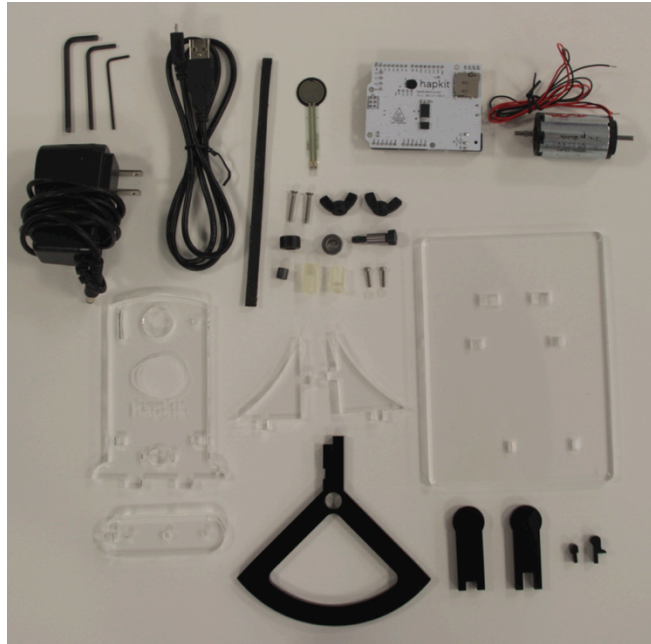


## Hapkit Assembly Instructions

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Version: November 7, 2013

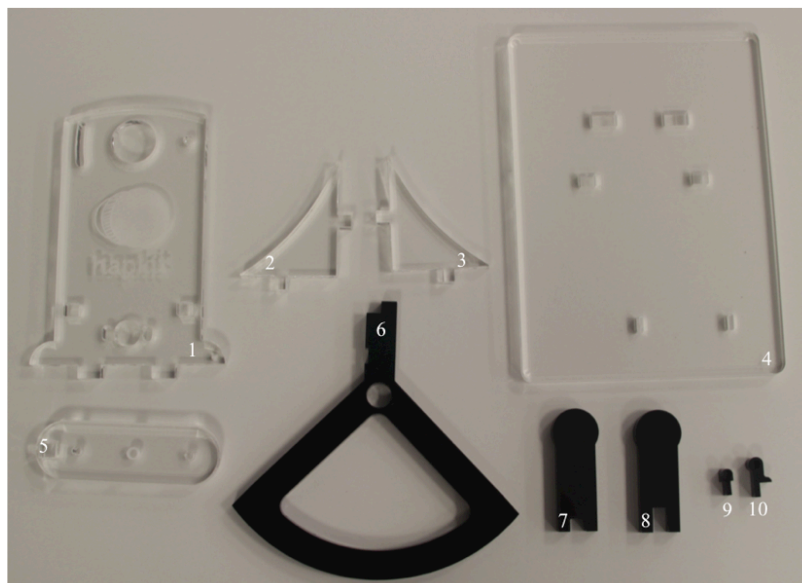
1. **Check Hapkit** to make sure that none of the build parts are missing. Refer to Parts List and image below. You may also need a ruler and a small (about 2.4mm) flathead screwdriver (not included in kit).



