

Backyard Brains Manipulator Building Instructions

Materials Needed:

The printed parts (go to <http://www.backyardbrains.com/products/micromanipulator>

11 6-32 Hex Nuts ([Grainger Part #2GA55](#))

one 4 inch 6-32 fasteners ([Grainger Part #1MY76](#))

two 3 inch 6-32 fasteners ([Grainger Part #1MY75](#))

four 2/56 Hex Nut ([Grainger Part #2FE43](#)) and accompanying 1/2 inch long fastener ([#1ZB29](#))

four 3/16 inch magnet cubes ([Amazon #B003VWST5C](#))

Tools Needed:

[Superglue Gel](#) (cyanoacrylate)

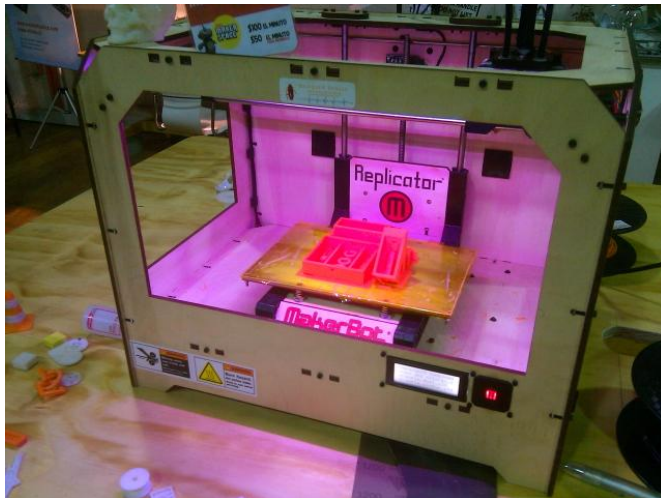
[3 in 1 machine oil](#)

Dremel Tool

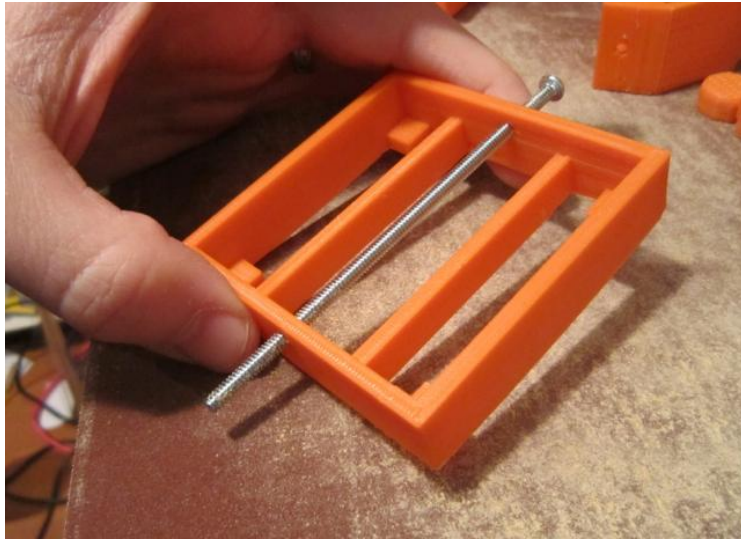
180 grit Sandpaper

Piece of Flat Metal for setting magnets

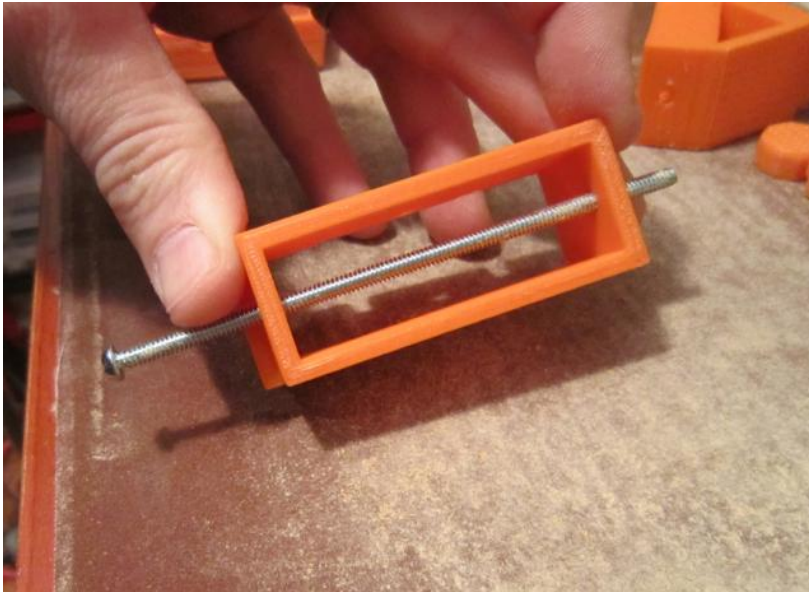
Tweezers are often useful during assembly



