The Original Egg-Bot ASSEMBLY GUIDE

The Original Egg-Bot kit is the product of many years of evolution, dating back to the first Eggbot, developed by motion control artist Bruce Shapiro in 1990. The present kit was developed by Evil Mad Scientist Laboratories in cooperation with Bruce Shapiro, Ben Trombley, and Brian Schmalz.

This kit is designed to allow you to draw on spherical & egg-shaped objects from about 1.5-4.25" (4-10 cm) in diameter. Internet access, simple tools, and a recent-generation computer (Mac/Win/Linux) with a USB port are required.

This assembly guide covers the procedures for putting together your Eggbot Kit. Typical assembly time is estimated to be 1-2 hours. Please exercise appropriate care when building it: The kit contains many small parts and some parts that could be sharp. Keep out of reach of small children. Older children and teens may require adult assistance.

An open-source hardware+software project. For links to design files, source code, examples, support resources & additional documentation, please visit: http://egg-bot.com/

Support Forum: http://www.evilmadscientist.com/forum/

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Kit version 2.0
Manual v. 2.0f
12/12/2010

STEP 0: It's the BOM.

Your kit came with a *bill of materials*: an up-to-date list of what's in your particular kit. The exact items may differ very slightly between versions of the kit.

BILL OF MATERIALS -- The Original Egg-Bot Kit — Kit Version 2.0

Line	name / description	Supplier/ Equiv.	item#	Qty
1	Chassis, Fiberglass (Set of 5 pcs)	---	Custom Fab	1
2	hex wrench: 5/64" (ball end)	McMaster	57185A43	1
3	hex wrench: 3/32" (nickel plate)	McMaster	53425A32	2
4	Nylon bushing 1/4"	Igus	MCI-04-02	1
5	Dowel pin, 1/4" x 2.5"	McMaster	98381A552	4
6	Threaded standoff, 6-32 x 7/8"	McMaster	93330A448	21
7	6-32 BSCS, 1/4"	McMaster	92949A144	13
8	Angle bracket	Digi-Key	4334K-ND	1
9	Spring	McMaster	9657K152	1
10	Shaft collar, 1/4" (plunger)	McMaster	9414T6	2
11	O-ring to retain 1/4" shaft	McMaster	5308T482	1
12	Nylon washer (Thrust bearing)	McMaster	95606A110	4
13	Egg Cups (Polyurethane bumper)	McMaster	9549SK173	1
14	EiBotBoard v 2.0	Schmalzhaus		4
15	4-40 x 5/8" cap screw, for EBB	McMaster	92196A112	4
16	4-40 nut-- for EBB	McMaster	90480A005	5
17	plastic spacer -- for EBB	McMaster	94639A704	2
18	Stepper motors	Japan Servo	KH42HM2-951	10
19	M3X6 BSCS, BLACK -- for motors & shaft collars	McMaster	91239A111	12
20	Nylon thumb screws, 6-32 x 1/4"	McMaster	94323A301	1
21	Shaft collar, 5mm, 1/2" OD, for egg motor shaft	McMaster	57485K85	
22	Pen Arm Backer	---	Custom Fab	1
	Shaft collar, 5mm, 10 mm OD - pen arm shaft	McMaster	90975A015	1
	Blind nut, 10-32	---	Custom Fab	
23	Pen Arm (distal)	McMaster	94855A201	1
	6-32 square nut	---	Custom Fab	
24	Pen arm (hinge clamp)	---	Custom Fab	1
25	Pen Arm, Proximal	---	Custom Fab	2
26	Flexure hinge, 0.010" acetal copolymer	---	Custom Fab	1
27	Flexure hinge washer, 0.020" delrin	McMaster	92470A095	2
28	Flexure hinge screws	McMaster	92949A146	2
29	6-32 BSCS, 3/8", for pen arm clamps	McMaster	94320A249	1
30	6-32 x 1/2" thumbscrew, nylon black	Generic		1
31	Servo motor, 9g class	McMaster	94323A315	1
32	Thumbscrew, 10-32 x 1/2"	Generic		1
33	Power supply, Universal input, 9V, 1A+ output	Generic		1
34	USB Cable, 6', A to mini-B	Office supply store		1
35	Pen (sharpie!)			

In the instructions, we refer to components by their line item number on the bill of materials. For example, **#1** is the chassis-- a set of five fiberglass pieces.

STEP 1: Tool Checklist

Essential tools: Needed to build and use the kit:

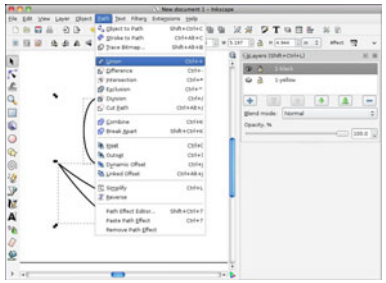
1. Small Phillips head screwdriver(s)

There are several places in the assembly process where you will need to provide a small Phillips head screwdriver. You may find it helpful to have a couple of different sizes handy.

2. Computer, Internet access, USB port....

To use the Eggbot, you'll need a reasonably recent vintage computer (Mac, Windows, or Linux) with an available USB port as well as internet access to download software.

All of the software that you'll need will always be available for free. Visit http://egg-bot.com/ to get started.



3. Electrical power

The Eggbot kit comes with a regulated universal-input power supply that accepts worldwide voltages and puts out 9 V DC at up to at least 1 A. (International users may need to supply a plug adapter to fit the prongs into local outlets.)

If you're using your own external power, make sure that it provides 9 to 18 V DC, has a center-positive plug and is rated for at least 1000 mA. (A 12V car battery with the right connector can do the job, for example.) Please be careful: Inappropriate voltage or polarity can cause permanent damage.

Suggested tools: Recommended; not required

1. Masking tape & Scissors, or Glue

There is a place in the appendix where you can-- optionally --use some little strips of masking tape as shims or glue (5-minute epoxy, for example) to fine-tune the performance.

2. Small cable ties

The wires on the stepper motors are long. There are mounting holes provided in case you want to tie them up with a couple of small cable ties.

3. Containers to hold small parts

Small bowls, an egg carton, or an array of paper cups may be helpful for organizing small parts while you put the Eggbot together.

And if you're so inclined...

Wire strippers, soldering iron, etc.

Rather than using cable ties, you may want to reduce the length of the wires on the stepper motors. If you'd like to trim, strip, and tin the wires, you're certainly welcome to do so.

OK, Let's get started! >>>

STEP 2: The first three parts

This is the Eggbot chassis, **#1** on your BOM. It consists of five separate pieces.

The chassis is made of fiberglass and copper.

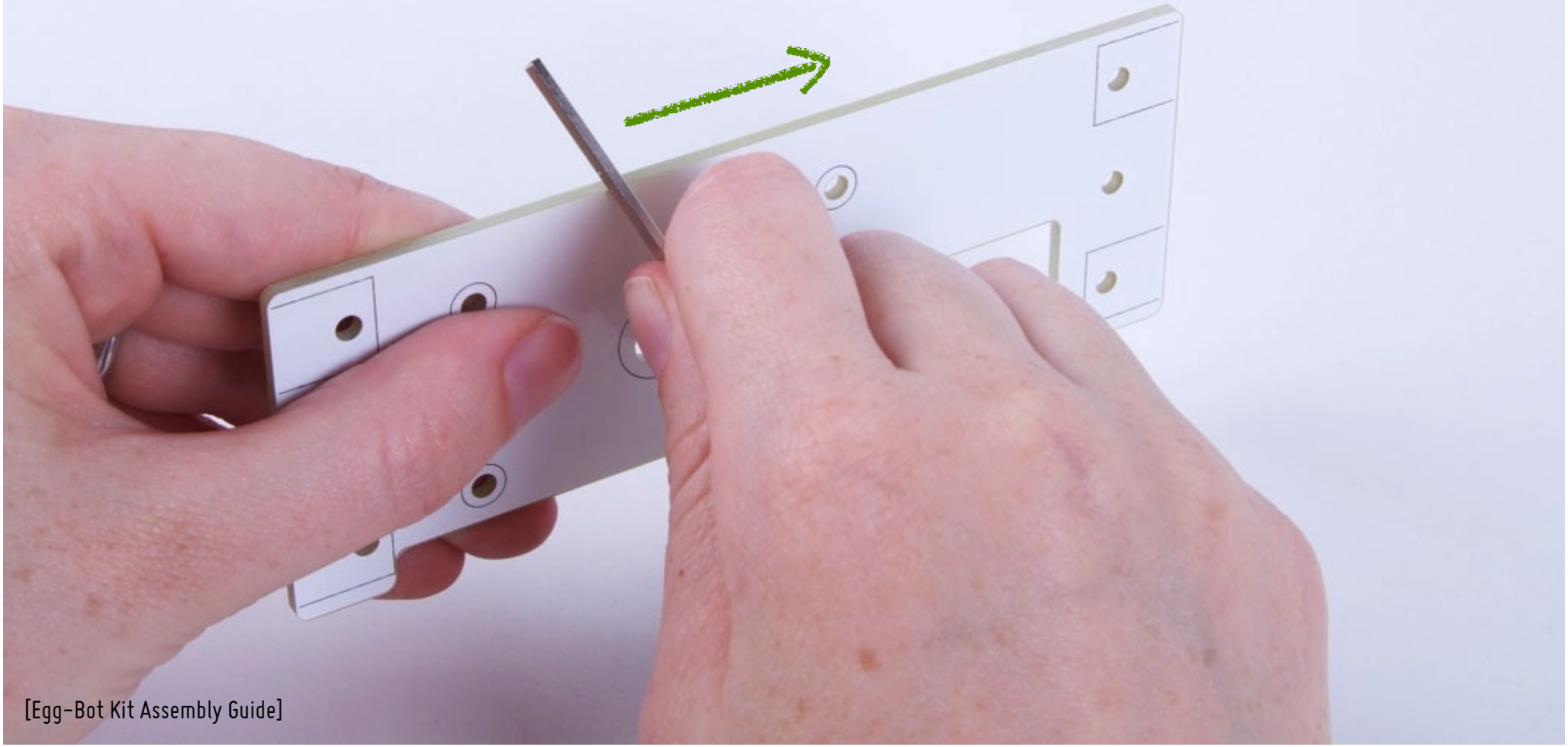
Its edges may initially be sharp, both from how it's cut, and from any residual tabs– little bridges that held the parts together during manufacturing. We'll address that in the next step, but *please handle with care* in the mean time.

Beyond the tools already mentioned, two additional tools are included in the Eggbot kit: A 5/64" hex wrench and a 3/32" hex wrench. You'll use them frequently.

STEP 3: Deburring the chassis

Use the nickel-plated hex wrench (the shiny one!) to remove any sharp edges from the five chassis pieces.

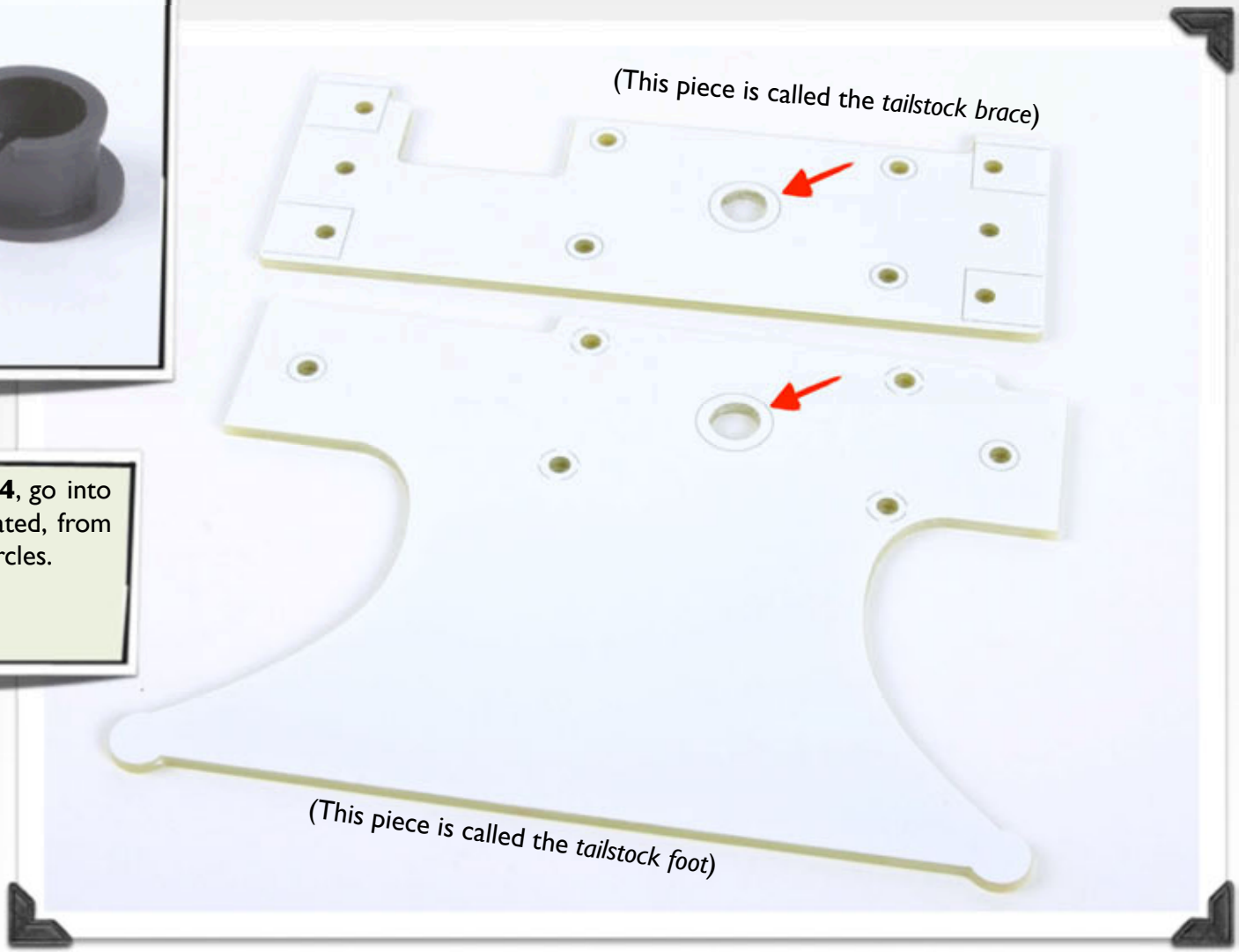
Rub the wrench along each chassis edge at a 45° angle. Usually one solid rub on each edge is sufficient to break any sharp corners.



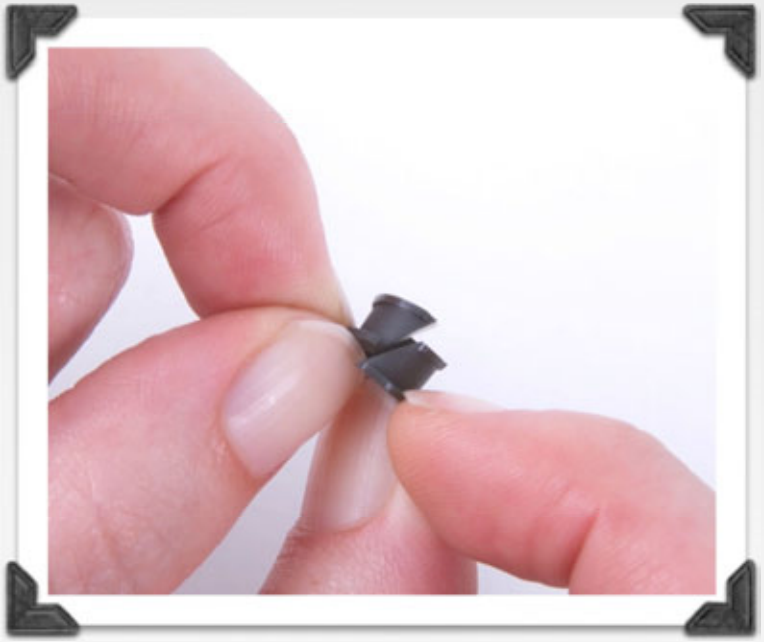
STEP 4: Split bushings, part I

The two nylon split bushings, part **#4**, go into the two of the chassis pieces indicated, from the sides labeled with the big black circles.

TO BE CONTINUED...



STEP 5: Split bushings, part II



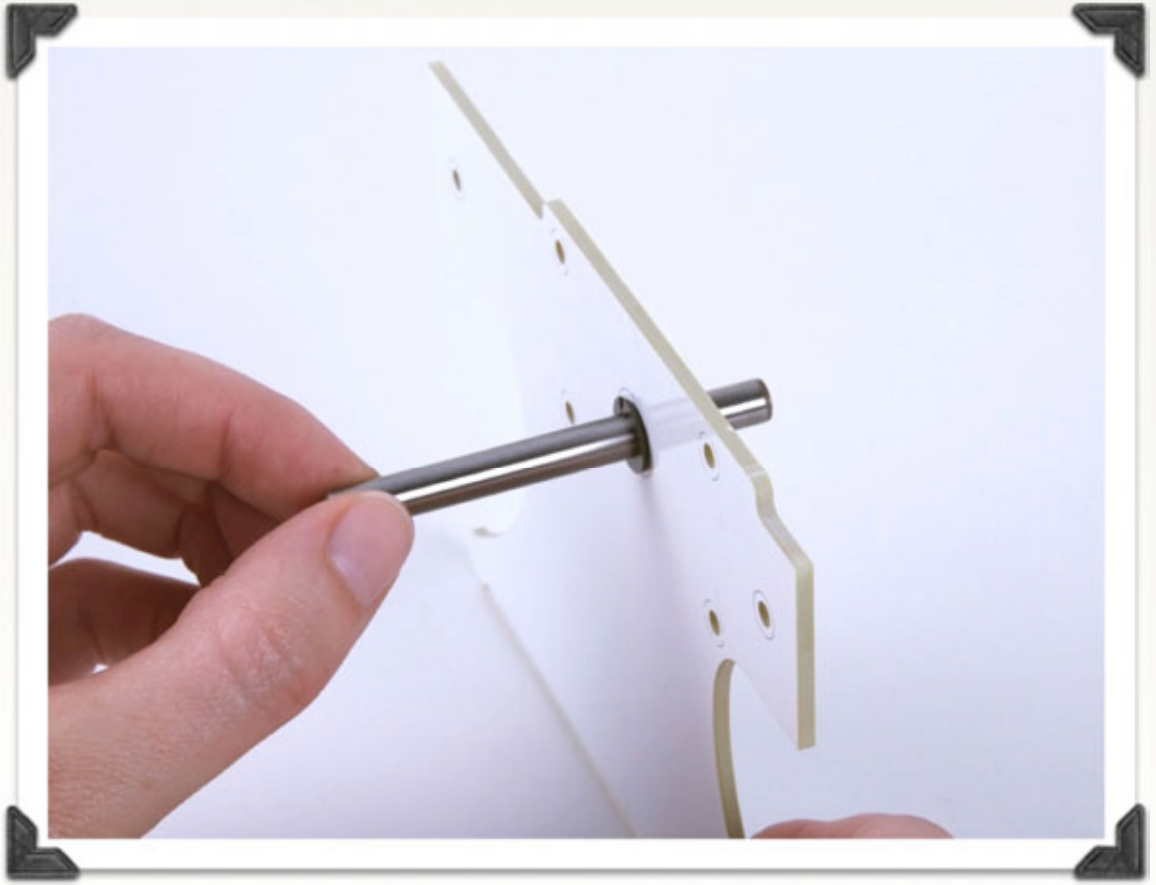
To install one of the bushings in the chassis, twist it as shown, so that you can insert it into the hole, one edge at a time. They "snap" into place, and it will be clear when they're installed correctly.

If necessary, the bushings can be removed by a similar process-- by pushing one edge of the bushing in and through the opposite side of the chassis board.

STEP 6: Test-fit the dowel pin

Part **#5** is a 1/4" diameter steel dowel pin.

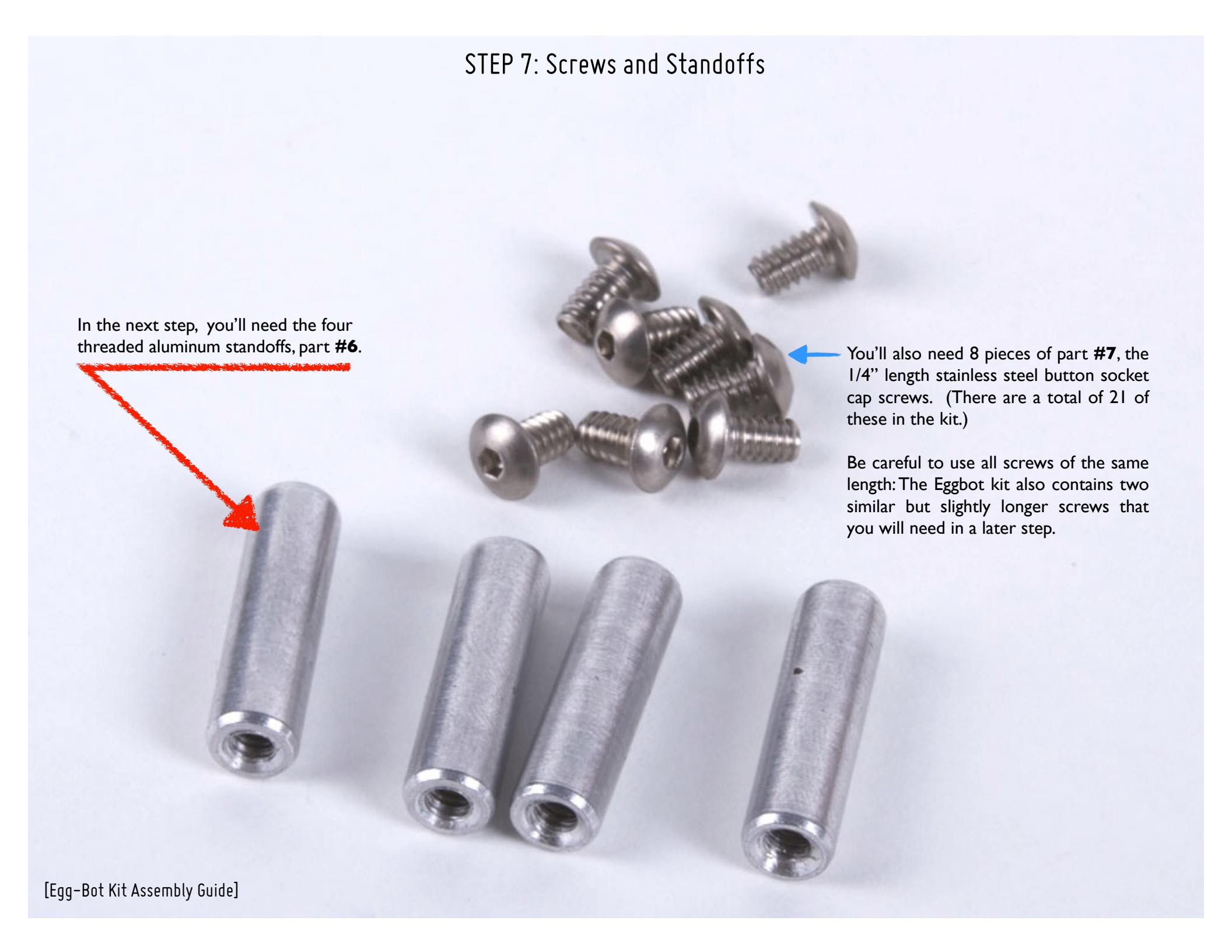
Carefully insert the dowel pin into each of the installed split bushings. The pin should slip *easily* into each of them and turn freely. Assuming that this is the case, set the dowel pin aside and go on to the next step.



In the unlikely event that it does not fit easily, *do not force it*. Instead, double-check that the bushings are fully seated and try again.

