Balancing your Helicopter for Incredibly Smooth Flight

I had no idea there would be such a huge response more information on balancing out the rotor systems of micro helicopters. This PDF file is a culmination of all the things that I have learned while serving in the US Army working on helicopters and then applying these concepts to micro helis. Why balance your helicopter? Well, balancing makes it much easier to fly. If you choose to spend the time to master the following techniques, you will be able to not only fly your heli smoothly, but your heli should be able to hover for short periods of time (in still air) hands off: My personal best has been 17 seconds (which seemed like at least a minute but the stop watch doesn't lie).

This actually applies to all helicopter models- Including the **Blade, Blade CP, FP, Honeybee CP, CP2 and any other single rotor helicopter**

To get your micro heli to fly smoothly and hands off- here is what you will be learning to do:

- Make sure your main shaft is true, and doesn't wobble (if it does then straighten it out- it's not that hard, just a little patience is required)
- Balance your rotor head (with fly bar paddles)
- Dynamically balance your rotor blades (weight and CG wise)
- Balance your tail rotor blade (I know its plastic but none of them are perfectly balanced and this will stop that bouncing and buzzing you see your heli doing)
- The finally, once your heli is all put together, you will need to balance out the fore and aft CG of the helicopter. When you install your battery pack you want to make sure the CG is centered under the main shaft.

Other Notes and things to check:

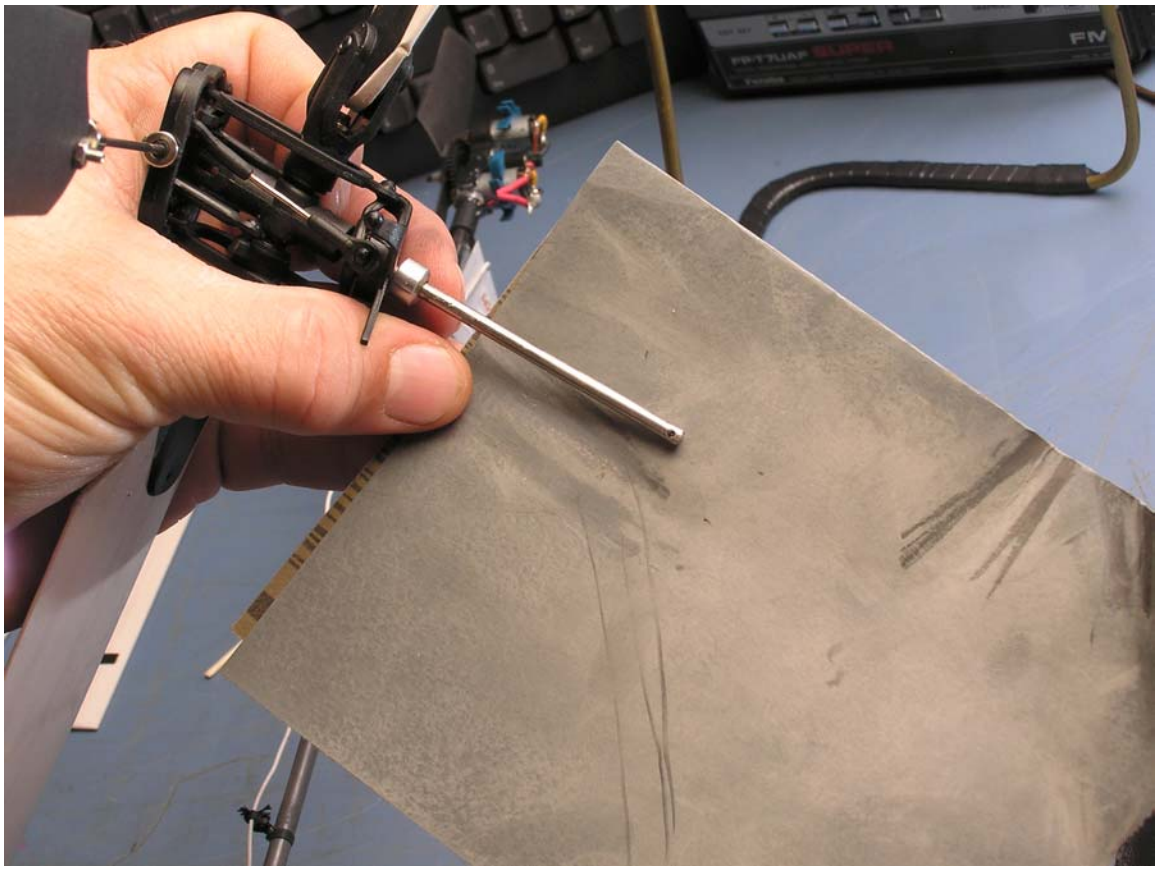
- Make sure your fly bar paddles are straight checking obvious things like the paddles are facing the right direction (yep- I have done that wrong before)
- Track your blades so they are flying in the same plane (at normal hovering rotor speeds)
- Then some slight adjustments on the trims on your transmitter and **you will have a heli that will hover in place hands off for seconds at a time**.

  That's all it takes! (Well it did take me a good 9 months to figure this stuff out- I just applied what we do to the full sized military helicopters and scaled it down to the little RC helis we all like to fly)