Print the file at your local hackerspace.



Using the 4 inch screw, "Ream" the holes in the X-axis so that the screw slides back and forth with ease. This is critically important for smoothness of operation. This may take a little elbow grease, as the hole is slightly smaller than the screw, and reaming removes a small layer of plastic from the inner diameter. This is by design so that the reaming makes a tight fit.



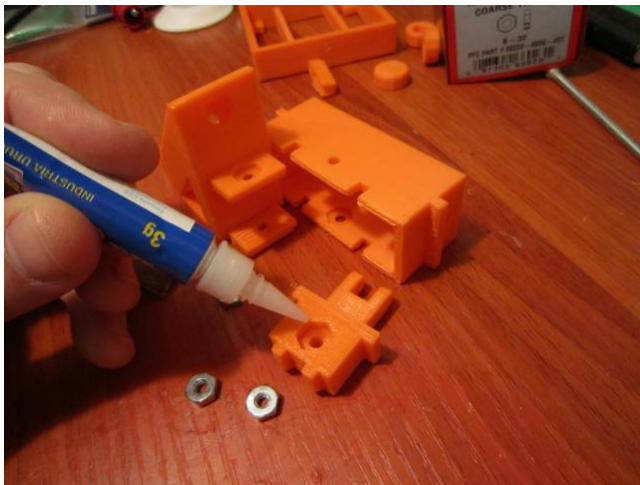
Ream the Y-axis. Note, only ream along the long dimension (as in picture)...NOT in the short dimension



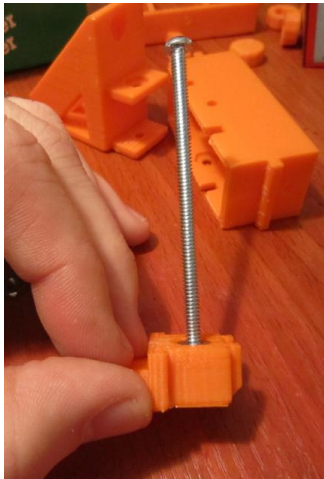
Ream the Z-axis.



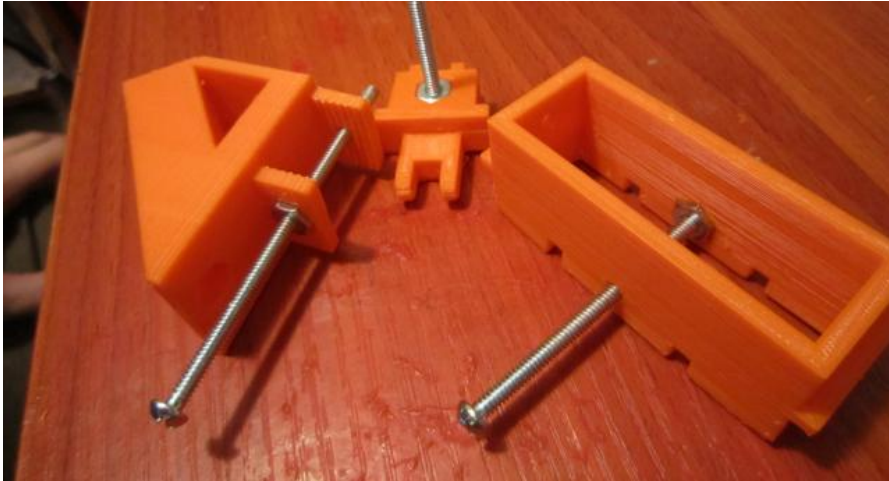
Now it's time to glue the three 6/32 Hex-Nuts to the moving pieces. Lightly sand one side of each nut.