(If the problem persists, please contact Evil Mad Science customer support for help: contact@evilmadscience.com)

STEP 7: Screws and Standoffs



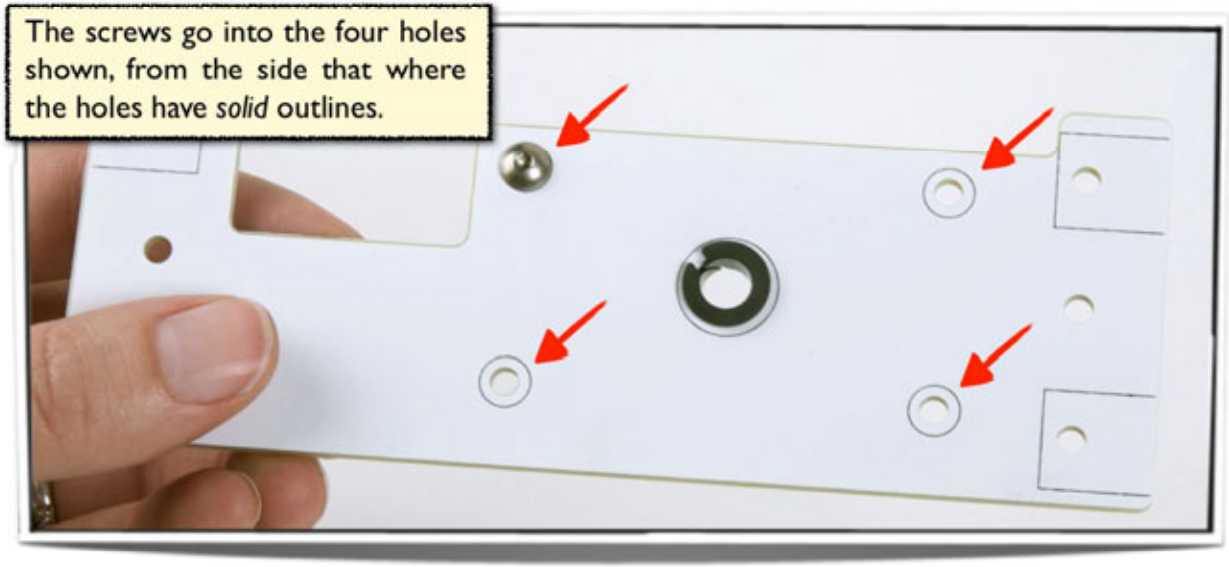
In the next step, you'll need the four threaded aluminum standoffs, part **#6**.

You'll also need 8 pieces of part **#7**, the 1/4" length stainless steel button socket cap screws. (There are a total of 21 of these in the kit.)

Be careful to use all screws of the same length: The Eggbot kit also contains two similar but slightly longer screws that you will need in a later step.

STEP 8: Adding Standoffs

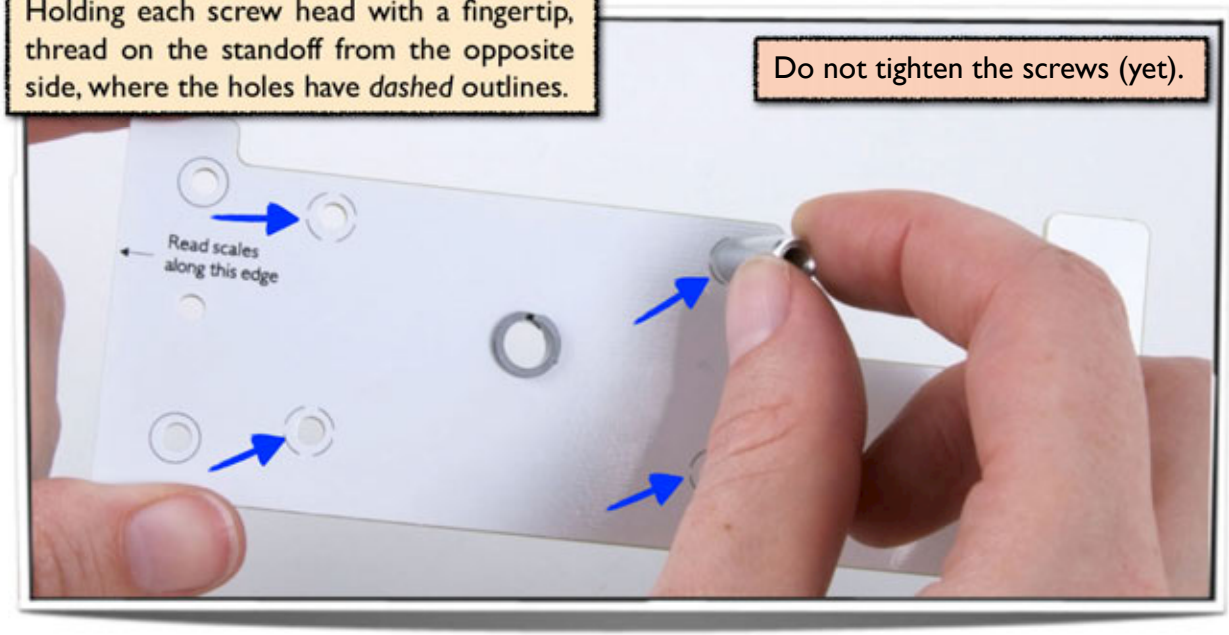
The screws go into the four holes shown, from the side that where the holes have *solid* outlines.



Here's how it looks once all four are added.

Holding each screw head with a fingertip, thread on the standoff from the opposite side, where the holes have *dashed* outlines.

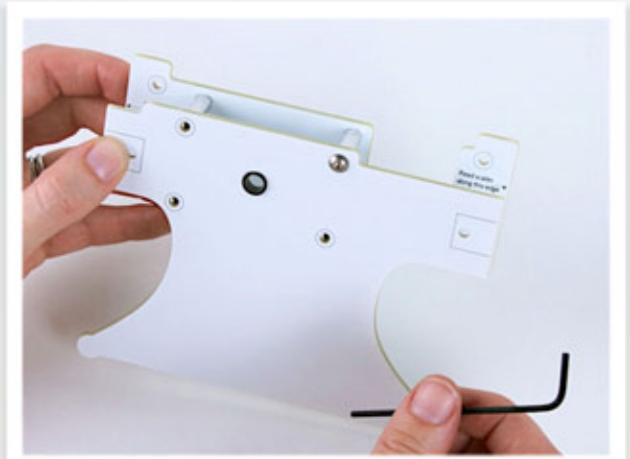
Do not tighten the screws (yet).



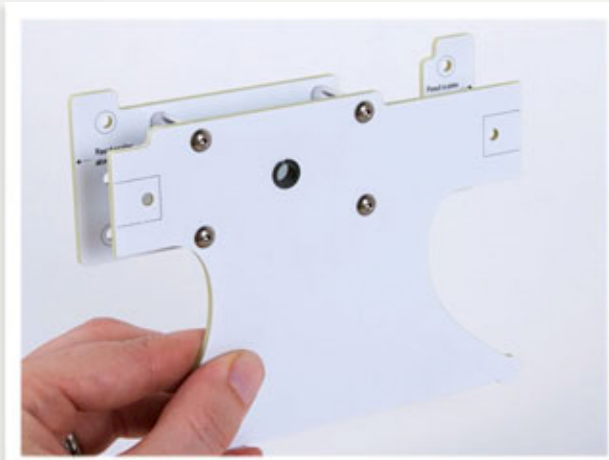
STEP 9: Mating the two tailstock pieces

Test fit the two tailstock pieces together: the standoffs go against the holes with the dashed outlines.

The other four screws go into the standoffs from the other side, again through the holes with solid outlines.



As you insert the screws, tighten them with the ball end of the 5/64" hex wrench. Be careful not to over-tighten the screws.



And, tighten the screws on both sides.

When you're done, the tailstock should look like this. You should have a clear view through both nylon bushings.

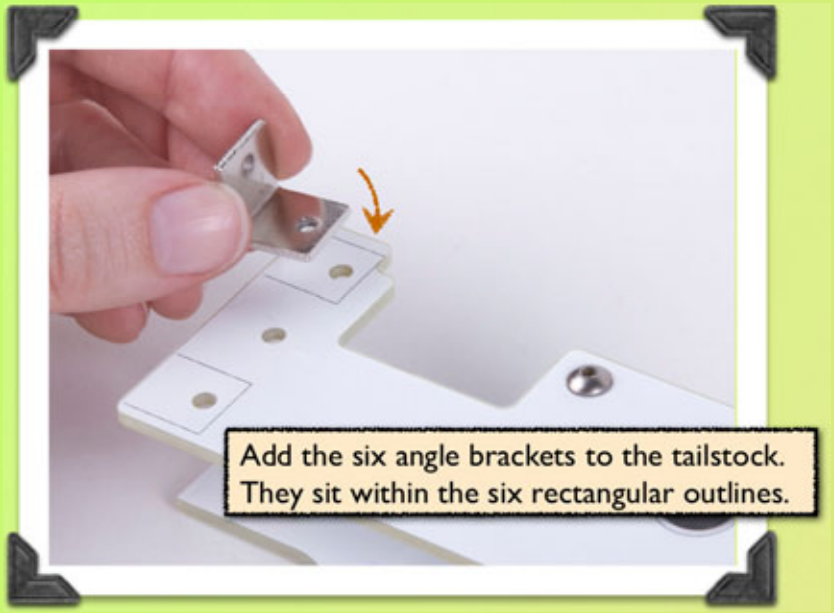
STEP 10: Angle brackets

In the next step, you'll need six of the steel angle brackets, part **#8**.

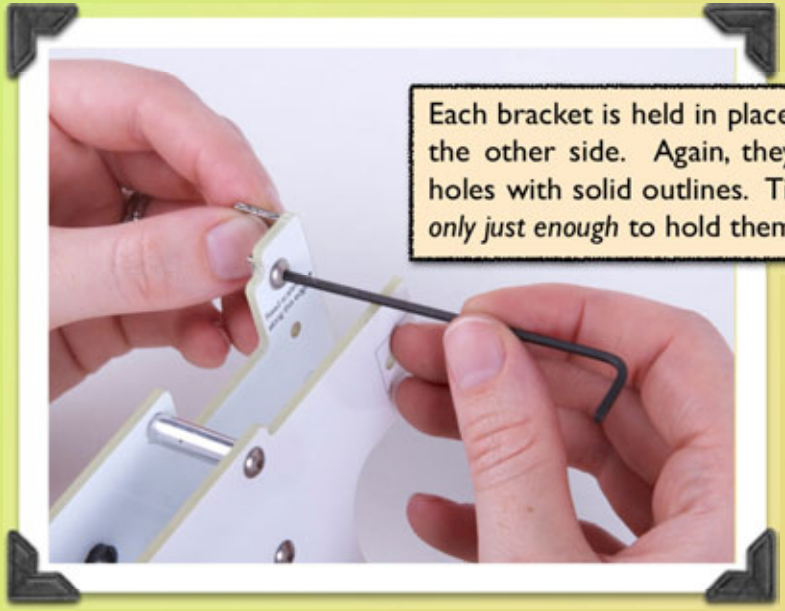
You'll also need 6 more pieces of part **#7**, the 1/4" length button socket cap screws.

Pro-tip: You may want to test-thread one of the steel screws into each side of each angle bracket, using the hex wrench. The threads in their holes may be rough, and this process can help to "break them in."

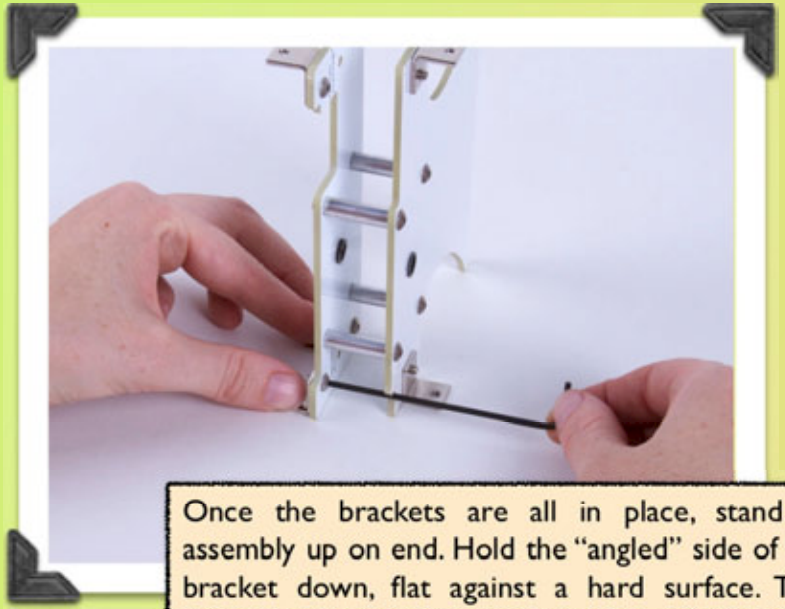
STEP 11: Adding tailstock angle brackets



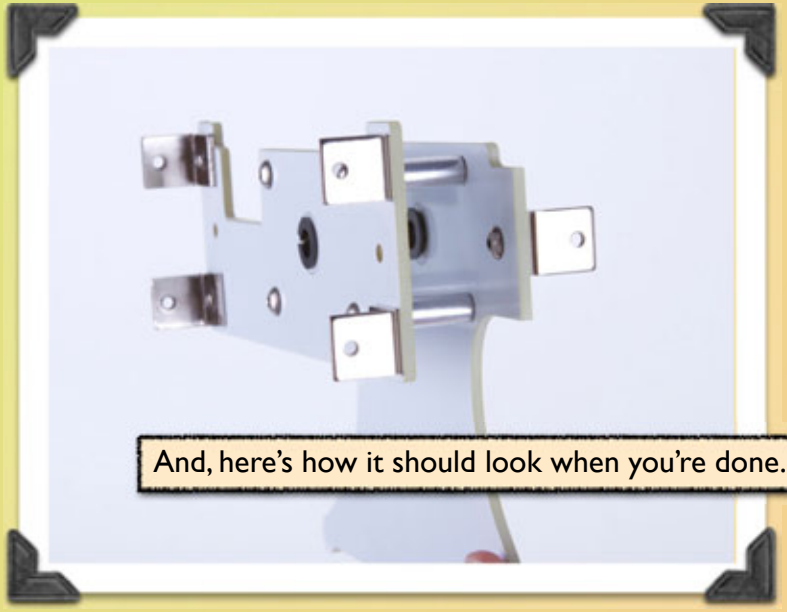
Add the six angle brackets to the tailstock. They sit within the six rectangular outlines.



Each bracket is held in place by a screw from the other side. Again, they go through the holes with solid outlines. Tighten the screws *only just enough* to hold them in place.



Once the brackets are all in place, stand the assembly up on end. Hold the "angled" side of each bracket down, flat against a hard surface. Then, tighten that bracket's screw well to hold it in place.



And, here's how it should look when you're done.

STEP 12: Adding headstock angle brackets

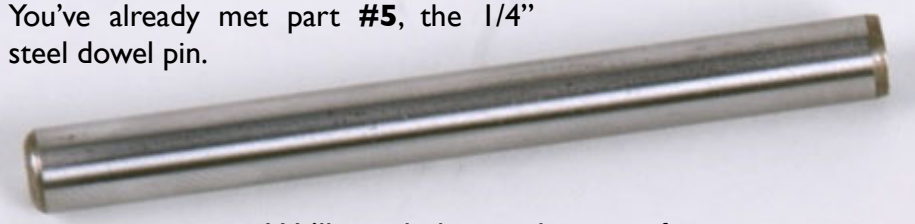
Using the same procedure as for the tailstock, use six more screws to add six angle brackets to the headstock.

As before, the angle brackets go in the outlined locations. Again, put the angle brackets in loosely at first and only tighten them once they're held flat.

It's a good idea to check that the angle brackets on both the headstock and tailstock appear to be "square" to the outlined locations. If they are askew, you'll find it harder to adjust the thumbscrews in upcoming steps.

STEP 13: Plunger Parts

You've already met part **#5**, the 1/4" steel dowel pin.



We'll need this in the next few steps, plus the other parts shown here:

Polyurethane "egg cups," part **#13**. There are four in each kit. You'll only need two, and two are there as extras.

***#9**, the steel spring*

#10, the 1/4" shaft collar.
(It's the one that fits the dowel pin)

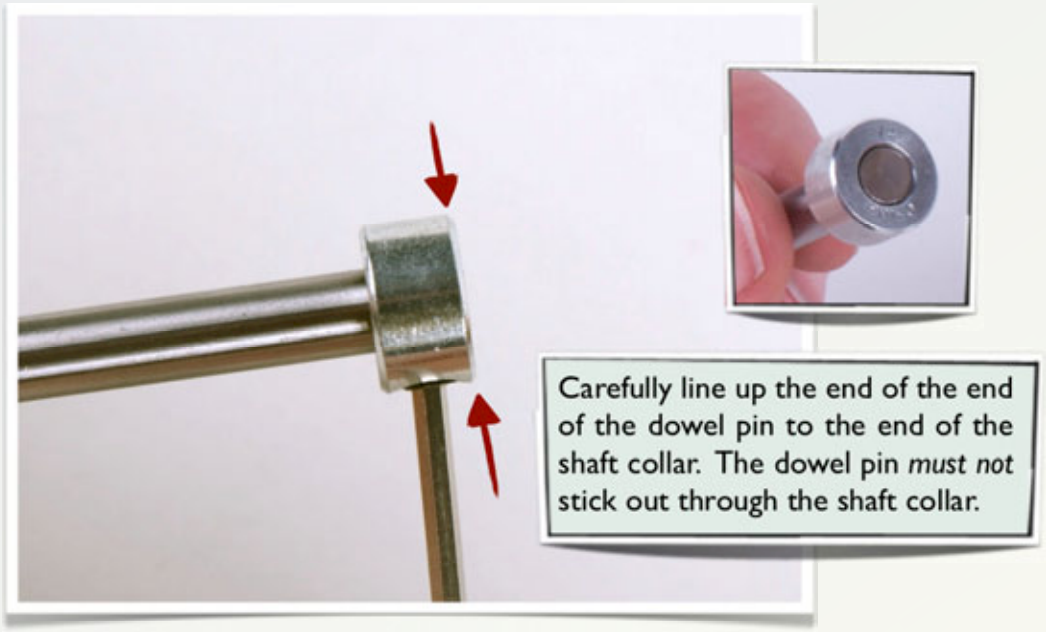
#11, the tiny O-ring

#12, the even tinier nylon washer

#3, the 3/32" hex wrench, which fits the little screw in the 1/4" shaft collar

STEP 14: Add the shaft collar to the dowel pin

Add the 1/4" shaft collar to the end (either end) of the dowel pin. You may need to loosen its screw, but it should fit easily.



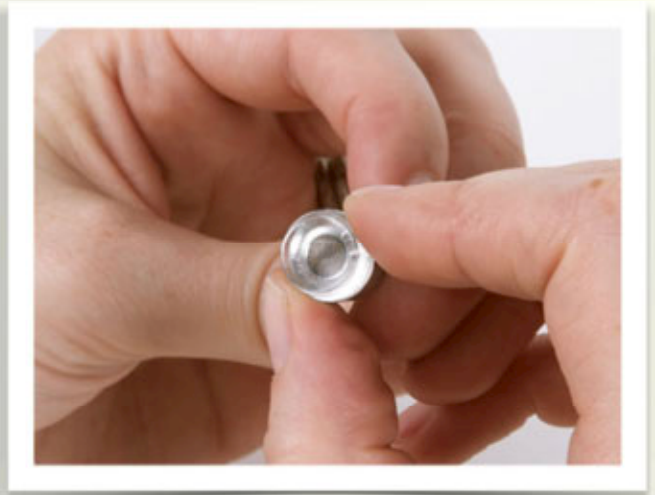
Carefully line up the end of the end of the dowel pin to the end of the shaft collar. The dowel pin *must not* stick out through the shaft collar.

Once the shaft collar is in place, tighten it well to keep it there. You can use the "long" arm of the wrench for extra leverage.

STEP 15: Adding an Egg Cup to the Plunger

We've already got the shaft collar on the dowel pin

Next, we'll add one of the self-adhesive polyurethane "egg cups" to the end.

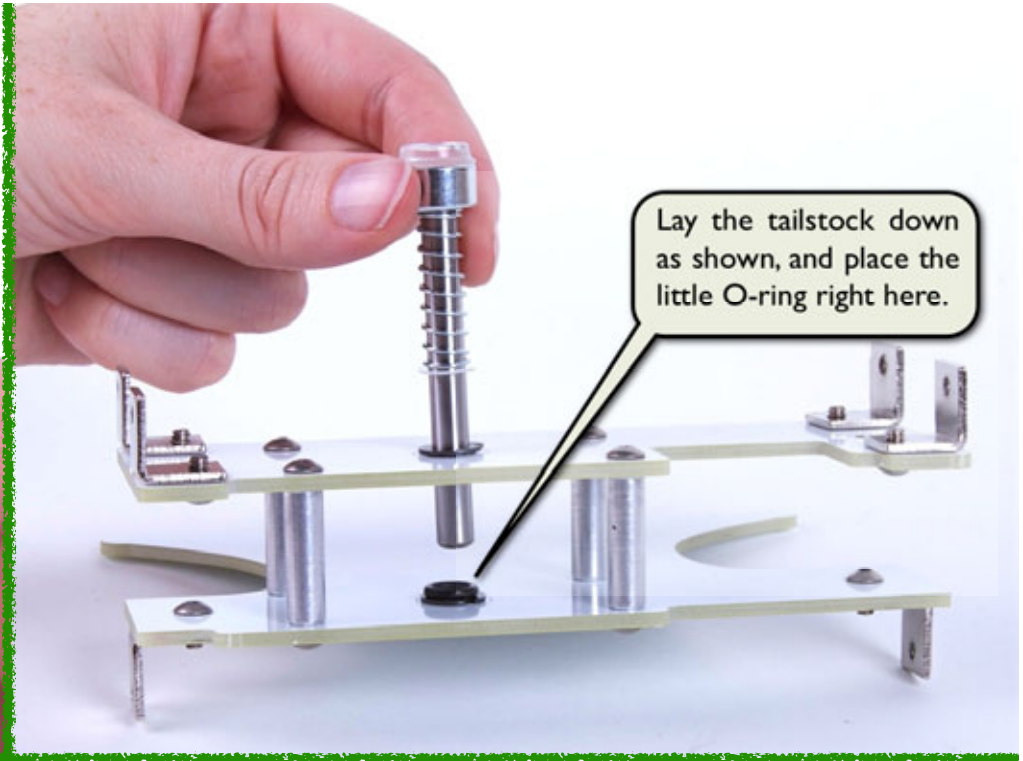


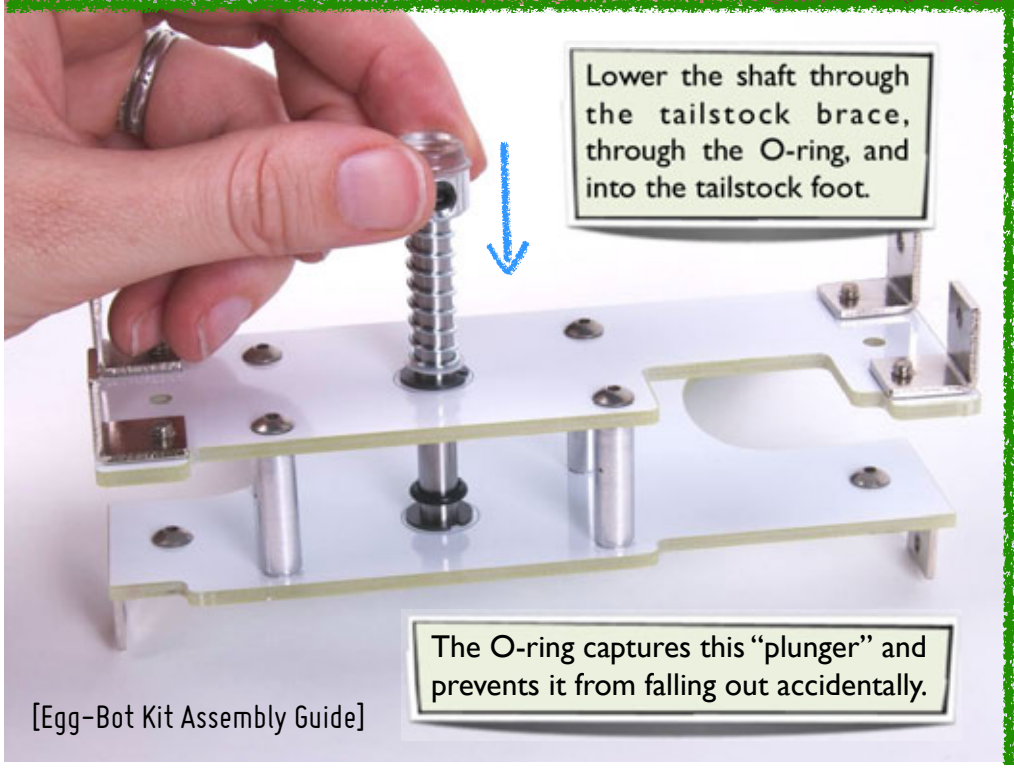
Check the shaft end and shaft collar for any dirt, oil, or other debris that could interfere with sticking the egg cup in place. Wipe them off if necessary.

