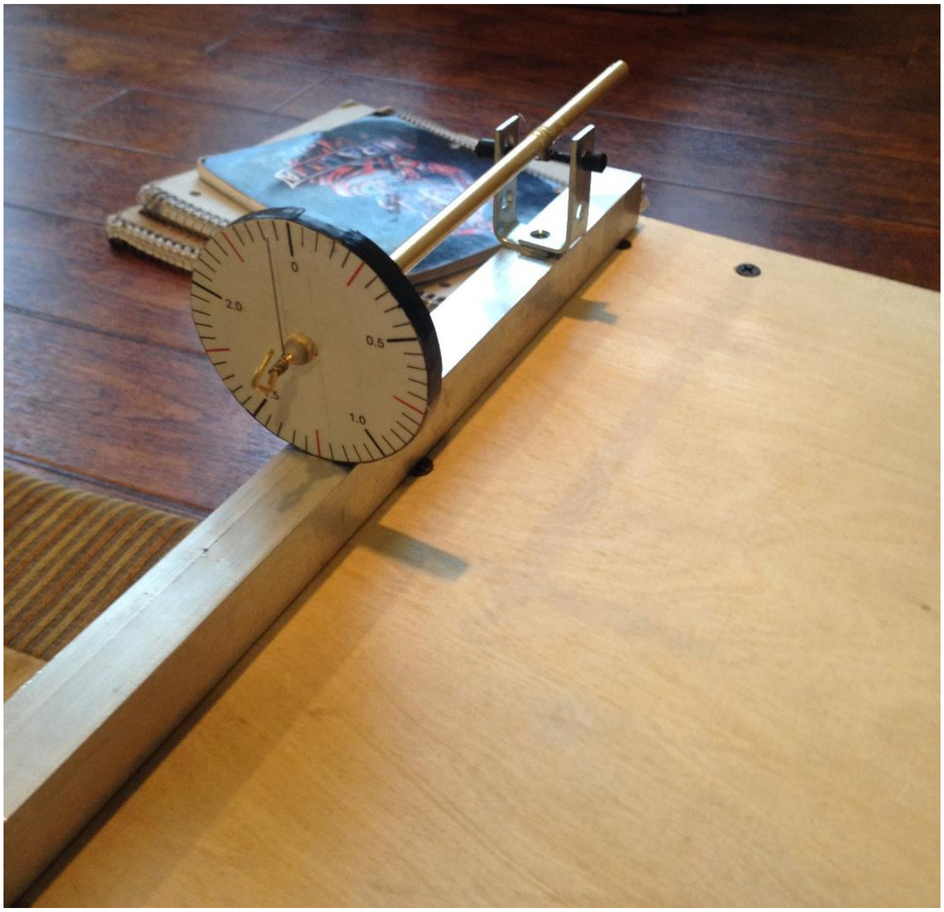
Torque Meter Construction

By DoctaDave



Preface

A torque meter is the most important tool a flyer can possibly have, and in my opinion it is even more important than a winder (since you get as much time as you want to set up your first flight, as official timing does not begin until you release your first flight). A torque meter can give a flier extremely useful information, such as the amount of torque that a rubber motor is exerting on the plane (surprise!). With this information, it is possible to consistently wind to max turns without breaking the motor, consistently reach the maximum height, consistently get well behaved launches, and find any inconsistencies in a rubber motor you are using. Notice the amount of times I mention consistency. This is key when flying a Wright Stuff plane as you need to be consistent in everything. Once you let go of the plane, you have no way to control it, so you have to be able to predict its behavior to get a flight that will not roll into a dive or fly straight into the ceiling. You can spend all day making adjustments to the CG (center of gravity), incidence, thrust angles, etc., but if you do not know the torque you are launching at or landing with, it will be very difficult to claim the gold medal.

If you don't wish to construct a torque meter, you can purchase one at either of these links:

http://www.freedomflightmodels.com/paypal.htm

http://www.ebay.com/itm/Rubber-Torque-Meter-for-Science-Olympiad-Wright-Stuff-/321579341922?pt=LH_DefaultDomain_0&hash=item4adf9f5862

Either will do, but I think the construction of the meter in the second link is much better.

Materials

Now for the construction of the torque meter, you will need a few supplies.

Tools:

- Sandpaper/grinding tool (dremel)
- Hack saw/dremel
- Drill with $^{5}/_{64}$" and ¼" bit
- Epoxy or solder (either one is fine, but I prefer epoxy)
- Ruler
- Wire cutters
- Needle nose pliers
- Marker/Sharpie

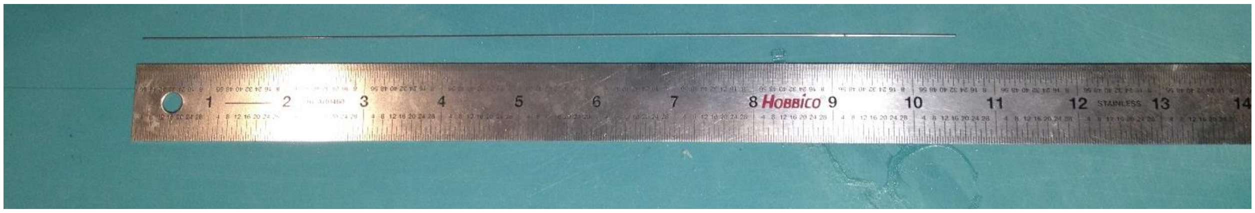
Materials

- ¼" Brass tubing (available at hobby shops)
- 1/16" brass tubing (available at hobby shops)
- .020" music wire (available at hobby shops)
- Some sort of flat material that is hard and durable (sheet of balsa wood, polycarbonate, thin plywood, bass wood, foam board etc.)
    - This will be used for the dial base
- Nose bearing from Ikara type propellers, or Peck Polymers bearing (http://www.faimodelsupply.com/product/nylon-thrust-bearings-qty-pkg-6-hole-i-d-364-o-d-18/)
- Electrical/duct tape
- Scrap metal/wood (see instructions below for further detail on shape)
- Thread/thin wire (optional)
- CA glue
- .015" music wire (optional as .020" wire can be substituted)
- Spray adhesive
- Clear tape

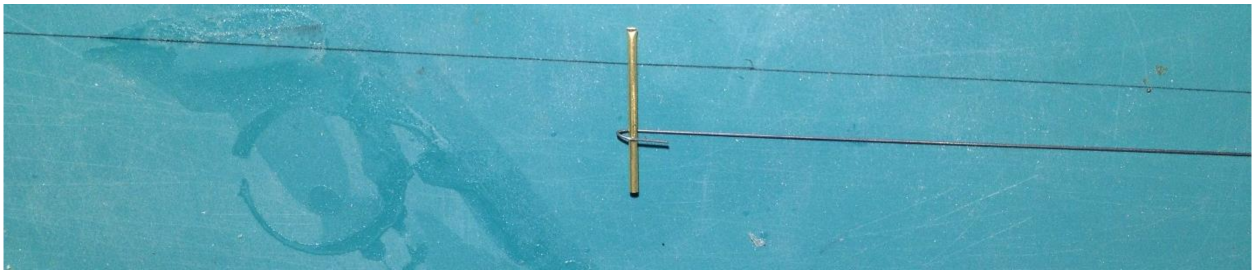
Construction

The commercial torque meters shown above all have a max torque of about 2.0 in. oz. I prefer a little more torque as some motors can be wound to over 2 in. oz. The one I will be constructing has a max torque reading of about 2.5 in. oz.

