Section 11: **Belts ‘N Stuff**

The following is the assembly instructions for the motors, belts and opto switches. The bill of materials for this assembly is:

<table>
<thead>
<tr>
<th>Description</th>
<th>Printed/Made/Purchased</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ja_z_opto_mount</td>
<td>Printed</td>
<td>1</td>
</tr>
<tr>
<td>Entire assembly from previous</td>
<td>Made</td>
<td>1</td>
</tr>
<tr>
<td>y_carriage_assembly</td>
<td>Made</td>
<td>1</td>
</tr>
<tr>
<td>M3 X 12 SHCS</td>
<td>Purchased</td>
<td>21</td>
</tr>
<tr>
<td>M3 Nut</td>
<td>Purchased</td>
<td>5</td>
</tr>
<tr>
<td>5/16” or M8 threaded rod</td>
<td>Purchased</td>
<td>1, cut to 45mm long</td>
</tr>
<tr>
<td>5/16” or M8 nut</td>
<td>Purchased</td>
<td>2</td>
</tr>
<tr>
<td>M8 washer</td>
<td>Purchased</td>
<td>3</td>
</tr>
<tr>
<td>Fender Washer</td>
<td>Purchased</td>
<td>2</td>
</tr>
<tr>
<td>608 bearing</td>
<td>Purchased</td>
<td>1</td>
</tr>
<tr>
<td>Stepper Motor</td>
<td>Purchased</td>
<td>3</td>
</tr>
<tr>
<td>XL or T5 pulley, 8 or 10 tooth</td>
<td>Purchased or Printed</td>
<td>3</td>
</tr>
<tr>
<td>Optoswitch Assembly</td>
<td>Purchased</td>
<td>3</td>
</tr>
<tr>
<td>Optoflags</td>
<td>Fabricated</td>
<td>3 different</td>
</tr>
<tr>
<td>M3 insulating washers</td>
<td>Purchased</td>
<td>6</td>
</tr>
</tbody>
</table>

The part “ja_z_opto_mount” in the build orientation.

The Z motor.
Loosen the y rod clamp screws and back out the rods to the front as shown. Then put the y carriage in place. Push the y rods back and snug up the screws again.

It should look like this.
If a manufactured 10 tooth pulley is used, the I.D. may not match that of the motor shaft. If it is too small, here is what to do.

Take the manufactured 10 tooth pulley and BACK OUT THE SET SCREWS THAT HOLD IT TO THE SHAFT!!!! They are hardened.
Put it in a drill press vise and tighten securely. Run the drill press at low speed and run the drill through the hole in a slow smooth motion. Lubricant helps here. It is best to buy a proper size bore pulley…

Place the motor in place and affix with 4 M3 X 12 SHCS and washers. If the screw hole in the motors are very shallow, you may have to stack washers under the screw heads so they do not
bottom out. Slide the pulley on and view from the side. Decide how the pulley should face (set screws near motor or away from motor) and how far out on the shaft it should be to be at the same height off the mount as the 20 tooth pulley.

Assemble the short threaded rod as shown. This picture is misleading. The mount goes between the right-most M8 washer and fender washer. From the top down, it goes: M8 nut, M8 washer, printed z mount, fender washer, M8 washer, 608 bearing, M8 washer, Fender washer and M8 nut.

It should look like this.
Slide the pulley on and view from the side. Decide how far out on the shaft it should be to be at the same height off the mount as the 20 tooth pulley and tighten securely.

Have a helper hold the two z threaded rods so they do not turn, and slip the tooth belt over the pulleys as shown. Snug (but not too snug) the belt with the idler pulley and tighten it by tightening the nuts on the top and bottom of the idler pulley short threaded rod.
A side view should look like this.

The X motor.

The x motor goes on the shaft in this orientation. Place it into the x motor mount and loosely tighten.
The belt wraps around as shown. It starts at the x carriage clamp. Then it goes over the motor pulley. Then it returns UNDER the carriage to the bottom of the 608 bearing of the other side. Next over the bearing to the other side of the x carriage and another clamp. Better said in pictures.
The adjustments of importance are:
  An 8 tooth and a 10 tooth pulley are different diameters. Depending on which you use adjust the motor up or down so that the top of the belt is level with the top of the x carriage.
  Snug the belt (but not too much) and tighten the carriage clamps (see Sells Mendel for description). Cut off excess belt.

The Y motor.

The y motor is complicated by not being able to tighten the set screws with the motor in place.

Put the motor in, and then decide on the proper position of the pulley on the shaft, by lining up with the fender washers.
Measure the position relative to the shaft. Remove motor and install pulley, tightening set screws firmly.

All tightened…
Install motor with 4 M3 X 12 SHCS (no washers). Put the screws at the middle of the slot they ride in. **Having the screws in a slot will later allow us to move the motor to change the y belt tension without removing the bed** (Oh how I wished for this, as every time to remove the bed is 30 minutes to re-level and test).
Belts go as shown on this side. Other side goes around 608 bearing as in Prusa Mendel. Snug up as per Sells and tighten clamps. Cut off excess belt.

