

ASSEMBLY GUIDE

The Original Egg-Bot – Version Ostrich 2.0

The **Ostrich EggBot kit** is the big brother of the Original EggBot kit. These kits are 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 4.25–6.25” (6–16 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 Ostrich EggBot Kit v2.0. 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 & documentation, please visit: <http://wiki.evilmadscientist.com/ostrich>

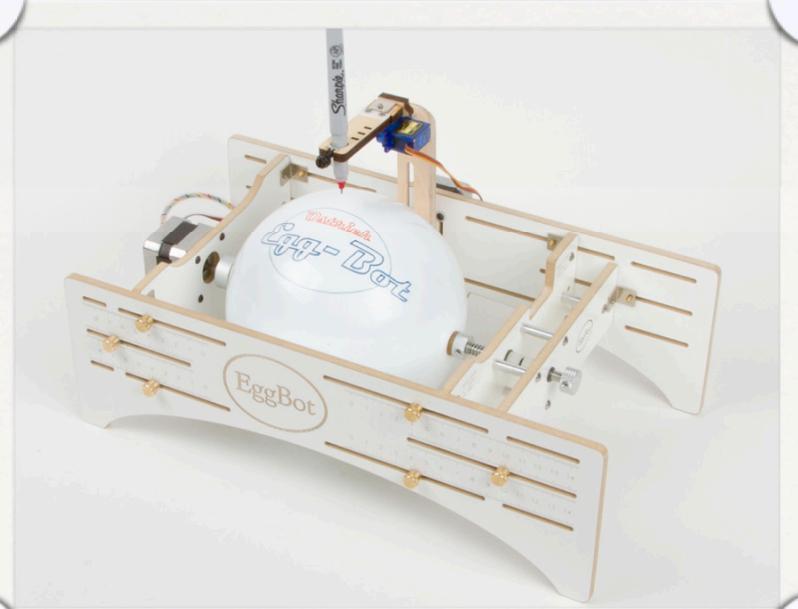
Support Forum: <http://forum.evilmadscientist.com/>

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.

Ostrich EggBot Kit v 2.0 Bill of Materials

Line	name / description	Qty
		1
1	Chassis, MDF/Melamine (set of 5 pcs)	1
2	Hex driver, ball end, 5/64"	1
3	Hex L-wrench, 5/64"	2
4	Hex L-wrench, 3/32", nickel plate	5
5	Nylon flange bushing	29
6	Threaded standoff, 6-32 x 7/8", aluminum	13
7	Button Socket Cap Screw 6-32 x 3/8"	1
8	Angle bracket	1
9	Steel dowel pin, 1/4" diameter x 3"	1
10	Precision Egg Coupler for 1/4" shaft with abrasive pad	1
11	Spring, 1/4" ID, 1" length, 5.8 lbs/inch	1
12	Nylon washer (Thrust bearing)	2
15	Tailstock Draw Knob	2
13	Nylon Spacer, 1/4" ID, 5/16" Length	1
14	O-ring to retain 1/4" shaft	4
16	EiBotBoard v. 2.0 by Schmalzhaus.com	4
17	4-40 x 1/2" phillips screw -- for EBB	5
18	#4 nylon washer -- for EBB	2
19	plastic spacer -- for EBB	2
20	Stepper Motor	8
21	Spiral wrap	16
22	Screw, M3x10 BSCS, black (for motors)	13
23	Nylon washer, #6	1
24	Brass thumbscrew, 6-32 x 1/2"	1
25	Precision Egg Coupler for 5 mm shaft with abrasive pad	1
26	Pen Arm (distal) with 6-32 square nut	2
27	Pen arm (hinge clamp)	1
28	Flexure hinge, 0.010" acetal copolymer	2
29	Flexure hinge washer, 0.20" delrin	1
30	Flexure hinge screws, Phillips head #2	1
31	Thumbscrew, nylon, 6-32 x 1/2	1
32	Servo motor	2
33	Servo motor mount	1
34	Threaded standoff, 6-32 x 3/4", aluminum	1
35	XL Pen Arm, "proximal"	1
36	Thumbscrew, brass, 10-32 x 1/2	1
37	Nylon Washer, #10	1
38	Aluminum Pen Arm Backer	1
39	Servo extension cable	1
40	Power Supply	1
41	USB Cable	1
42	Pen, Sharpie Ultra fine	1
43	Spring, 1/4" ID, 1" length, 18.3 lbs/inch	1
44	Rubber washer, 1" OD	1



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 MDF pieces with white melamine surfaces.

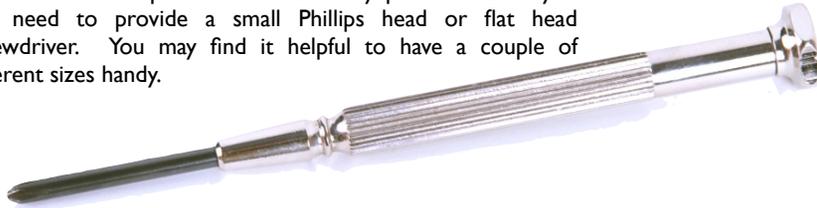
STEP 1: Tool Checklist

Essential tools: Needed to build and use the kit:

Suggested tools: Recommended; not required

1. Small screwdriver(s)

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

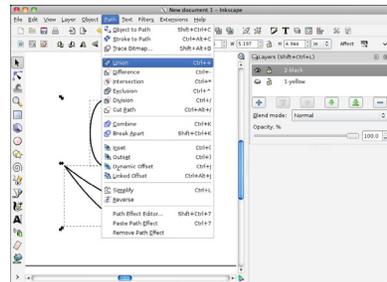


2. Computer, Internet access, USB port....

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://wiki.evilmadscientist.com/EggBot> to get started.



3. Electrical power

The EggBot kit comes with a regulated universal-input power supply that accepts worldwide voltages and puts out 9V 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.

1. 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.

2. 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.

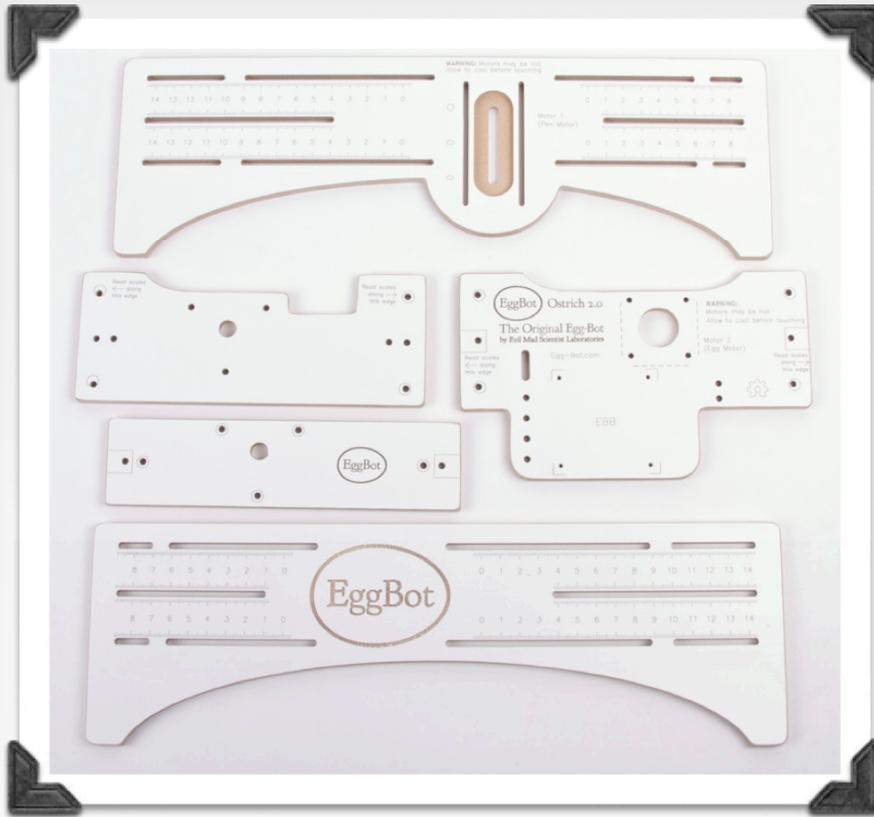
And if you're so inclined...



Wire strippers, soldering iron, etc.

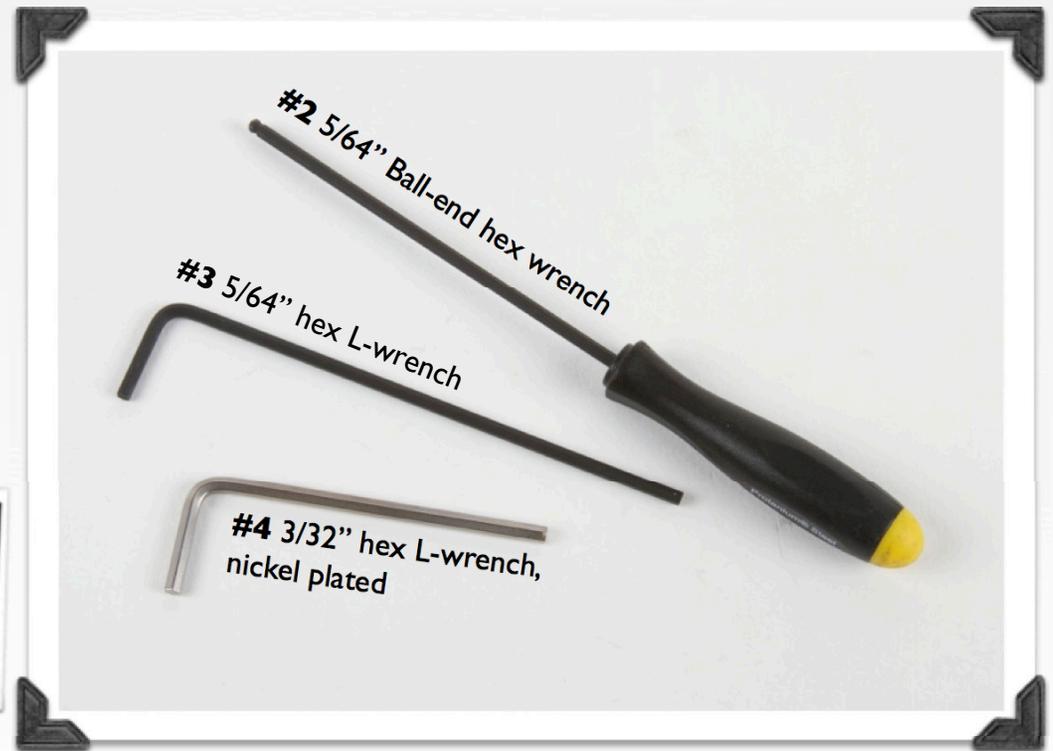
Rather than using cable ties, you may want to reduce the length of the wires on the stepper motors. If you'd like to trim, strip, and tin the wires, you're certainly welcome to do so.

STEP 2: The first few parts



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

The chassis is made of CNC cut MDF with laser engraved white melamine surfaces.



Beyond the tools already mentioned, three additional tools are included in the EggBot kit:  A $5/64$ " ball-end hex driver, a $5/64$ " hex L-wrench and a $3/32$ " hex wrench.

STEP 4: Flanged bushings, part I

Nylon flanged bushings, part #5

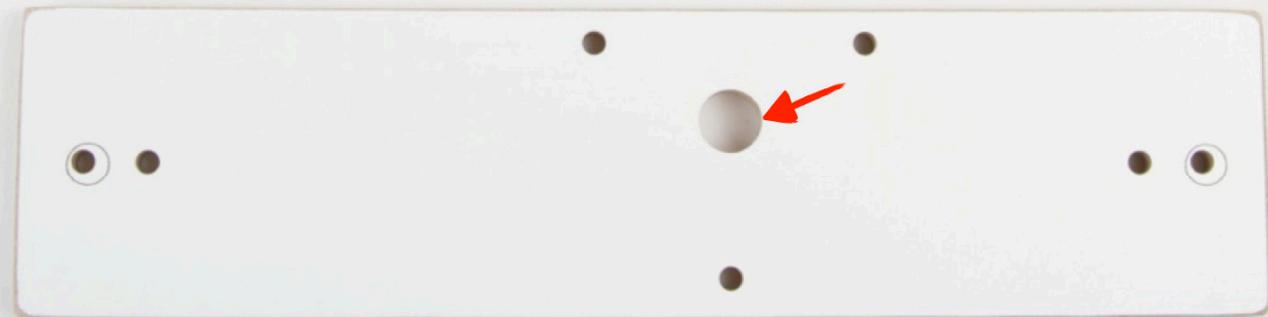
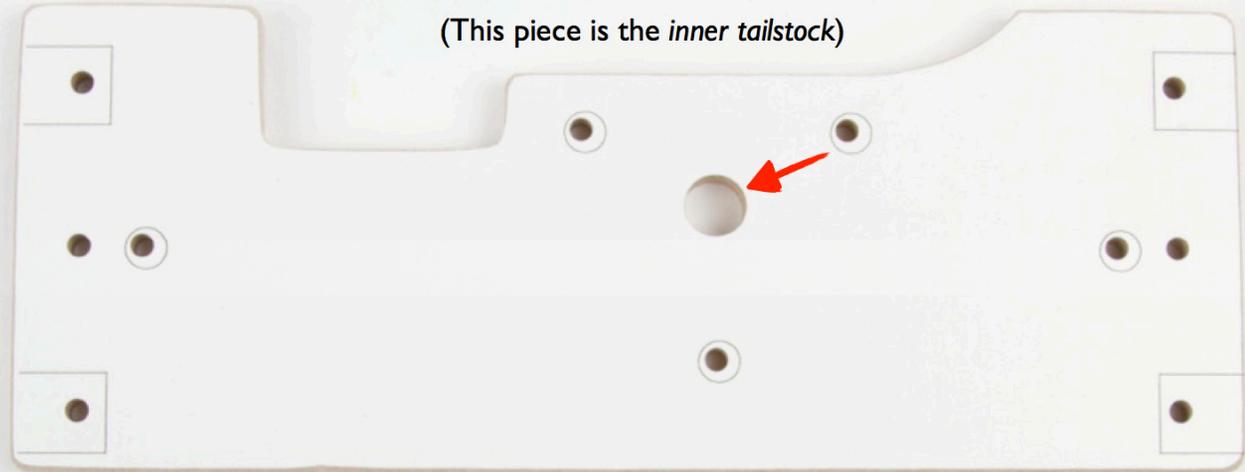


The two nylon flanged bushings, part #5, go into the indicated sides of the two chassis tailstock pieces.

Orient the two pieces as shown, paying attention to both the outline shape and the engraved markings.

TO BE CONTINUED...

(This piece is the *inner tailstock*)



(This piece is called the *tailstock back*)

STEP 5: Split bushings, part II



Press the two bushings into their holes. To install one, press it into the hole until the flange is flush against the surface without any gap.



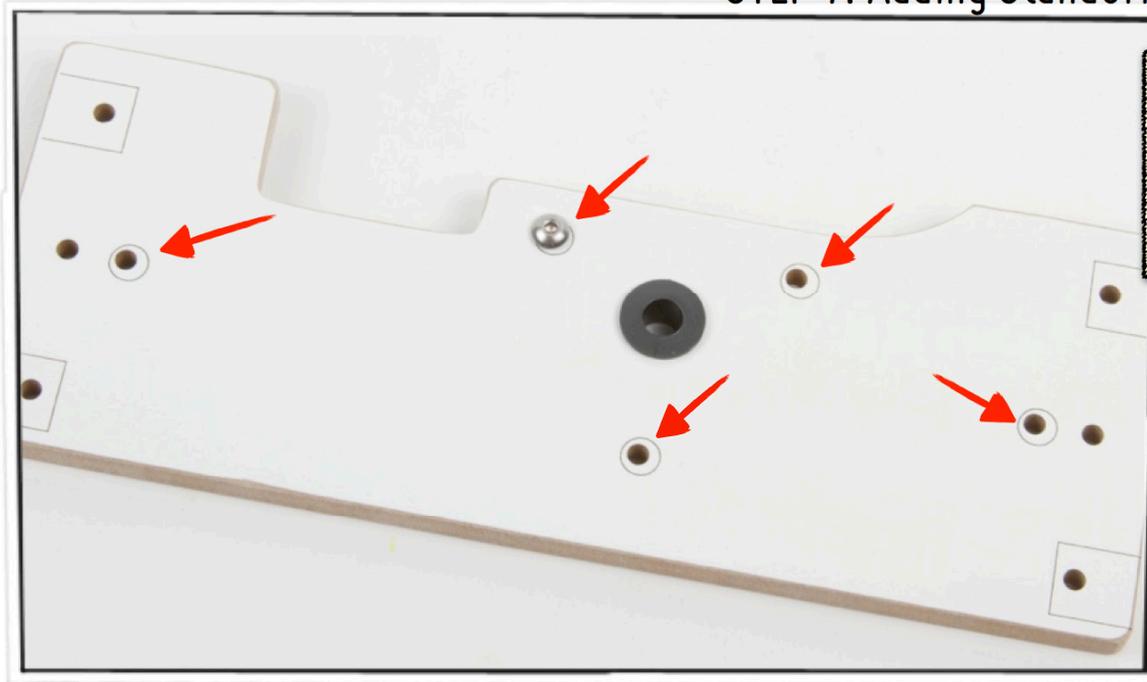
STEP 6: Screws and Standoffs

In the next step, you'll need the five 7/8" long threaded aluminum standoffs, part **#6**.



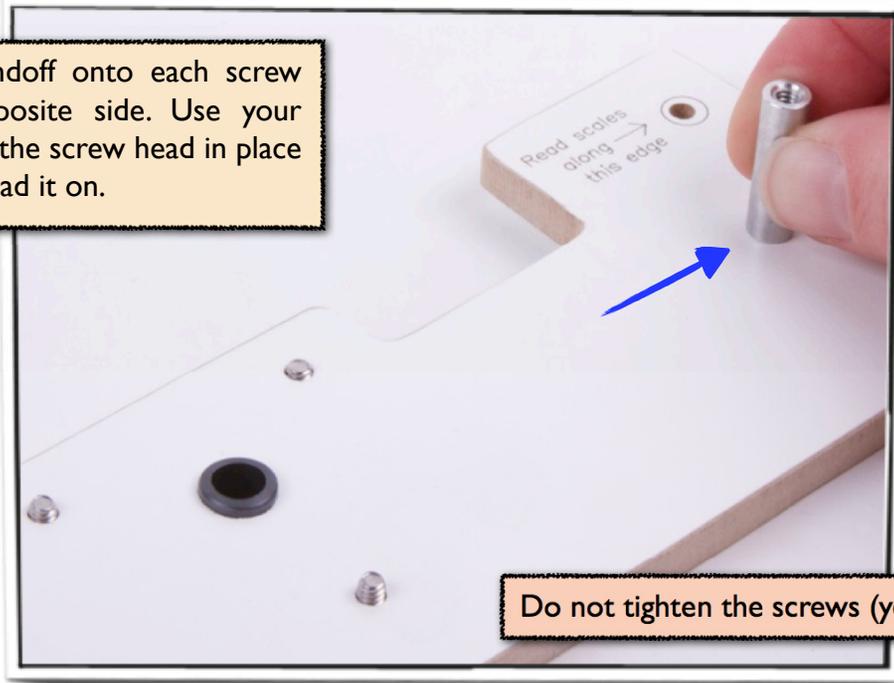
You'll also need 10 pieces of part **#7**, the 3/8" length stainless steel button socket cap screws. (There are a total of 29 of these in the kit.)