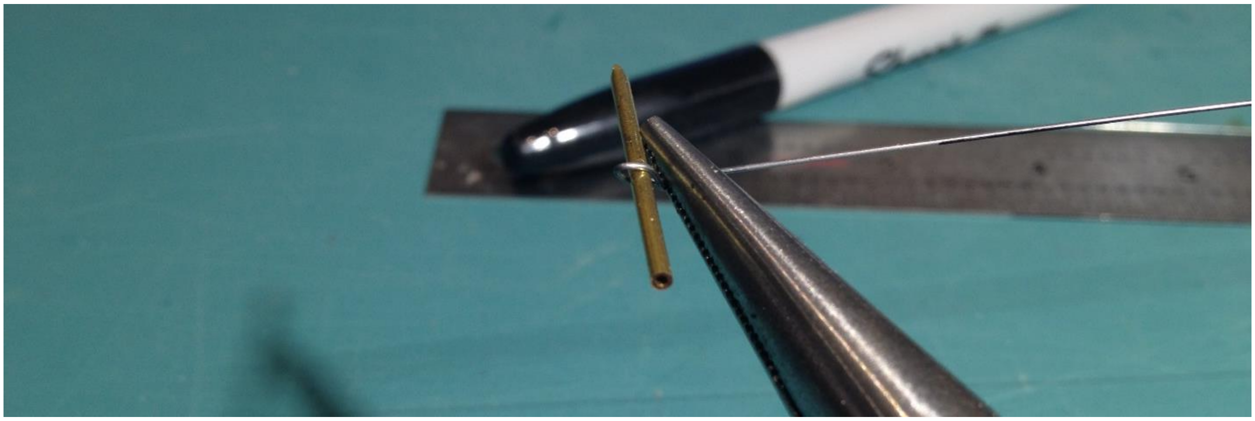
The construction starts by cutting the torque wire. The torque wire is the wire that resists the turning of the rubber motor when winding. Cut the .020" music wire to approximately 10.5 inches as shown below.



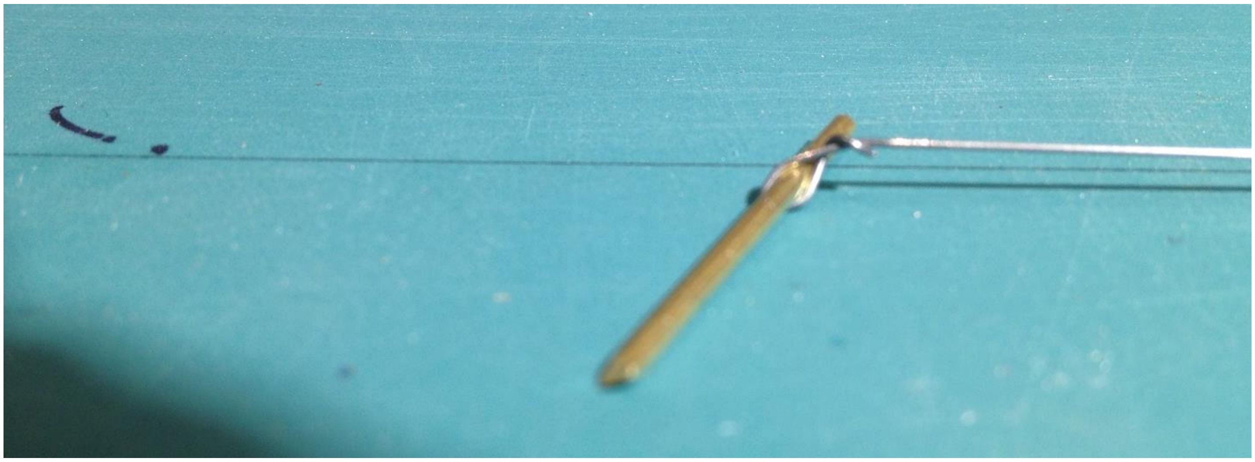
The next step is to cut about 2 inches of 1/16" brass tubing and loop about half an inch of torque wire around it.



Take your needle nose pliers and grasp the torque wire like so:

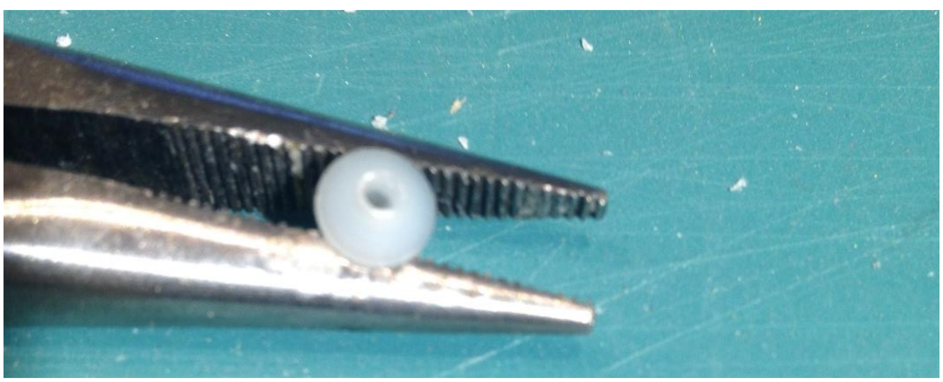


Hold the wire firmly with the pliers, and with your other free hand, hold the brass tube, and twist it to get this result:

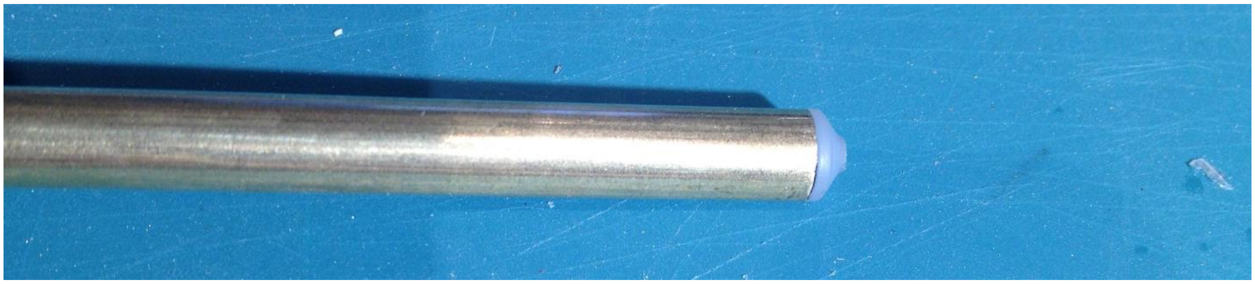


Next we will drill out the bearing. Below I have two bearing types that I have found to work. Other similar things such as plastic or Teflon tubing may work. Experiment and find out! I will be using the bearing on the right, as it has a longer body.

