

Laser Project

Solder Fume Extractor

Prepared for Bainbridge BARN, ETA Studio - bainbridgebarn.org



Overview

In this project, you will make a benchtop solder fume extractor. This fume extractor features adjustable tilt, a high-output LED work-light and replaceable carbon filter. You'll cut out the parts for the base and housing on the laser, assemble the wiring, print some 3D parts, then glue and screw it all together.

Material required

- 2 sheets 300 x 500 3.2mm thick MDF or Plywood
- Laser fume extractor parts kit from ETA (detailed materials list at the end of this doc)
- White glue
- Epoxy or hot melt glue

Difficulty level

This project difficulty level is: MEDIUM, based on the complexity of the assembly and the need to do some soldering and 3D printing. But it is not HARD. You'll get a chance to practice the laser skills, 3D printer skills and soldering skills. The instructions assume you have beginner level skills in these areas.

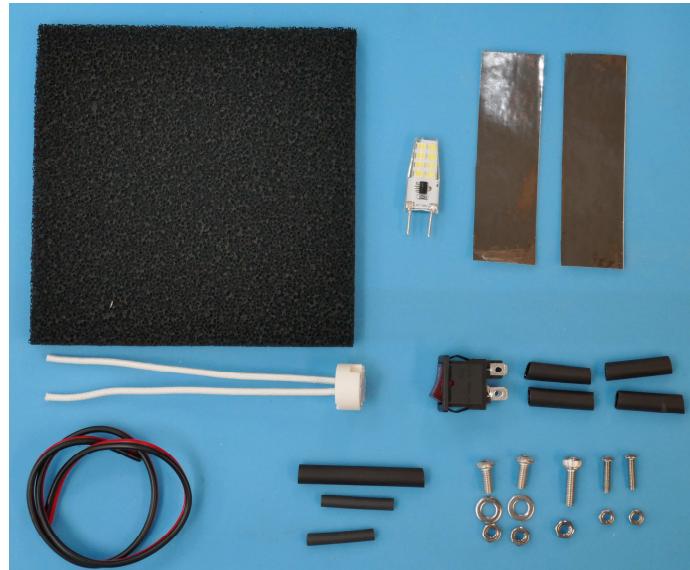
Safety First

1. Always follow the safety procedures you learned in the laser class.
2. Steps for using the laser are posted. Follow them.
3. We were all beginners once. If you have a question, ask a monitor for help.
4. Never try to run the laser with the lid open.

PARTS

What's in the parts bag:

QTY	DESCRIPTION
1	120V DPDT panel mount switch
1	G8 bulb socket
1	G8 LED bulb
1.5	18ga 2 conductor zip-cord
2	3/16" shrink tube, 25mm
4	1/4" shrink tube, 25mm
1	1/4" shrink tube, 50mm
2	M4 x 10 Button head screw
2	M4 washer
3	M4 nut
1	M4 x 12 cap head screw
2	M3 x 12 button head screw
2	M3 hex nut
1	3/8" thick carbon filter
160	Mylar reflector bird tape
160	two sided tape



What's in the fan box:

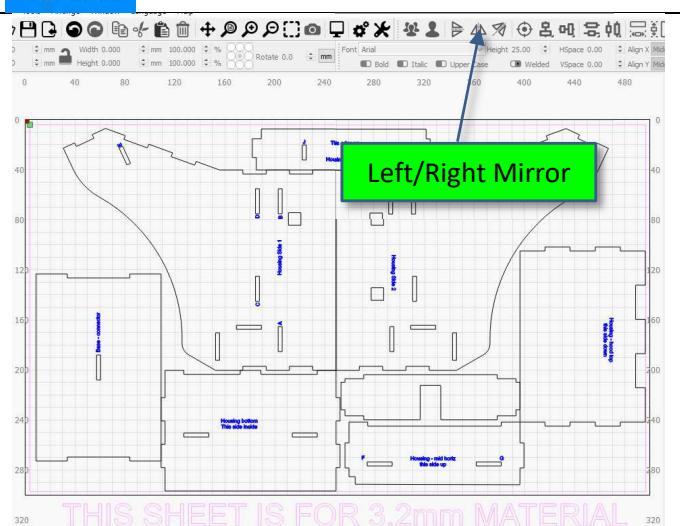
QTY	DESCRIPTION
1	120mm muffin fan, 120v
1	Power cord
2	Finger guard
4	M3 x 60mm screw
4	M3 Nut

OK, Let's get started...