These instructions presume that you use purchased 10 tooth pulleys. I recommend this, since it reduces backlash and gives better prints (cost about $30). If you simply must use printed pulleys, be sure that they are proper for your belting (XL or T5). Follow the Sells Mendel instruction for attaching to shafts. Be sure to install them at the proper distance out the shaft to have the belt at their mid-point, which is different for each axis motor.

The x axis microswitch. Put the M3 X 12 SHCS through the optoswitch and PCB (you may have to gently ream the PCB hole with a drill to get the optoswitch hole to line up with the PCB hole). Then put an M3 insulating washer on each screw and insert through holes. Hold a nut on the back and gently run the screw into the nut. Snug slightly, being careful not to break the board. You will want to trim the soldered tails on the parts really close, and use enough insulating washers to put the tails safely above the surface, so no flexing force is on the board.
The y axis is similarly, except the nuts are already pressed into the motor mount.

The z mount is a little more complicated. It is a printable spring, with +/- 2mm travel from the nominal position. I printed it at 25% fill, same as the rest of the parts. Take the “ja_z_opto_mount” and ream the holes clean.
First we put a nut on an M3 screw and press it into the hex recesses as shown (2X).

Remove the screw, insert it from the other side, and bottom them. Then remove screws.
Now pull nuts into the “ja_right_z_mount” as shown (2X).
The result looks like this.

Next we put a nut on a screw and push it into the central hex recess. Push it in by hand and remove screw.
We will now pull it to the bottom of the recess. However, we can’t just use a screw, since the printed spring might crack. Use 2 M8 washers as spacers between the spring “leaves” as shown.

Then the nut can be bottomed out. Then remove screw. THE NUT MUST BE SECURELY BOTTOMED TO HAVE THE Z ADJUSTMENT STABLE!!!
Re-assemble without the M8 washer-spacers, and you have the above
Other views.

Now use two M3 X 12 SHCS to affix the assembly to the “ja_right_z_mount”.
Another view.

Then use 2 more screws, and insulating washers to attach the optoswitch to the mount.
Another view. In use, we will level the bed with the bed mounting screws. Then the fine adjustment will be made with the central screw in this spring (as in Sells Mandel).

Optoflags
The optoflags for this Mandel are very easy to fabricate and install. Follow the DXF files for the unbent-too-long flags. Then attach, bend to suit and cutoff. I used thin brass. Any metal sheet about 0.5mm thick should be fine.
The x flag and optoswitch is shown above. Since I changed the design to move the extruder to the center of the x carriage, the flag will be a few cm shorter than in this picture.

The y flag.

The y optoswitch.
The z flag and switch.

To cutoff the z axis optoflag at the right length, I do the following, AFTER THE HEATED BED IS INSTALLED:

1.) Level the bed using a drill bit or some such between the bed and extruder. Adjust the 3 or 4 adjusting nuts to get the bed at the same height as you move the x and y carriage to all corners and center of the bed.
2.) Set the spring screw so the plastic spring leaves are parallel (like in the above picture).
3.) Run the z home command.
4.) Measure nozzle to bed distance.
5.) Trim the opto flag this amount (-).
6.) Then loosen (open) the spring about 1mm
7.) Re-home and test. If about 1mm, all is good. Adjust the bed down using the screw in the center of the spring to get about 0.25mm clearance to start. Add more layer thickness in slicing tool for first layer.

WOW, DONE…..
Now add your choice of bed, electronics and extruder. A few pertinent comments are:

For the heated bed I used a piece of ¼” thick aluminum with heaters, run by a temperature controller and zero crossing switch. I only print with ABS, so it is a necessity. Since the plate is rigid, I used 3 screws for support. If you have a flexible bed (like a PCB based heater or very thin plate) you will want to use 4 adjustment screws. I do not use bed springs, as it is too much trouble to adjust. I use long screws to fasten the bed to the frog, with double nuts on each side of the frog to lock them. A real pain to adjust, but it is reliable and does not move. Since I made the heated bed before this design, it uses M4 screws, but M3 would be easier to adjust.

A Wade’s extruder, can mount as in the Sells Mendel (perpendicular to the x axis), since the belt return is under the carriage. An Adrian’s extruder also mounts in its proper orientation (gear parallel to x axis). Of course, spacers are needed for gear clearance for Adrian’s. Stacked washers will work if you do not have a printer to print some spacers.

If you are going to use a thick sheet electronics mount for the front, I have designed a simple one-piece mount for it that only used the same M3 X 12 SHCS and nut as here (shameless plug). Also, a mount for the Gen 3 stepper board, if anyone still uses that. Soon I will have a simple reinforcement for the frame to use in place of the thick sheet, if you desire it. I have also designed a simple-to-print Wades extruder body. It is printed in 3 slices and glued together to avoid overhangs. I will post all these shortly.
Here the Mendel has just completed its first calibration cube!

Here is an overall picture, on my messy workbench.

It has now printed a child. Will print a grandchild soon, I just have to get more electronics.

GO FORTH AND MULTIPLY.....