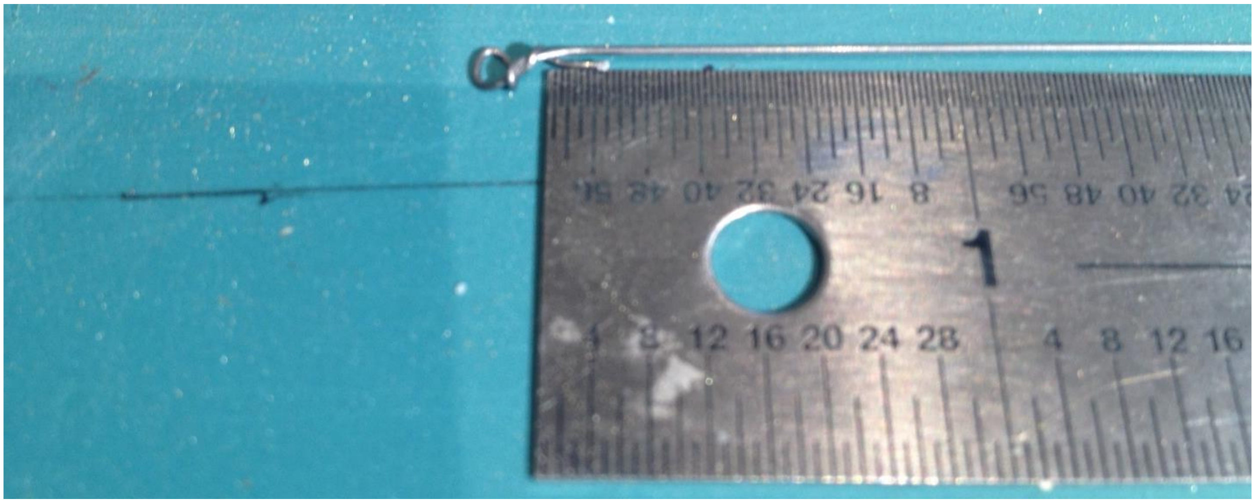
Take your drill and 5/64” bit, and drill straight into the hole already existing in the bearing. Then take a piece of 1/16” brass tubing and insert it into the bearing. The tubing should rotate freely inside, if not, widen the hole in the bearing until it does. You want the tubing to be able to turn freely inside the bearing, but it should not have too much play.

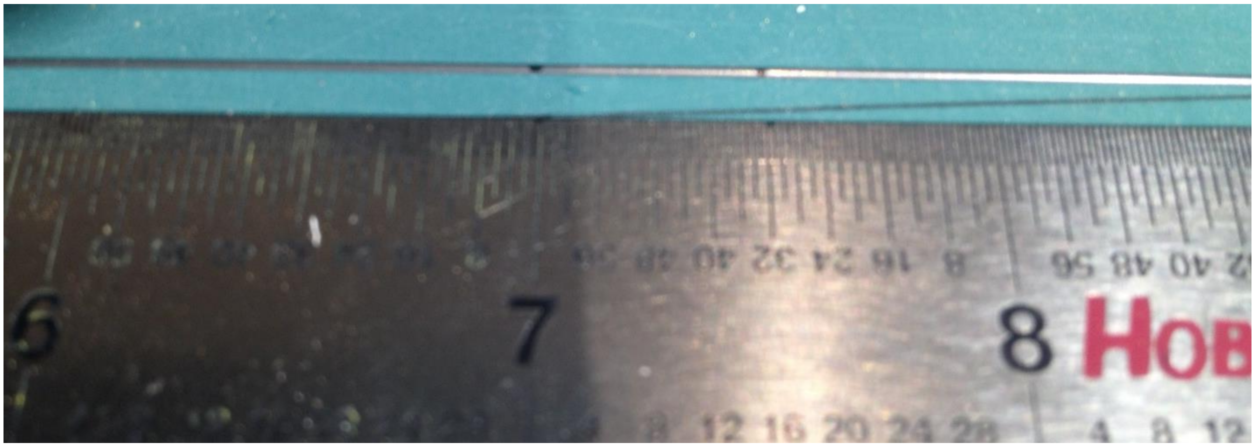


Next, go ahead and take a piece of electrical tape, and slice it so that its width is the same as the height of the bearing. Then wrap it around the base of the bearing. You want it to be thick enough so that when you slide the bearing into the ¼" brass tubing it will be snug.



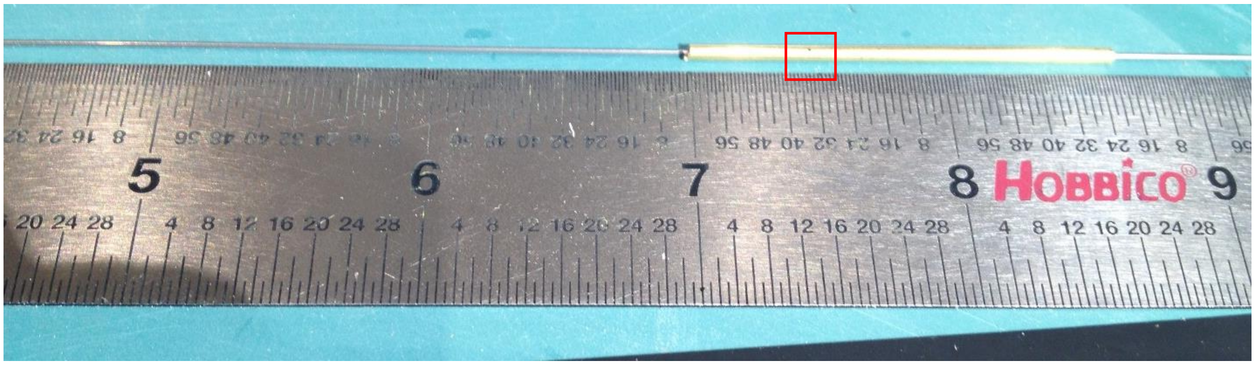
Next we will prep the torque wire to be fitted with the hook. Starting from the last turn of wire, lay out your ruler (as shown in the picture below) and make marks at 7 inches, and 7.5 inches.



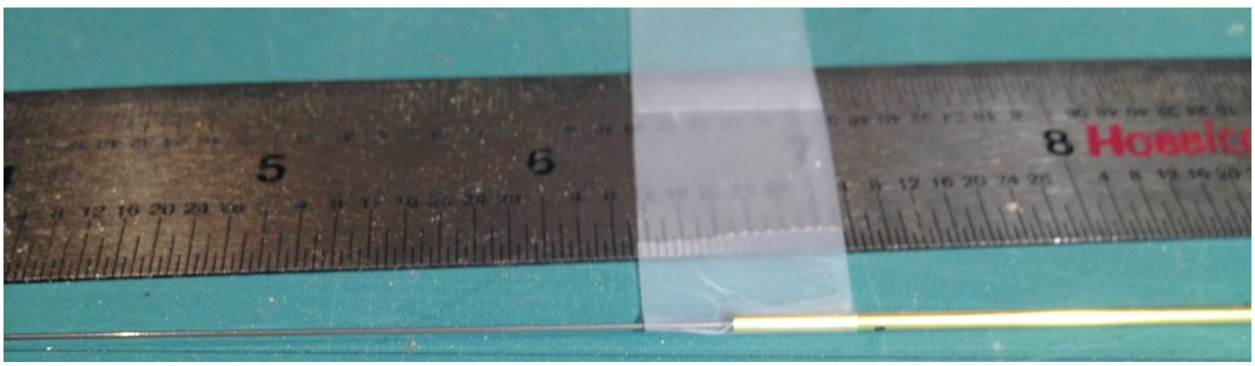


THIS STEP IS IMPORTANT: TAKE YOUR BEARING, AND SLIDE IT ONTO THE TORQUE WIRE. DO NOT MOVE ONTO THE NEXT STEP UNTIL THIS IS COMPLETE, OTHERWISE YOU WILL HAVE TO RESTART.