Then, take one of the egg cups, and carefully align it over the very center of the dowel pin and shaft collar. Press it lightly into place.

Inspect the egg cup, and check that it's fairly well centered on the shaft end. If it is, press it again to help affix it in place. If not, try to realign it and then press it into place.

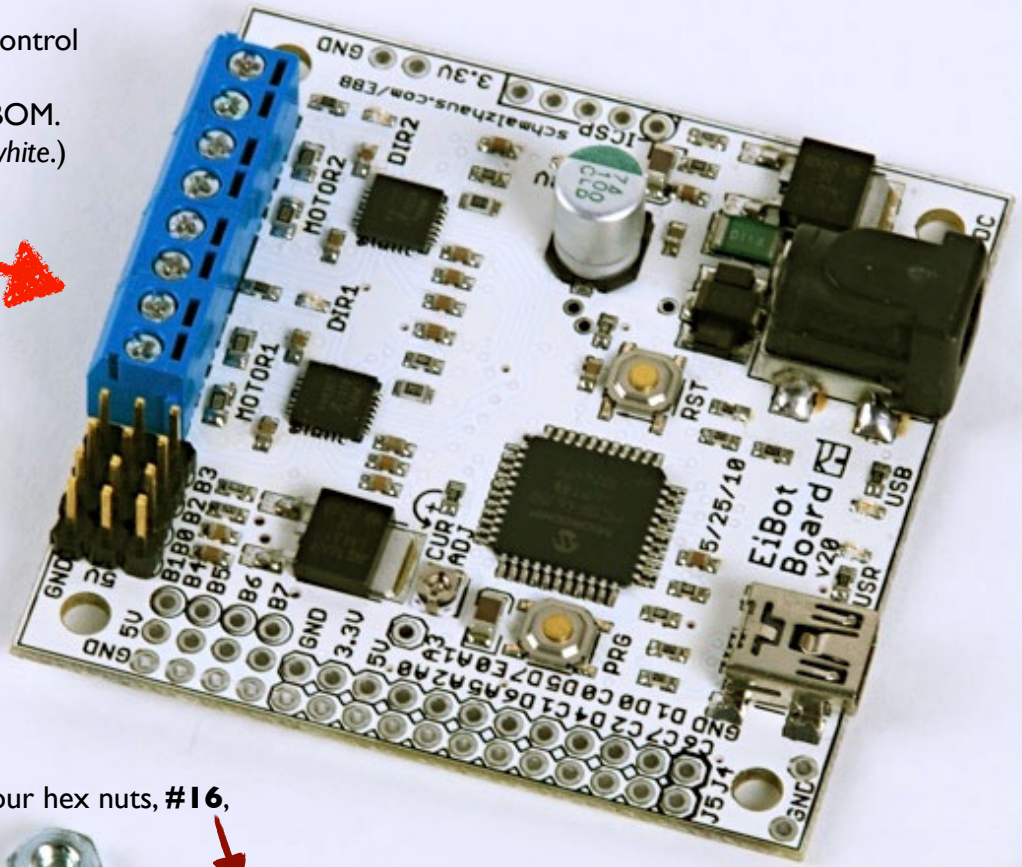
STEP 16: Installing the Plunger





STEP 17: The EBB and its mounting hardware

Next, we're going to mount the Eggbot control circuit board. This is the *EiBotBoard*, aka *EggBotBoard*, aka *EBB*, and **#14** on your BOM. (This circuit board may be either *red or white*.)



You'll also need....

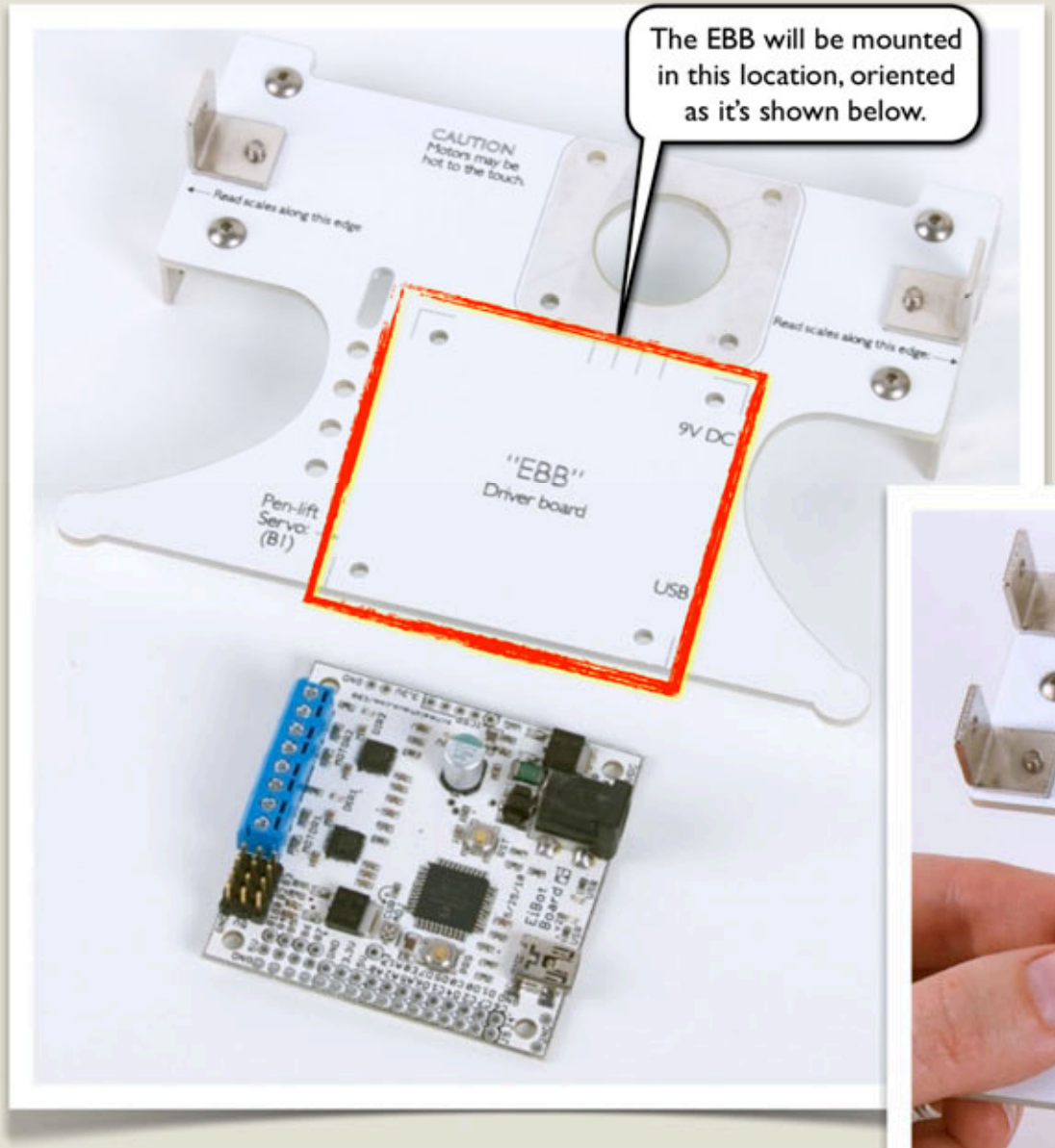
Four longer hex cap screws, **#15**,

Four hex nuts, **#16**,

And four nylon spacers, **#17**.

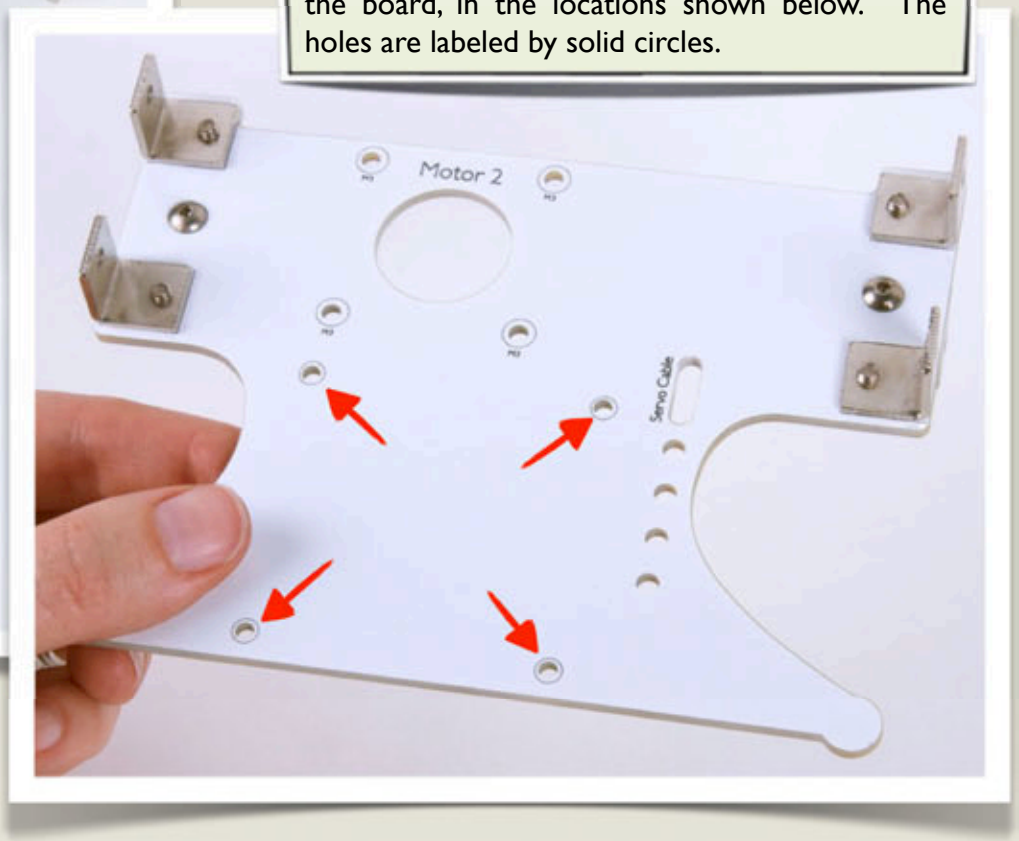
You'll also need the 3/32" hex wrench again; it fits the heads of those hex cap screws.

STEP 18: Where we mount the EBB

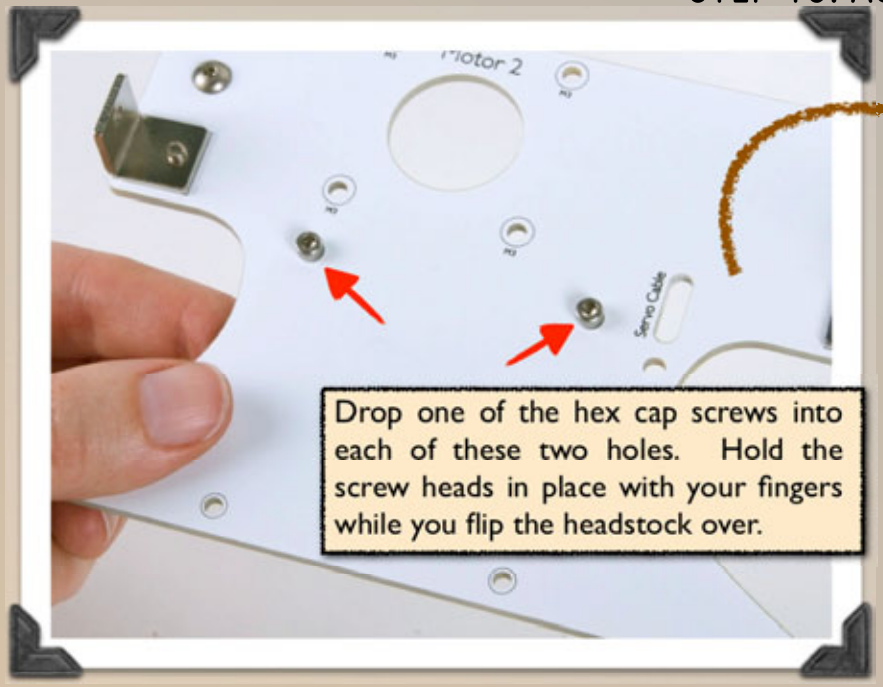


The EBB has mounting holes on its four corners.

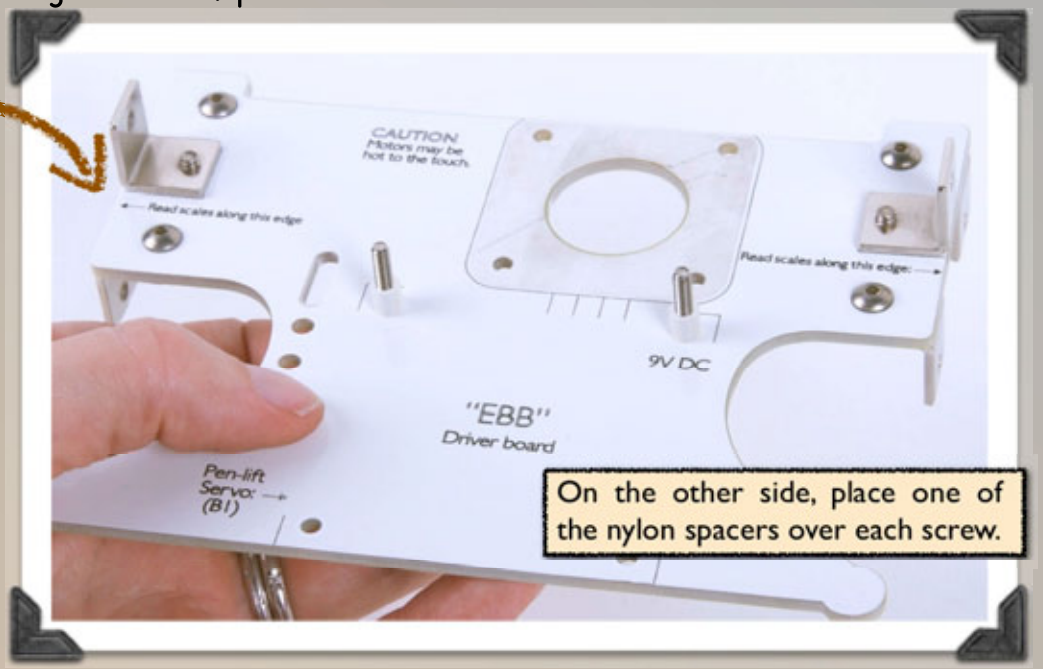
To mount it, we're going to put those four long & hex cap skinny screws in from the back side of the board, in the locations shown below. The holes are labeled by solid circles.



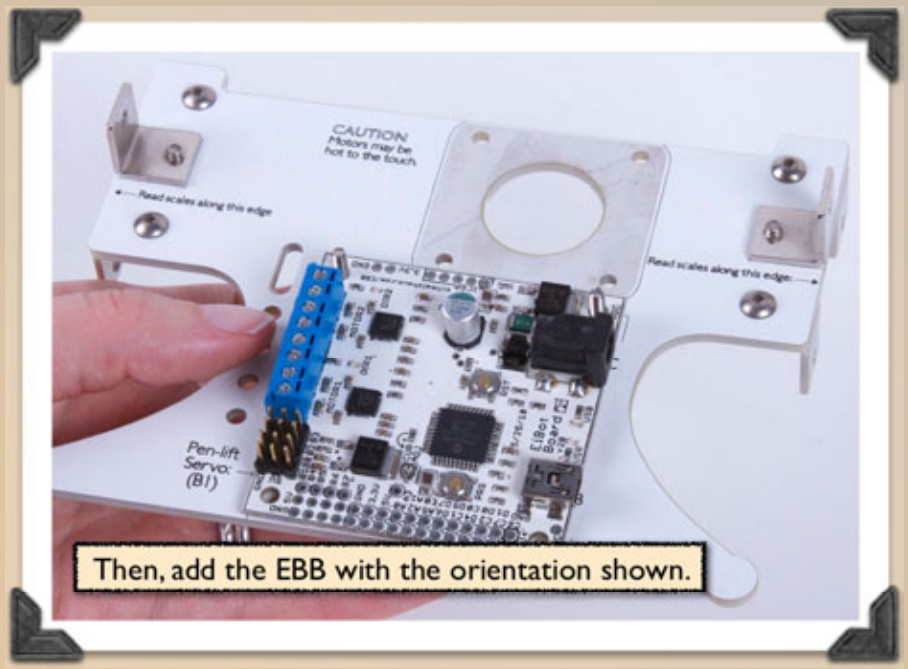
STEP 19: Adding the EBB, part I



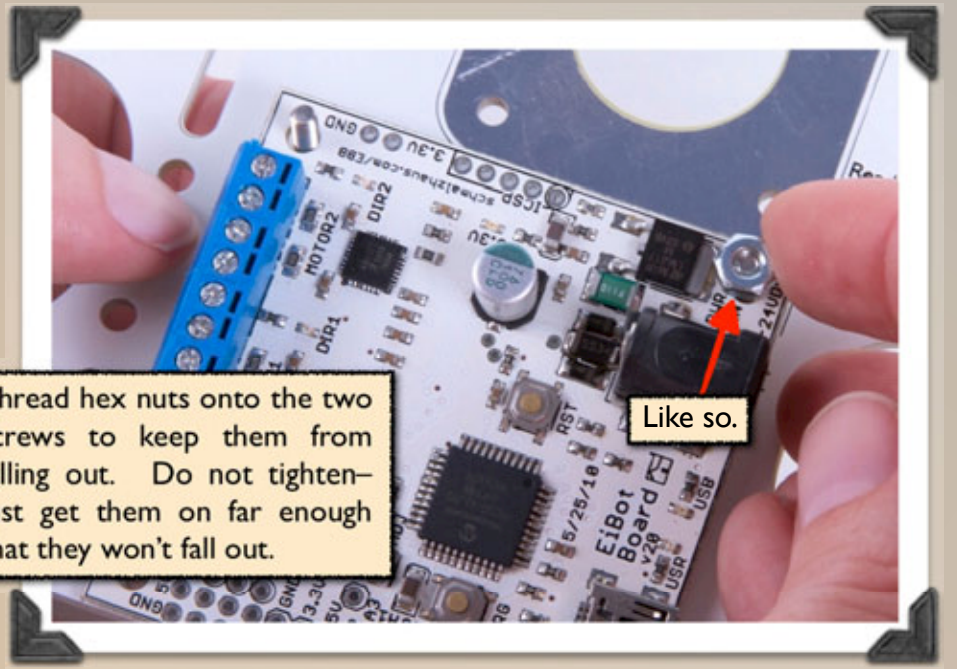
Drop one of the hex cap screws into each of these two holes. Hold the screw heads in place with your fingers while you flip the headstock over.



On the other side, place one of the nylon spacers over each screw.

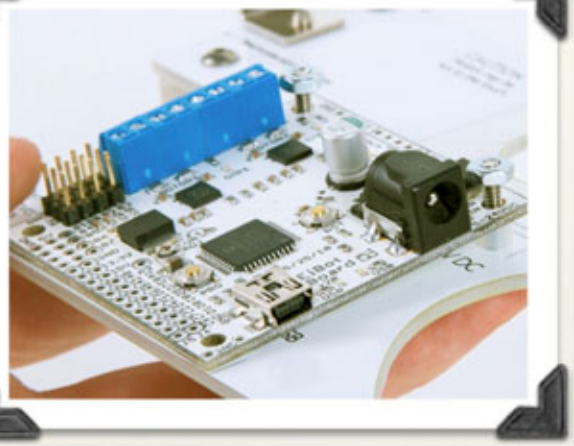


Then, add the EBB with the orientation shown.

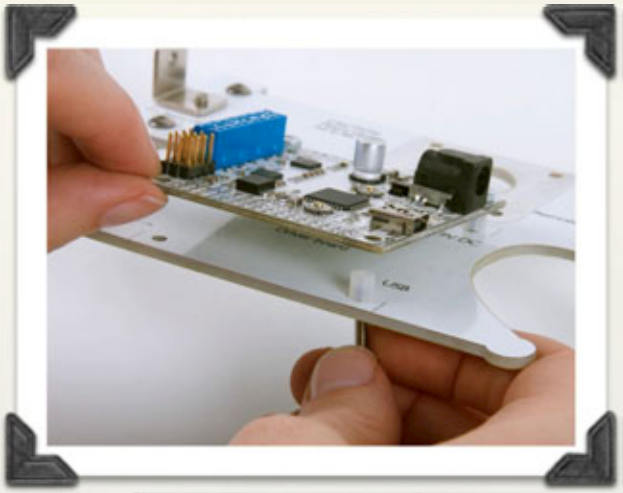


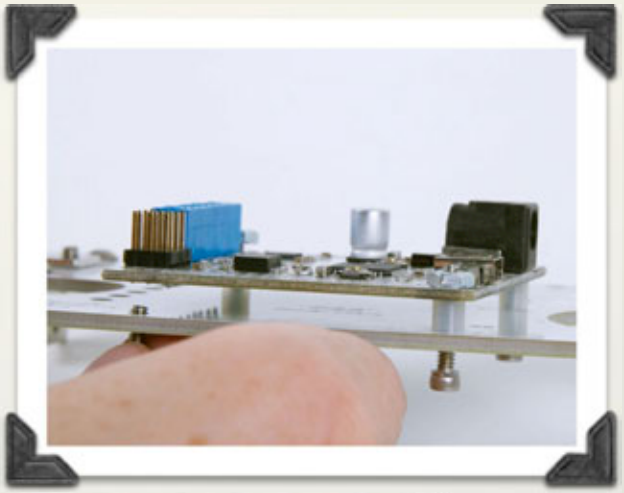
Thread hex nuts onto the two screws to keep them from falling out. Do not tighten– just get them on far enough that they won't fall out.

STEP 20: Adding the EBB, part II



Two screws and nuts already hold the EBB loosely in place, "hinged" at the top by those two screws.

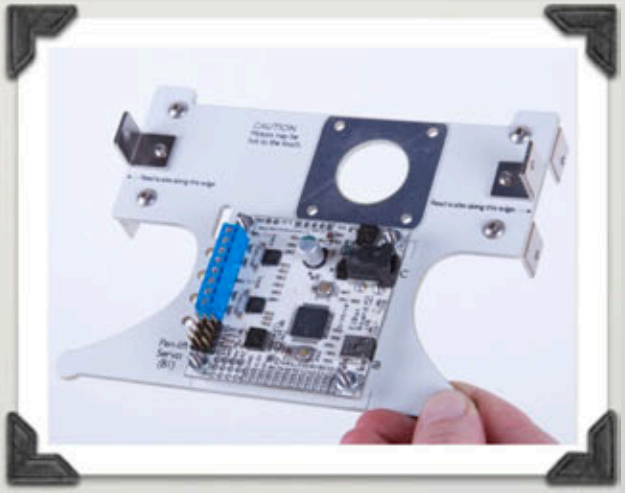




For the two remaining holes, push a screw up from the bottom, add the spacer, and thread on the nut from the top side of the EBB.

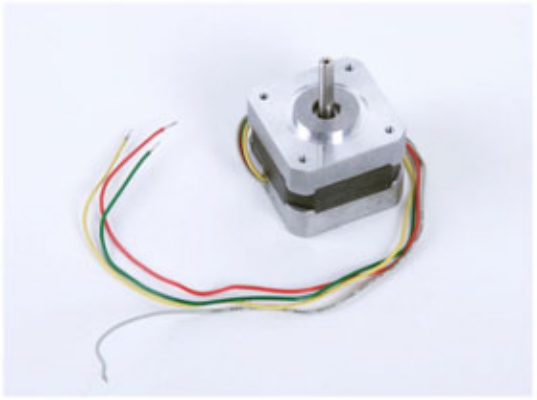
Here's how the board looks, mounted with all four screws & spacers.