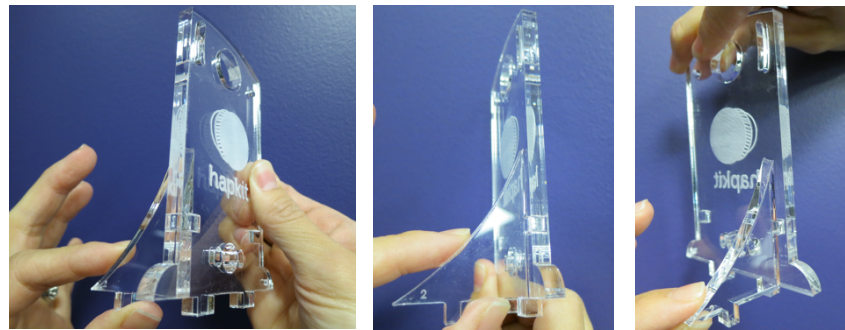
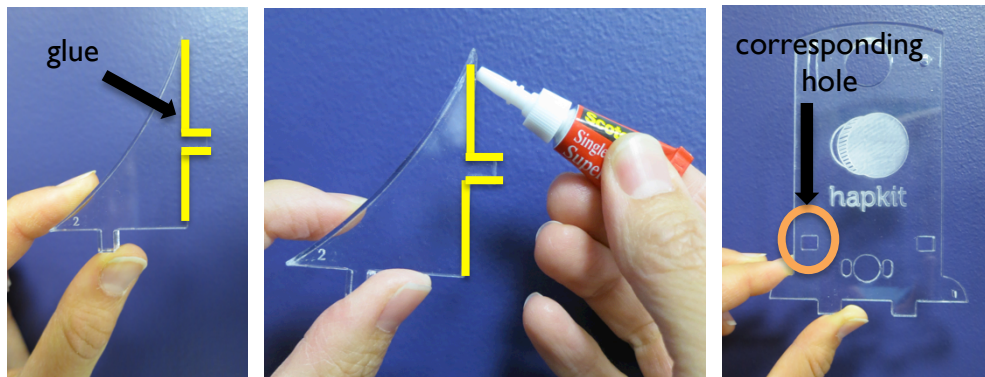
### 2. Assemble Hapkit frame (pieces shown below)

The following steps are more easily done with a partner because the superglue gel dries quickly. It is also helpful to do the gluing steps over newspaper – just be careful to not glue your pieces to the paper). If at any step you find that the pieces will not glue together, set the pieces aside and wait.

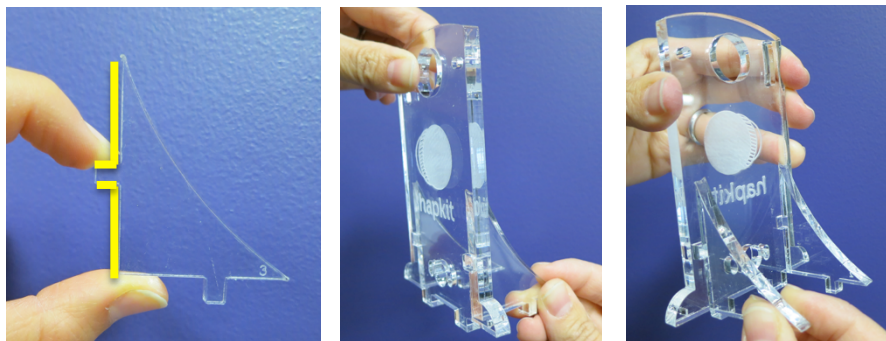
**Note:** It is important to notice the number etched into acrylic pieces #1 - #8. Pay attention to the number as well as which side of the piece it's etched onto. (The approximate locations of the numbers are shown below.)



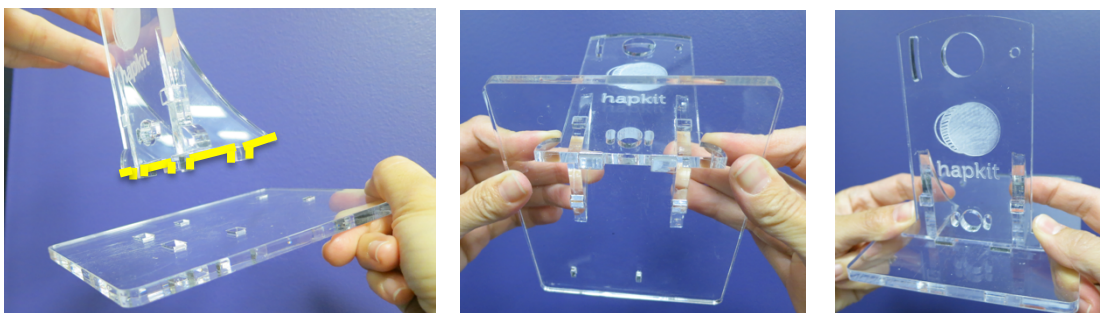
2.a) Put superglue (provided in the kit and shown in yellow) on the edge of the *support* piece (#2) shown in the figure. Place the tab into the corresponding hole in the *frontplate* (#1). Try to make sure that the *support* piece is as straight as possible (is perpendicular to the bottom edge of the *frontplate*). Press down until the support is secured to the inside of the *frontplate*. This may take a few minutes.



