

# Ornithopter Tutorial

December 15, 2023

# 1 Materials

This ornithopter was printed using PLA plastic. In total the bird uses less than 40g of PLA to print. I used a 2s brushless motor meant for drone racing, Motor with a 20A 2s motor controller, Motor Controller. For the micro controller I used a 3.3v adafruit trinket. For batteries I used two 1s lipo batteries. An alternative could be to use one 2s lipo battery however it may be heavier and you'd have to slightly modify the circuit. For lubrication on the gears I used a silicon based lubricant. For the wing brackets I used normal PLA however due to the fragility of the sticks I would recommend using PLA tough or any stronger filament. To print the ornithopter I used a prusa mk3 s+. To keep the bird light I used 5% infill on most parts. I used bearings with an inner diameter of 5mm and an outer diameter of 10mm

## 2 Construction of the Ornithoper

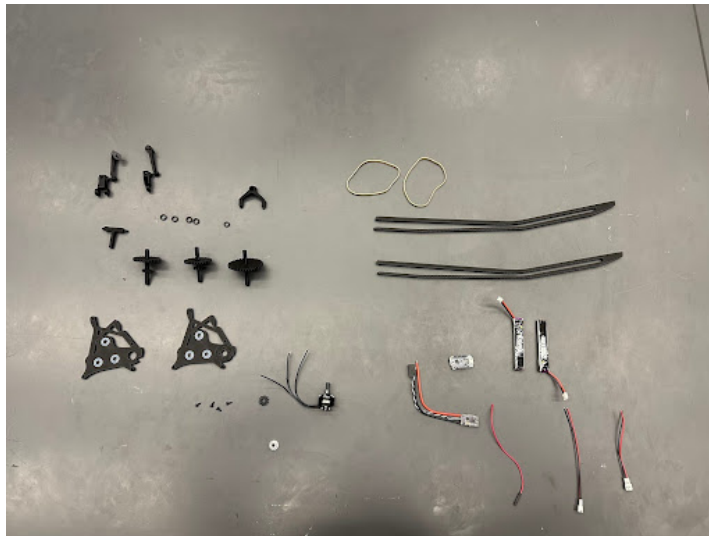


Figure 1: Most of the parts laid out, I've already put the bearings into the holes, just smack them with a mallet to go in. This tutorial is slightly outdated but differences should be clear.

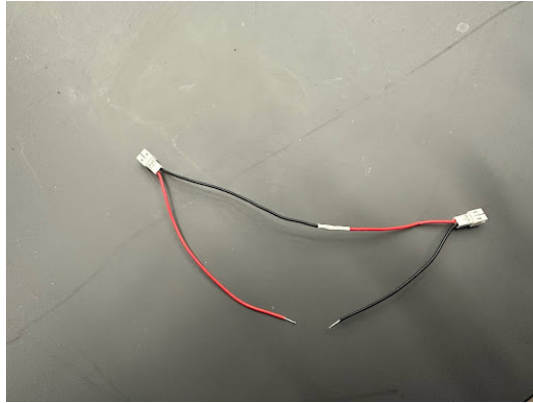


Figure 2: Join a negative and positive end of the JST connectors.

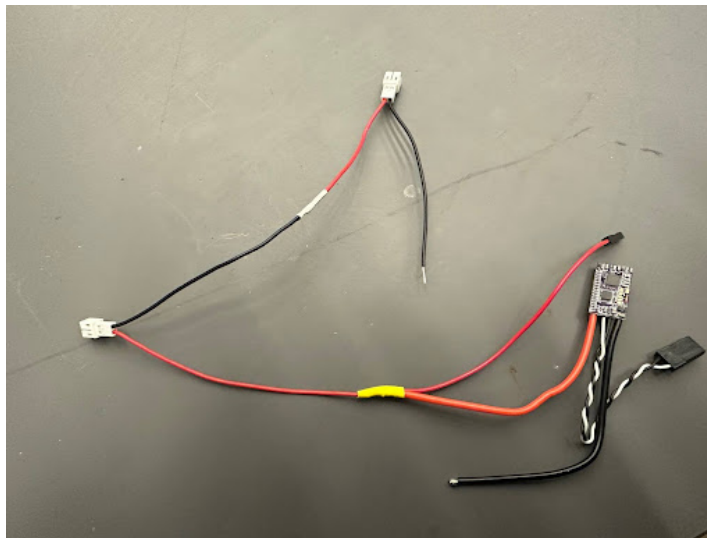


Figure 3: Join the positive end of the motor controller with the positive end of our JST connectors with a female wire to supply power to the microcontroller.

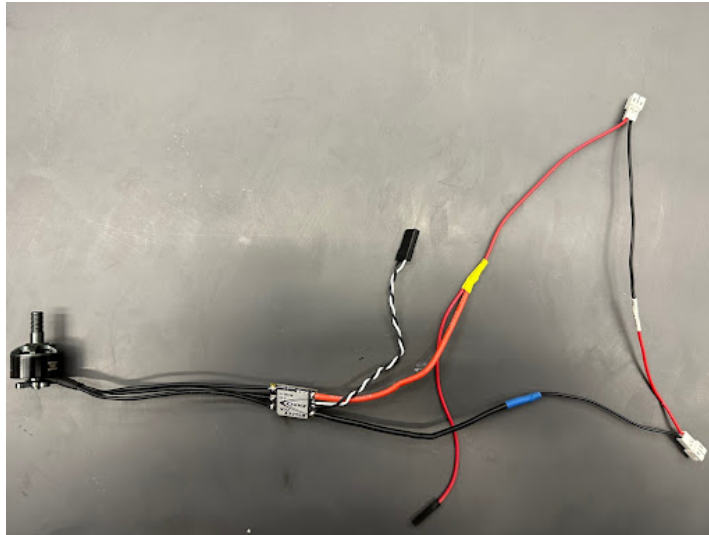


Figure 4: Join the two negative ends.



Figure 5: Solder the Motor to the controller. I've flipped two wires here because later a threaded gear will be screwed onto the drive shaft and the motor needs to go in the reverse direction so that the gear will not be unscrewed.

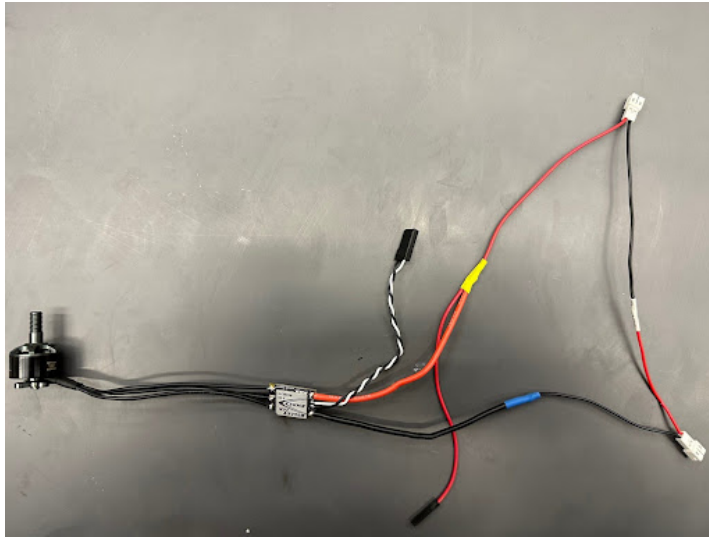


Figure 6: The final product.

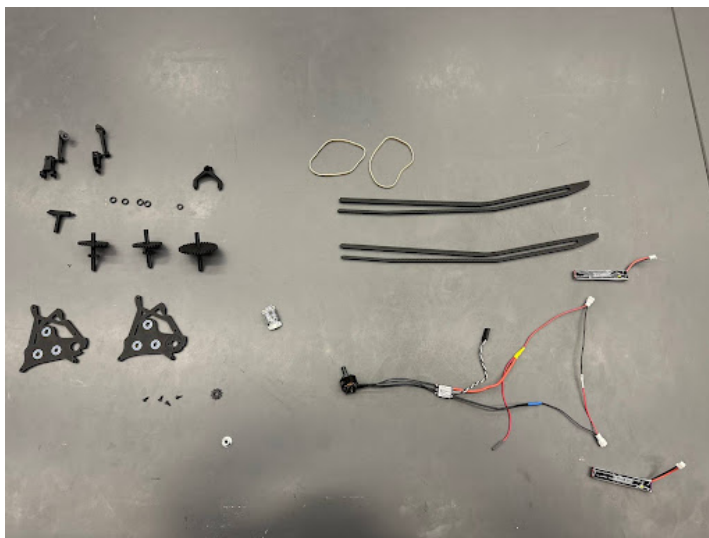


Figure 7: All parts with electronics soldered.



Figure 8: Screw the motor onto the mount-side wall. Make sure the wires face the back.

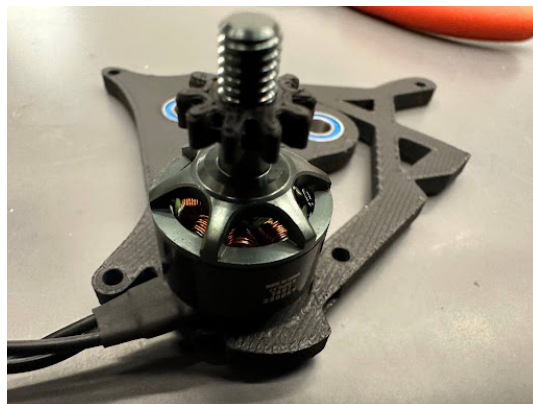


Figure 9: Screw the 10T threaded gear onto the motor, you may need to use needle nose pliers to hold the gear and then twist the motor with your fingers until it is all the way on. Before proceeding be sure to refine your printed gears by carefully sanding.



Figure 10: First take the axle with the 40T gear and place the longer side of the axle into the top bearing.

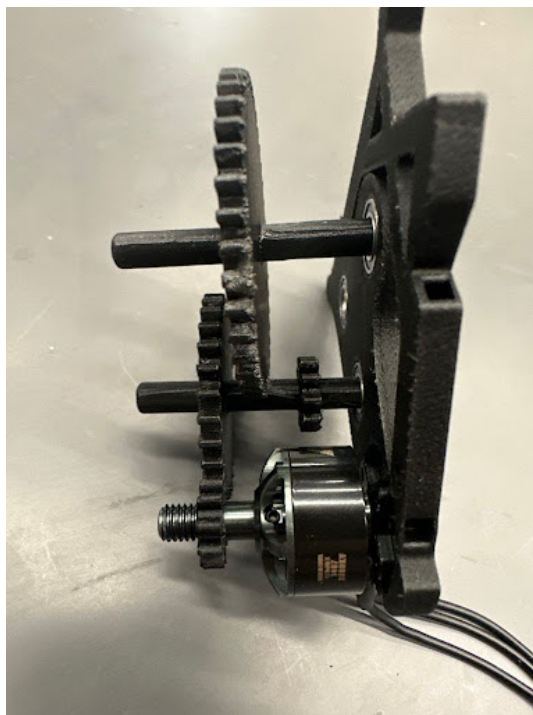


Figure 11: Then place the axle with the gears farther apart into the first bearing as above.



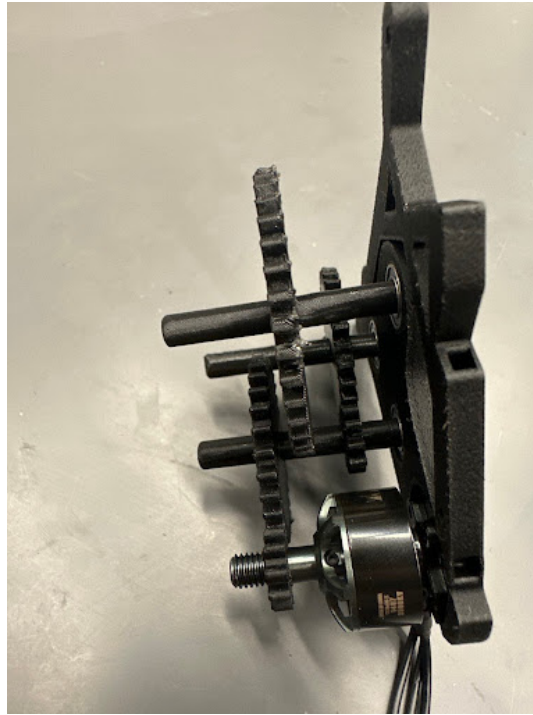


Figure 12: Then place the third shaft into the third bearing, 30T gear side first. You may need to unalign the first two axles to get it in place. Now make sure all of the axles line up and are meshed as above.

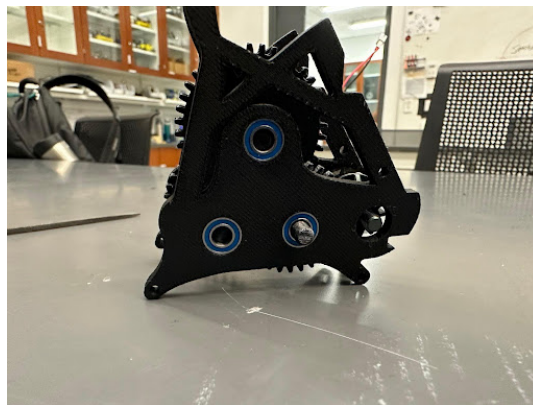


Figure 13: Slide the other wall on for now don't worry about the alignment of the axles.

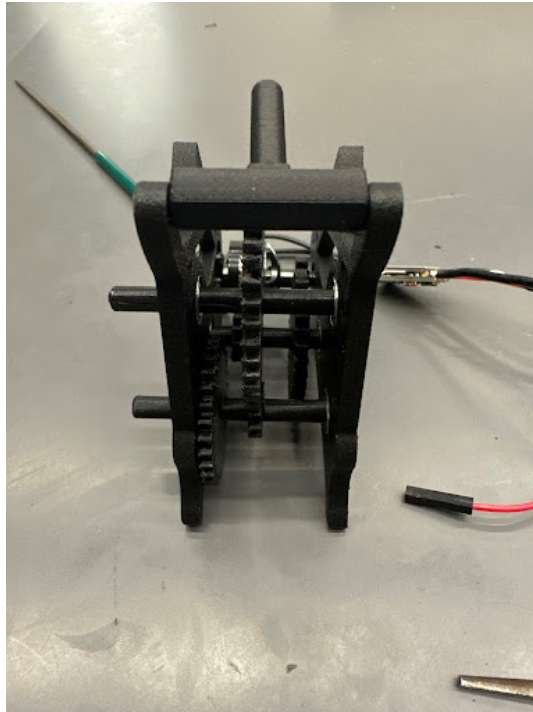


Figure 14: Add the top spacer so that the walls stay a fixed distance apart. You might need to smack it with a mallet.

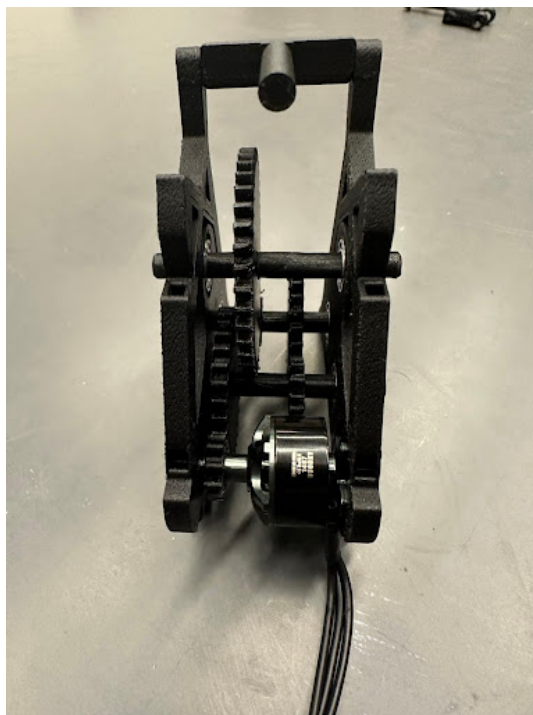


Figure 15: Now you can realign all the axles so there is an equal distance beyond the bearings (the axles are centered and aligned) it may take some patience.



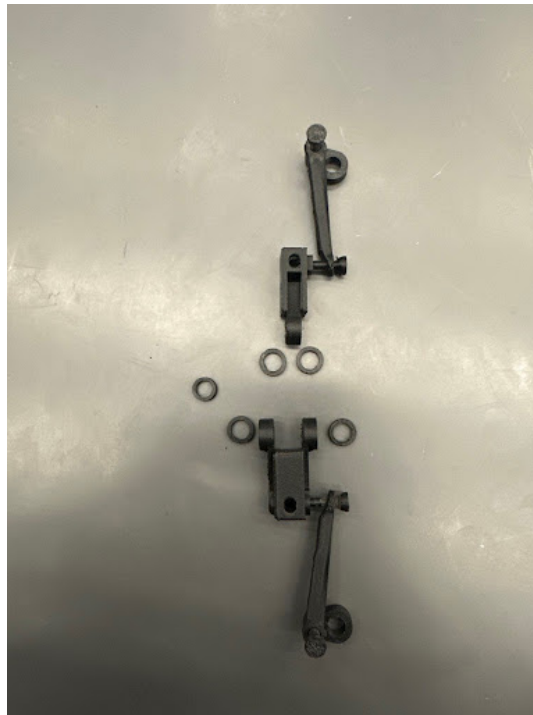


Figure 16: Now we place the wing brackets..

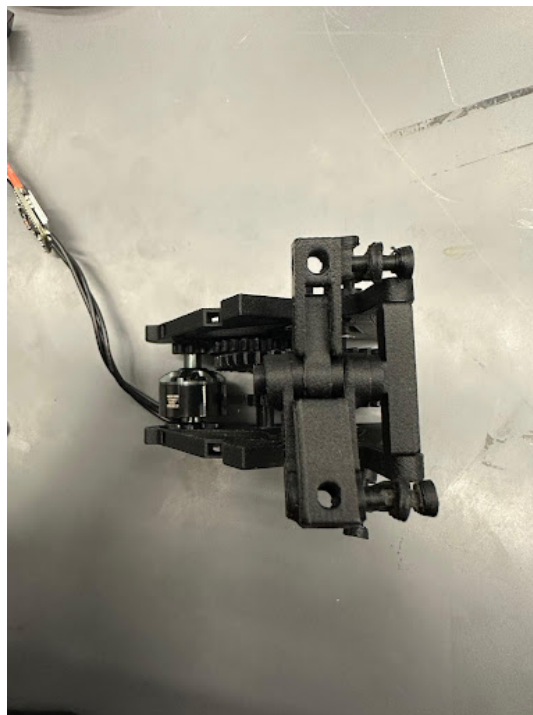


Figure 17: They slide onto the top shaft as above (with the spacers and end cap rotated)



Figure 18: If there is no room for the fourth spacer just smack the end cap on. It will take patience to slide the brackets and spacers on because they should be tight.

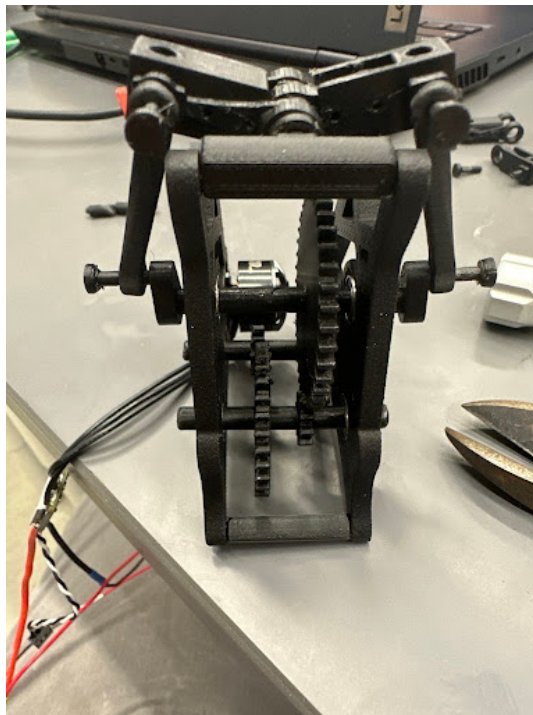


Figure 19: To get the end cap on, I pushed it against a table.

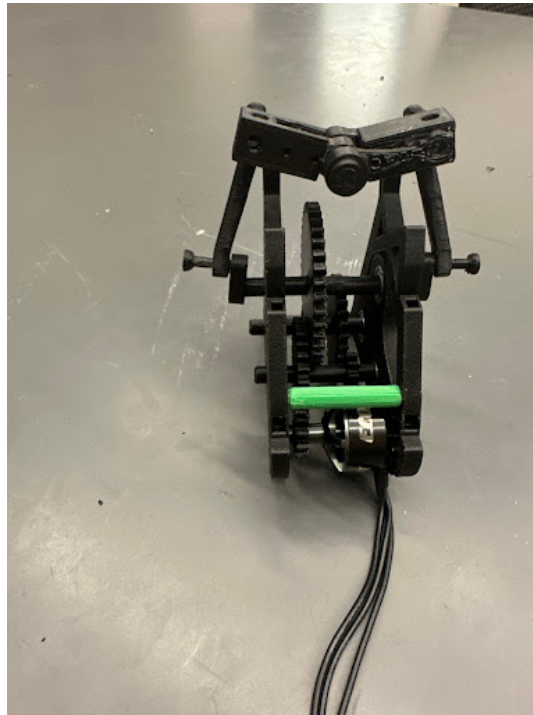


Figure 20: Next, I've added a spacer at the front holes. We add another one above the motor.

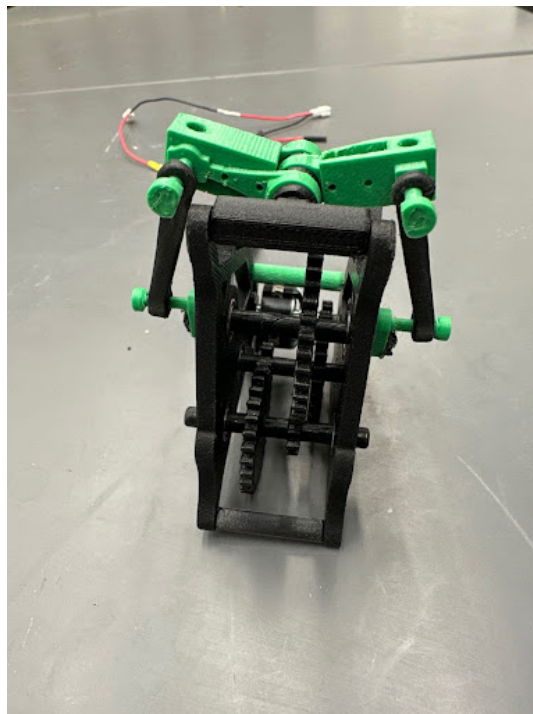


Figure 21: To get these in just spread the walls apart and then smack with a mallet. Now we move onto the cranks, parts have turned green because I broke the black ones.

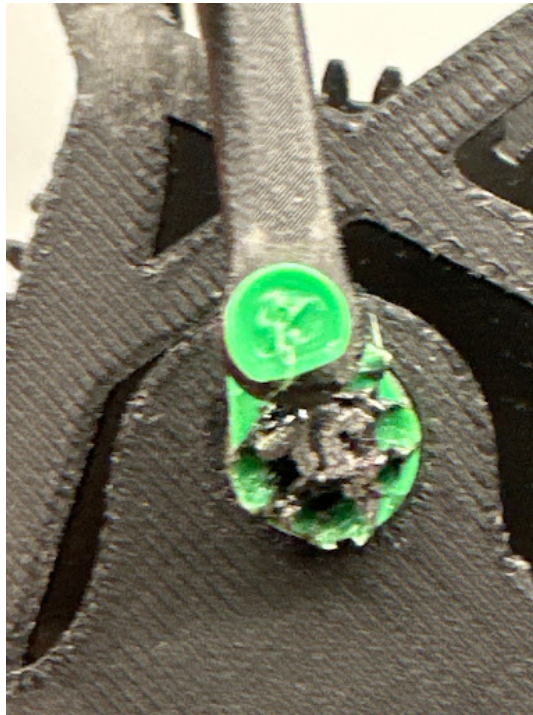


Figure 22: After sliding the cranks on, I used a soldering iron to fuse them with the axle.

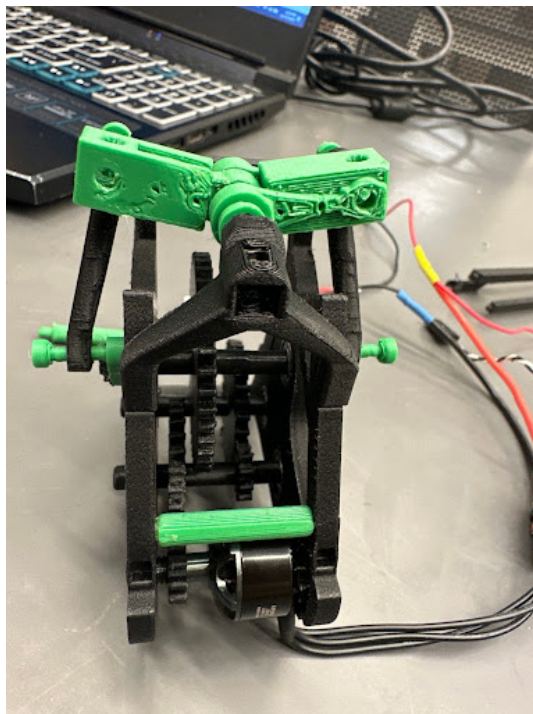


Figure 23: Now we add the spine holder, just pop it into the holes. The newer version also snaps onto the top spacer





Figure 24: Now add the spacers into the tail. Smack with a mallet.



Figure 25: Now align the shafts and slide collars on. To secure the collars into place, I used a soldering iron. I leave the rest to you! Have fun and good luck getting it to fly - it is possible. To mount all the electronics I just symmetrically taped them onto the gearbox.