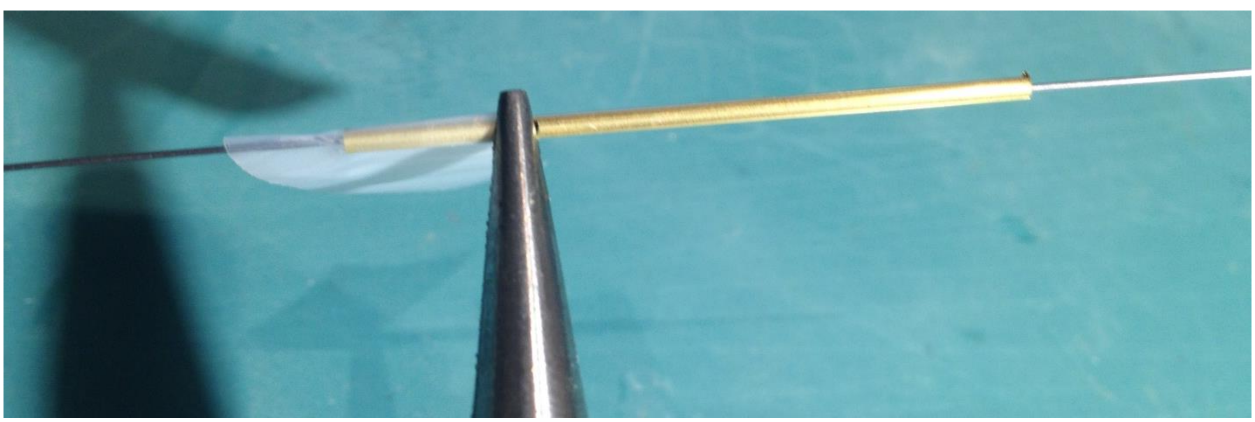
Next, take a 2 inch piece of 1/16” tubing and slide it onto the torque wire. The thrust bearing should be in between the loop of wire, and the tube of 1/16” brass. Make a marking on the brass tube half an inch from the side closest to the loop of wire. Then align the end of the brass tube to the 7” mark on the torque wire you made earlier.

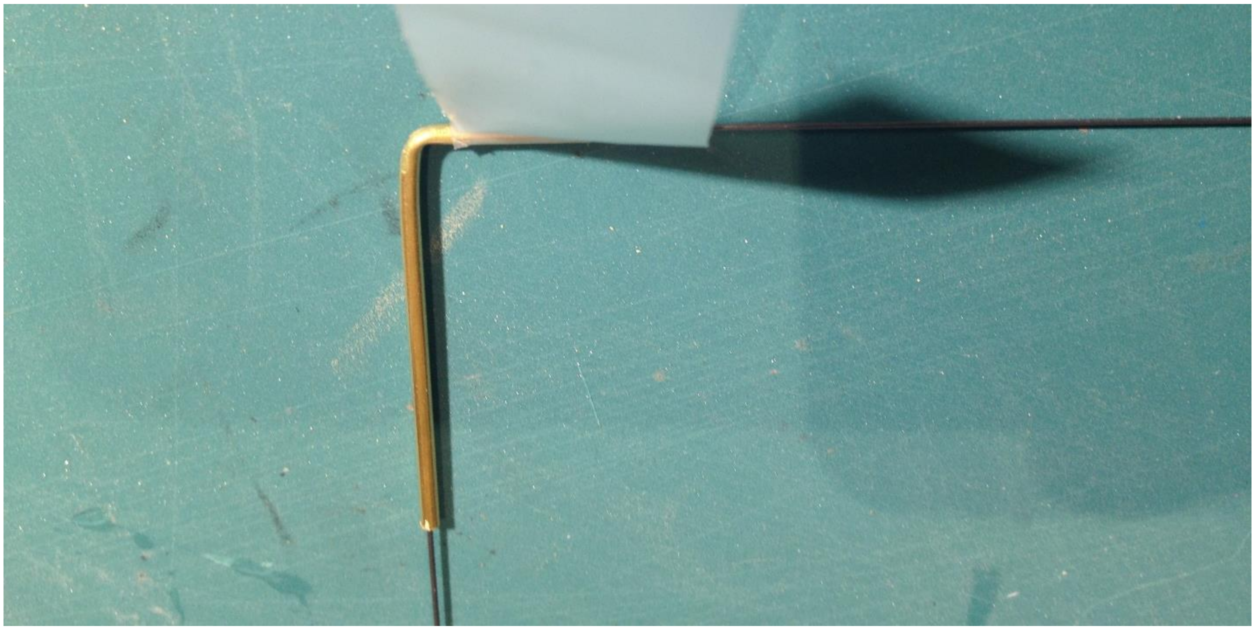


Take a small strip of tape and lay it onto the brass tube, and the torque wire, and wrap it around both to secure the brass tube to the wire.



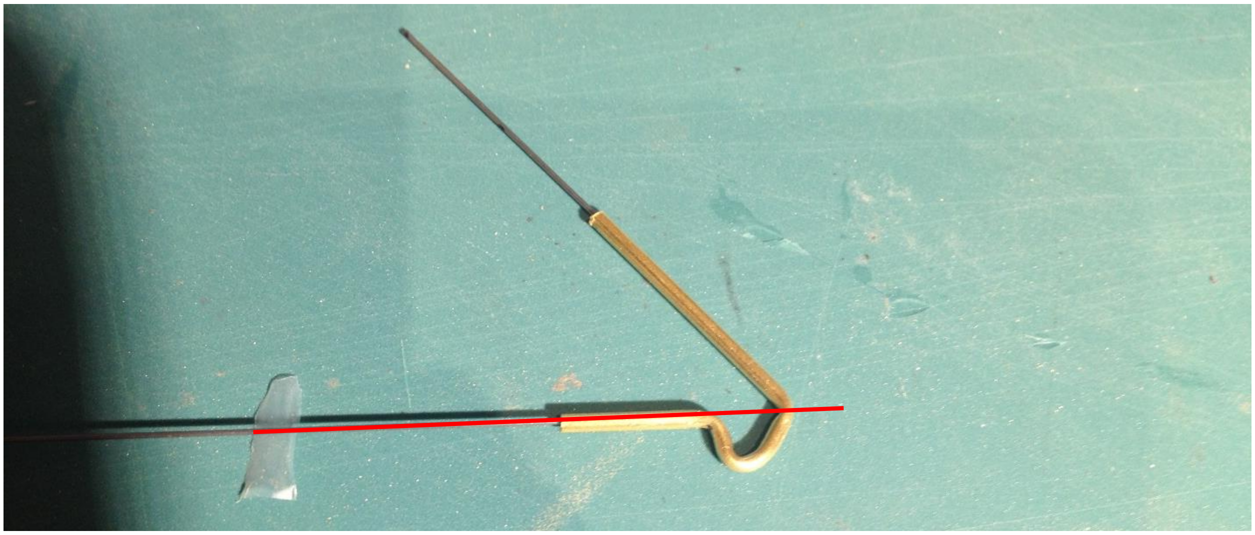
Take your pliers and grasp the brass tubing at the mark you made on the brass tubing. Then bend the tube to 90 degrees to lock the torque wire in place.