STEP 7: Adding Standoffs

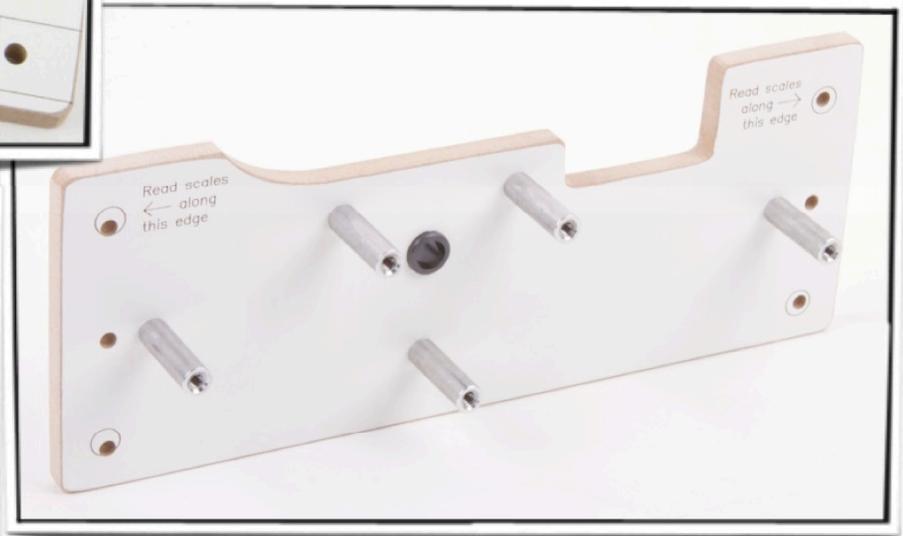


The screws go into the five holes shown, from the side that where the holes are marked with solid circles. (Note that the circles are not always well-centered around the holes.)

Thread a standoff onto each screw from the opposite side. Use your finger to hold the screw head in place while you thread it on.



Do not tighten the screws (yet).

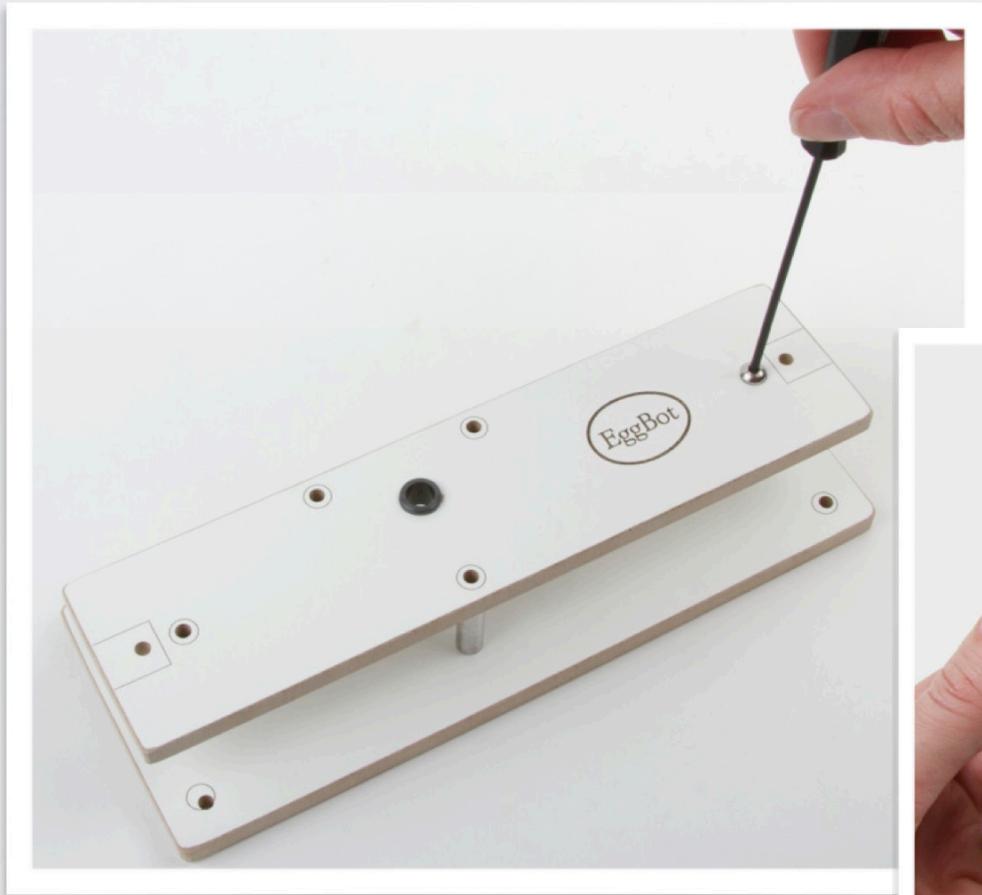


Here's how it looks once all five are added.

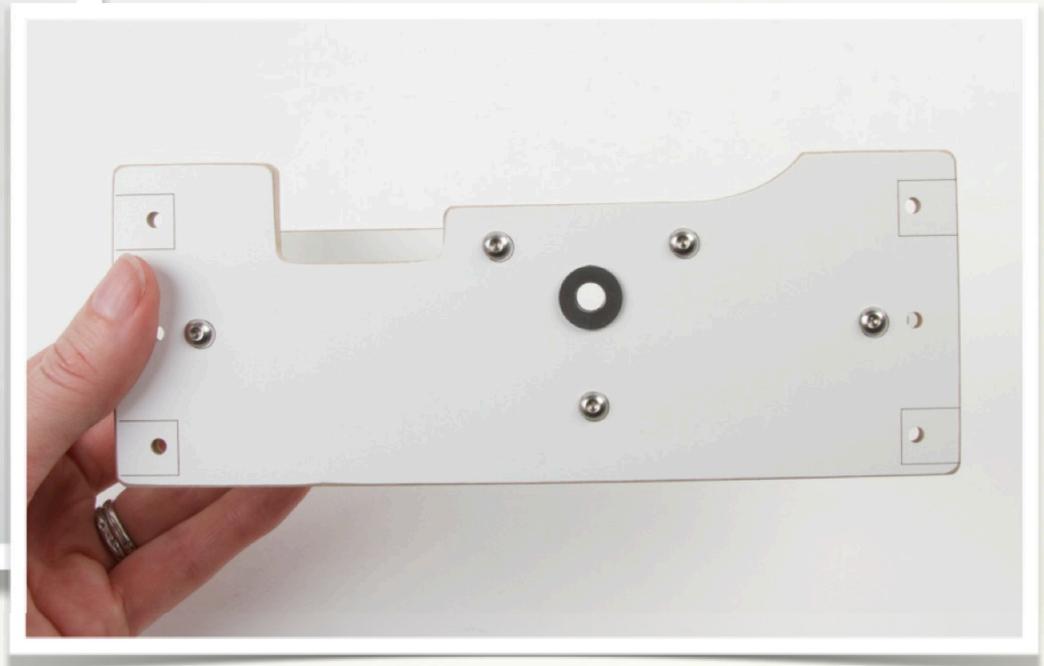
STEP 8: Mating the two tailstock pieces

Test fit the two tailstock pieces together: The standoffs go against the unmarked holes on the other piece.

The other five 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 9: 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 3/8" 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.”

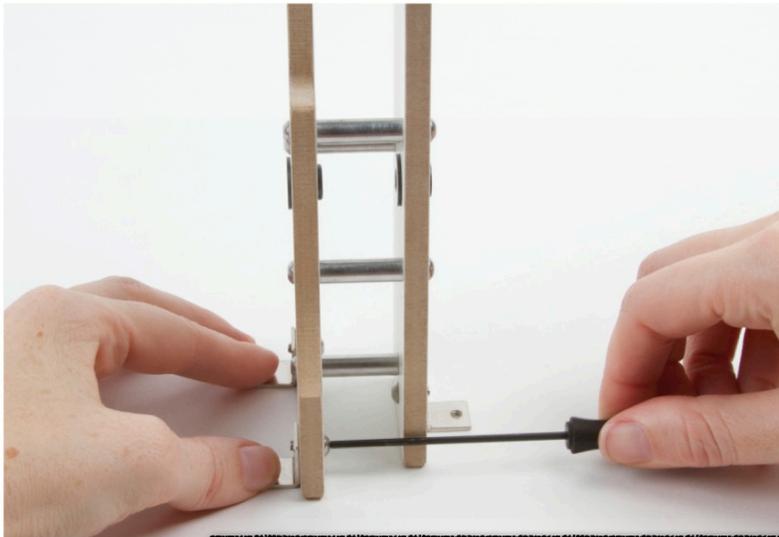
STEP 10: Adding tailstock angle brackets



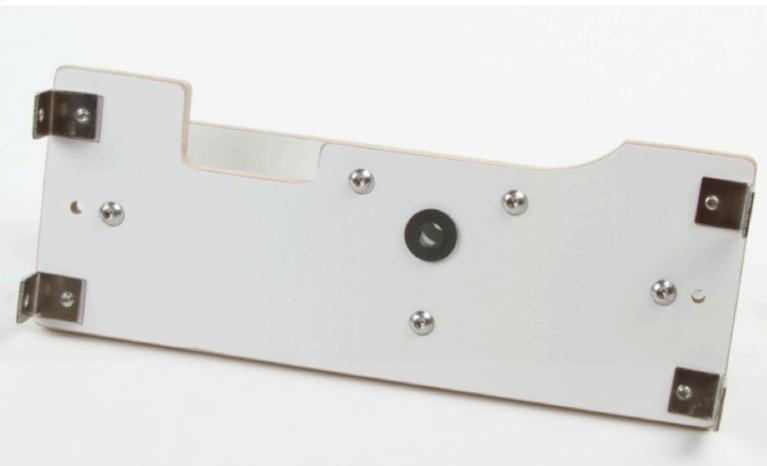
Add the six angle brackets to the tailstock. They sit within the six rectangular outlines.



Each bracket is held in place by a screw from the other side. 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 11: 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.



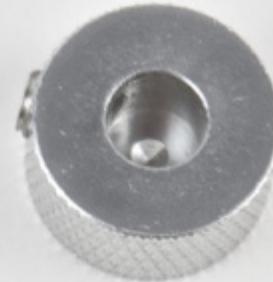
STEP 12: Plunger Parts

Part **#9** is the 1/4" steel dowel pin.

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



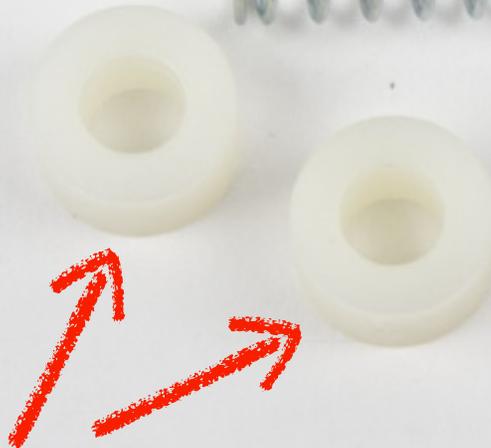
#15, tailstock draw knob for 1/4" shaft



#11, the steel spring.
*(There is another, stronger spring
for optional use as well.
Use the regular one for now.)*



#10, precision egg coupler for 1/4" shaft



#14, the tiny O-ring

#12, the even tinier nylon washer



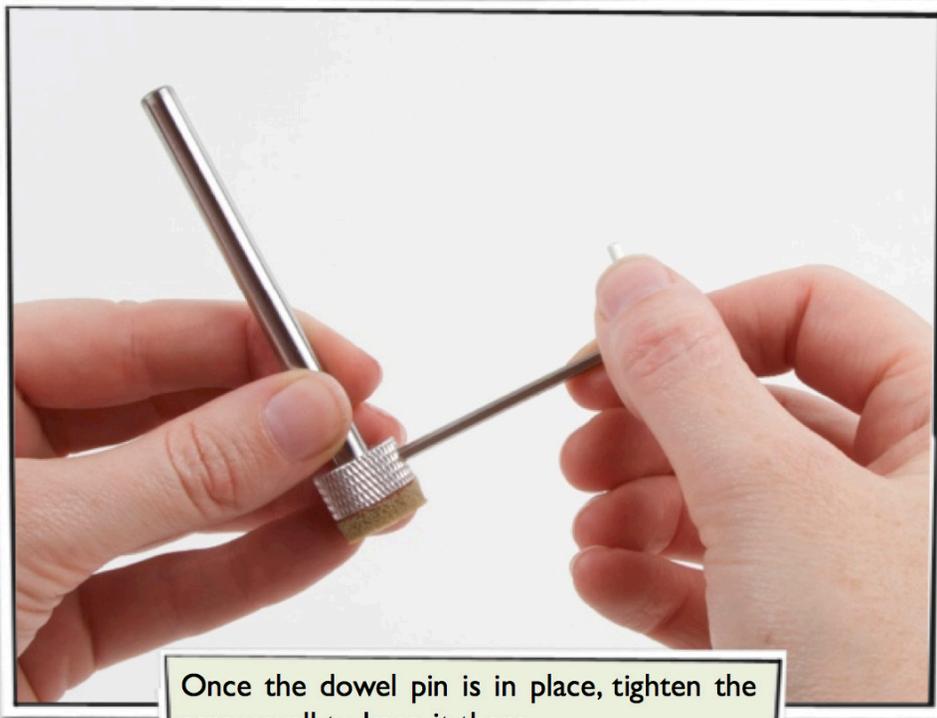
#13, the two 5/16" long nylon (plastic) spacers.

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

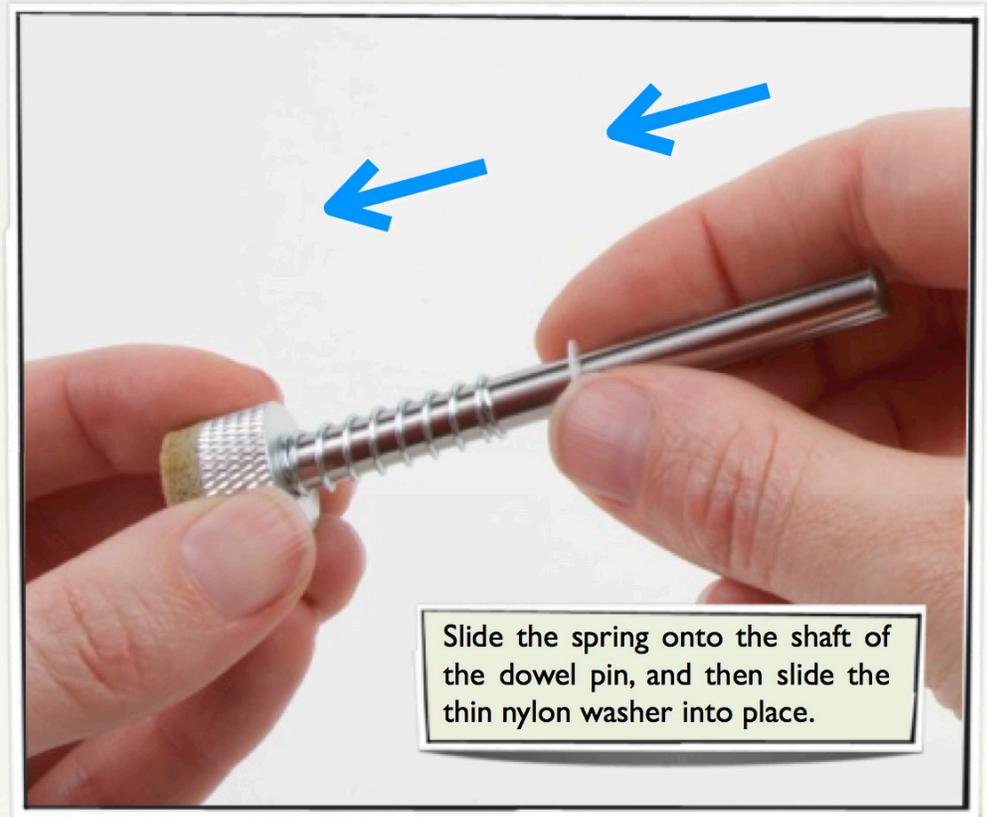


STEP 13: Add the coupler to the dowel pin

Add the 1/4" precision coupler to the end (either end) of the dowel pin. You may need to loosen the screw for the shaft collar inside, but it should fit easily and sit flush against the wooden back of the coupler.

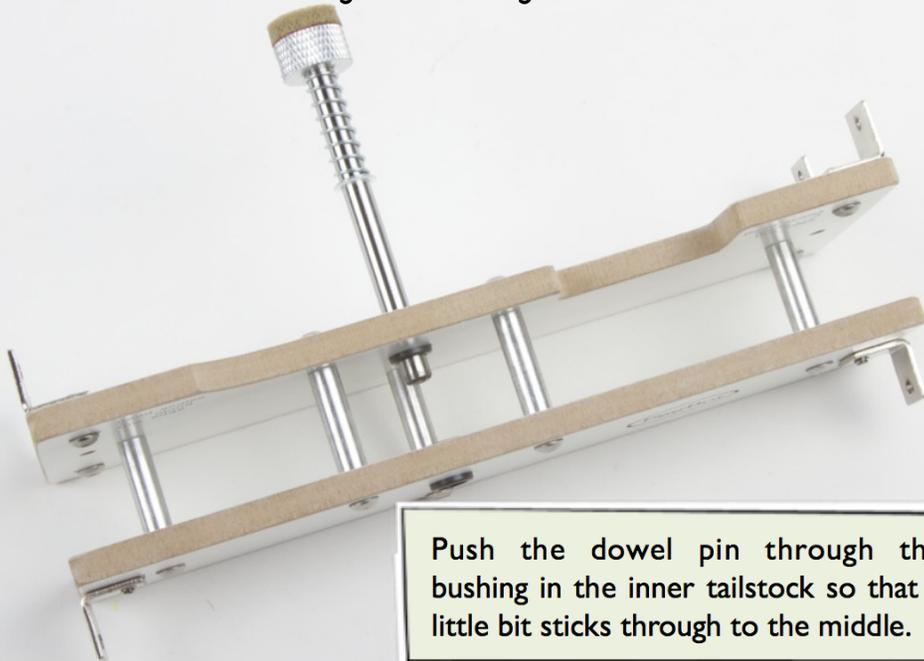


Once the dowel pin is in place, tighten the screw well to keep it there.

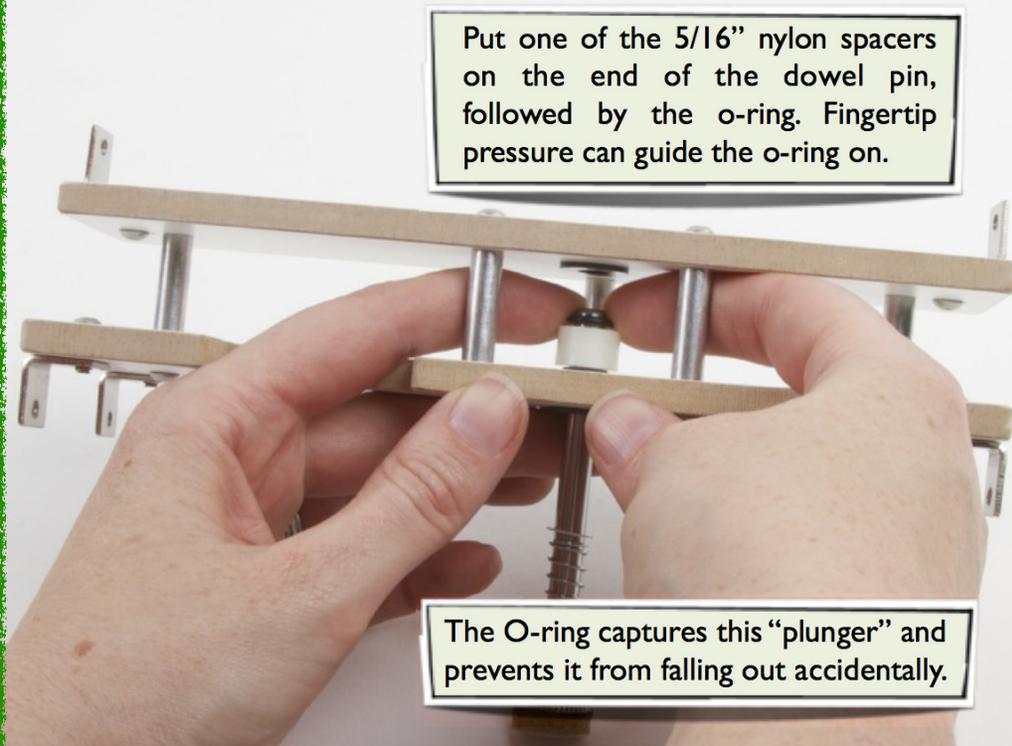


Slide the spring onto the shaft of the dowel pin, and then slide the thin nylon washer into place.

STEP 14: Installing the Plunger

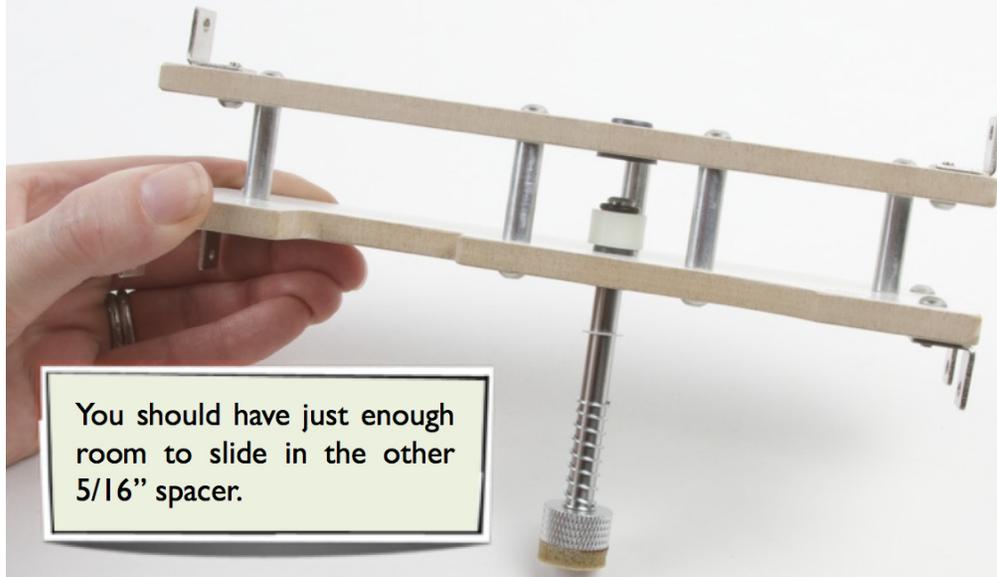


Push the dowel pin through the bushing in the inner tailstock so that a little bit sticks through to the middle.

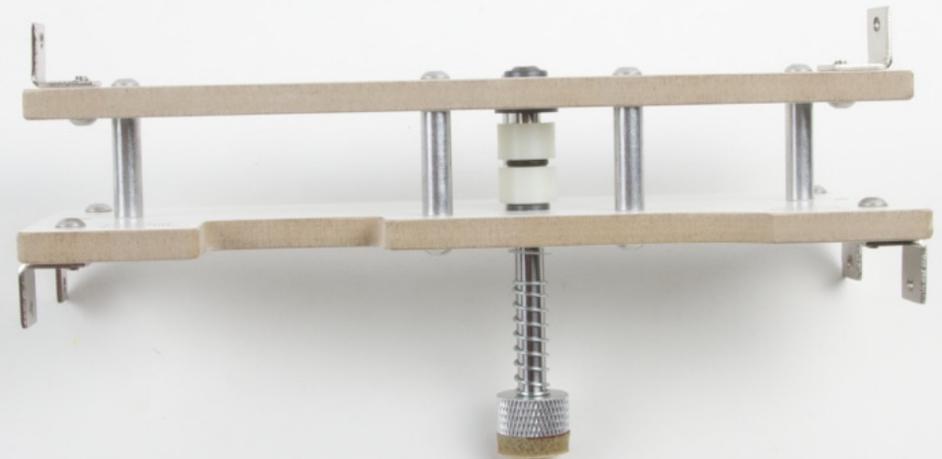


Put one of the 5/16" nylon spacers on the end of the dowel pin, followed by the o-ring. Fingertip pressure can guide the o-ring on.

The O-ring captures this "plunger" and prevents it from falling out accidentally.



You should have just enough room to slide in the other 5/16" spacer.



The plunger is now in place--just one thing left...

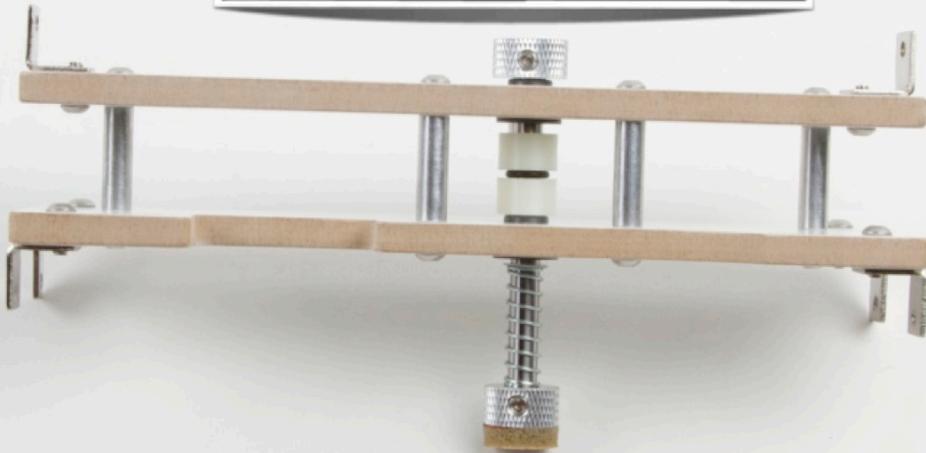
STEP 15: Installing the Plunger (continued)

Push the plunger against the spring to fully engage the plunger.



Gently release it, and the o-ring will keep it from coming out.

The tailstock assembly is now complete



Install the tailstock drawknob on the other end of the dowel pin using the 3/32" hex wrench.



STEP 16: 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 **#16** on your BOM. (This circuit board may be either red or white.)



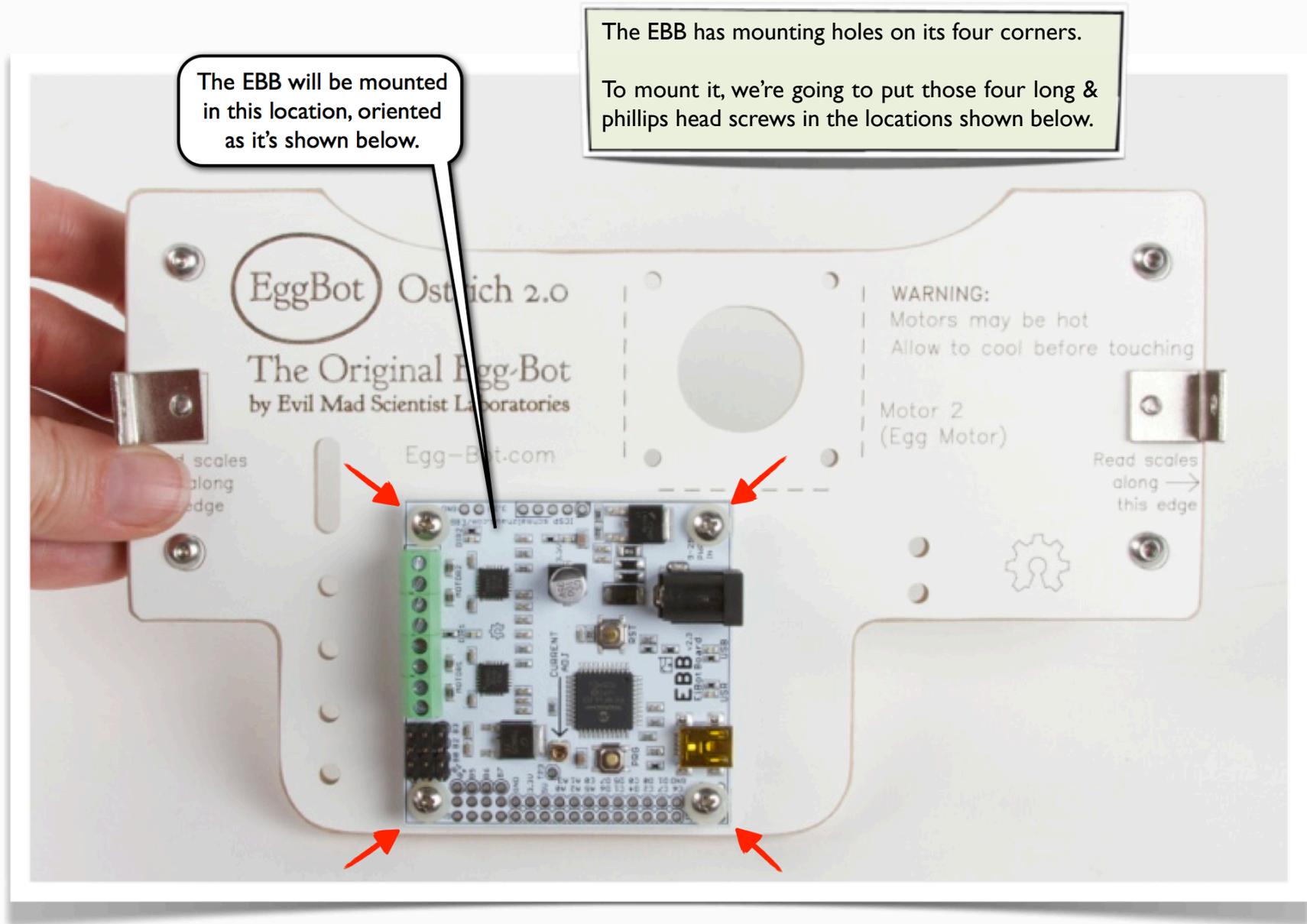
You'll also need a phillips head screwdriver and...

Four phillips head screws, **#17**.

Four nylon washers, **#18**.

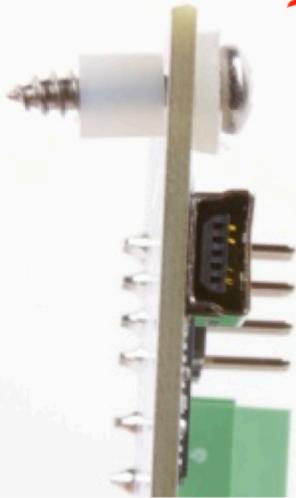
Four nylon spacers, **#19**.

STEP 17: Where we mount the EBB

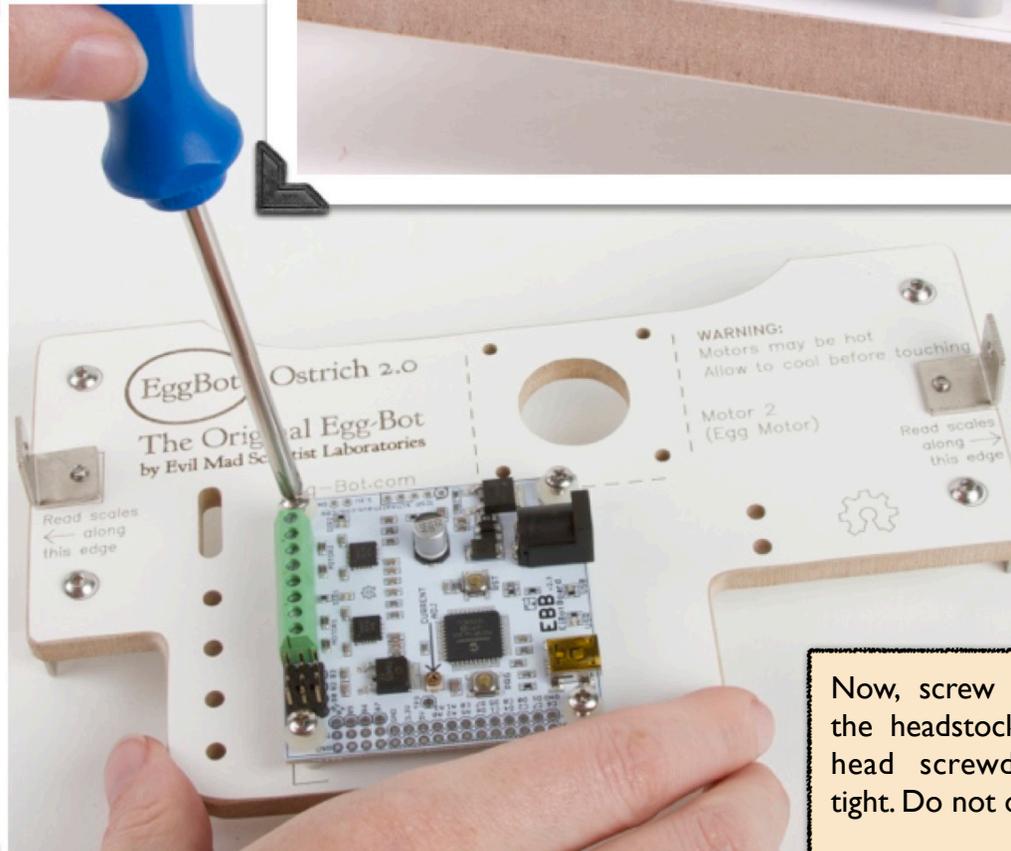
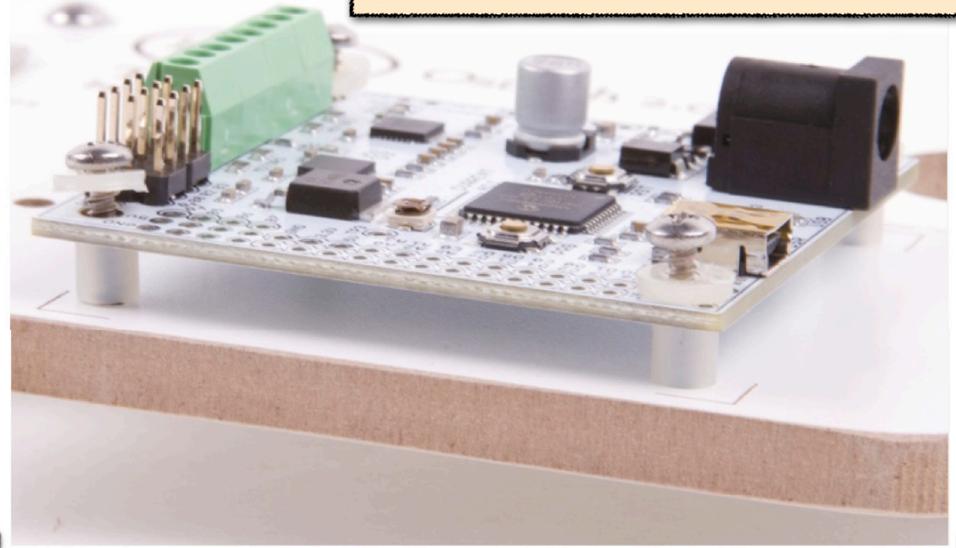


STEP 18: Adding the EBB, part I

Put the washers onto the phillips head screws and then put the screws through the mounting holes in the corners of the EBB. Put the spacers on the screws below the EBB.

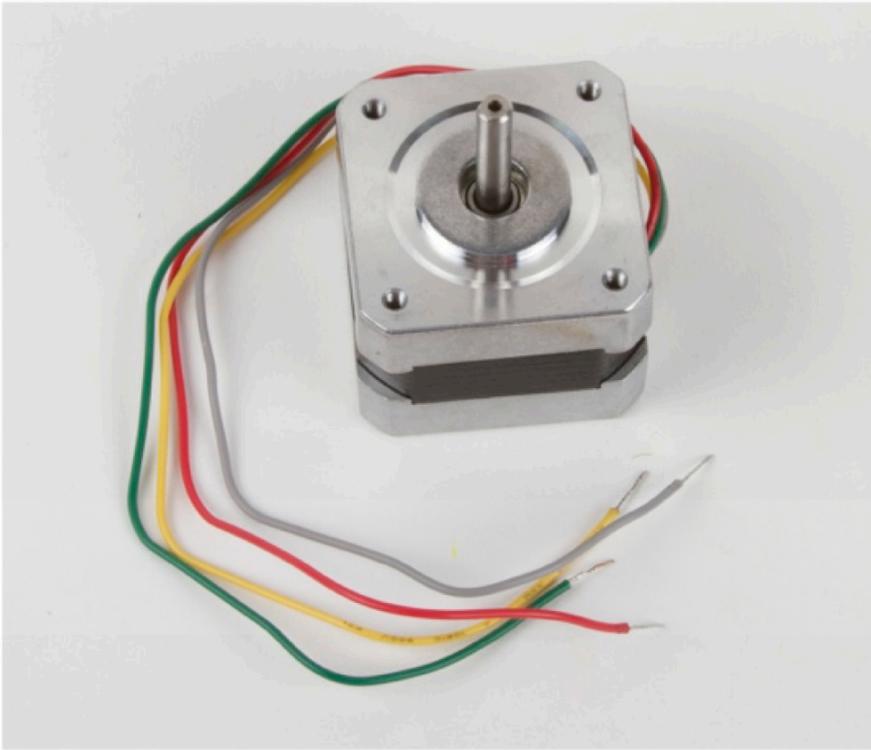


Align the EBB on the headstock and position the screw tips so that they're resting in the pilot holes.



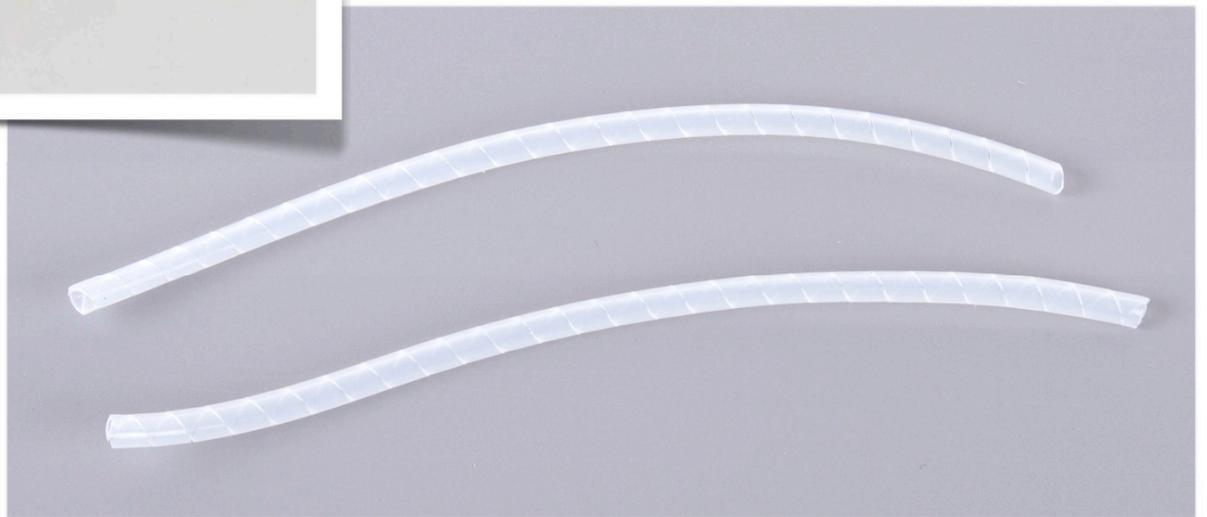
Now, screw the screws into the headstock using a phillips head screwdriver until just tight. Do not overtighten.

STEP 20: Stepper motors



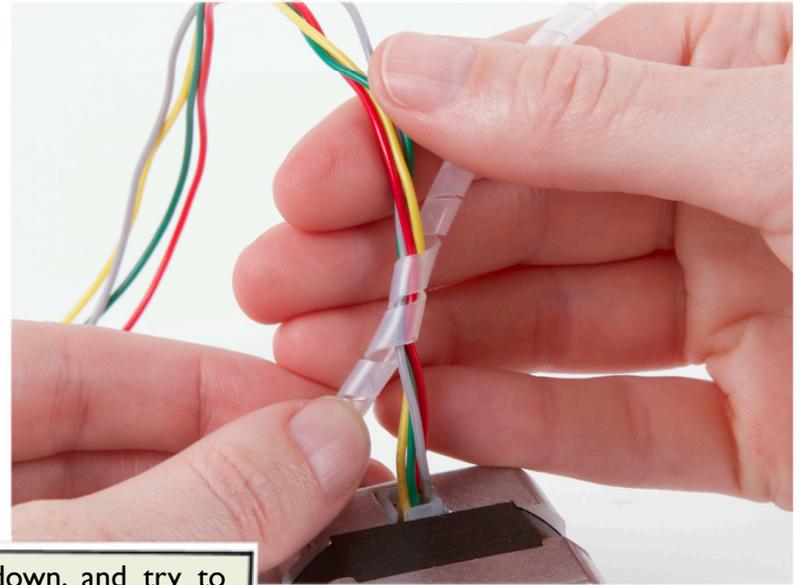
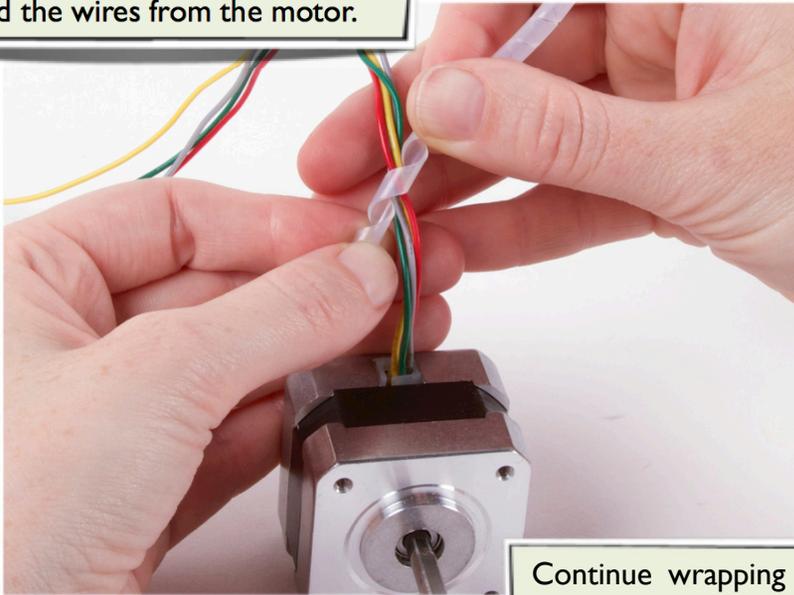
It's a bipolar stepper motor!
(Part **#20** on the BOM.)

Spiral wrap tubing for keeping
your wires neat and tidy.
(Part **#21** on the BOM.)

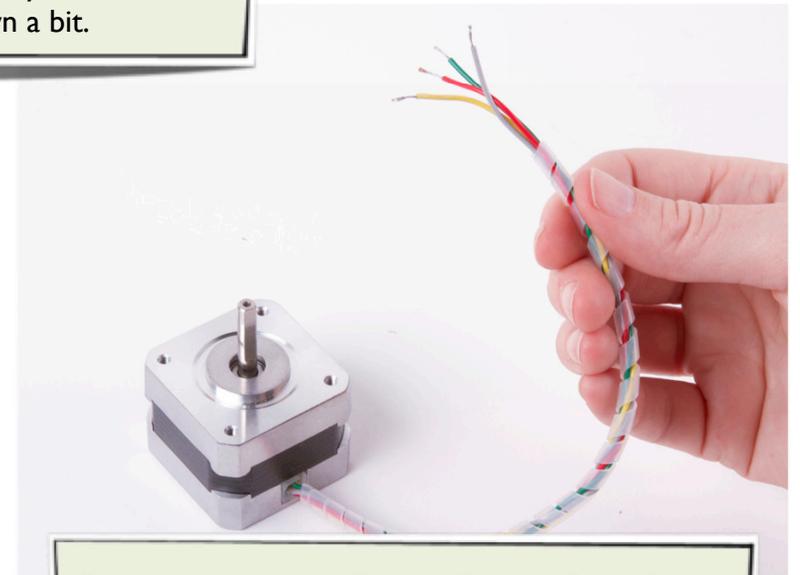
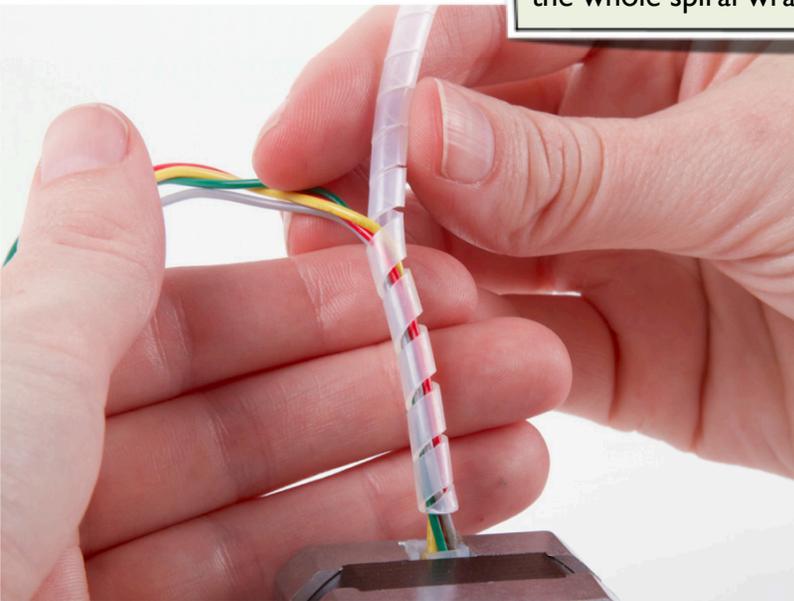


STEP 21: Wrapping the stepper motor wires

Twist the spiral wrap tubing to open up a bit. Take that opening, and wrap it around the wires from the motor.



Continue wrapping the spiral down, and try to position one end of the spiral wrap tubing close to the body of the motor. You may need to slide the whole spiral wrap up or down a bit.

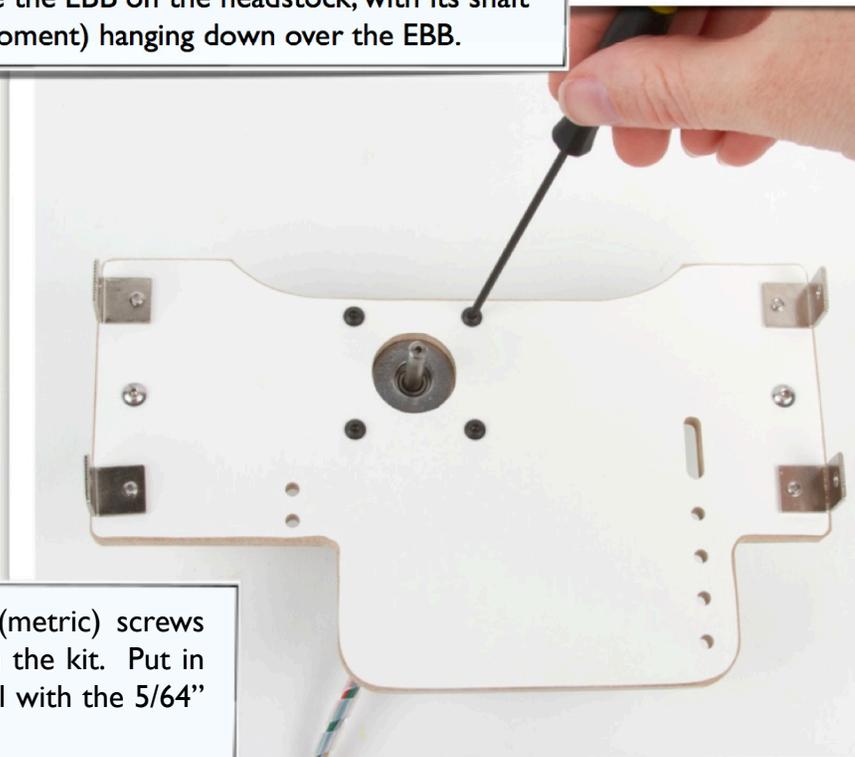


Continue wrapping the spiral upwards, making a neat wire bundle. Repeat for the other motor.

STEP 22: Installing Motor 2, the “Egg Motor”



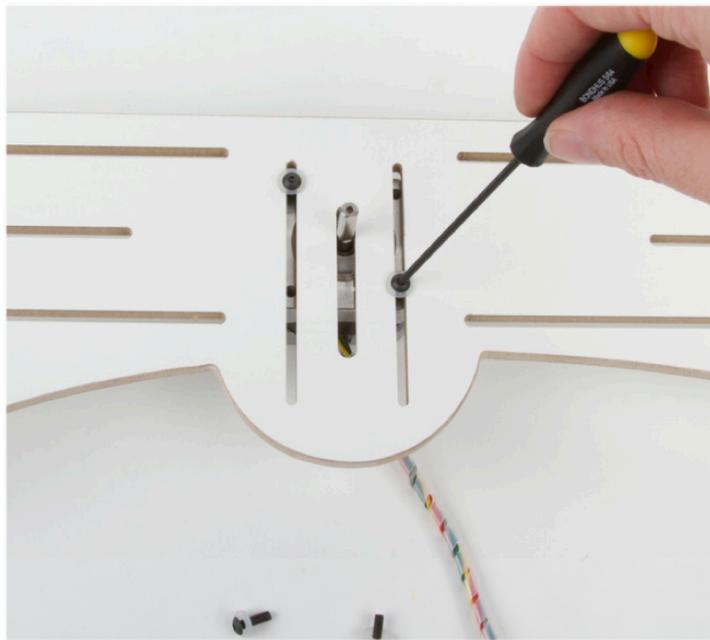
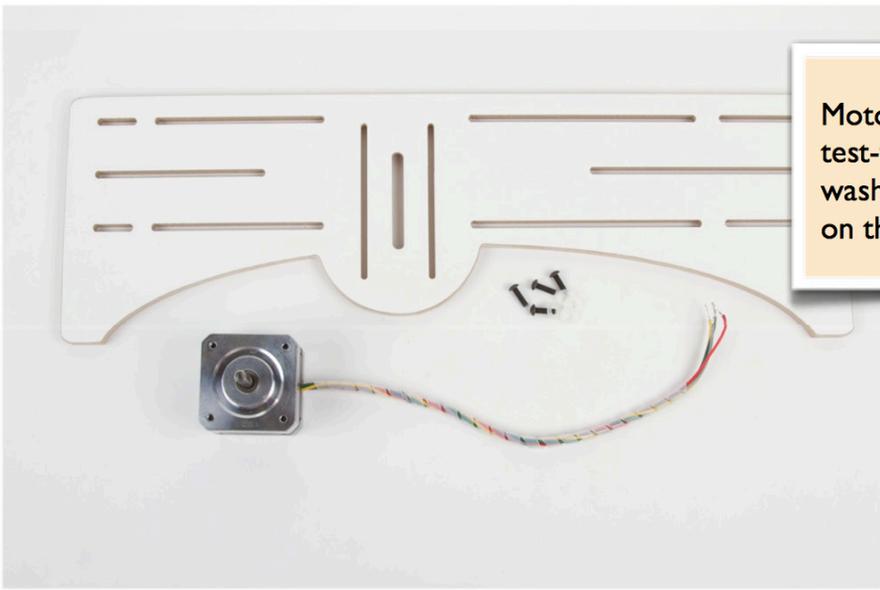
Test fit the motor in place. It sits above the EBB on the headstock, with its shaft poking through and its wires (for the moment) hanging down over the EBB.



The motor is held in by four M3 (metric) screws (part **#22**), the *black metal* screws in the kit. Put in all four screws and tighten them well with the 5/64” hex wrench.*

STEP 23: 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. This time, you’ll also use part **#23**, nylon washers, to make motor height adjustment easier. Place the washers on the black M3 screws before installing them to fix it in place.



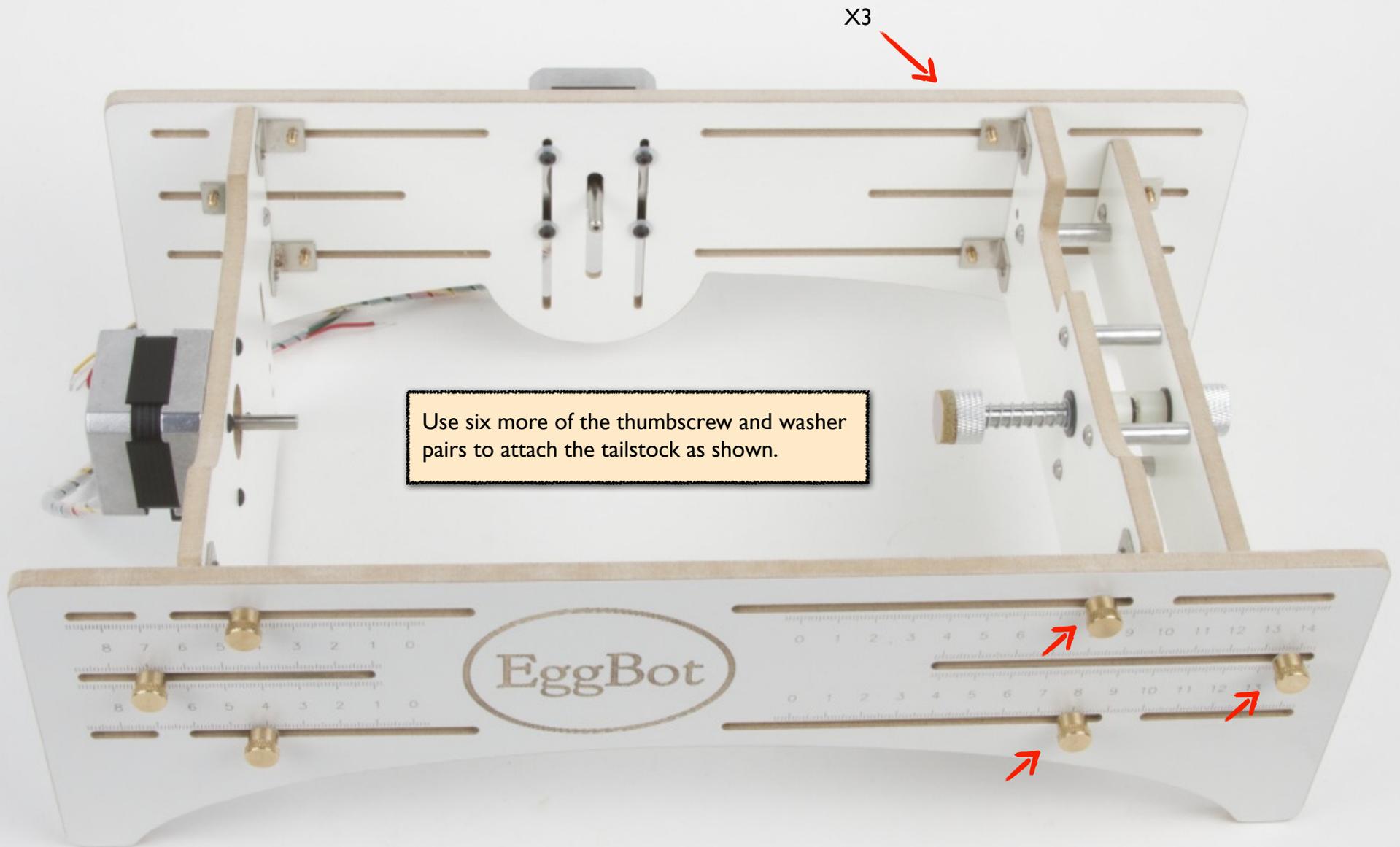
STEP 24: Attach the Headstock to the Chassis

Part #23 is the same plastic washer used for the pen motor screws. Part #24 is a brass thumbscrew. These fit through the long slots in the chassis side walls and thread into the angle brackets on the headstock. Use six screw and washer pairs to attach the headstock to the side walls. The washers will help them slide over the chassis surface during adjustments.

Part, #23 and #24
(6-32 x 1/2" brass thumbscrews
and nylon washers)



STEP 25: Attach the Tailstock to the Chassis

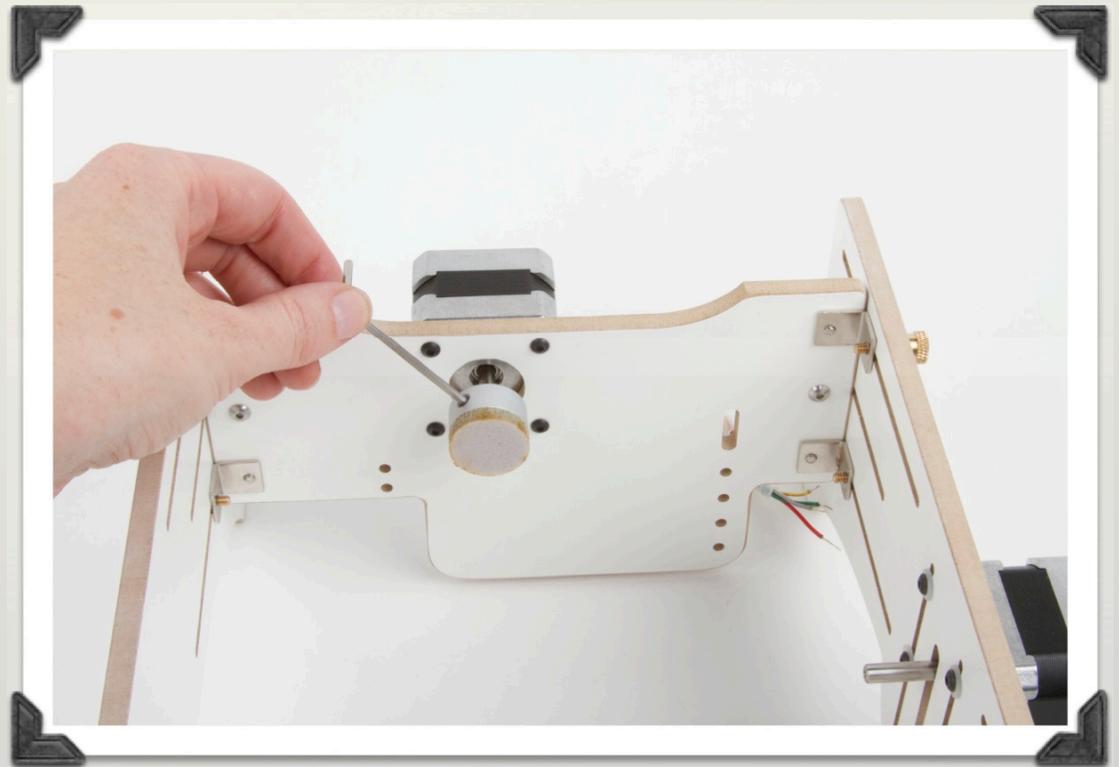


STEP 26: The other Egg Coupler

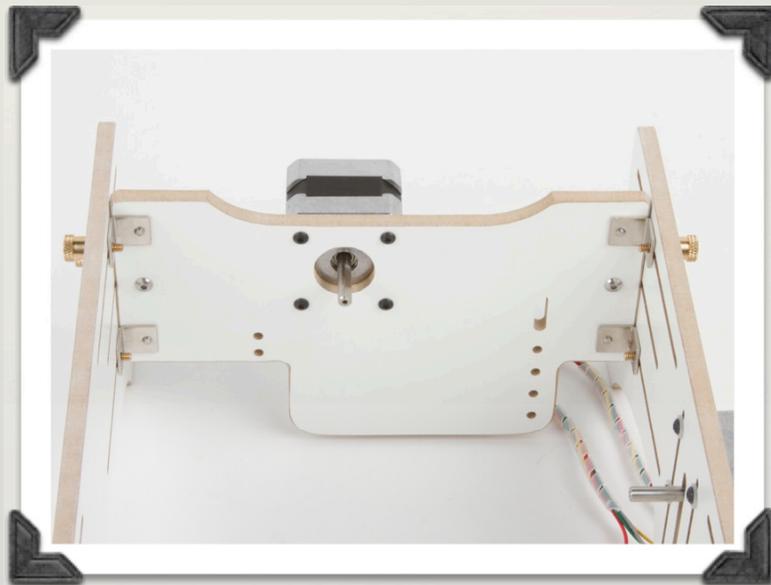
Next we need **#25**, (the precision egg coupler for the 5 mm shaft) and the 3/32" wrench.



Slide the collar into place so that the end of the motor shaft just touches the back of the abrasive pad. Orient the screw so that it will tighten down onto the flat face of the motor shaft.



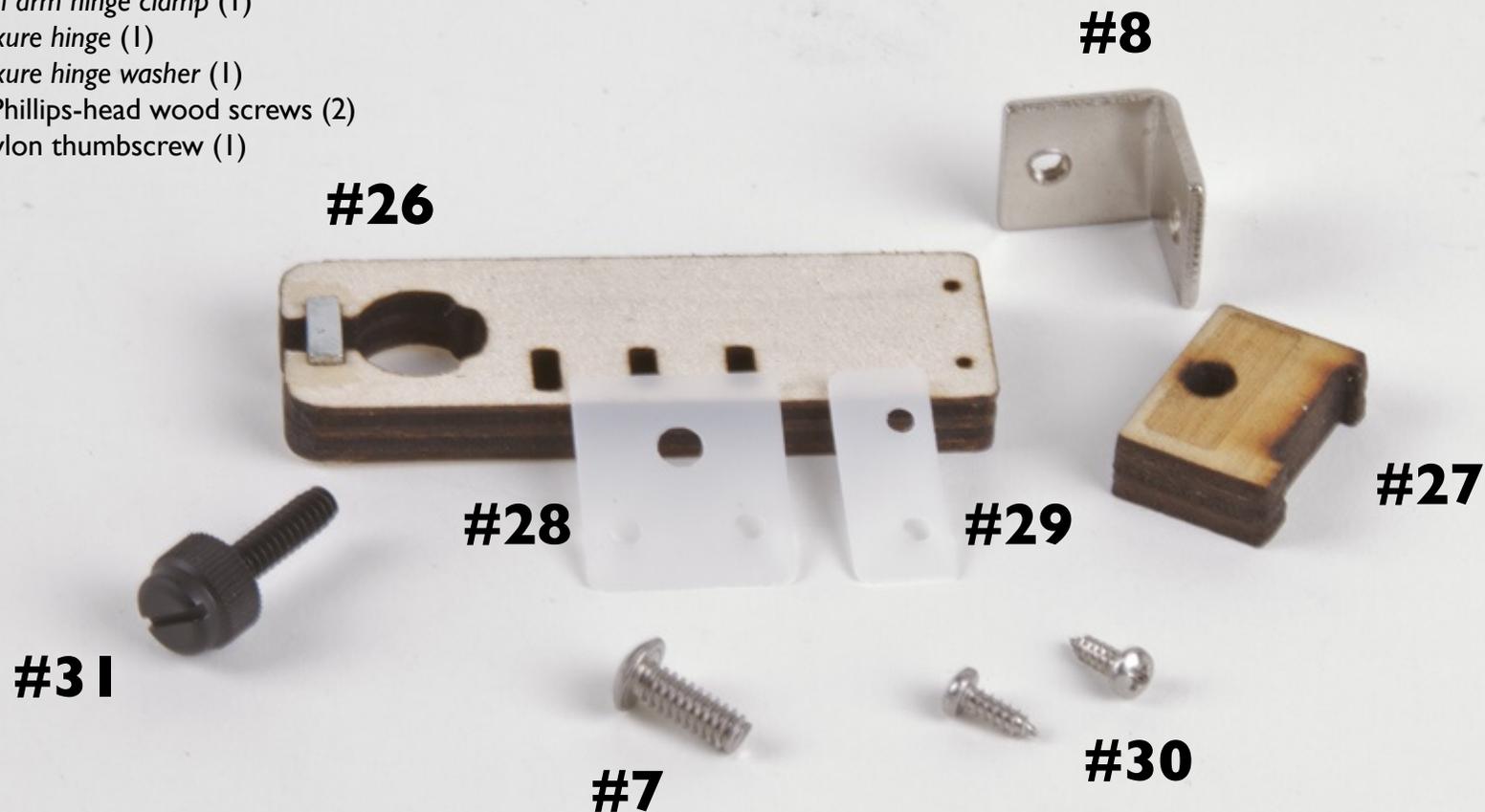
Once the coupler is in the right place, tighten it well. (But, do not use excessive force that might damage the motor.)



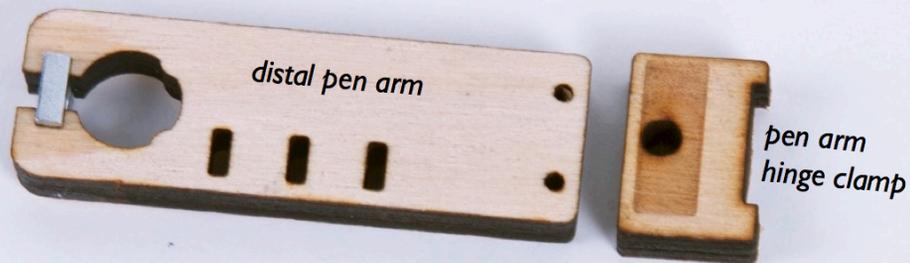
STEP 27: The Distal Pen Arm Parts

- #7, 3/8" stainless button socket cap screw (1)
- #8, Angle bracket (1)
- #26, the *distal pen arm* (1)
- #27, the *pen arm hinge clamp* (1)
- #28, the *flexure hinge* (1)
- #29, the *flexure hinge washer* (1)
- #30, Small Phillips-head wood screws (2)
- #31, 1/2" nylon thumbscrew (1)

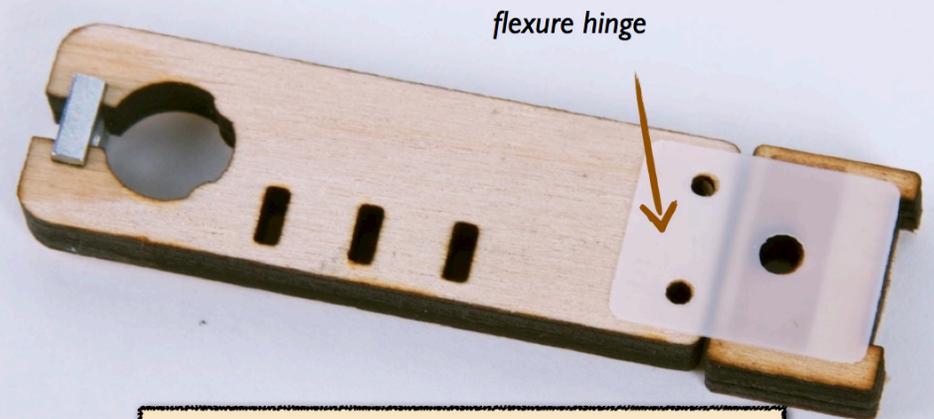
The parts shown here will be used in the next few steps, as we build up the distal pen arm. Gather them up, and let's get going!



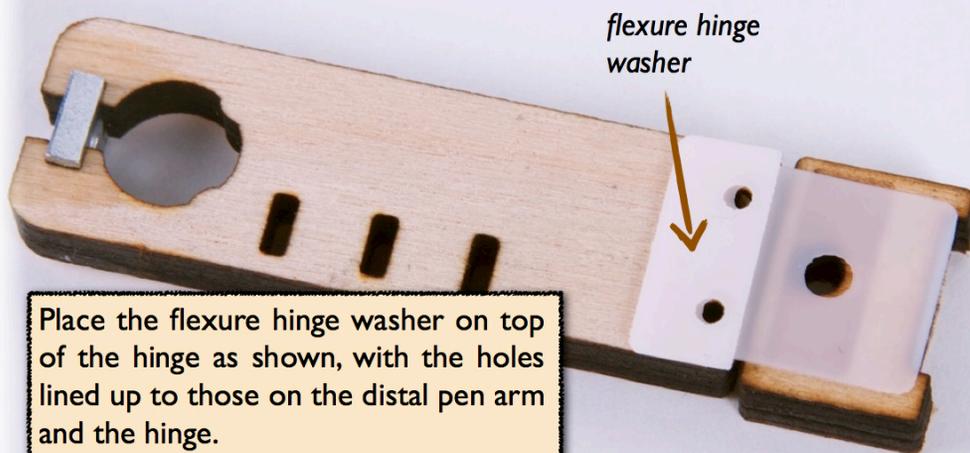
STEP 28: Adding the pen arm hinge



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.



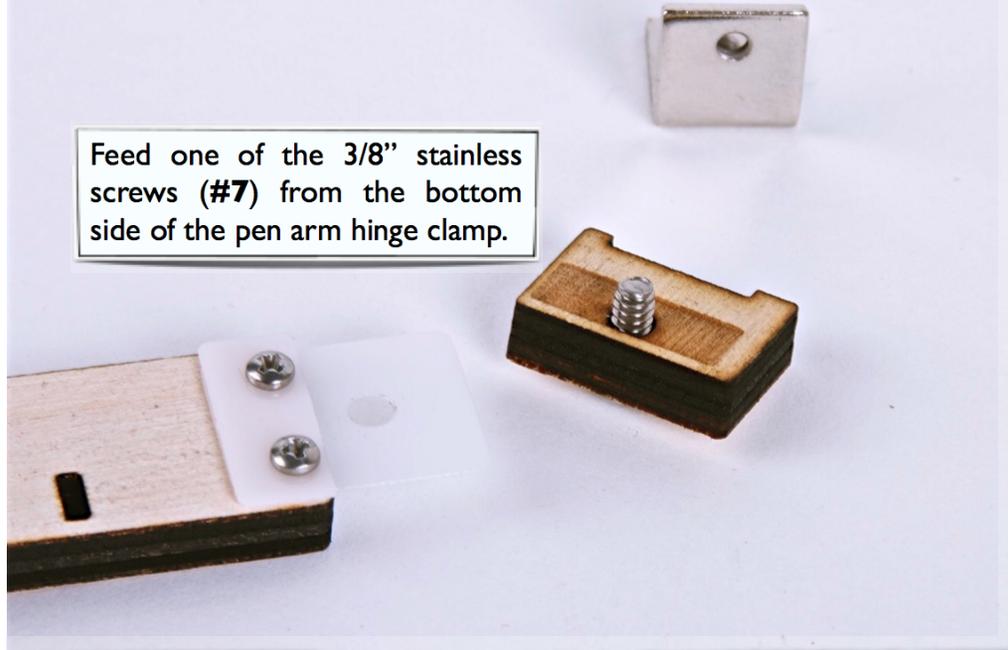
Place the flexure hinge washer on top of the hinge as shown, with the holes lined up to those on the distal pen arm and the hinge.



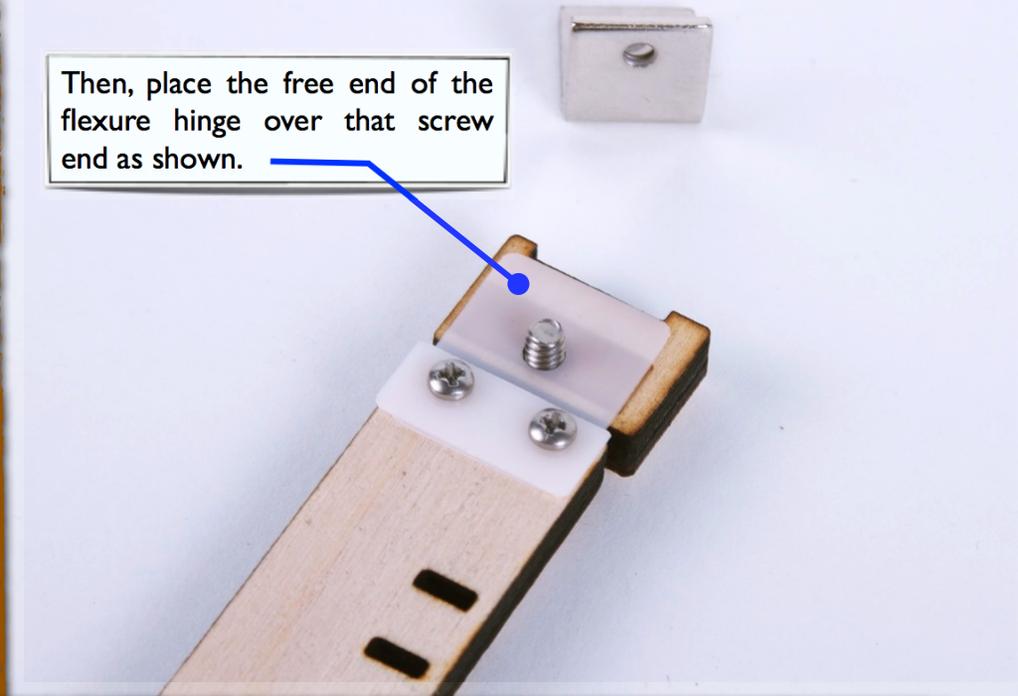
Put the two small Phillips-head wood screws through the holes in the washer, and tighten them in place.

STEP 29: Add the Pen Arm Hinge Clamp

Feed one of the 3/8" stainless screws (#7) from the bottom side of the pen arm hinge clamp.



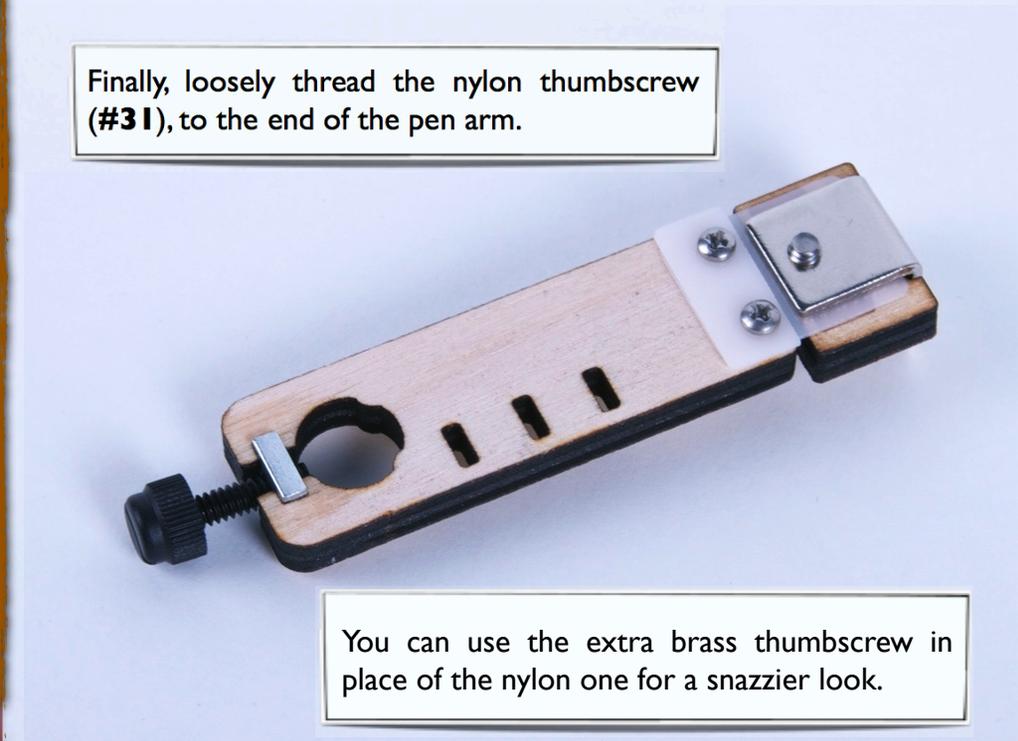
Then, place the free end of the flexure hinge over that screw end as shown.



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

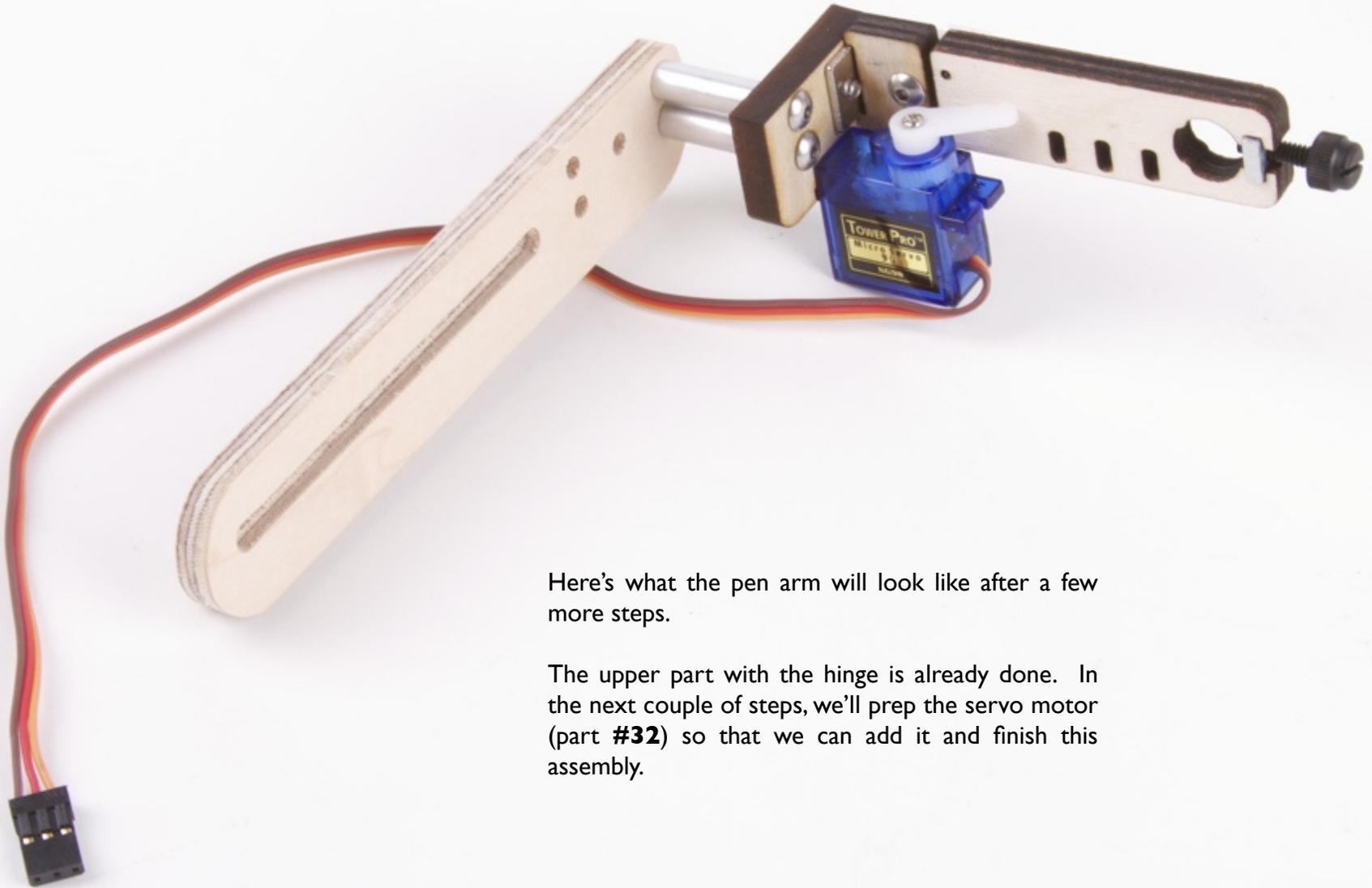


Finally, loosely thread the nylon thumbscrew (#31), to the end of the pen arm.



You can use the extra brass thumbscrew in place of the nylon one for a snazzier look.

STEP 30: A look at what's to come.

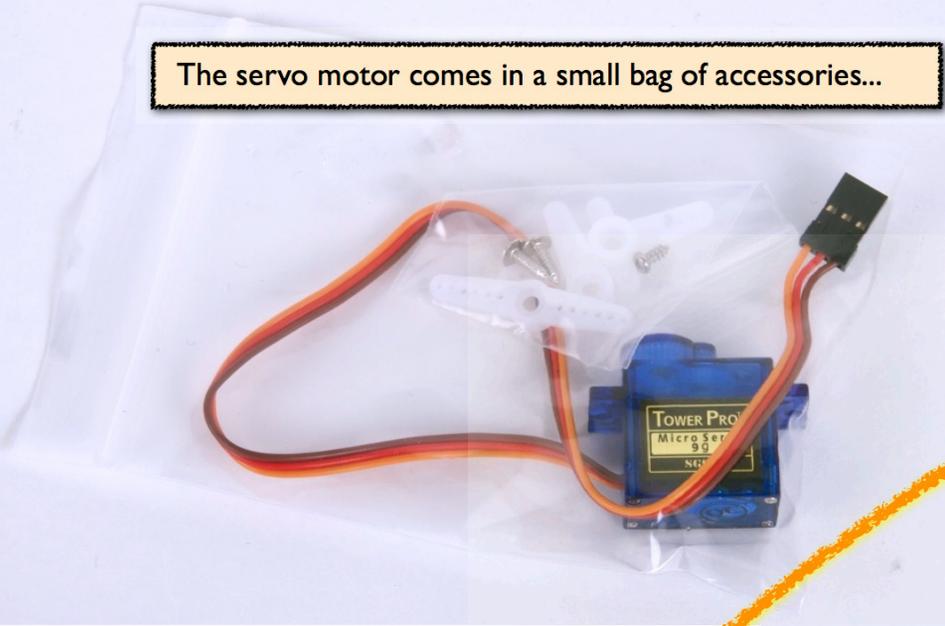


Here's what the pen arm will look like after a few more steps.

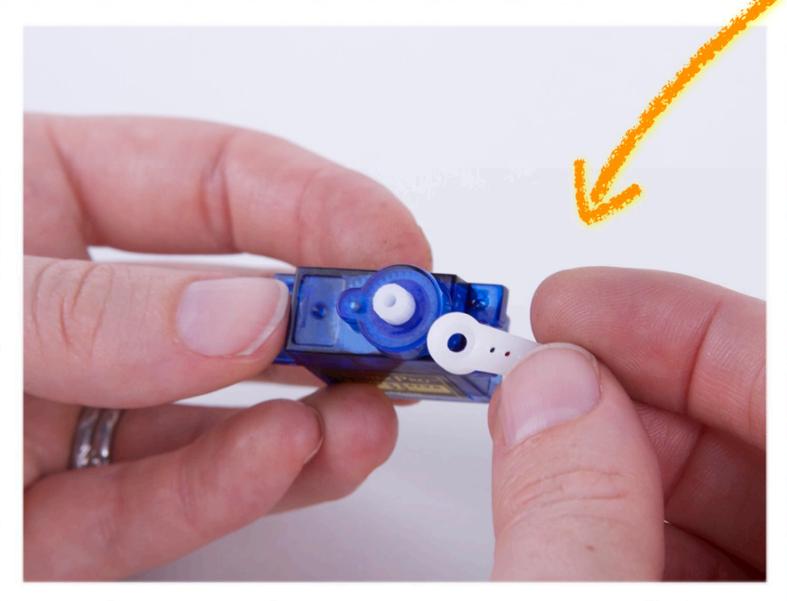
The upper part with the hinge is already done. In the next couple of steps, we'll prep the servo motor (part **#32**) so that we can add it and finish this assembly.

STEP 31: The servo motor, initial setup

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

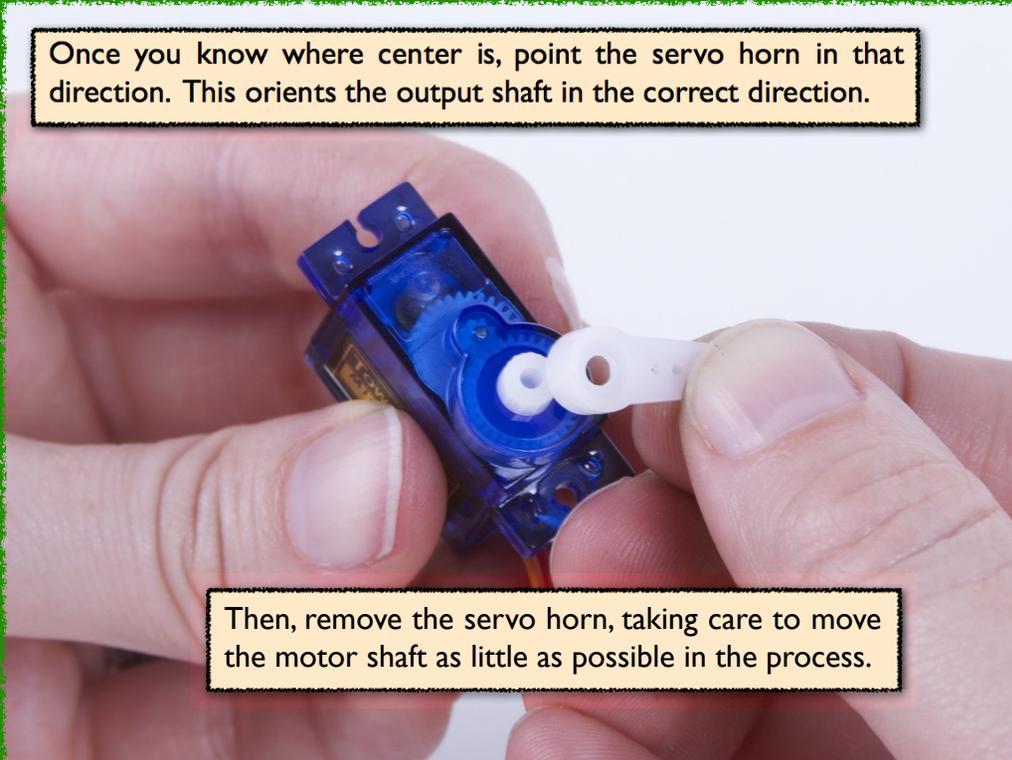
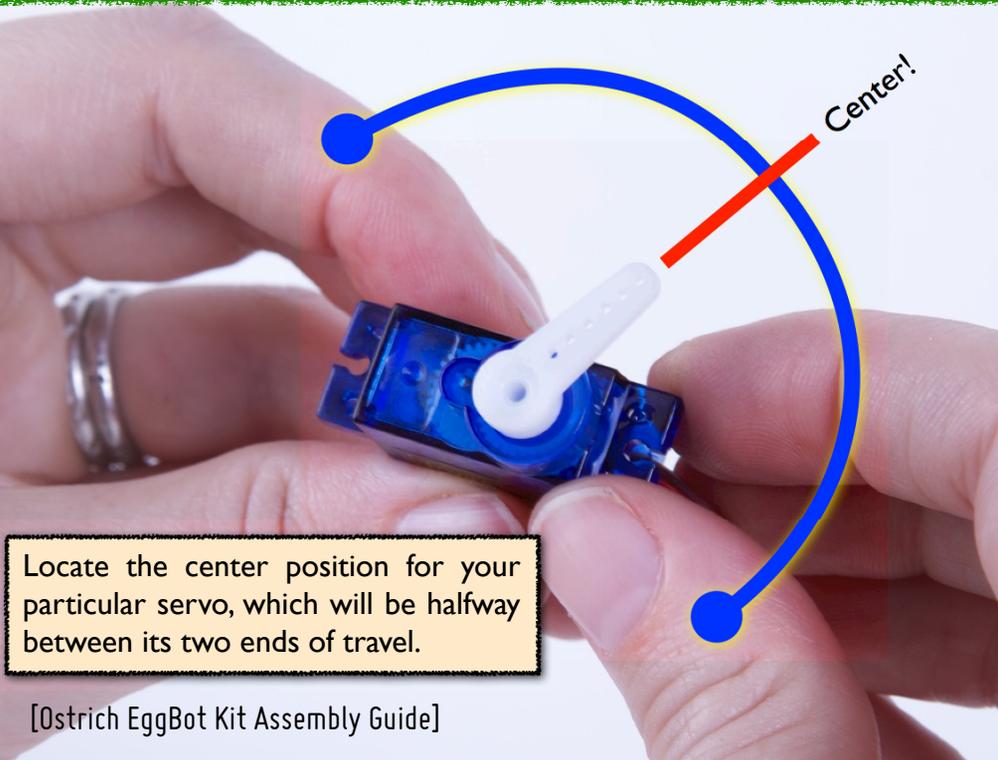
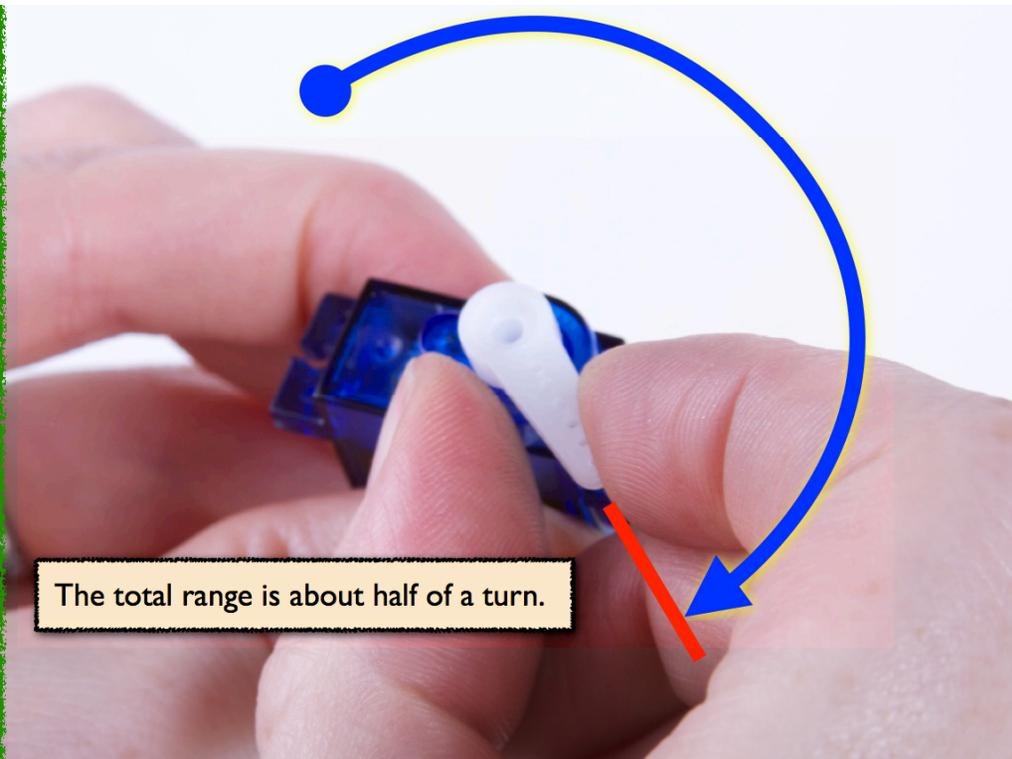


We'll only need these parts; set the others aside.

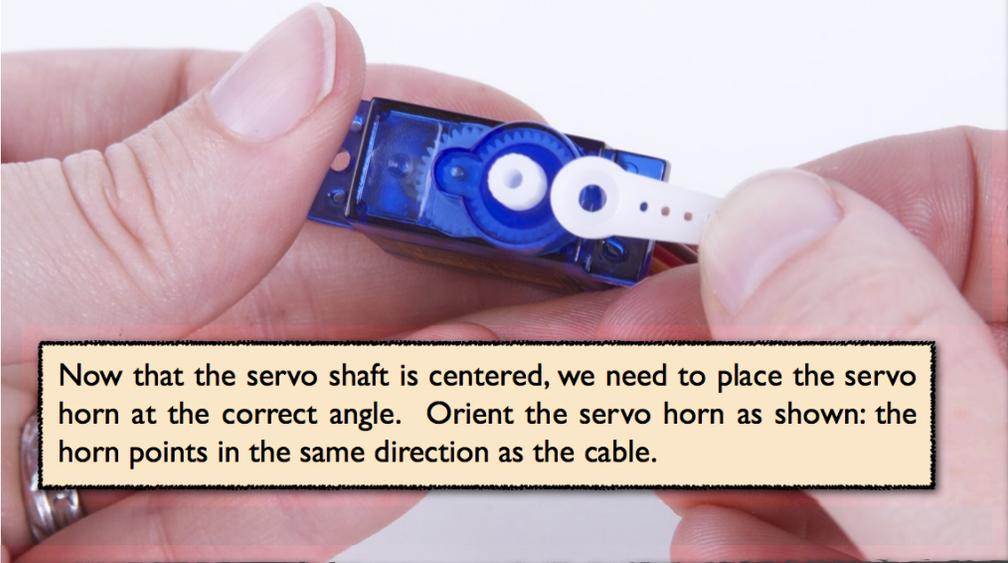


Take this piece, the *servo horn*, and push it onto the servo motor shaft. (Do not screw it in place; its position is not final yet.)

STEP 32: Find the Servo's Center



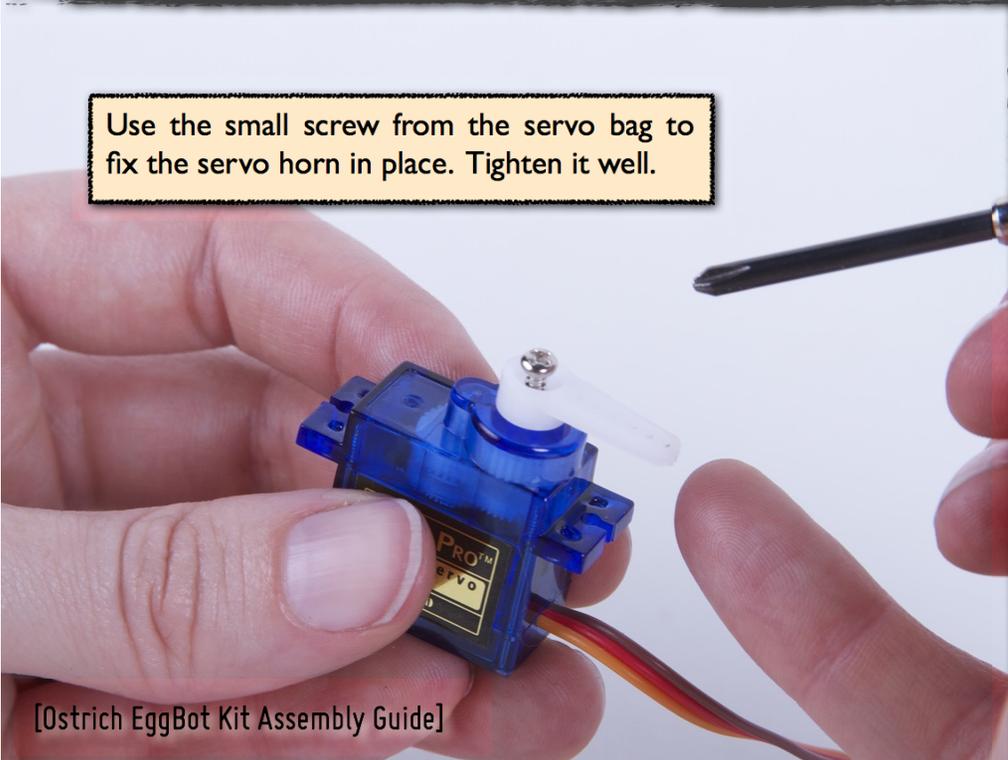
STEP 33: Final installation of servo horn



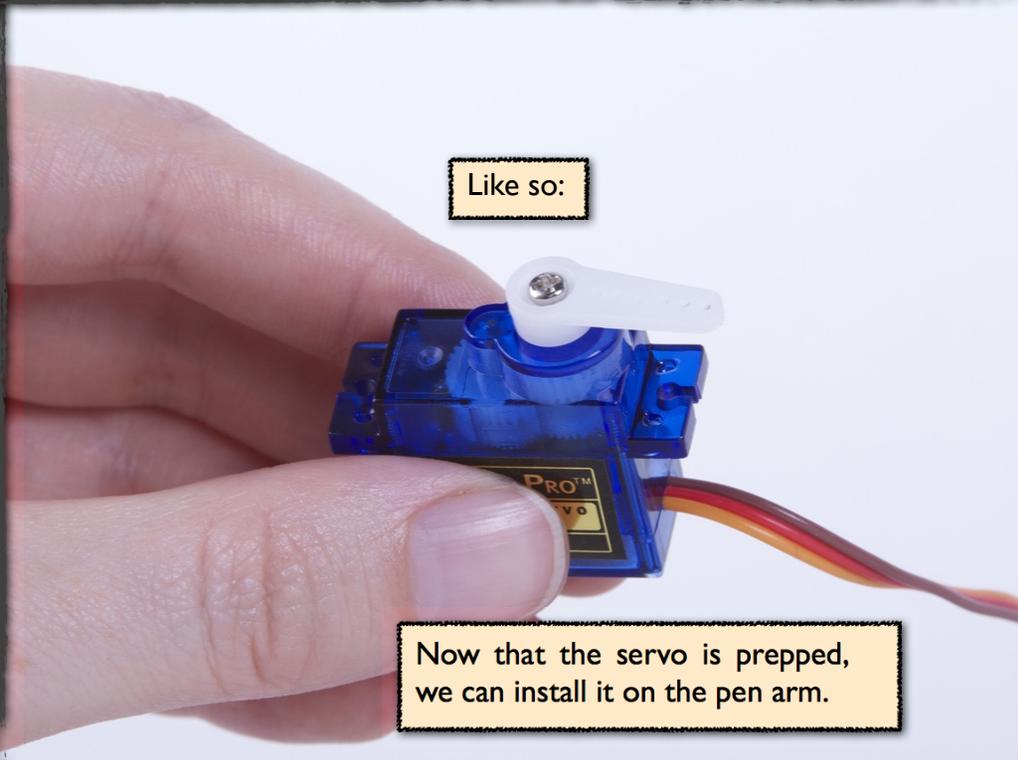
Now that the servo shaft is centered, we need to place the servo horn at the correct angle. Orient the servo horn as shown: the horn points in the same direction as the cable.



Press the servo horn onto the shaft



Use the small screw from the servo bag to fix the servo horn in place. Tighten it well.



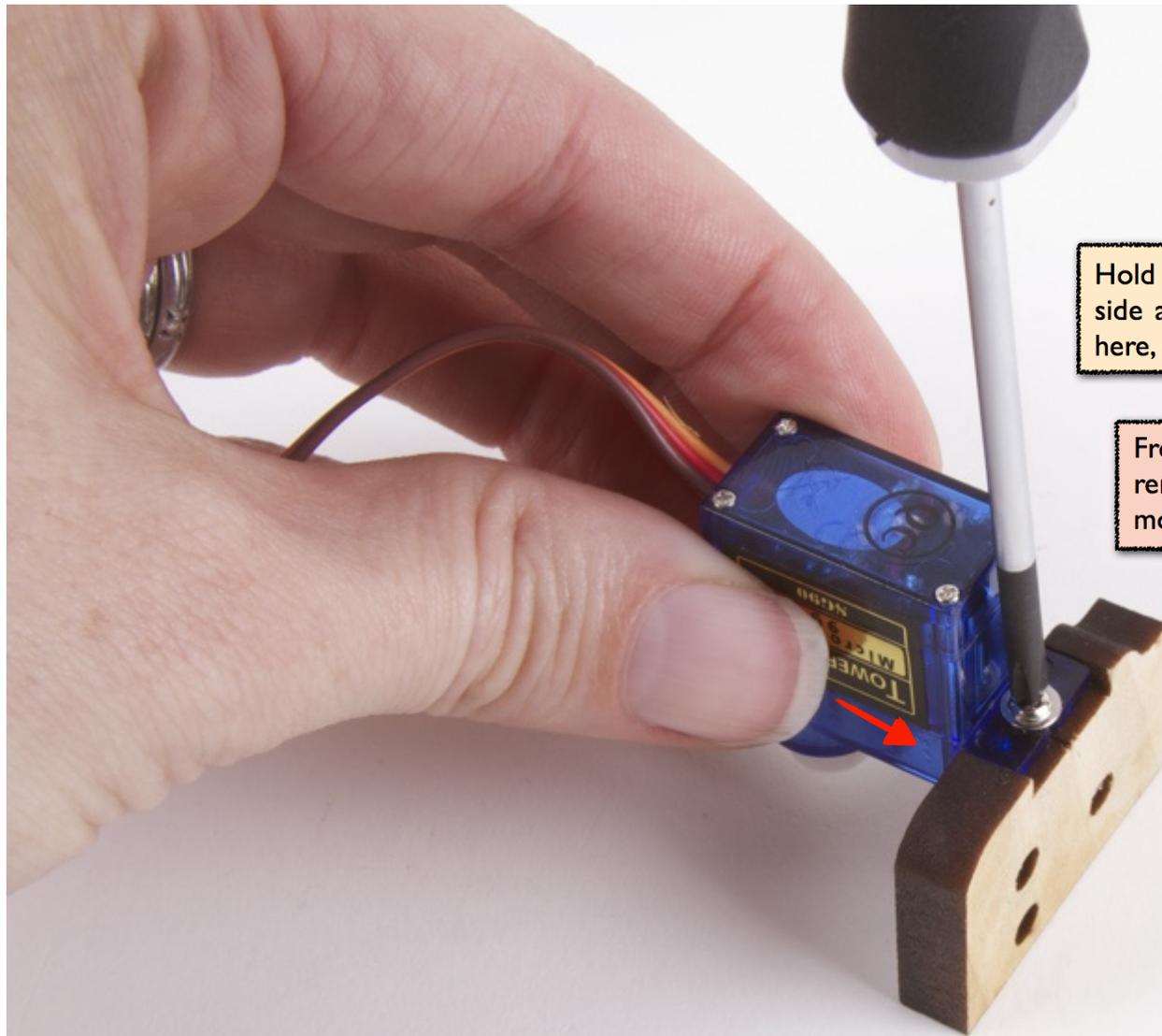
Like so:

Now that the servo is prepped, we can install it on the pen arm.

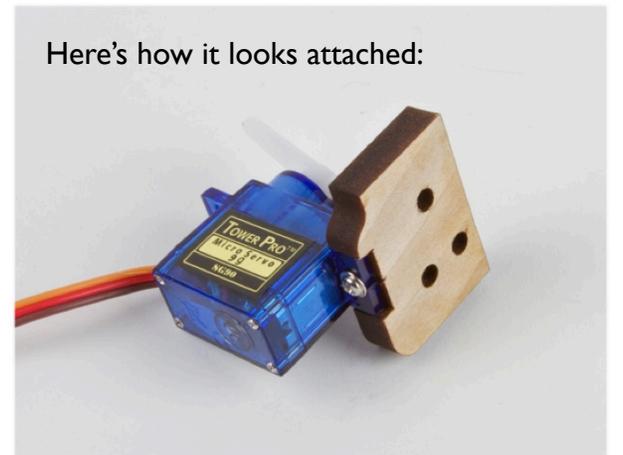
STEP 34: Install the Servo Motor

Hold the servo motor down and flush against the side against the servo mount (part #33) 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:

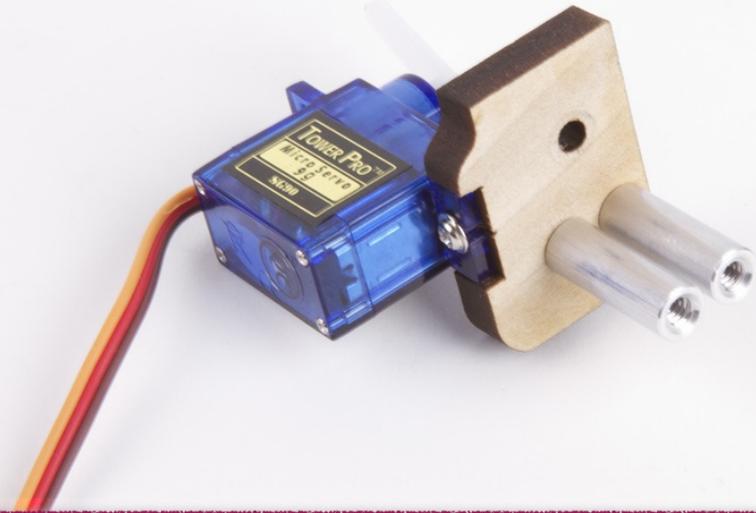


STEP 35: Adding the Proximal pen arm



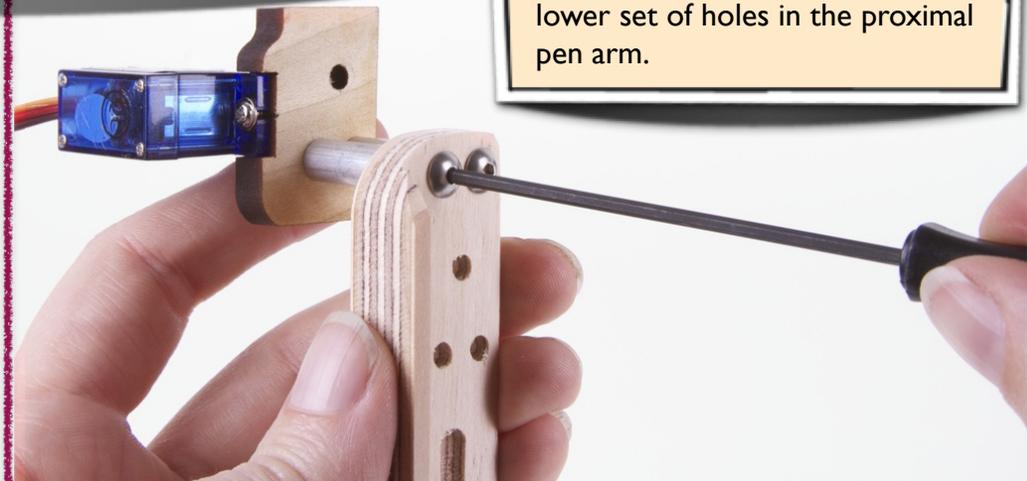
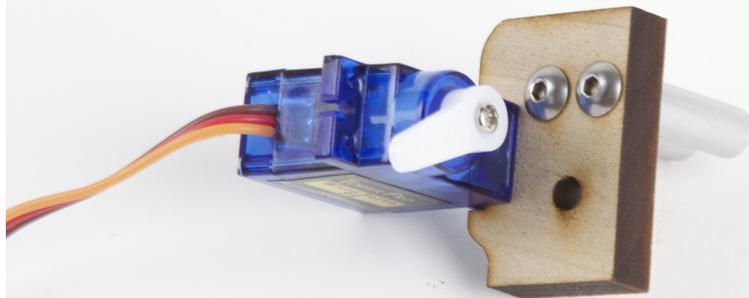
Use two more 3/8" stainless screw (#7) to attach the two 3/4" standoffs (#34) to the two bottom holes in the servo mount.

You can hold the screw in place with a fingertip while threading the standoffs on, just like we did for the standoffs on the tailstock.



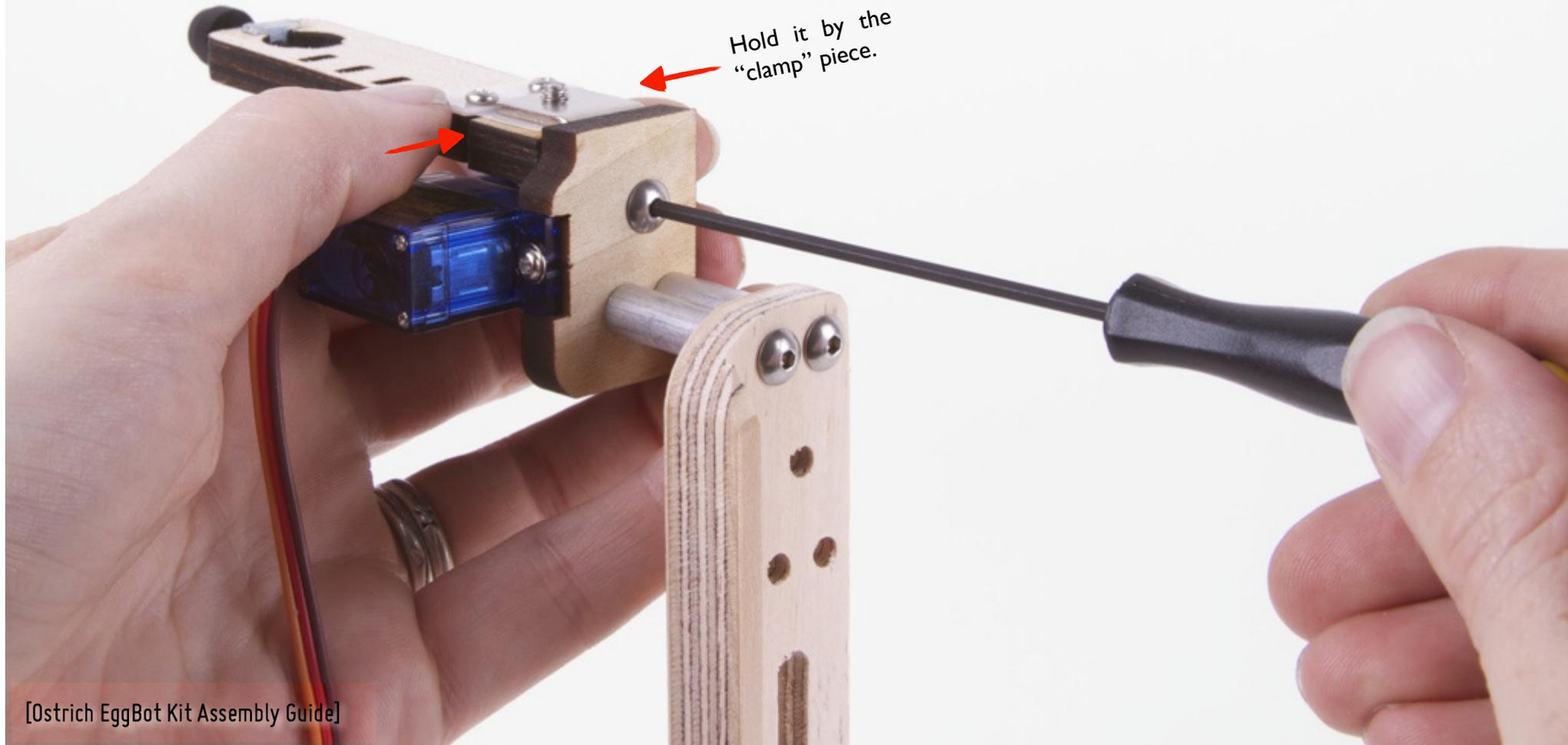
Then attach the proximal pen arm (part #35) to the standoffs with two more 3/8" screws. Orient the ridge on the proximal pen arm away from the servo and servo mount. Tighten all four screws with the 5/64" hex wrench.

Pro-tip: When you're plotting on smaller objects, you may want to move the servo mount to the lower set of holes in the proximal pen arm.

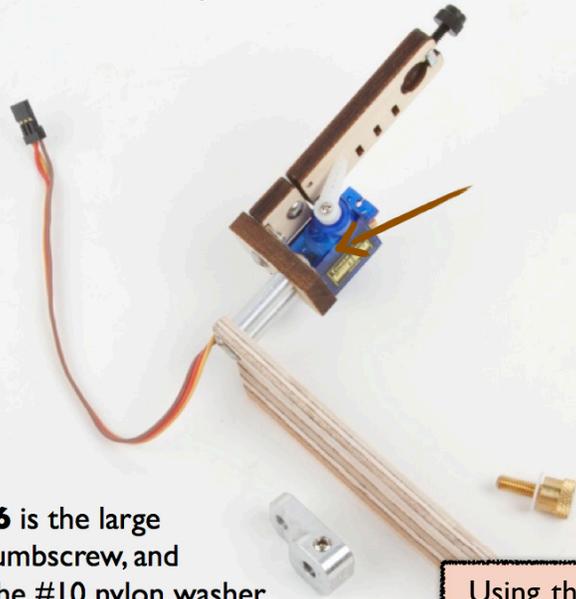


STEP 36: Adding the Distal pen arm

Use another 3/8" stainless screw (#7) to attach the pen arm assembly with the hinge to the proximal pen arm. Tighten it in place with the 5/64" hex wrench.

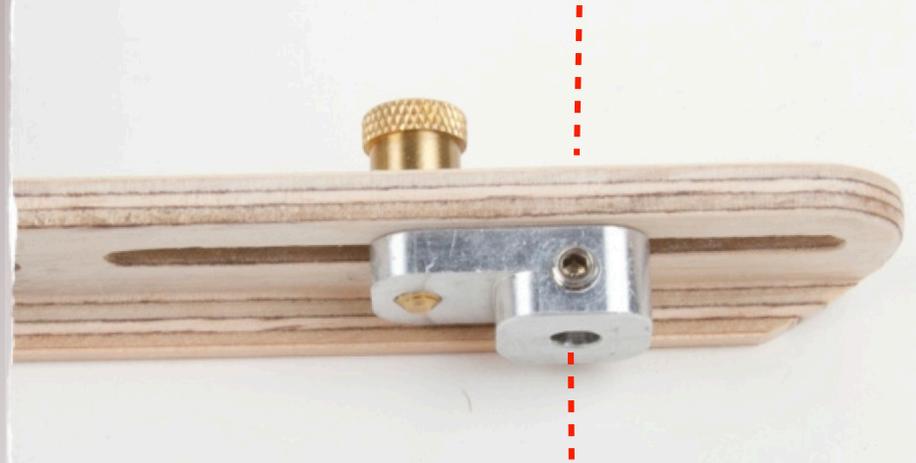
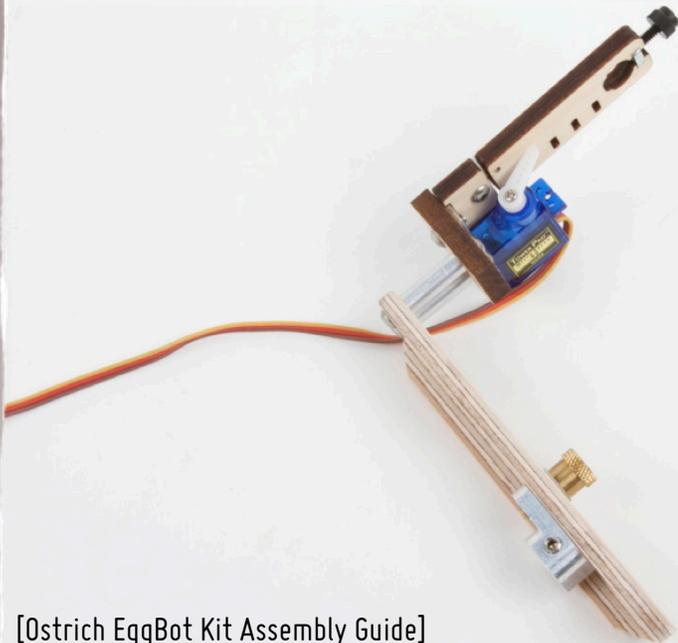


STEP 37: Adding the Pen Arm Backer

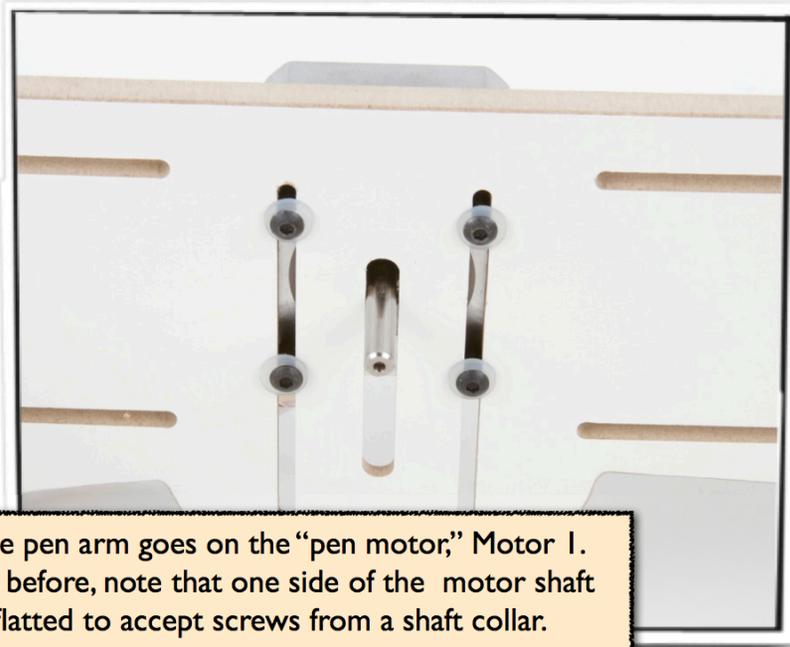


Part **#36** is the large brass thumbscrew, and **#37** is the #10 nylon washer

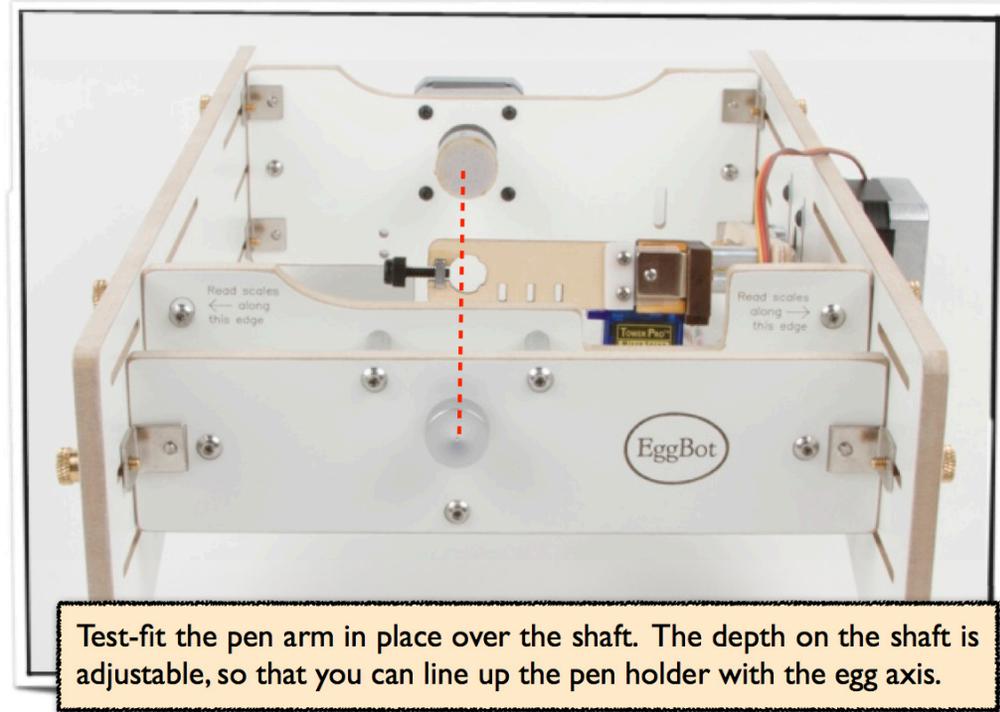
Using the large brass thumbscrew with its larger washer, attach the pen arm backer (part **#38**) to the proximal pen arm. Make sure that it's lined up so that you can see clear through the shaft mounting hole.



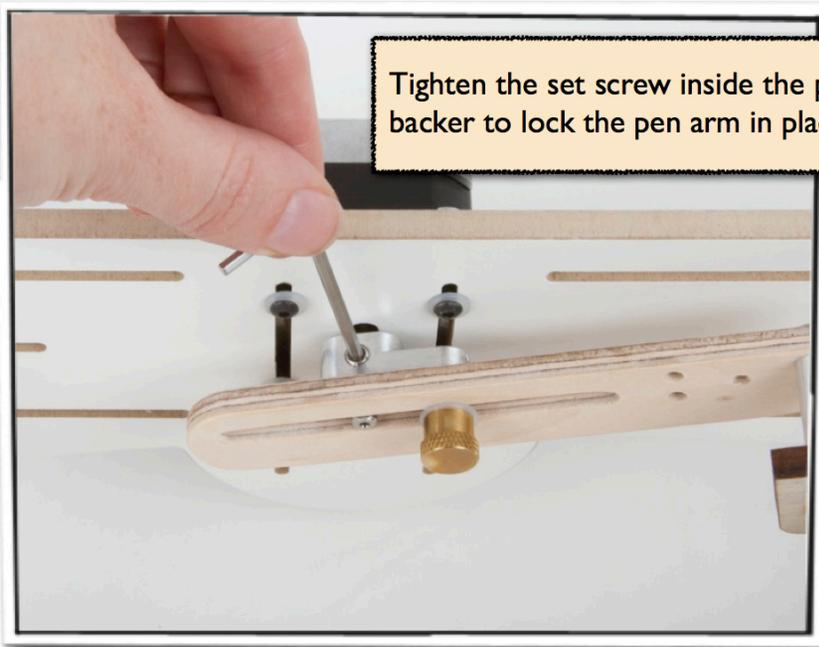
STEP 38: Installing the pen arm



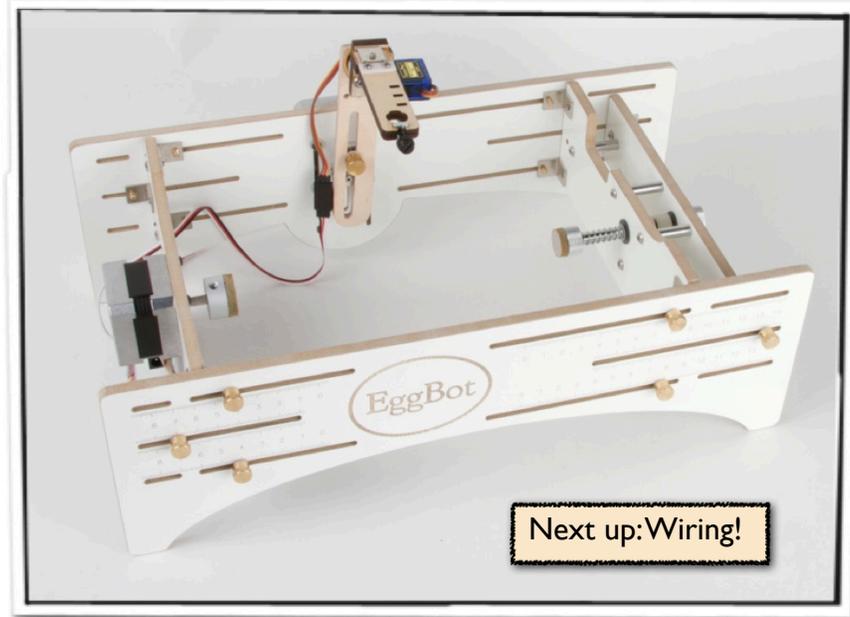
The pen arm goes on the “pen motor,” Motor 1. As before, note that one side of the motor shaft is flatted to accept screws from a shaft collar.



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.



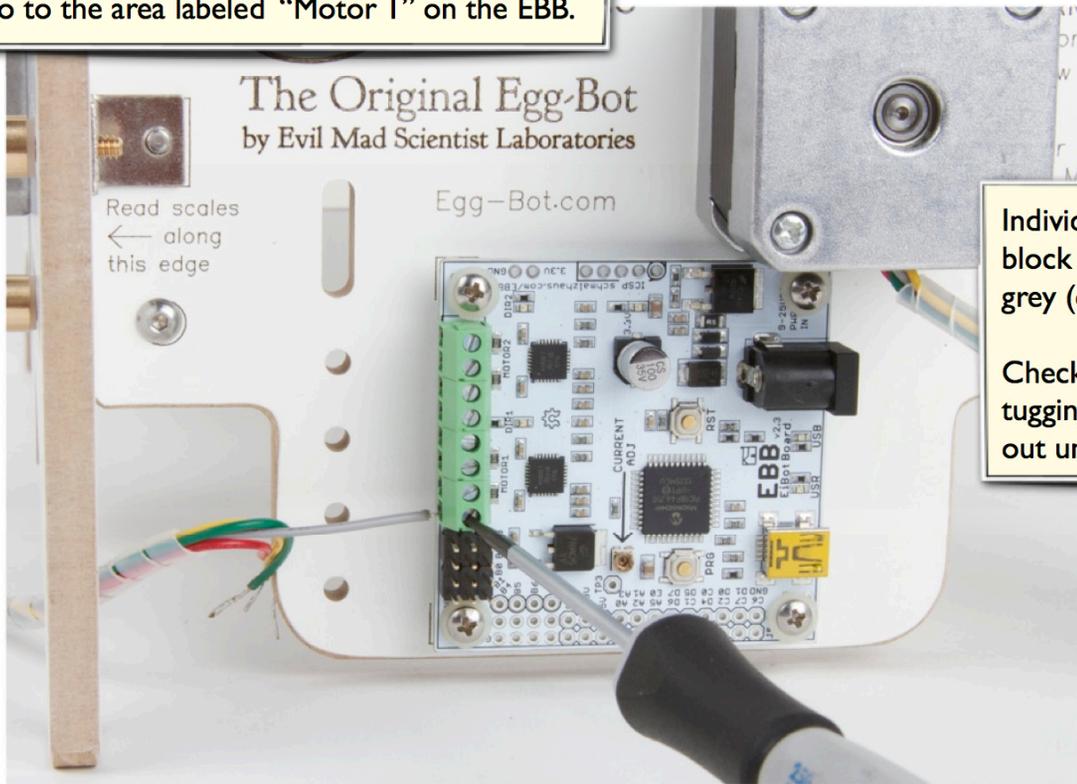
Tighten the set screw inside the pen arm backer to lock the pen arm in place.



Next up: Wiring!

STEP 39: Wiring the Stepper Motors

The four wires from Motor 1 (the pen motor) go to the area labeled "Motor 1" on the EBB.



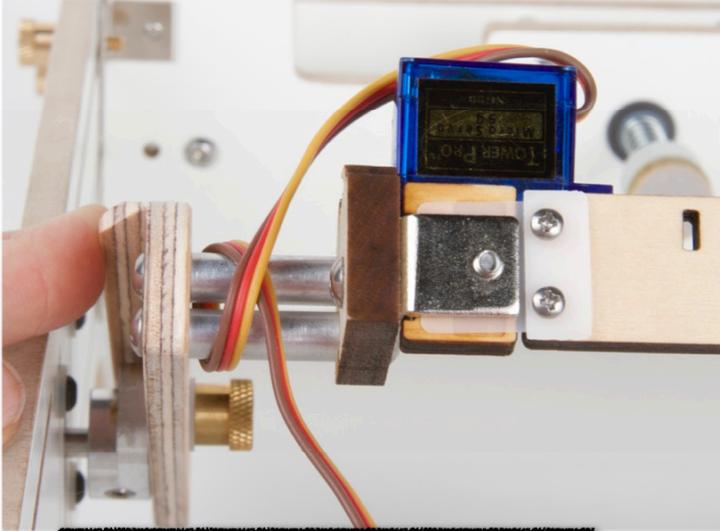
Individually insert the four wires into the terminal block and screw them down. The wire order is: grey (or brown), green, yellow, pink, bottom to top.

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

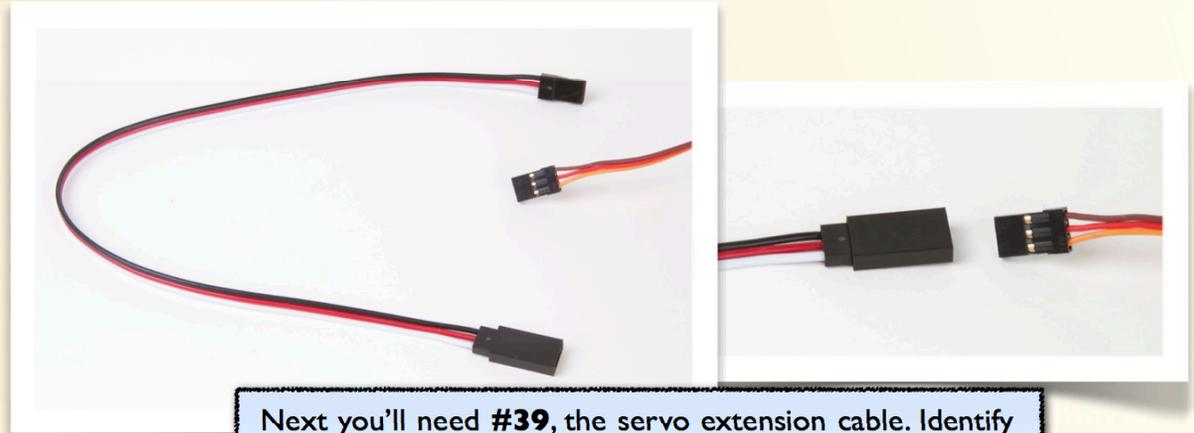
Wire up Motor 2 next. Its four wires go to the "Motor 2" area of the EBB. Wire order is again grey (or brown), green, yellow, pink, bottom to top.



STEP 40: Servo Motor Wiring



To keep the servo cable out of the way, you may want to route it around the standoffs on the pen arm.

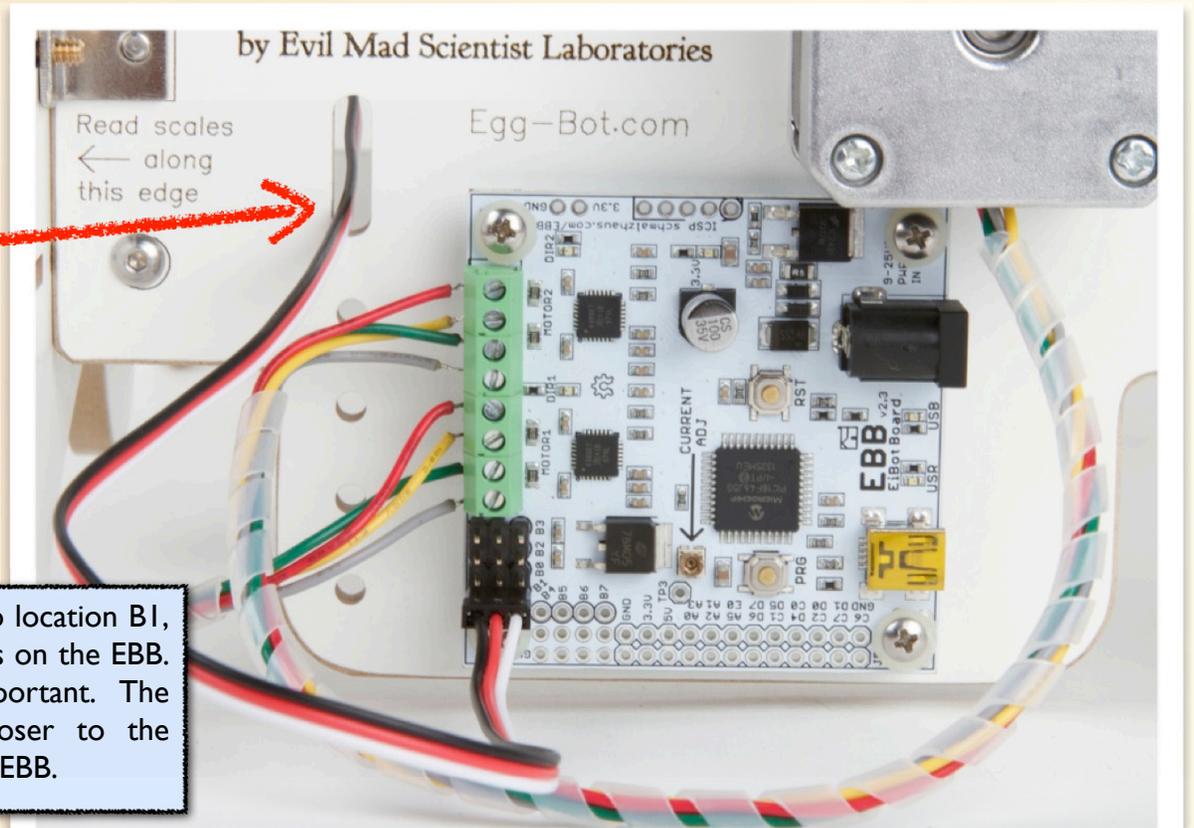


Next you'll need **#39**, the servo extension cable. Identify the larger end and align the black wire on the extension cable with the brown wire on the servo cable.

Connect the cables together firmly. You can route the unconnected end of the extension cable through the slot on the headstock.

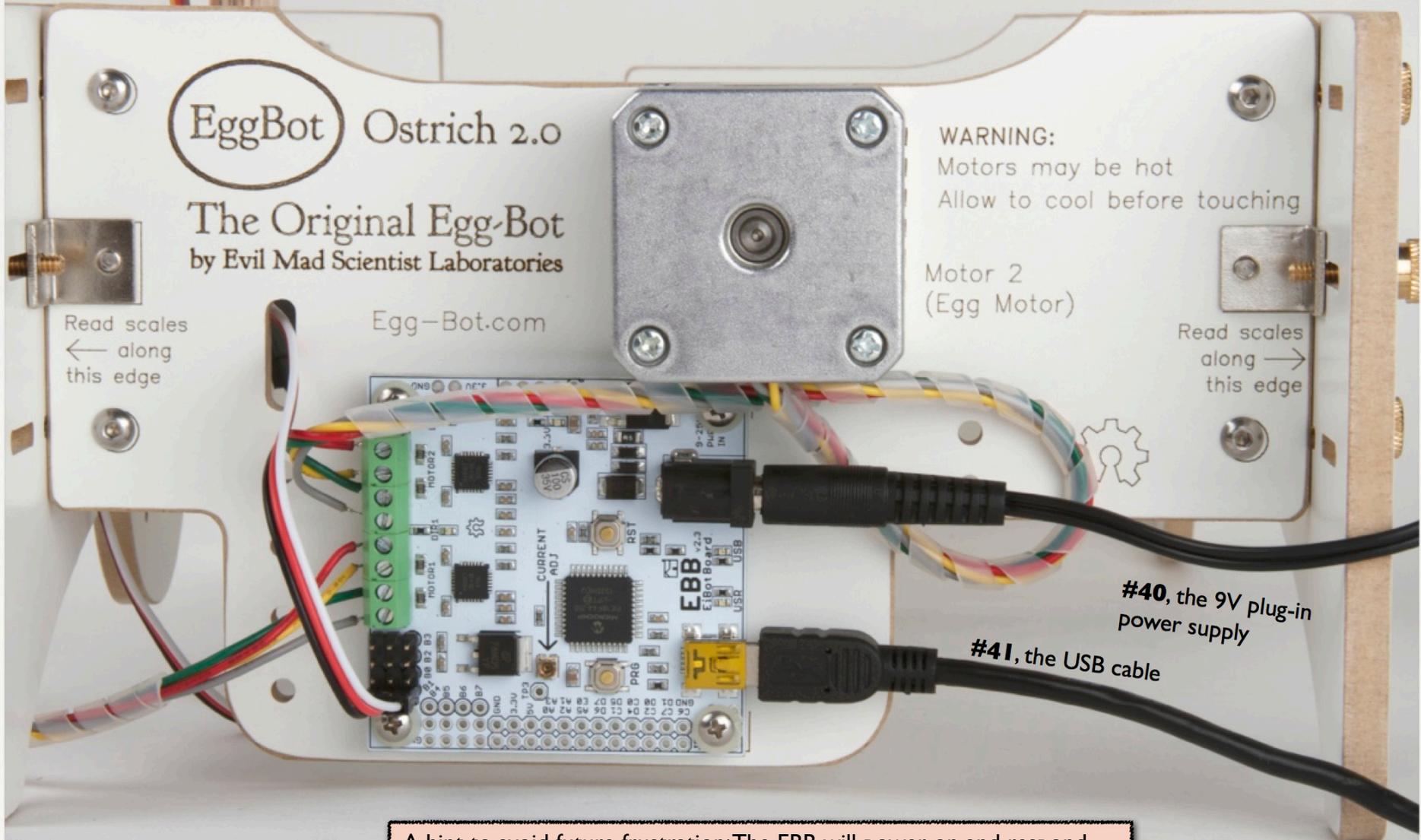


The servo cable connects to location B1, the bottom set of three pins on the EBB. The cable orientation is important. The black wire is the one closer to the outside (the left side) of the EBB.



STEP 41: Connectivity

Hook up the power supply and USB cable.



WARNING:
Motors may be hot
Allow to cool before touching

Motor 2
(Egg Motor)

Read scales
← along
this edge

Read scales
along →
this edge

#40, the 9V plug-in
power supply

#41, the USB cable

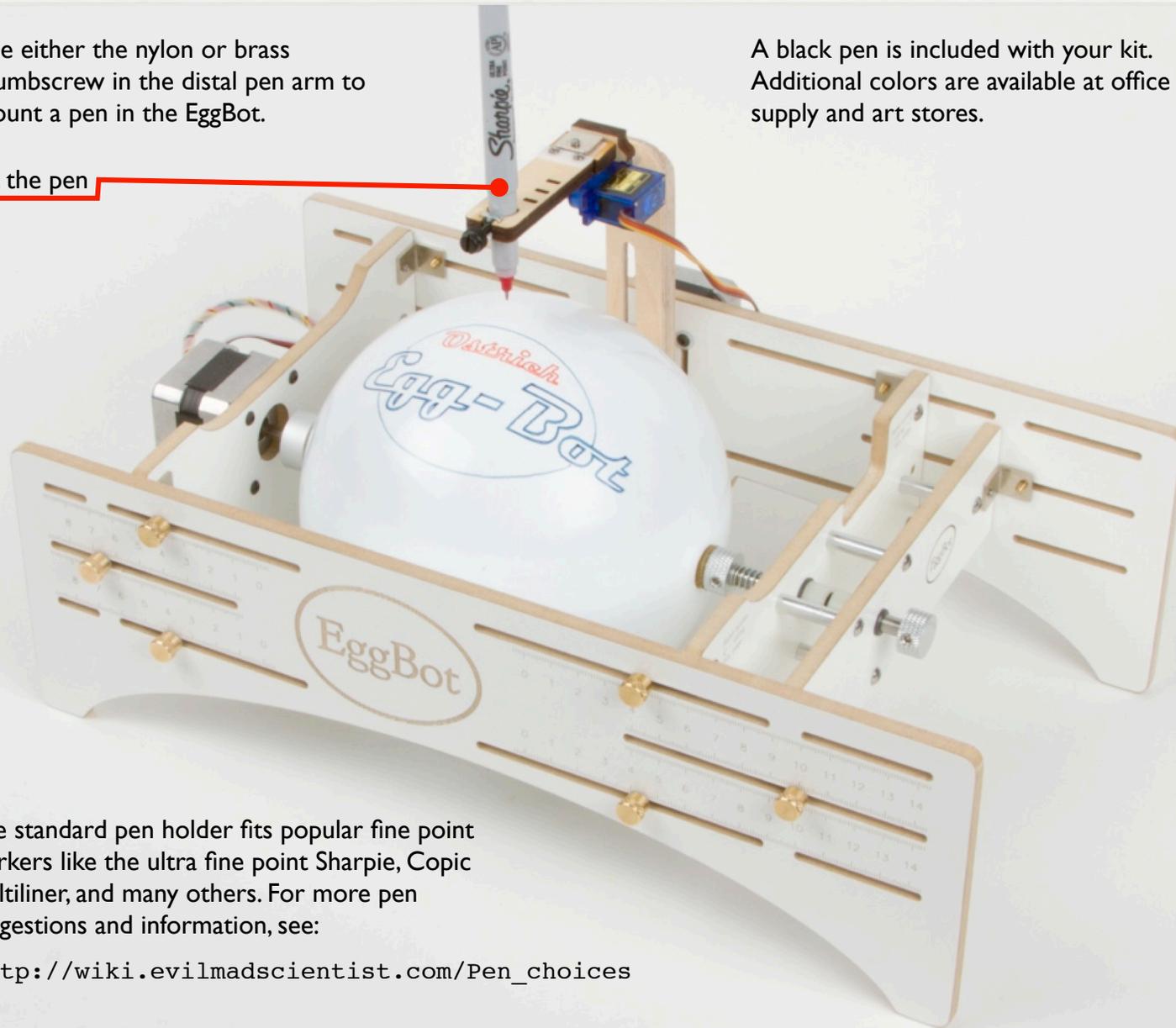
A hint to avoid future frustration: The EBB will power on and respond to computer commands while only the USB cable is plugged in, but the motors will not move unless the 9V supply is plugged in as well.

STEP 42: Adding a pen

Use either the nylon or brass thumbscrew in the distal pen arm to mount a pen in the EggBot.

A black pen is included with your kit. Additional colors are available at office supply and art stores.

#40, the pen



The standard pen holder fits popular fine point markers like the ultra fine point Sharpie, Copic Multiliner, and many others. For more pen suggestions and information, see:

http://wiki.evilmadscientist.com/Pen_choices

- FIN -

w00t! Your EggBot is now assembled, so this concludes the basic assembly instructions for the Ostrich EggBot Kit.

You should have a few pieces left over, including:

- A large rubber washer, which can be used with the egg couplers to hold smooth objects in place.
- An exceptionally strong spring, which can be used when more force is required to hold the object you're plotting on.
- An extra thumbscrew for the distal pen arm. You can use the nylon one when you are using a pen you might be worried about scratching, and the brass one when you want more rigid support there. Also, it looks nice.

If you're just building up a new kit, and/or using an EggBot 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.evilmadscientist.com/EggBot>

You can also get there from the "Support" tab at <http://www.egg-bot.com/>

Appendices follow.