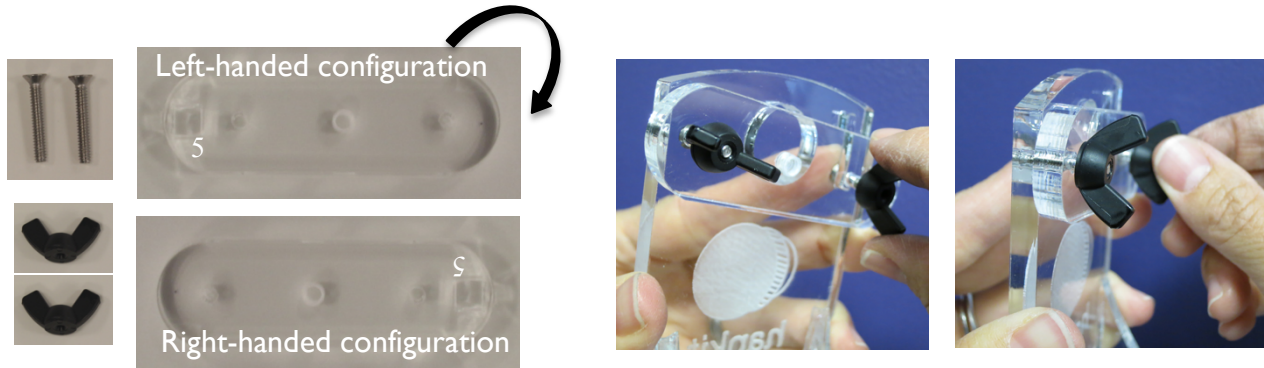
2.b) Repeat with the second *support* piece (#3).



2.c) Put glue along bottom edge of the *support* pieces (#2 & #3) and *frontplate* (#1). Place the tabs into the corresponding holes in the *base* (#4) and press down until secure. It is important to apply a fair amount of pressure for up to a few minutes to ensure the frame is securely in place.

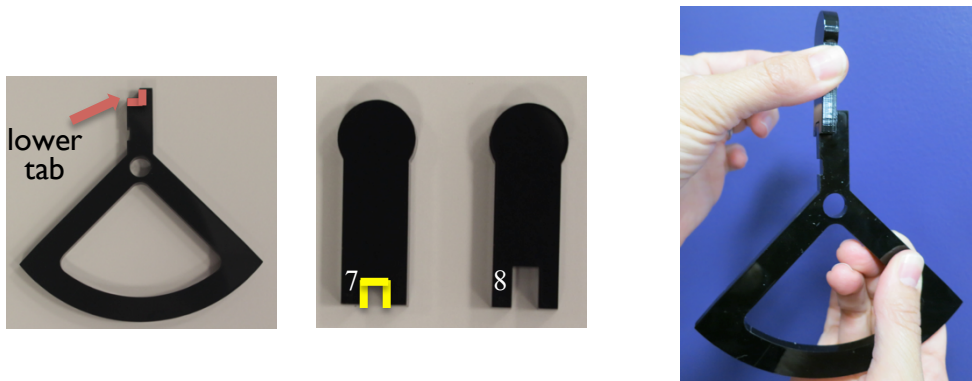


2.d) Using the  $\frac{3}{4}$ " length screws and the wing nuts, attach the *height adjustment bar* (#5) to the **back** of the *frontplate* (#1). If you are left handed, make sure that the square hole is on the left hand side as shown in the figures below. If you are right handed, make sure that the square hole is on the right hand side. Flip the *height adjustment bar* (#5) as shown below, making sure that the engraved "5" is still on the top (side that will come in contact with the *frontplate* (#1)). Tighten wing nuts just enough to keep the bar in place, but do not tighten fully. **Note:** It is important that the side of the height adjustment bar with the engraved "5" is in contact with the back of the frontplate.