Remove the tape and continue to bend the hook into the following shape. The shape itself is not too important, except the point of the hook should be in a straight line to the torque wire. Try to get this done within the first attempt, as successive bends to the brass tube will break it. Sand the tip of the hook so it does not damage any rubbers or O-rings that are slid onto it.

(Note how the torque wire and the point of the hook are within a straight line of each other.)

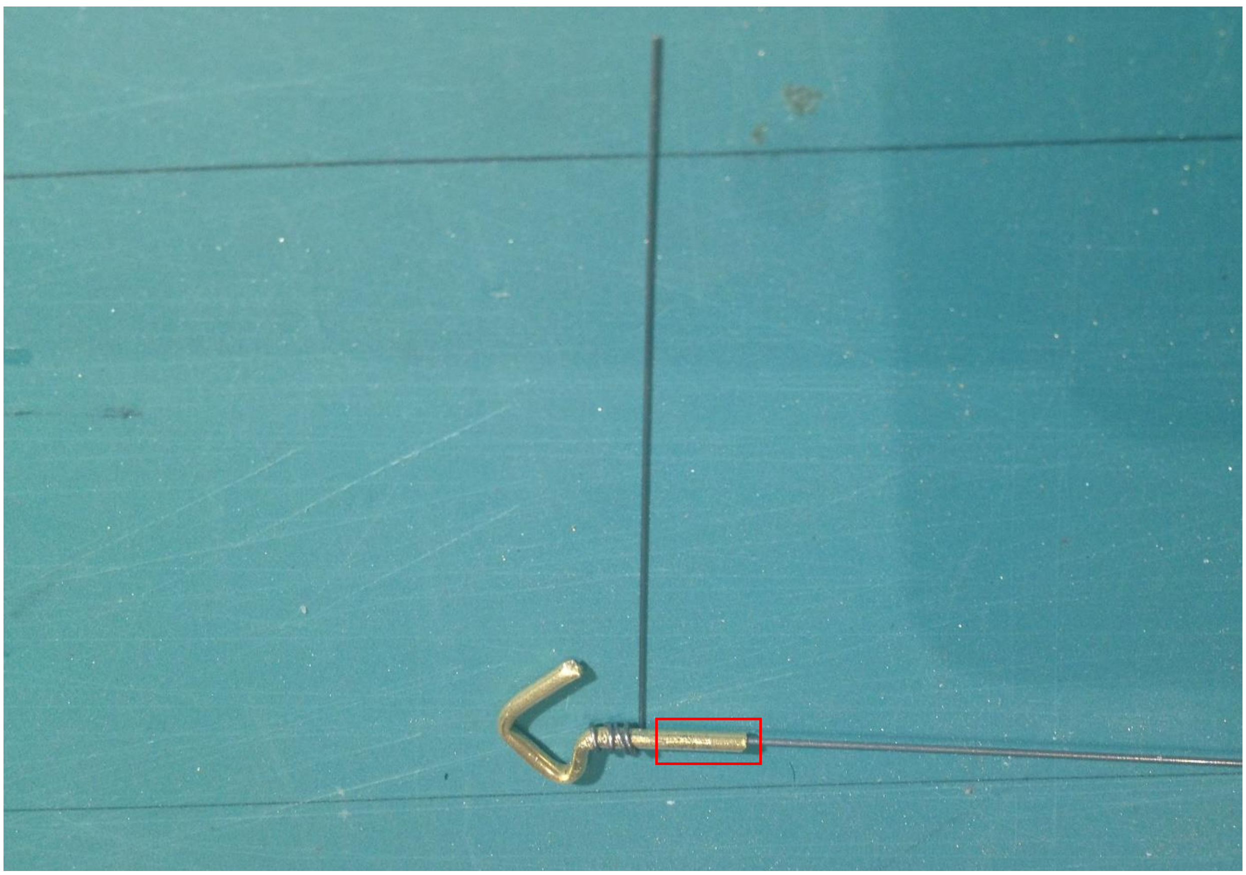


Trimmed hook

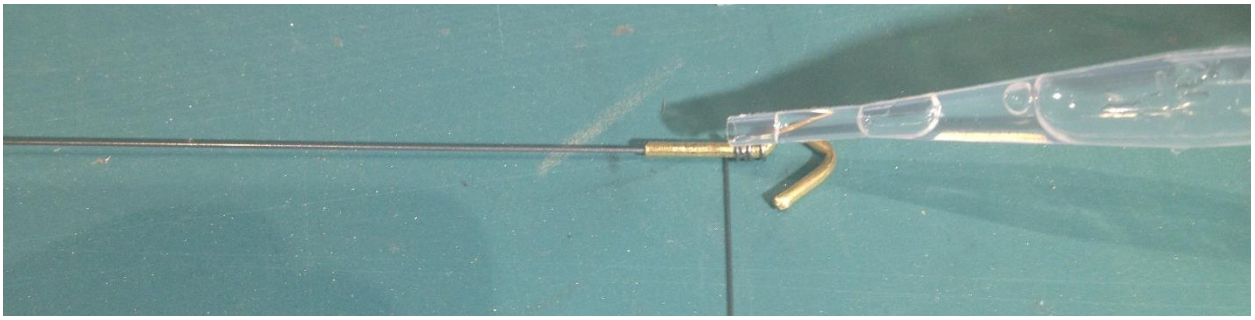
Final sanded hook

Next we will attach the pointer wire to the hook. First take your .015” music wire, and cut approximately 3 inches of it. Wrap one end around the hook several times. You want the hook to be about 1/8” away from the edge of the hook shaft, but you do not want wraps of wire behind the pointer wire (red zone)

If you do not have .015” wire, you can use your .020” wire, but the loops will be much harder to create.



Lay your hook and your pointer so they are flat against the table. You want them to line up. Then take a small bit of CA glue and lightly dab the wire and the hook. You only need a small drop as this is temporary.



The pointer wire and the hook should be attached together now. We will strengthen this bond with either solder, or with epoxy. This is where you need to make a judgement call. I chose to go with 5 minute epoxy over soldering because in my experience, solder isn't as resilient to impacts, and it is much more time consuming. Using epoxy is easy and provides great strength. If you choose to use solder, I do not have instructions for it, and you will have to go off of your own intuition.