Now, tighten the screws with the hex wrench. But, only to "finger tight." A good way do this is to hold each hex nut with your fingers.

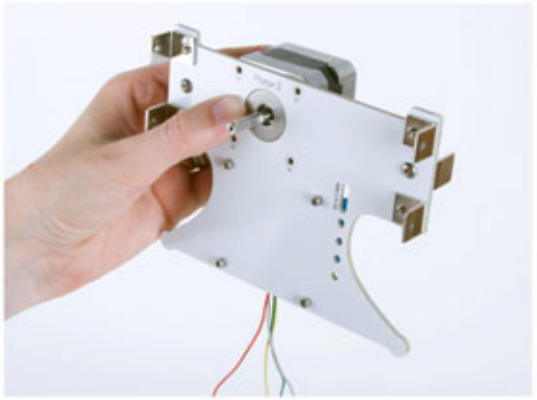


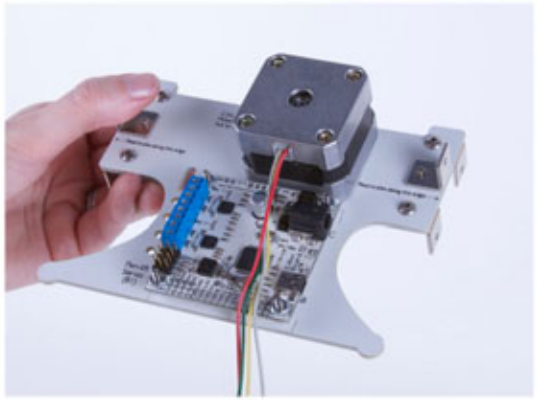
EBB installation complete!

STEP 21: Installing Motor 2, the "Egg Motor"

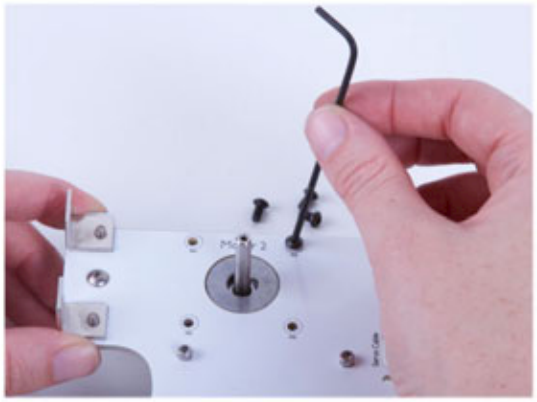


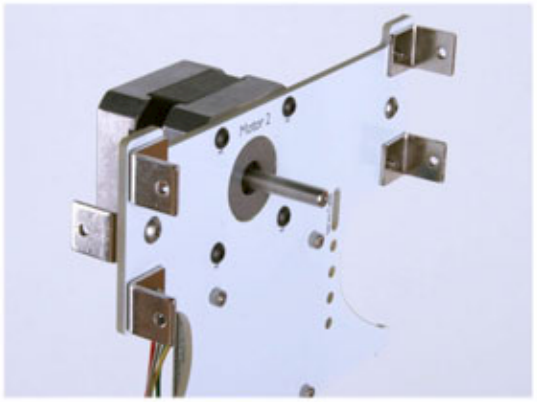
It's a bipolar stepper motor! (Part **#18** on the BOM.)



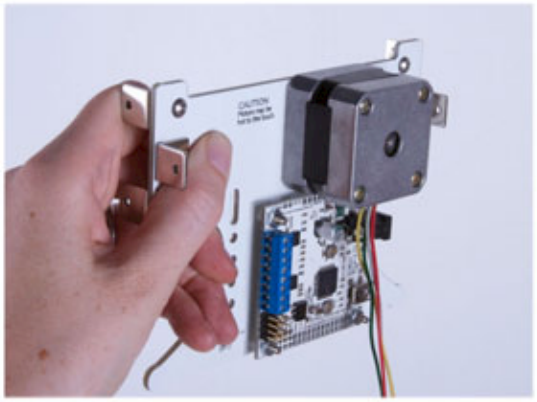


Test fit the motor in place. It sits above the EBB on the headstock, with its shaft poking through and its wires (for the moment) hanging down over the EBB.





The motor is held in by four M3 (metric) screws (part **#19**), the *black metal screws* in the kit. Put in all four screws and tighten them well with the 5/64" hex wrench.*

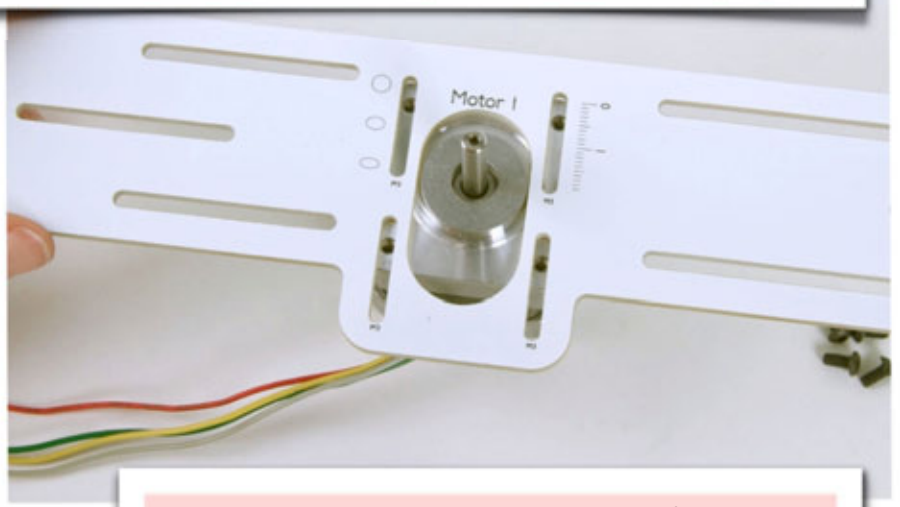


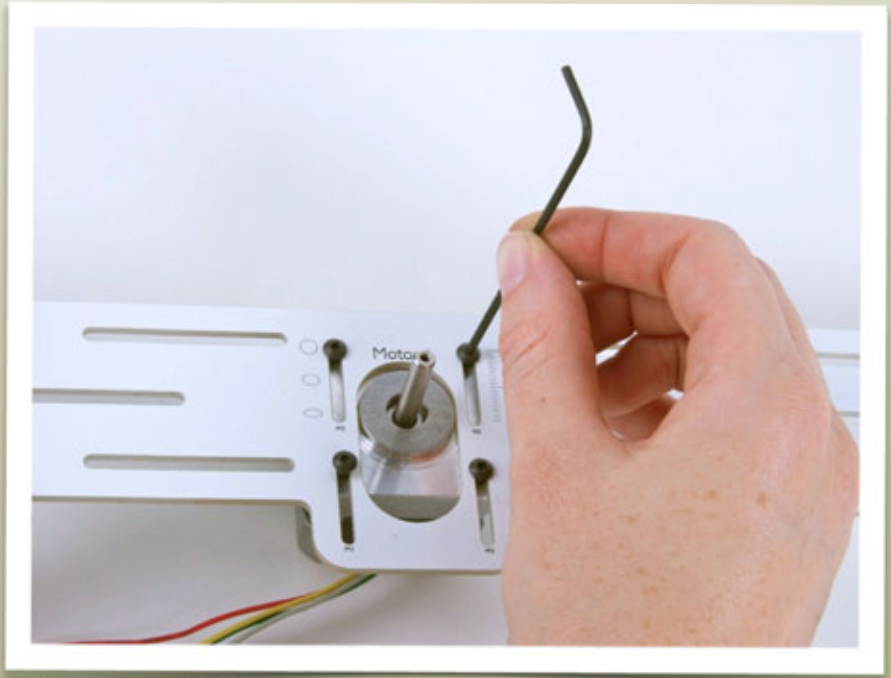
Here's the motor, fixed in place. It's called the "egg motor" because it turns the egg (or whatever else is mounted in the Eggbot).

*Purists: Unorthodox, maybe, but totally legit: 5/64" = 2 mm to within 0.001". But you knew that, right? :)

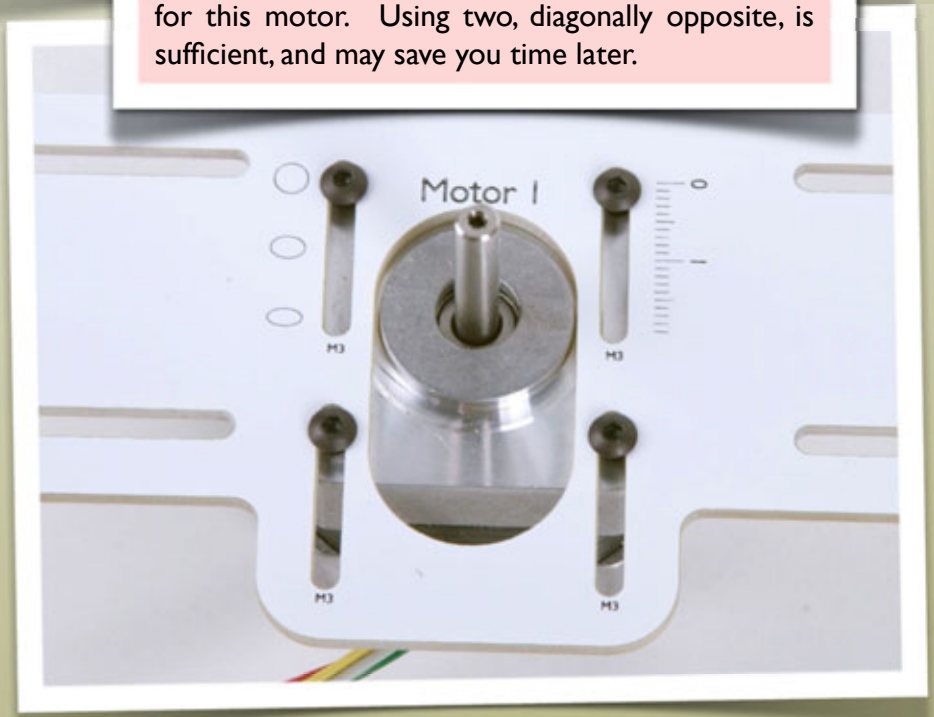
STEP 22: Installing Motor 1, the "Pen Motor"

Motor 1, the "pen motor" attaches to the chassis side wall. As before, test-fit the motor in place and then use the black M3 screws to fix it in place. The screws on this motor only need to be moderately tight.





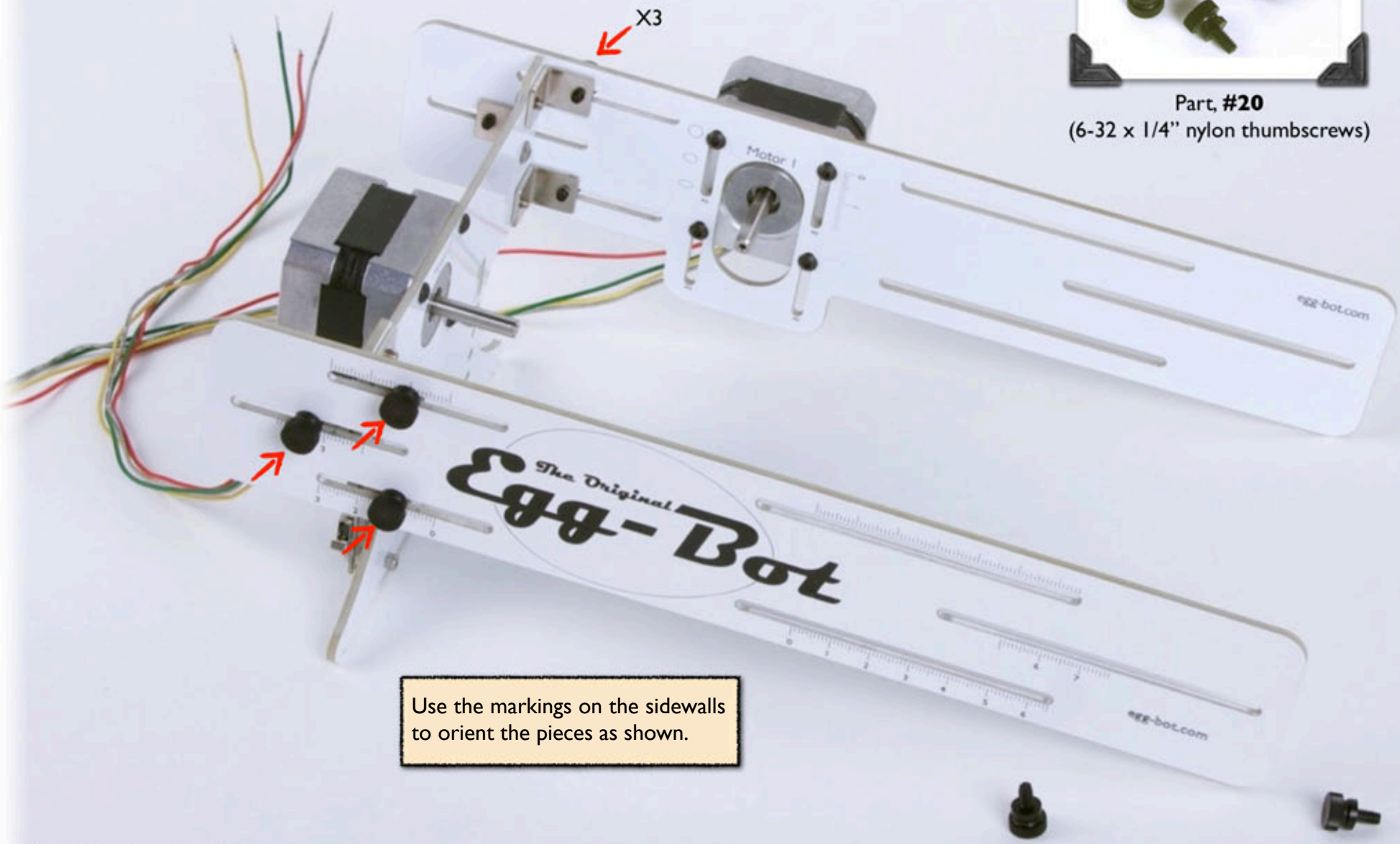
Pro-tip: You *do not* need to install all four screws for this motor. Using two, diagonally opposite, is sufficient, and may save you time later.



STEP 23: Attach the Headstock to the Chassis

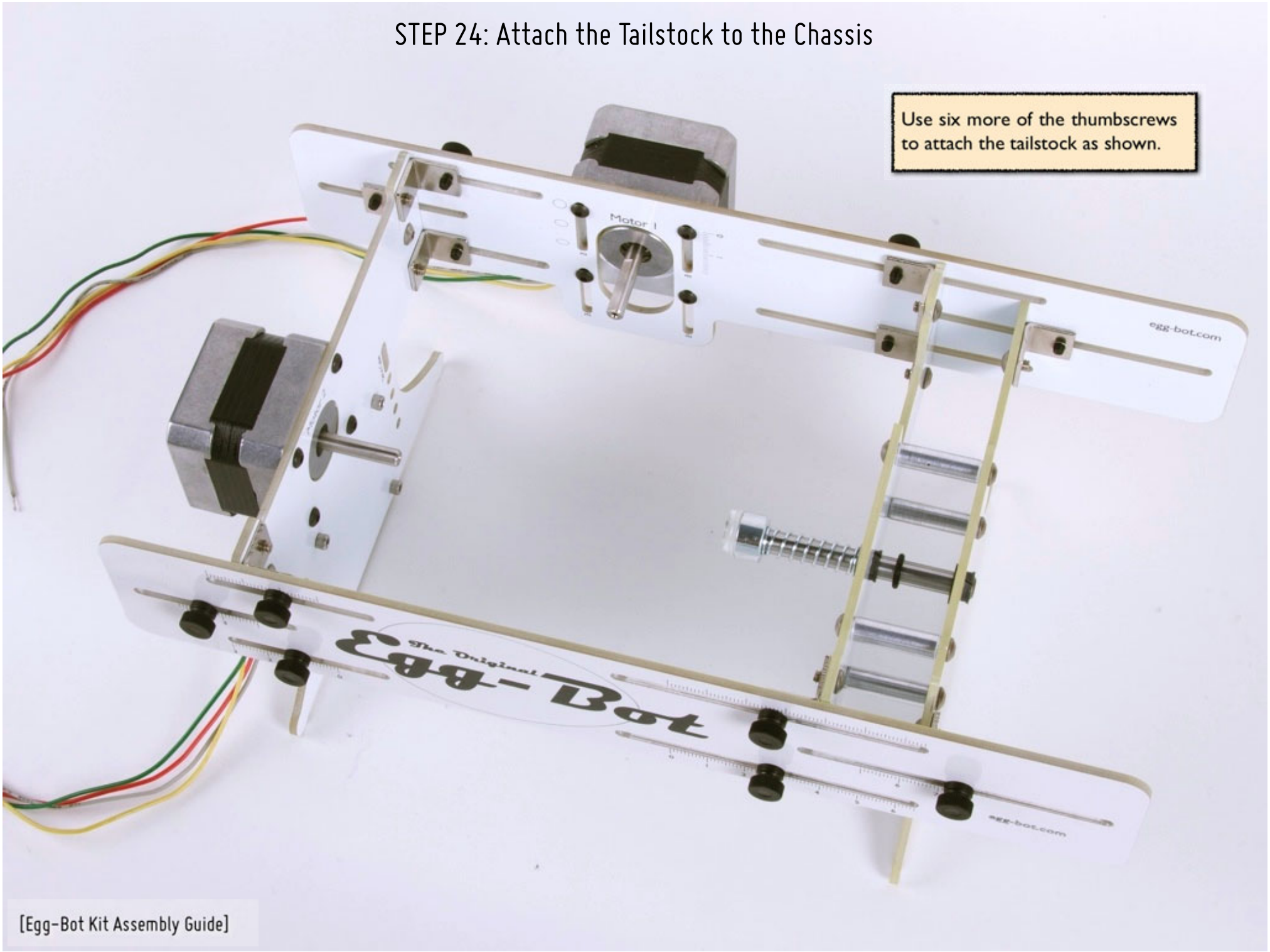
Part **#20** is a small black plastic thumbscrew. These fit through the long slots in the chassis side walls and thread into the angle brackets on the headstock. Use six of them to attach the headstock to the side walls.

Part, **#20**
(6-32 x 1/4" nylon thumbscrews)



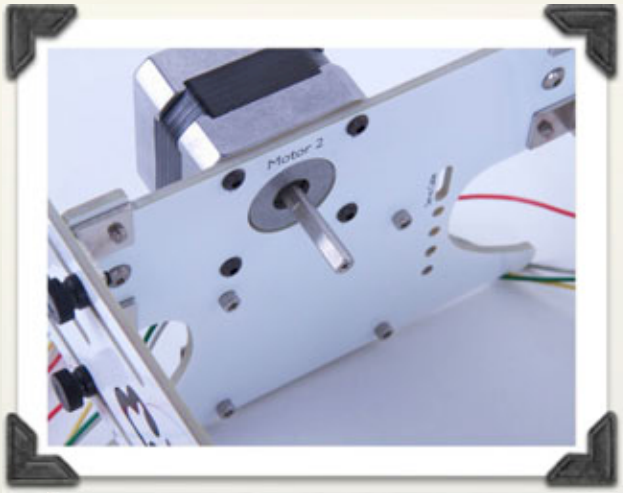
Use the markings on the sidewalls to orient the pieces as shown.

STEP 24: Attach the Tailstock to the Chassis

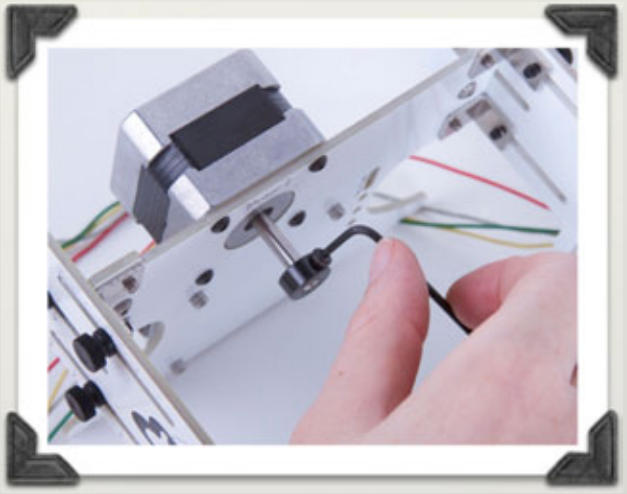


STEP 25: The other Egg Cup

Next we need **#21**, (a 5 mm shaft collar that fits nicely around the motor shaft) plus one more black M3 screw and the 5/64 wrench.



Thread the screw into the shaft collar, and slide the collar into place. Orient the screw such that it will tighten down onto the flat face of the motor shaft. As before, the shaft collar goes flush to the end of the shaft; the shaft must not protrude.

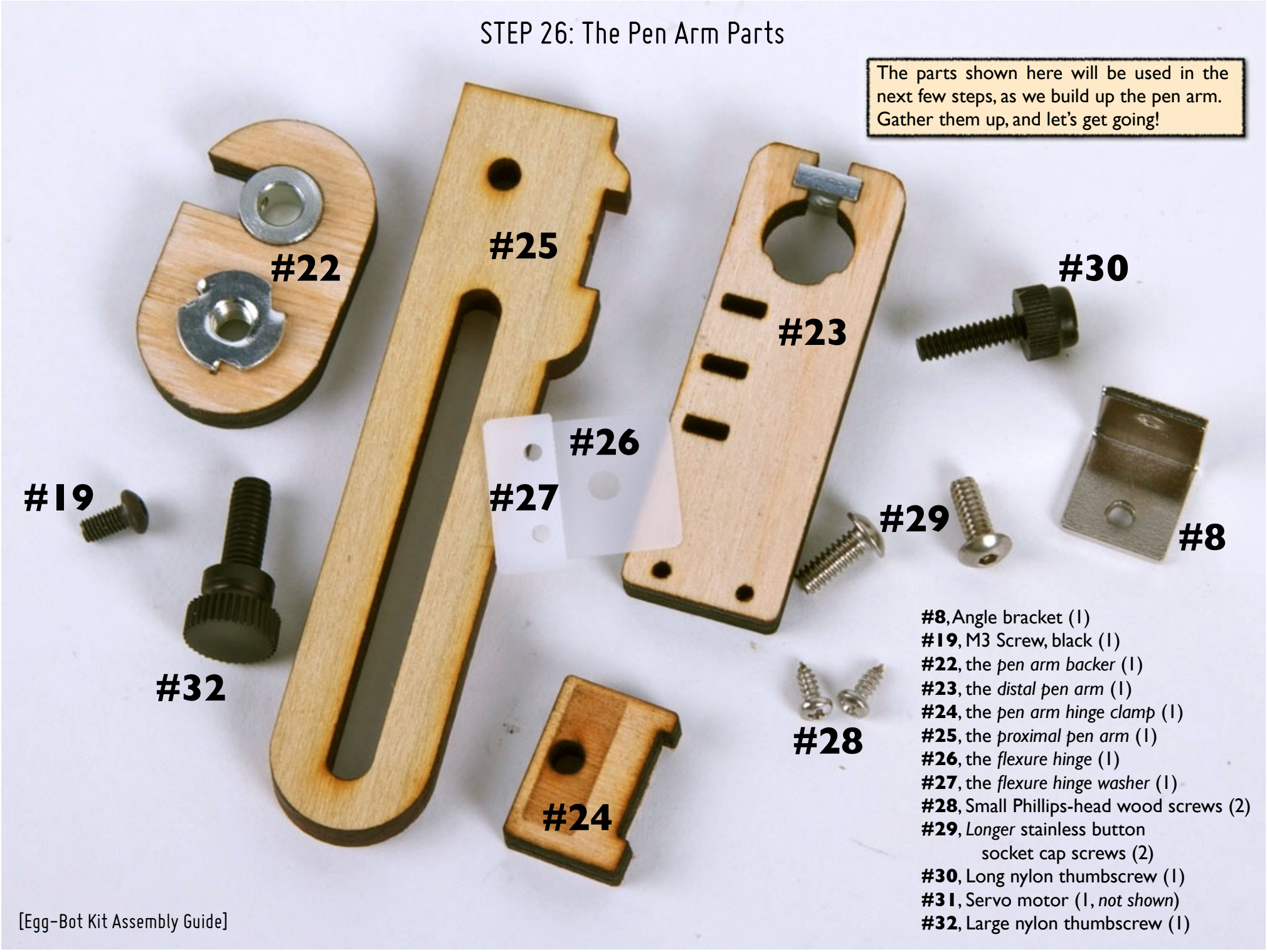


Once the shaft collar is in the right place, tighten it well. (But, do not use excessive force that might damage the motor.)