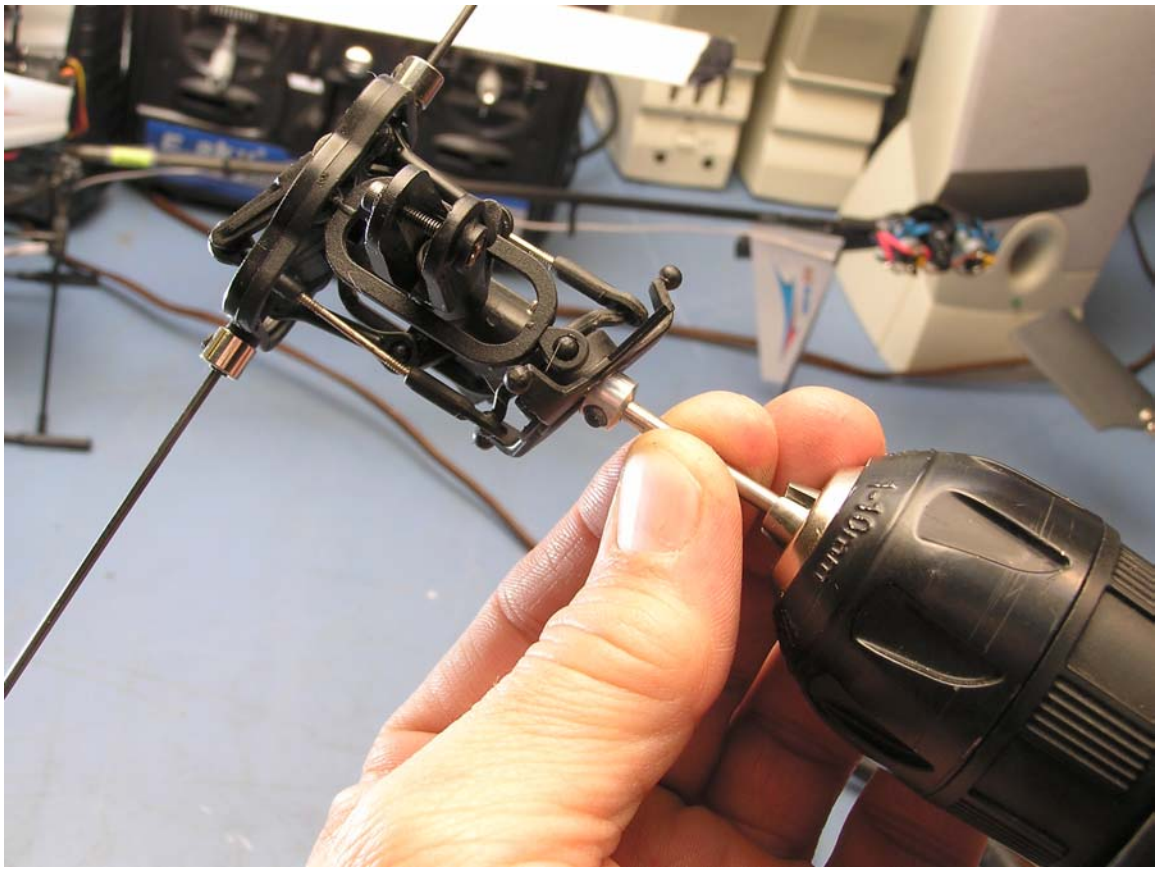
Truing the main drive shaft

The main drive shaft is made of relatively soft steel. The advantage is that it will bend in a crash and not break other parts of your heli (like the frame and bearings) The disadvantages is the annoyance of having to either replace it or go through the hassle of re-truing it. A bent shaft will make your rotor head wobble and it will be more difficult to control. At higher RPMs it will make your rotor head assembly wear out alot faster. You will need to remove the rotor system from your heli.

On the Honeybee type series there sometimes is a burr at the bottom that you will need to use some fine sandpaper to smooth out before it will slip out of the frame. (See photo below)

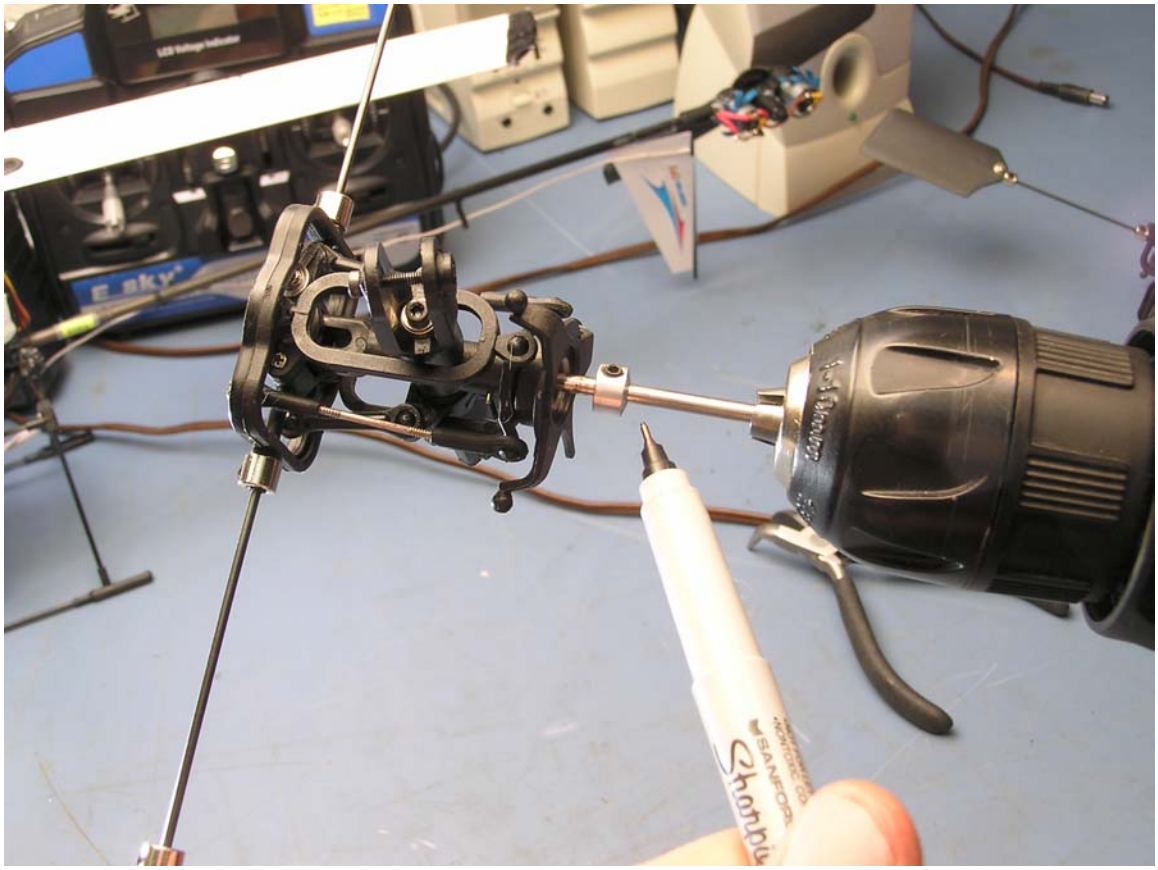


To true your main shaft- the method I use (I have 3 honeybee CP-2s) is to remove the rotor assembly and chuck it into my cordless drill.



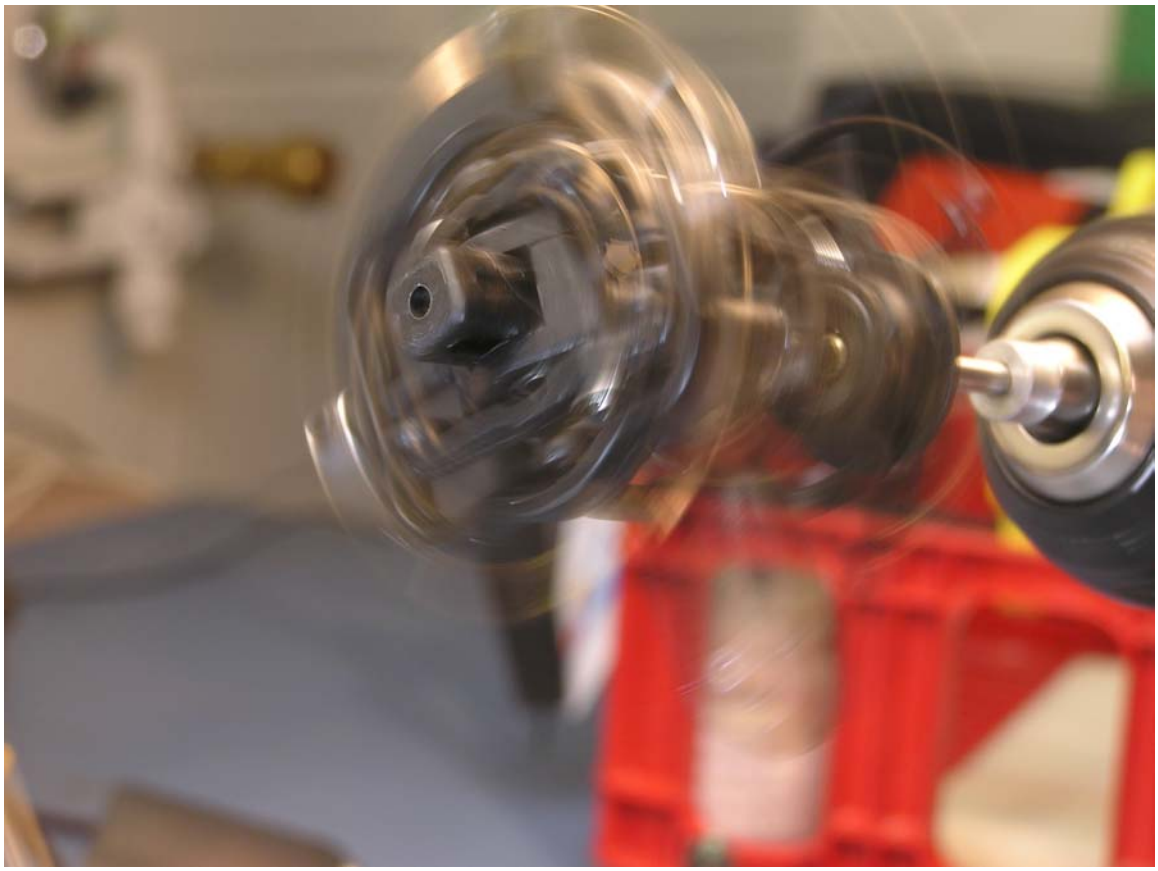
This allows me to spin the shaft and see where the bends are.