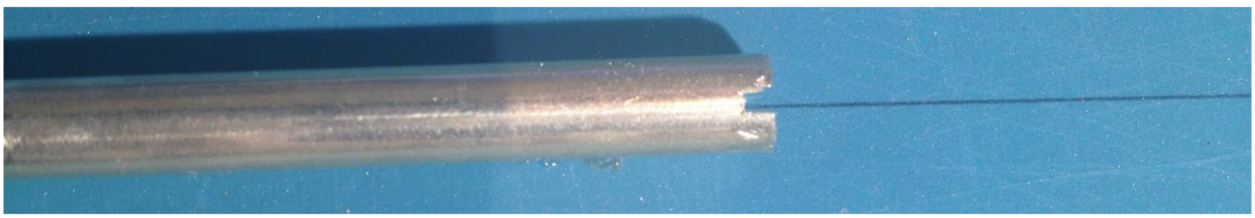
If you chose to use epoxy, go ahead and make a small mix of it. You really won't need much. Make sure you are using gloves, and you aren't working on a surface that can't be damaged.

Using a Popsicle stick or a stick of balsa, apply epoxy to the loops of wire, but try not to get any on the hook behind the pointer wire. If you do, simply wipe off the epoxy with a paper towel before it can dry.

Let the epoxy dry before moving onto the next step. (This is why I use a 5 minute epoxy)

Slide the thrust bearing over the hook shaft, and then slide the ¼" brass tube over the thrust bearing. Position it to be identical to what is shown in the picture below:

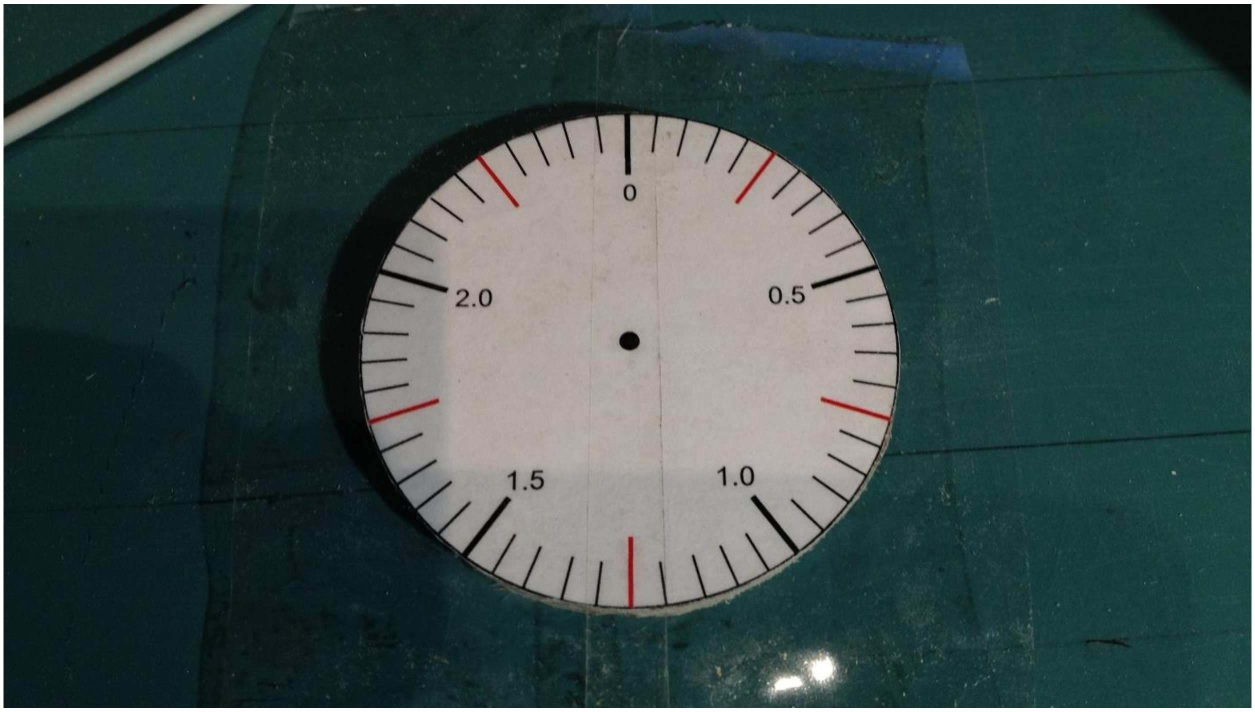
Using a hack saw, cut off the other end of the brass tube so it is 7.5 inches in length. The loop of wire on the torque wire should be covered by about 1/8" of brass tubing. Next using the hacksaw or dremel tool, slice slits into the end of the tube.



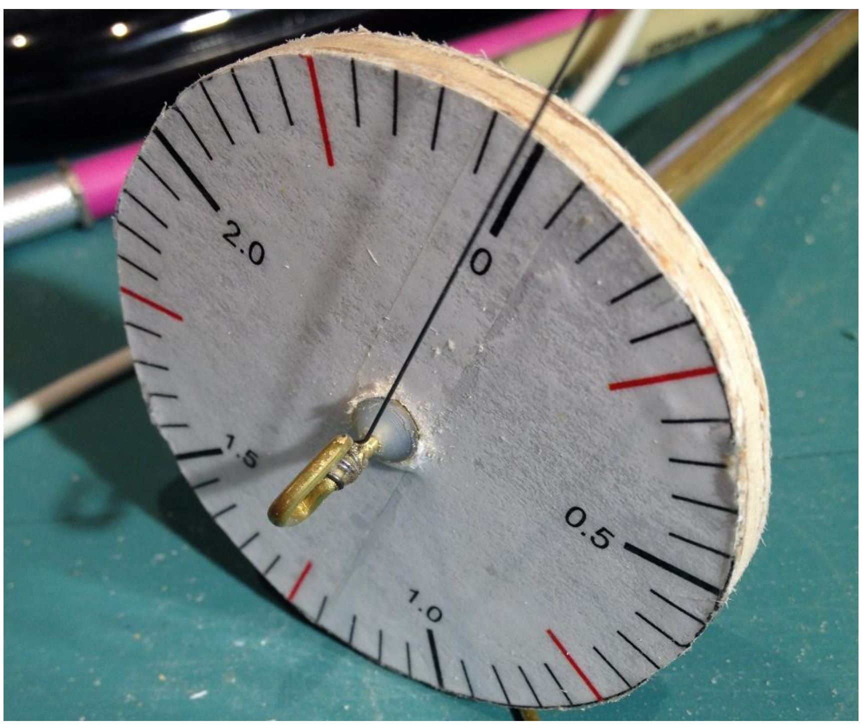
Continue to make the slits deeper until you are able to slide a small length of 1/16" tubing into the torque wire loop. You want the brass tubing to sit inside of the slits. After, pull on the hook with a good amount of force, and make sure that the hook cannot extend out of the thrust bearing farther than in the picture below.

Prepare some more epoxy, and give the 1/16” tubing in the rear a good coating of it. Also try to get a good amount of epoxy on the loop of the torque wire. This keeps it from moving when winding. If you don’t put enough on the loop of the wire, the epoxy may crack over time and will have to be re-glued. When it dries, remove the excess tube and epoxy.

