Uno

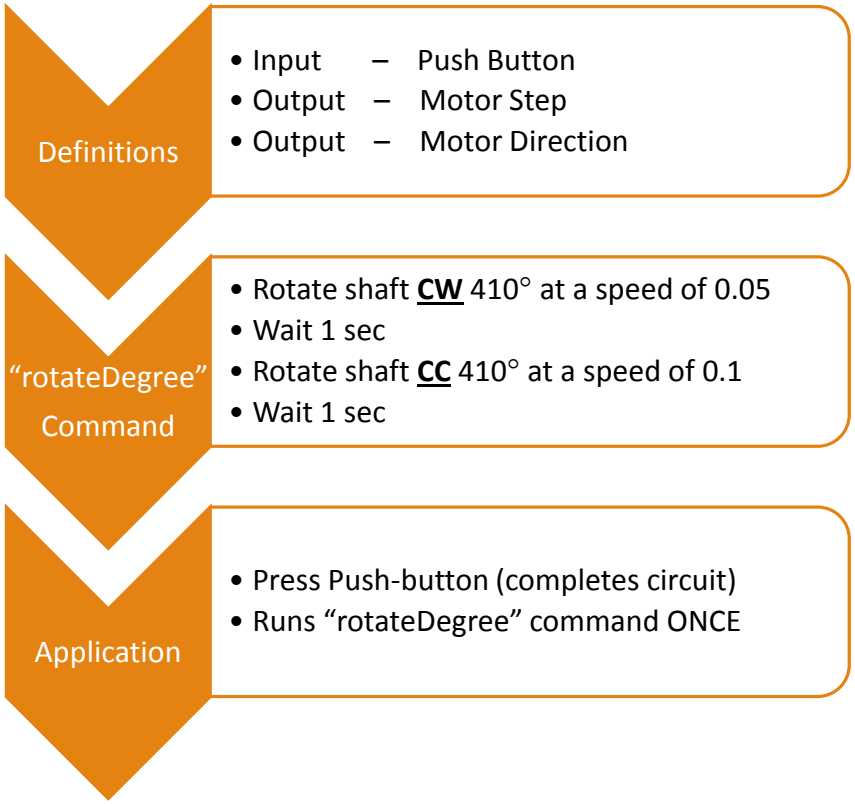






Controls

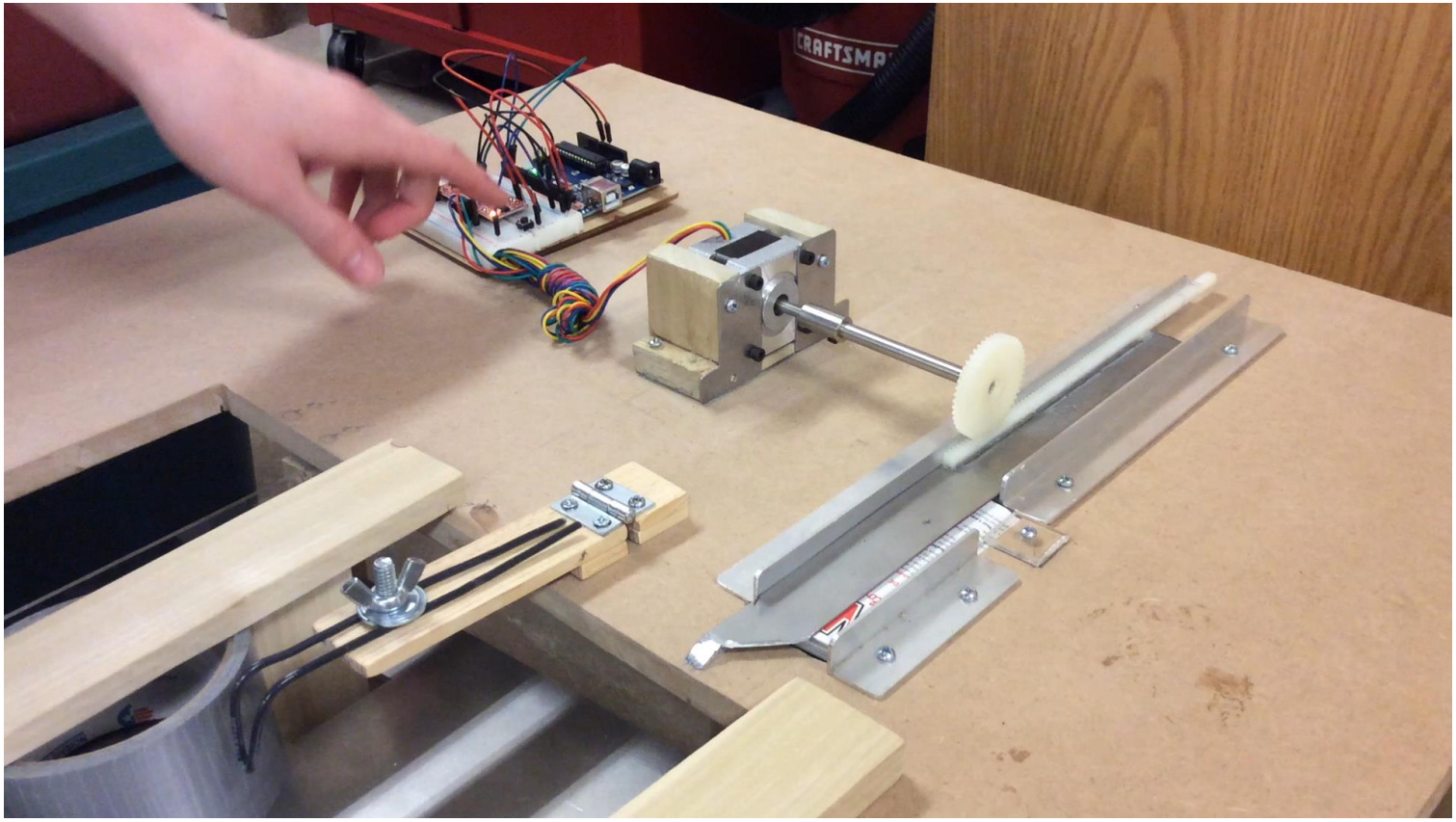
2. Software – Code Function Block



Evaluation

Final Prototype

Final Prototype



Evaluation Results

Design Requirement	Importance	Units	Minimum Goal	Ideal Goal		Test Method	Status
1. Adjustable for different size packaging	Medium	Inches	***Dim's of cardstock we were given***	Min: 6.5" x 4"	Max: 9.5" x 6"	Adjustable boxes	PASS
2. Automate manual insertion process	High	Pass / Fail	Activated manual insertion by push-button, manual removal or cardstock.	Activated insertion by push-button and removal of cardstock.		Wedge inserts manual without human interaction	PENDING
3. Increase current production rates per employee	High	Manual / Min	7.7	10		PENDING	PENDING
4. Minimize cost to manufacture	Medium	Dollars	Within $500 Budget	Less than $250		$400	PASS
5. Employees protected from pinch points and electrical components	High	Pass / Fail	Electrical components are covered, wedge mechanism is covered and e-stop is in place.	Component is completely seal and only needs to be opened to re-fill manuals and cardstock packaging.		PENDING	PENDING

Next Steps…

Material Selection
- Current: economical and workable
- Suggested: use aluminum to tighten tolerances & re-design spring locations

Mechanism (Motor/Wedge/Rack & Pinion)
- Current: lightweight, durable & easy to install
- Suggested: stronger motor & additional wedge iterations

Controls
- Current: simple, long life & adaptable
- Suggested: add emergency stop

Further Automation
- Removal of card
- Holding card in place during insertion
- Continuous cycle vs. one-time cycle

Ease of Loading Cards & Instructions

THANK YOU!