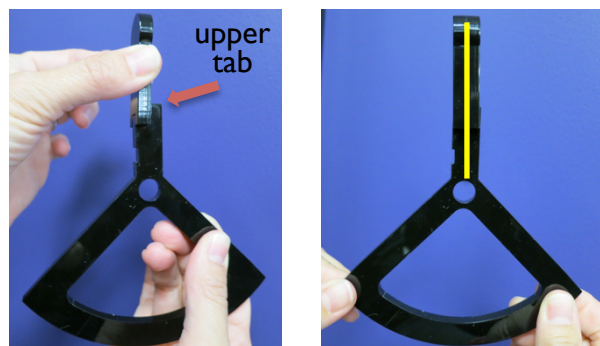


### 3. Assemble Hapkit sector pulley

3.a) Put glue on the inside of the cutout on the *handle1* piece (#7) and attach it to the lower tab on the top of the *sector pulley* (#6) as shown in the figure. The "7" should be facing outwards.

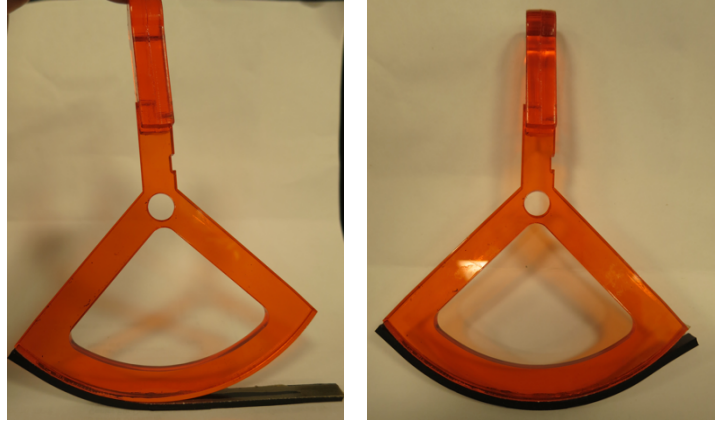
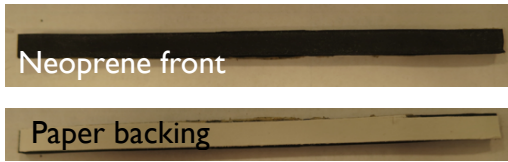


3.b) Repeat with *handle2* (#8), attaching it to the upper tab on the top of the *sector pulley* (#6). Also make sure to put glue along the backside of *handle2* (#8) in order to secure it to *handle1* (#7). Again the "8" should be facing outwards. **Note:** Although the attachment of #7 and #8 could go either way, because of the way the laser cutter cuts, the two pieces fit together best when the etched numbers face out.

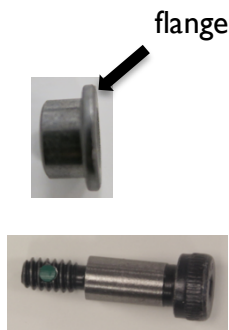


3.c) Remove the paper backing for the adhesive on the Neoprene strip, and place the Neoprene (sticky side up) on the table. Carefully attach the Neoprene to the *sector pulley* (#6) by rolling the *sector pulley* along the Neoprene, making it as smooth as possible. Cut off the remainder of the Neoprene. If the ends of the neoprene strip are not fully attached, use a small drop of glue.

**Note:** If the adhesive backing is not sticking well to the Neoprene, it can be removed and the entire Neoprene strip can be glued to the sector wheel. Try to make sure that the Neoprene is attached as smoothly as possible.



3.d) Press the sleeve bushing into the hole in the *sector pulley* (#6). The flanged part of the bushing should be on the same side as the etched “6” and the same side as the protractor marks at the bottom of the *sector pulley*. Then insert the shoulder screw through the sleeve bushing as shown in the figures below.