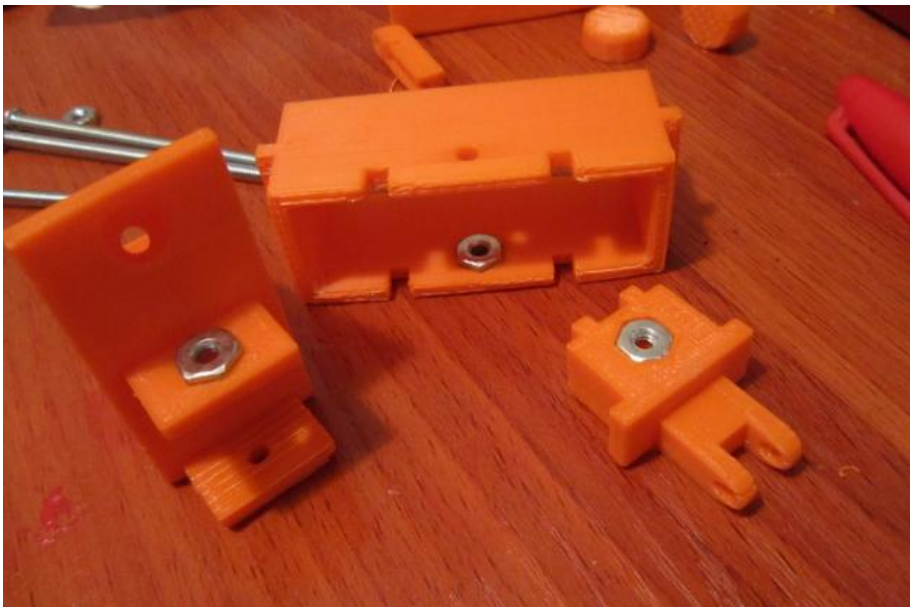
Add a couple dabs of super glue to the Hex-nut inset walls. Avoid getting glue inside the inner hole. Place Hex-nut inside, sanded side down



Screw in 3 inch fastener to secure nut and keep it straight while it the superglue dries. Screw in fastener all the way down, but not sticking out. **MAKE SURE FASTENER IS STRAIGHT.** This is critical for smooth operation of the moving part and diminishes wobble.



Repeat for other two pieces. Glue takes about five minutes to set.



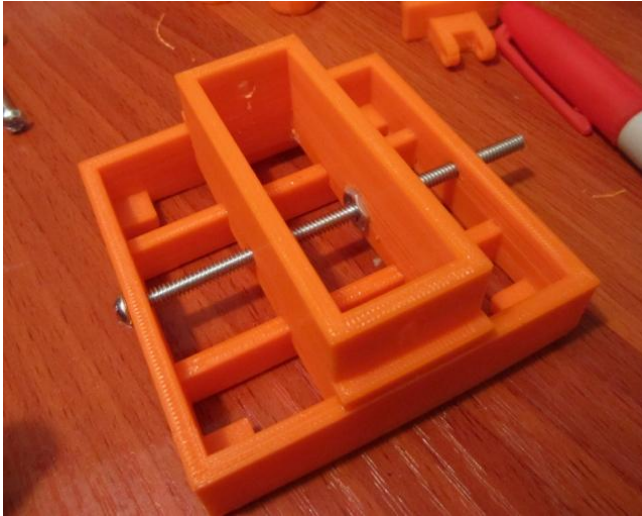
After the glue dries, remove screws that were helping to set nuts. Add some machine oil to nut threads



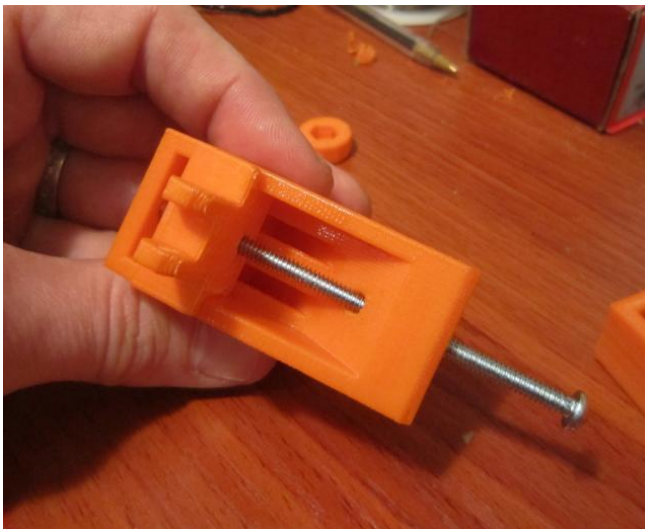
Oil all touching edges, and place y-axis inside x-axis. With oil the part should slide back and forth. Move back and forth the part rapidly with elbow grease to "break in" part. YOU SHOULD NOT NEED TO SAND PARTS to enable a fit. Move back and forth to "break in"



Locate 3 screws of the following lengths:
3.25 inches
3.75 inches (no head) see August 2013 Update at end of document
3 inches
2.25 inches
You can precut these from the 4 and 3 inch screws with a dremel



Screw in 3.25 inch fastener. Screw in all the way so that there is no space between the head of the screw and the outer wall.



Oil the Electrode holder #1, and make sure it slides back and forth. Move back and forth to "break in." This is a very tight fit by design. Only sand if absolutely necessary. Make sure the side of the electrode holder WITHOUT the nut is facing down. Screw in 2.25 fastener from the bottom.



This is what it should look like. Make sure head of fastener is screwed in from underside is as far in as it can go. A way to test this is to keep turning with a screwdriver when you encounter resistance. The electrode holder #1 should then begin to move.



Insert electrode holder #2 in electrode holder #1, and secure with the $\frac{5}{8}$ inch long 2-56 fastener and accompanying nut.

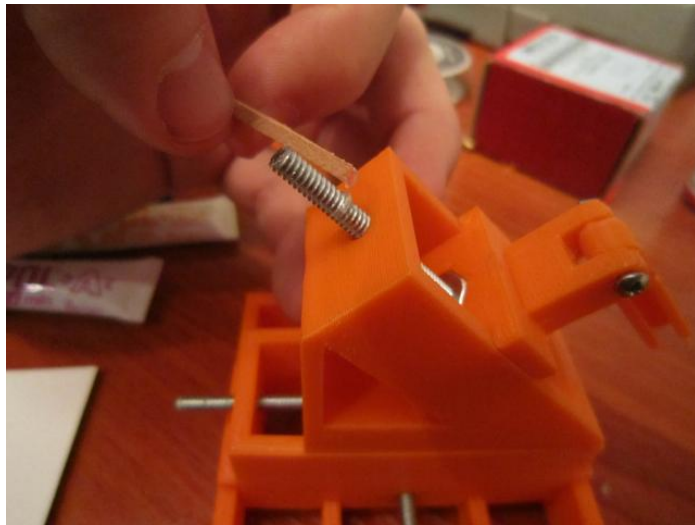


Oil the bottom of the Z-axis and insert into y-axis. Part should slide back and forth easily, especially after you "break it in" by moving the piece rapidly back and forth.

Prepare some epoxy



Epoxy is now longer needed for this, You can use superglue gel for all glueing steps (August 2013 update)



Apply a small bit of epoxy $\frac{1}{8}$ inch above where fastener comes out of z-axis.



Hand tighten HEX nut on fastener. Tighten by hand to 2-3 finger force strength

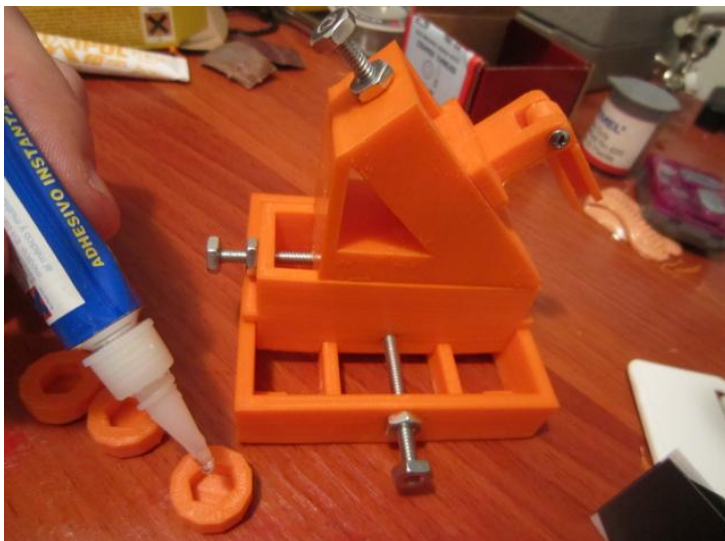


Apply some epoxy to end of the fastener



Install another HEX nut. Leave flush with end of fastener

Repeat for other two axes



Now it's time for the knobs. Add a bit of superglue to the inside of the knobs.



Install Knobs. Make sure the knobs look straight when viewed from the side and are not crooked. If knob appears not to fit, use elbow grease. Some knobs will fit better than others. This is due to the limitations of the 3D printer and cooling of the plastic.



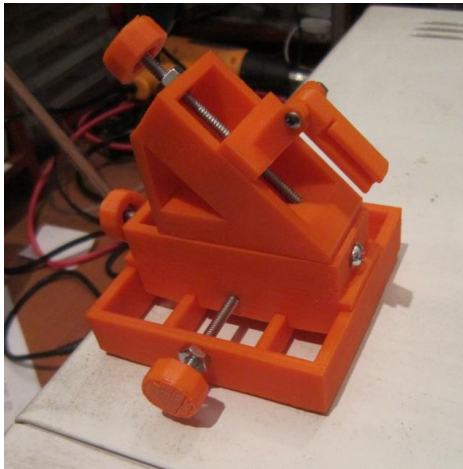
Knobs should look like this when done



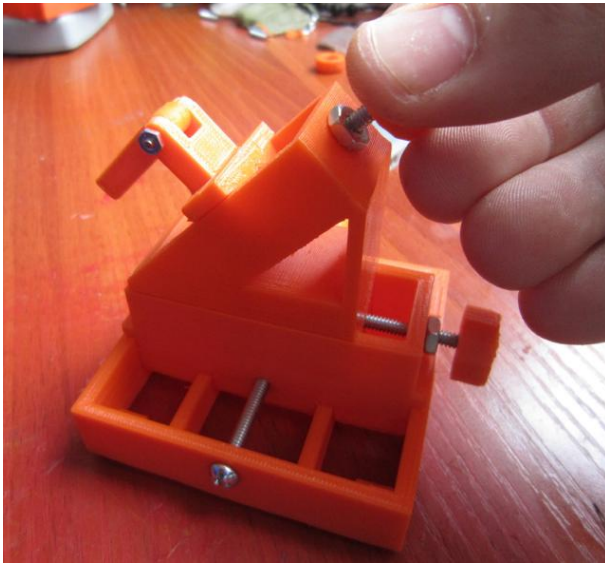
Now it's time for the magnets. Prepare some more epoxy, and place liberally in the holes in the base. Do not let epoxy spill out of hole though.



Insert Magnets. Try to do with magnet poles all facing same direction.



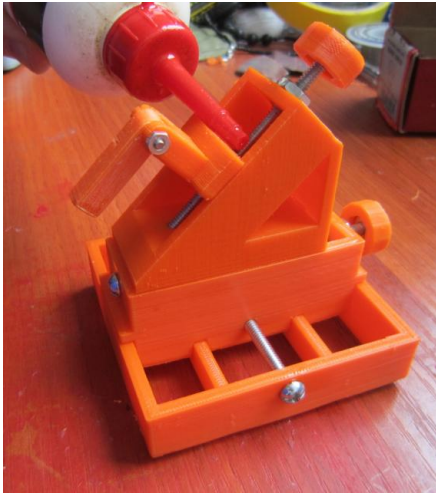
Magnets need to be leveled now. For this, use a flat piece of metal. Place the Searcher on the metal in a quick, rapid motion, so that magnets do not pull out of base. Leave Searcher alone for 1-2 hours for epoxy to set.