Contact Information:

- Marianna Smith mrs108@zips.uakron.edu
- Ashley Cuthbert anc36@zips.uakron.edu
- Rachael Innocenzi rli5@zips.uakron.edu
- Dr. Jerry Drummond drummon@uakron.edu

Appendix

Appendix – Responsibilities

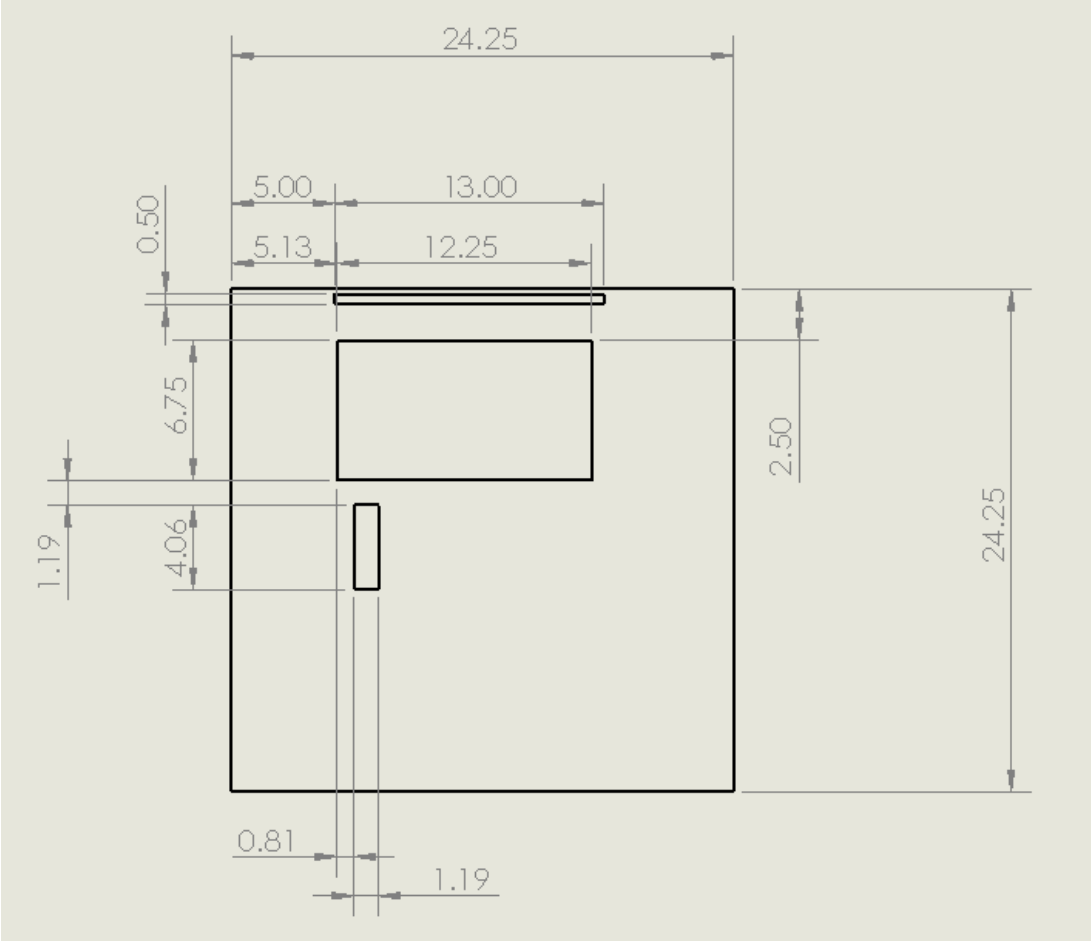
Task	Lead
Initial Project Design	All
Concept Drawings	Rachael Innocenzi
Electrical & Instrumentation	Ashley Cuthbert
Construction	Marianna Smith
Testing & Evaluation	All

Appendix – Part Drawings

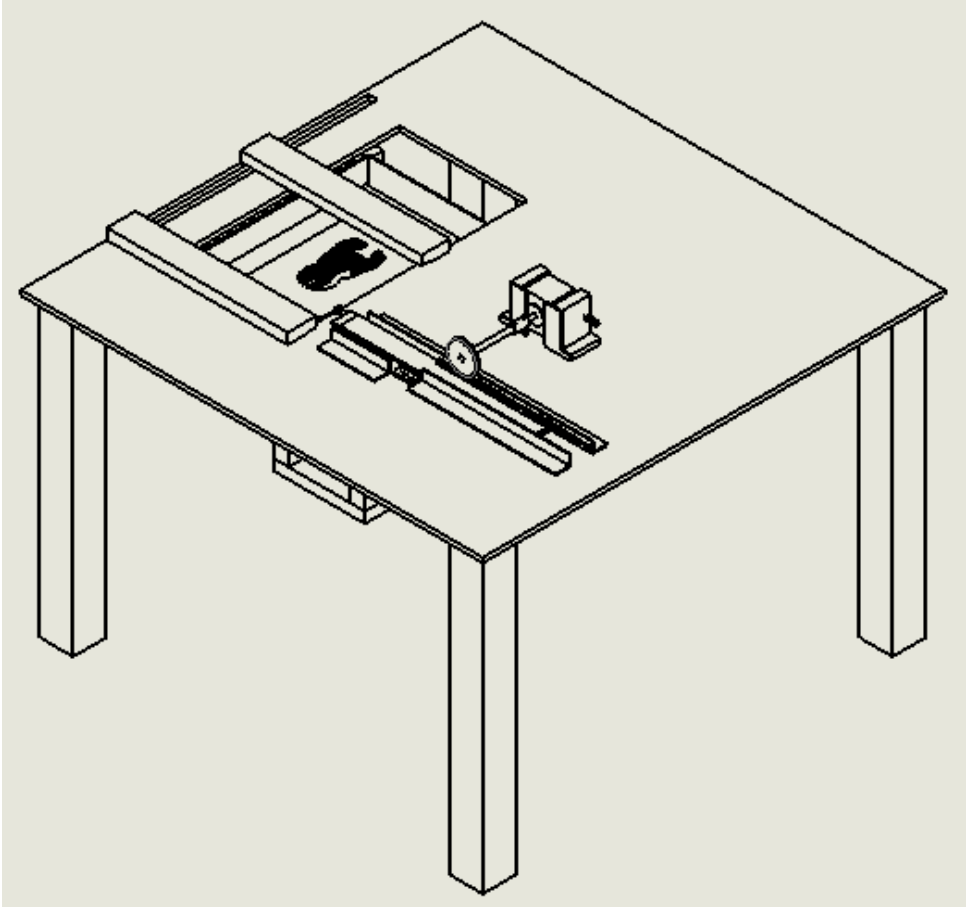
Please note:

The following part drawings were created before production. As the build progressed, dimensions were changed and components were added as needed.