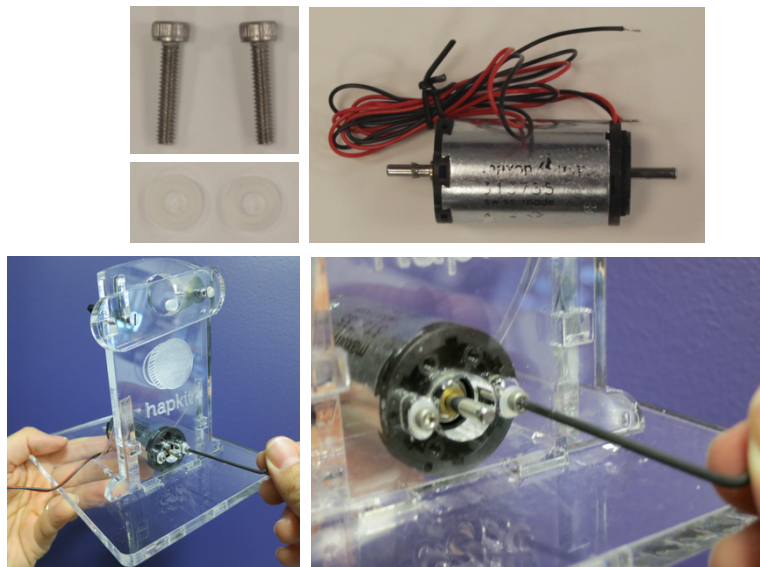


3.e) Slip the shaft collar onto the back of the shoulder screw and tighten using the 3/32” hex key. **Note:** The setscrew in the shaft collar may need to be loosened before it will fit onto the shoulder screw. Squeeze the acrylic between the flanged bushing and the shaft collar. Be sure that when you pinch the shaft collar between two fingers, the sector pulley can easily swing back and forth, but does not slide horizontally along the shoulder screw. This may take some adjustments.

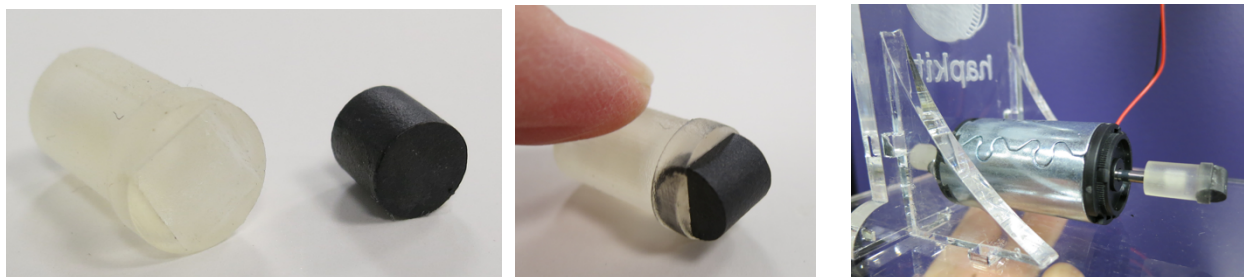


#### 4. Attach parts to the Hapkit frame

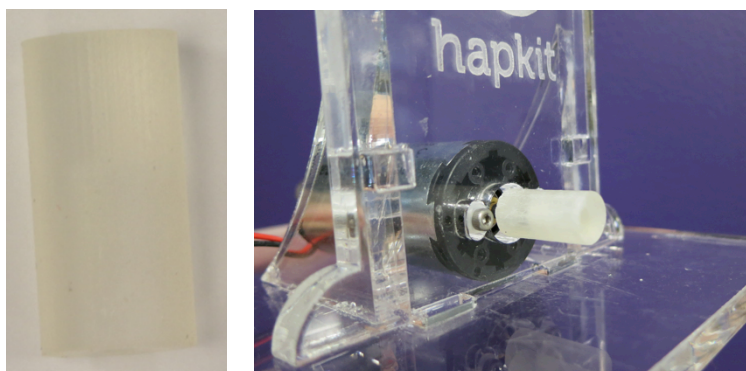
4.a) Use the 1.5mm hex key with the washers and M2 screws to attach the motor to the *frontplate*. The washers should be slipped onto the M2 screws and then screwed into place.



