

Step-By-Step Instructions for Developing a Motorized Retractable Joystick

You will need to follow both the mechanical part instructions and the electrical part instructions to get a working product. Each section contains materials needed along with some helpful guiding links. For a detailed summary table of materials and tools required, see Appendix A.

Electrical Part:

- 1) What you need: (The links to where we ordered the parts are provided as a reference, but you can definitely get these parts from other sources)
 - a) a breadboard [ordered from:
https://www.amazon.com/pack-Solderless-Breadboard-400-points/dp/B01GDTDK9E/ref=sr_1_3?s=industrial&ie=UTF8&qid=1513148420&sr=1-3&keywords=%285+pack%29+Solderless+Breadboard+400+tie+points]
 - b) an Arduino Nano board and its USB cable [can be purchased here:
<https://store.arduino.cc/usa/arduino-nano>]
 - c) a L293D chip, [can be purchased here:
https://www.amazon.com/Adafruit-H-Bridge-Motor-Driver-Steppers/dp/B00NAY2URO/ref=sr_1_3?ie=UTF8&qid=1513148653&sr=8-3&keywords=l293d]
 - d) 3* 270 ohm resistors, [can be purchased here:
https://www.amazon.com/dp/B0185FCVXK/ref=biss_dp_t_asn]
 - e) 1* 3.5mm stereo jack (button jack) [ordered from:
https://www.amazon.com/Conshine-Female-Repair-Headphone-Soldering/dp/B076NH44K6/ref=sr_1_1?s=electronics&ie=UTF8&qid=1513148495&sr=1-1&keywords=Conshine+10Pcs+3.5mm+3+Pole+Female+Repair+Headphone+Jack+Audio+Stereo+Plug+Soldering]
 - f) 1* click button [The one we used were supplied through DME vendors, but here are some options: <https://enablingdevices.com/product-category/switches/>]
 - g) 1* limit switch [ordered from:
https://www.amazon.com/URBESTAC-Momentary-Hinge-Roller-Switches/dp/B00MFRMFS6/ref=sr_1_1?s=industrial&ie=UTF8&qid=1513148329&sr=1-1&keywords=URBESTAC+250V+5A+SPDT+1NO+1NC+Momentary+Hinge+Roller+Lever+Micro+Switches+3+Pins+10+Pcs]
 - h) 1*toggle switch [can be purchased here:
https://www.amazon.com/FBApayipa-Solder-Rocker-Switch-Toggle/dp/B01N2U8PK0/ref=sr_1_14?ie=UTF8&qid=1513181142&sr=8-14&keywords=toggle+switch]
 - i) USB port [ordered from:
https://www.banggood.com/10Pcs-DC-DC-Buck-Module-6-24V-12V24V-to-5V-3A-USB-Step-Down-Power-Supply-Charger-Efficiency-97_5-p-1106578.html?cur_warehouse=CN]
 - j) 1* motor that satisfies the requirements of your joystick
 - k) Wires
 - l) Soldering tools
 - m) Zip-ties

- n) Electrical tape
 - o) Arduino IDE software (download at: <https://www.arduino.cc/en/Main/Software>)
- 2) Wire the circuit following the schematics (Figure 1) or the breadboard wiring layout (Figure 2). A wired circuit should look like something shown in Figure 3. The following steps of wiring your circuits are provided for reference.
- a) Plug the Arduino Nano Board to the breadboard.
 - b) Plug the L293D motor driver to the breadboard.
 - c) Plug the resistors to the breadboard.
 - d) Wire these components following the schematics and the breadboard wiring layout.
 - e) Solder wires onto the button jack.
 - f) Tape the button jack on one side of the breadboard using electrical tape.
 - g) Solder wires onto the toggle switch.
 - h) Tape the toggle switch on the same side of the breadboard using electrical tape.
 - i) Secure the placements of the button jack and the toggle switch with a zip tie.
 - j) Plug the wires of the button jack and the toggle switch to the corresponding positions based on Figure 1 and Figure 2.
 - k) Solder wires onto the limit switch.
 - l) Solder wires onto the motor.
 - m) You might want to connect the motor and the limit switch to the circuit after you are done with the mechanical assembly.
 - n) Plug the click button into the button jack.