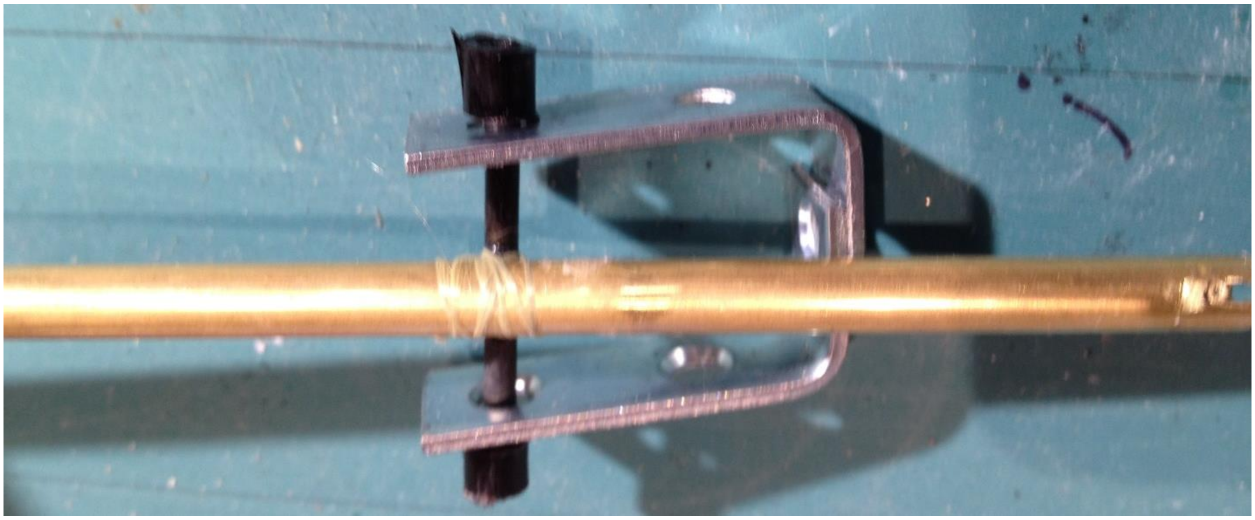
Use the image of the dial face provided at the end of the guide and print it out. The dial provided has a diameter of 3”. I wanted a torque meter with a dial face of 2.5” in diameter, so in the print settings I set the scaling to 83%. Print out the dial face to the desired size and cut it out. Then trace the circle onto your flat material. I am using 1/8” bass wood sheet laminated with 2 sheets of 1/32” balsa to make a very strong but lightweight plywood. Cut out the traced circle on your flat hard material, and then use a spray adhesive to attach the dial face to the dial base. Once it’s securely attached, you can use some clear tape to protect the dial face.



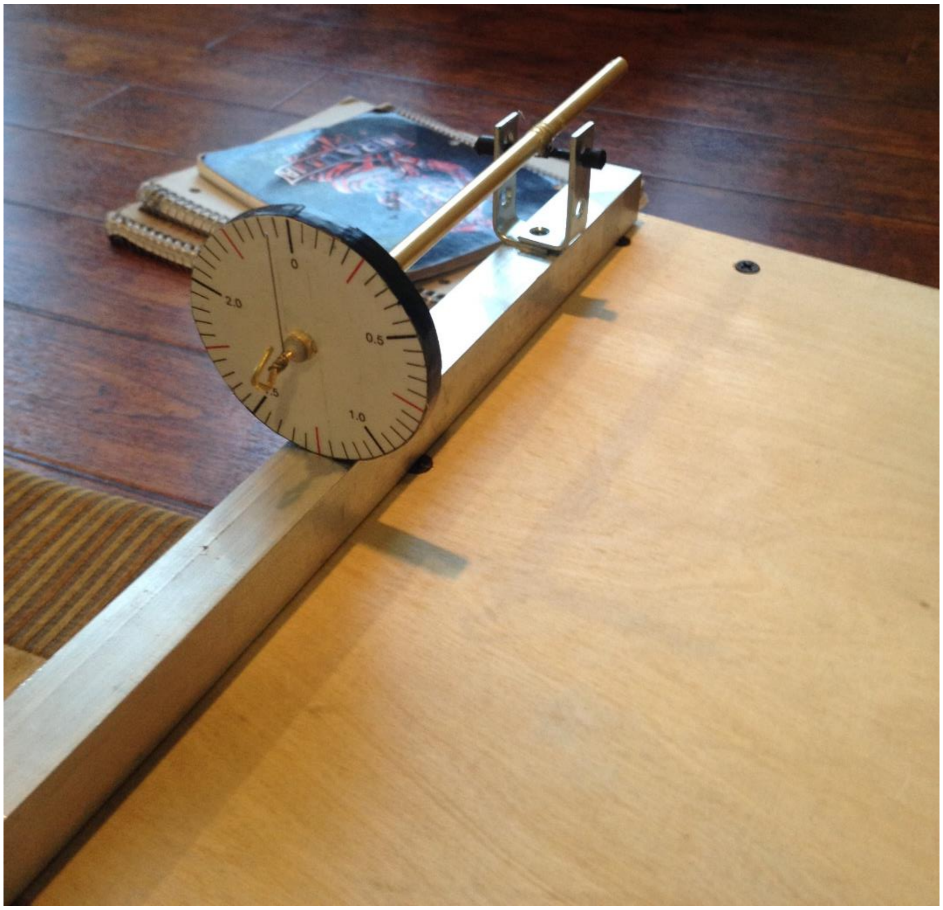
Use your ¼" drill bit and drill out the hole in the center, then slide the dial onto the torque meter. Line up the "0" mark on the dial with the pointer wire. Trim the pointer wire until it is just a small bit shorter than the radius of the dial face. You want to be able to put the dial face against the table and turn the wire 360 degrees without having the pointer table contact the table. Use a little epoxy to secure the dial to the correct position on the ¼" brass tube.