As before, check the shaft and collar for any excess debris, and *carefully* apply another self-adhesive "egg cup" to end of the shaft collar. Do your best to center it before pressing it firmly to help set it in place.

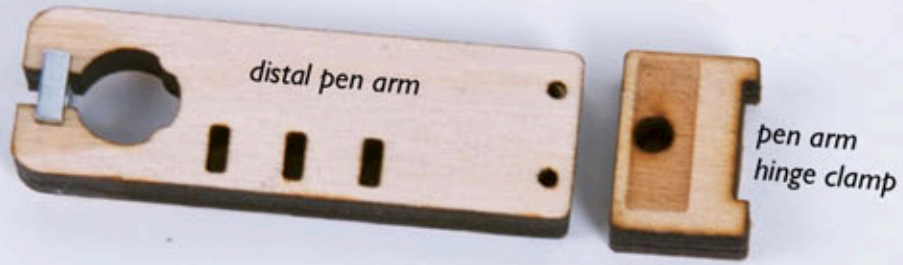
STEP 26: The Pen Arm Parts

The parts shown here will be used in the next few steps, as we build up the pen arm. Gather them up, and let's get going!

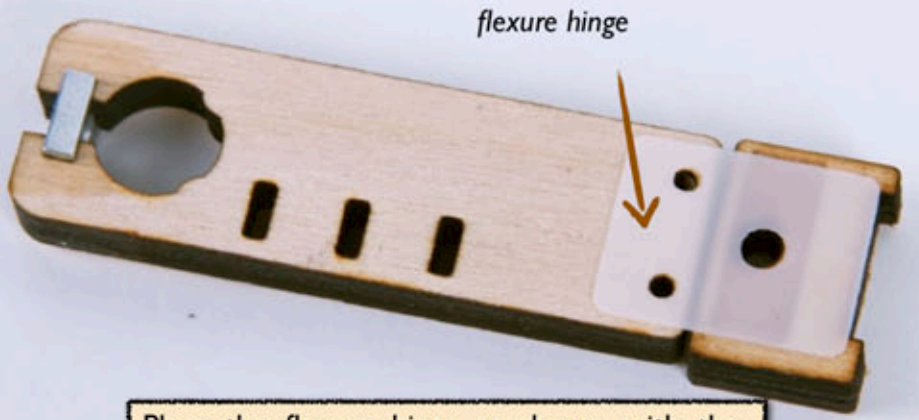


#8, Angle bracket (1)
#19, M3 Screw, black (1)
#22, the *pen arm backer* (1)
#23, the *distal pen arm* (1)
#24, the *pen arm hinge clamp* (1)
#25, the *proximal pen arm* (1)
#26, the *flexure hinge* (1)
#27, the *flexure hinge washer* (1)
#28, Small Phillips-head wood screws (2)
#29, *Longer* stainless button socket cap screws (2)
#30, Long nylon thumbscrew (1)
#31, Servo motor (1, *not shown*)
#32, Large nylon thumbscrew (1)

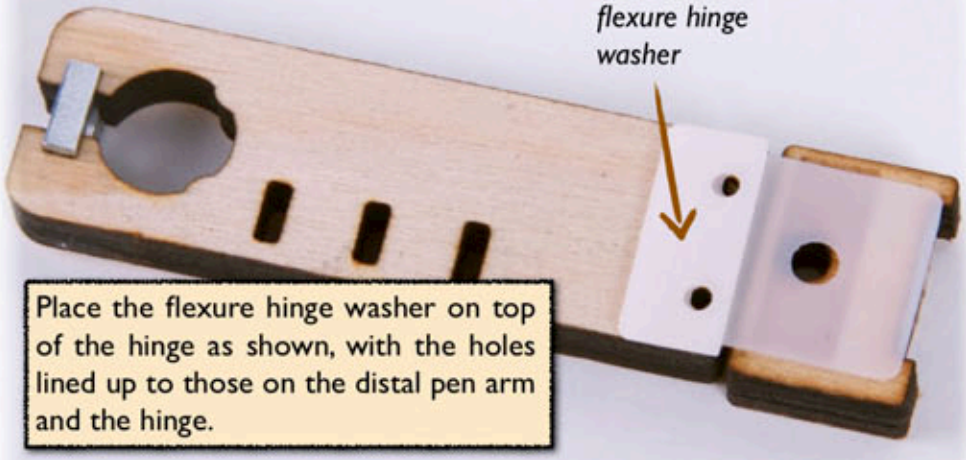
STEP 27: Adding the pen arm hinge



In this step we attach the hinge and washer to the distal pen arm. (The clamp is just along for the ride.) Orient the distal pen arm and clamp as shown.



Place the flexure hinge as shown, with the holes lined up to those on the distal pen arm.



Place the flexure hinge washer on top of the hinge as shown, with the holes lined up to those on the distal pen arm and the hinge.

Put the two small Phillips-head wood screws through the holes in the washer, and tighten them in place.

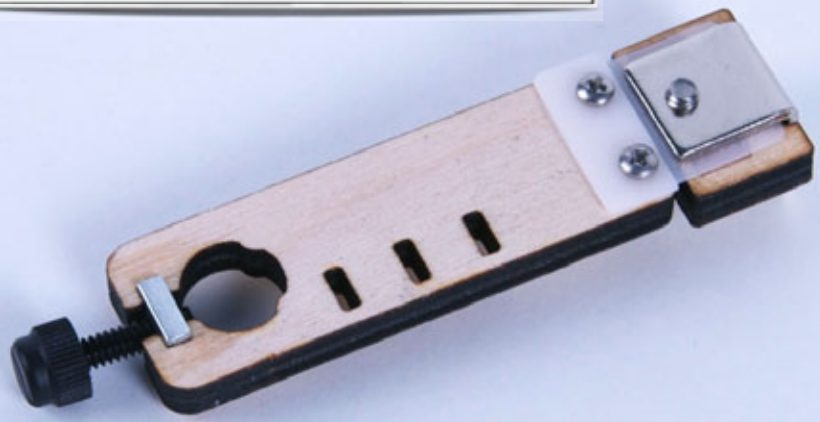
STEP 28: Add the Pen Arm Hinge Clamp

Feed one of the "long" stainless screws (**#29**) from the bottom side of the pen arm hinge clamp.

Then, place the free end of the flexure hinge over that screw end as shown.

Add the angle bracket on top of the hinge and screw it tightly into place with the 5/64" hex wrench.

Finally, loosely thread the "long" nylon thumbscrew (**#30**), to the end of the pen arm.



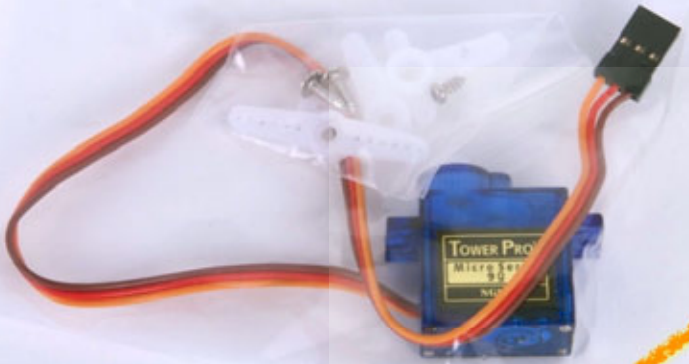
STEP 29: A look at what's to come.

Here's what the pen arm will look like after a few more steps.

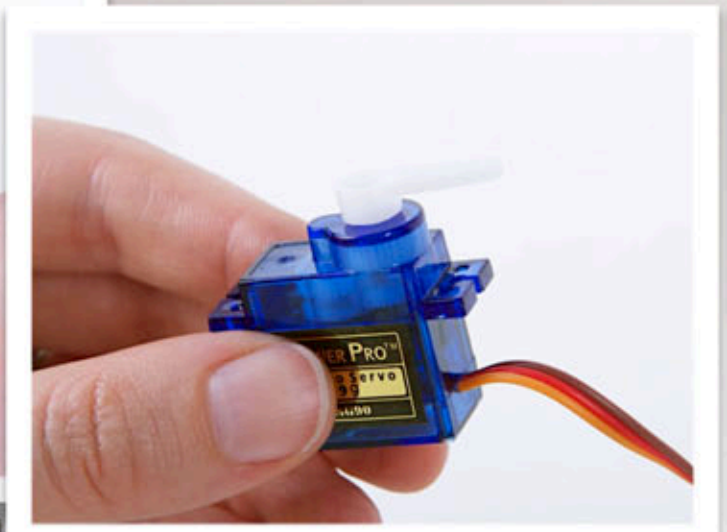
The upper part with the hinge is already done. In the next couple of steps, we'll prep the servo motor so that we can add it and finish this assembly.

STEP 30: The servo motor, initial setup

The servo motor comes in a small bag of accessories...

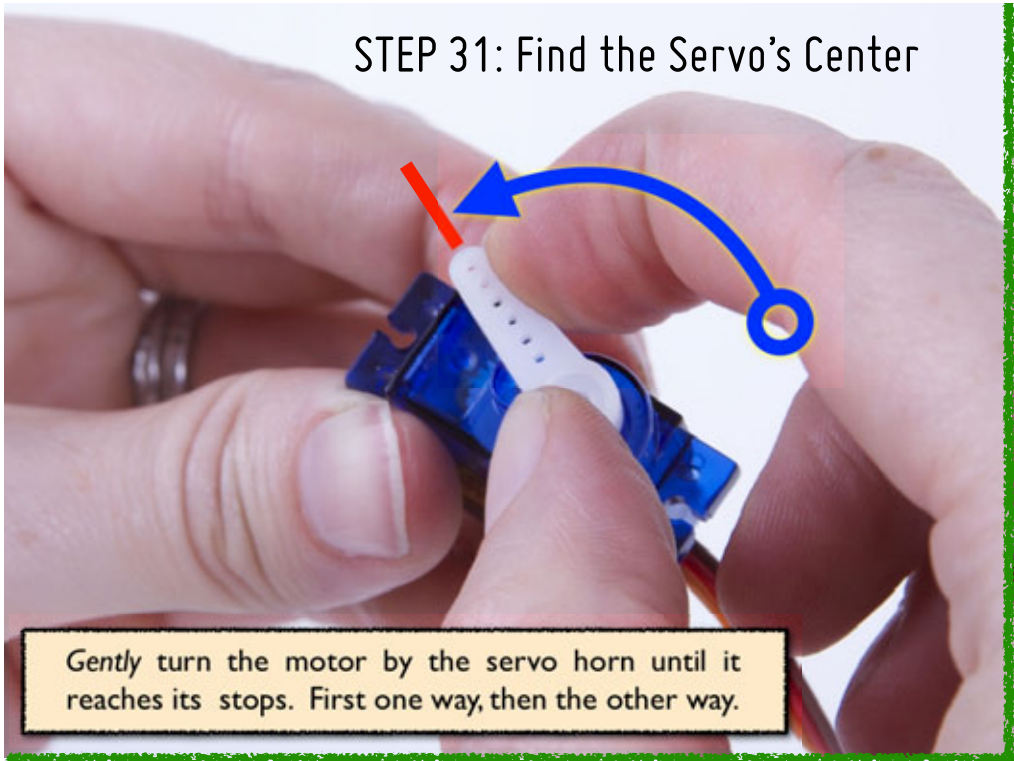


We'll only need these parts; set the others aside.

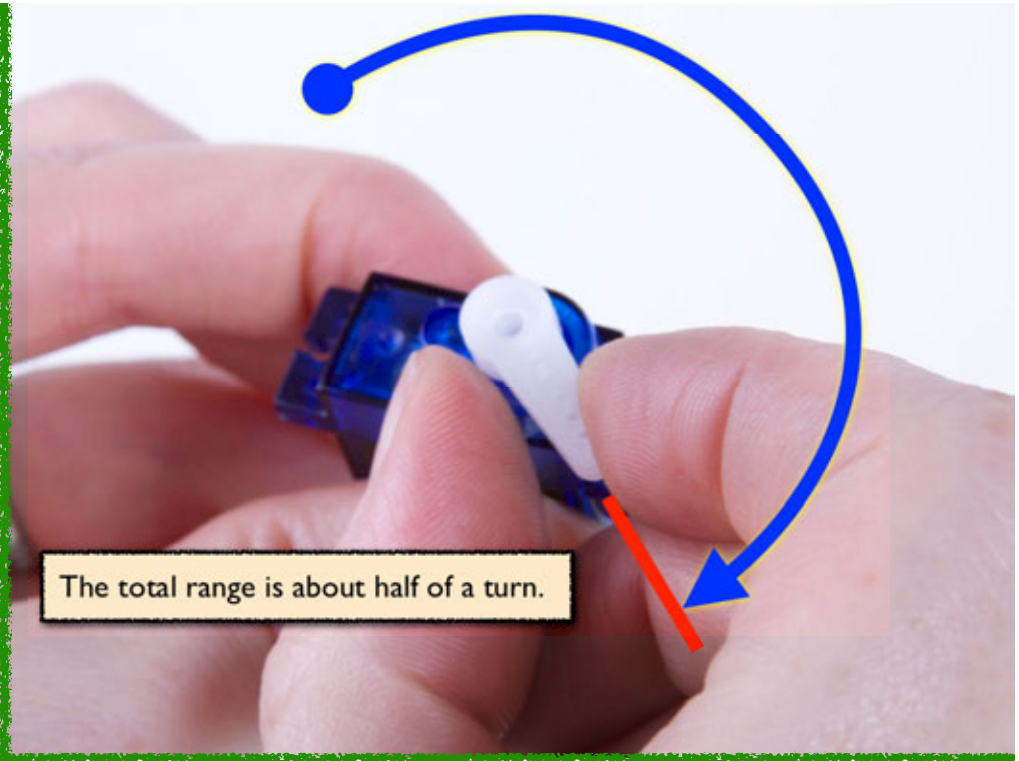


Take this piece, the *servo horn*, and push it onto the servo motor shaft. (Do not screw it in place; its position is not final yet.)

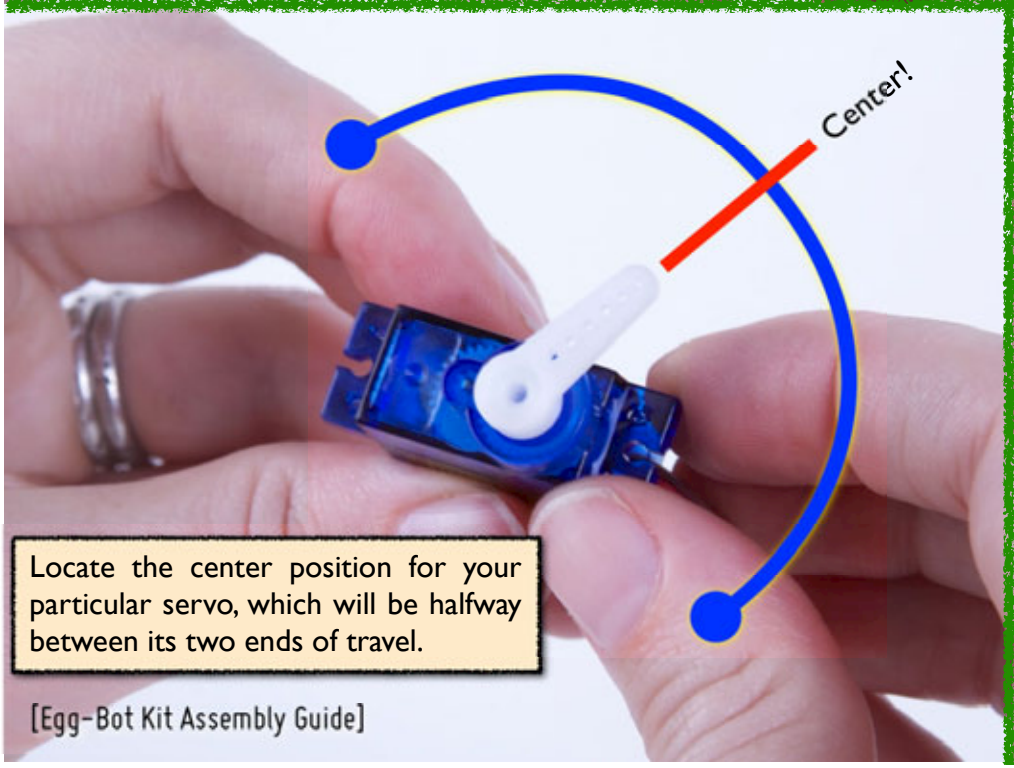
STEP 31: Find the Servo's Center



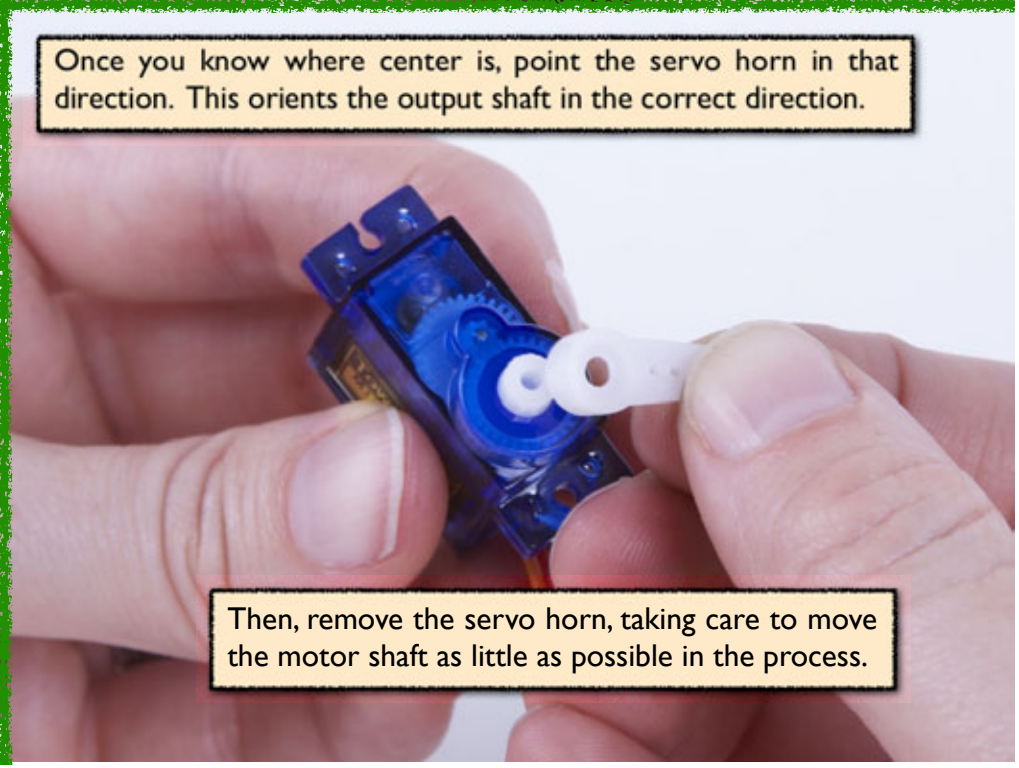
Gently turn the motor by the servo horn until it reaches its stops. First one way, then the other way.



The total range is about half of a turn.



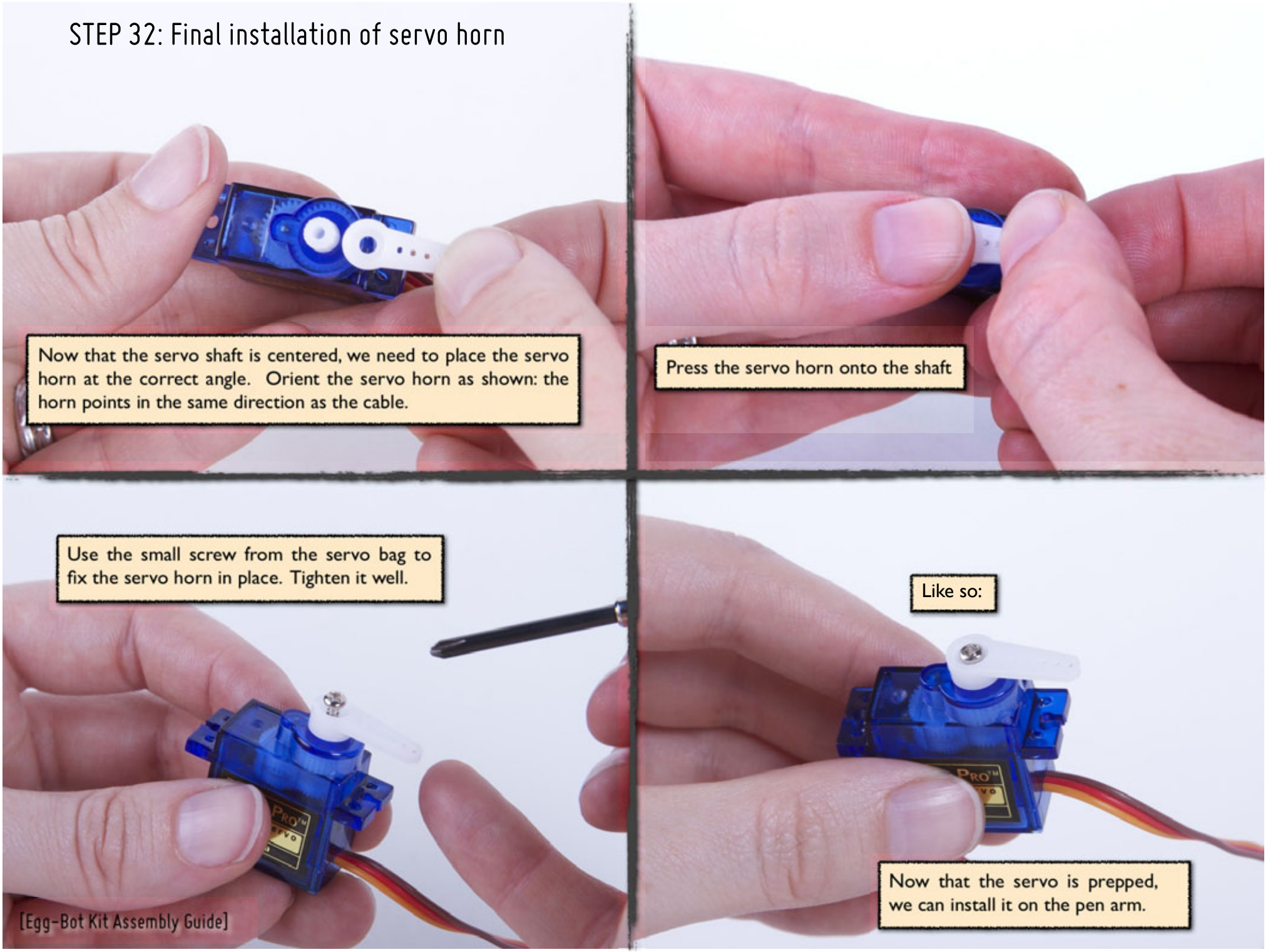
Locate the center position for your particular servo, which will be halfway between its two ends of travel.



Once you know where center is, point the servo horn in that direction. This orients the output shaft in the correct direction.

Then, remove the servo horn, taking care to move the motor shaft as little as possible in the process.

STEP 32: Final installation of servo horn

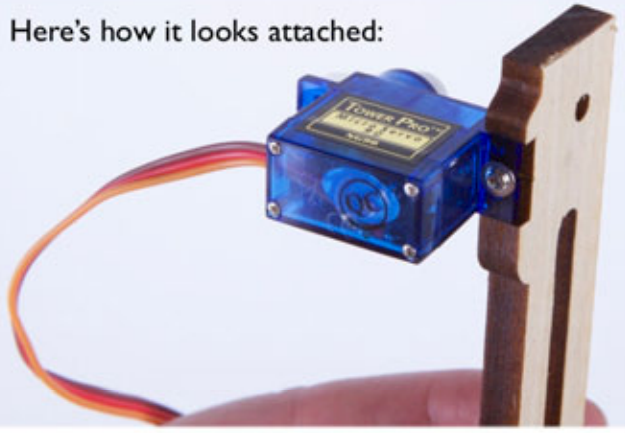


STEP 33: Install the Servo Motor

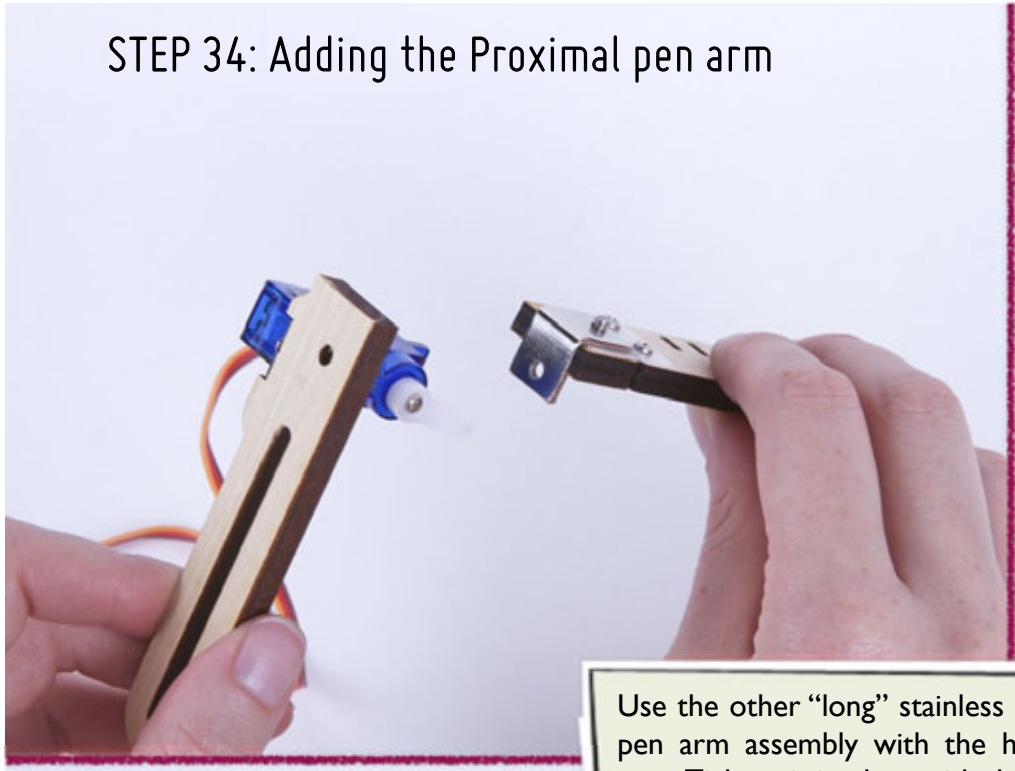
Hold the servo motor down and flush against the side against the proximal pen arm as shown here, such that there is *no gap* between them.

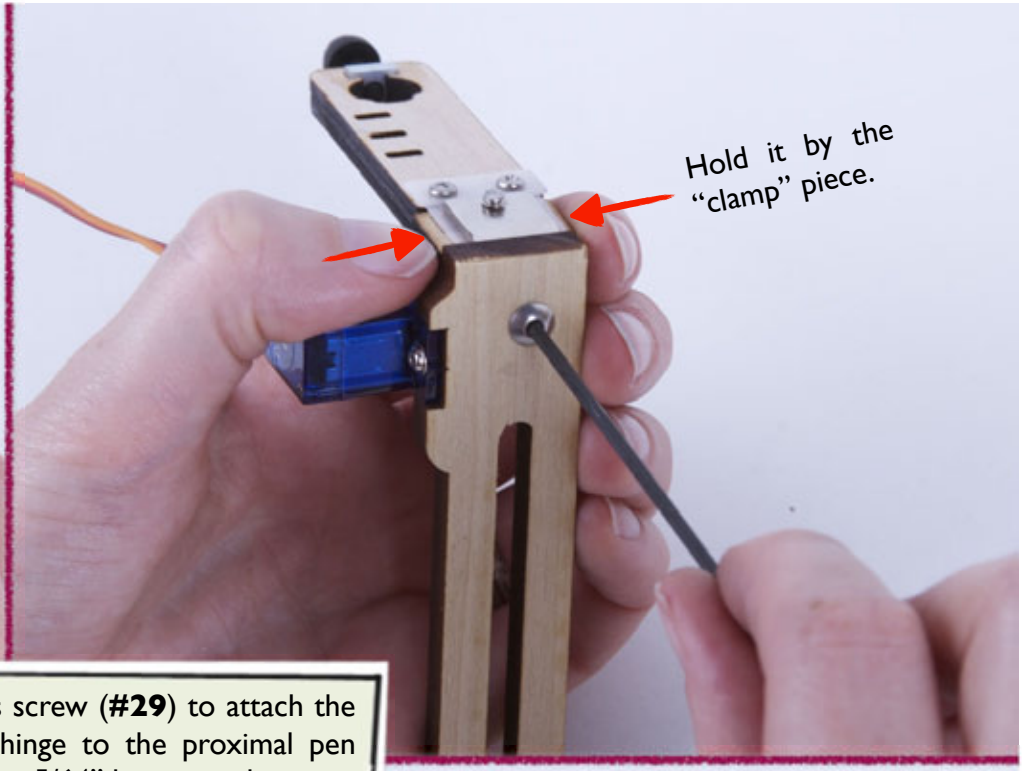
From the set of servo accessories, take one of the two remaining (larger size) screws, and use it to screw the servo motor down into the wood of the proximal pen arm.

Here's how it looks attached:

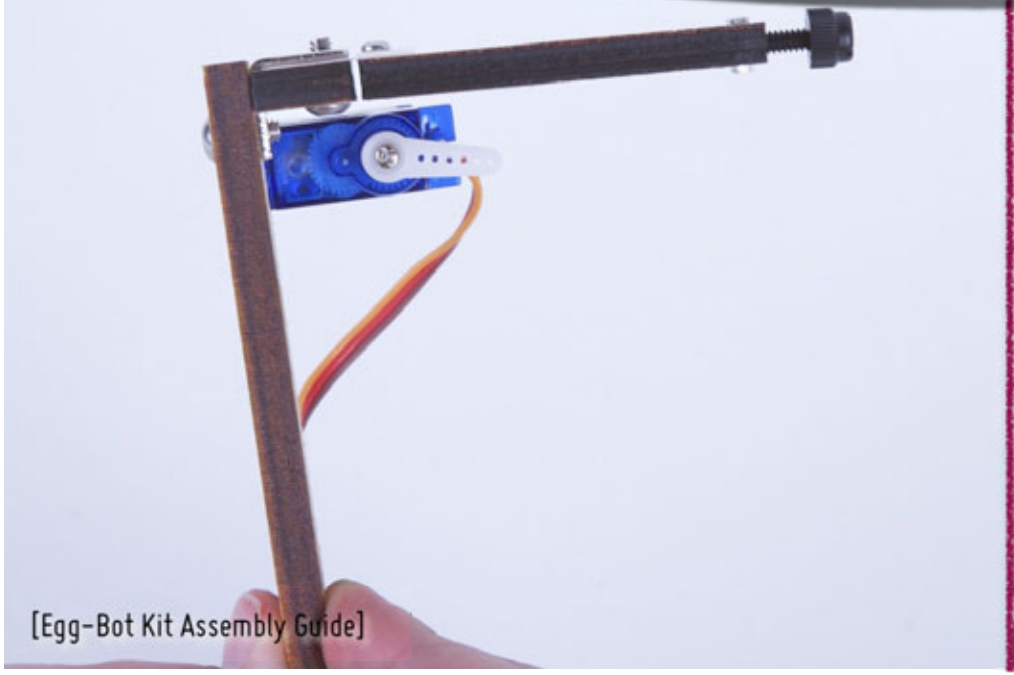


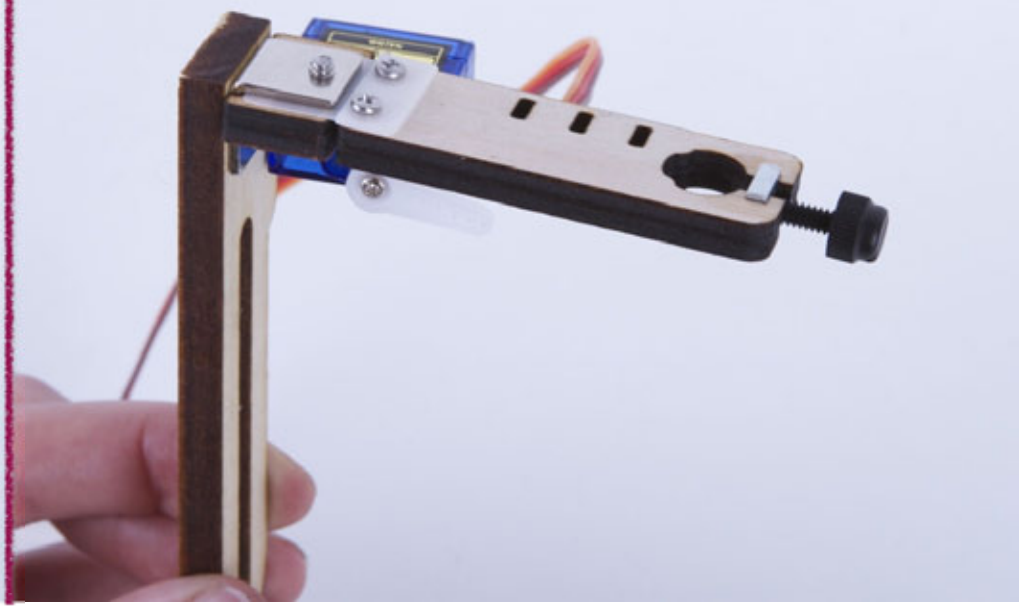
STEP 34: Adding the Proximal pen arm



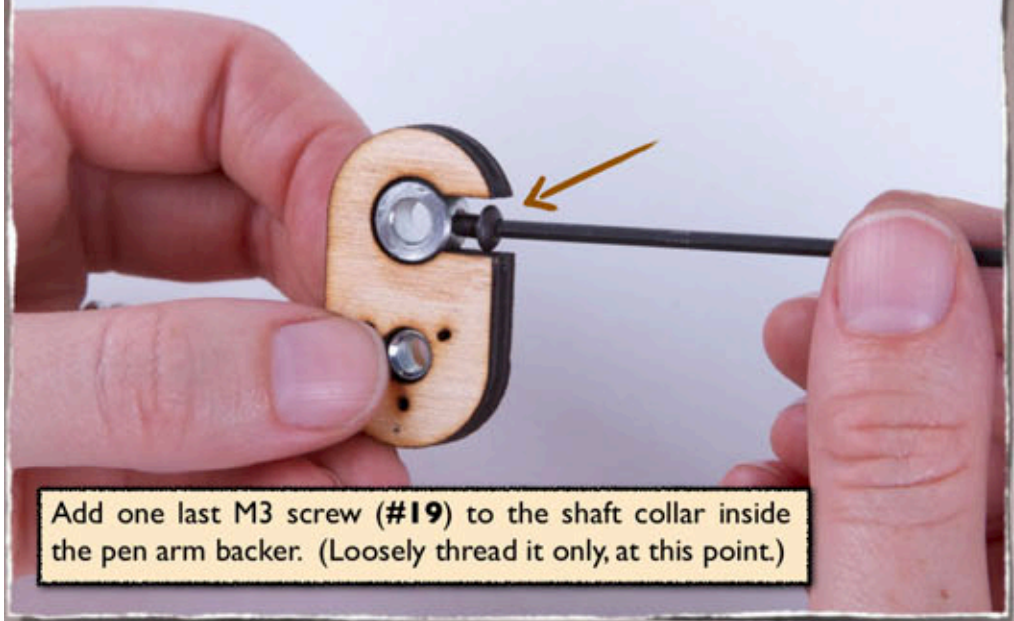


Use the other "long" stainless screw (**#29**) to attach the pen arm assembly with the hinge to the proximal pen arm. Tighten it in place with the 5/64" hex wrench.

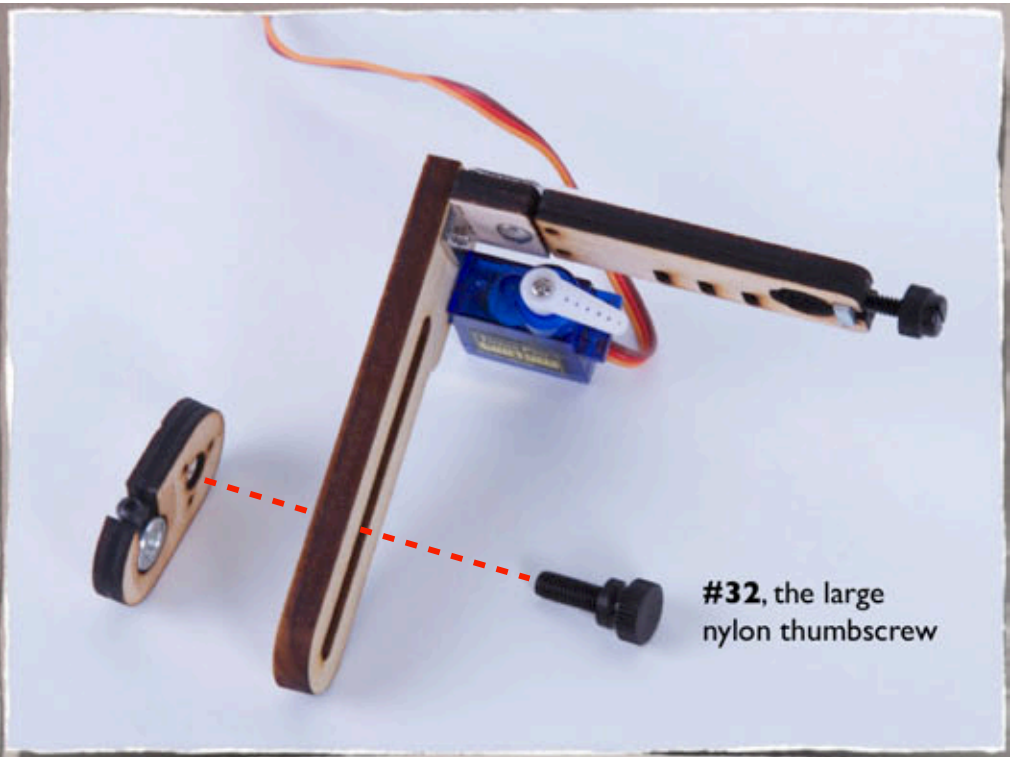




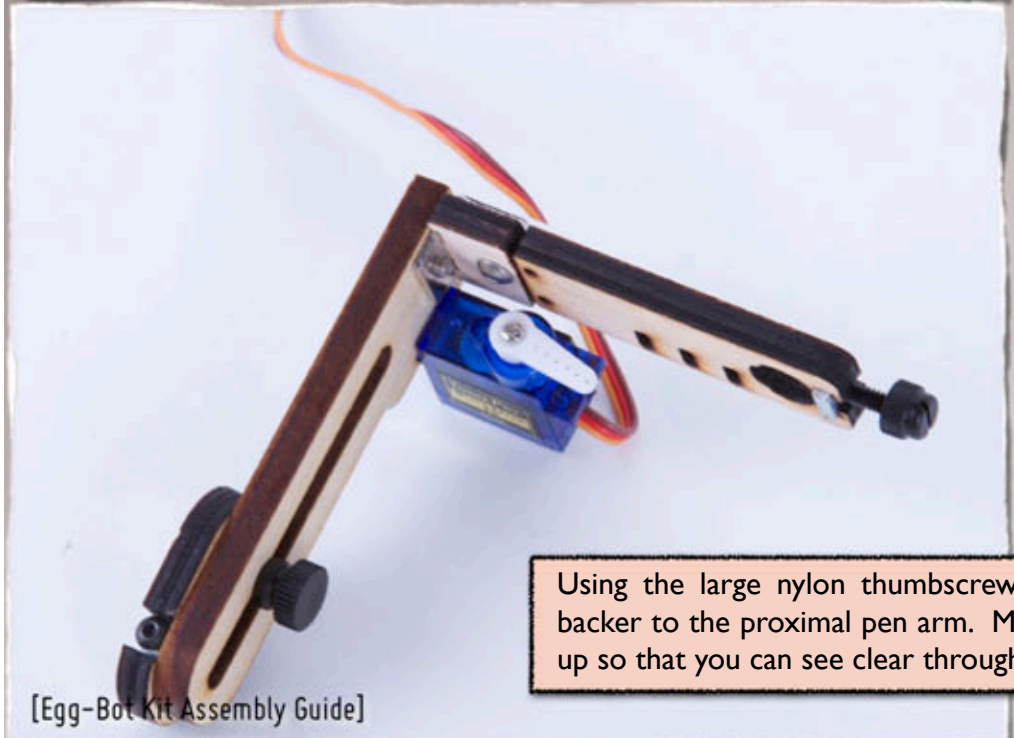
STEP 35: Adding the Pen Arm Backer

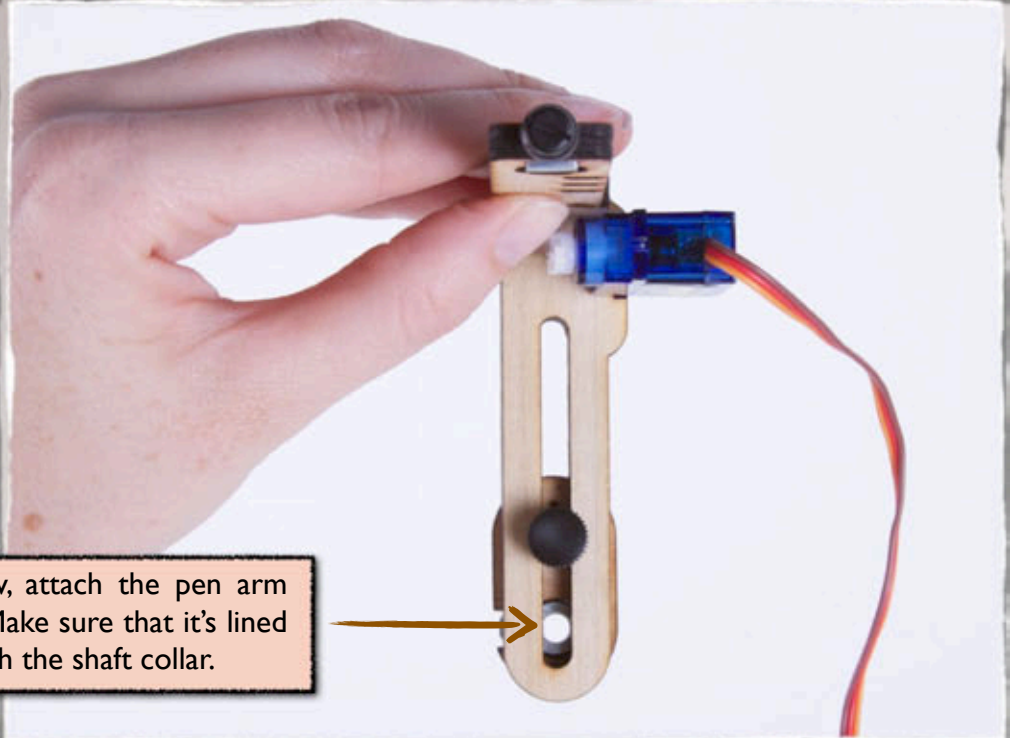


Add one last M3 screw (**#19**) to the shaft collar inside the pen arm backer. (Loosely thread it only, at this point.)



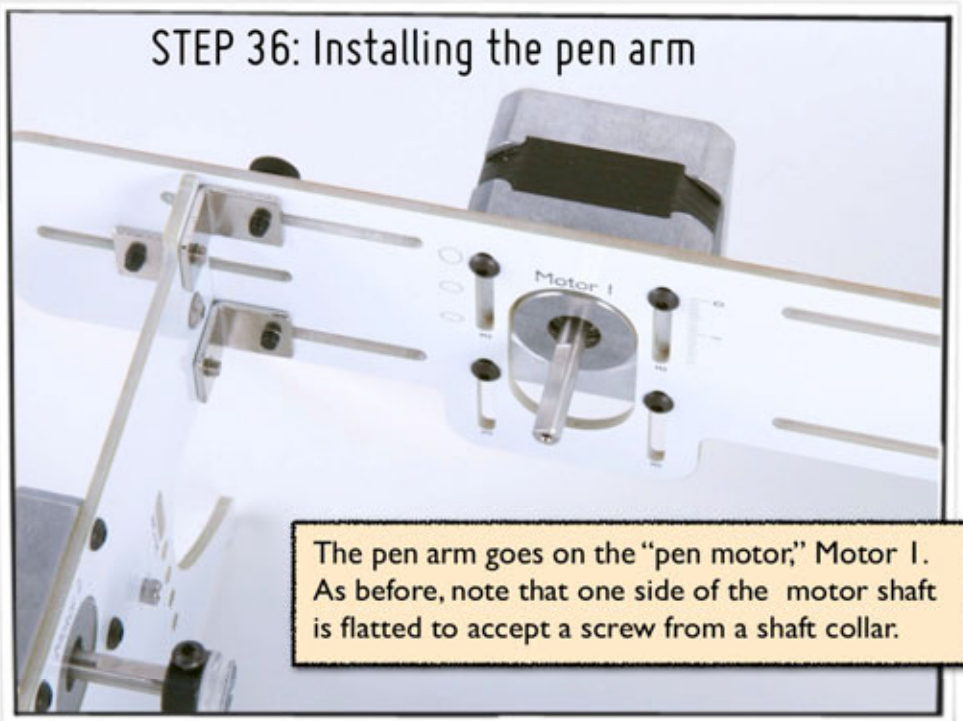
#32, the large nylon thumbscrew



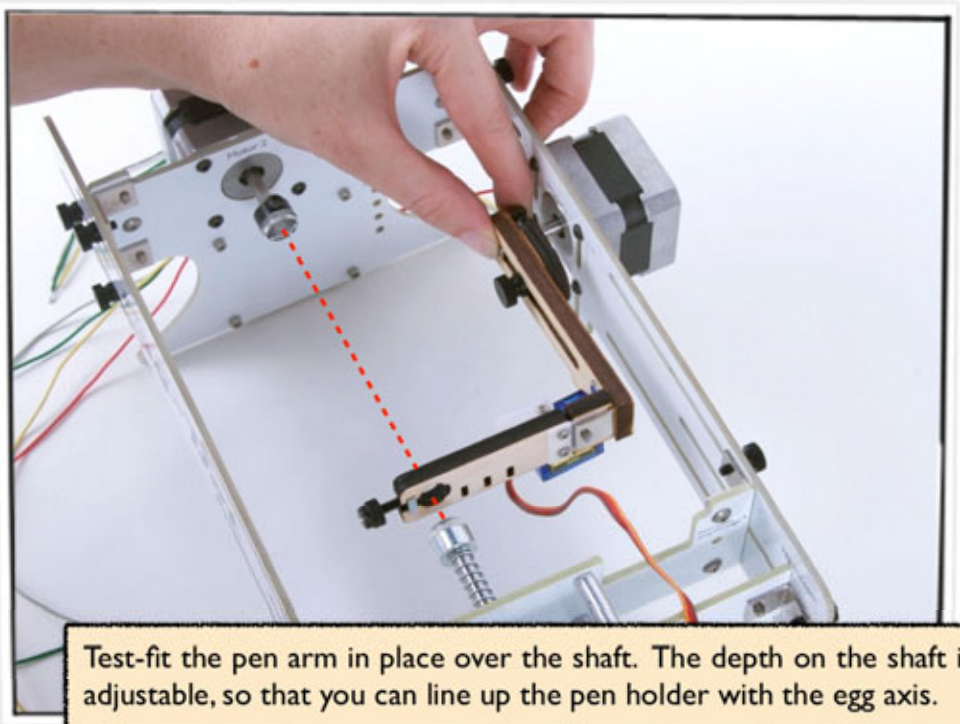


Using the large nylon thumbscrew, attach the pen arm backer to the proximal pen arm. Make sure that it's lined up so that you can see clear through the shaft collar.

STEP 36: Installing the pen arm

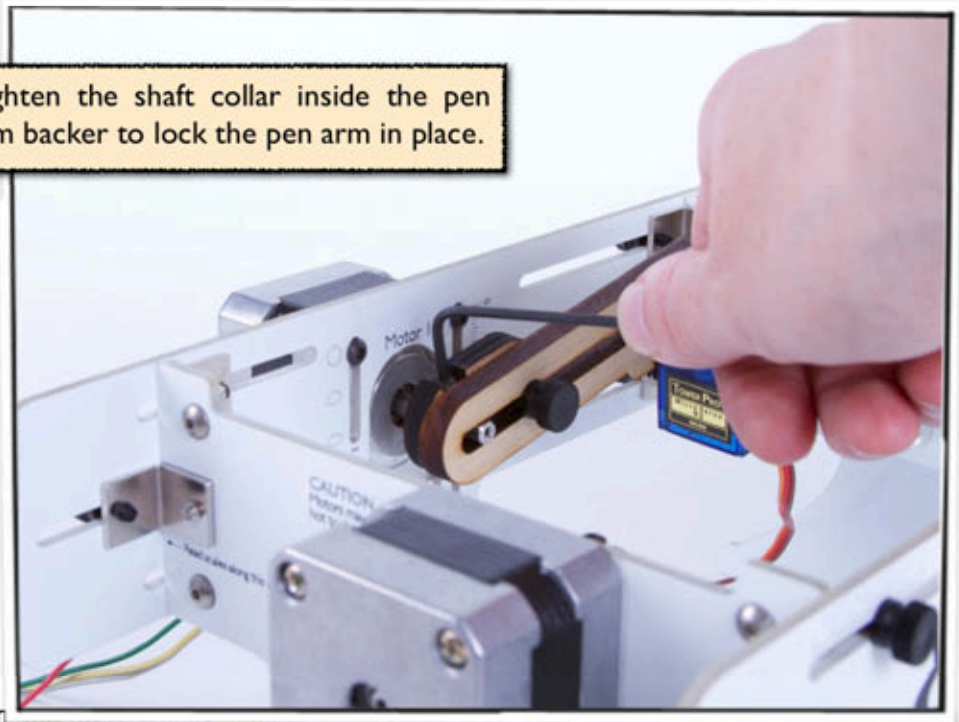


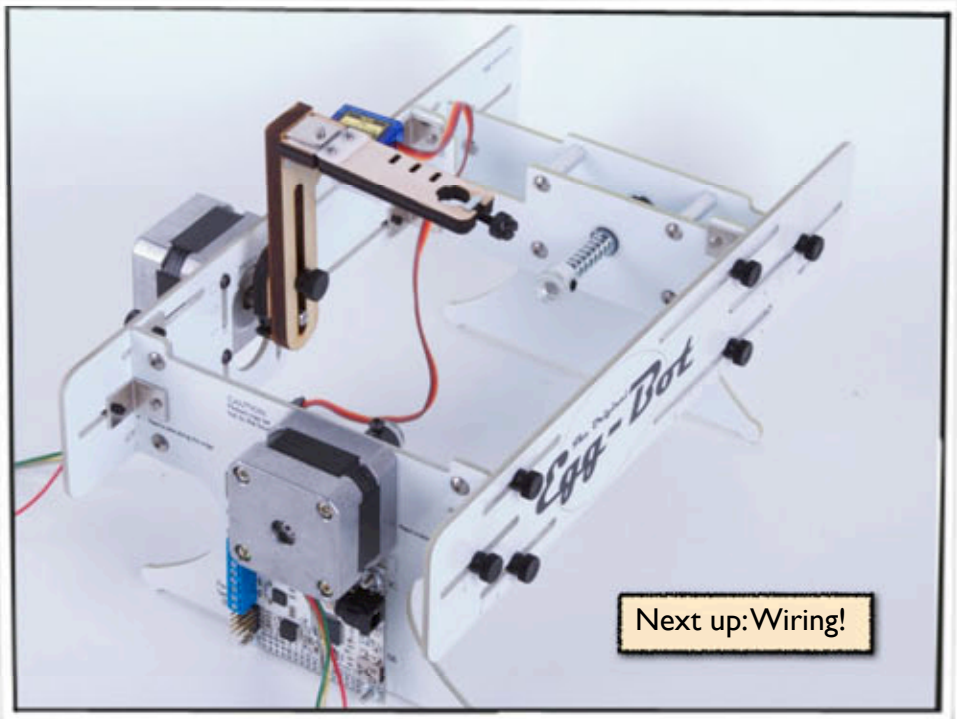
The pen arm goes on the "pen motor," Motor 1. As before, note that one side of the motor shaft is flatted to accept a screw from a shaft collar.



Test-fit the pen arm in place over the shaft. The depth on the shaft is adjustable, so that you can line up the pen holder with the egg axis.

Tighten the shaft collar inside the pen arm backer to lock the pen arm in place.

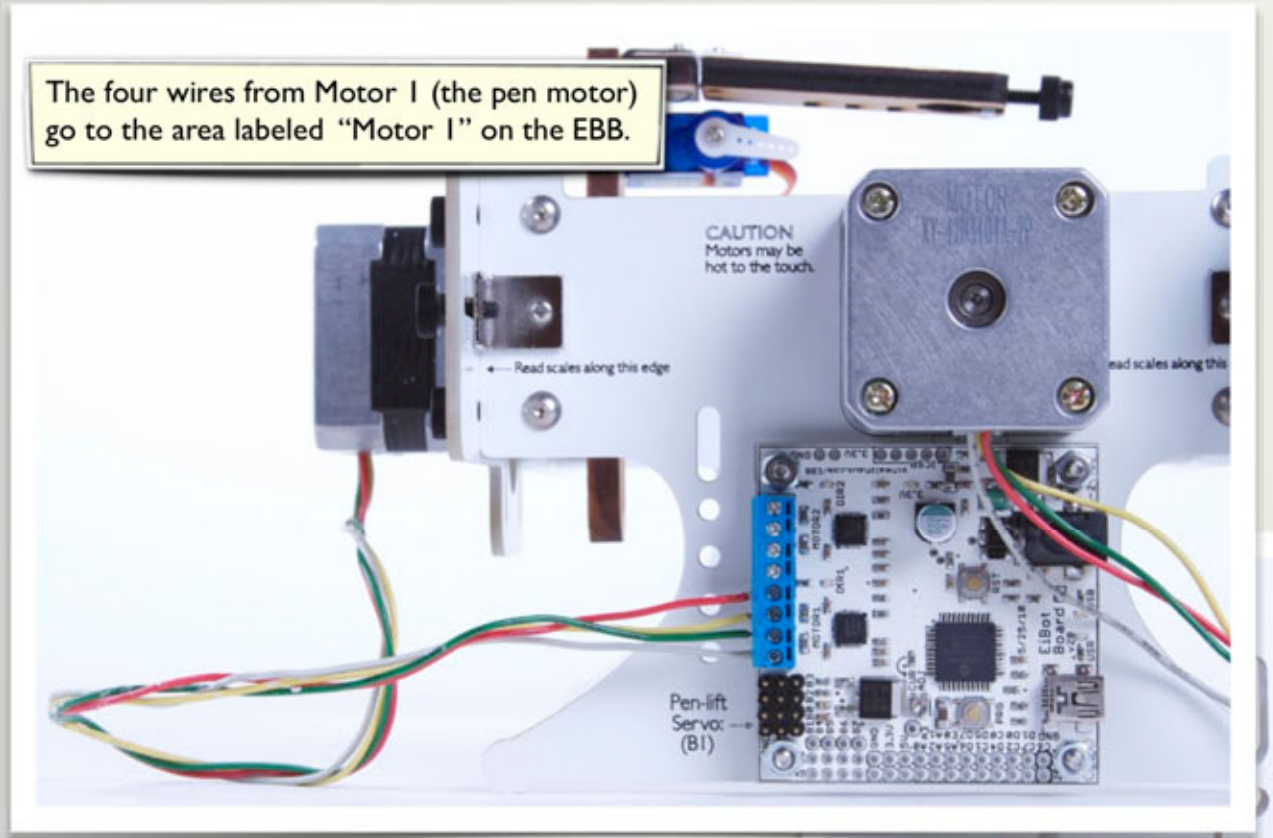


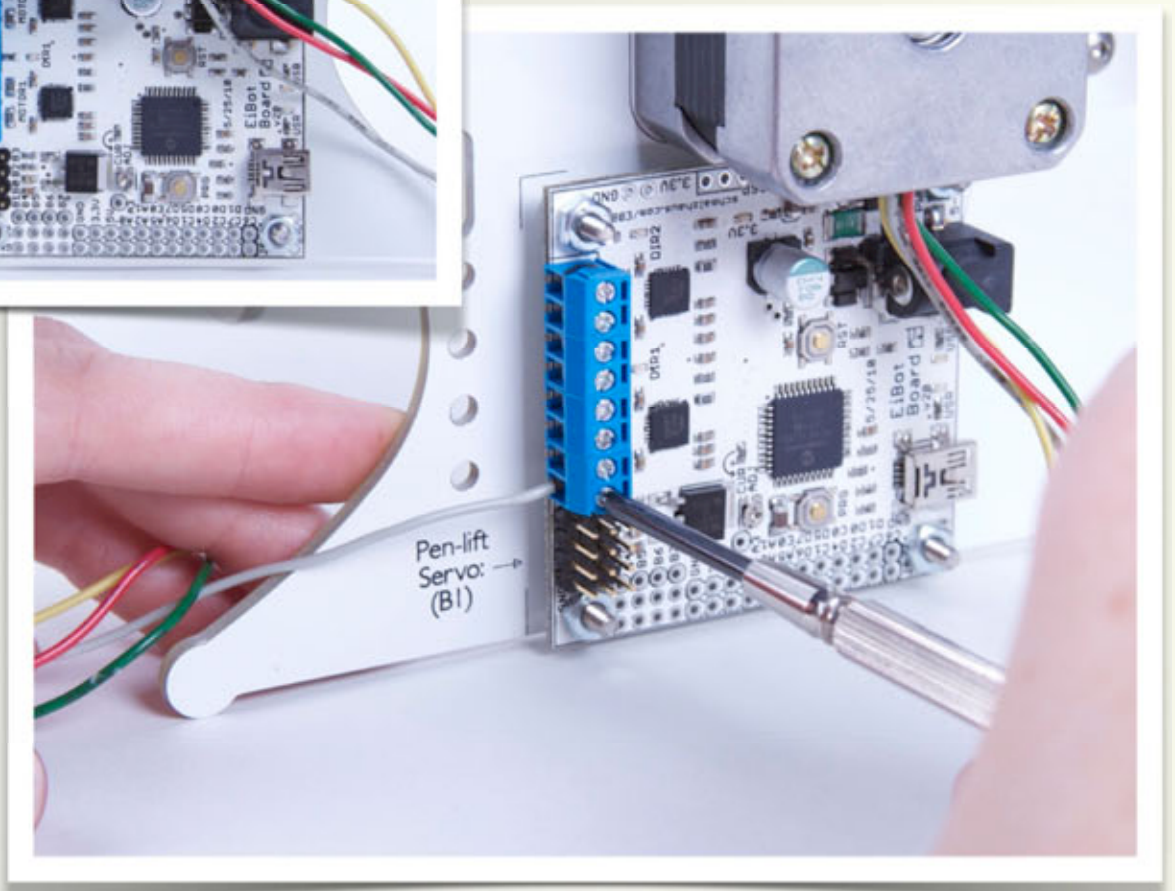


Next up: Wiring!

[Egg

STEP 37: Wiring Motor 1

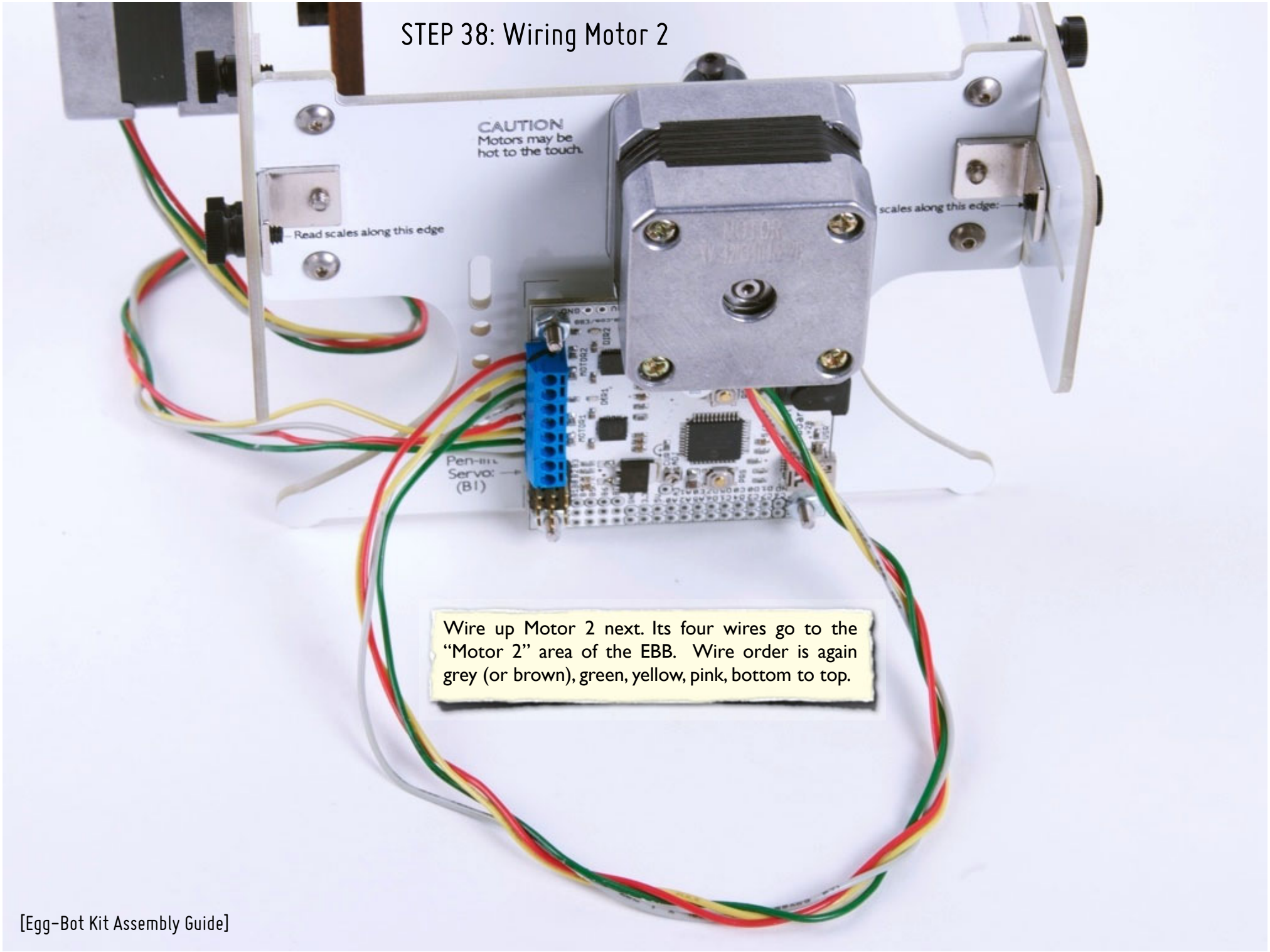




Individually insert the four wires into the terminal block and screw them down. The wire order is: grey (or brown), green, yellow, pink, bottom to top.

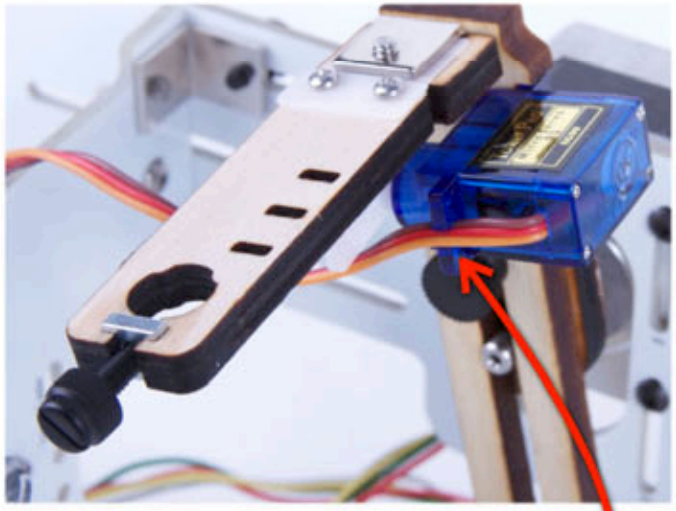
Check that each wire in the terminal is secure by tugging on it gently; you don't want them coming out unexpectedly.

STEP 38: Wiring Motor 2

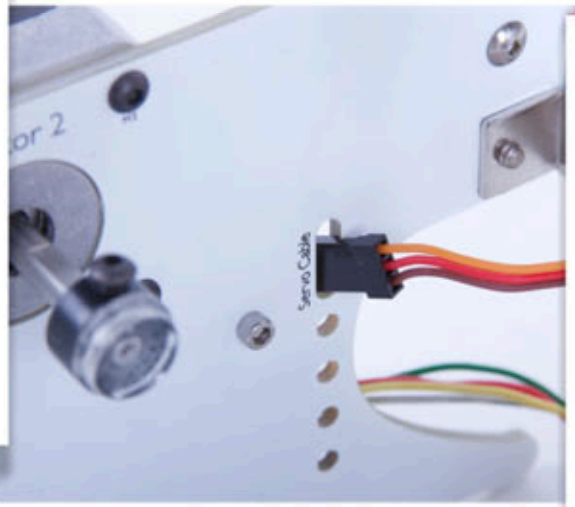


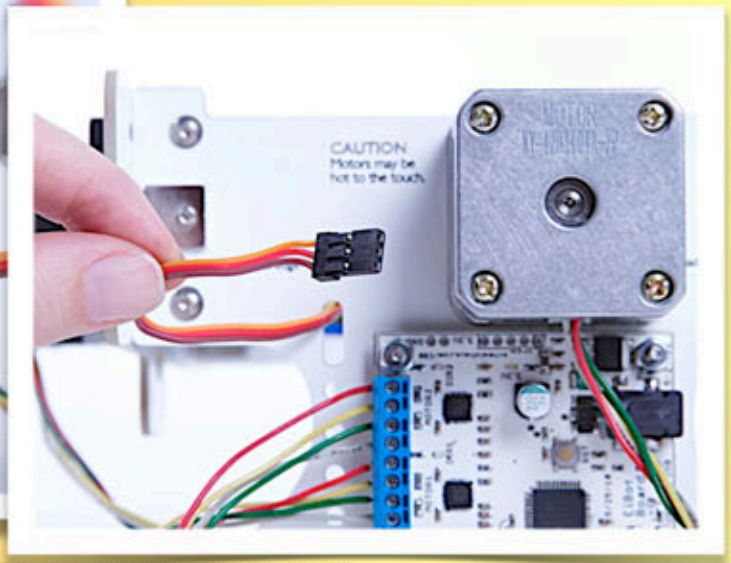
Wire up Motor 2 next. Its four wires go to the "Motor 2" area of the EBB. Wire order is again grey (or brown), green, yellow, pink, bottom to top.

STEP 39: Servo Motor Wiring

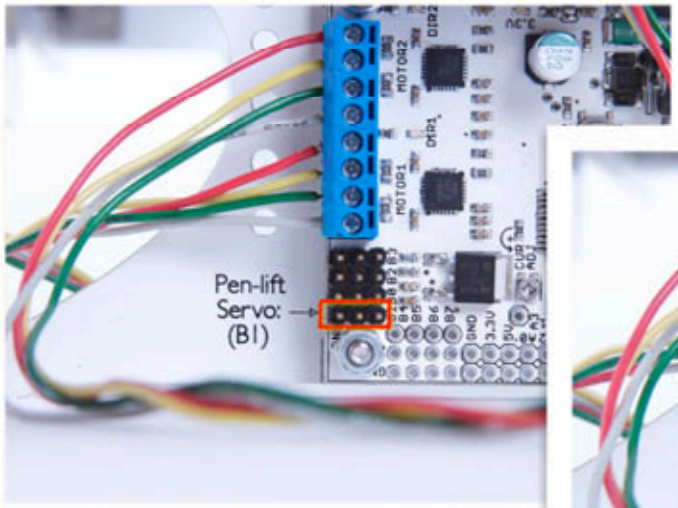


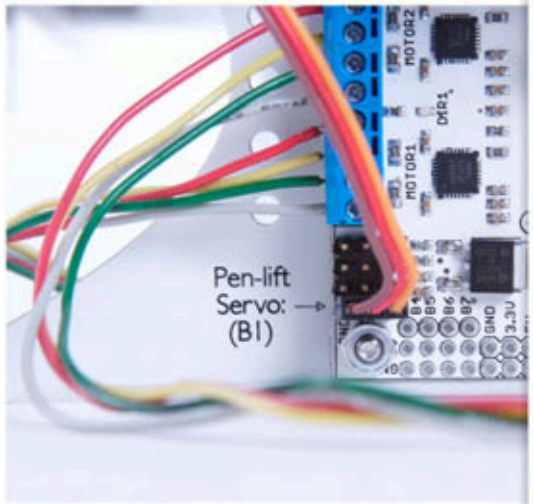
To keep the servo cable out of the way, route it through the "screw hole" of the servo casing, like so:



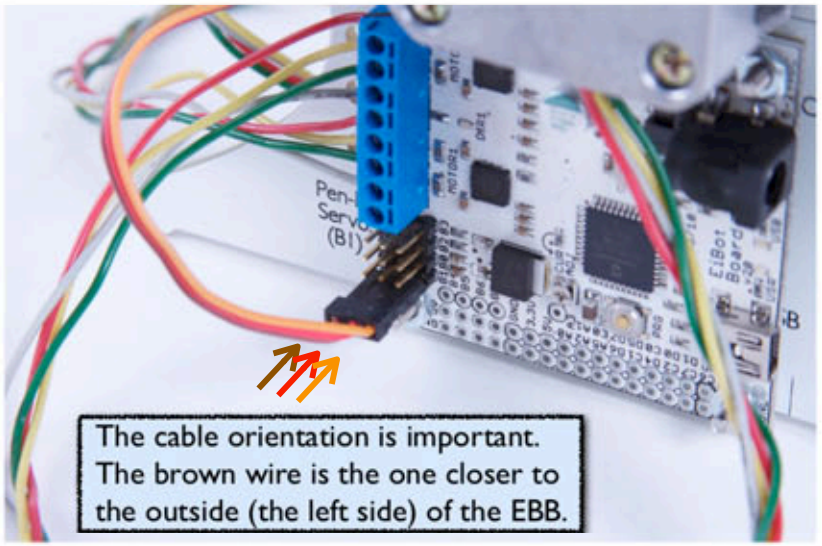


Route the end of the cable through the slot in the headstock labeled "Servo Cable," and pull it through.



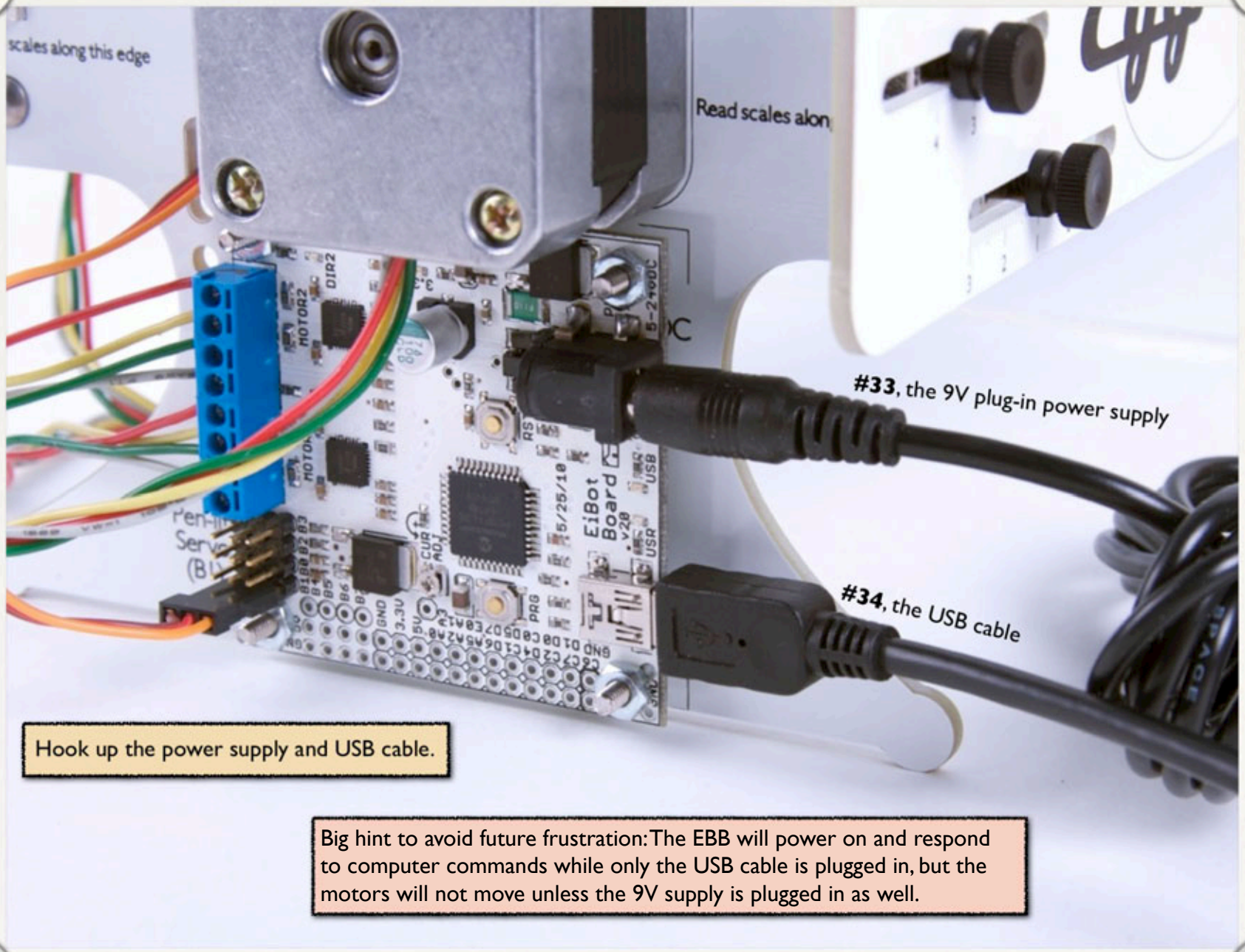


The servo cable connects to location B1, the bottom set of three pins on the EBB.



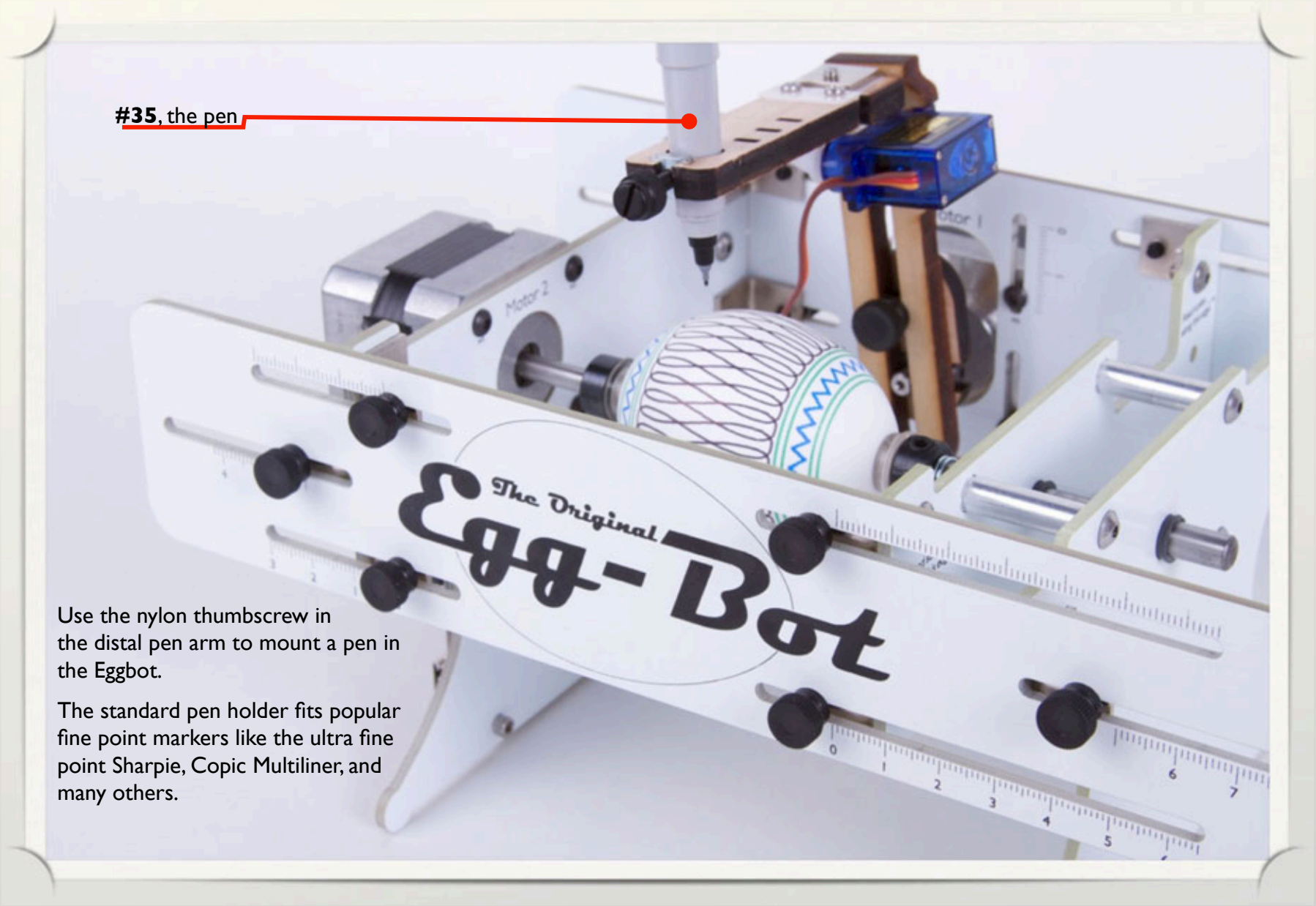
The cable orientation is important. The brown wire is the one closer to the outside (the left side) of the EBB.

STEP 40: Connectivity



Big hint to avoid future frustration: The EBB will power on and respond to computer commands while only the USB cable is plugged in, but the motors will not move unless the 9V supply is plugged in as well.

STEP 41: Adding a pen



Use the nylon thumbscrew in the distal pen arm to mount a pen in the Eggbot.

The standard pen holder fits popular fine point markers like the ultra fine point Sharpie, Copic Multiliner, and many others.

- FIN -

w00t! Your Eggbot is now assembled, so this concludes the basic assembly instructions for the Egg-Bot Kit.

If you're just building up a new kit, and/or using an Egg-Bot for the first time, you will probably want to learn about the following topics next:

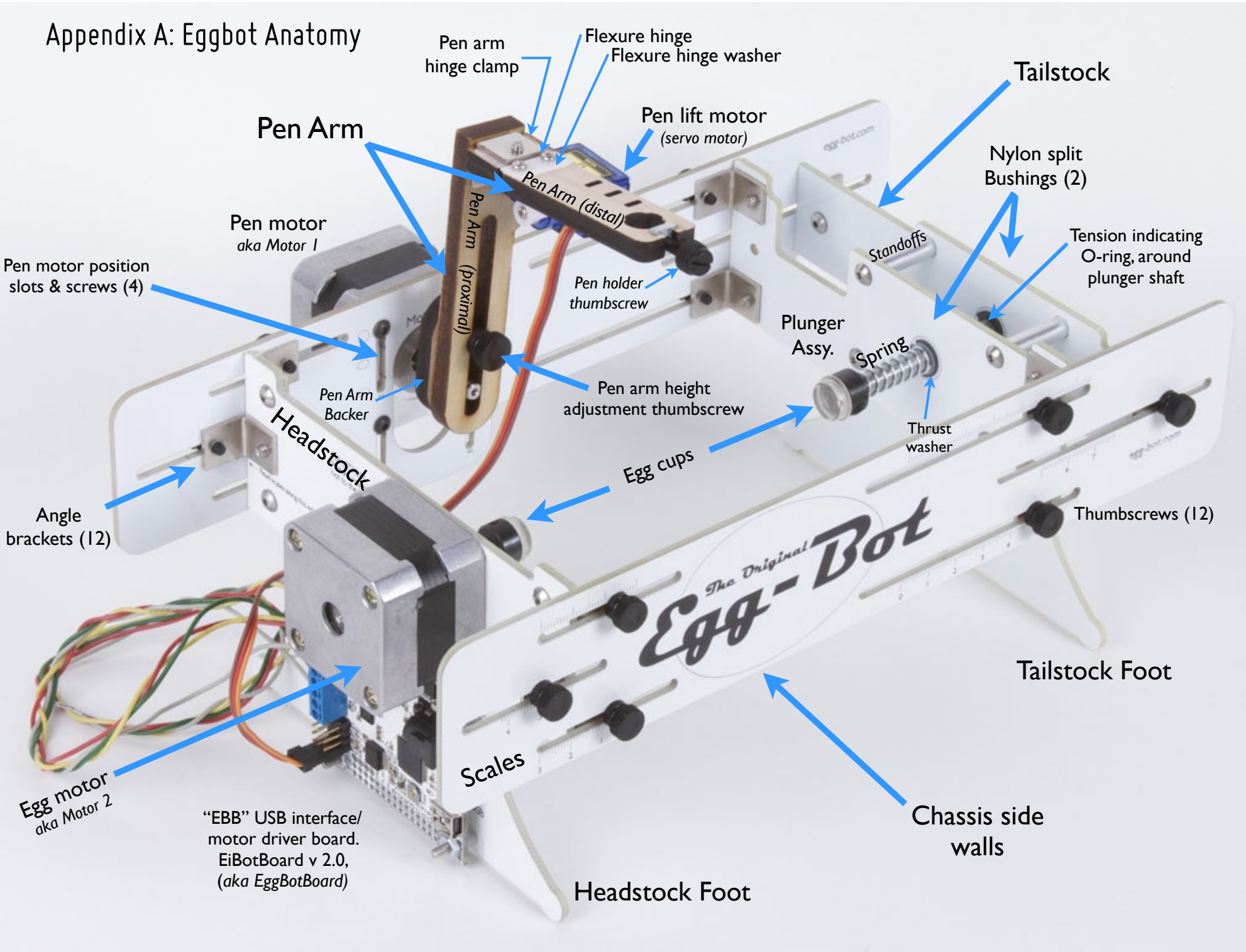
- Installing Eggbot software
- How to set up the Eggbot to draw on any given object
- How to do make your first drawing with the Eggbot

This documentation (and much more) is hosted at: `http://wiki.evilmadscience.com/eggbot`

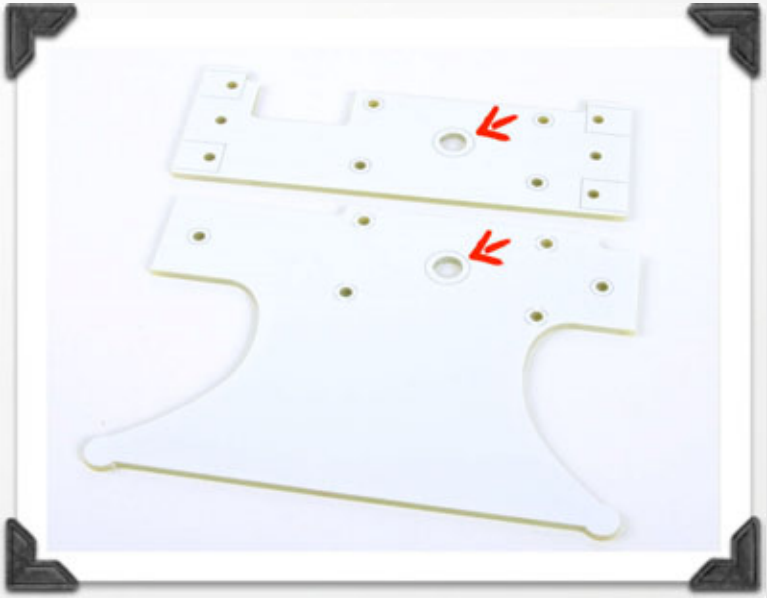
You can also get there from the "Documentation" tab at `http://www.egg-bot.com/`

Appendices follow.

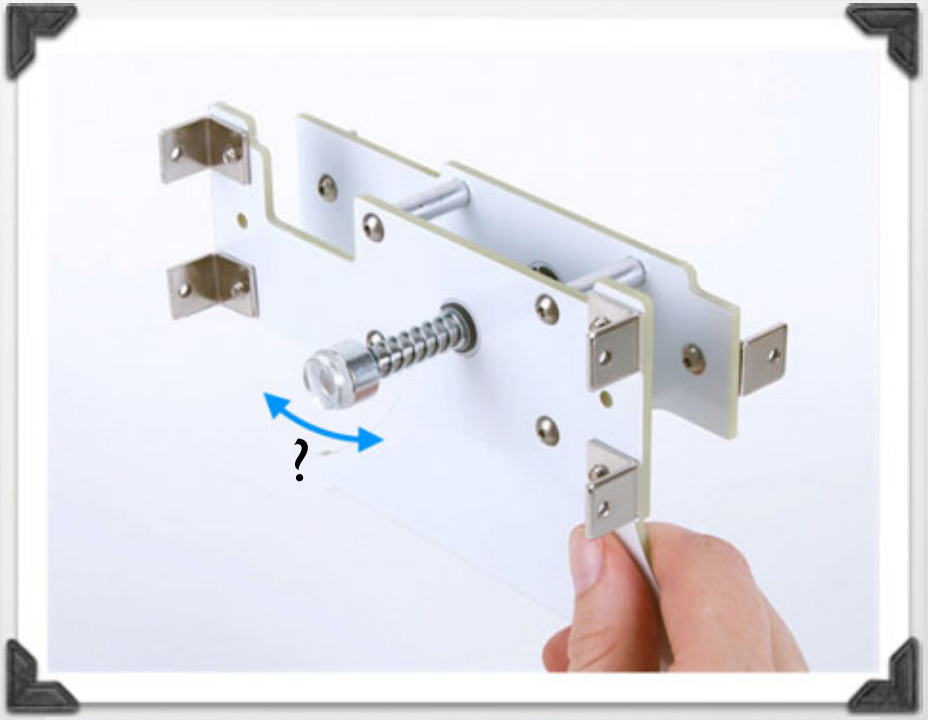
Appendix A: Eggbot Anatomy



Appendix B: Improving plunger precision, part 1



The holes in the tailstock where the split bushings sit have some natural variation in diameter. If the holes are slightly too small, the split bushings will still fit, but the 1/4" plunger rod *will not* move smoothly. In that case, plotting is simply not possible. Consequently, we try to err on the side of "too large" in the hole diameter.

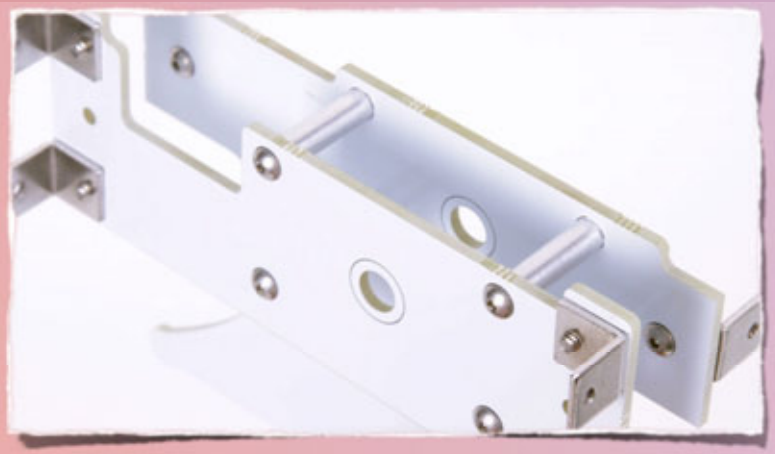


However, when the holes are slightly oversized, there's a new issue, which is that the plunger can wiggle a bit from side to side. That can lead to a loss of precision in plotting.

In practice, it's much less of a problem than you might think, because the plunger is operated under tension and tends to stay put fairly well once you begin plotting.

None the less, it may be desirable to take out some or all of the slack in the bushing position. We'll show two approaches: Shimming them with tape and gluing them in place.

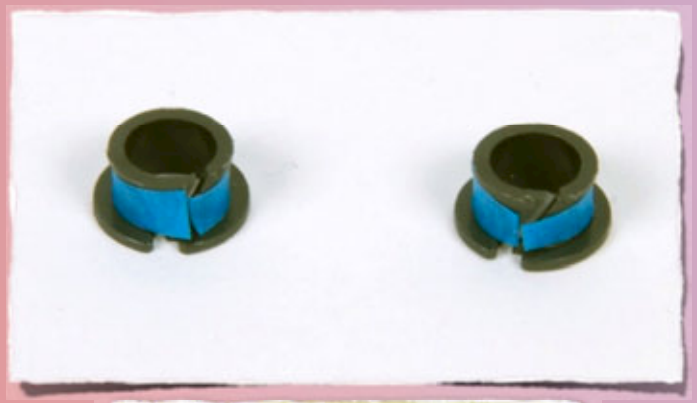
Appendix B: Improving plunger precision, part 2



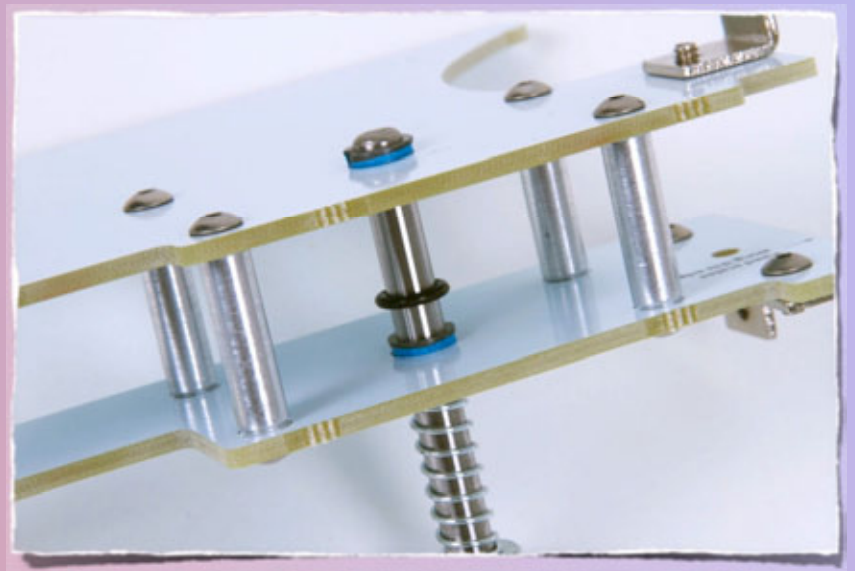
As mentioned in Step 5, the bushings are removable. Essentially, they can be pushed out from the back side, just by pushing on the correct side of the split section.

Masking tape can be used to shim the bushings to reduce the amount of lateral play. (You'll probably use beige tape, but we use blue so that you can see it more easily.

Cut tape.

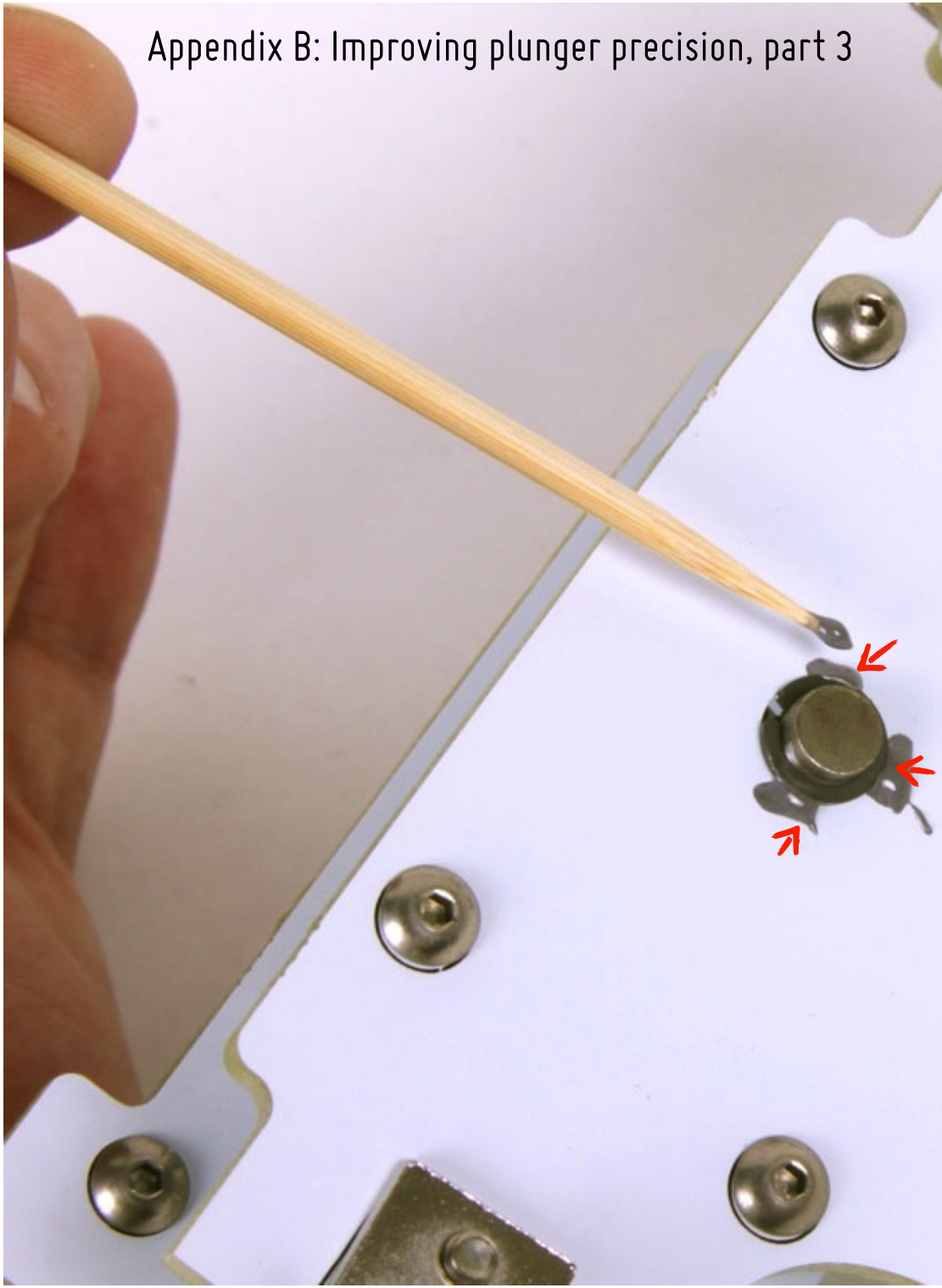


Apply tape-- wrap around most of the way, not covering the slit. You can do more than one layer.



Re-insert bushings. *Only you* will know its secret.

Appendix B: Improving plunger precision, part 3



Glue works, too. (Better, actually.) If you choose to go this way, please consider the following advice:

1. If possible, use 5-minute epoxy or similar compounds. Viscous, high-quality wood glues or hobby glues can be used with care. Avoid thin or runny glues. CA (superglue) is not recommended.

2. Leave the tailstock assembled and the plunger (dowel pin) in place when you glue the bushings. This ensures that the bushings are in the right place and are held at the correct diameter to fit the plunger.

3. Glue the bushings *and not the plunger* to the tailstock.

4. Err on the side of too little, not too much glue. A few tiny drops are sufficient, and you don't want to get any in the slit or where it could touch the plunger. And, if you ever want to remove the bushings again....