4.b) Glue the magnet into the *magnet holder* and push it onto the back shaft of the motor. It should be difficult to push it onto the shaft, but if it feels like you are applying too much force, remove the piece and clean out the hole using one of the hex keys provided. Then try pushing the *magnet holder* onto the shaft again. The figure below illustrates how far you should push the piece along the shaft. **Note:** The shaft should not be pushed all the way to the end of the hole as shown below.



4.c) Push the *drive wheel* onto the front shaft of the motor. Follow instructions from above for cleaning the inside of the hole if needed. The figure below illustrates how far you should push the *drive wheel* along the shaft. The back of the *drive wheel* should almost be flush against the front side of the *frontplate*, but should not be pushed all the way.

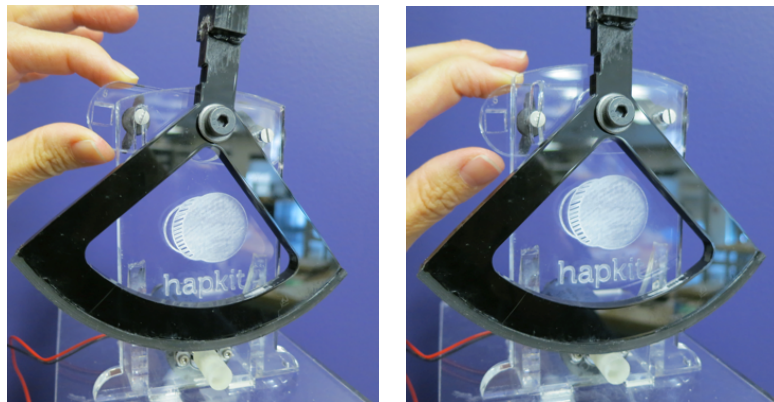


4.d) Using the 1/8" hex key, screw the *sector pulley* into the threaded hole in the middle of the *height adjustment bar* (#5). It should become hard to screw the shoulder screw when the green pellet comes into contact with the threads, but just keep turning the hex key. Tighten until there is approximately 1/4" between the back of the *sector pulley* (#6) and the front side of the *frontplate* (#1).

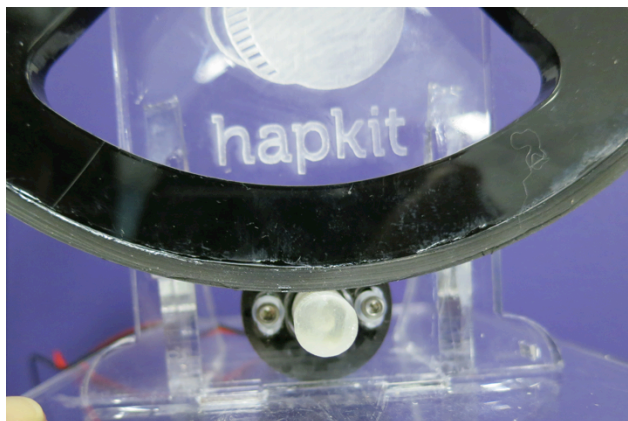


4.e) In order to adjust the amount of friction between the *sector pulley* (#6) and the *drive wheel*, first tighten the wing nut on the right. Then swing the *height adjustment bar* (#5) up or down as needed, such that the neoprene strip is slightly compressed on the *drive wheel*, but the *sector pulley* (#6) can still swing back and forth without too much force. Then tighten the other wing nut.

Changing the height of the height adjustment bar:

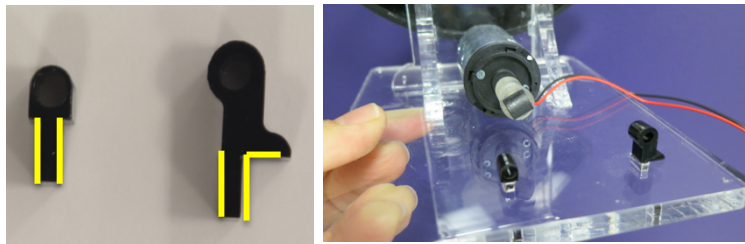


Make sure the height has been adjusted so that there is sufficient friction force between the sector pulley and drive wheel so that turning the drive wheel with your finger will turn the sector pulley.