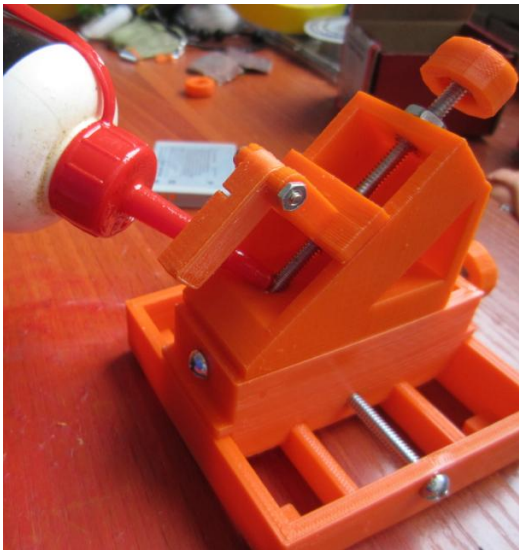
Now it's time to "break" the light bond that has formed between the nuts and the plastic. Use a quick, forceful turn of each knob. The nut should stay affixed in place to the fastener, and thus turning the knobs causes the moving parts to begin sliding on their axis. It will seem rough, so you need...



Oil! Oil ALL Points on each axis. Oil the point between the nut and the wall....



Oil the point where the nut is on the moving part, and in general along the fastener...



And the point where the other end of the screw intersects with the other wall.



Also apply oil along the head of the screw. Repeat for the other 2 axis. Also oil all plastic/plastic sliding junctions.

Check all axes for smooth movement and turning. Oil where appropriate.

And you are done with construction! Build the Electrode per the other google doc instructions, and then check Searcher under a microscope to ensure smooth movement. See our youtube video at:

https://www.youtube.com/watch?feature=player_embedded&v=2PFyaAw8_zg

To get an idea of how smooth the movements should be.

August 2013 Update

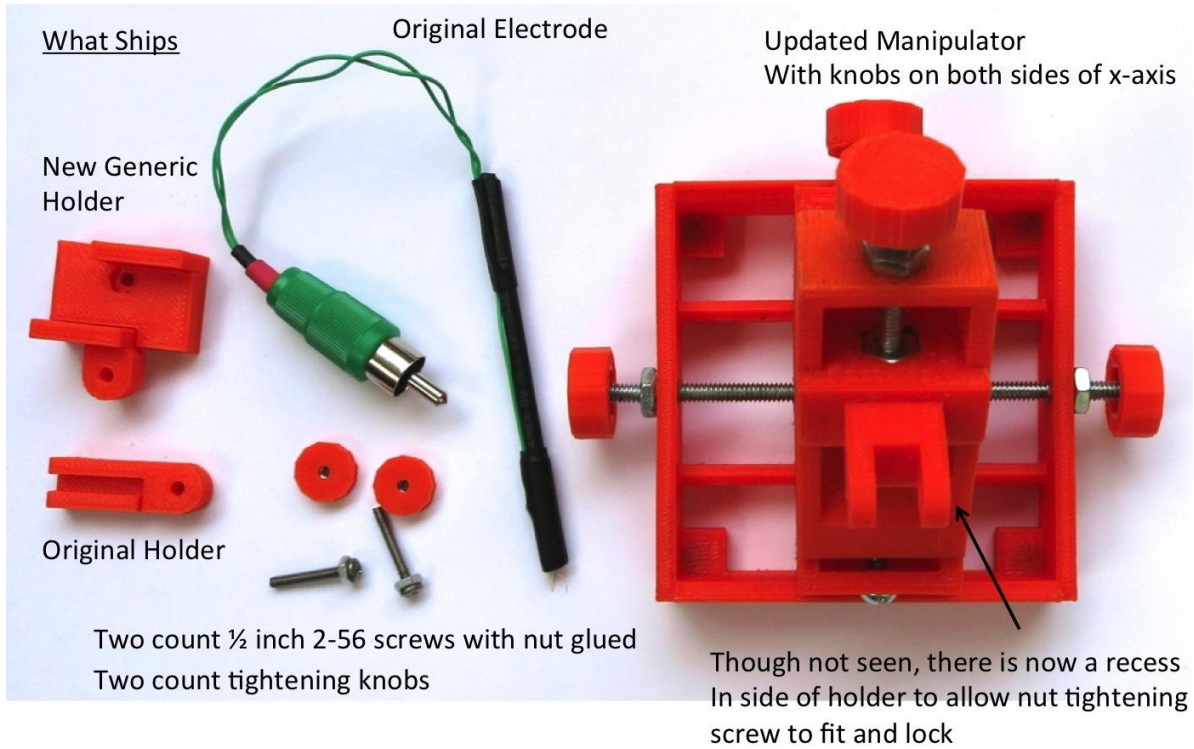
With this update:

- 1) There is an additional knob on the x-axis so you can flip it around on the completo (sometimes you have very little space between phone holder on completo and manipulator...this allows you to flip the position around)
- 2) A locking mechanism for the holders
- 3) The manipulator will now ship with two holder types
- 4) The knobs have a small notch so you can easily count truns

(past updates from April 2013)

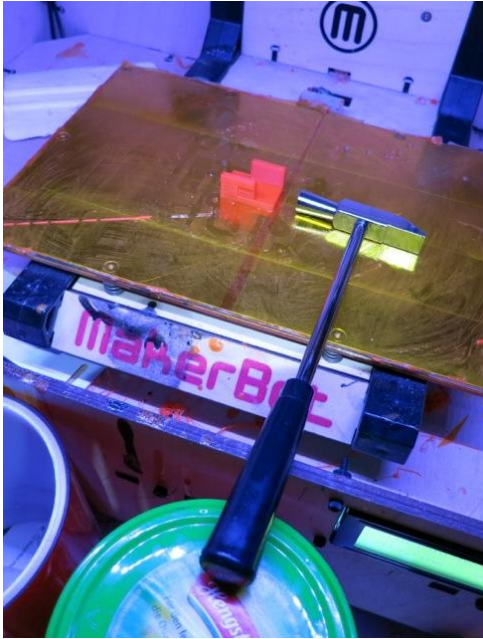
- 1) The whole assembly can be printed without rafts or supports - eliminating annoying material removal steps
- 2) Superglue gel works just as well for all assembly adhesion steps, eliminating need to prepare and use epoxy.

What Ships (in both standalone and Completo version):



Updated Instructions:

1. This is how new version prints off Replicator. Notice new parts - It takes ~4 hours to print at default medium setting on MakerWare software (10% infill, 2 shells, 0.2 mm height)



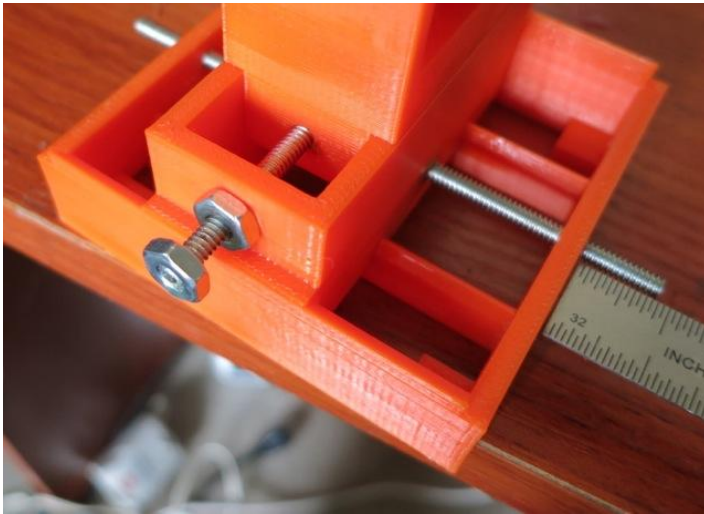
The small pieces can be very hard to remove from Replicator table that had an an acetone slurry applied. Removing by hand with force often damages the parts. I bought a small rock/hobby hammer, and a forceful, smart tap on side will liberate pieces. This doesn't result in noticeable blemishes on piece but you should check.



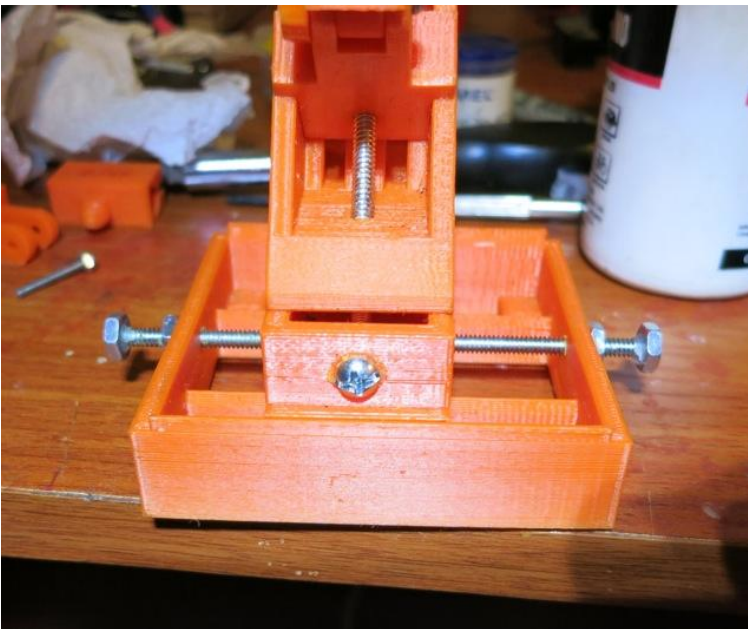
Run hammer along table and tap lower end of piece (Not the walls)



2. Cut the 4 inch faster down to 3.75 inches, FROM THE HEAD end. A sock or cloth around fastener while it is in the vise will reduce damage to threads.



When installing the base axis, use a ruler and measure both sides to ensure the same length of the bolt is sticking out of both sides -- it should be $\sim\frac{3}{8}$ inches



Assemble in similar fashion to previous version, but now with nuts on both sides.



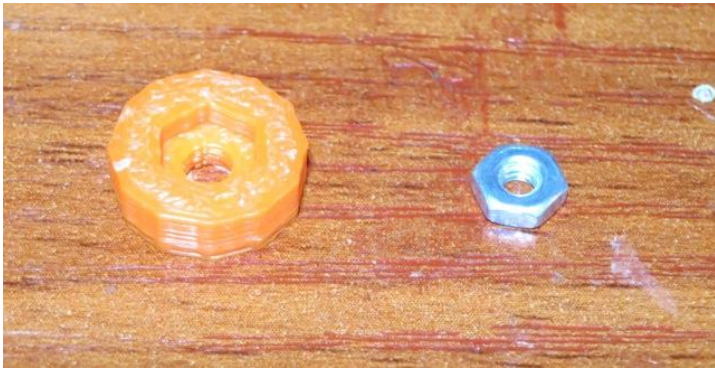
Install knobs using glue as you have done on previous versions



3. Making the lock fasteners.
Apply a little bit of glue to threads near head of 1/2 inch fastener, and....



Tighten it down. You need two of these.



4. Make lock down nuts. Sand the faces of the 2/56 nuts, and...

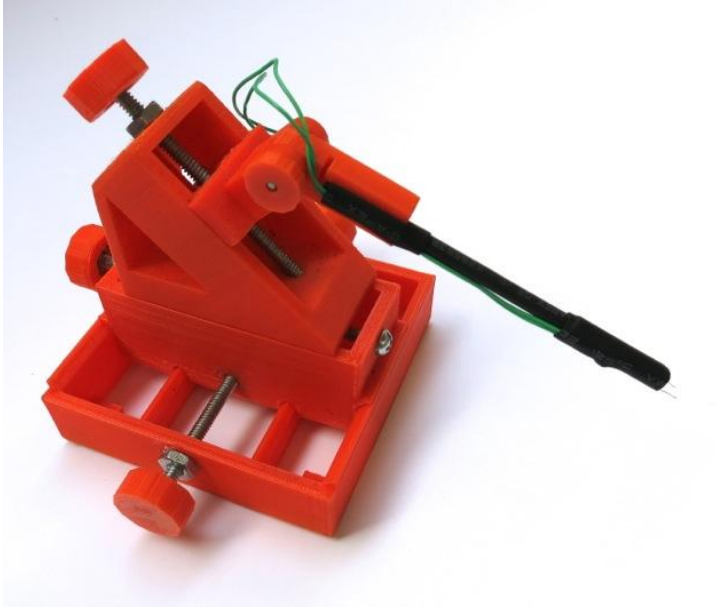


Glue them inside holder!



As you have done in previous steps, keep nut aligned in hole during glue drying step by screwing in fastener. After glue has dried make sure nuts spins easily around fastener.

5. And that's that. Configuration 1:



And Configuration 2. Glass rod is just for example in this photo and does not ship with unit.