This picture shows the area where the shaft usually bends. It is the point just above the top bearing on the frame. (See the area where the pen is pointing)



Once you find or figure out which direction it is bent you can gently bend it back. Go slowly and make small adjustments. In this photo I am showing how I normally true my shaft back into shape.

Work slowly and make small adjustments. You can check your progress by watching the end or top of the rotor head while it is spinning. You know you are there when the center of the screw or end seems to not be wobbling or moving anymore.

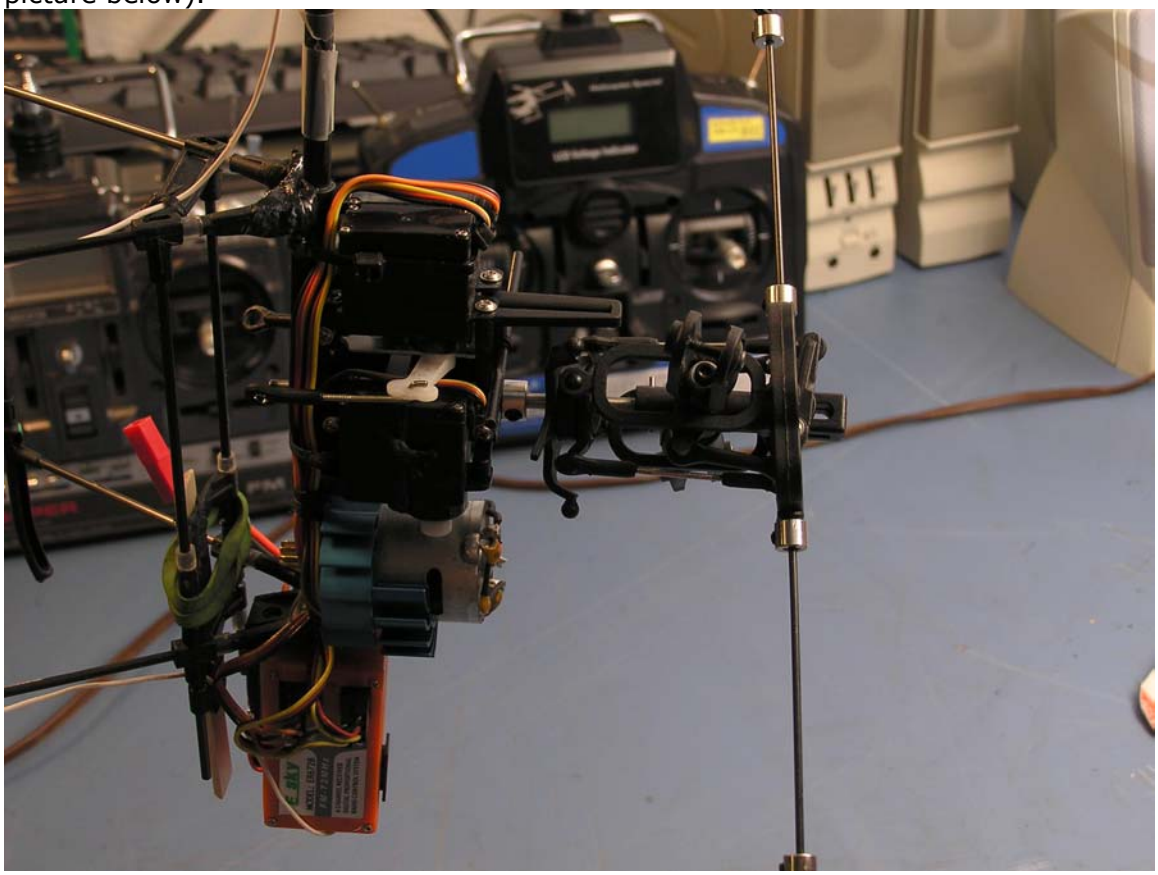


Now that you are finished with this step you can move on to balancing your rotor head.

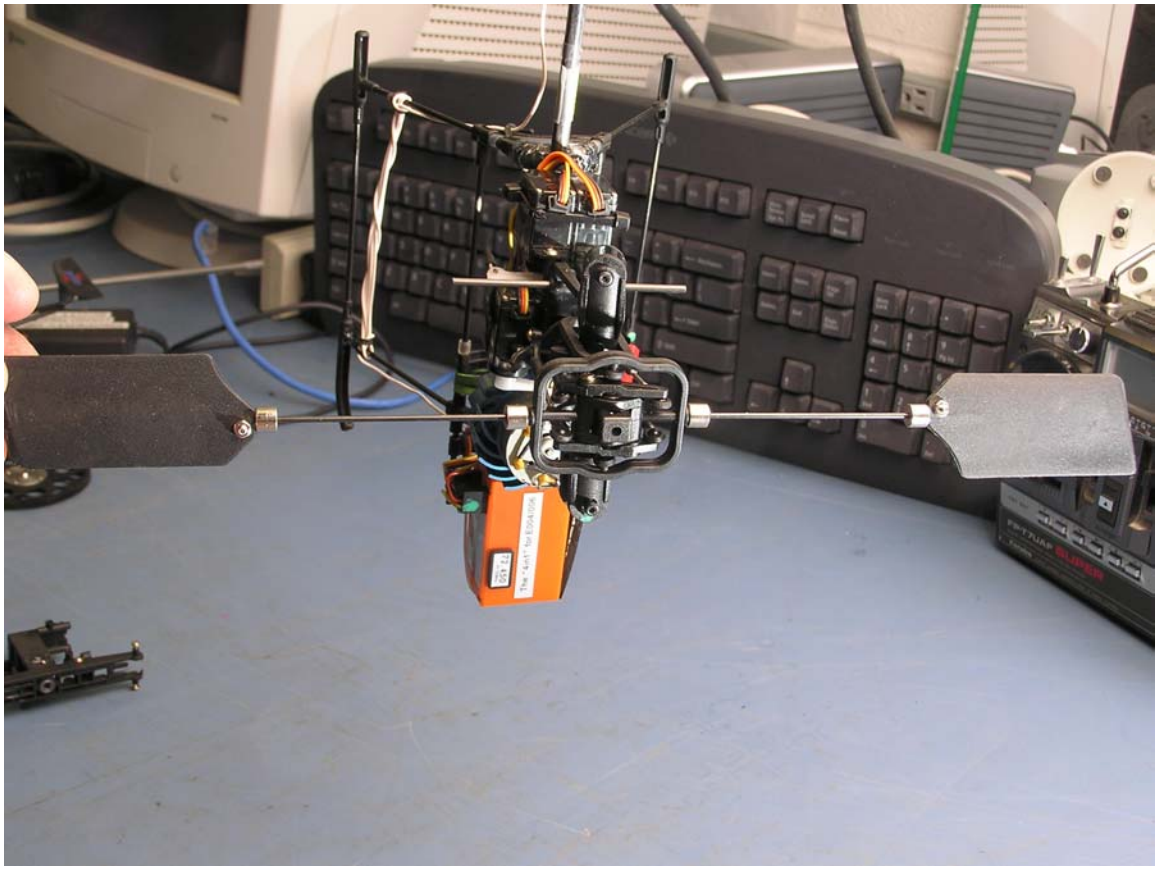
The next step in setting up your heli for nice and smooth handling is to:

BALANCE THE MAIN ROTOR HEAD AND FLYBAR

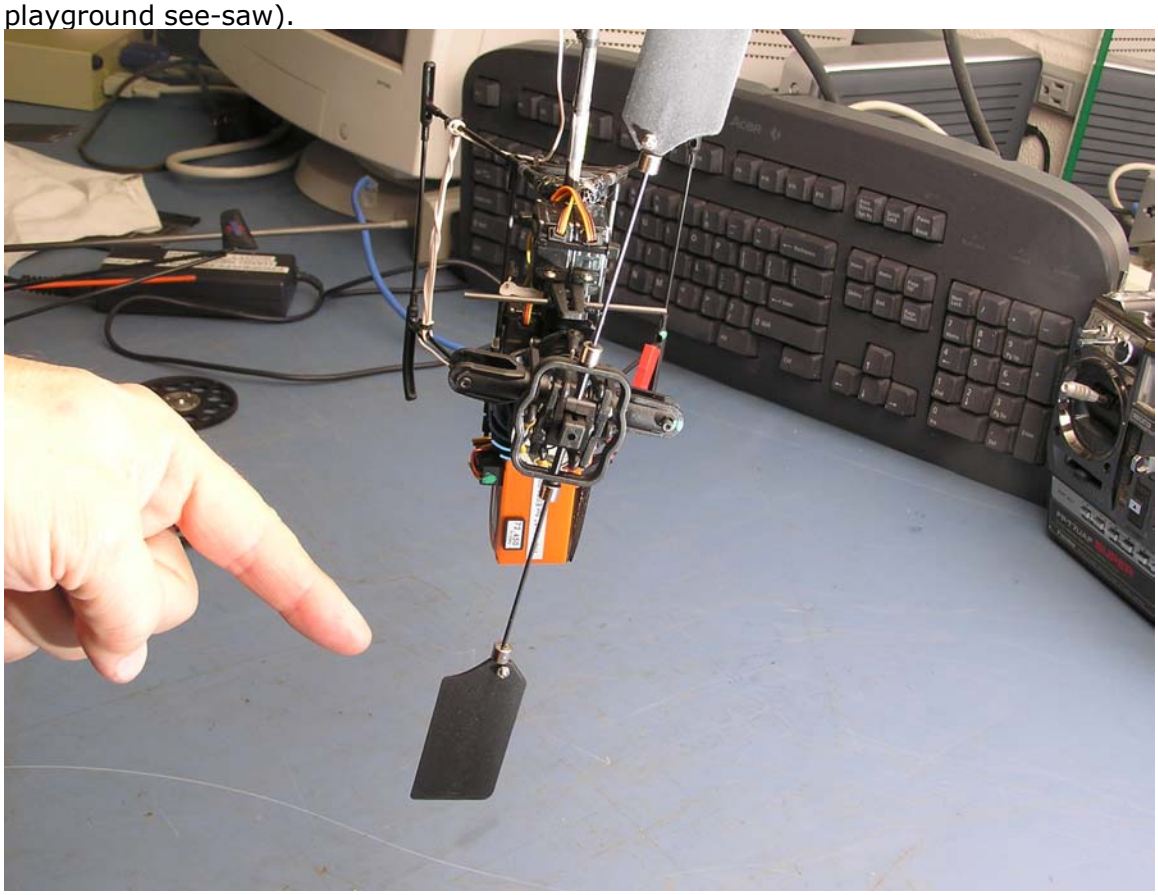
You will do this without the blades installed. You can use your helicopter or if you have an old broken or spare frame (with bearings) then slide your main shaft into the bearings. You will want the swash plate to be disconnected from the servos and able to move very freely when held in the vertical position (see the position in the picture below).



Here is a front view. Hold your heli frame so that the rotor head can turn and watch to see what happens. Normally, you will find that one paddle will seem heavier than the other side.

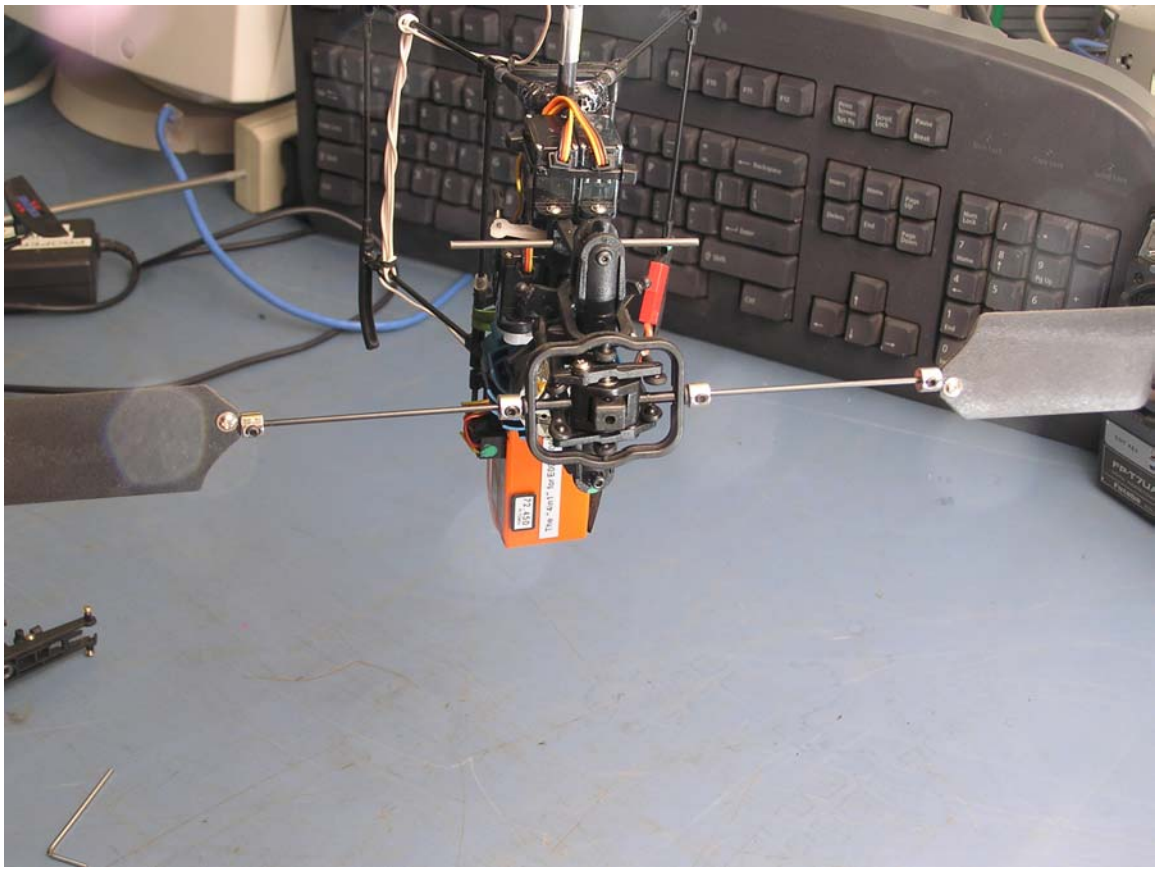


This picture shows which half of the rotor head is heavier. (Kind of like kids on a playground see-saw).



To make adjustments and to get your rotor head to balance out you will need to loosen the collars and slide the fly bar slightly toward the lighter side. Then check your progress and repeat until it starts to balance out.

As you continue to make small adjustments, eventually you will find the point where the fly bar will pretty much stay in any position you leave it- meaning you now have your rotor head assembly balanced.



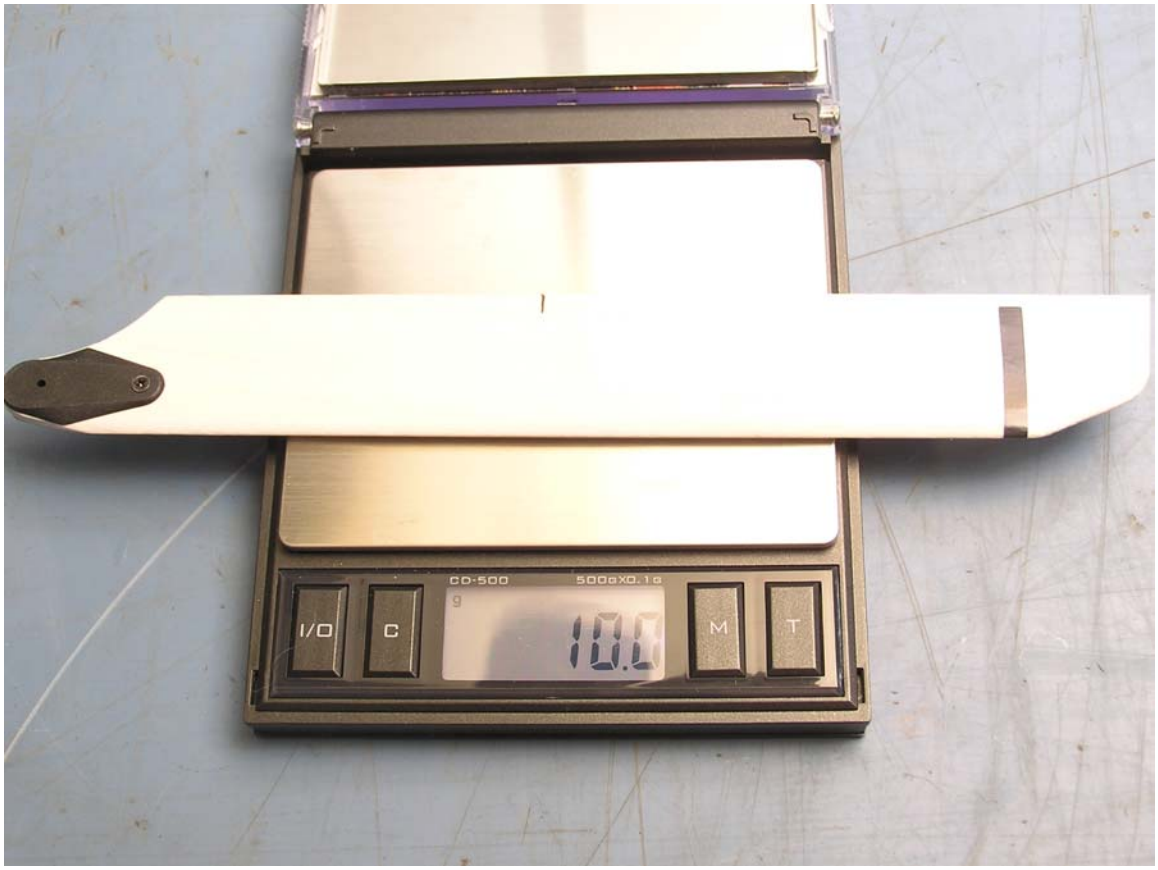
Now you can install your rotor head assembly on your helicopter and proceed on with balancing out your rotor blades.

BALANCING THE BLADES:
There are a number of ways you can go about balancing your blades. A simpler method is to use a blade balancer but that will only statically balance your blades. That's fine except when you are flying- your rotor blades are rotating so you only get half the equation right. Dynamically balancing the rotor blades is what we do with full sized helicopters. This method requires a little bit more effort but it will give you a very smooth flying set of blades.

I balance the blades with a .1 gram scale. You can get them mail order for as little as 20 bucks. I found this one- it's a 500 gram scale on amazon.com for about 30 dollars, including shipping. (See picture below). They are pretty popular and in high demand which makes them inexpensive.

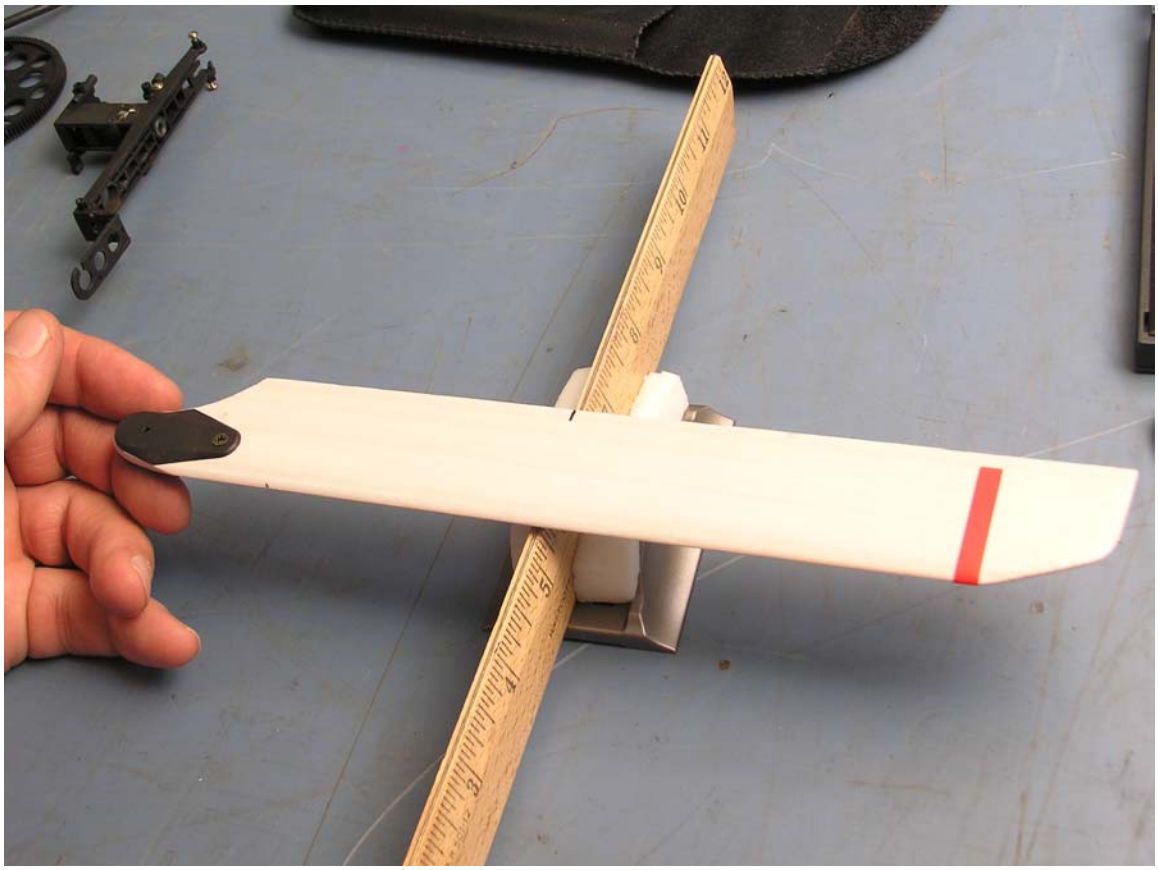
Make sure your blades are of the same kind and type. Weigh them both and write the weights on the under side of the blades. One blade will be slightly heaver than the other.

This is the black blade (you can mark them anyway you like)

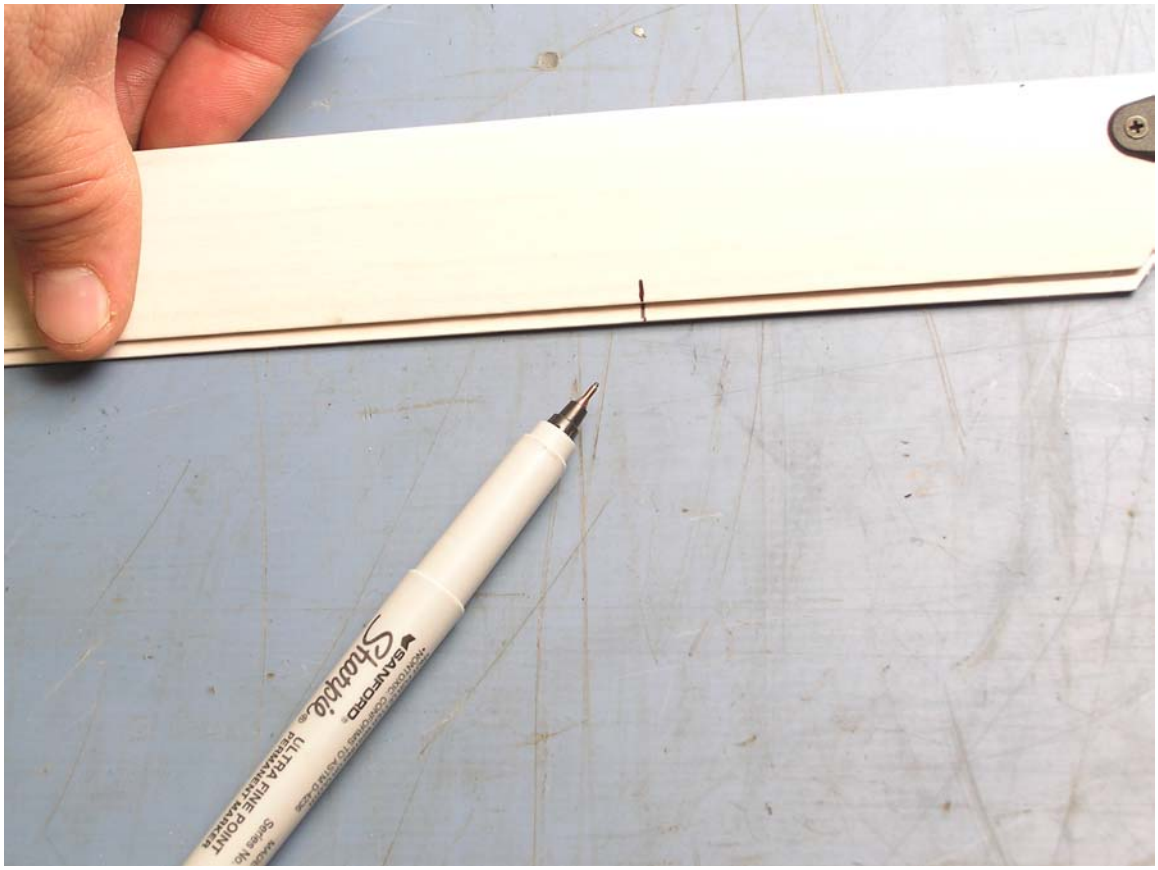


Here is the red blade. Notice it is .3 grams heavier than the black blade. We will use this in the next step of dynamically balancing the blades.

Now that we know the weights of both of the blades, we will proceed to finding the CG (balance point) of the heavier blade. I do this by laying the blade lengthwise over the edge of a wooden ruler (with a metal strip). Any narrow object will work to find the CG. Once you find the CG (Balance point) of the blade you will want to mark it.



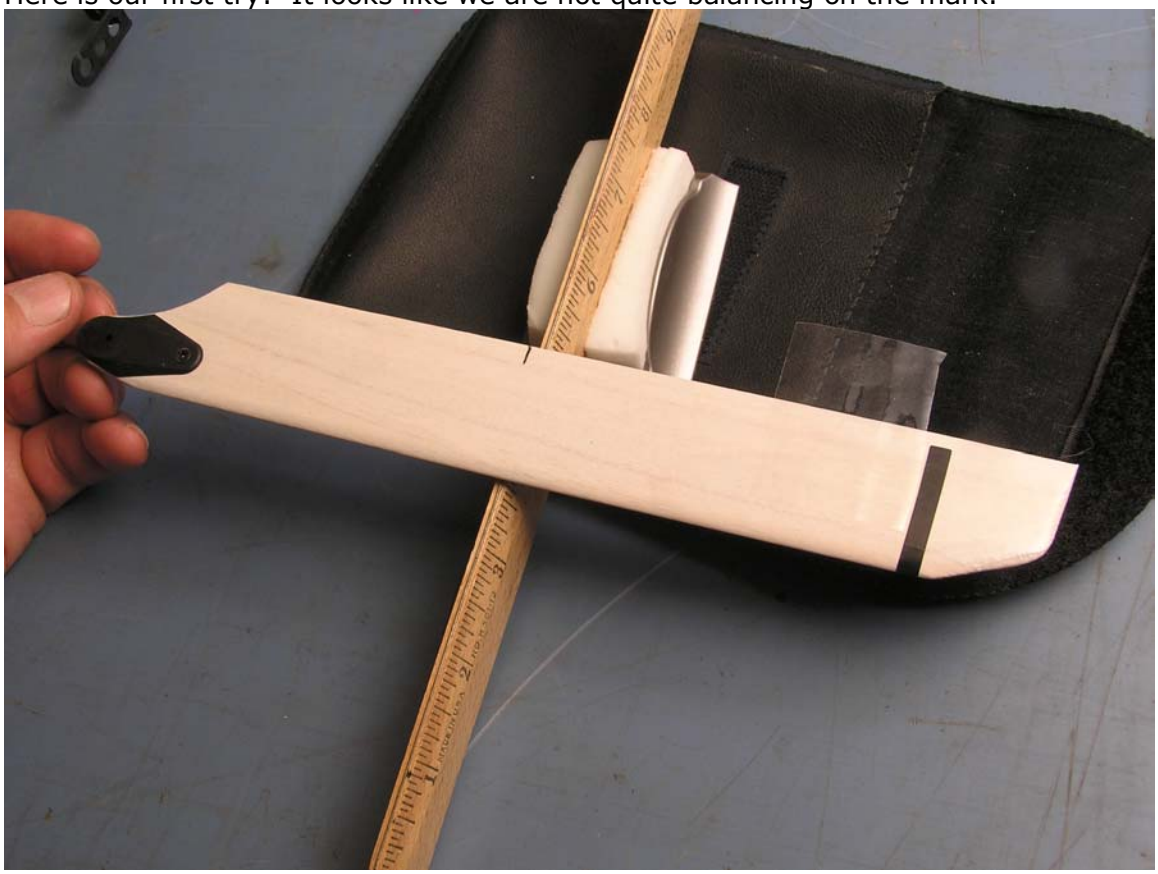
Next you will want to transfer this mark onto the other blade so we can (in the next step) make adjustments to it, so that the CGs (Balance points) of both blades will match.



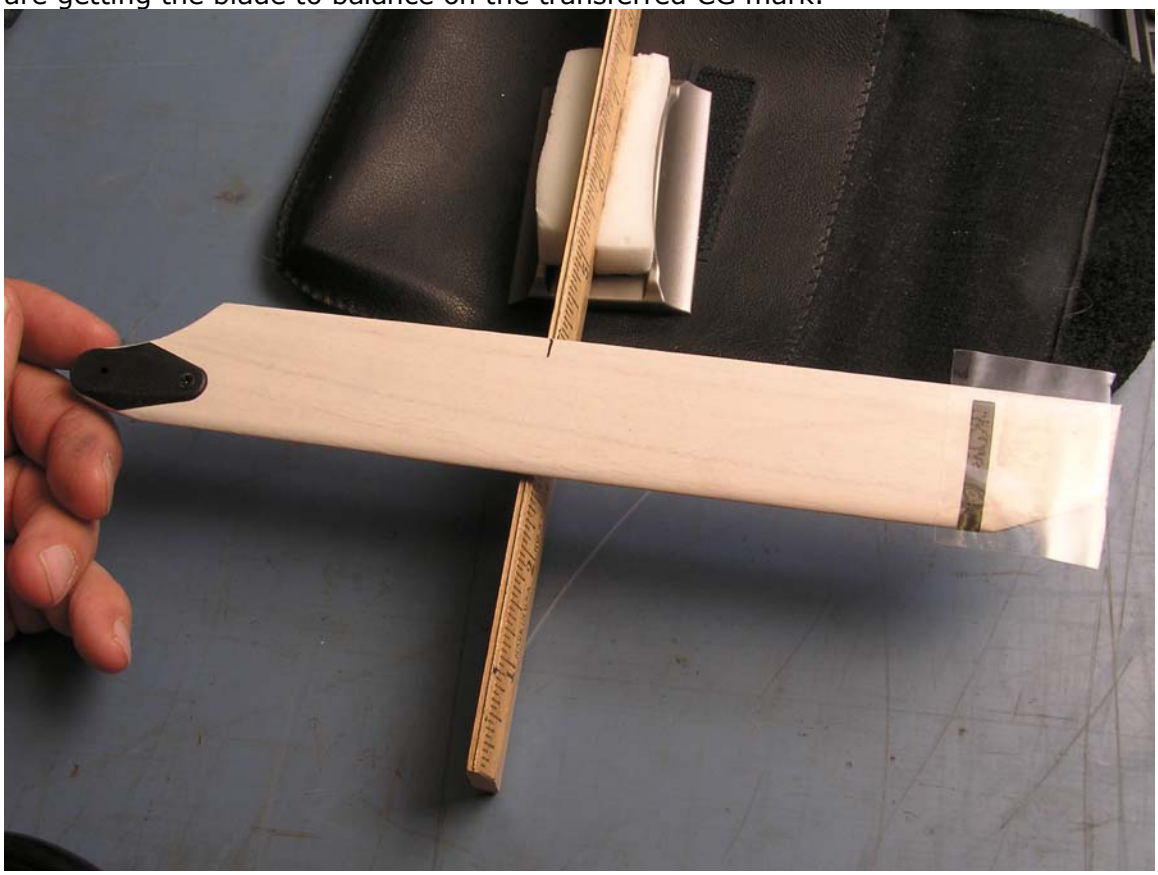
Now get some packing tape and cut a piece that weighs the same amount as the difference in the weights between the blades. The trick it to gently lay the piece of tape on the lighter blade while balancing it on the ruler. The idea it to get the blade to have the same center of gravity and same weight as the other blade. If you do this then you will have a very nicely balanced pair of rotor blades. It takes some practice at first but you will get the hang of it pretty quickly.

In this picture we have grabbed the lighter blade, as our goal is to use a piece or two of packing tape to try to get the blade weights to be as close to the same as we can and at the same time, get both blade CGs to be in the same place. You may have to use several pieces of tape and experiment with where to put them to make this happen.

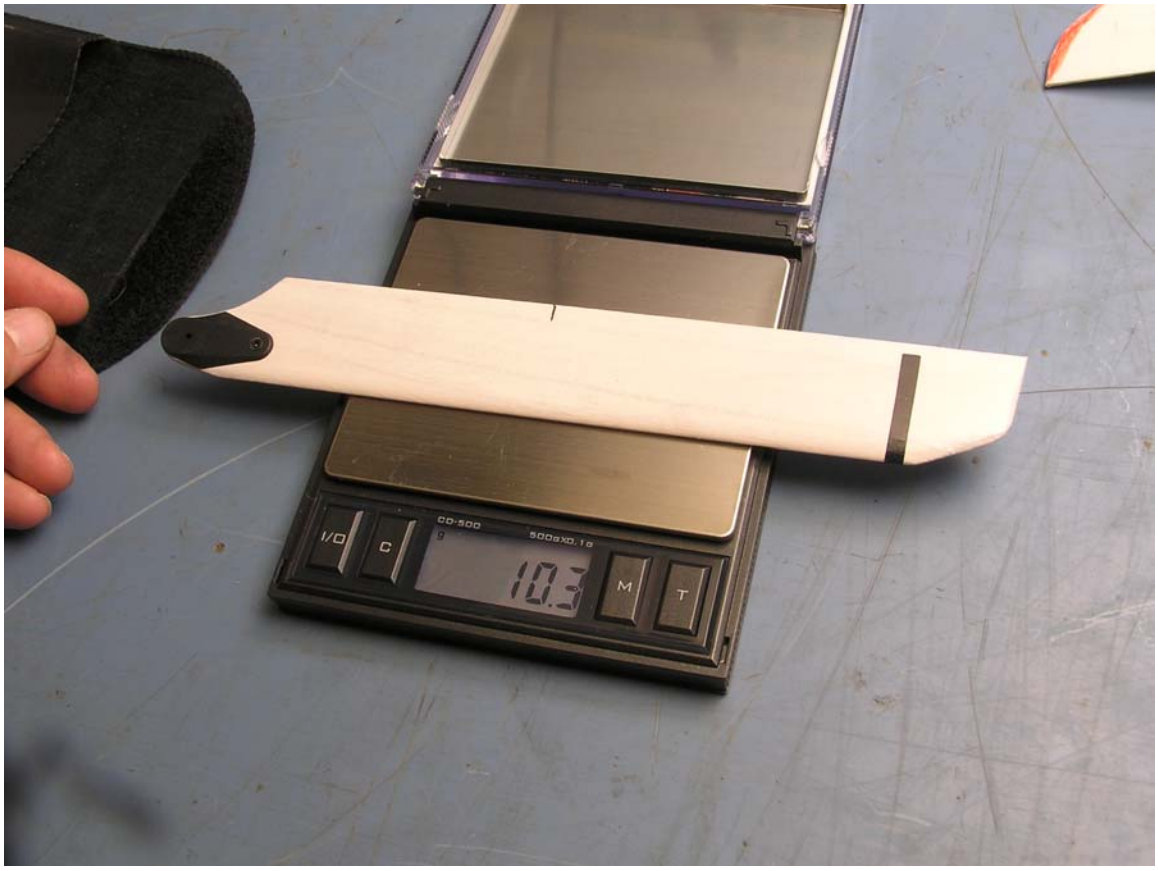
Here is our first try: It looks like we are not quite balancing on the mark.



Here is another try where we moved the piece of tape a little farther out and now we are getting the blade to balance on the transferred CG mark.



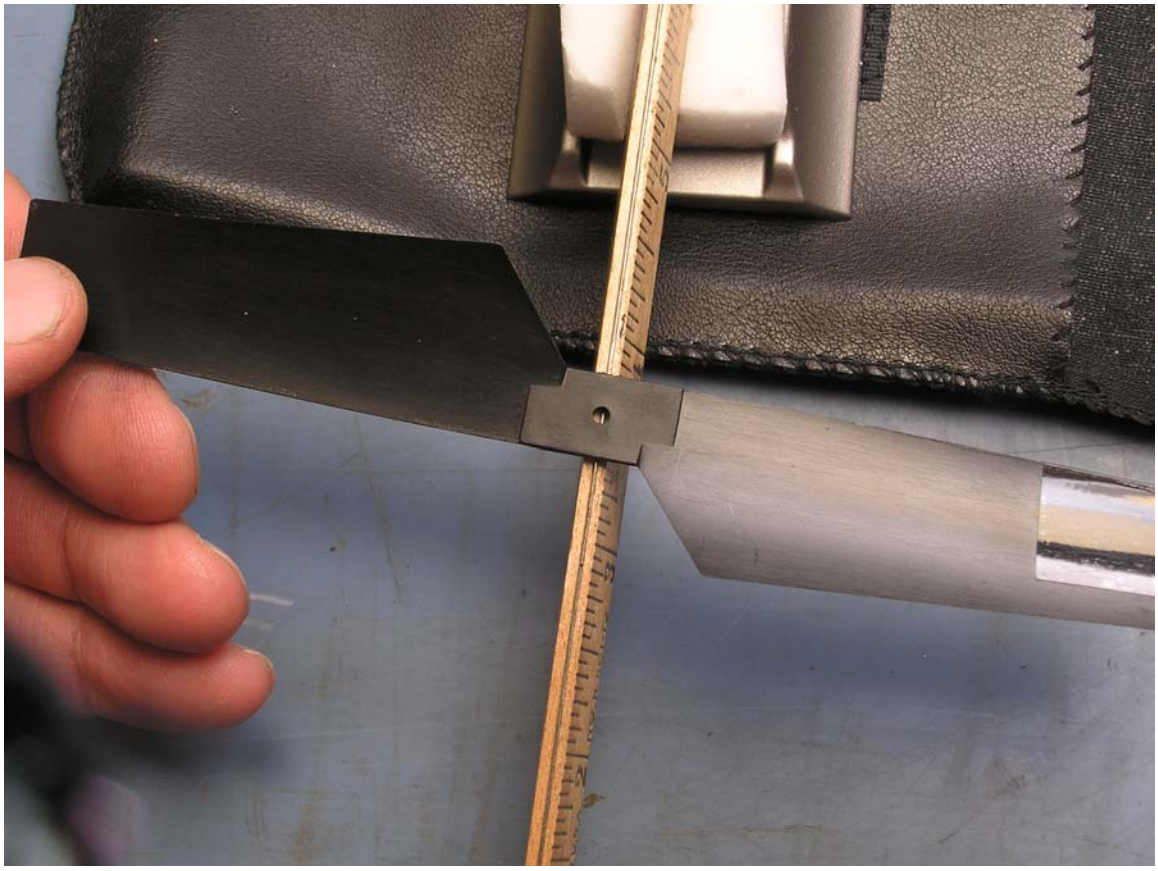
Checking the weight we found we have a great match as the weights are now the same. So the next step is to fold the tape over the edge of the blade and make sure it is flush and tight against the rotor blade. You have now successfully both statically and dynamically balanced out this set of rotor blades. Well done! Now install them on your already trued and balanced rotor head.



If you happen to ding a blade while flying your heli- no problem just put a piece of tape on the leading edge to cover the ding and rebalance your blades.

Next up is: **Tail Rotor Balancing**

I balance the tail using the same wooden ruler turned up on edge. Lay the tail rotor blade on the metal edge of the ruler, centered on the hole where it fits on the drive shaft. You will find that even the new ones right out of the package will be out of balance, so just tack a small piece of packing tape on which ever end is lighter and move it around until you find the right spot to make it balance.



Affix the tape and check your work. You may need to add a little more tape until the blade balances with the hole centered on the metal edge of the ruler. Put it back on your heli and try it out. This will eliminate the high frequency vibrations that make the tail end of your helicopter bounce around.

You will still need to track your rotor blades while running your helicopter. This is done to make sure one blade is not flying higher than the other (and providing even lift). Your manual should have some pretty good pictures of this and explain how to do it. Also verify, that your fly bar paddles are both flying in the same plane (one is not at a different angle than the other).

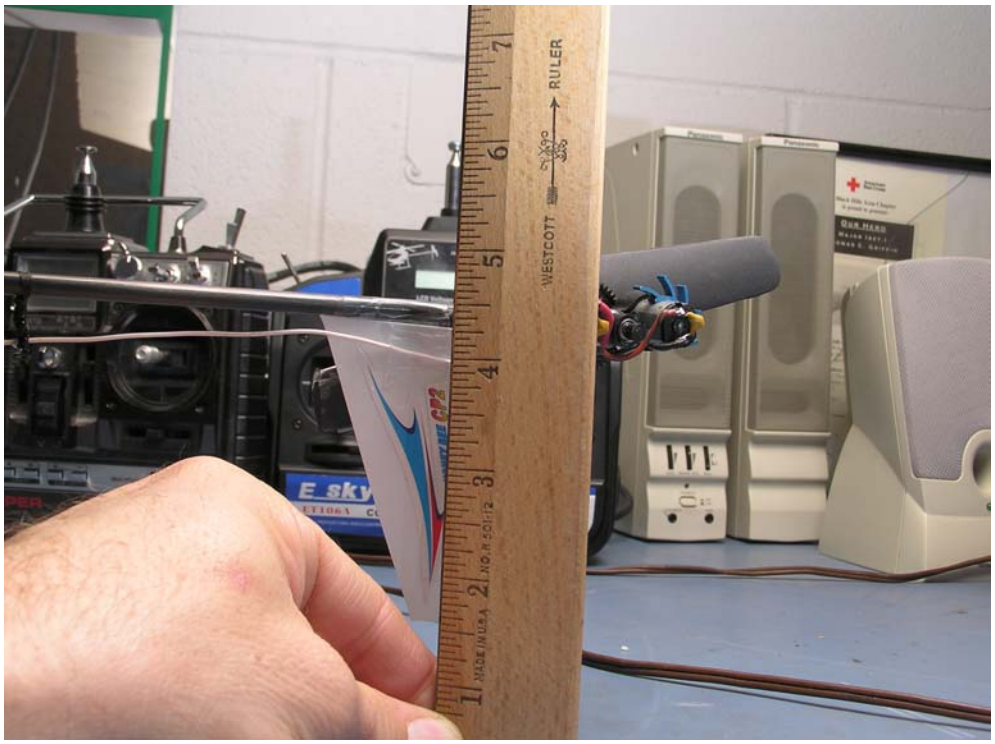
The last step to smooth flying is to balance the CG of the entire helicopter. There are a variety of different ways to do this. I made a stand out of a piece of brass rod from the local hardware store. The idea is to support the helicopter by the fly bar (in the position shown) to see if it is nose heavy or tail heavy.

Normally you will shift the position of the battery forward or back to get the helicopter frame to be perfectly level. This results is the helicopter being perfectly balanced while being suspended under the rotor head.

You can just look at the frame of the heli to see if it is balanced (and make adjustments until it is) or you can use a ruler to check the distance of the tail boom from the top of your level table.

Here is measuring the forward distance.

Then adjust the battery pack position until both distances are the same.



Your heli is now balanced for flight!
Now run it up and go fly! You might have to make some small adjustments on your transmitter but you should have a very smooth flying helicopter that is both easy to handle and will hover in place by itself!

If you need more information or have suggestions on how I can improve this PDF file- email me at Scott.Helmann@us.army.mil.

Good Luck and Happy Flying!

-SSG Scott