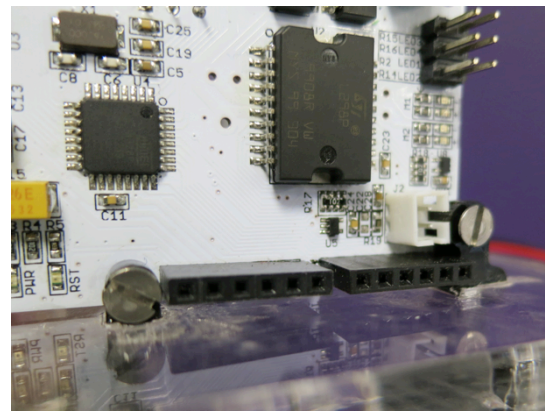
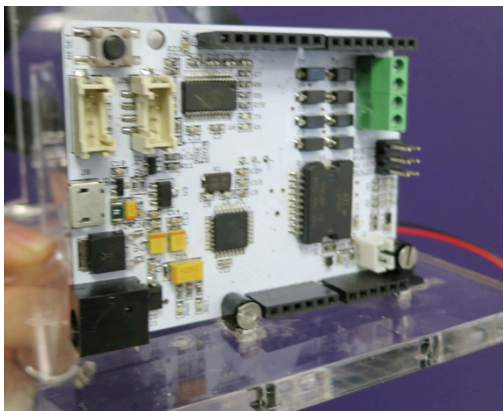


## 5. Set up the electronics

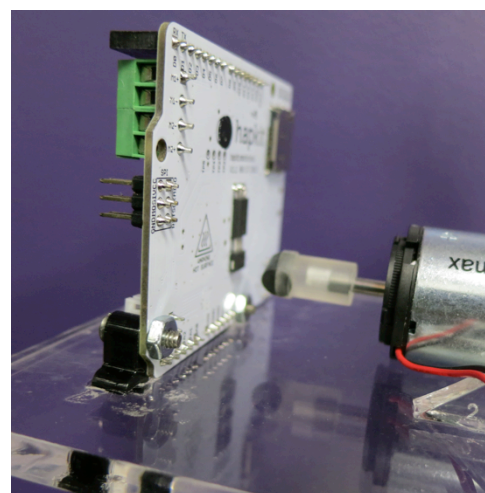
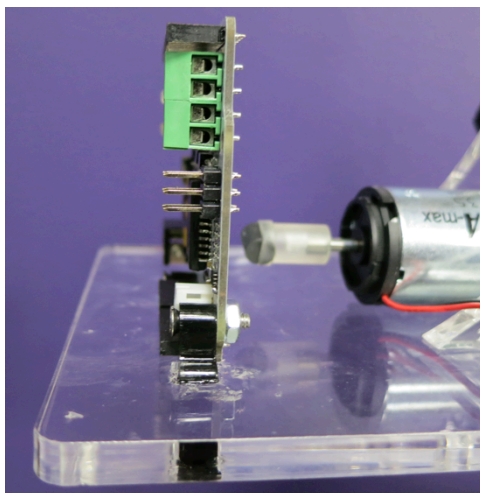
5.a) Glue the *PCB mounts* (#9 & #10) into the corresponding holes in the Hapkit base (#4). They should be oriented as shown in the figure below.