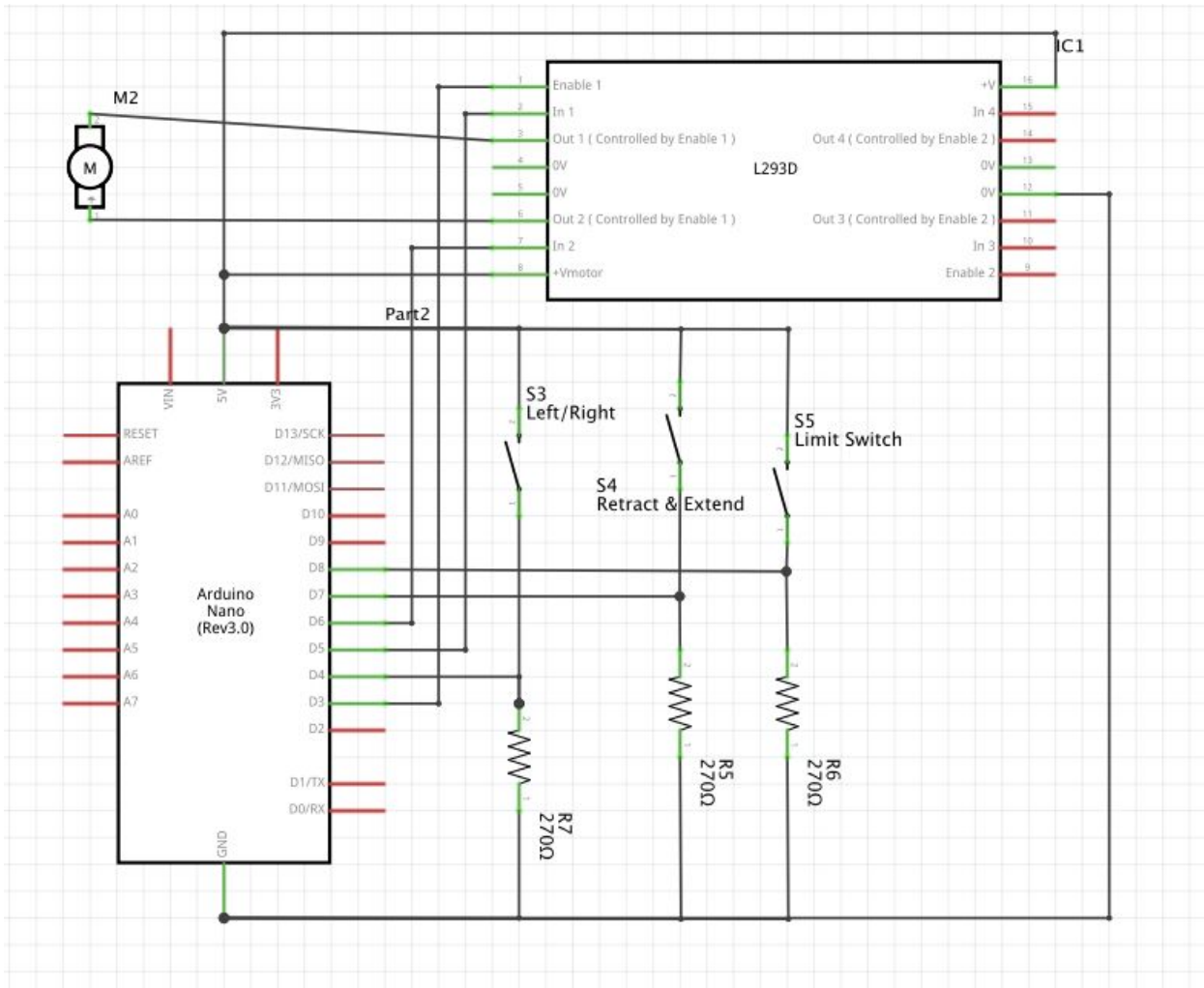


Figure 1-Schematics of the Circuits

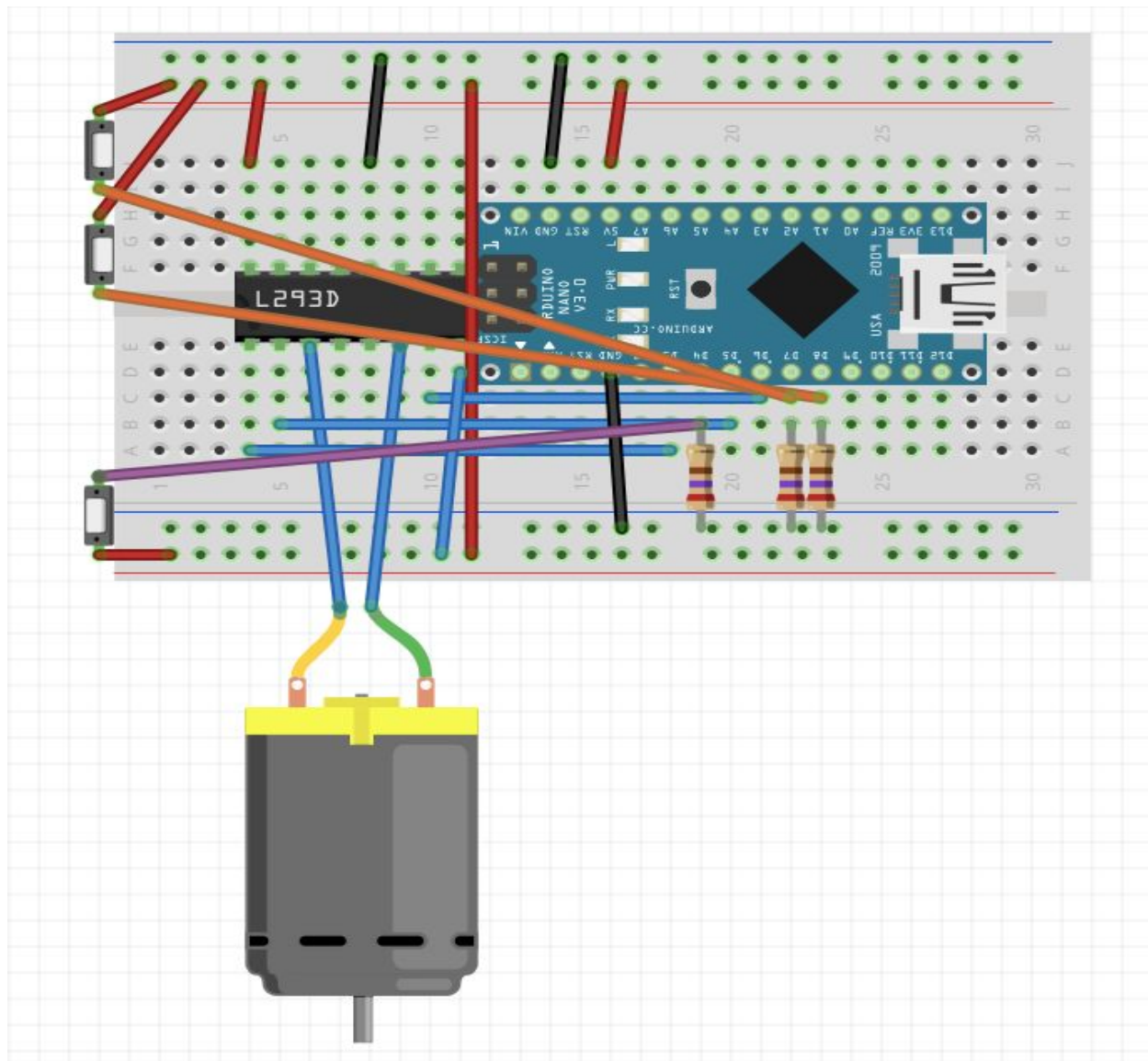


Figure 2-Breadboard wiring layout of the circuit

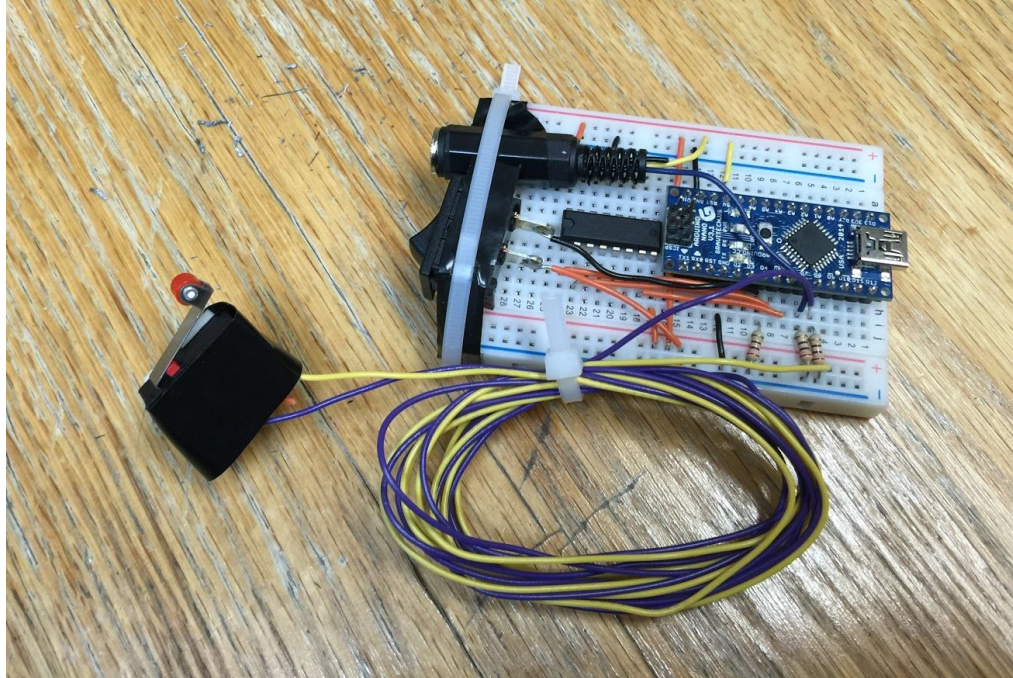
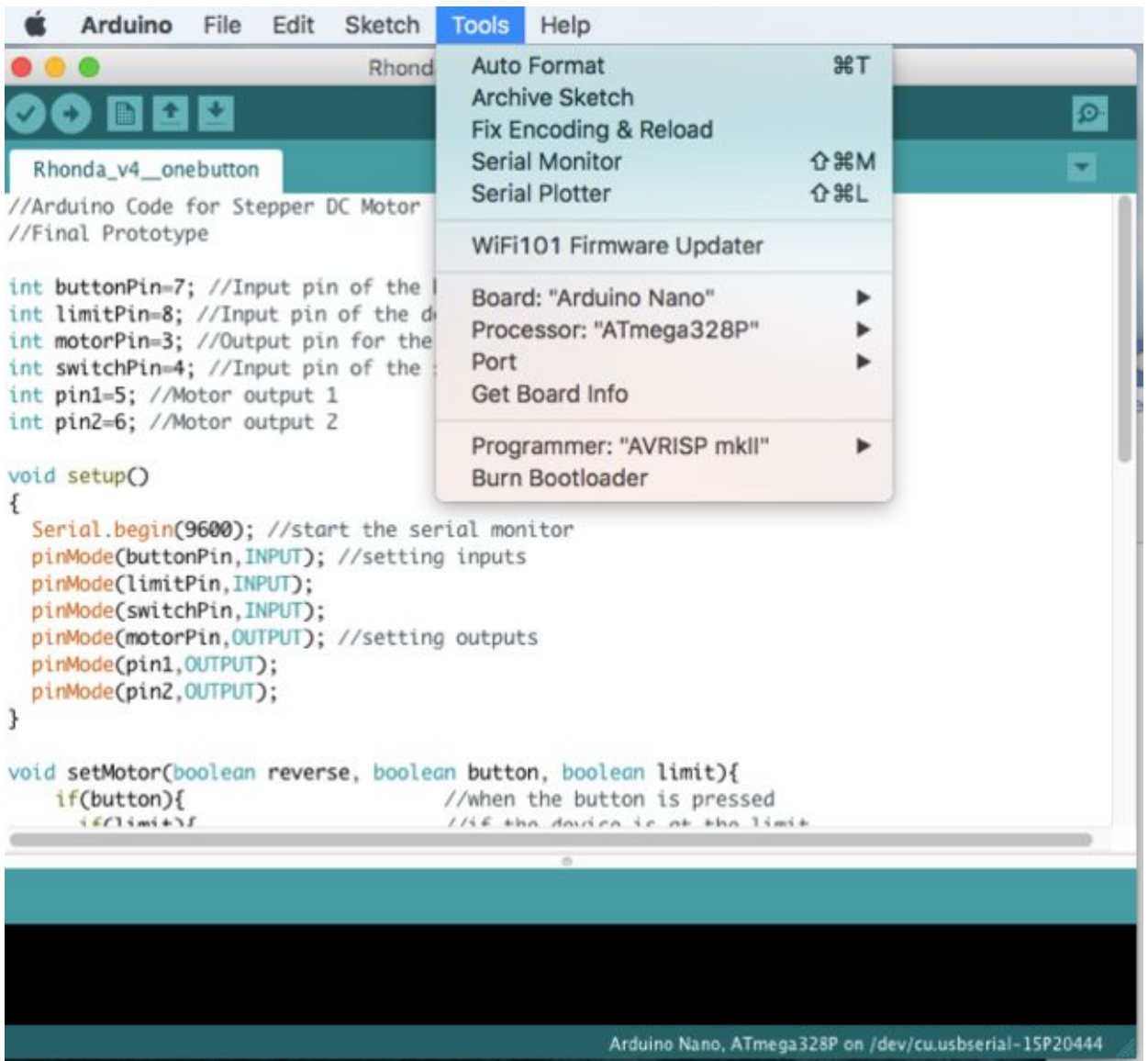



Figure 3 - A wired circuit without plugging in wires of motors

- 3) Download Arduino IDE and install it on your computer from:
<https://www.arduino.cc/en/Main/Software>
- 4) Download Arduino code from:
https://github.com/teamrhonda/ArduinoCode/blob/master/Rhonda_v4_onebutton.ino
- 5) Open the downloaded Arduino code with Arduino IDE on your computer.
- 6) Your interface should look like something shown in Figure below.



- 7) Connect the Arduino board to your computer.
- 8) Click Tools and make sure the following settings are correct.
 - a) Set the Board to "Arduino Nano."
 - b) Set the Processor to "ATmega 328."
 - c) Set the Port to the USB Port.
- 9) Press the upload  button.
- 10) Wait until the interface reads "Upload Completed."
- 11) Temporarily attach motor and limit switch to test your circuit.

12) Complete **Mechanical Part** outlined below.

13) Change the timing if you need based on your joystick arm retracting and extending time and angle in **Line 52**. The current time is set to 5500 (which equals to 5.5 seconds), you can customize your time here.

```
51   if(button){
52     delay(5500);           //Motor rotation time input (set in microseconds)
53   }
```

14) Change the speed if you need based on your preferences in **Line 25 and Line 30**. The current speed is set to the maximum as 255. You can enter a number (0~255) to customize the rotating speed, where 0 is at rest, and 255 is at maximum speed.

```
22 void setMotor(boolean reverse, boolean button, boolean limit){
23   if(button){           //when the button is pressed
24     if(limit){         //if the device is at the limit
25       analogWrite(motorPin,255); //rotate the motor, speed is between 0 to 255.
26       digitalWrite(pin1, !reverse); //CW if on right-handed mode, CCW if on left-handed mode
27       digitalWrite(pin2, reverse);
28     }
29     else if(!limit){   //if the device is not at the limit
30       analogWrite(motorPin,255); //rotate the motor
31       digitalWrite(pin1, reverse); //CCW if on right-handed mode, CW if on left-handed mode
32       digitalWrite(pin2, !reverse);
33     }
34   }
```

15) Once you are done with the **Mechanical Part** assembly, plug the motor wires and the limit switch wires to the breadboard as indicated in Figure 1 and 2.

16) If not already completed, connect USB port to the wheelchair power supply. The input of the buck converter connects to the 24V power supply (power port to power port, and ground port to ground port).

17) Now, plug the Arduino into the USB port to supply power.

18) Congratulations! You can now move your joystick by clicking the button!

Mechanical Part:

1) What you need:

- a) 2* 2"x2" 1.5" Angle L-bracket
- b) 1* 1" Aluminum Square Bar Stock Piece (length depends on requirements, ours was 2.5" long)
- c) 6 flathead M3 screws
- d) 1 ¼-20 screw and lock nut
- e) 1 M6 screw
- f) 1 #8-32 flathead screw
- g) 1 ¾" #10-32 set-screw
- h) 1 ¼" #10-32 set-screw

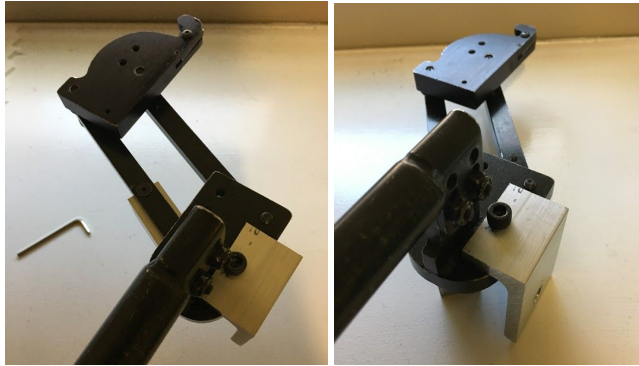
- i) 2 #2-56 flathead screws
 - j) Electronics housing (for example, a 3.9"x3.9"x2.4" (98mmx98mmx61mm waterproof box) [ordered from:
https://www.amazon.com/uxcell-98mmx98mmx61mm-Retardant-Dustproof-5Terminals/dp/B071FLTH52/ref=sr_1_1?s=hi&ie=UTF8&qid=1513148545&sr=1-1&keywords=uxcell+3.9%22x3.9%22x2.4%22%2898mmx98mmx61mm%29+ABS+Flame+Retardant+Dustproof+IP66+Junction+Box+Universal+Project+Enclosure]
- 2) Machine parts out of aluminum L-shaped angle stock and aluminum square bar stock using drawings (see Appendix B). You can reference the 3D STL files at <https://github.com/teamrhonda/CAD-files>.
 - 3) Modify the outer bar of joystick arm as indicated in Outer Arm drawing (see Appendix B). You can also reference outer_arm.STL (https://github.com/teamrhonda/CAD-files/blob/master/outer_arm.STL).
 - 4) Assemble as follows:
 - a) Attach motor to the motor bracket by aligning the holes and screwing in the M3 flathead screws (not all 6 will be needed to keep the motor in place but screw in as many as possible for maximum secureness; make sure to use screws of the correct length according to the thickness of the bracket in order to prevent damage to the motor).



