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

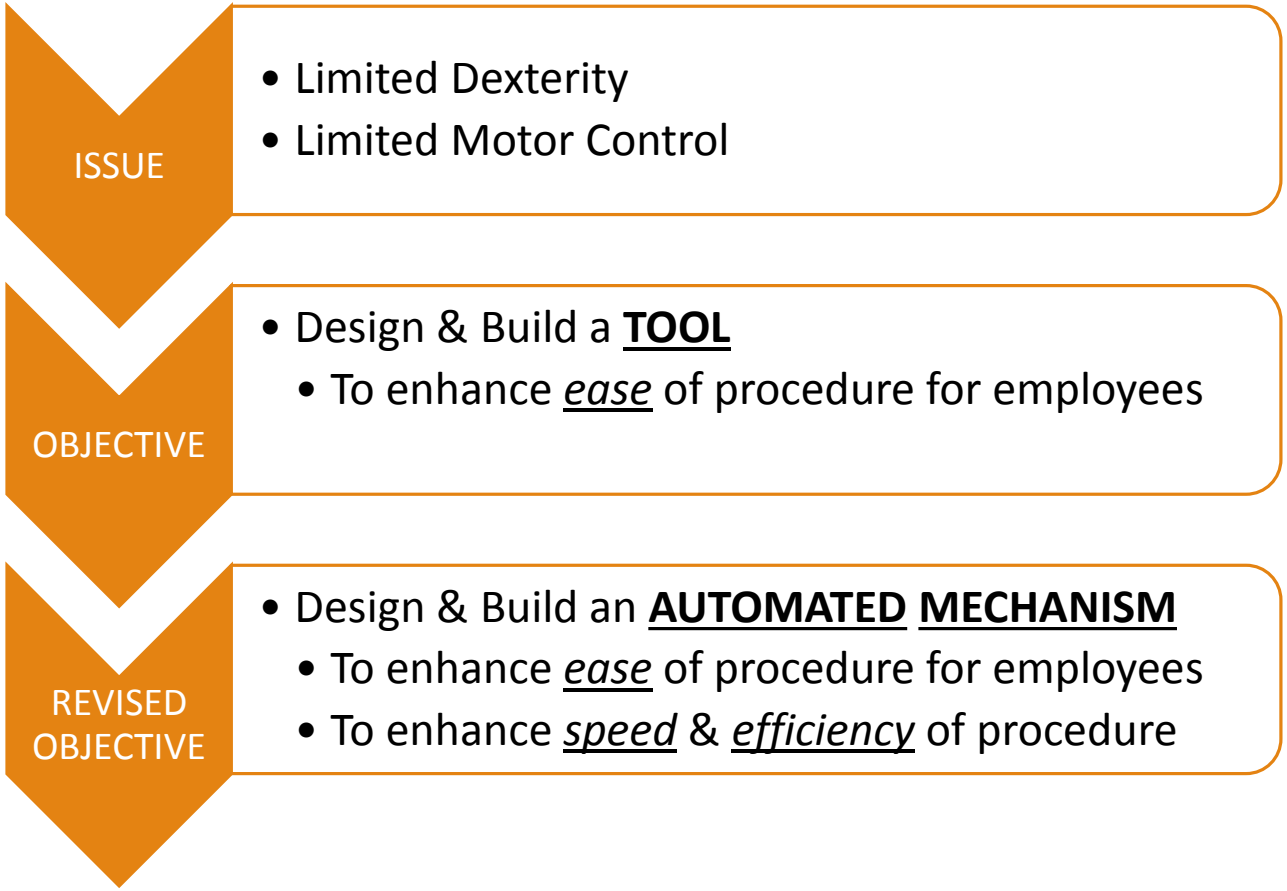
# Problem Definition

# 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

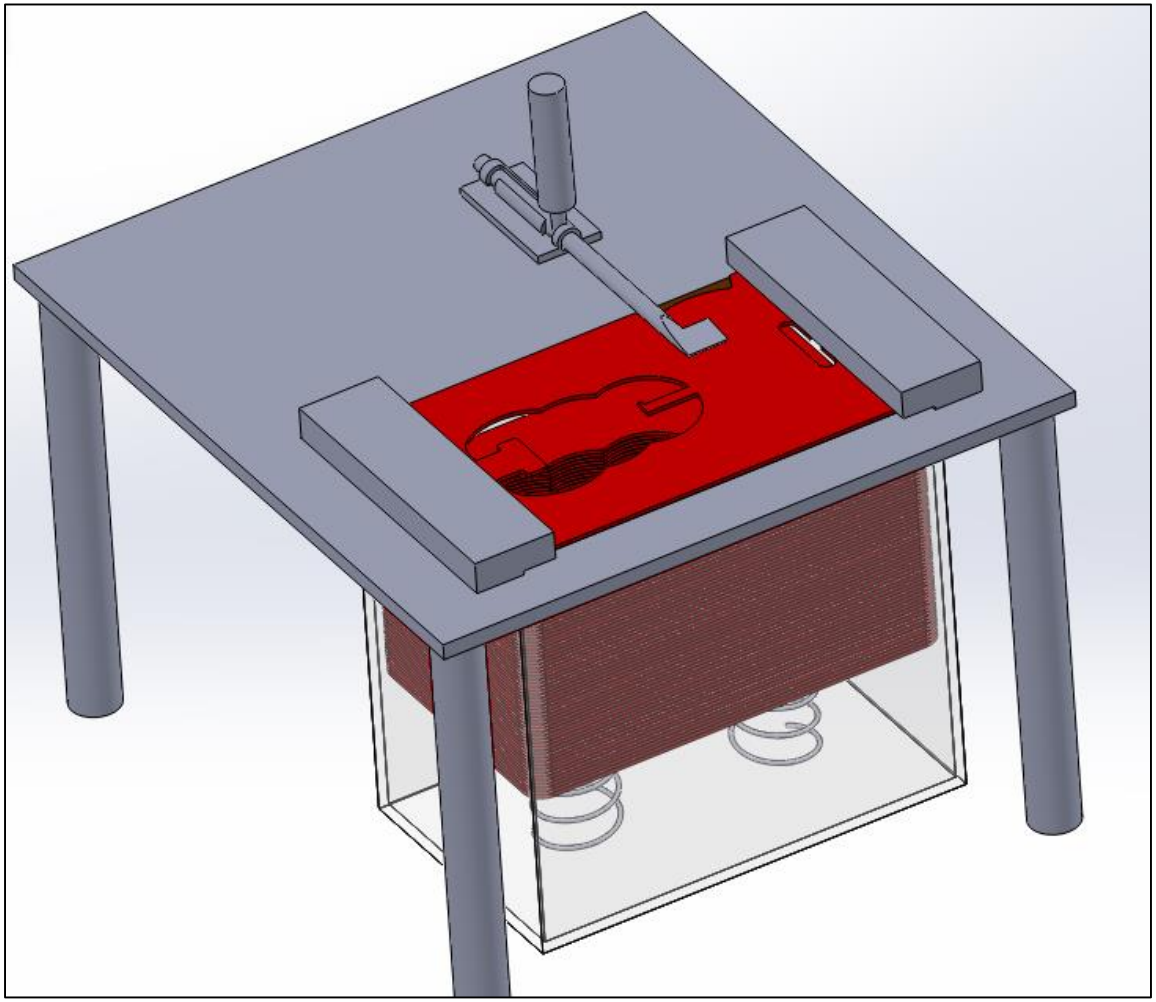


*Figure 1*

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*

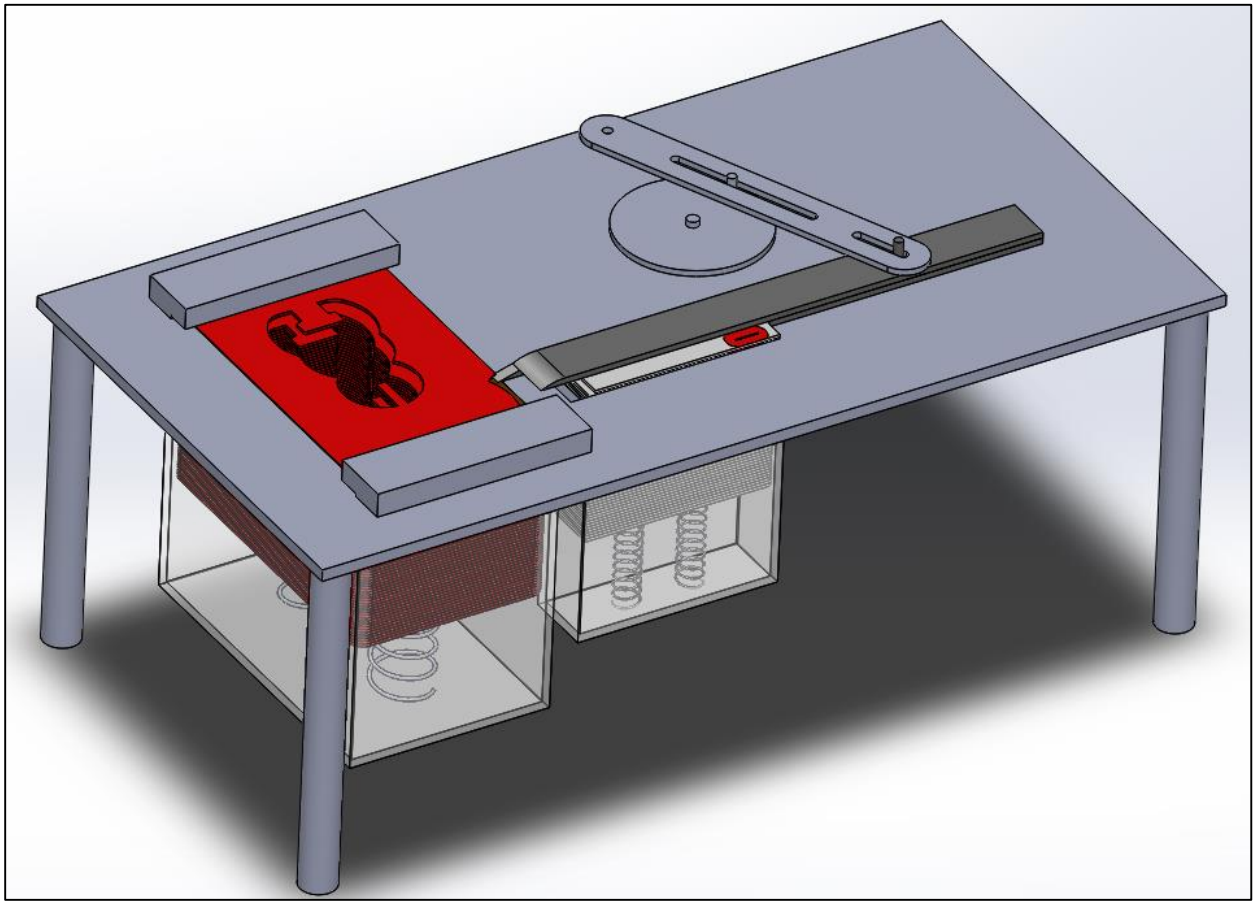


*Figure 2*

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

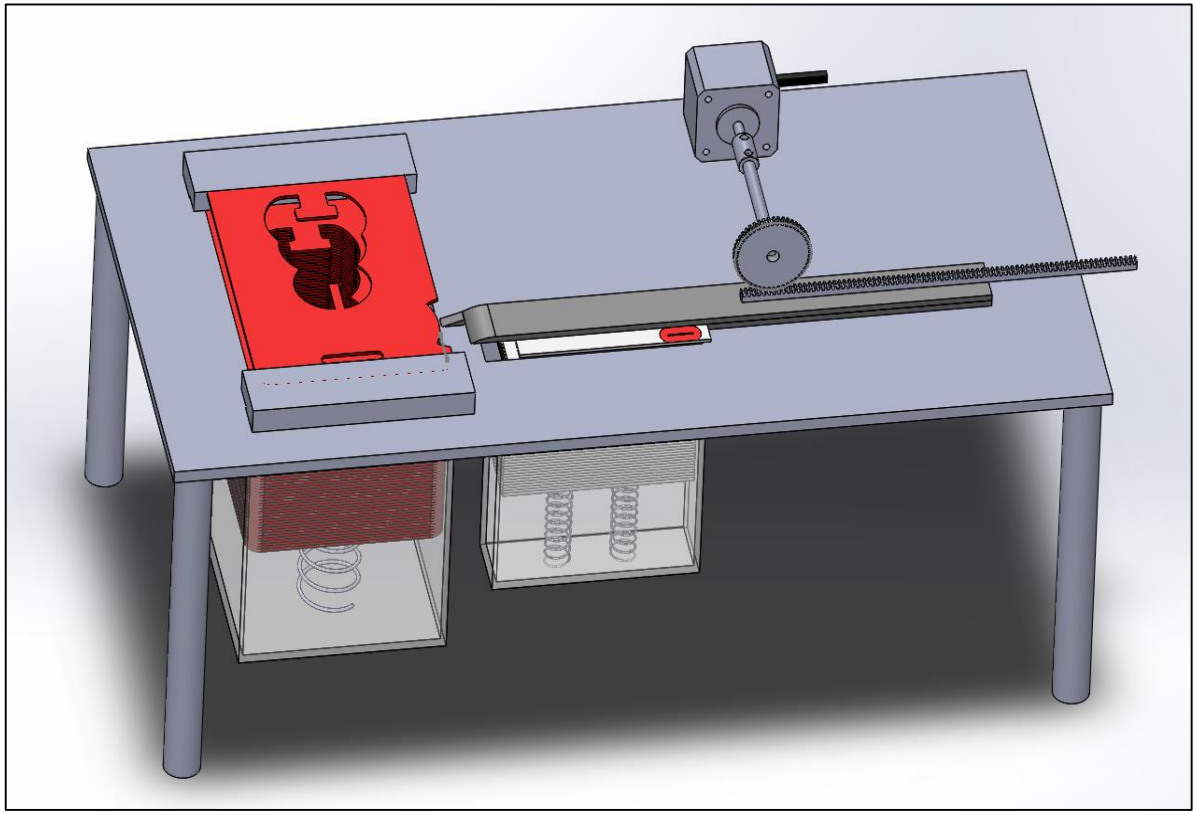


*Figure 3*

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

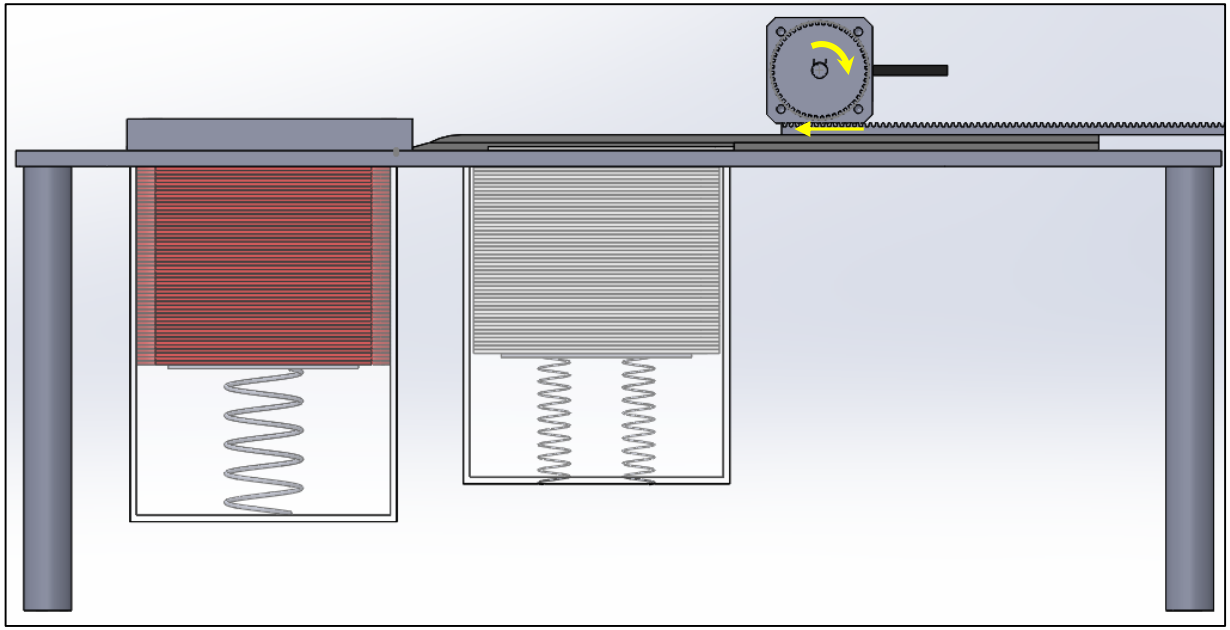


*Figure 4*

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

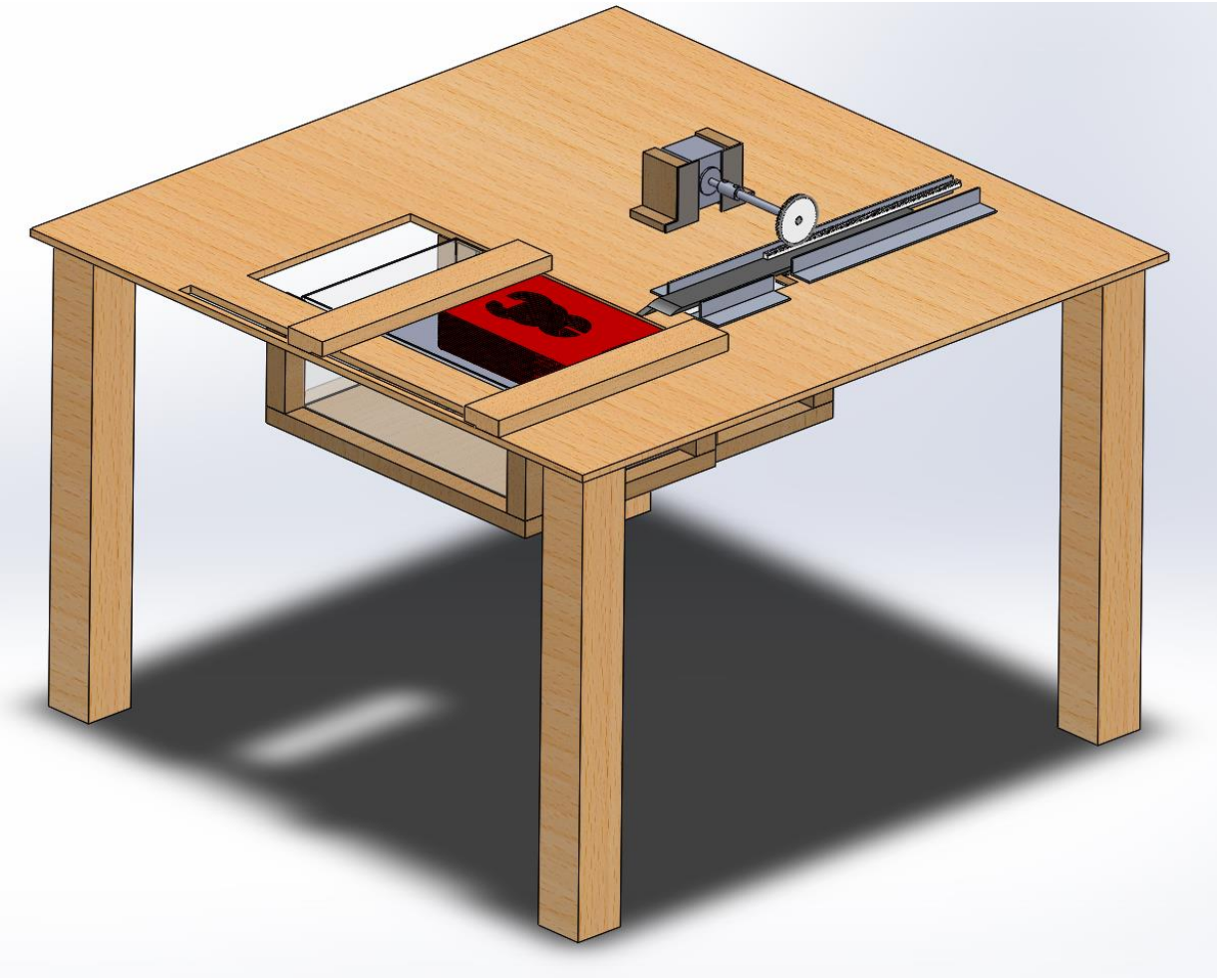
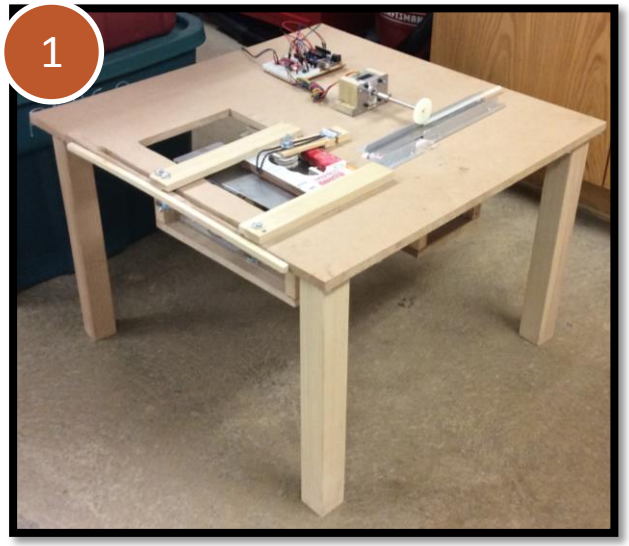
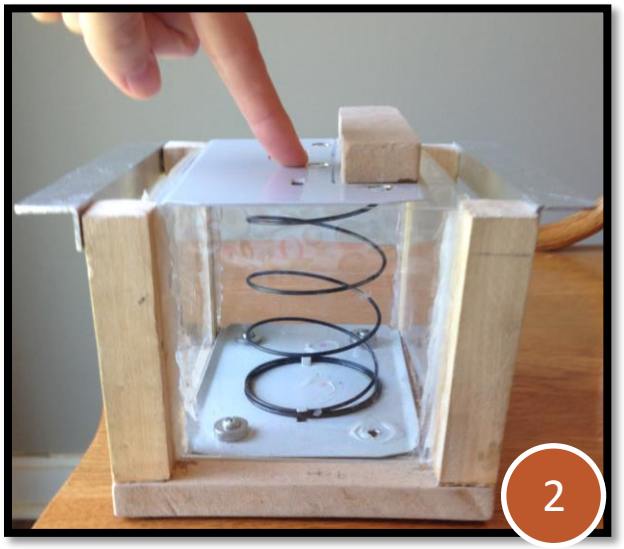


*Figure 5*

# Table

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

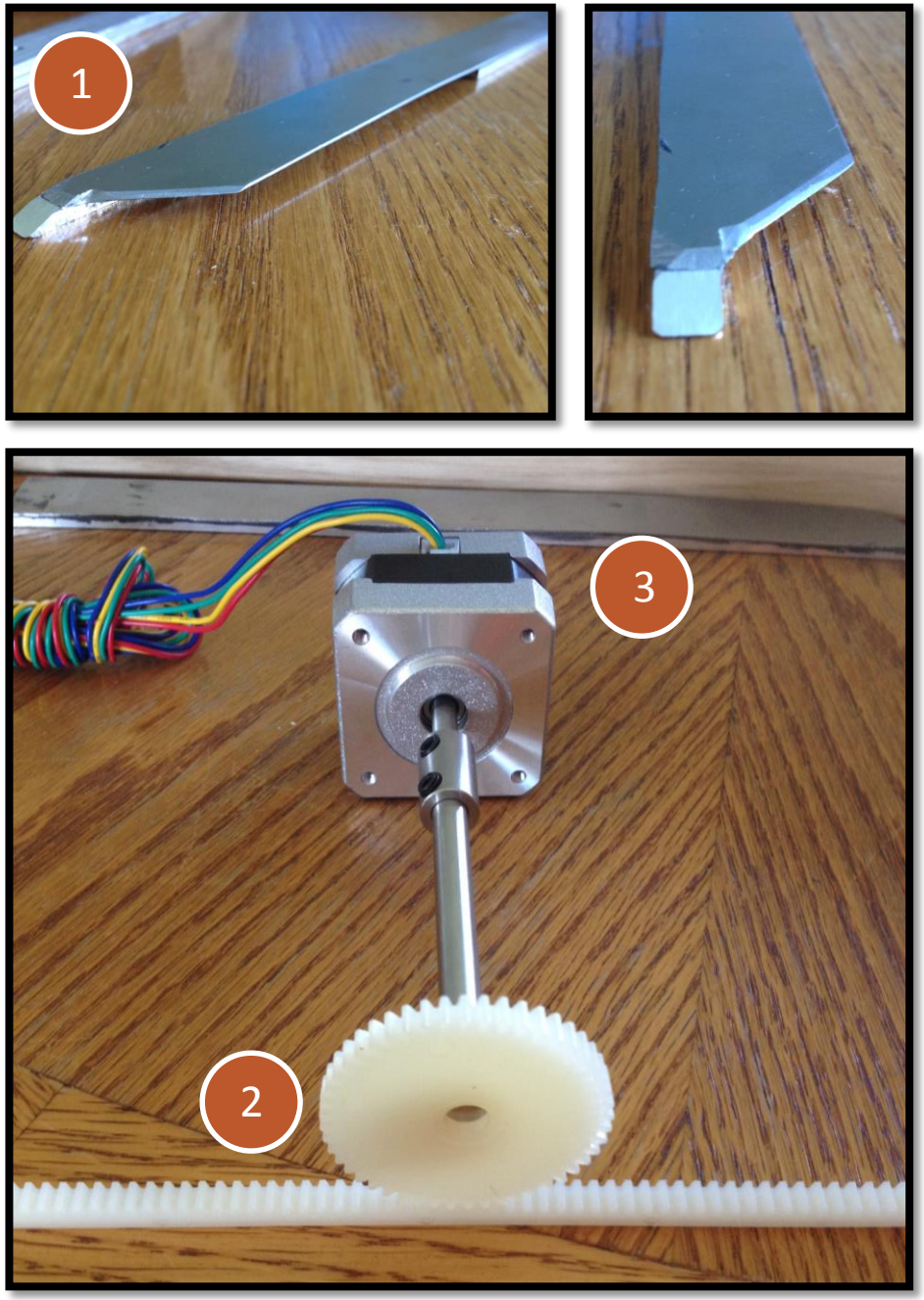




# Mechanism

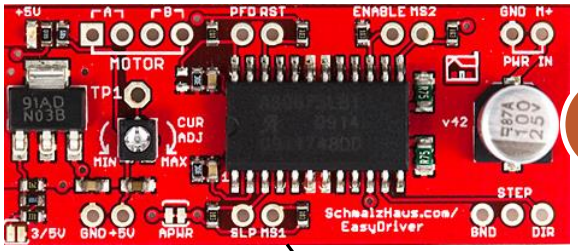
1. Wedge
2. Rack & Pinion
3. Stepper Motor



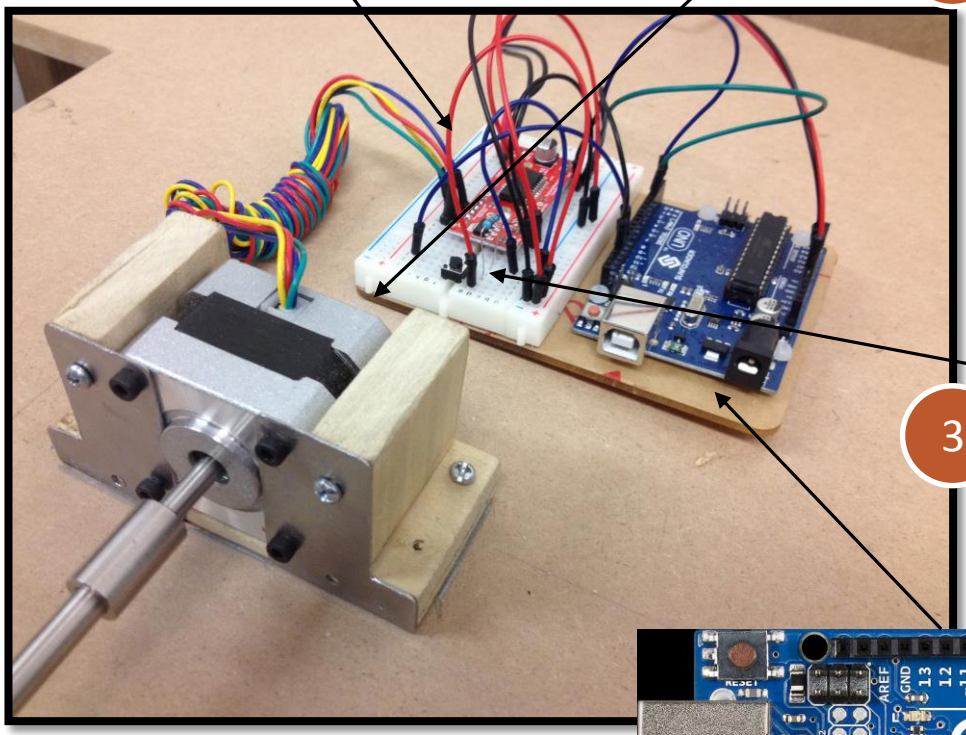
# Controls

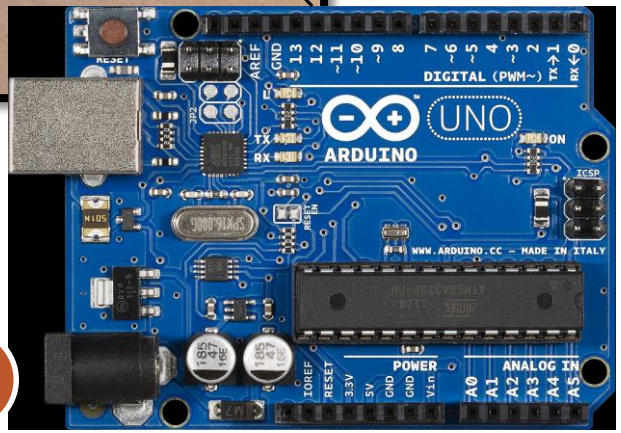
Hardware

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



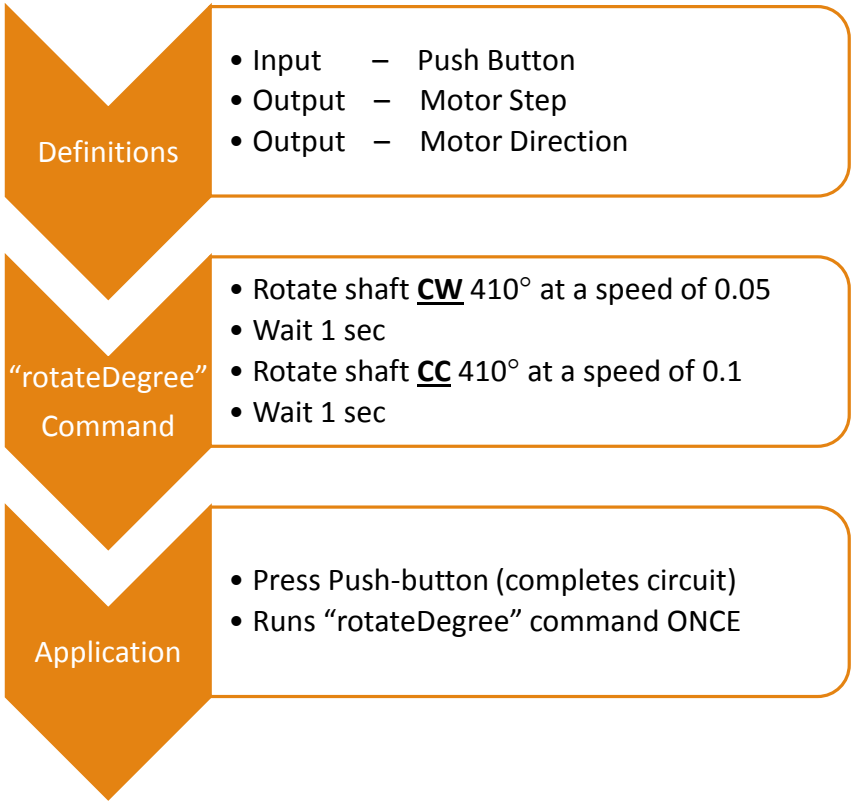




# Controls

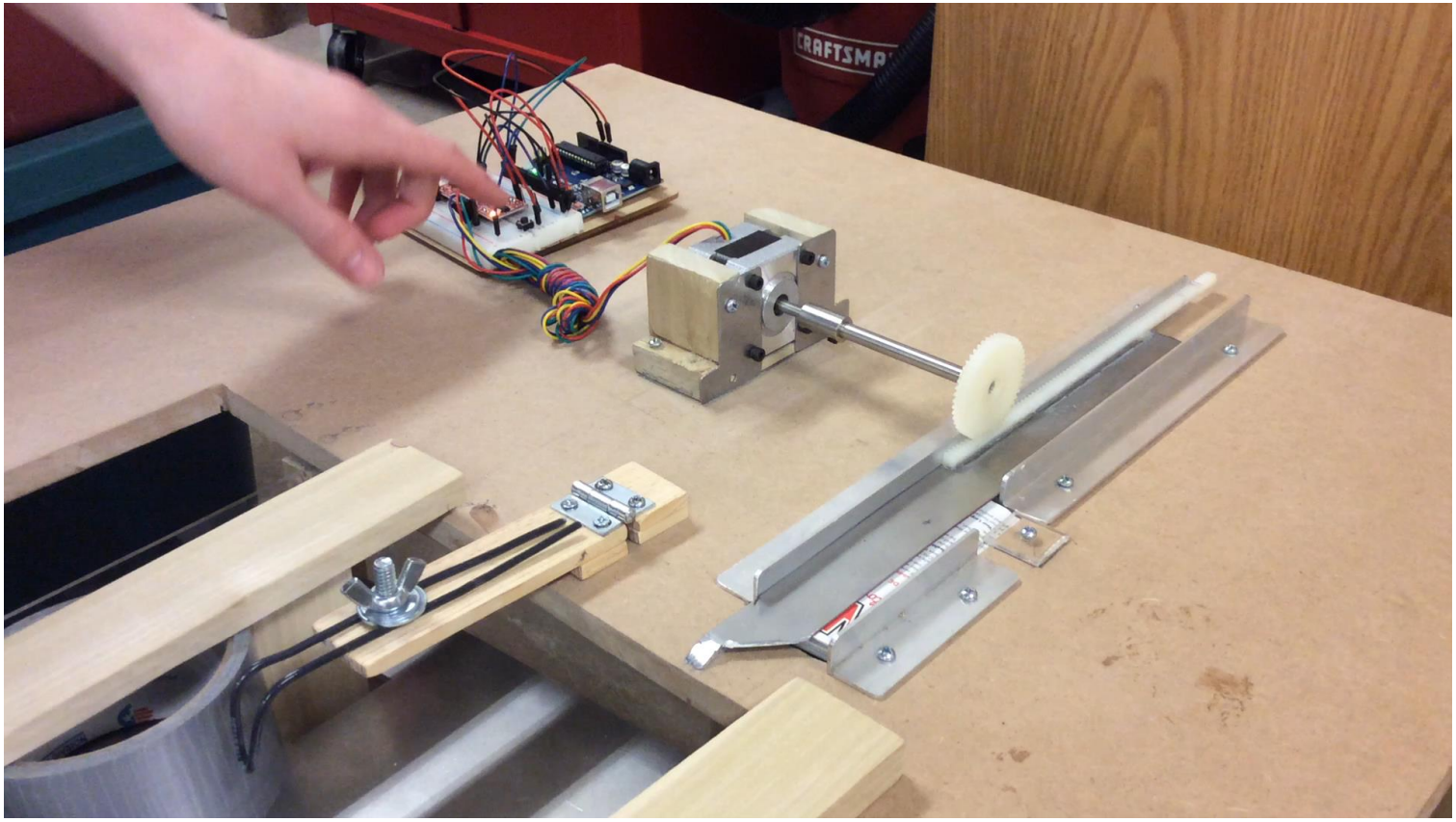
2. Software – Code Function Block



# 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

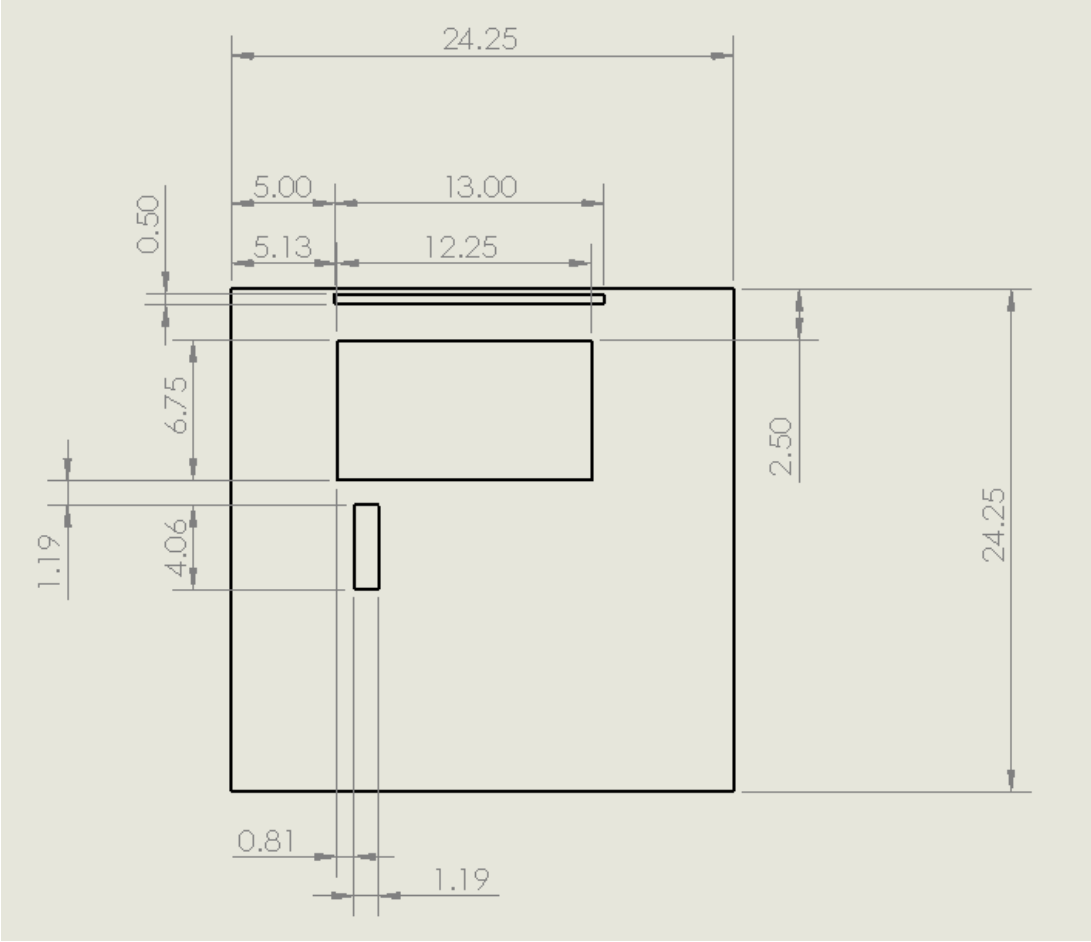
| Task | Lead |
| --- | --- |
| Initial Project Design | All |
| Concept Drawings | Rachael Innocenzi |
| Electrical & Instrumentation | Ashley Cuthbert |
| Construction | Marianna Smith |
| Testing & Evaluation | All |

# Appendix – Part Drawings

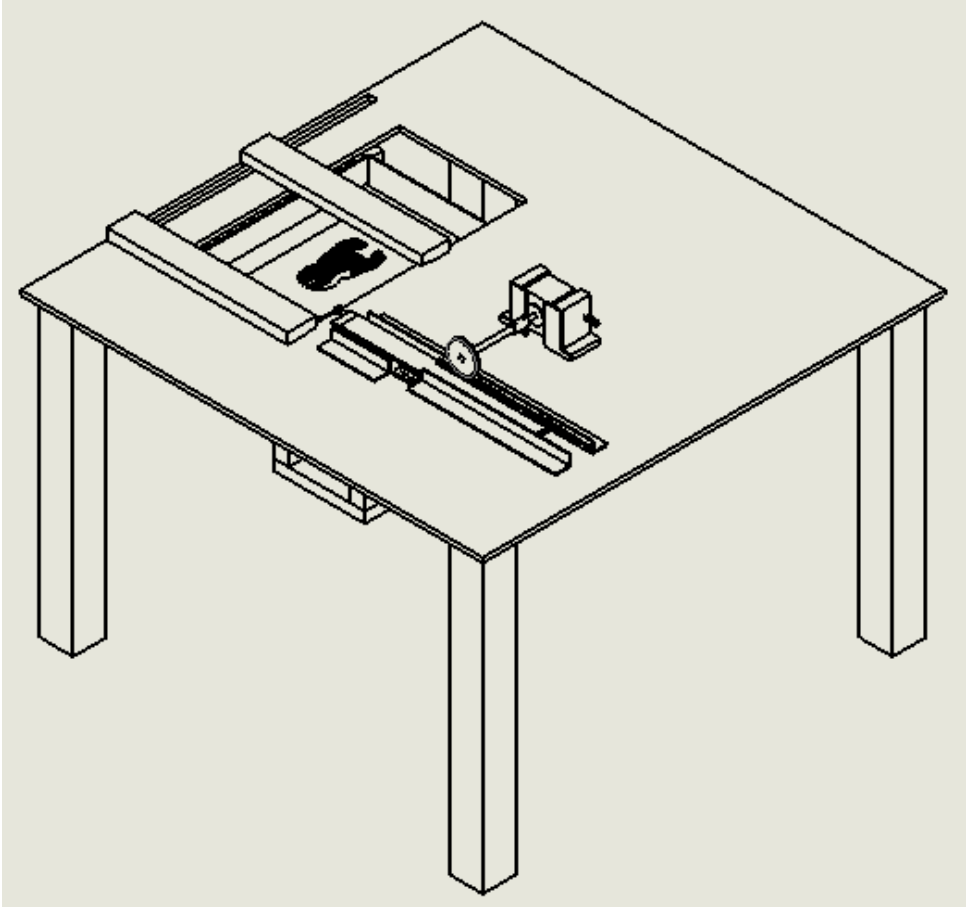
Please note:

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

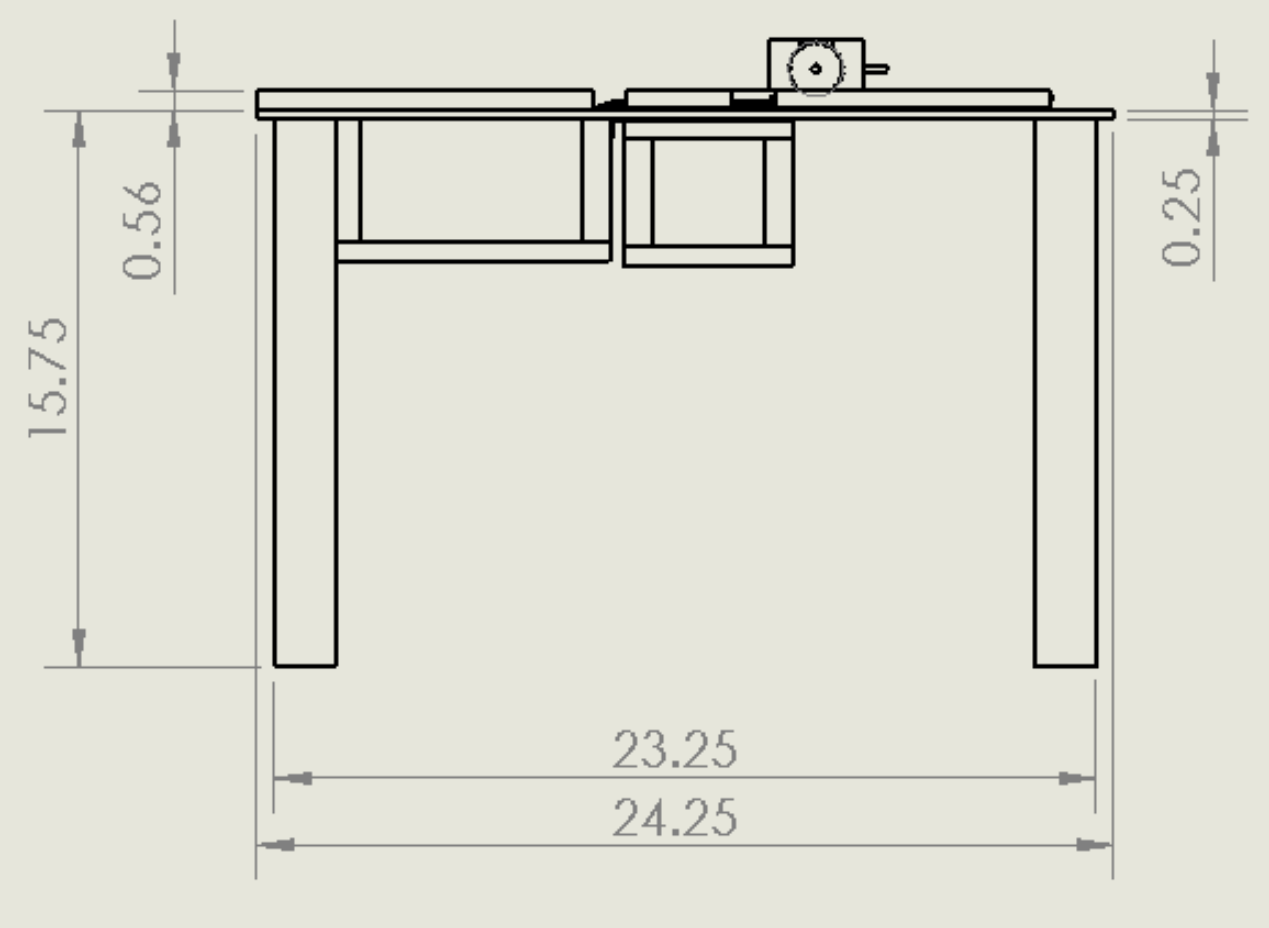
# Appendix – Part Drawings Table Top



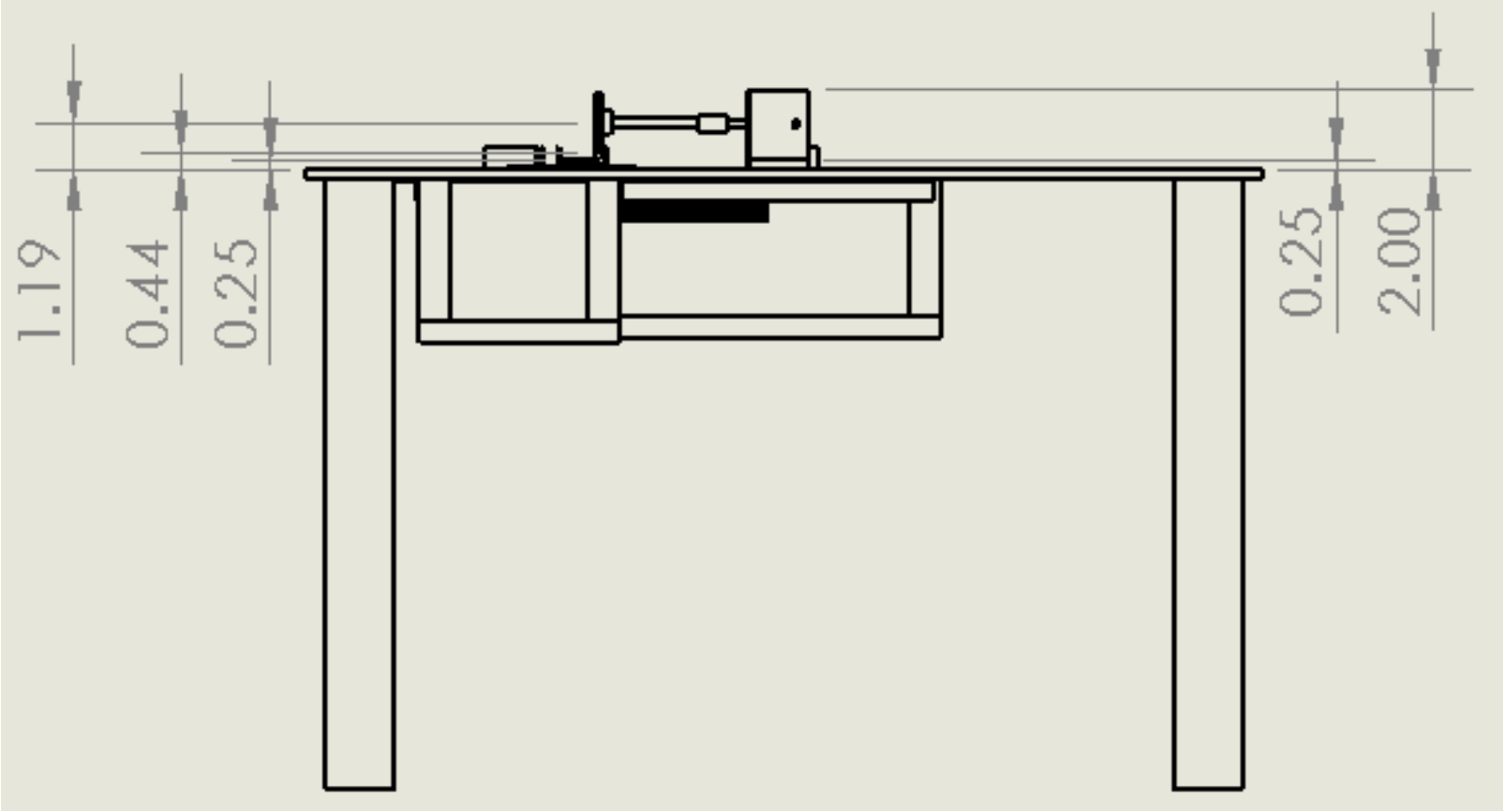
# Appendix – Final Concept Drawings (1)



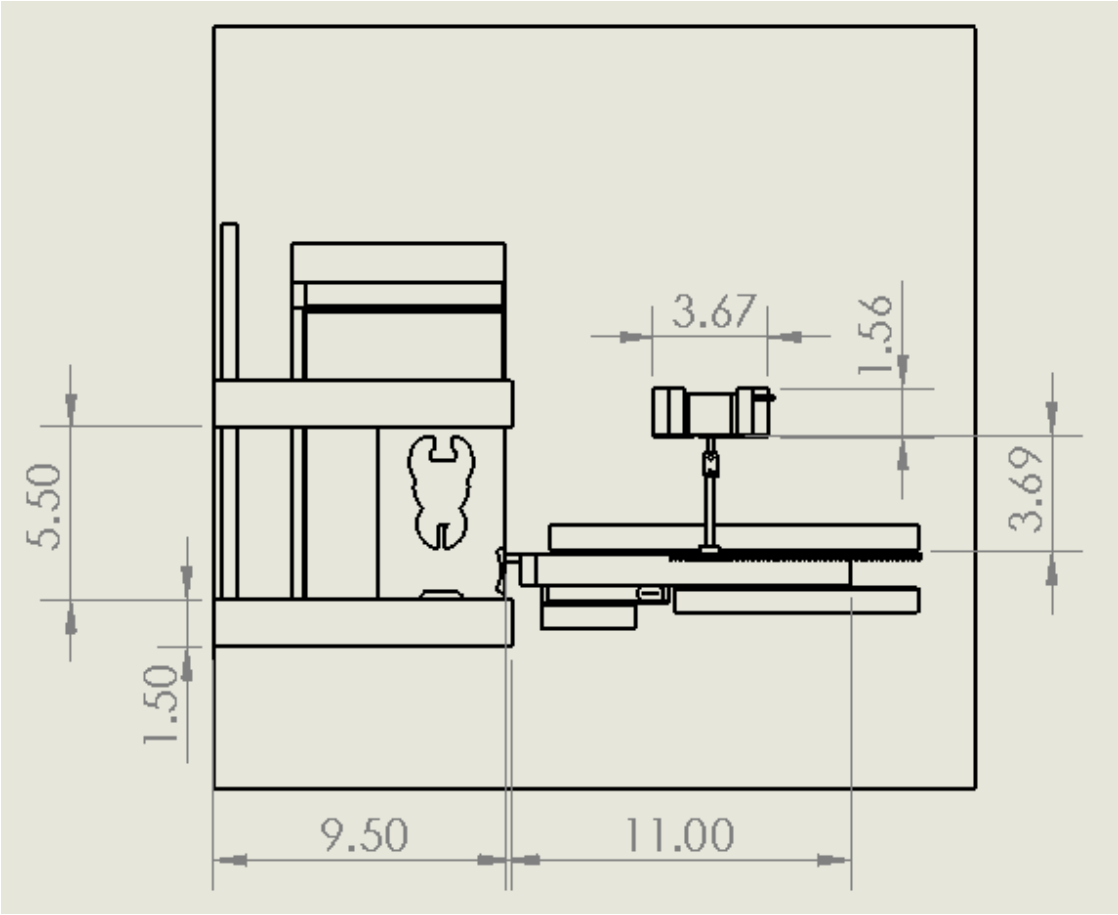
# Appendix – Final Concept Drawings (2)



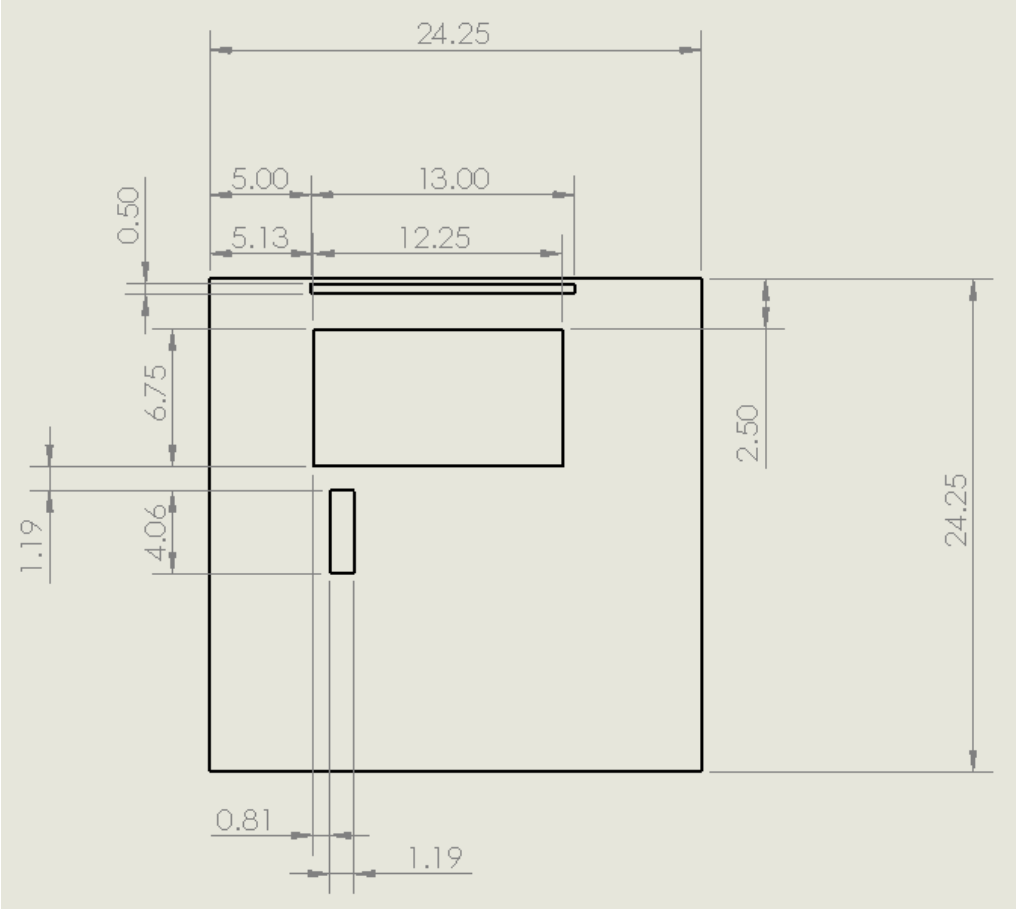
# Appendix – Final Concept Drawings (3)



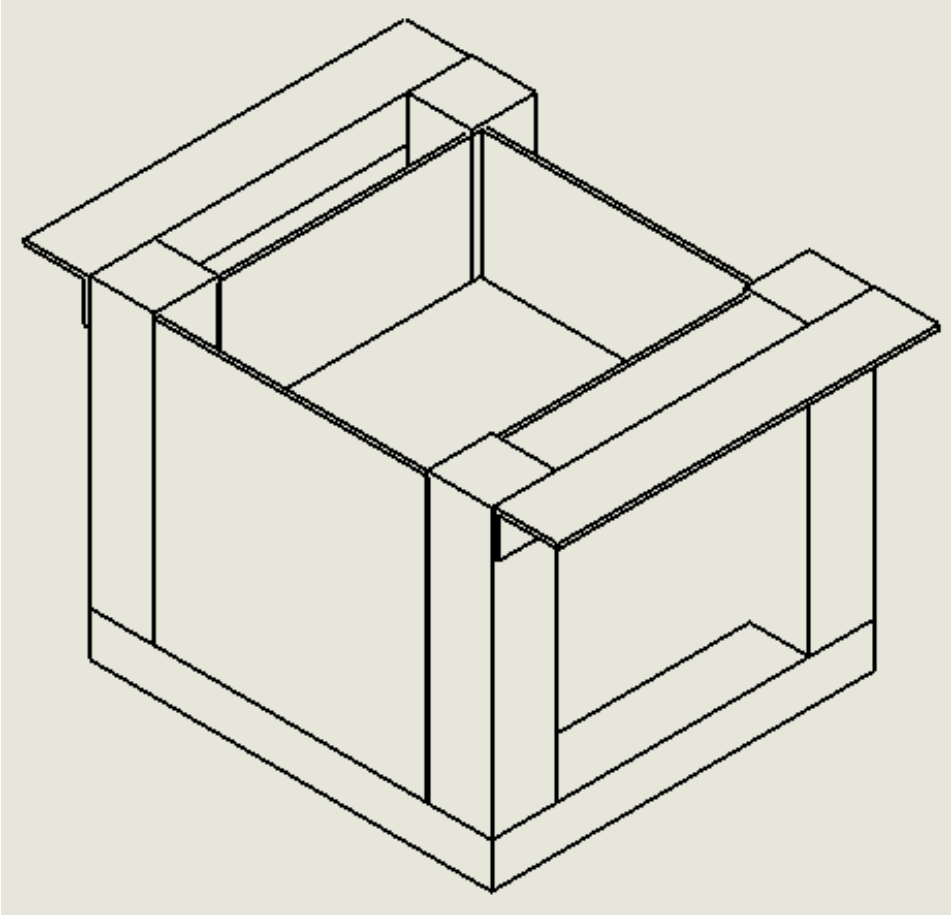
# Appendix – Final Concept Drawings (4)



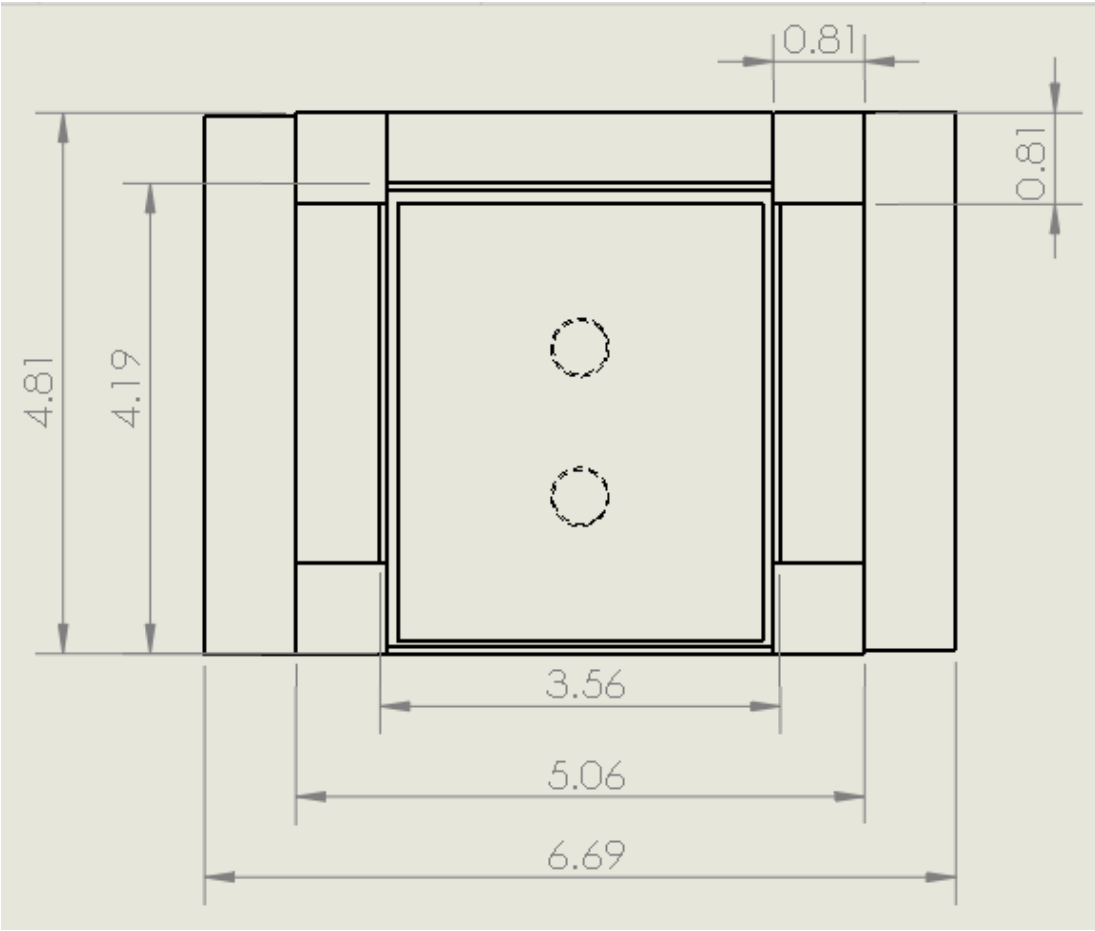
# Appendix – Part Drawings Table Top



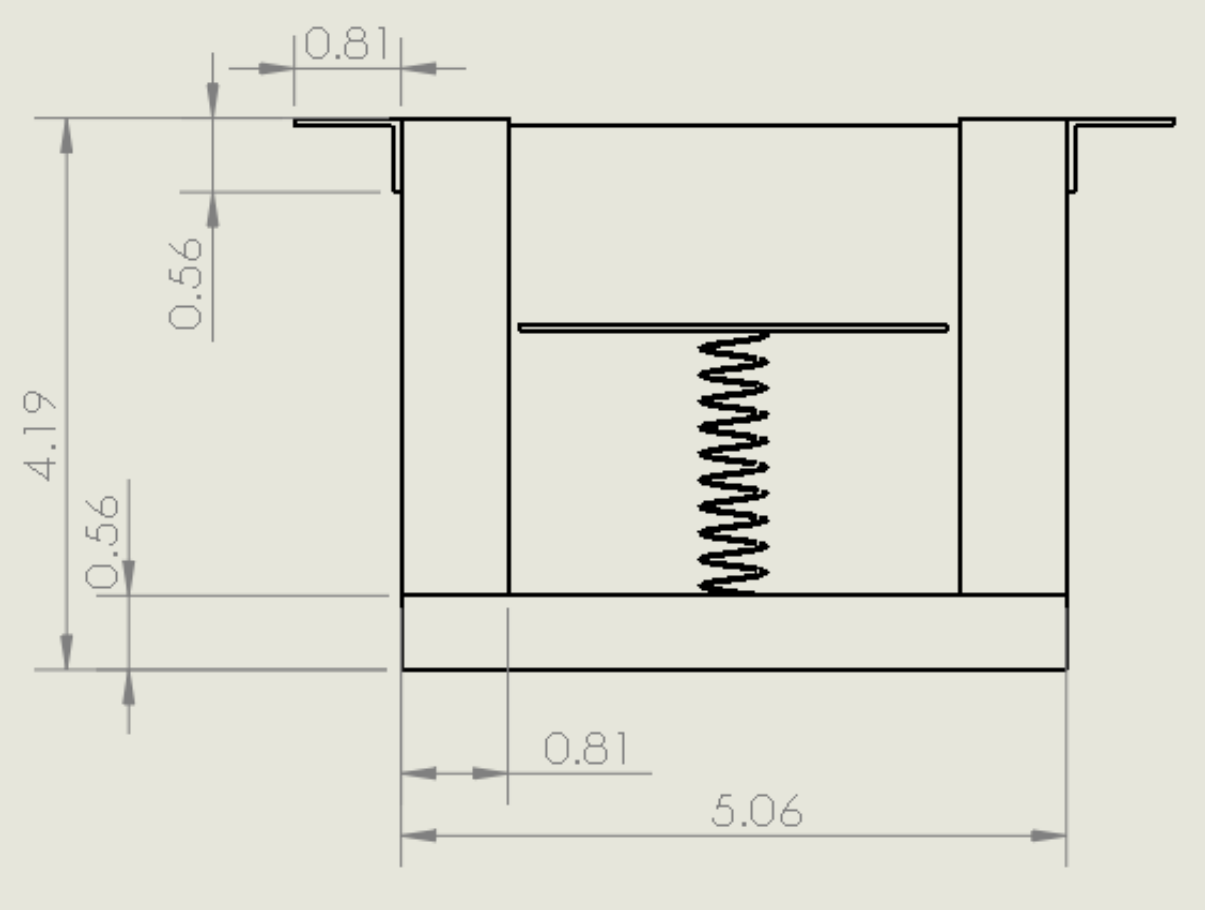
# Appendix – Instruction Manual Box Drawings (1)



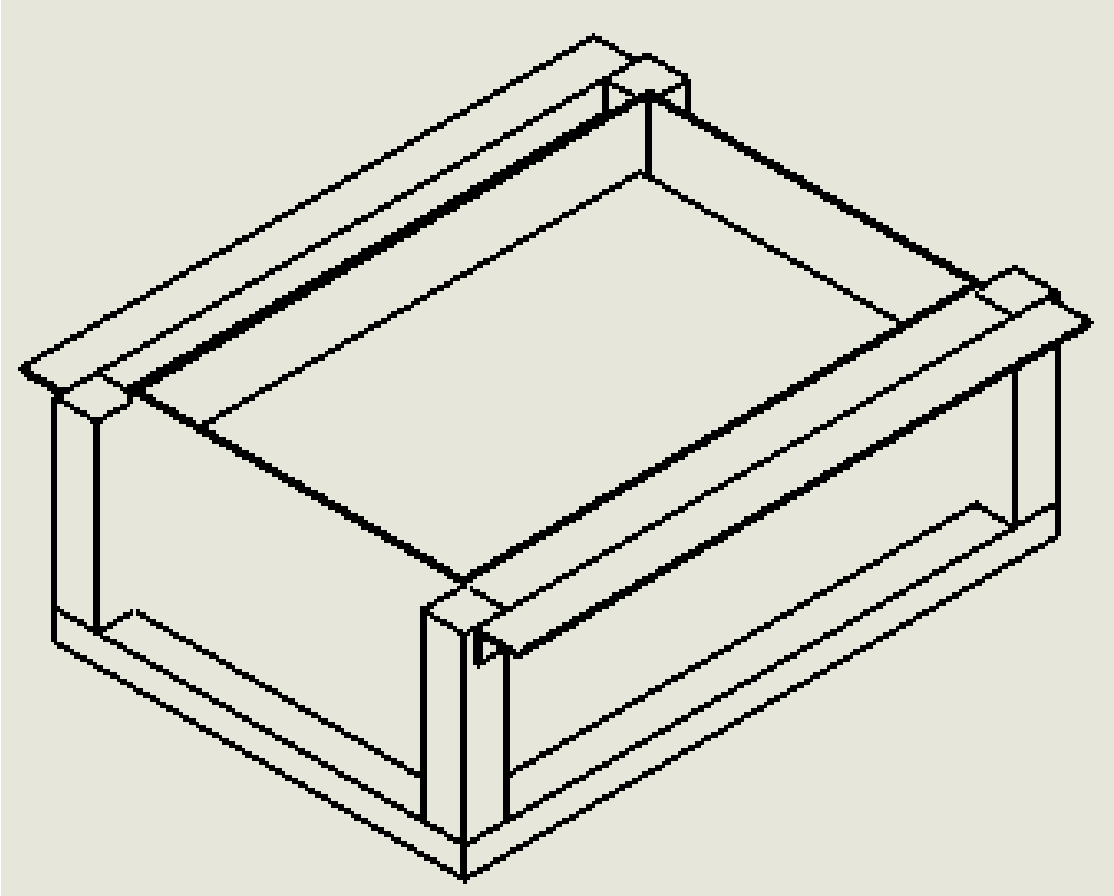
# Appendix – Instruction Manual Box Drawings (2)



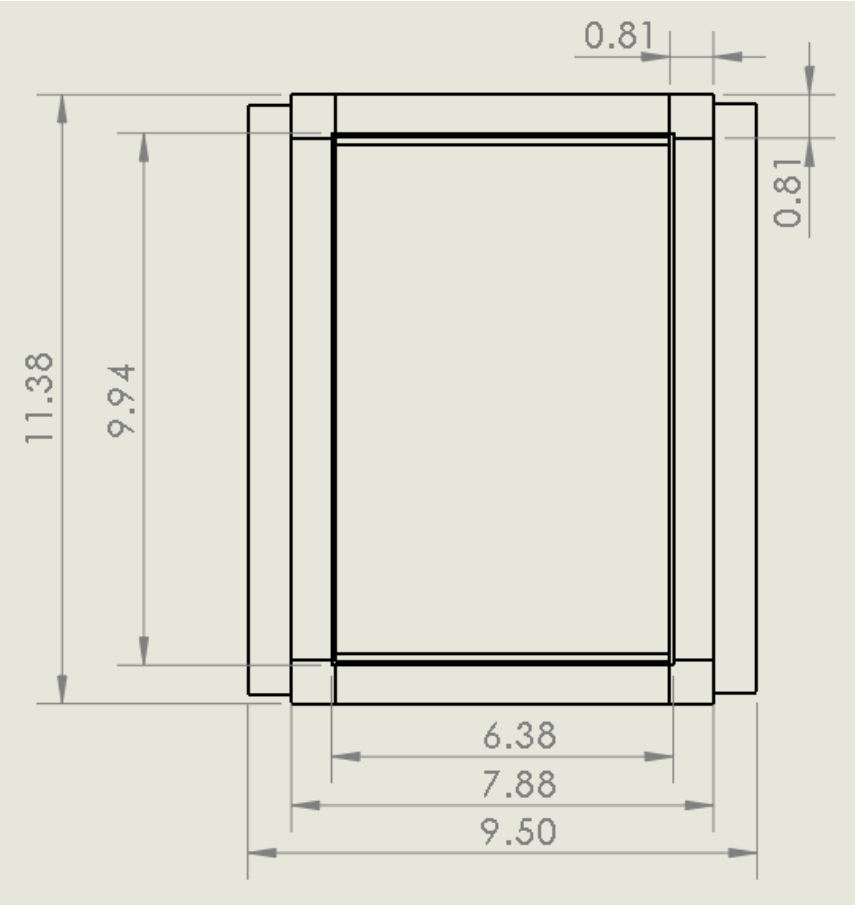
# Appendix – Instruction Manual Box Drawings (3)



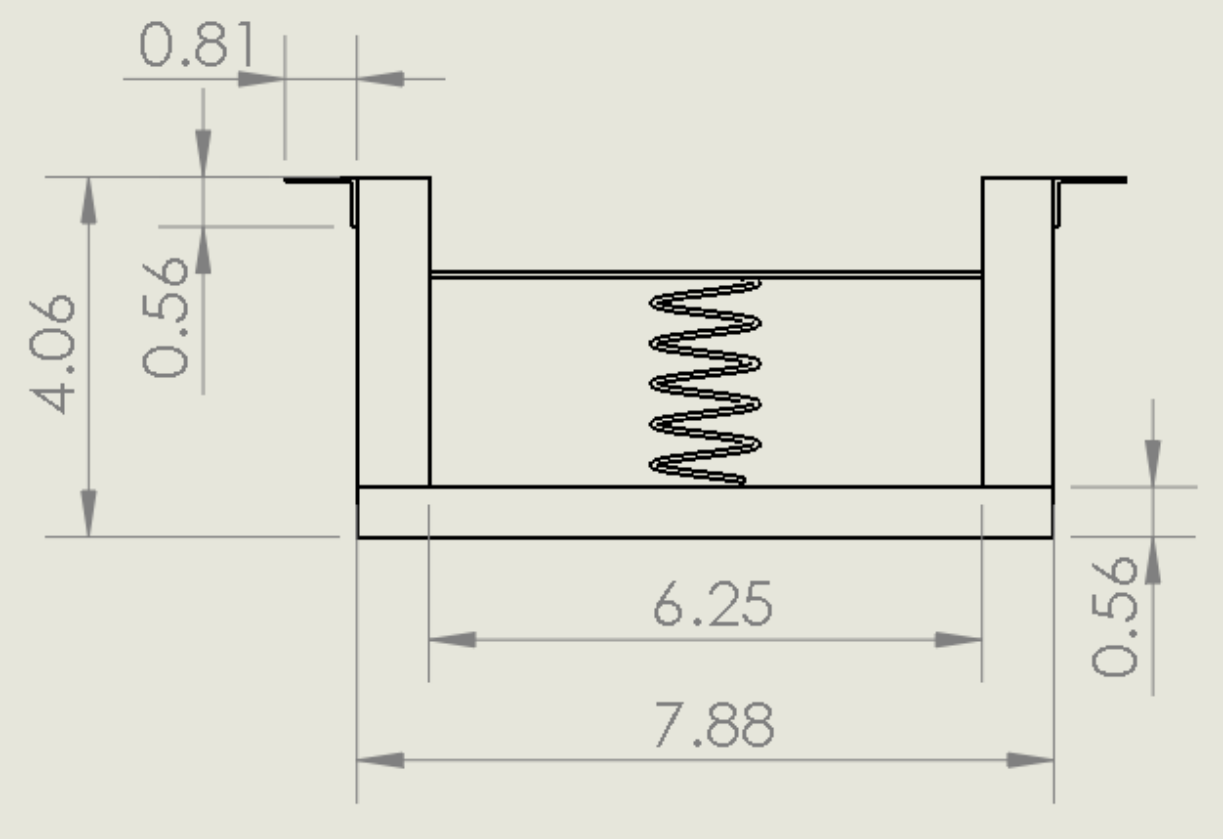
# Appendix – Cardstock Box Drawings (1)



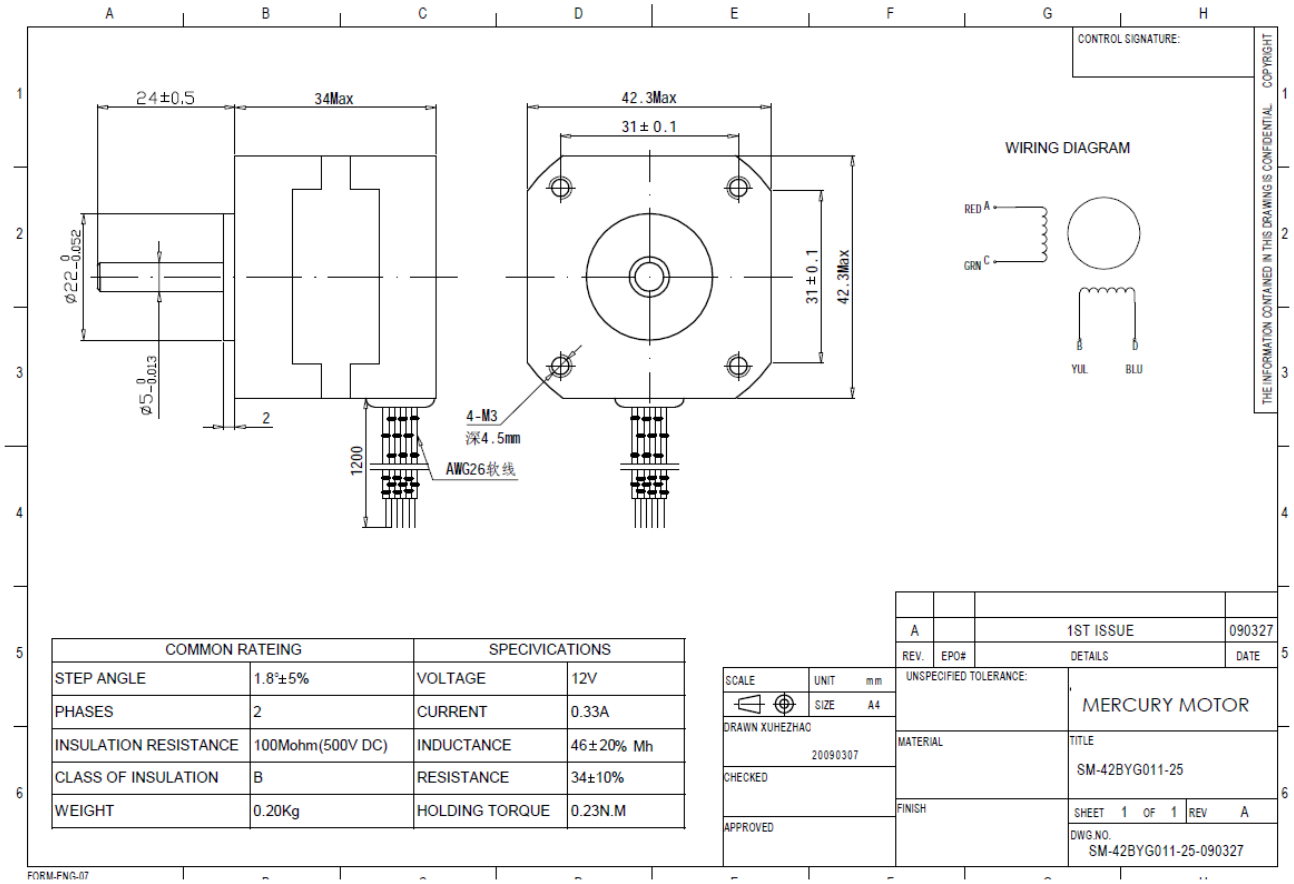
# Appendix – Cardstock Box Drawings (2)



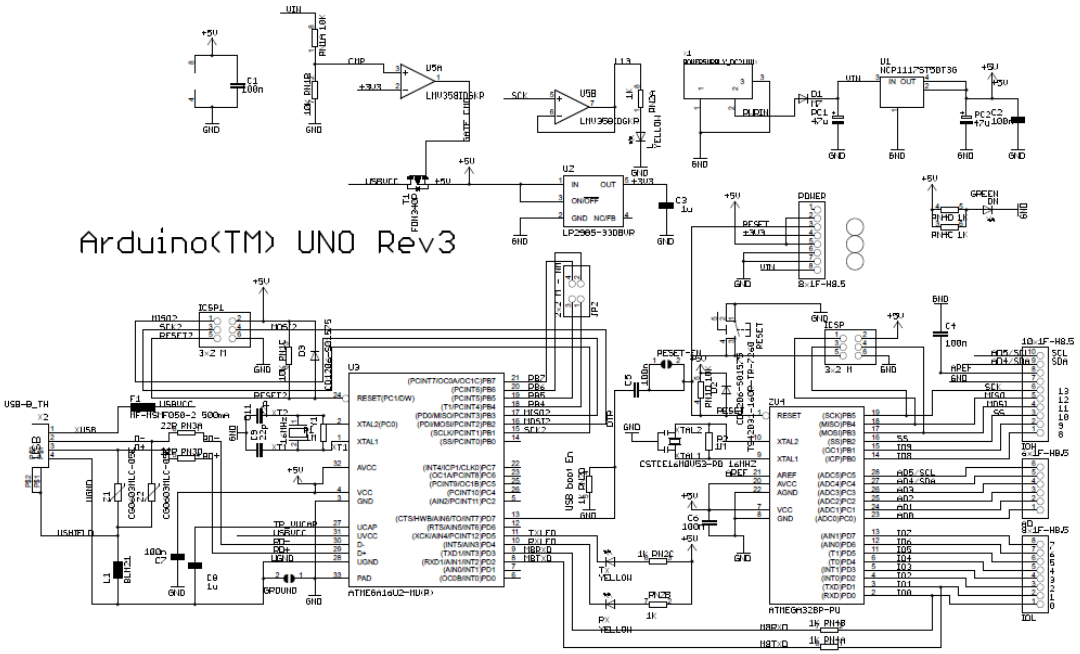
# Appendix – Cardstock Box Drawings (3)



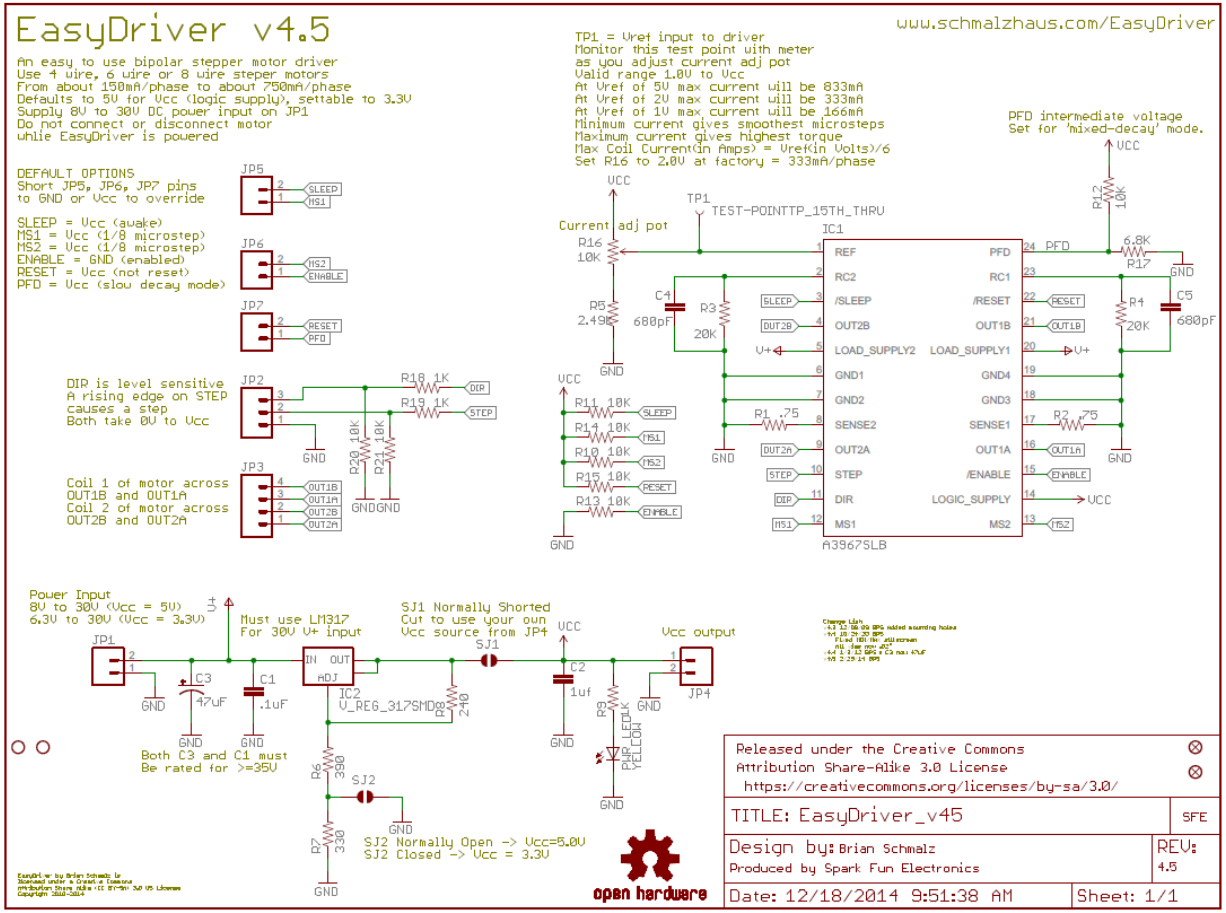
# Appendix – Part Drawings Stepper Motor



# 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);
  }
}
```

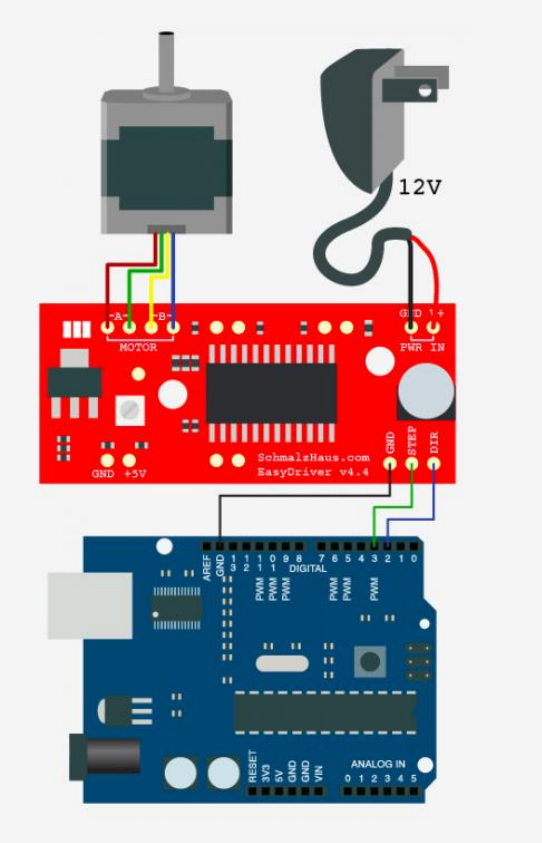
# Appendix – Code (cont'd)

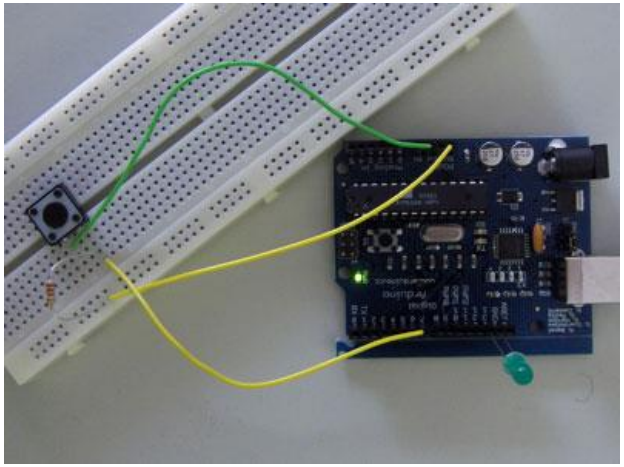
```
void setup() {
  pinMode(DIR_PIN, OUTPUT);
  pinMode(STEP_PIN, OUTPUT);
  pinMode(BUTTON_PIN, INPUT);
}


  //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*** | | |