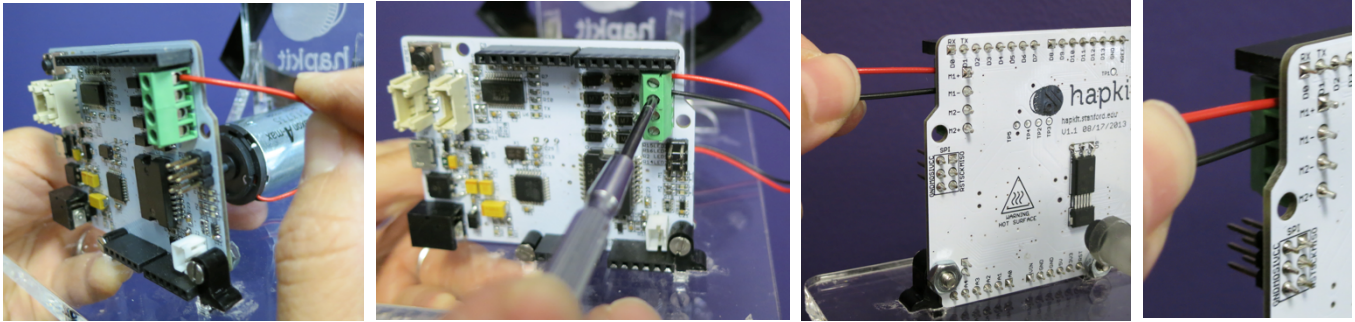
5.b) Use the 1/2" screws and nuts, to attach the *PCB mounts* (#9 & #10) to the PCB as shown in the figure.



Make sure that the MR sensor is facing the magnet. There should be about a centimeter between the magnet and the MR sensor.



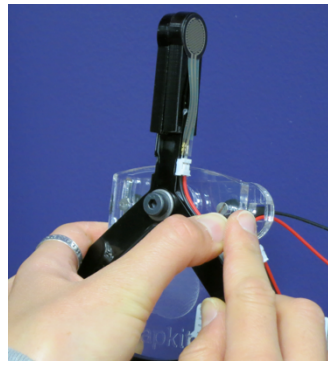
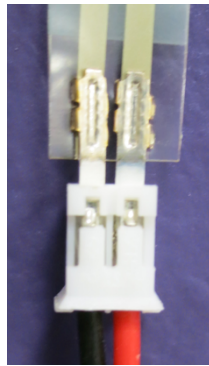
5.c) Connect the wires from the motor to the PCB using a flathead screwdriver. [**Note:** Using a 2.4mm screwdriver is recommended, however it is not included in the kit.] Connect the black wire to the PCB output labeled “MI-” and connect the red wire to the output labeled “MI+”.



5.d) Push the leads of the FSR into the female moxex connector on one side of the cable. When looking at the front side of the FSR, the left lead should be inserted into the side with the black wire, and the right lead should be inserted into the side with the red cable. Put super glue on the backside of the moxex connector and press it into the slot in the sector pulley as shown in the figure. (Note that if you are left handed, the FSR should be on the other side of the handle from that shown below. You want the FSR mounted on the side of the device that has the hole in the height adjustment bar.) Remove the backing on the circular part of the FSR to expose the sticky surface and press it onto the circular part of the handle. Try to make the FSR lie as flat as possible against the handle.

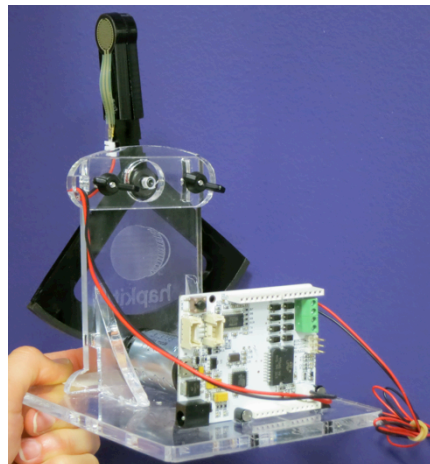
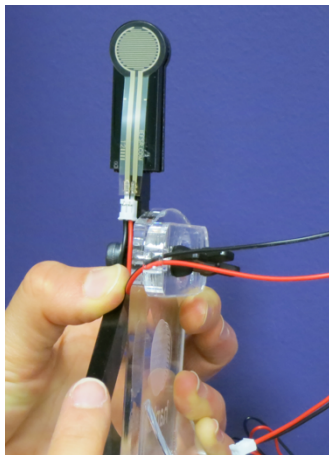


FSR front view



FSR mounted on handle

5.e) Route the other end of the FSR cable through the square hole in the *height adjustment bar* and connect the female moxex to the male connector on the PCB as shown.





The assembled Hapkit should look like this:

