Delta Throttle Assembly Instructions

Contents

Bill of Materials

Be sure to read the entire document before buying anything.

Part	Vendor	PN	Price	Quantity	Total Price
37mm M4 Aluminum hex standoff	McMaster	95947A260	1.48	6	8.88
4-40 machine screws	McMaster	91251A831	10.32	1	10.32
M4 16mm threaded stud, pack of 10	McMaster	93805A256	5.46	2	10.92
Music wire torsion spring	McMaster	9271K642	6.13	1	6.13
Brass heat set 4-40 threaded insert	McMaster	93365A122	11.48	1	11.48
3/8" D shaft potentiometer	Digikey	CT3062-ND	2.80	3	8.40
tactile buttons	Digikey	CKN9087CT-ND	0.28	2	0.56
Hat switch	Digikey	JS5208	2.42	1	2.42
Pro Micro - 3.3V/8MHz	Sparkfun	DEV-12587	15.96	1	15.96
6' micro usb cable	Sparkfun	CAB-10215	4.95	1	4.95
3’ 10 wire ribbon cable	Sparkfun	CAB-10649	0.95	1	0.95
Traxxas Rod ends	Tower Hobbies	LXKMD6	6.99	1	6.99
TOTAL					56.7801

Notes

- Although not required, it is a nice upgrade to replace the music wire torsion springs with the equivalent stainless steel spring. (McMaster PN 9287K222). Be aware that while the normal torsion springs come in a pack of 6, the stainless steel springs come individually, so remember to buy 3.
- If you choose to 3D print the push rod linkages, you can exclude the 6-32 standoffs and threaded rod, but you will still need the Traxxas rod ends.
- There is some room for customization on the length of the standoffs. If you would prefer the device to be shorter you can use 1.5” standoffs.
- The buttons and hat switches are all up to you to configure to your own liking. You can buy whatever you want here.

Additional materials

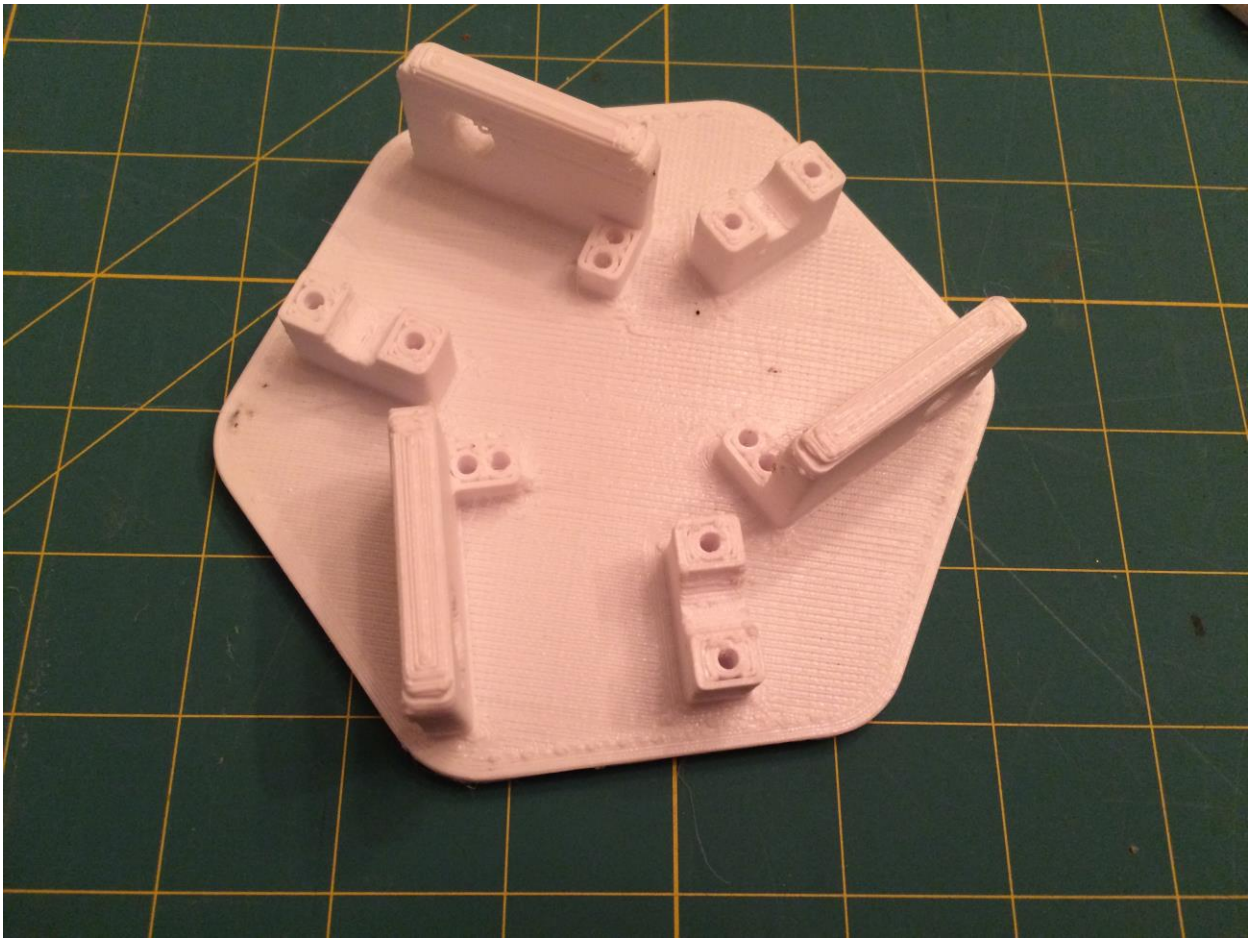
- 5 Minute epoxy
- Super glue
- Double sided tape
- 3D printer filament – high quality (strength)

Required tools

- 3D Printer
- Hand drill
    - 3/8” drill bit
    - 0.141” (#26) drill bit
- Soldering iron – fine tip is best
- Sand paper – medium grit, for smoothing out 3d print bearing surfaces

Printed Parts

I printed my parts from T-Glase and Colorfabb XT. These are both excellent filaments and very strong, but I am sure the design would work just as well with PLA or ABS.



Base:

The base piece is probably the most challenging part due to the large flat bottom. Even with PLA I saw some warping. If you don’t have a heated bed you might struggle with this piece a bit. The settings listed below are what I used, but they are tuned for maximum print speed, so I would recommend a 0.2 or 0.1mm layer height, and infill up to 70% for maximum part quality. This is the largest part with a

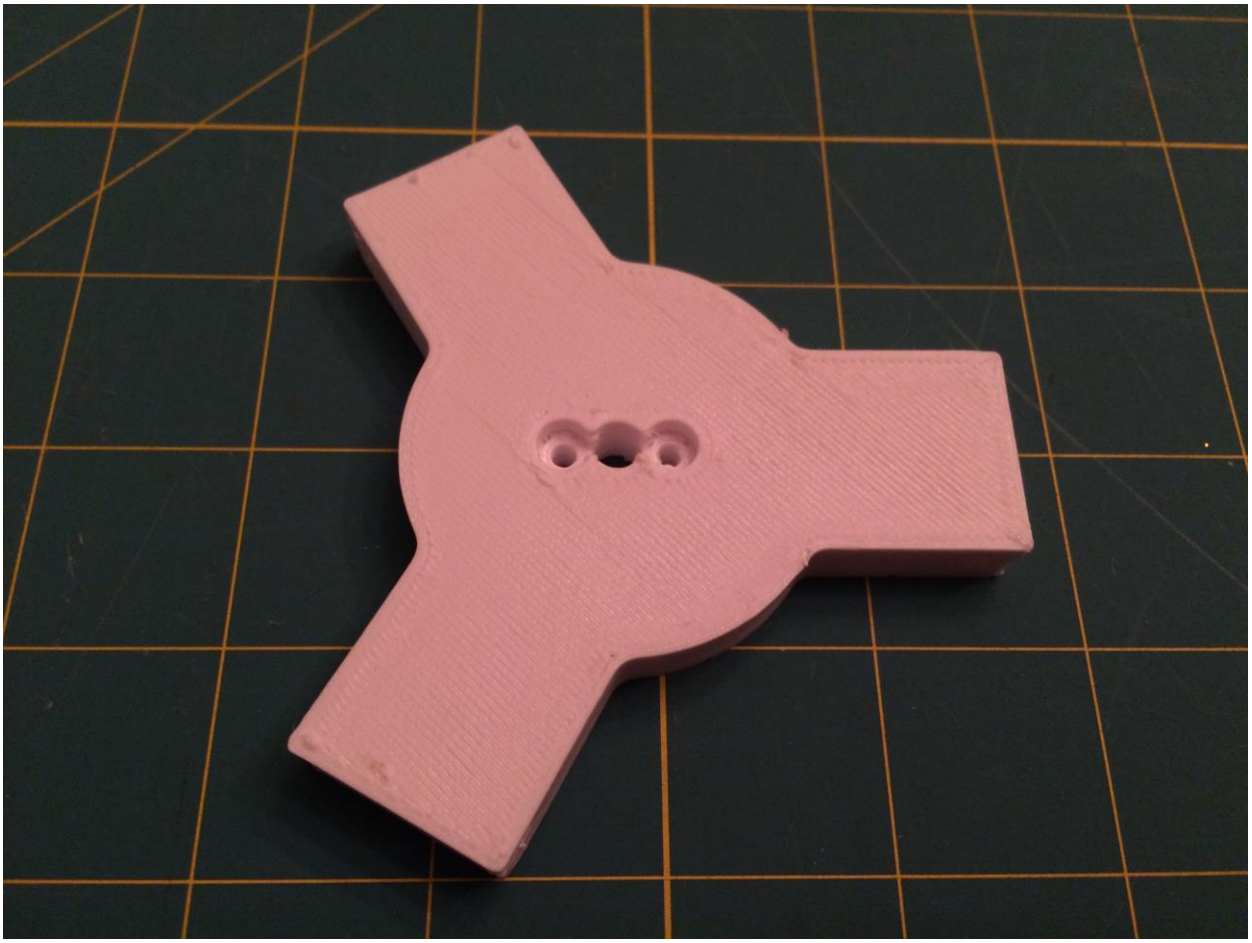
diameter of 5.25”. If you print with low infill to increase speed, increase the number of perimeter layers to 4 or 5 to increase strength.

- Filament: Colorfabb XT
- Layer height: 0.3 mm
- Infill: 30%

Pivot arms:

The pivot arms are printed in two pieces and glued together with epoxy. Layer height doesn’t matter so much, but be sure to use high infill. This is probably the most critical piece for strength and rigidity. I recommend printing all three sets at a time to give adequate cooling time. A useful trick for this piece is to have the potentiometers ready when the print finishes, and stick them into the d-shaft hole while the print is still warm. It wasn’t necessary for me but it could be useful.

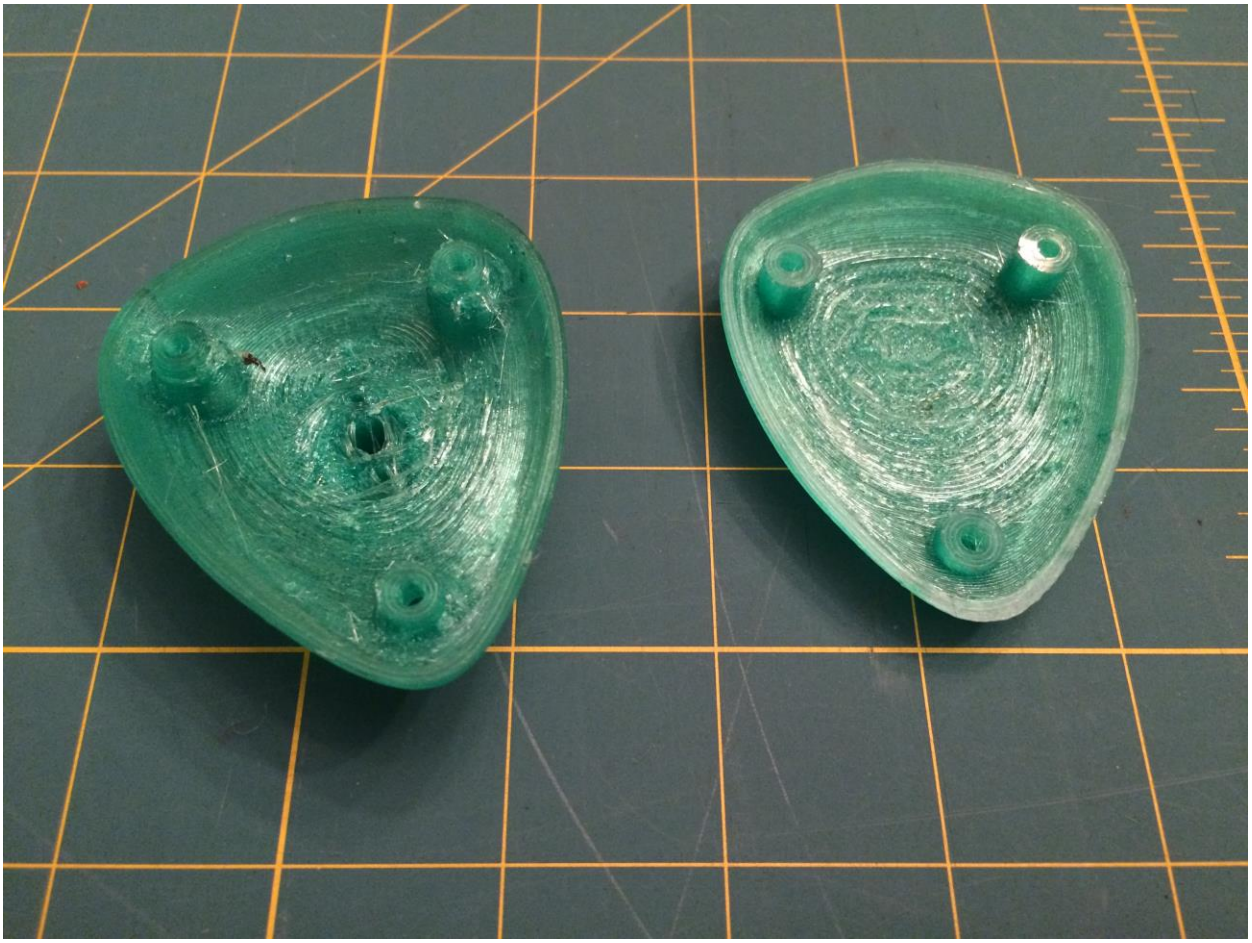
- Filament: T-glase
- Layer height: 0.3 mm
- Infill: 70%



Handle base:

Make sure you print this part in the orientation shown so no support is required for the clearance holes. Print with high infill, but the layer height is not critical. This is a pretty simple part.

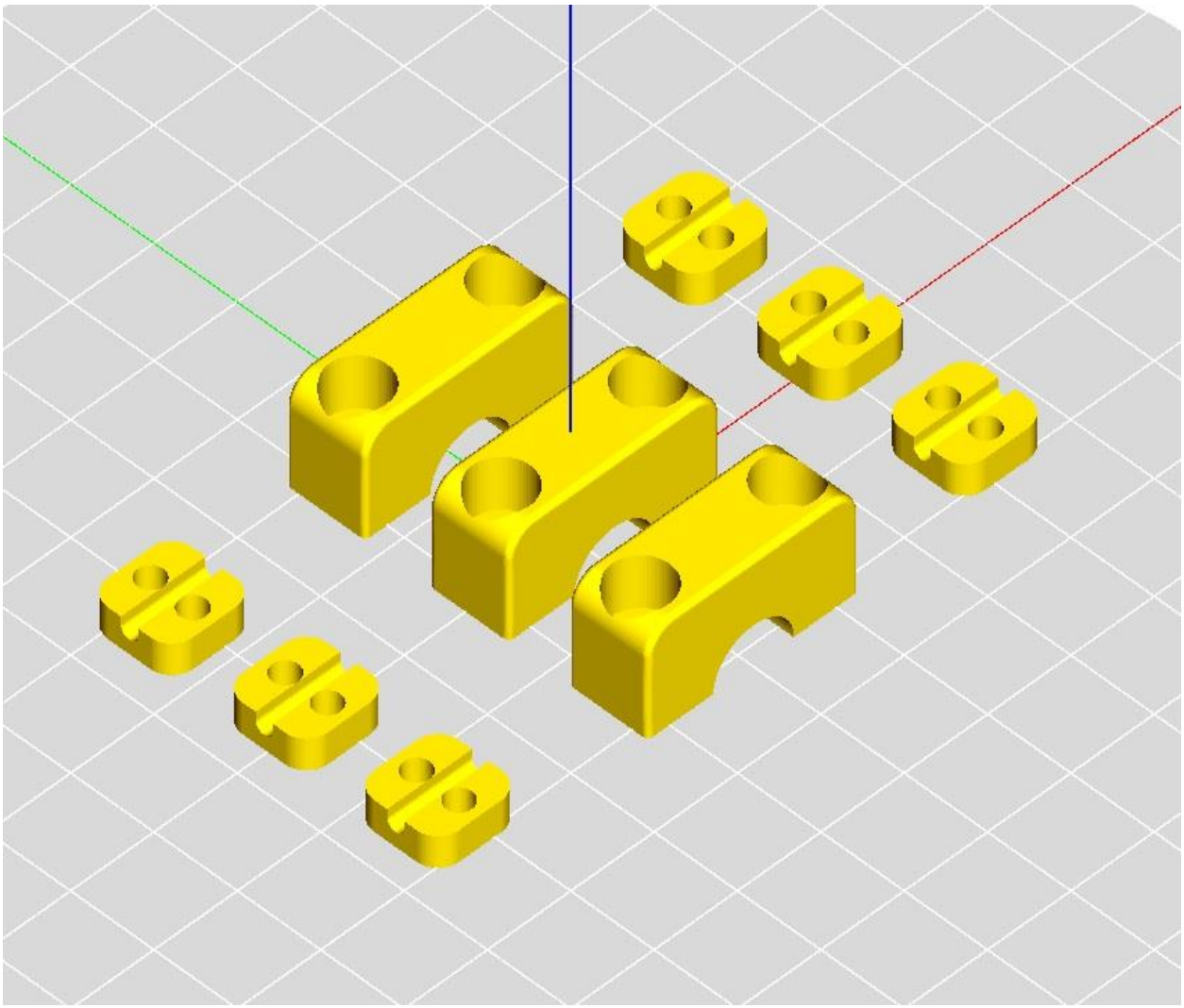
- Filament: Colorfabb XT
- Layer height: 0.3 mm
- Infill: 70%



Handle pieces:

Print these at 100% infill and 0.1mm layer height. Print them in the orientation shown in picture 2, so the support material is on the inside. Layer height shown is 0.2mm but I recommend finer if you have time.

- Filament: T-Glase
- Layer height: 0.1 mm
- Infill: 100%



Small Parts:

Print in the orientation shown (arrangement doesn't matter). Print at maximum quality because the parts are all small.

- Filament: T-Glase
- Layer height: 0.1 mm
- Infill: 100%

Linkages (optional):

This can be a challenging part. The idea is to take the swivel balls out of the traxxas rod ends and insert them into these parts. I printed them in PLA for rigidity, but a different polymer might be easier to press the swivel balls in to so there is a bit of a tradeoff. The hole dimension is very critical so if your printer isn't just right you might need to scale the print slightly. Measure the swivel balls with calipers and compare to the inside of the hole to determine how much to scale.

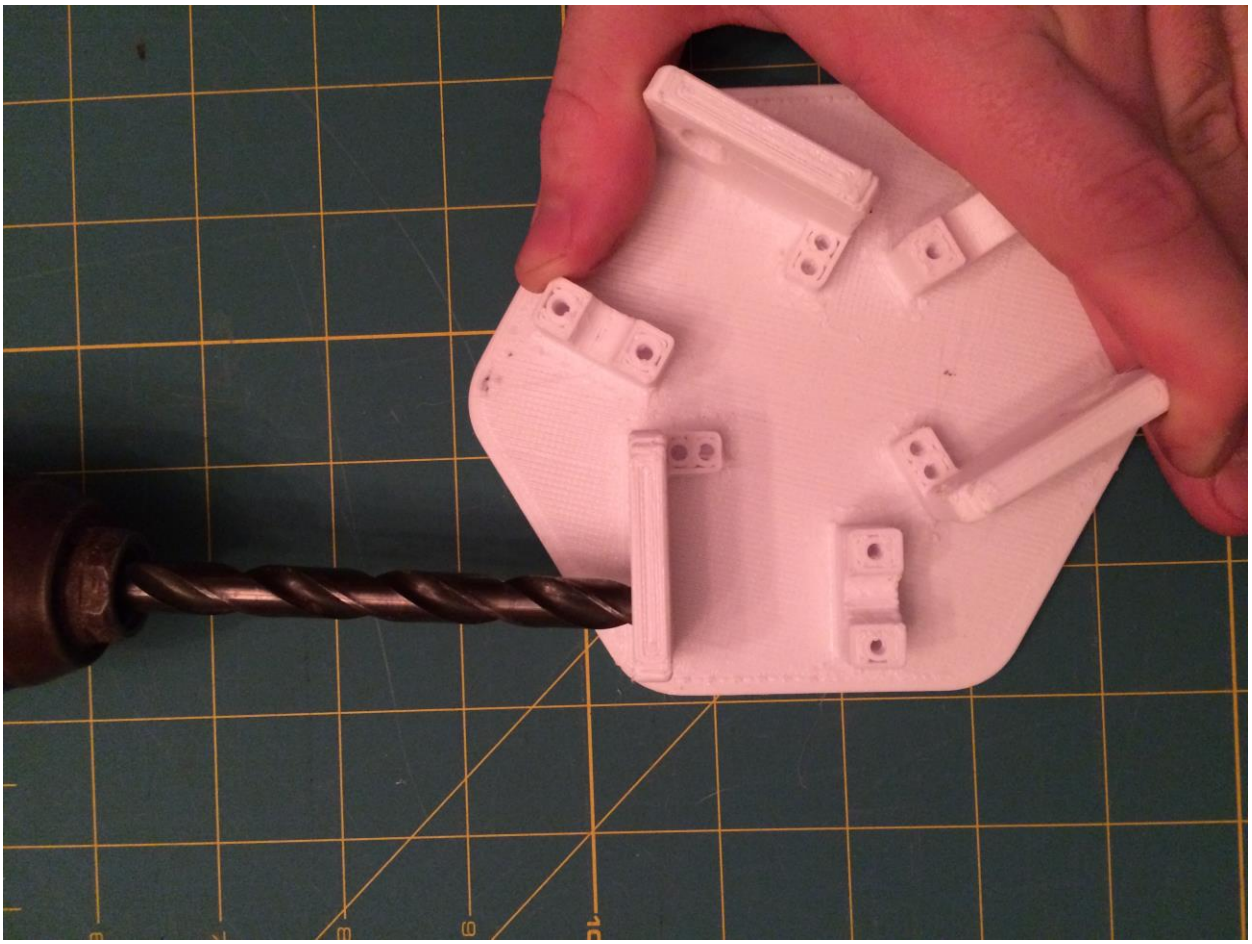
- Filament: PLA
- Layer height: 0.1 mm
- Infill: 100%

Mechanical Assembly

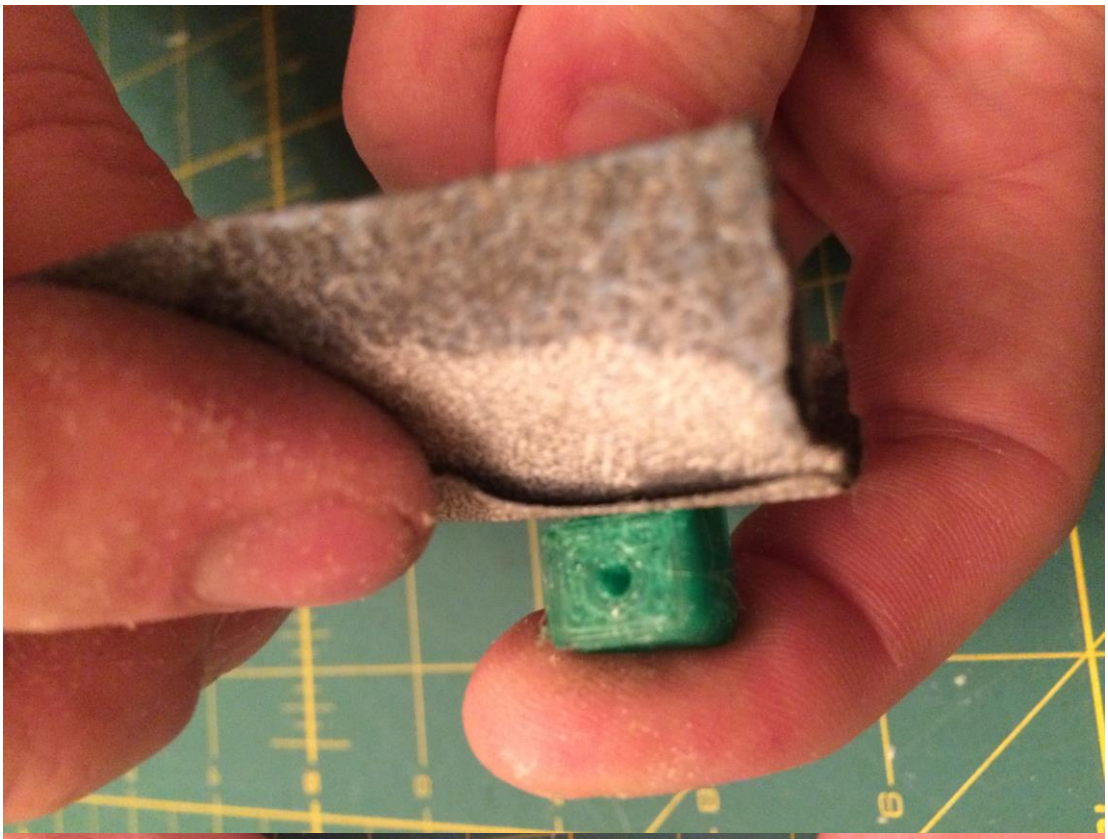
Cleaning up printed parts

1. Clean up any stringing or general printing defects. If you want to sand the handle or vapor smooth it you can do that, but don't do any kind of surface treatment that might alter the dimensions on the other parts.
2. Drill out all of the small holes with the 0.141" drill. Conveniently, this is about the right size for a 4-40 clearance hole as well as the hole for the threaded inserts Do not drill the pivot arms until after they have been glued together.

3. Drill out the potentiometer hole with the 3/8” drill bit. You can also use the drill bit to smooth out the semi-circle on the base and pivot arm holder.



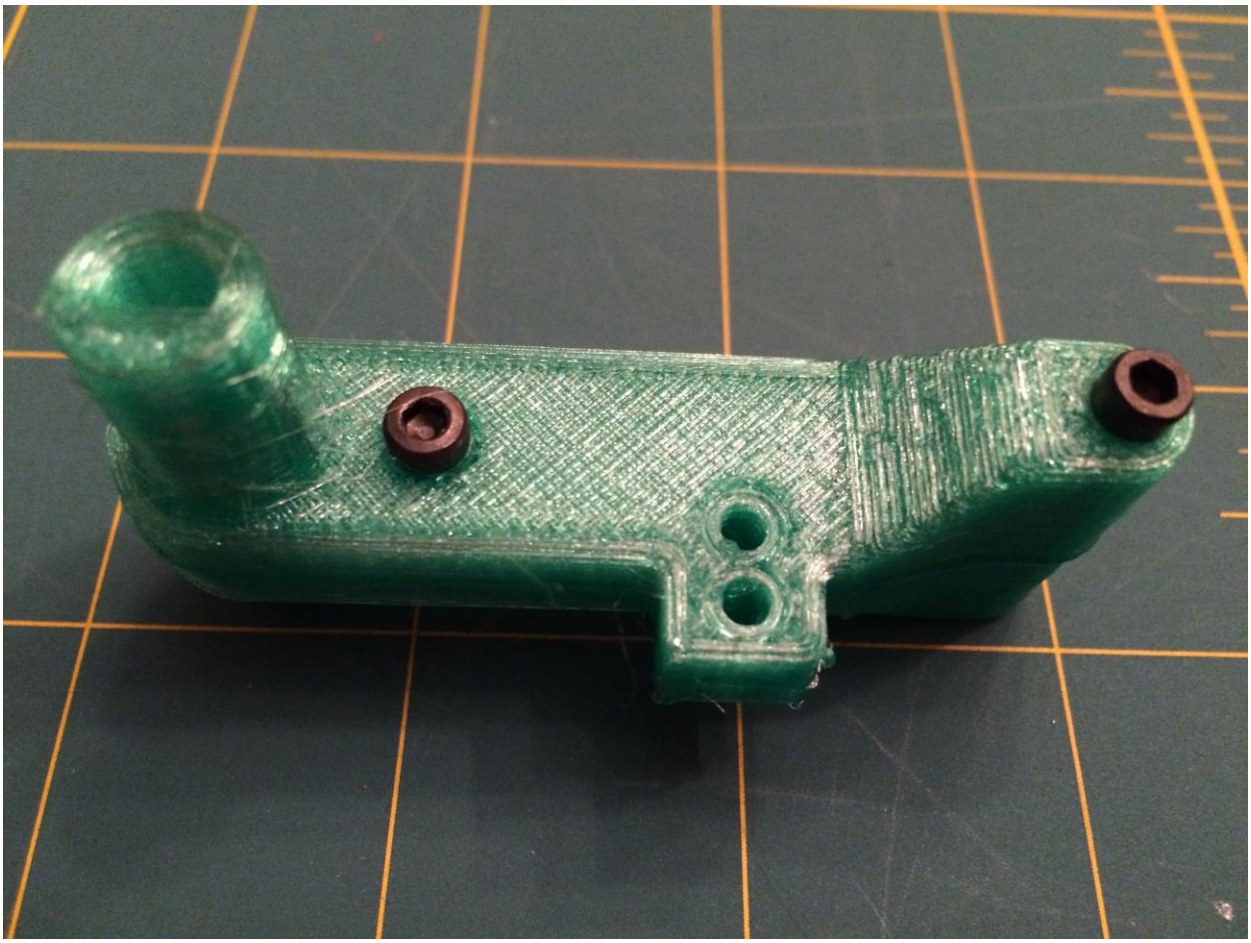
4. Lightly sand the bearing surface of the pivot arm, base, and pivot arm holder. Test fit them all together to verify the arm can pivot smoothly.



Gluing the pivot arms

Before mixing your epoxy, prepare a few 4-40 or M3 screws. You will need a 1” long screw and a 3/8” long screw to hold the pivot arm together while the epoxy cures. Mix up some 5 minute epoxy and spread it on the bottom of one half of the pivot arm assembly. Put the two halves together and screw them together as shown. These screws are temporary so you don’t need to worry about threaded inserts. It is best to let the epoxy cure for several hours before removing the screws, so it might be a good idea to have three sets of screws so you can complete all of the pivot arms at once.

If you print this part in ABS, you might try using acetone to glue the two halves together, but I have not attempted this.



Threaded inserts

The threaded inserts are heat set inserts. You will press the inserts in with a soldering iron. I found that a tip fine enough to fit inside the insert was very helpful

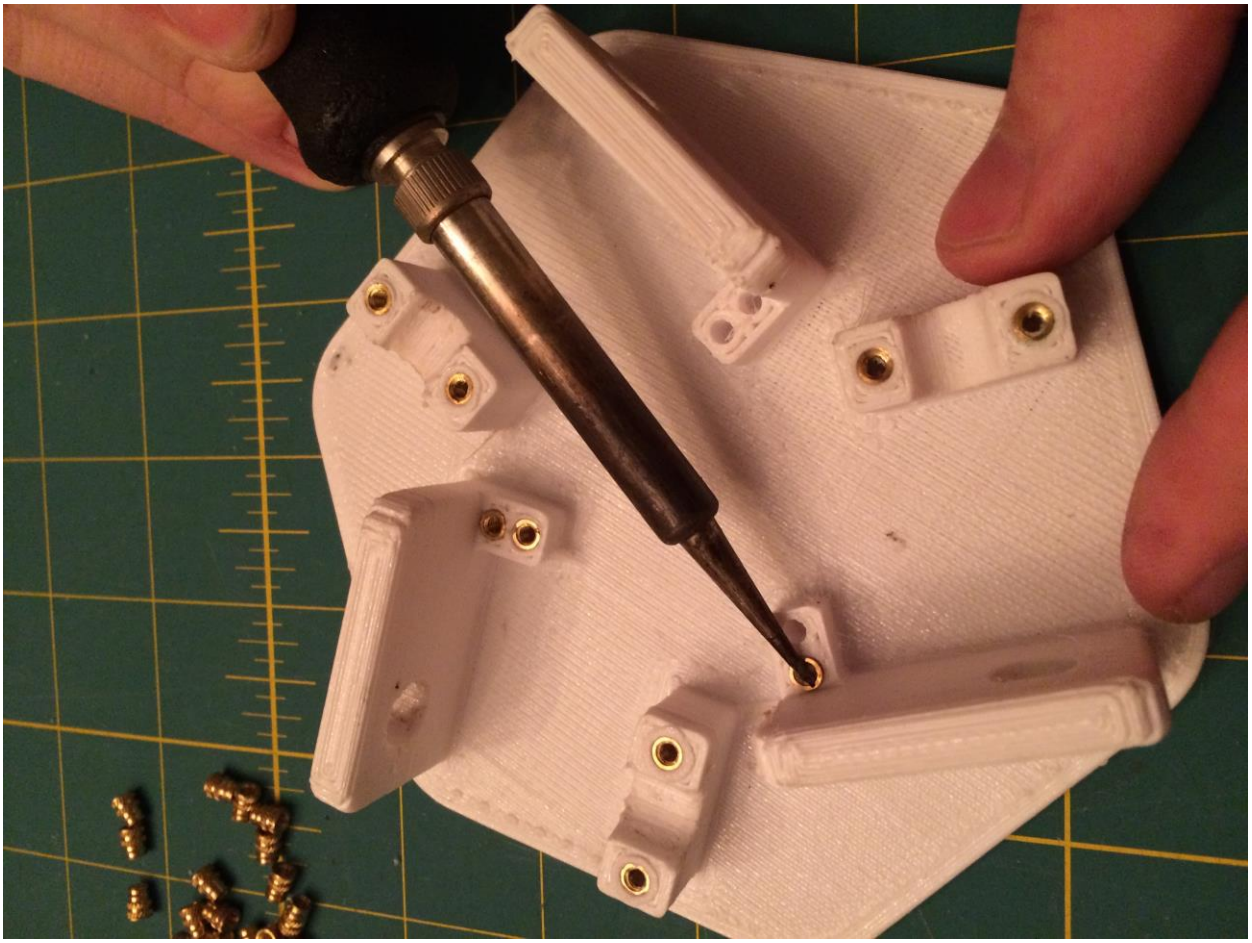
If you have a nice soldering iron you may want to switch to a different tip because you will get melted plastic on the tip, which is pretty bad for actual soldering. If you don't have any other tips, you can scrape the plastic off with a knife once it has cooled. Place the insert on the soldering iron like this and carefully press them in to the following holes. It will be helpful to have a small cold flat metal tool nearby to press the insert in flush with the plastic once you remove the soldering iron.

Base threaded inserts

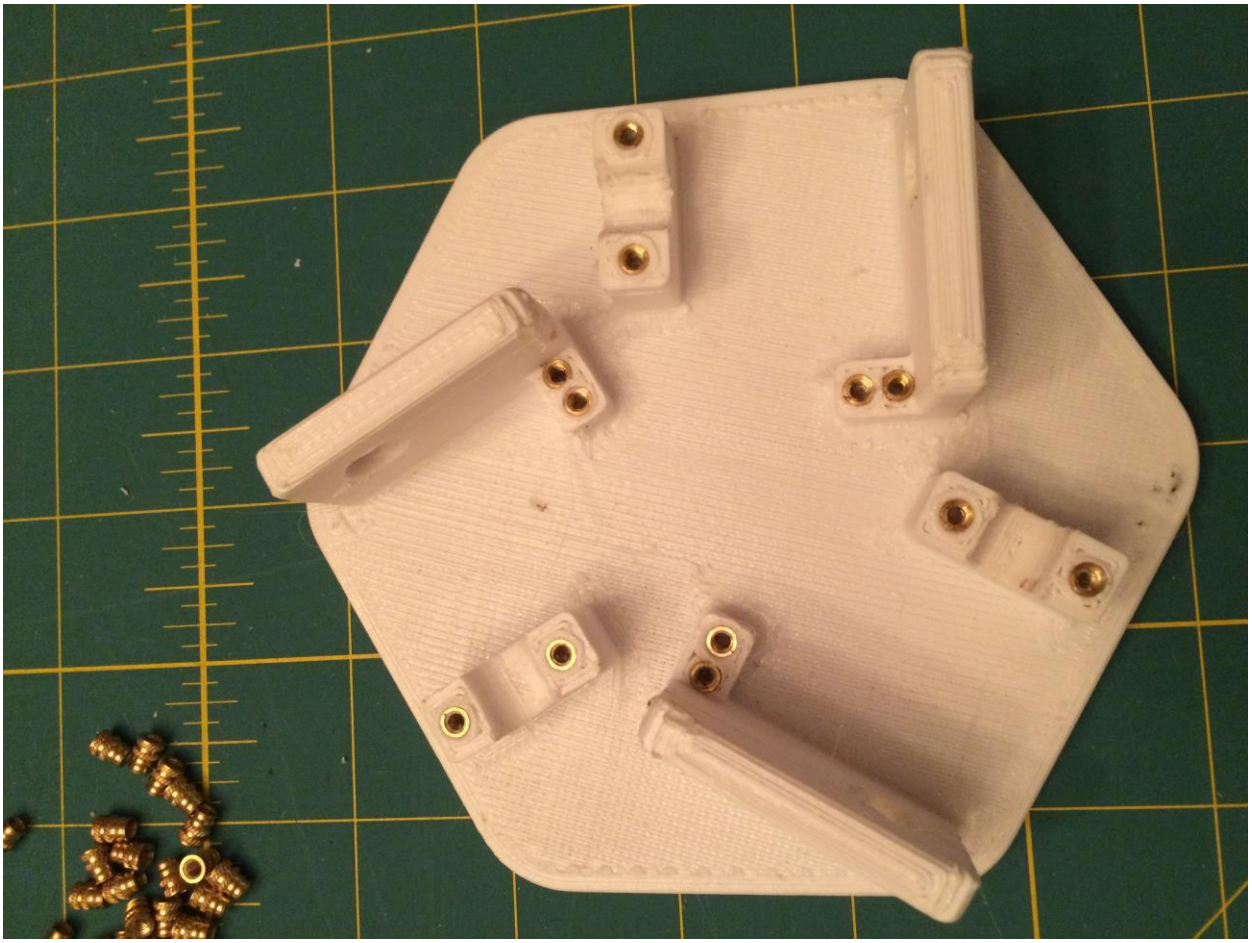
Beginning to press in the insert

Ready to remove the soldering iron

Using the top of a hex wrench to press the insert in flush with the plastic



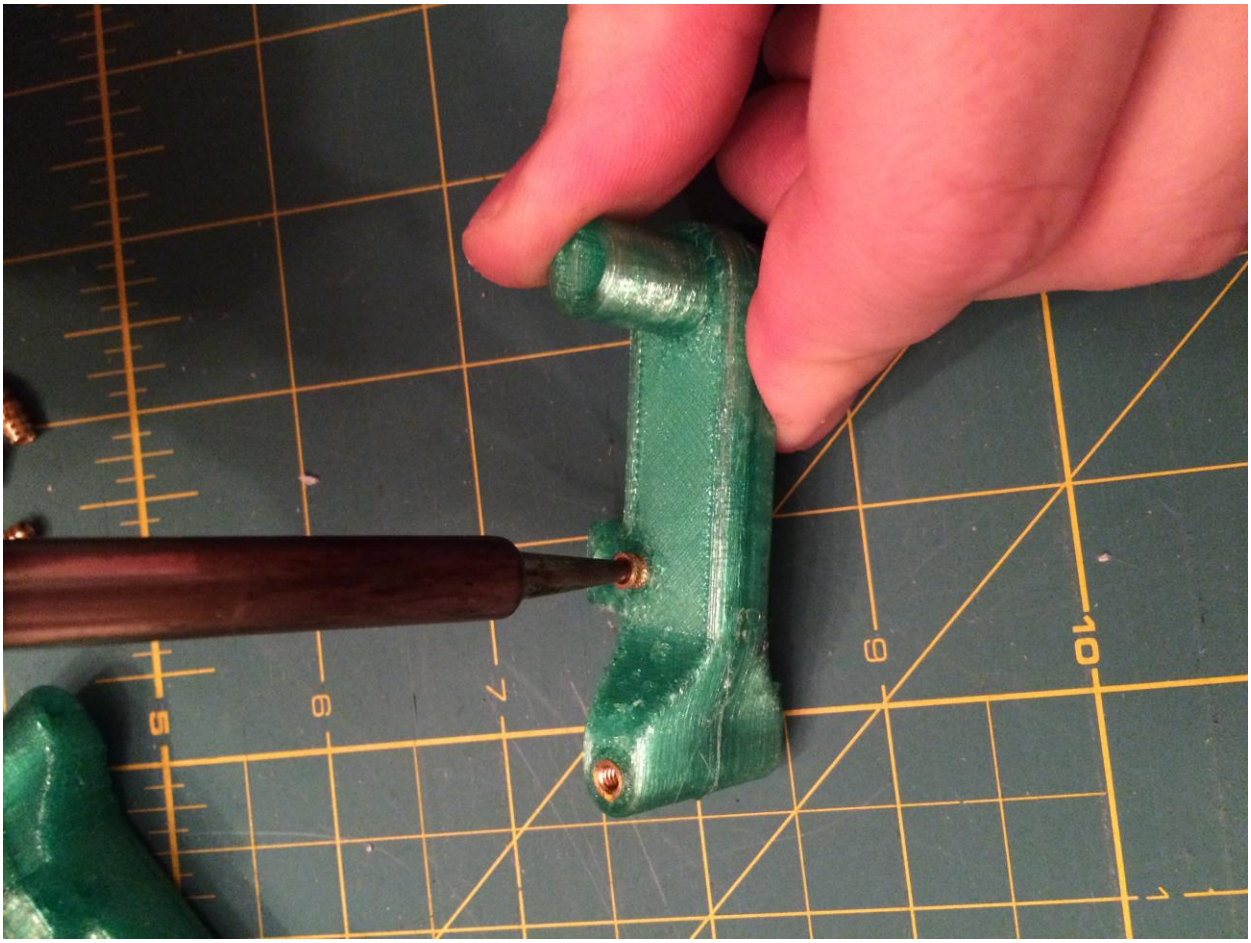
This particular insert requires holding the iron at a different angle



All inserts pressed in.

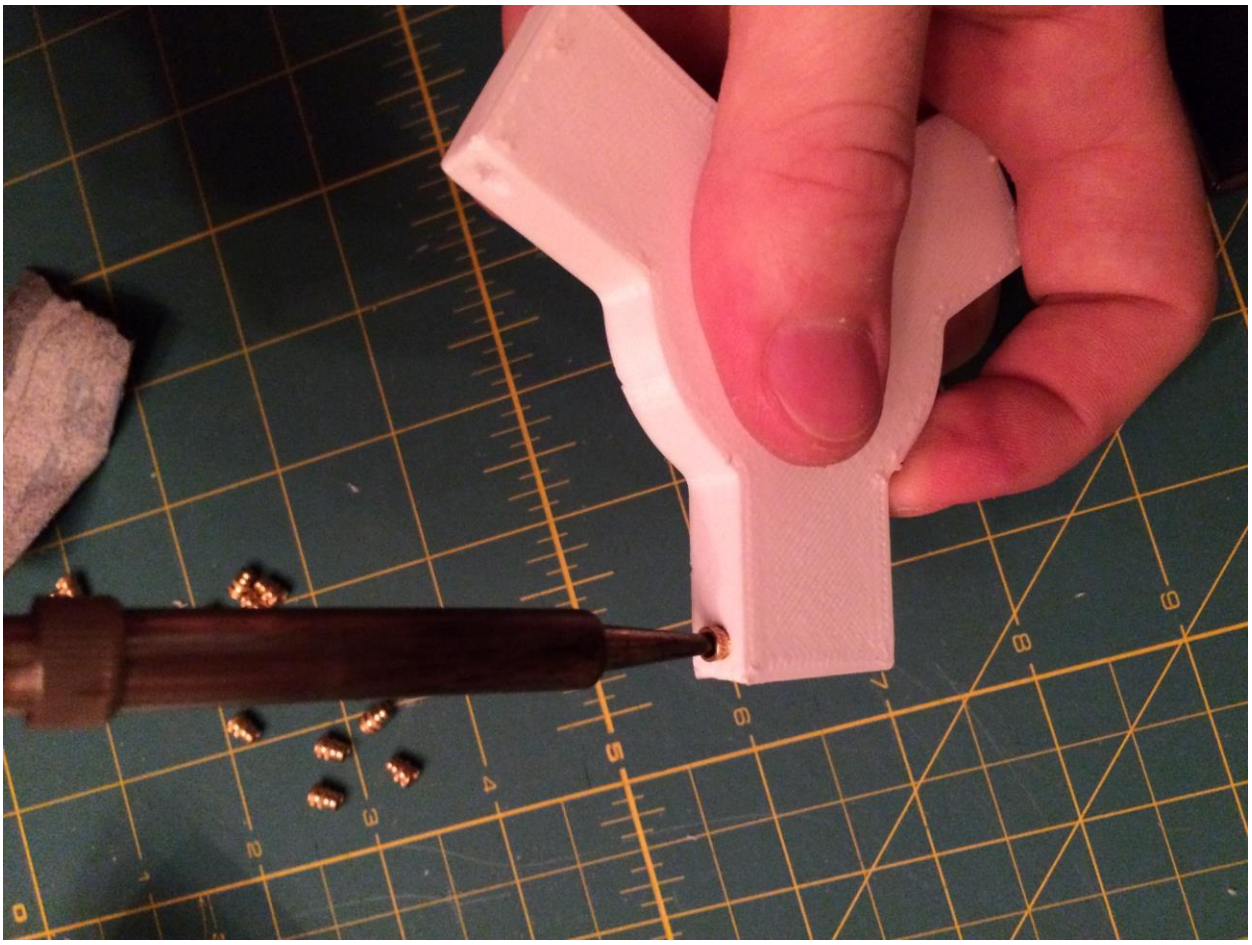
Pivot arm threaded inserts

Press an insert into each side of the top of the arm.



Press an insert into the spring clip. Make sure you press the inserts onto the side with the slot for the potentiometer D-shaft.

Handle bottom threaded inserts



Press six total inserts into each hole in the handle base.

Handle middle inserts

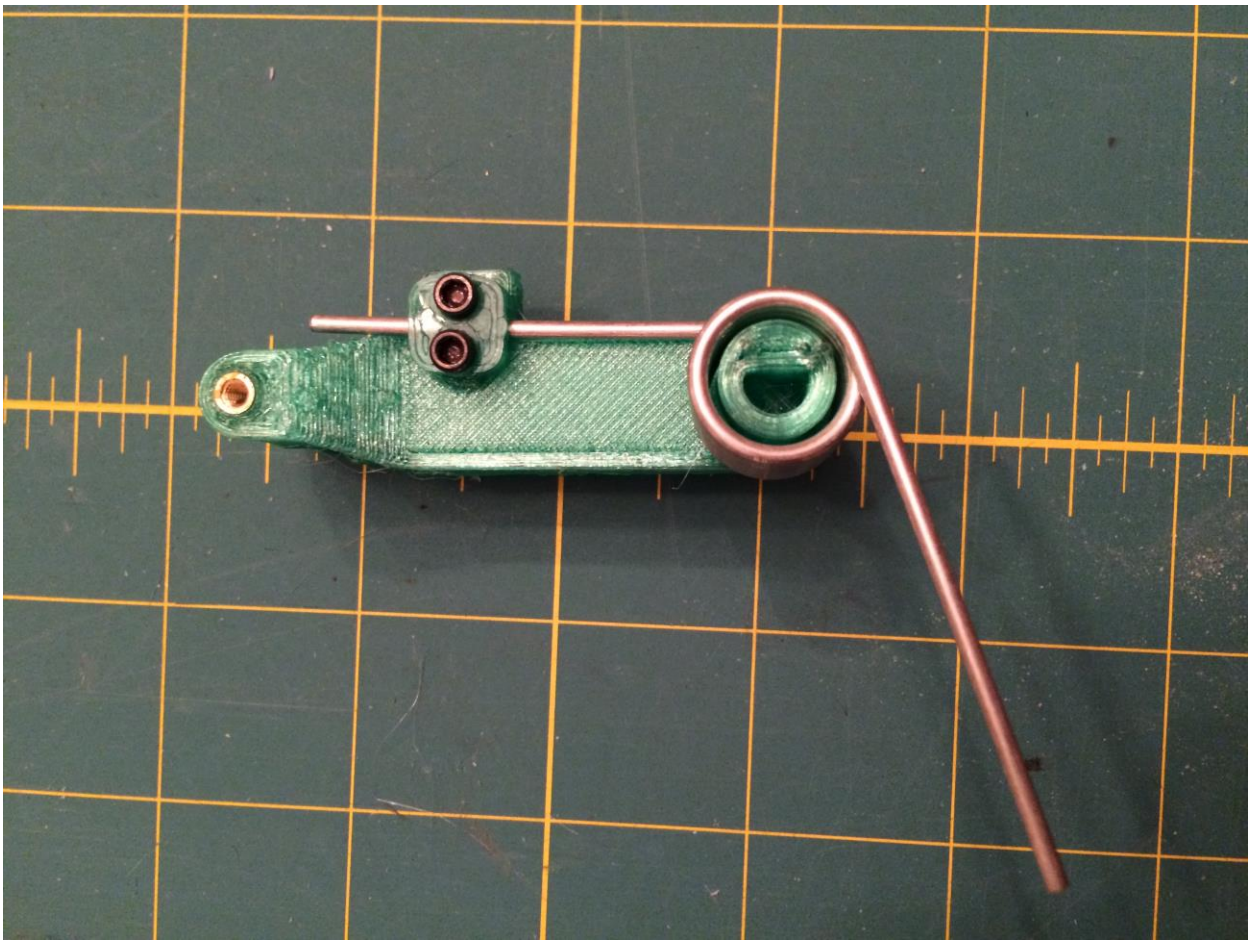
Press two inserts into the bottom of the handle middle piece. Do not press inserts into the three other holes.

Handle top inserts

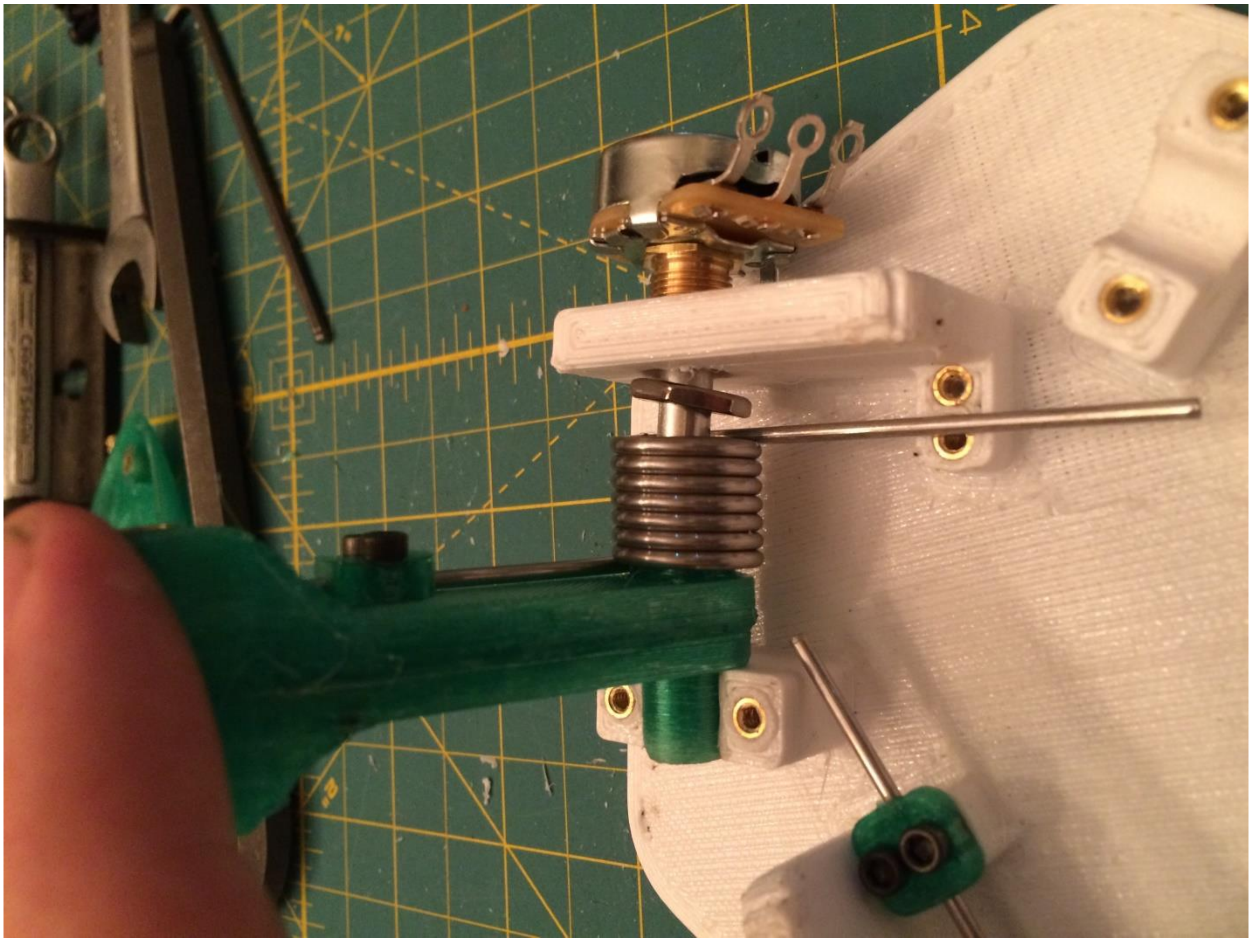
Press inserts into all three holes in the handle top.

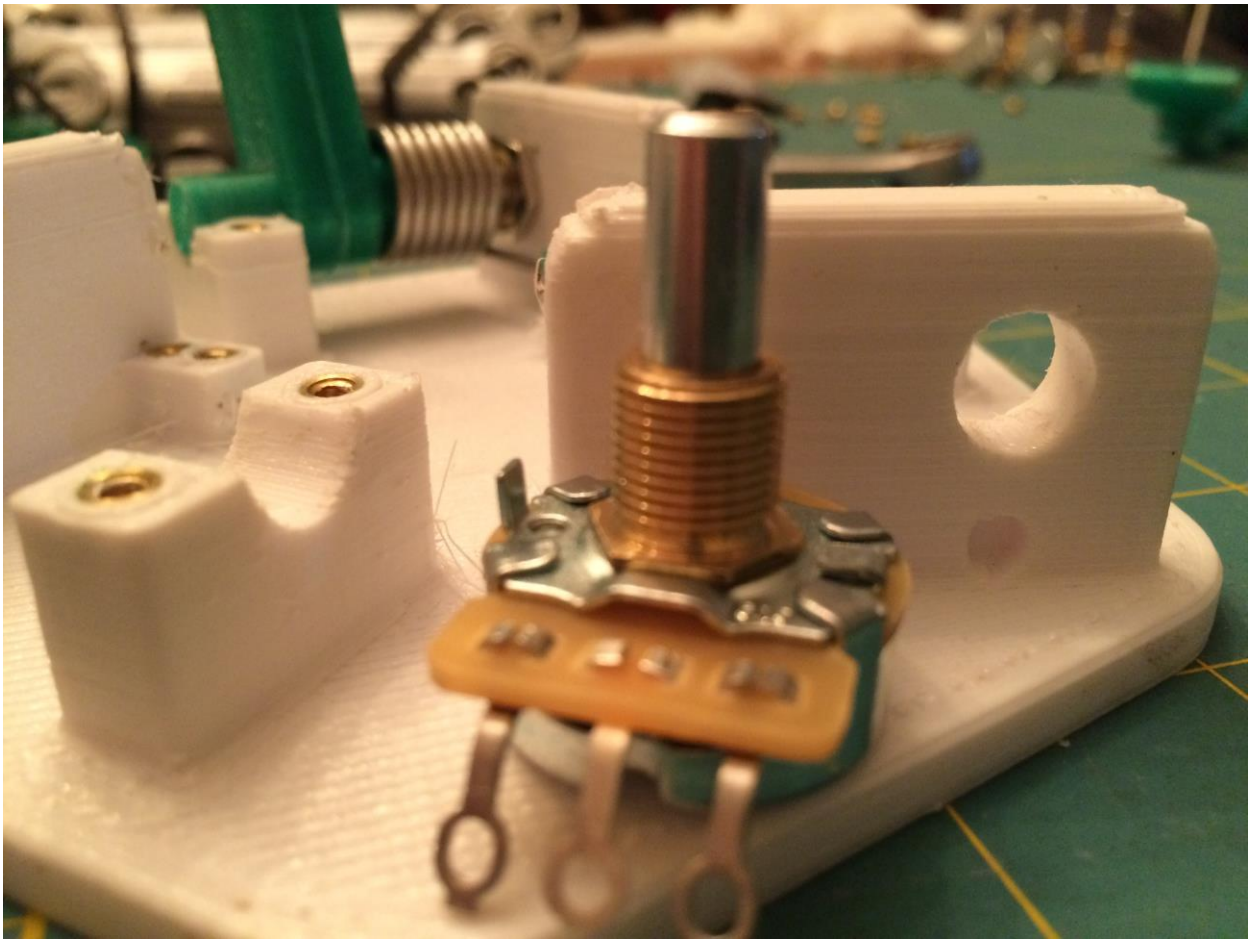
Pivot arm assembly

1. Put a spring around the D-Shaft side of the pivot arm, and attach with a clip. Make sure that the spring loops are centered around the shaft.

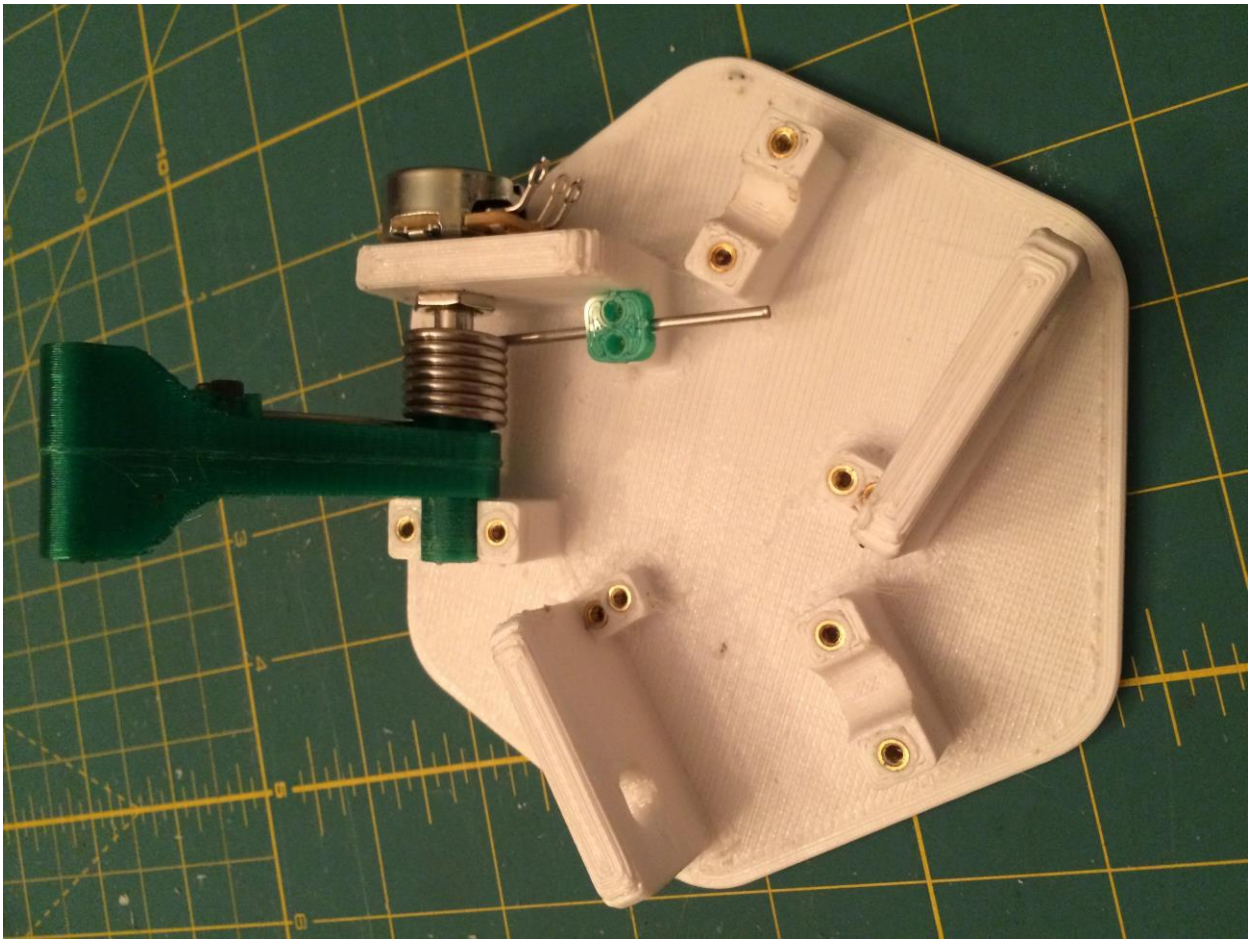


2. Place the pivot arm in position with one of the nuts that came with the potentiometers. Slide the potentiometer through the hole, through the nut, and into the slot in the pivot arm.

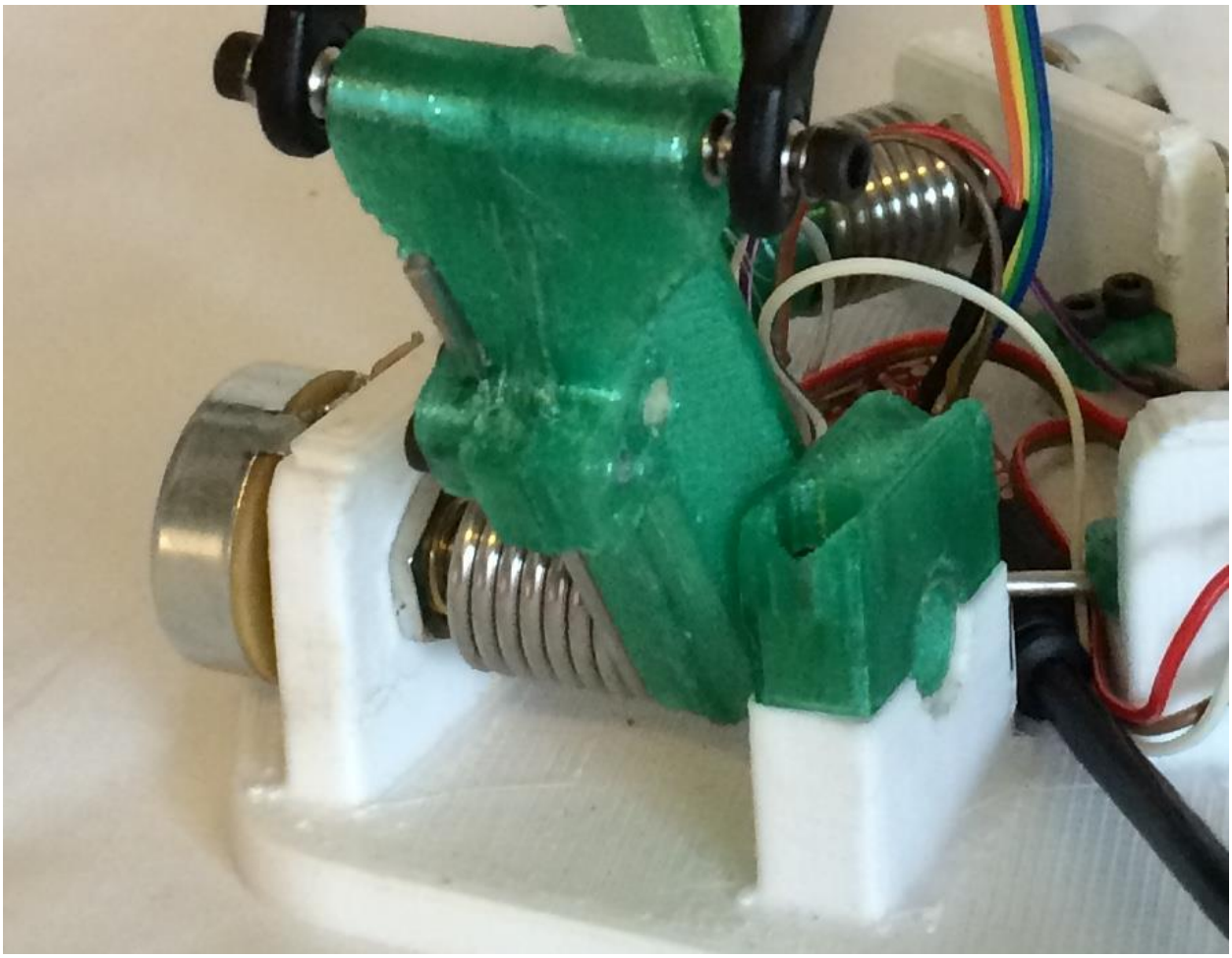




Make sure the tab on the potentiometer fits into the small hole in the base.



3. Tighten the nut on the potentiometer to hold it in place.
4. Attach the other side of the spring with a clip.
5. Screw down the pivot arm holder do the desired tightness



Repeat for the other two pivot arms.

Push Rod Assembly

Metal push rods

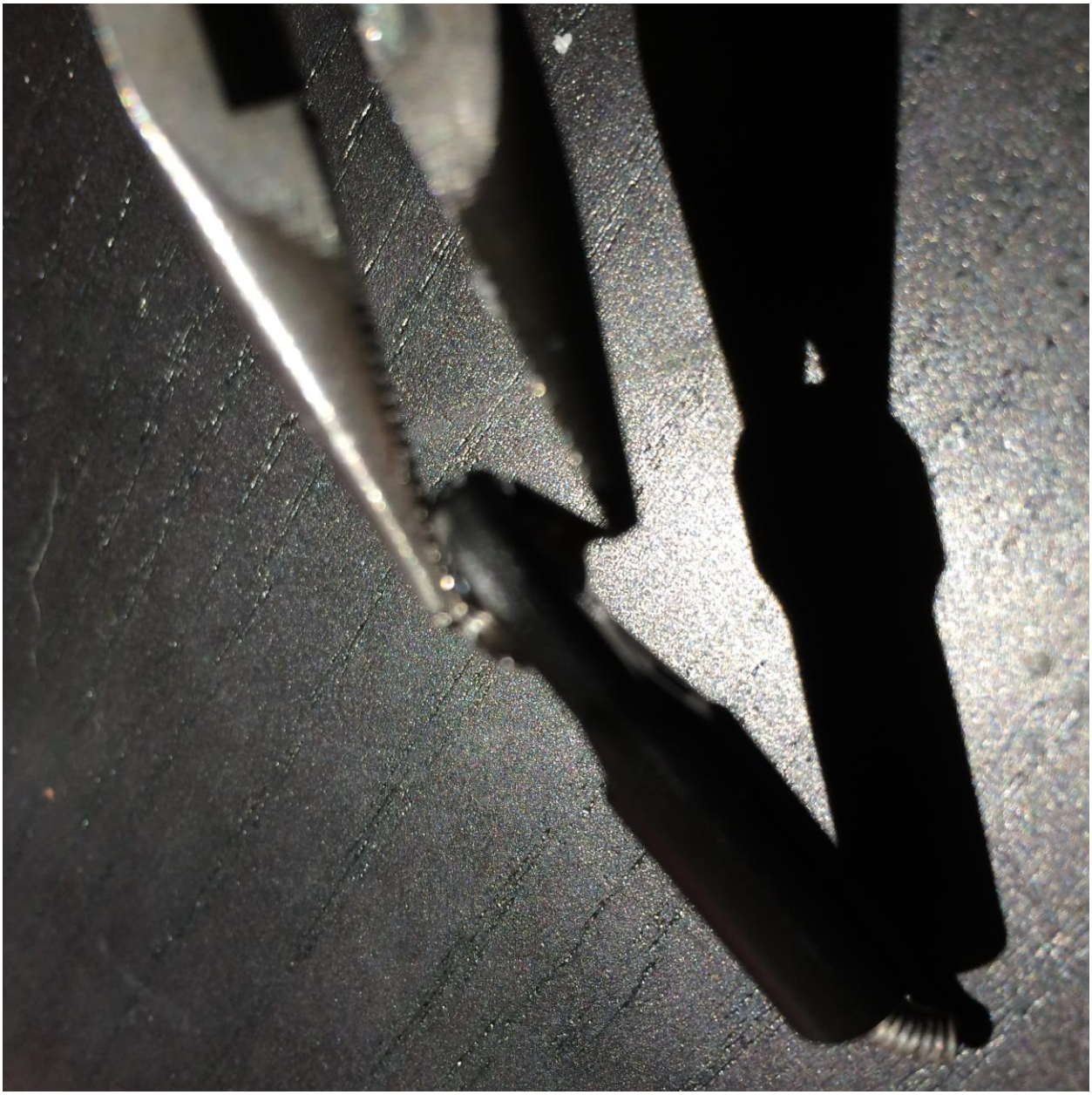
1. Screw a threaded stud into each side of the hex standoffs. You should apply a little Loctite or epoxy to the threaded stud so it doesn't come out.

2. Screw the rod ends onto each stud. Make sure they are lined up with each other. Again you can put a little epoxy on the stud to keep it from rotating.

Printed push rods

This option will be cheaper if you can get it to work, but requires a well calibrated printer.

1. At first print just one push rod because you will likely need to adjust the size slightly.
2. With a drill or knife, lightly drill the bottom side of each hole. The goal is to simply soften the edge, not drill all the way through. The interior of the hole is spherical to hold the swivel ball, and if you drill all the way through the swivel ball will fall out.
3. With a pair of pliers remove the swivel ball from the traxxas rod end.

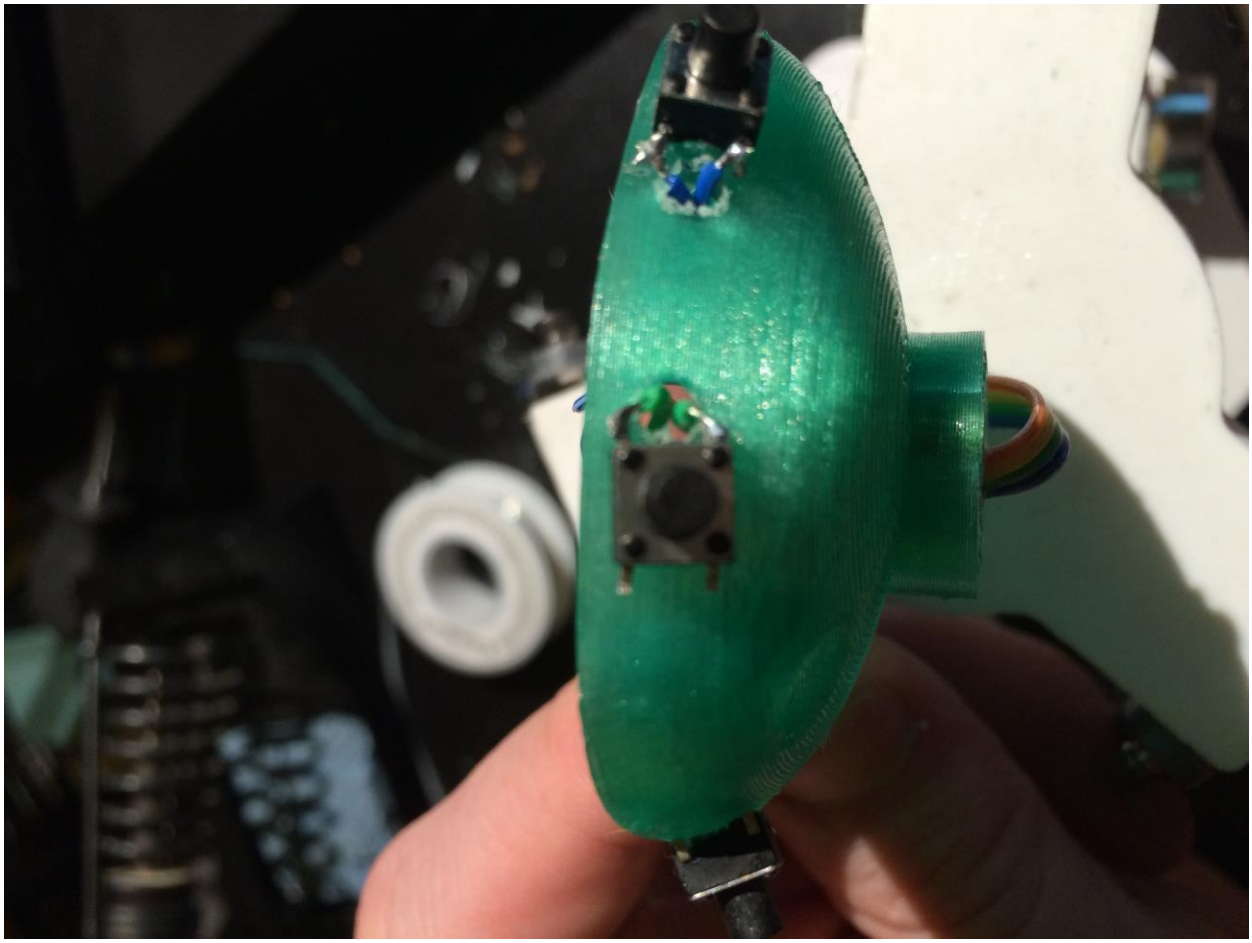


4. Press the ball in to the end of the plastic push rod. It should be able to rotate freely, if it can't, scale the print up slightly and print again.

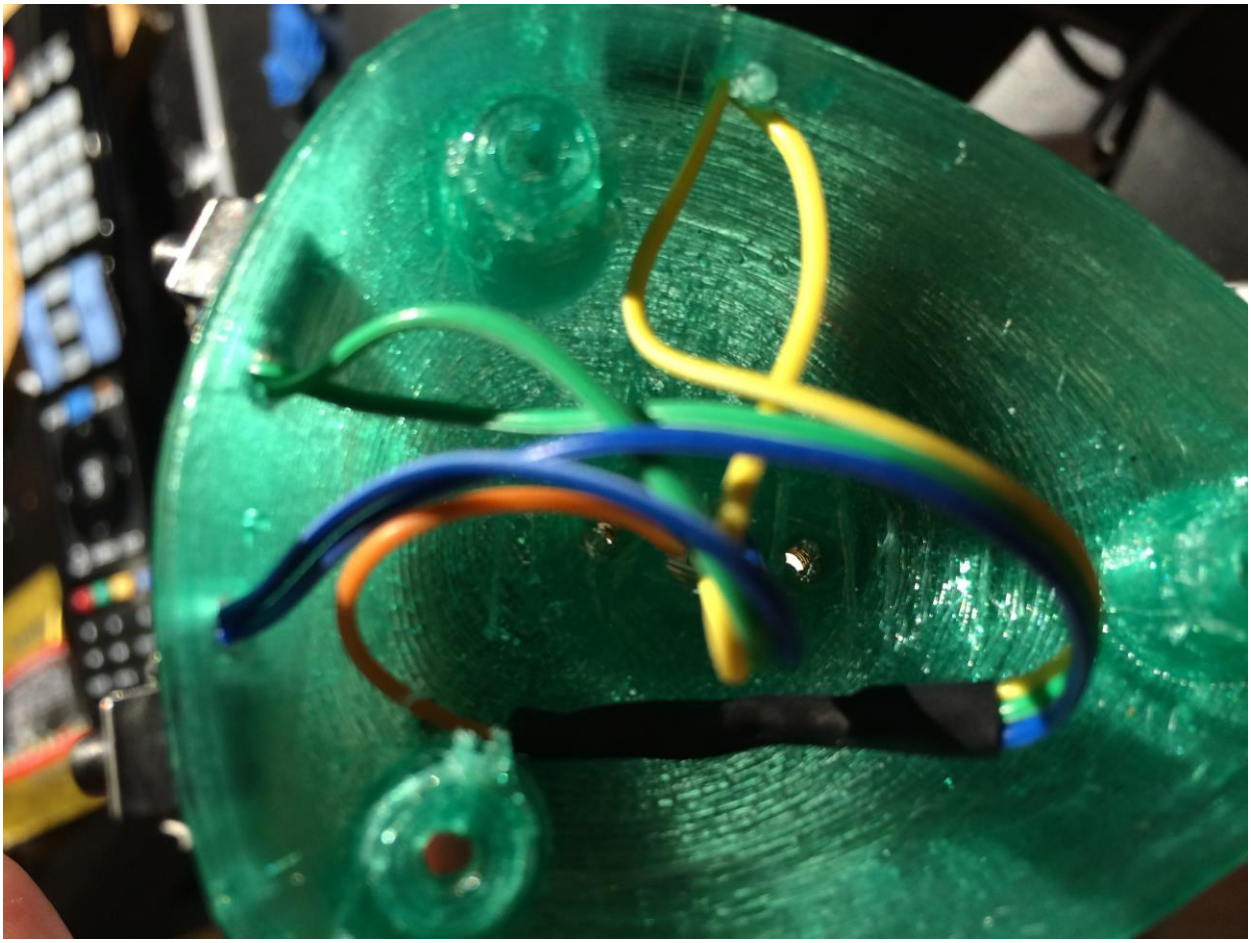
Handle Assembly

1. Determine where you will glue your buttons, hat, etc. to the bottom of the handle. The microcontroller board has room for 14 additional digital signals and 1 additional analog signal. I chose three buttons, but two buttons and a hat would also work well. The hat listed above has 5 digital signals, four directions plus a center click.

2. Drill small holes for the button wires.



3. Prepare a 14” ribbon cable with a wire for each button, plus a common wire. Ie. For 3 buttons, a 4 wire ribbon, for two buttons and a hat, an 8 wire ribbon. Solder each wire to a button. Inside the handle, solder a second wire to each button, and solder all of those wires together with the common wire. Refer to the electrical diagram and picture below for more details.



Shown in this picture are the three signals wires in blue, yellow, and green. Each button has two wires going in, one set runs down to the microcontroller, and one set combines into the orange common wire, which goes to ground.

4. Super glue the ribbon cable to the inside bottom of the handle to secure it in place.

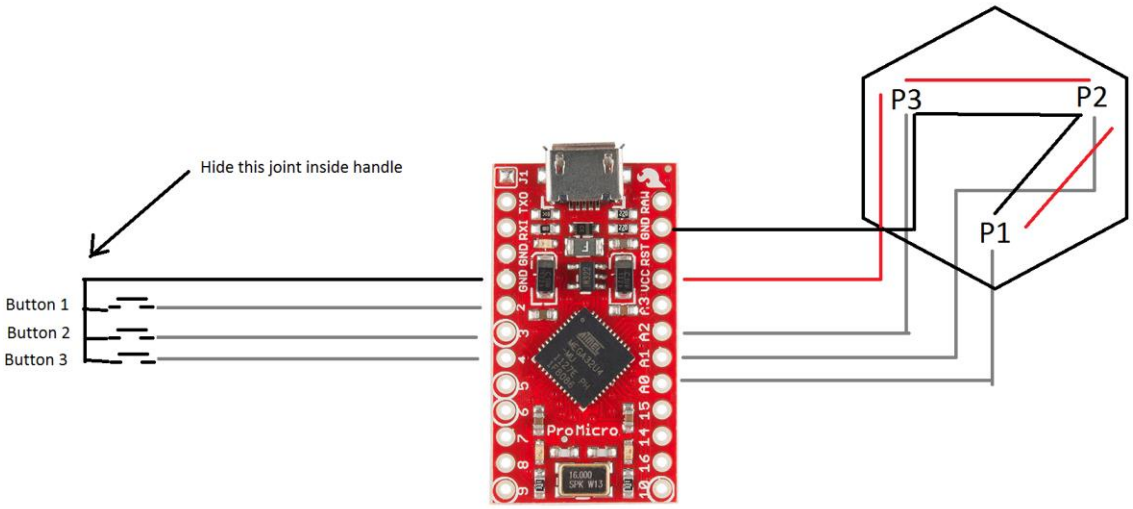
Final Assembly

1. Screw the handle on to the handle base plate.
2. Screw the push rods on to the handle base plate
3. Screw the push rods on to the pivot arms.

Hopefully when you are all done it looks like this (without the wires)

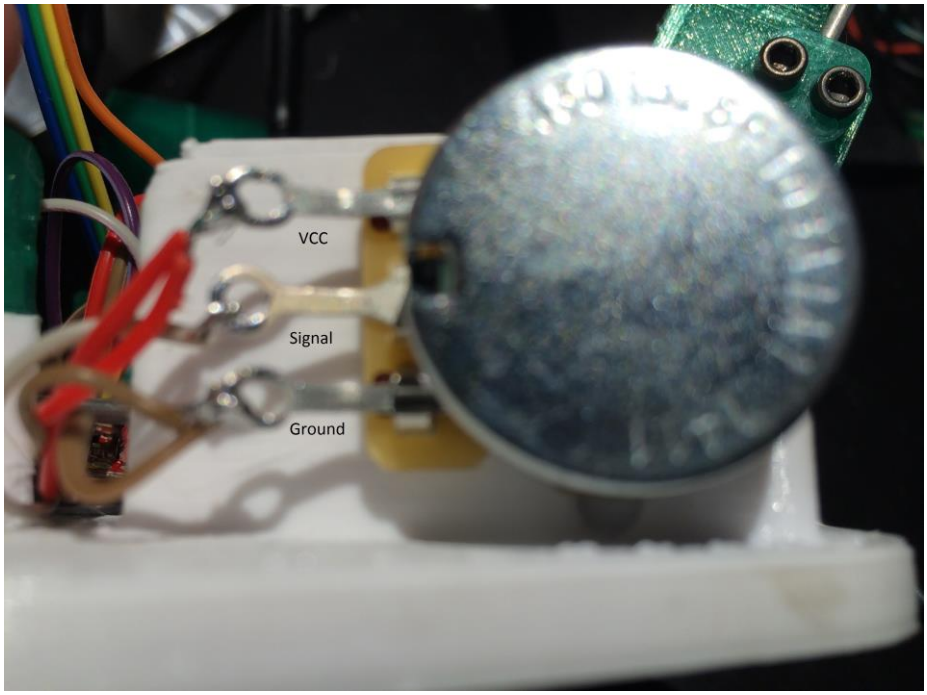
Electrical Assembly

Basic wiring diagram



1. Wire all of the buttons in the handle.
2. Wire power and ground to each potentiometer. The wiring will be cleanest if you daisy chain them. With the potentiometer mounted to the base, the top pin is VCC, the middle is the analog signal, and the bottom is ground. The drawing above shows which potentiometer is wired to which input.

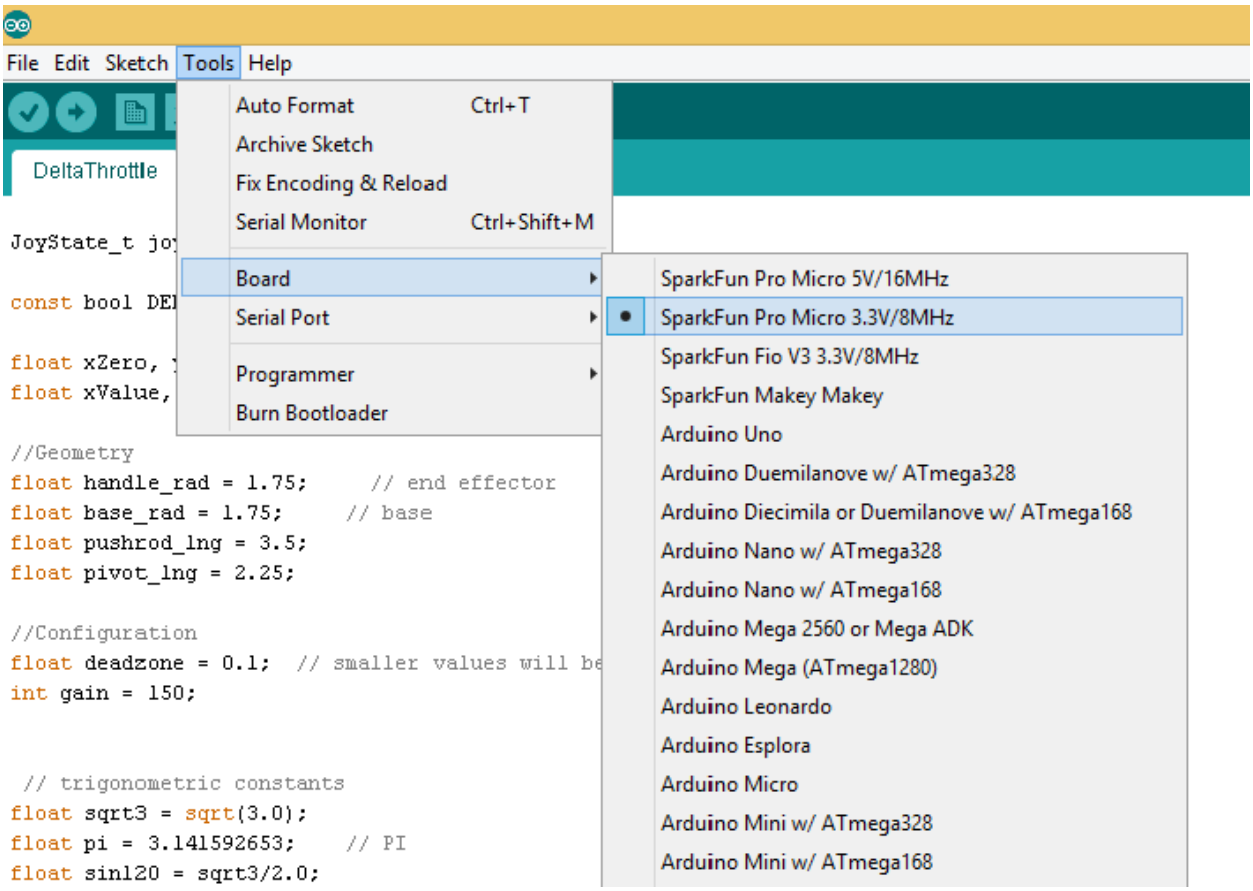
   P1 -> A0, P2 -> A1, P3 -> A2



Programming

1. Follow the instructions from spark fun to install the Arduino software and drivers. https://learn.sparkfun.com/tutorials/pro-micro--fio-v3-hookup-guide

2. In the code folder you will see “HID.cpp”, “USBAPI.h”, and “USBCore.cpp”.
3. Navigate to “C:\Program Files (x86)\Arduino\hardware\arduino\cores\arduino” or the equivalent depending on where the Arduino software is installed.
4. Back up the original “HID.cpp”, “USBAPI.h”, and “USBCore.cpp” to a different folder.
5. Copy the new “HID.cpp”, “USBAPI.h”, and “USBCore.cpp” into the folder.
6. Open the DeltaThrottle folder, and open DeltaThrottle.ino
7. Select Tools>Board>Sparkfun Pro Micro 3.3V (or 5V if you bought that version)



8. Select the correct serial port and upload the code

Credits

Metanurb for his instructable on how to make a joystick with the Pro Micro

http://www.instructables.com/id/Add-a-little-two-analog-axis-thumb-joystick-to-you/

mzavatsky on the trossen robotics forums for the explanation of delta robot kinematics

http://forums.trossenrobotics.com/tutorials/introduction-129/delta-robot-kinematics-3276/