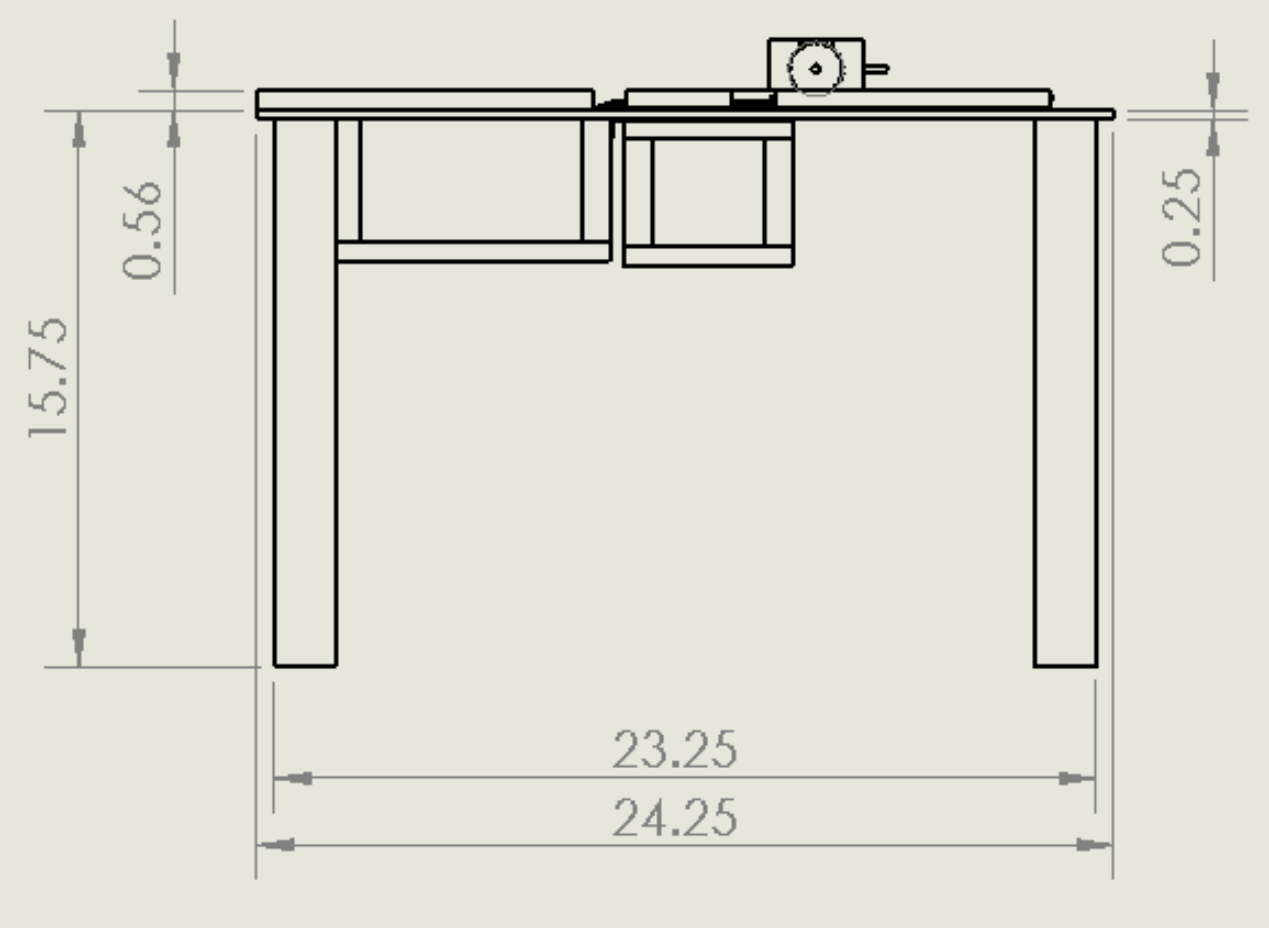
Appendix – Part Drawings Table Top



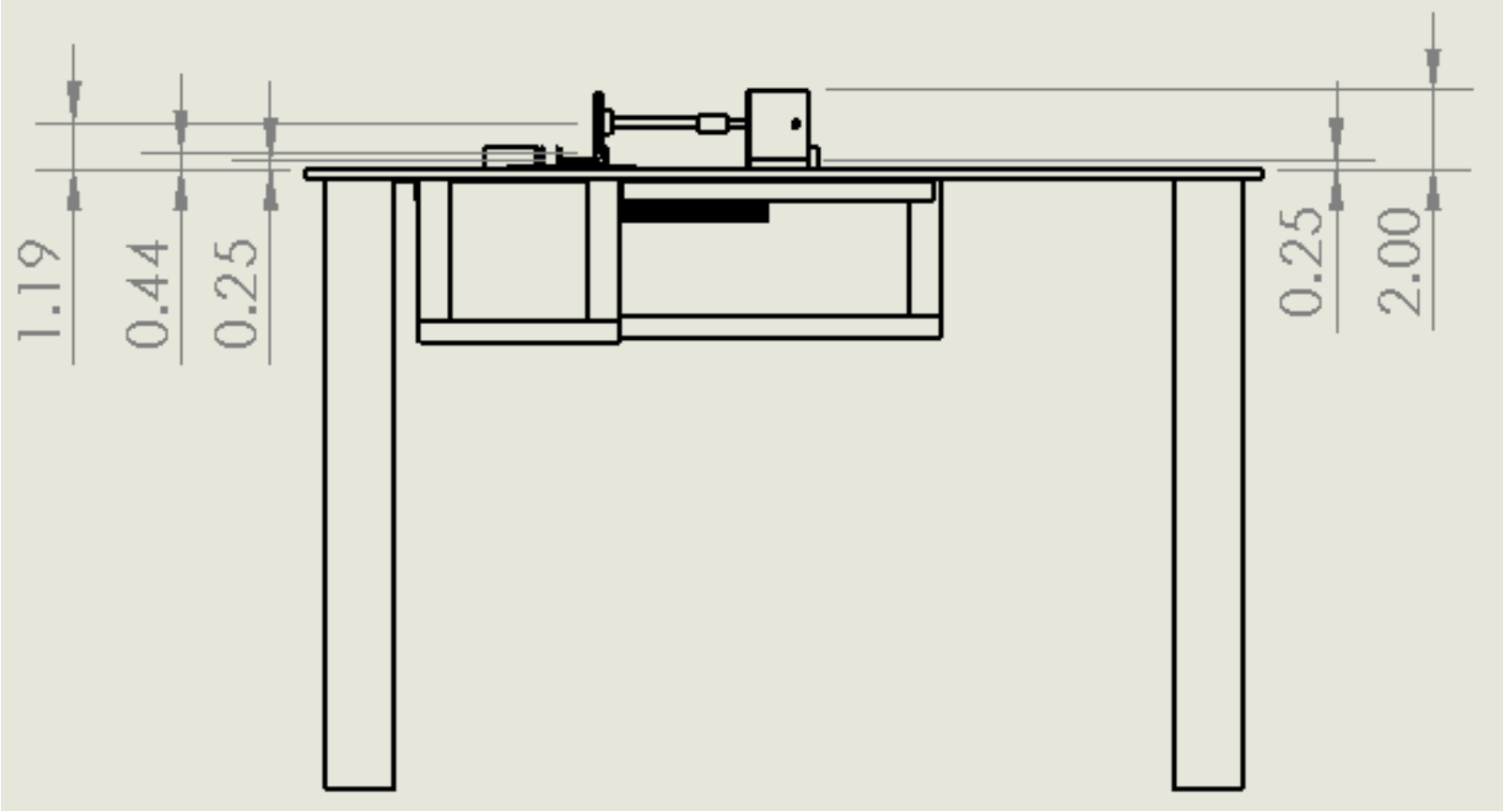
Appendix – Final Concept Drawings (1)



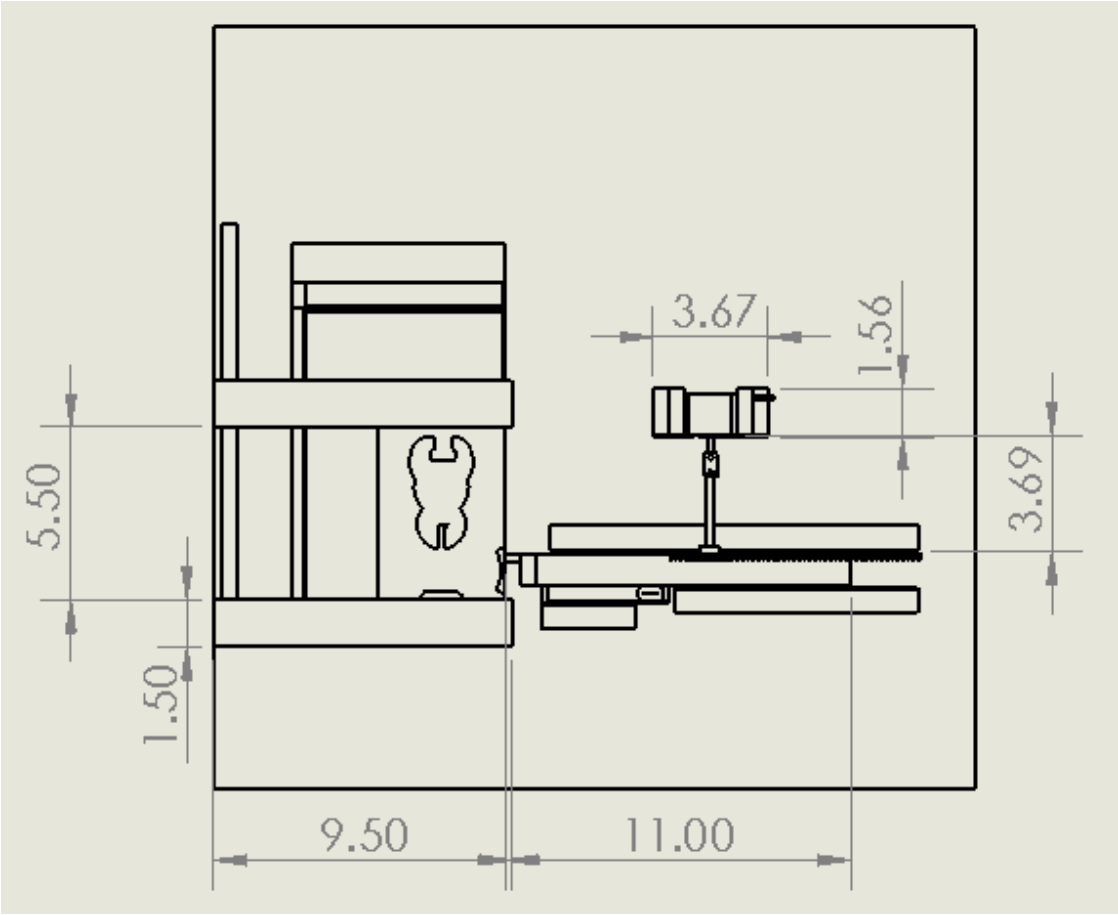
Appendix – Final Concept Drawings (2)



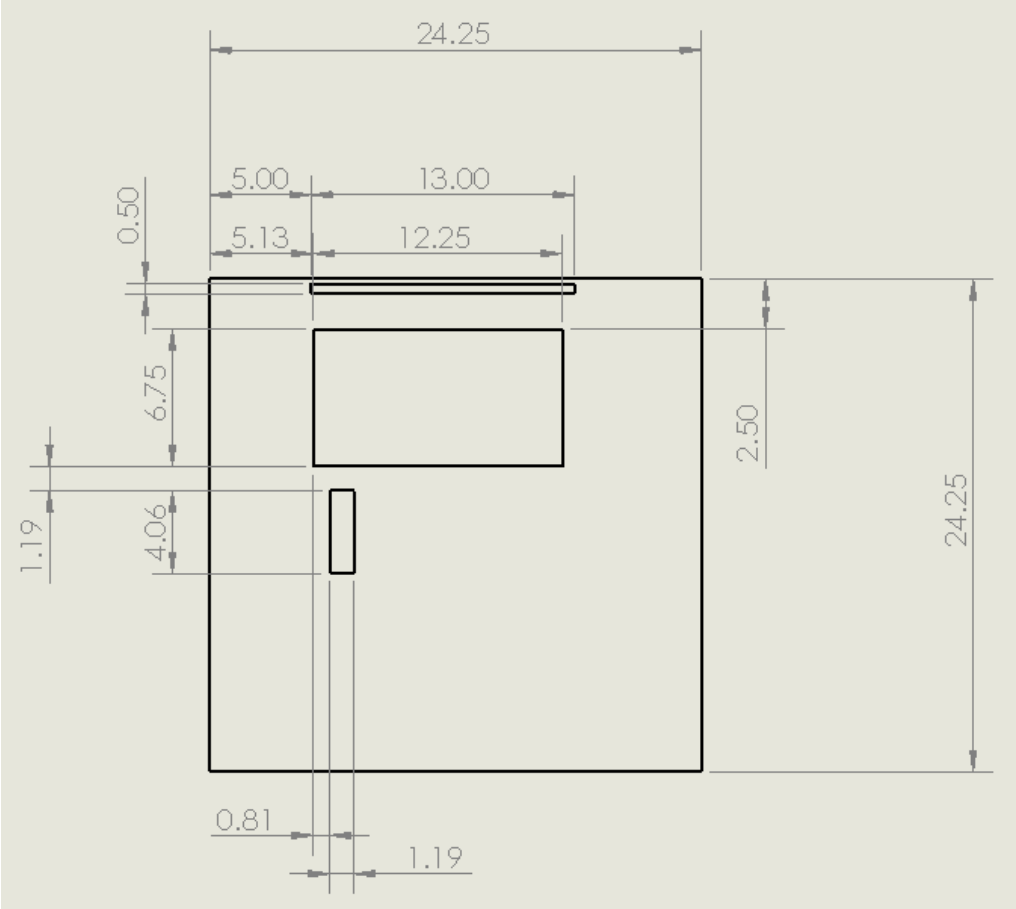
Appendix – Final Concept Drawings (3)



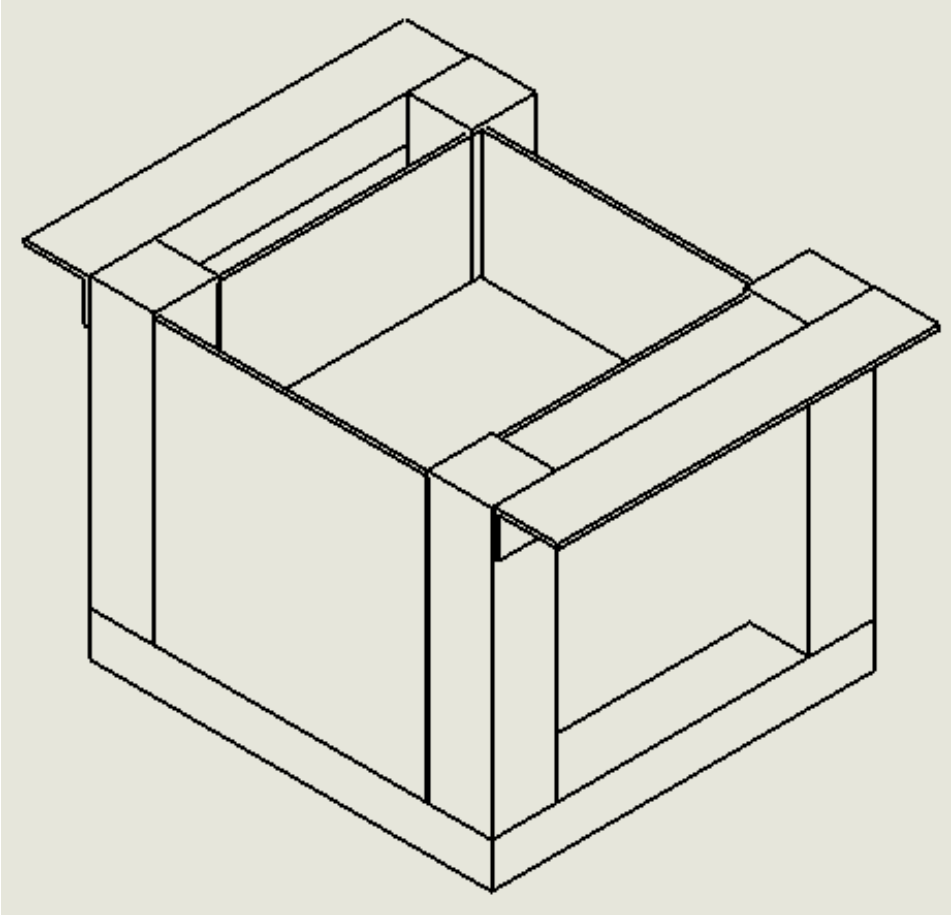
Appendix – Final Concept Drawings (4)



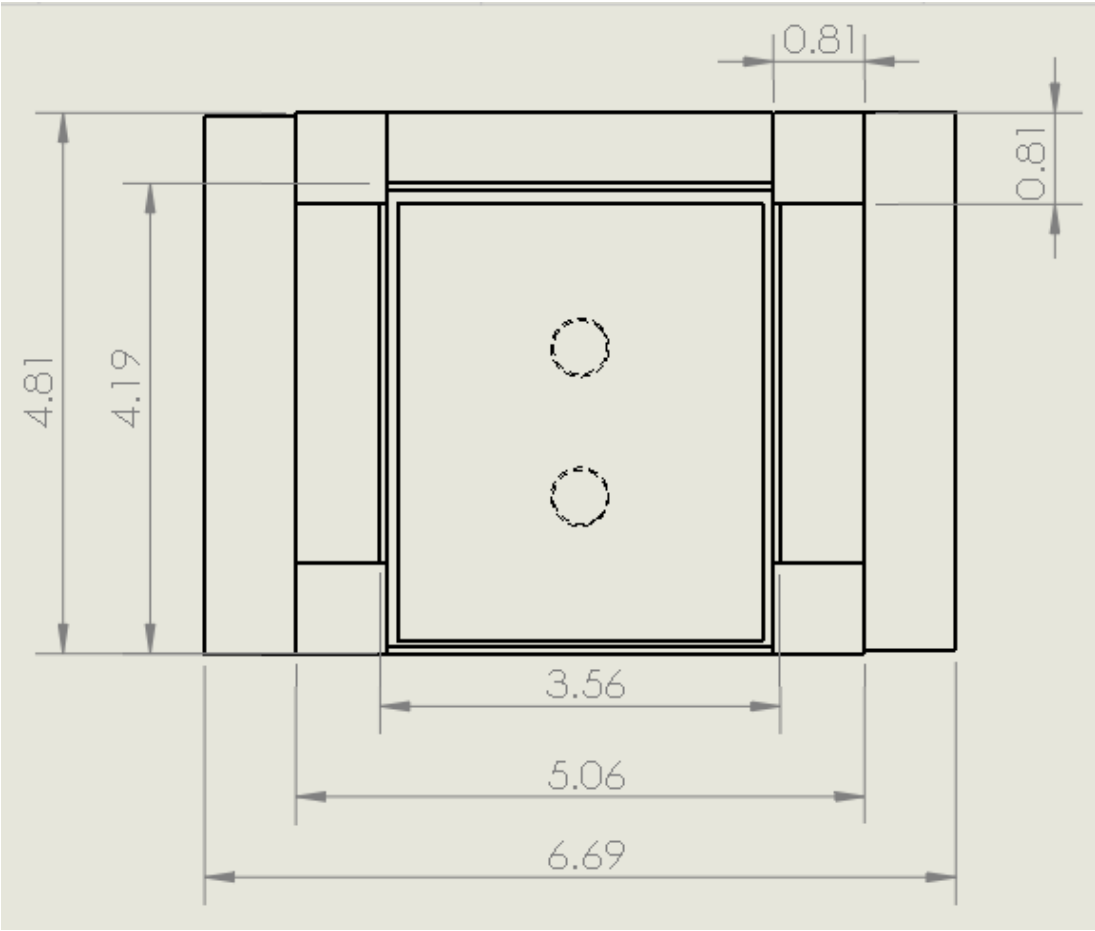
Appendix – Part Drawings Table Top



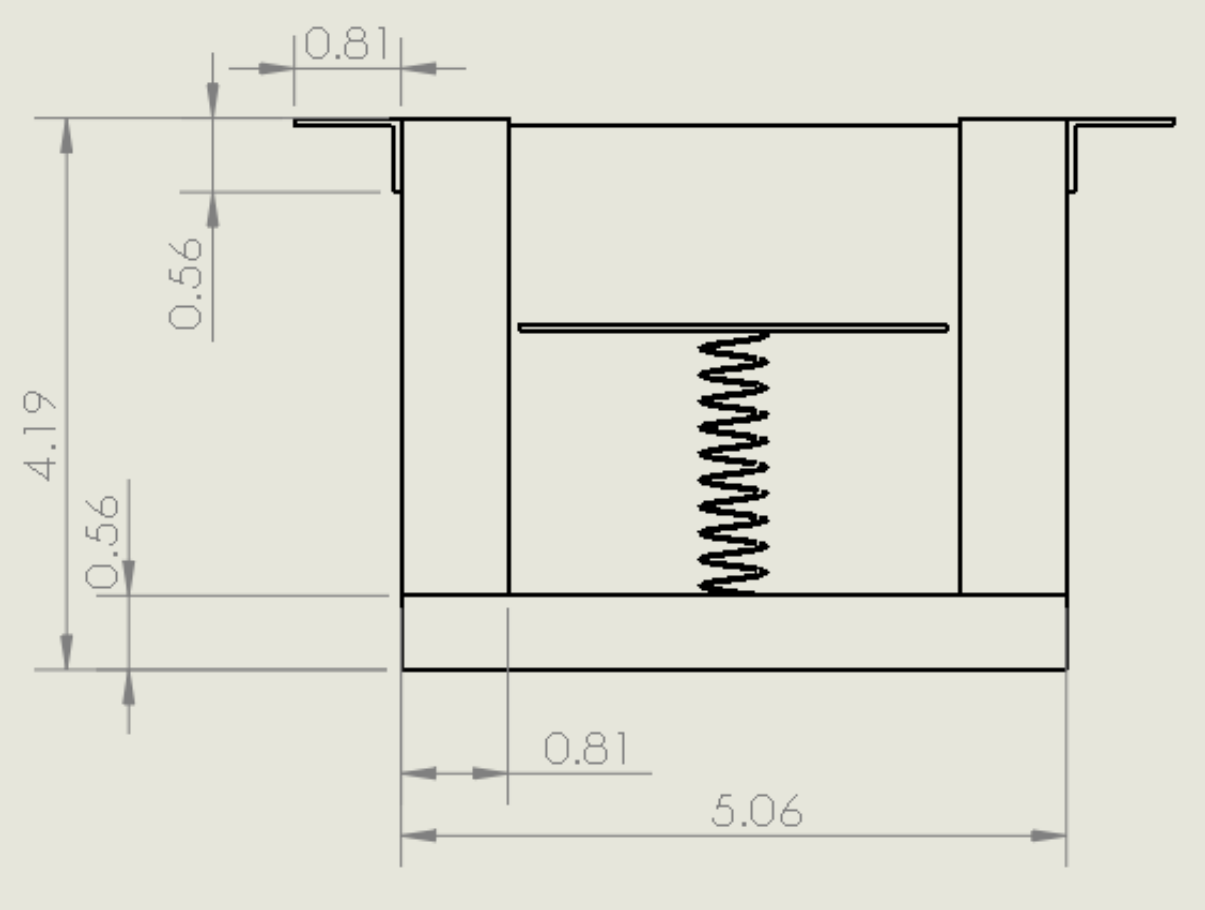
Appendix – Instruction Manual Box Drawings (1)



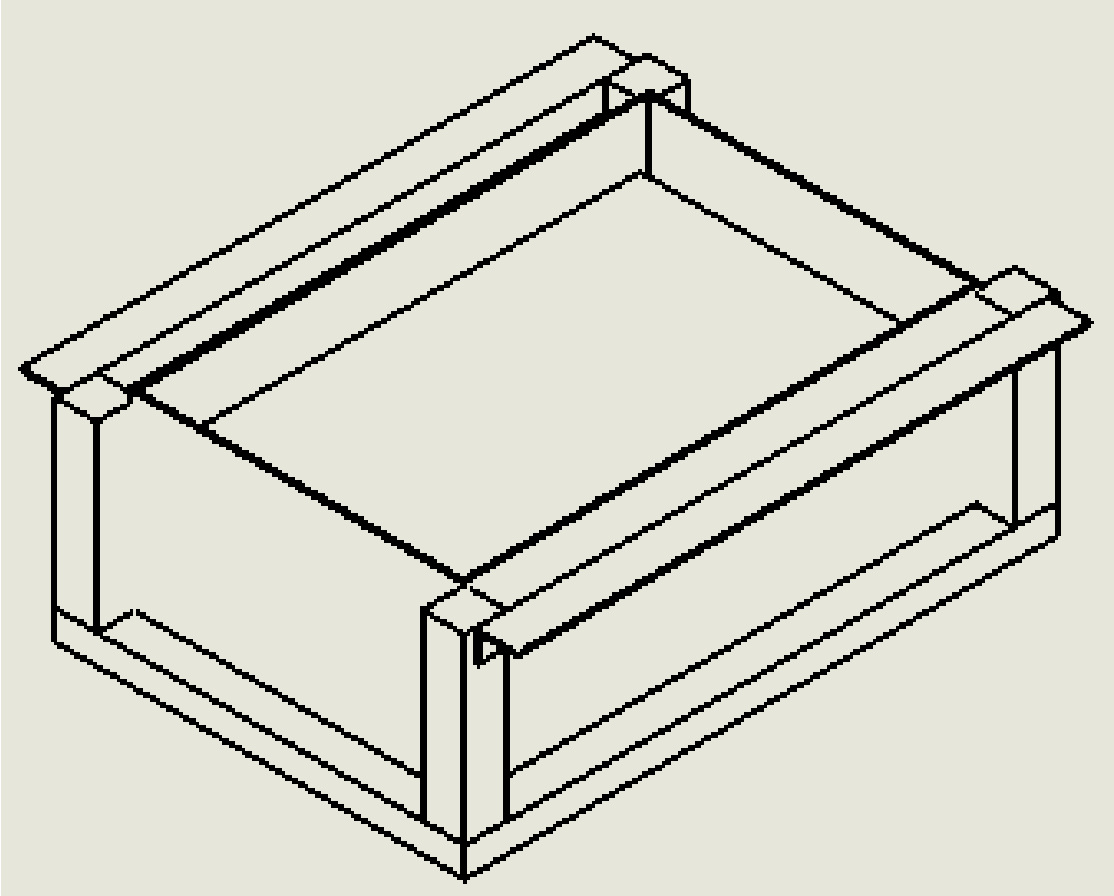
Appendix – Instruction Manual Box Drawings (2)



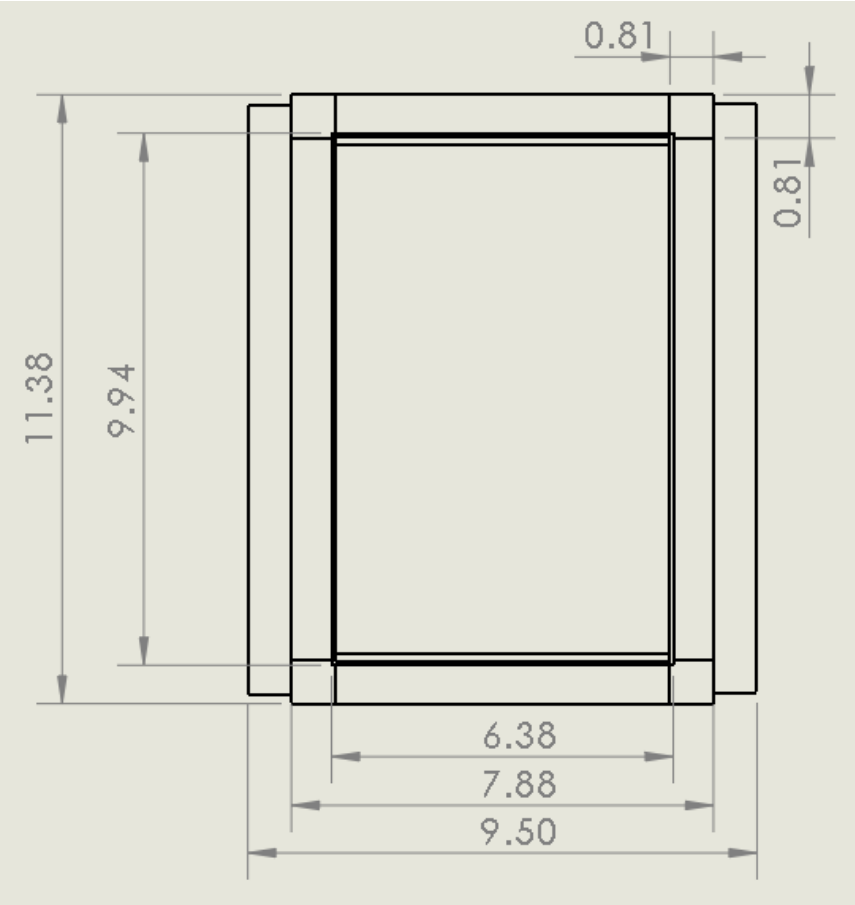
Appendix – Instruction Manual Box Drawings (3)



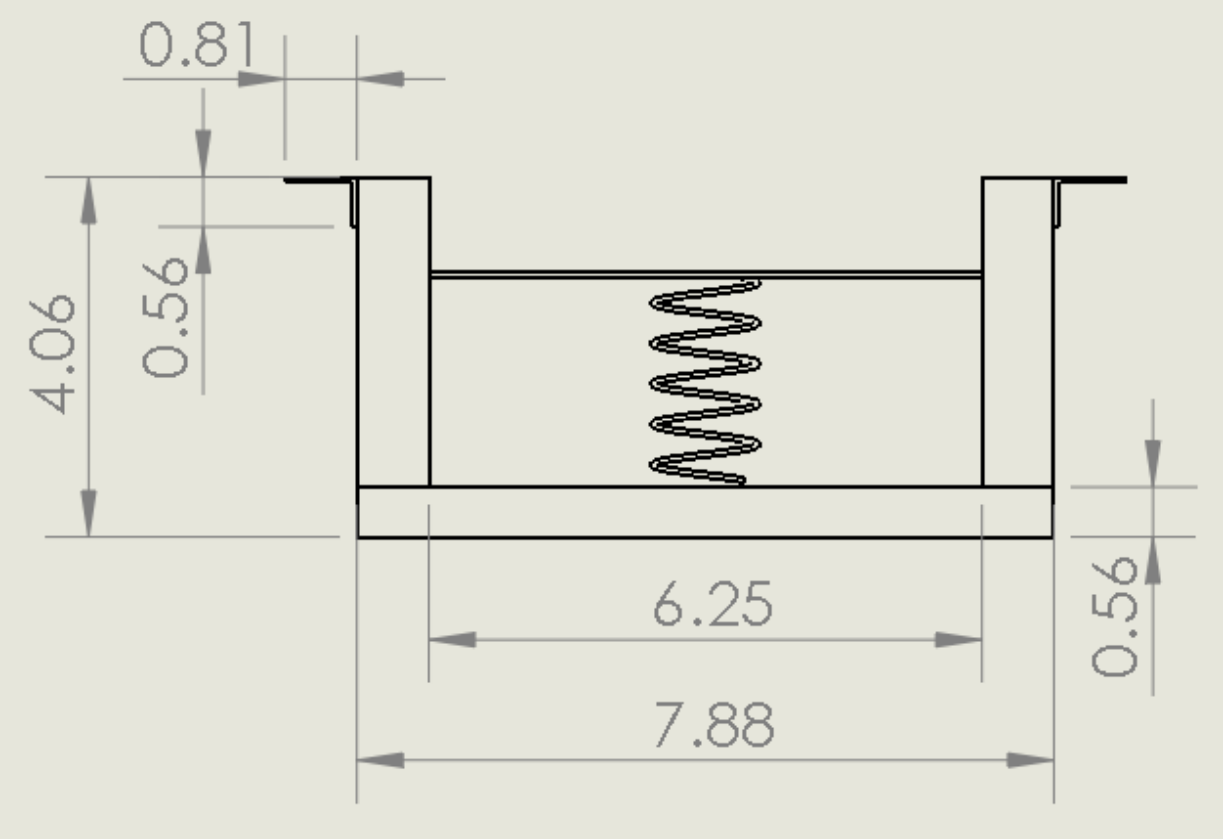
Appendix – Cardstock Box Drawings (1)



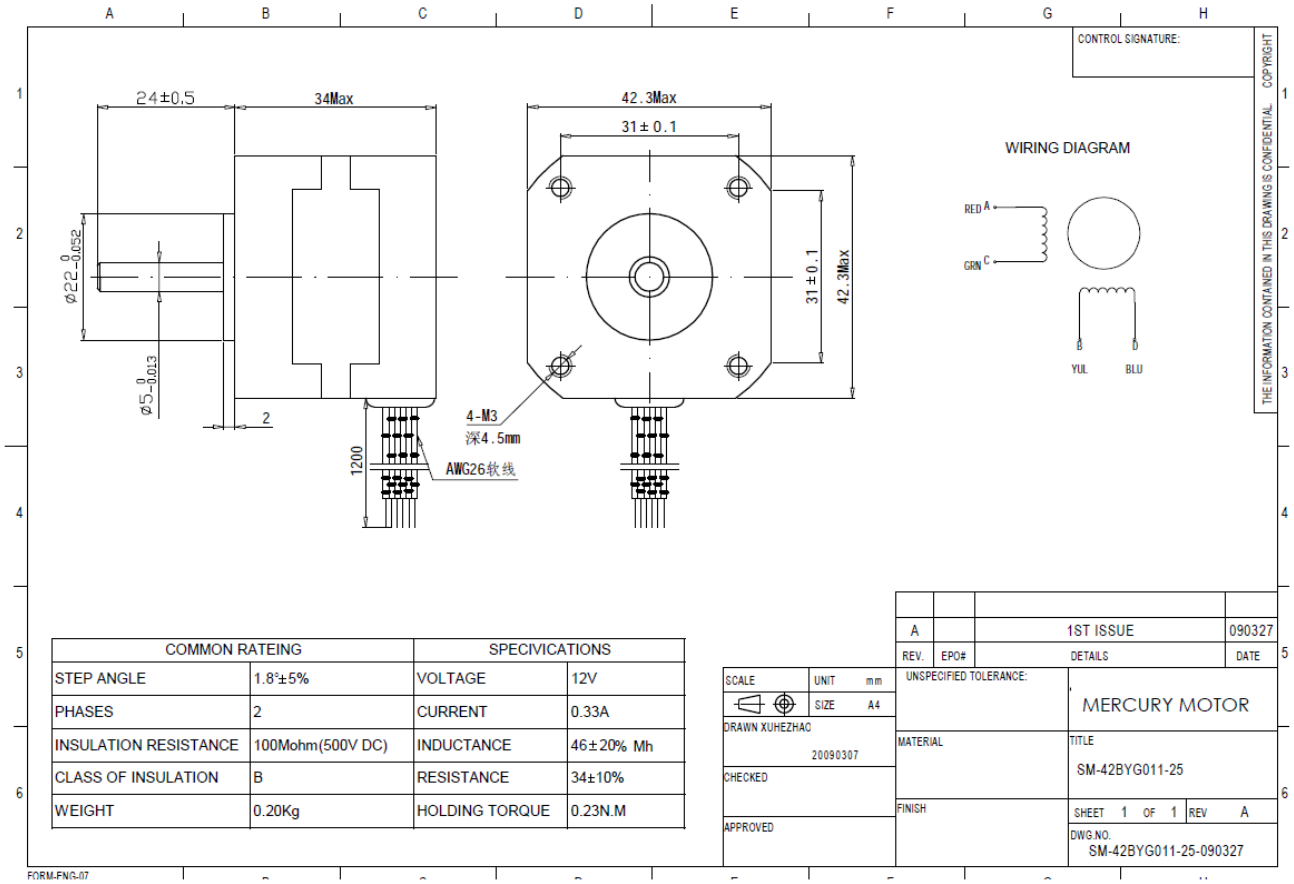
Appendix – Cardstock Box Drawings (2)



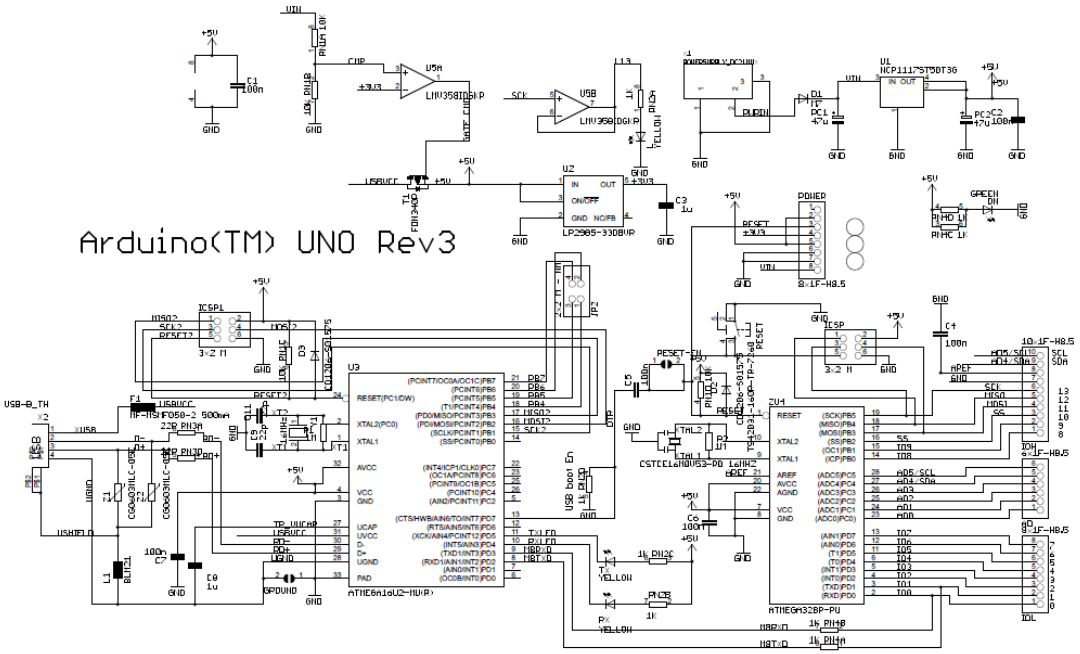
Appendix – Cardstock Box Drawings (3)



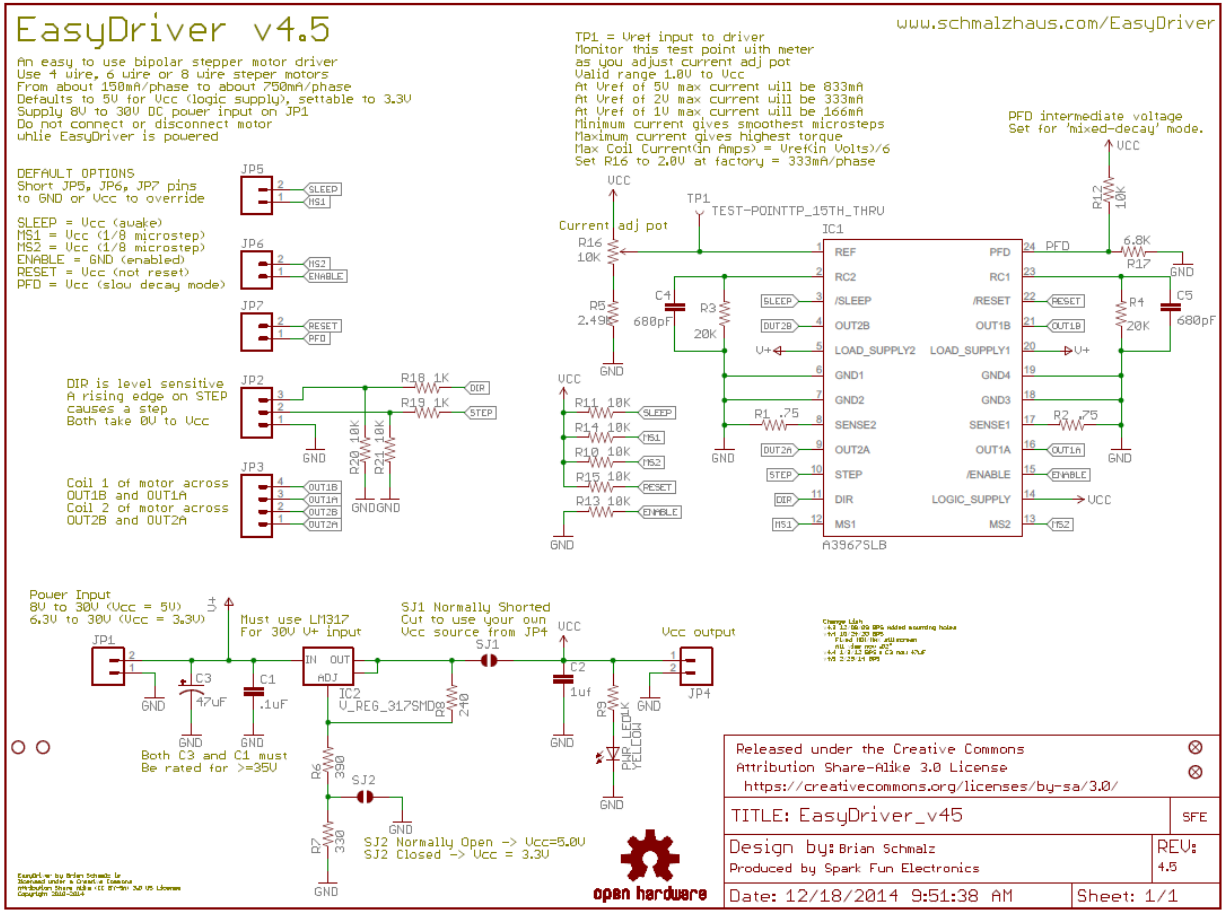
Appendix – Part Drawings Stepper Motor



Appendix – Schematic Microcontroller



Appendix – Schematic Motor Controller



Appendix - Code

```
////////////////////////////////////////////////////////////////////

//©2011 bildr

//Released under the MIT License - Please reuse change and share

//Using the easy stepper with your arduino

//use rotate and/or rotateDeg to controll stepper motor

//speed is any number from .01 -> 1 with 1 being fastest -

//Slower Speed == Stronger movement

////////////////////////////////////////////////////////////////////


#define DIR_PIN 2

#define STEP_PIN 3


const int BUTTON_PIN = 12;      // variable for push button pin

int buttonstate = 0;            // variable for push button status
```

Appendix – Code (cont'd)

```
void rotateDeg(float deg, float speed){
  //rotate a specific number of degrees (negitive for reverse movement)
  //speed is any number from .01 -> 1 with 1 being fastest - Slower is stronger
  int dir = (deg > 0)? HIGH:LOW;
  digitalWrite(DIR_PIN,dir);

  int steps = abs(deg)*(1/0.225);
  float usDelay = (1/speed) * 70;

  for(int i=0; i < steps; i++){
    digitalWrite(STEP_PIN, HIGH);
    delayMicroseconds(usDelay);
    digitalWrite(STEP_PIN, LOW);
    delayMicroseconds(usDelay);
  }
}
```

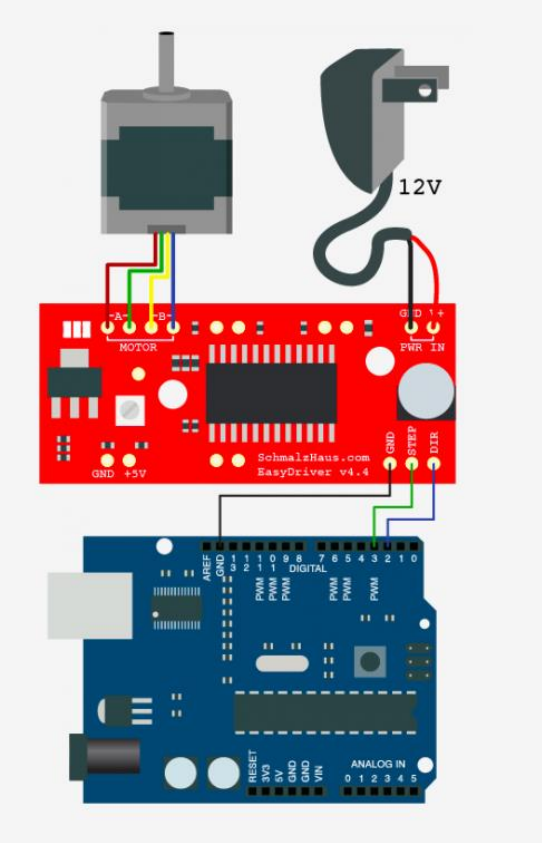
Appendix – Code (cont'd)

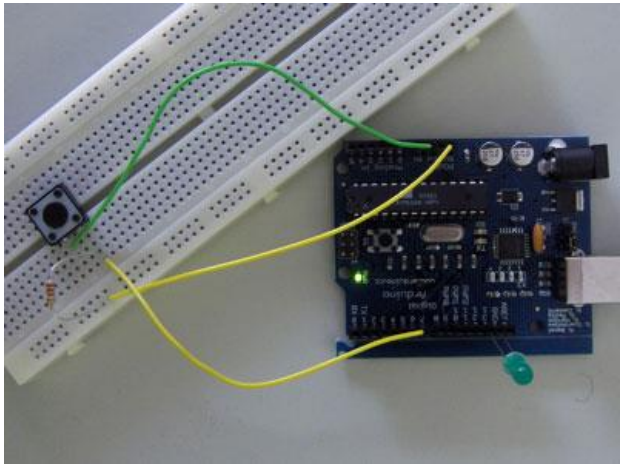
```
void setup() {
  pinMode(DIR_PIN, OUTPUT);
  pinMode(STEP_PIN, OUTPUT);
  pinMode(BUTTON_PIN, INPUT);
}


  //This example code is in the public domain.
 //"switch code" from the rduinoclassroom.com (Smiley)


void loop(){
// Get the state of the push button
buttonstate = digitalRead(BUTTON_PIN);
```

Appendix – Code (cont'd)

```
//Ask, "is the button pressed?"
//If YES, the buttonstate is HIGH.
if (buttonstate == HIGH){

  //rotate a specific number of degrees
  rotateDeg(-410, 0.05);
  delay(1000);
  rotateDeg(410, 0.1);  //reverse
  delay(1000);
  }
}
```

Appendix – Wiring Diagram





Note:
The picture to the left shows the simple schematic for powering the stepper motor. In order to power the Arduino Uno from the wall connection also, connect wires from the "GND" and "+5V" of the Easy Driver to the "GND" and "5V" of the Arduino Uno.

To insert the button into the controls, we used the concept shown in the picture above and taken from the tutorial on the Arduino Environment website (http://www.arduino.cc/en/Tutorial/Pushbutton) However, the button pin connection was changed to position 12 on the Arduino Uno.

Appendix – Materials & Suppliers

The University of Akron
Weaver Industries
05/04/15

FY	2015
Project Name	Senior Design - Manual Insertion
Budget Amoun	$500.00

	Total Spending
Invoiced:	$ 343.62
Balance:	$156.38

Project Accounting Worksheet

PO Date	Confirmation Code	Originator	Description	Vendor	Amount	Qty	Total Amount	Payment Method	Comments
03/15/15		AC	Fiberboard for Table-top	Home Depot	$ 9.97	1	$ 9.97	Debit - 7150	
		AC	Table Legs	Home Depot	$ 5.98	4	$ 23.92	Debit - 7150	
		AC	Baseplate for Cardboard & Manual Holder	Home Depot	$ 7.24	2	$ 14.48	Debit - 7150	
			Sales Tax		***$ 3.26***		***$ -***		
03/23/15	106-0688818-6617862	AC	Arduino UNO R3 Beginner's Kit	Amazon	$ 38.99	1	$ 38.99	Debit - 7150	2-day shipping
			Shipping		***$ -***		***$ -***		
03/23/15	0323ACUTHBERT	AC	Nylon Spur Gear (48 pitch)	McMaster-Carr	$ 10.55	1	$ 10.55	Debit - 7150	Ground shipping (1-6 days)
		AC	Nylon Spur Gear (32 pitch)	McMaster-Carr	$ 9.83	1	$ 9.83	Debit - 7150	
		AC	Nylon Rack (48 pitch)	McMaster-Carr	$ 5.82	1	$ 5.82	Debit - 7150	
		AC	Nylon Rack (32 pitch)	McMaster-Carr	$ 6.46	1	$ 6.46	Debit - 7150	
			Shipping & Sales Tax		*?*				
03/23/15	100048564	AC	Set Screw Shaft Coupler	Robot Shop	$ 4.99	1	$ 4.99	Debit - 7150	Ground shipping (1-6 days)
		AC	Precision Shaft	Robot Shop	$ 1.19	1	$ 1.19	Debit - 7150	
			Shipping		***$ 9.00***	***1***	***$ 9.00***	Debit - 7150	
03/23/15	1985850	AC	Stepper Motor w/ Cable	SparkFun	$ 14.95	1	$ 14.95	Debit - 7150	UPS 3-day Air
		AC	Stepper Motor -68 oz-in	SparkFun	$ 16.95	1	$ 16.95	Debit - 7150	
		AC	EasyDriver - Stepper Motor Driver	SparkFun	$ 14.95	1	$ 14.95	Debit - 7150	
			Shipping		***$ 13.31***	***1***	***$ 13.31***	Debit - 7150	
04/03/15		MS	Top plates to hang table legs	Home Depot	$ 2.78	4	$ 11.12	Debit - 9639	
		MS	***Sales Tax***		***$ 0.75***	***1***	***$ 0.75***		
04/12/15		MS	GORILLA WOOD GLUE 18OZ	Home Depot	$ 4.97	1	$ 4.97	Debit - 9639	
		MS	SQUARE DOWEL 3/4" X 36"	Home Depot	$ 2.85	3	$ 8.55	Debit - 9639	
		MS	1" CORNER BRACE ZINC 20PK	Home Depot	$ 7.48	2	$ 14.96	Debit - 9639	
		MS	#6X1/2" ZINC RND HD PHIL WOODSCREW	Home Depot	$ 1.18	4	$ 4.72	Debit - 9639	
		MS	1/4" ZINC WASHERS	Home Depot	$ 1.18	1	$ 1.18	Debit - 9639	
		MS	#10 ZINC WASHERS	Home Depot	$ 1.18	1	$ 1.18	Debit - 9639	
		MS	***Sales Tax***		***$ 2.40***	***1***	***$ 2.40***		

Appendix – Materials & Suppliers

The University of Akron
Weaver Industries
05/04/15

FY	2015		Total Spending
Project Name	Senior Design - Manual Insertion	**Invoiced:**	$ 343.62
Budget Amoun	$500.00	**Balance:**	$156.38

Project Accounting Worksheet

PO Date	Confirmation Code	Originator	Description	Vendor	Amount	Qty	Total Amount	Payment Method	Comments
04/20/15		MS	LOCTITE ULTRA LIQ CONTROL SUPER GLUE	Home Depot	$ 3.48	1	$ 3.48	Debit - 9639	
		MS	48"X3/4"X1/2"X1/16" OFFSET ANGLE	Home Depot	$ 5.67	2	$ 11.34	Debit - 9639	
		MS	WING NUT ZINC 3/8"-16	Home Depot	$ 1.18	1	$ 1.18	Debit - 9639	
		MS	PRO GRADE ACRYLIC SHEET CUTTING TOOL	Home Depot	$ 4.98	1	$ 4.98	Debit - 9639	
		MS	J-B KWIKWELD	Home Depot	$ 5.27	1	$ 5.27	Debit - 9639	
		MS	FOAM 1.0 WOOD HANDLE BRUSH	Home Depot	$ 0.94	2	$ 1.88	Debit - 9639	
		MS	12"X3/8-16 THREADED ROD ZINC	Home Depot	$ 1.37	1	$ 1.37	Debit - 9639	
		MS	.093"X11"X14" CLEAR ACRYLIC SHEET	Home Depot	$ 4.78	4	$ 19.12	Debit - 9639	
		MS	***Sales Tax***		***$ 3.22***	***1***	***$ 3.22***		
04/23/15		MS	LN PERFECT GLUE CLEAR (liquid nails)	Home Depot	$ 3.97	1	$ 3.97	Debit - 9639	
		MS	DREMEL 4"X2" REPLACEMENT BLADE	Home Depot	$ 9.20	1	$ 9.20	Debit - 9639	
		MS	3M PGP SPONGE BLOCK XCRSE 36G/60E (sanding block)	Home Depot	$ 3.97	1	$ 3.97	Debit - 9639	
		MS	3M PGP SPONGE DANGLE MED 80G/120E (sanding block)	Home Depot	$ 4.28	1	$ 4.28	Debit - 9639	
		MS	***Sales Tax***		***$ 1.45***	***1***	***$ 1.45***		
04/24/15		MS	GE SILICONE II K&B CLEAR 2.8OZ	Home Depot	$ 3.98	1	$ 3.98	Debit - 9639	
		MS	LN SMALL PROJECTS SILICONE CLEAR 4OZ	Home Depot	$ 3.97	1	$ 3.97	Debit - 9639	
		MS	***Sales Tax***		***$ 0.54***	***1***	***$ 0.54***		
04/29/15		MS	SQUARE DOWEL 3/4" X 36"		$ 2.85	1	$ 2.85	Debit - 9639	
		MS	3M PGP SPONGE BLOCK MED 80G/120E		$ 3.97	2	$ 7.94	Debit - 9639	
		MS	LOCTITE ULTRA LIQ CONTROL SUPER GLUE		$ 3.48	1	$ 3.48	Debit - 9639	
		MS	***Sales Tax***		***$ 0.96***	***1***	***$ 0.96***		