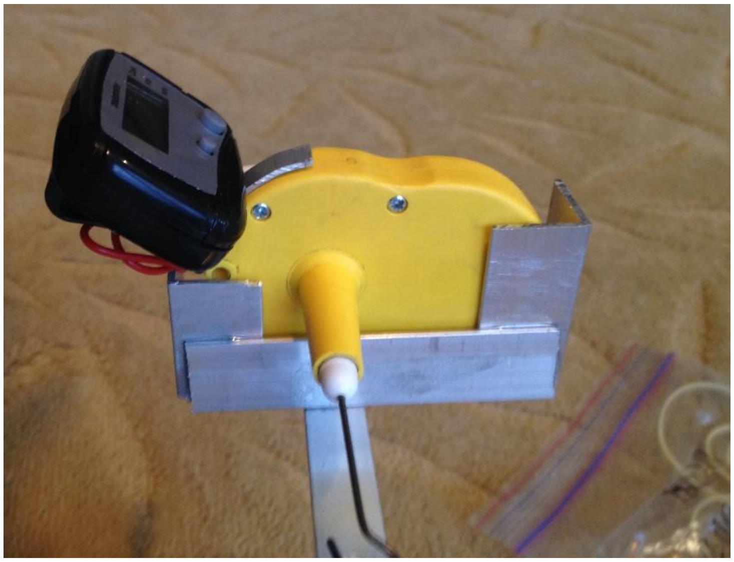


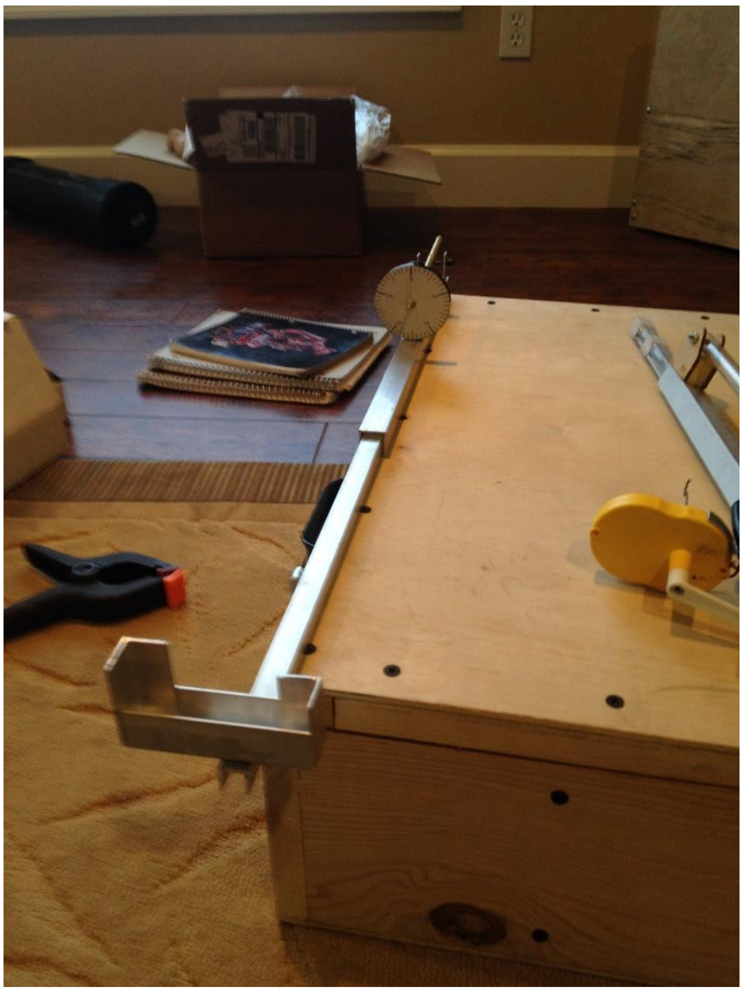
To construct the gimbal you can use some bent metal, wood, or anything that can be drilled out to accept an axle for rotation. In my torque meter, I used 2 metal corner brackets that were glued together. For the axle I used some carbon fiber rod. Any sort of rod such as a nail, dowel etc. can be used. To attach the rod to the torque meter, you can wrap the rod to the torque meter with some thread or string, and then epoxy.



The last step in this build is to make something to attach the torque meter to. The simplest method is to use a piece of wood and screwing or gluing the torque meter to the wood, and then attach a holder for the winder so the hook to hook distance of the torque meter and the winder is the same as the hook to hook distance of the propeller and rear hook are the same. I used aluminum square tubing, with a smaller aluminum tube on the inside, so the distance of the torque meter and the winder can be changed. Also, this allows the torque meter assembly to be more compact. The winder holder can be made from any sort of flat material. I used aluminum angle bars epoxied together.







Your torque meter is now finished!

Using the Torque Meter

Winding

(Note: this is not a guide to trimming a plane, but rather a guide to use a torque meter to get consistent flights and speed up some aspects of the trimming process. In this guide I am assuming your plane can already fly in appropriately sized circles, climb, and cruise.)

A poor practice that I commonly see at competitions are people that wind directly on the plane. This is very risky, as blowing a motor will often result in a blown up plane. Also, winding on the plane puts stress on the propeller shaft and will often bend it, causing a loss in efficiency. Another disadvantage of winding on the plane is that it requires a second pair of hands to hold the plane, so if you do not have a partner for this event, you will bug someone to hold the plane for you as you wind.

Make sure that your torque meter is also clamped down onto a table or a heavy object and to lubricate your motors before you start winding. When winding on the torque meter, start off by hooking an o-ring to the hook on the meter, and then an o-ring on the hook of the winder. Step back and stretch the motor to about 5-6 times its unstretched length. The motor may feel like it is going to break, but it will not. Wind to about half the expected turns, and then start slowly walking towards the torque meter. Your goal is to reach the hook to hook distance of the plane by the time you reach the maximum number of winds the motor can take. It will take some experimenting to figure out all of these values so don't be scared to break a motor or two. Once you figure out the maximum number of winds a motor can take, record the torque meter reading. This is the maximum torque a motor of that width can output. You will most likely not want to attach the motor to your plane at this point, as the force is rather excessive for a Wright Stuff plane. There is a technique called dewinding, that is used by "professional" flyers, where they wind to the maximum number of turns, and then wind the other way to take winds out of the motor. This causes a decrease in the torque, and allows the plane to rise climb without hitting the ceiling, but the energy inside the motor is more than if you were to just directly wind to that torque.

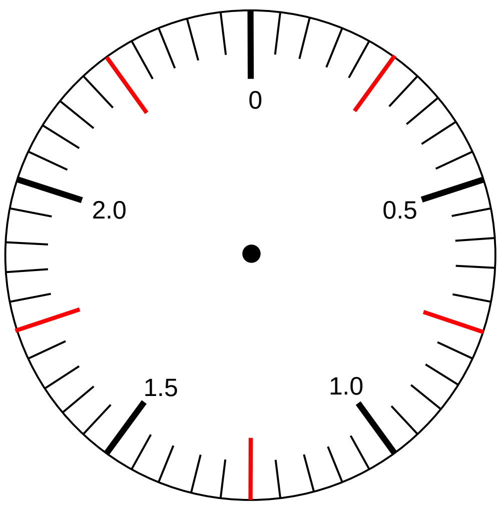
To put the technique of dewinding into practice, wind to just below the breaking point of the motor, and back off (another word for dewind) about half of the winds you put in. This is a safe starting point. Then firmly grasp the o-ring from your winder and slide it off. With your other hand, take your plane, and hook the o-ring onto the rear hook. Then take the o-ring from your torque meter and hook it onto the propeller. Walk to your desired position of launch and release your plane. The approximate height that the plane reaches should be recorded. If your plane does not reach just a few inches below the ceiling, repeat the procedure described above, but back off less. Keep adding more turns to the motor until your plane climbs and stops just a few inches below the ceiling. Record the torque meter reading and this should be the launch torque for the specific ceiling height, and motor width you are using. Using your recorded data, you can adjust to various flying sites and predict what launch torque you should use.

If at any point you notice that your plane does not climb even with an increase in torque, your plane may not be designed or built to handle such a high torque. Let's say your plane climbs, rolls, and then dives right after being launched. Somethings that can attribute to this are: not enough wing wash-in; too flexible of a motor stick, too much down-thrust, or not enough wing area on the inner wing. Check your build plans and see if these things are up to spec on your plane. If you try launching with >0.5 in. oz. of torque, it would be normal for the plane to roll and dive, so don’t stress too much about it. You would want to measure the maximum torque your plane can handle so you never overwind and possibly damage your plane.

Hopefully this guide has been helpful and you have learned how to get consistent flights!

If you have any questions feel free to email me at davidbyang1@gmail.com, or PM me. My username is DoctaDave.

Good luck!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0.5
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1.5
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