- b) Align coupling piece below outer bar and screw into place with an 1/2" #8-32 flathead screw. You may need to drill and tap a 8-32 hole into the arm in order to connect the coupling piece to the arm. *In this case, the arm swings out counter-clockwise, so the outer bar (from the perspective of the power wheelchair user) is on the left. For right-handed users, this will be reversed.



c) Attach top bracket to the retractable arm with the M6 screw (loosely).



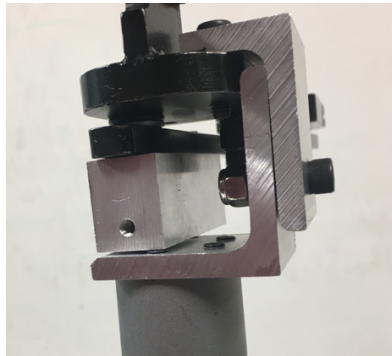
d) Bring the retractable arm to extended position.



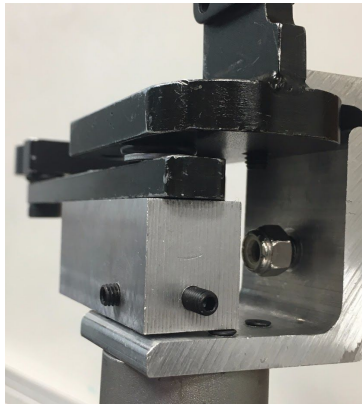
e) Attach motor-motor bracket sub assembly to retractable arm by inserting the motor shaft into the corresponding hole on the coupling piece. The bracket part should slot in between the arm and the top bracket, aligning the holes.



- f) Use the 1/4-20 screw and a lock-nut to fasten the two brackets together. Then, tighten the M6 screw on the top bracket.



- g) Making sure mount is in the extended position, secure the motor to the coupling with the 10-32 set-screw/s.

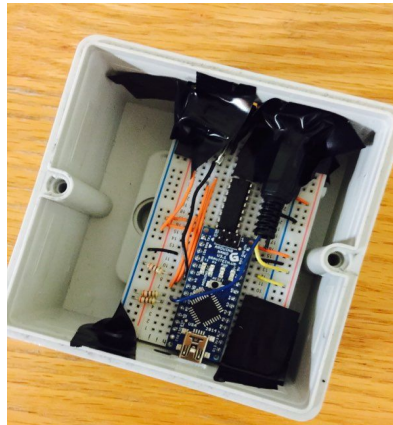


*Note on attaching set-screws: set-screws must interface with *flat* side of D-shaft. In order to adjust the shaft direction, attach motor to power supply until flat side is in the desired position. Alternatively, set up the circuit as outlined in **Electrical Part** above and change the timing (see 12) so it is in the desired position. Remember to change the timing back after assembly!

- h) Screw on limit switch with 2 #2-56 screws (make sure the limit switch will be closed in the fully outward position - in our case, the shoulder bolt presses it closed).



- 5) Place breadboard circuit assembled in **Electrical Part** into electronics housing box.



- 6) Using a mill and/or drill, create slots and holes for connectors (Arduino USB port, button jack, and toggle switch).
7) Fit respective electrical components into slots/holes.



- 8) For disassembly, follow assembly instructions in the reverse order. If your motor burns out and you only would like to *replace* your motor, see below.

9) Motor Replacement Procedure:

- a) Remove set-screw that holds shaft to coupling piece.
- a) Unscrew ¼-20 bracket fastener and lock-nut.
- b) Pull motor-motor bracket sub assembly out and unscrew motor for replacement.
- c) Attach new motor to bracket with screws.
- d) Insert new motor shaft into the hole in the coupling piece, slotting the bracket into place (loosen top M6 screw if needed).
- e) Screw the ¼-20 screw and lock-nut to fasten the brackets again (tighten top M6 screw if needed).
- f) Finally, secure the shaft to the coupling with the set-screw.

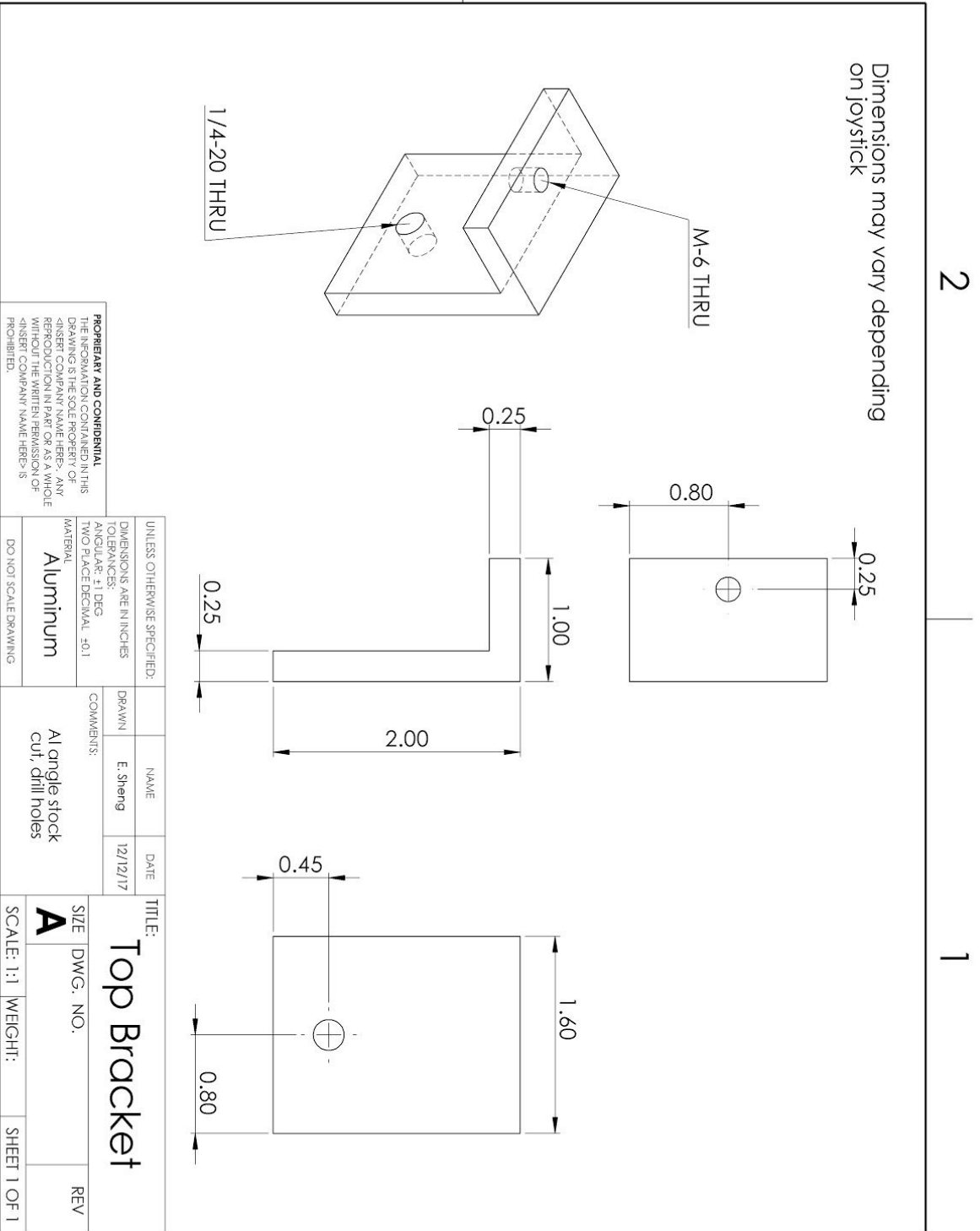
Appendix A: Bill of Materials

Parts	Quantity	Available at:
Breadboard (Solderless Breadboard 400 tie points)	1	Amazon or Digikey
Arduino Nano (Rev 3.0) with USB cable	1	Amazon, Digikey, or Arduino
L293D (IC MOTOR DRIVER PAR 16-DIP)	1	Amazon or Digikey
24V-5V Buck Converter w/ USB Port	1	Banggood.com
DC Gearmotor (Cytron 12V 24RPM 210 oz-in Spur Gearmotor) *subject to user requirements	1	RobotShop
Resistors (270 Ω)	3	Amazon or Digikey
Buttons	2	From DME vendors (i.e. Enabling Devices)
Toggle Switch	1	Amazon
Limit Switch	1	Amazon
Button jacks (3.5mm 3 Pole Female Repair Headphone Jack Audio Stereo Plug Soldering)	2	Amazon
Wire (22 gauge wire)	Varies	Amazon
Electrical Tape	-	Amazon
Zip Tie	At least 2	Amazon
Electronics Housing (for example, a 3.9"x3.9"x2.4" (98mm x 98mm x 61mm waterproof box)	1	Amazon
2"x2" Angle L-bracket	2	Grainger or other raw material provider

1" Aluminum Square Bar Stock	1	Grainger or other raw material provider
3/4" and 1/4" 10-32 set-screw	1	McMaster-Carr
Flathead M3 screws	6	McMaster-Carr
1/4 - 20 screw	1	McMaster-Carr
M6 screw	1	McMaster-Carr
#8-32 flathead screw	1	McMaster-Carr
#2-56 flathead screw	2	McMaster-Carr
Tools	Quantity	Available at:
Wire Stripping Tool	1	Amazon
Solder	Varies	Amazon
Solder Iron	1	Amazon
#10-32 tap	1	
#8-32 tap	1	
M-3 tap	1	
Drill bits	Variety	
Mill (not necessarily required, but helpful)		Machine Shop

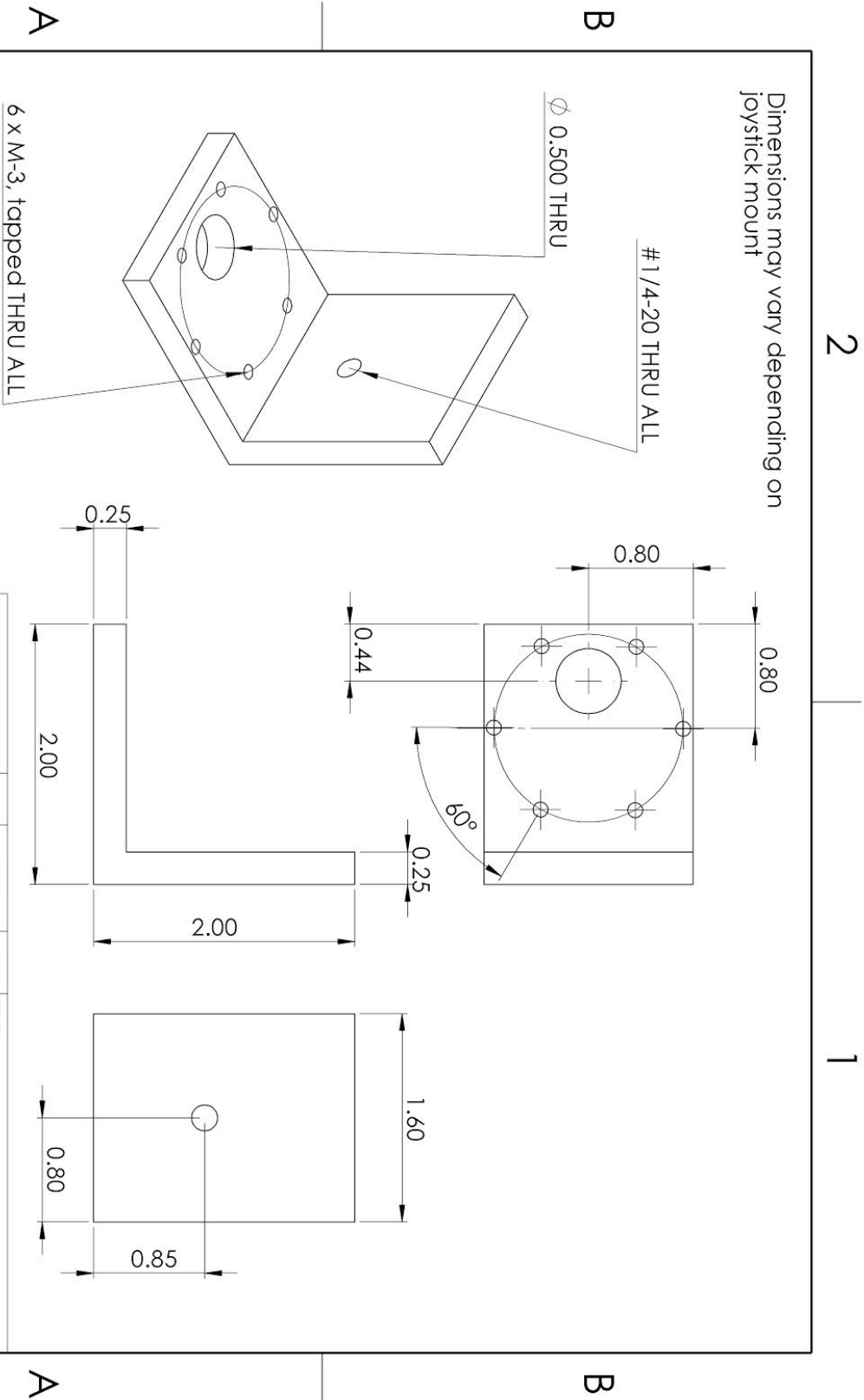
Appendix B: Mechanical Part Drawings

1. Top Bracket



2. Bottom Bracket

Dimensions may vary depending on joystick mount



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES: ANGULAR: ±1 DEG TWO PLACE DECIMAL: ±0.1 MATERIAL		DRAWN		NAME		DATE		TITLE:	
Aluminum		Esheng		12/12/17		Bottom Bracket		SIZE DWG. NO. REV	
DO NOT SCALE DRAWING		Angle Al stock, cut, mill, drill holes		SCALE: 1:1		WEIGHT:		SHEET 1 OF 1	

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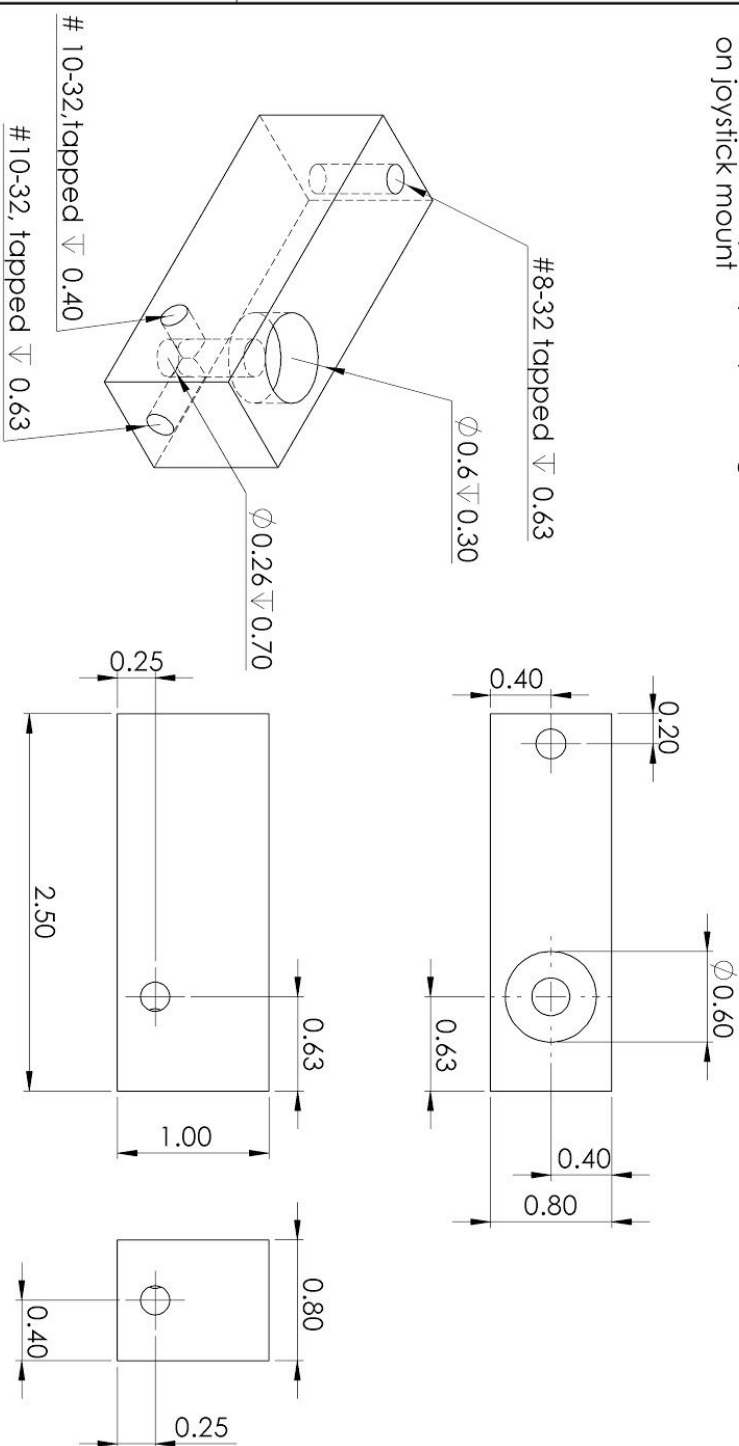
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1

2

1

Dimensions may vary depending on joystick mount



B

B

A

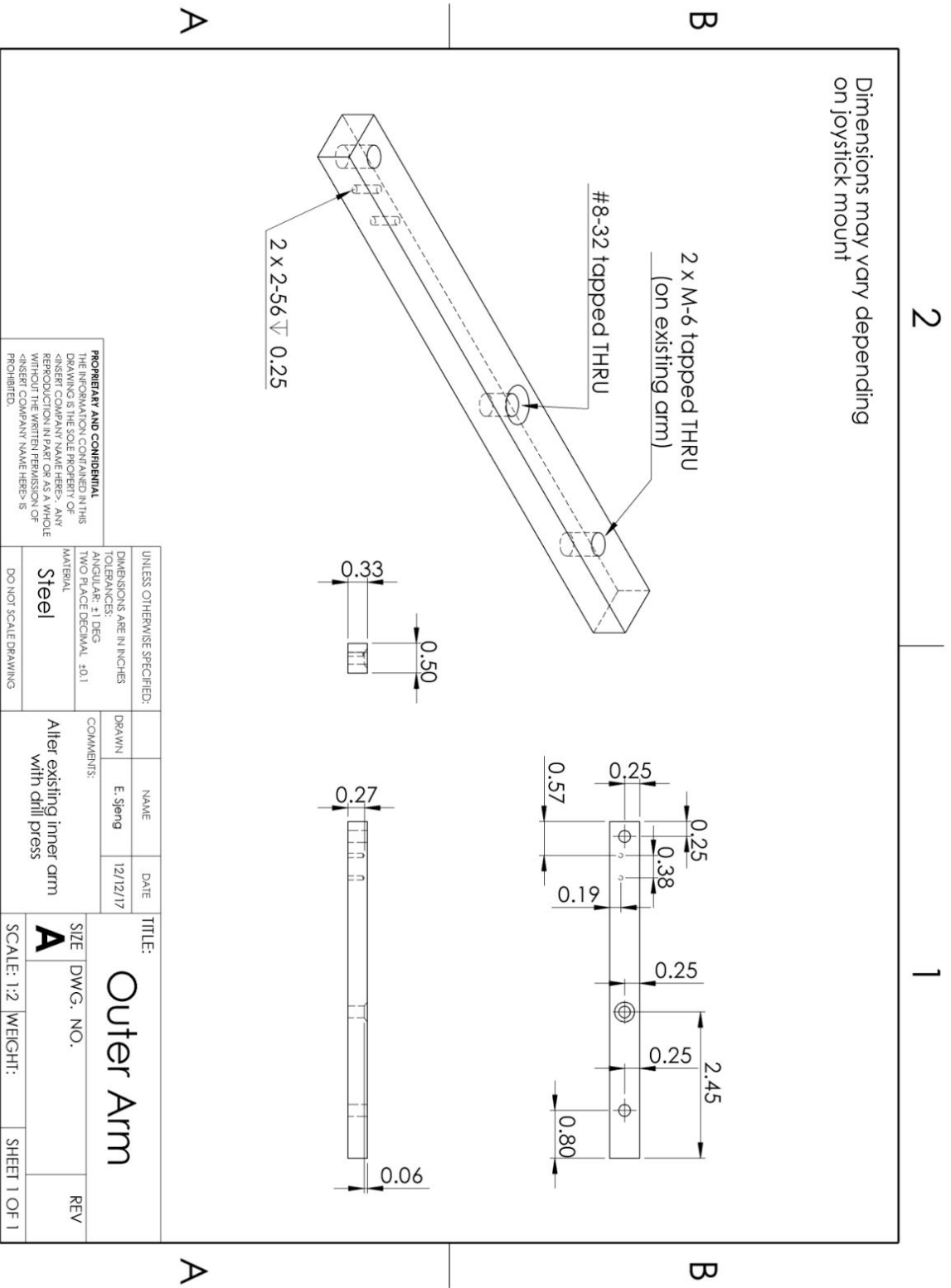
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UNLESS OTHERWISE SPECIFIED:		DRAWN		NAME		DATE	
DIMENSIONS ARE IN INCHES		CHECKED					
TOLERANCES:		ENG APPR.					
FRACTIONAL \pm		MFG APPR.					
ANGULAR MACH \pm		Q.A.					
TWO PLACE DECIMAL \pm		COMMENTS:					
THREE PLACE DECIMAL \pm		A1, cut, mill, drill					
INTERPRET GEOMETRIC TOLERANCING PER:		SIZE		DWG. NO.		REV	
MATERIAL		A					
FINISH		SCALE: 1:1		WEIGHT:		SHEET 1 OF 1	
DO NOT SCALE DRAWING		1					
NEXT ASSY		2					
USED ON							
APPLICATION							

3. Coupling Part

4. Outer Arm



2

1