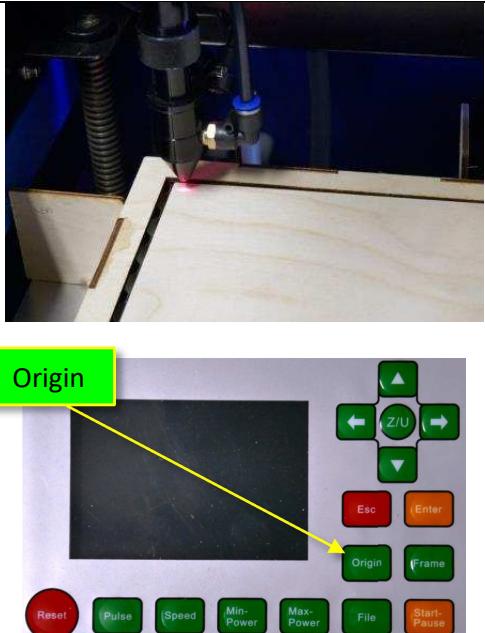
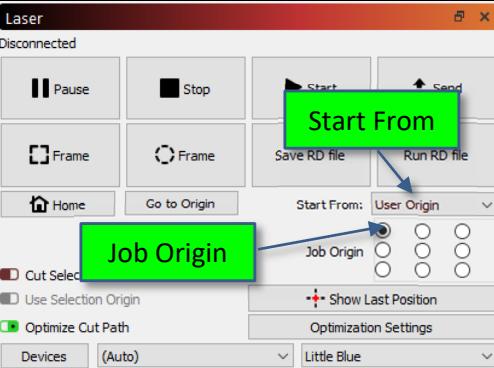
TASK 1 - Get prepared

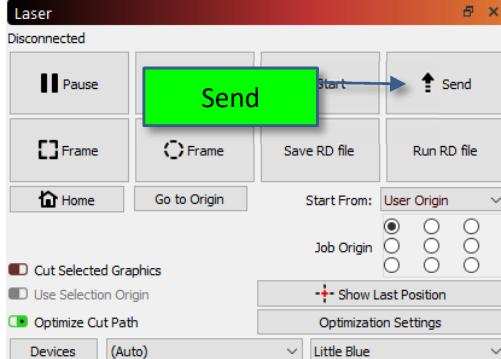
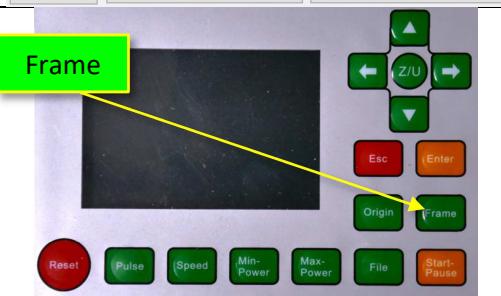
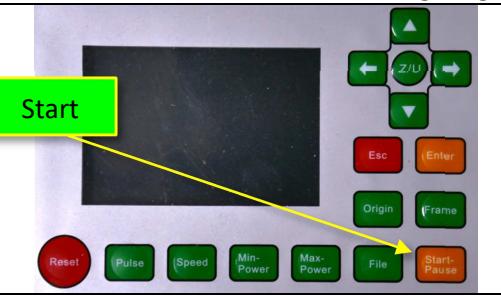
1	Get two pieces of material that are 300mm x 500mm and 3.2mm (1/8") thick. These can be purchased from the ETA studio material stock cupboard. MDF is recommended, but plywood will also work.	Ask the studio monitor for assistance purchasing the material.
2	Verify your material thickness using calipers. They are located in the toolbox, usually the bottom drawer.	If the material is thicker than 3.2mm, you may be filing some holes a little larger to fit the tabs in. If it's 3.0mm, you should be fine.
3	Get the zip file for this project . The files are located on all of the workstations in a desktop folder called "ETA-PROJECTS", and the zip file is called "solder fume extractor V1.zip"	
4	The files in the zip archive are: Laser fume extractor instructions.pdf Sheet 1 – 300 x 500.lbrn Sheet 1 – 300 x 500.lbrn STL files (directory) knob.stl Nut keeper for knob.stl Nut keeper for pivot – need 2.stl strain relief.stl switch mount.stl	

TASK 2 - Cutting and Engraving the first sheet

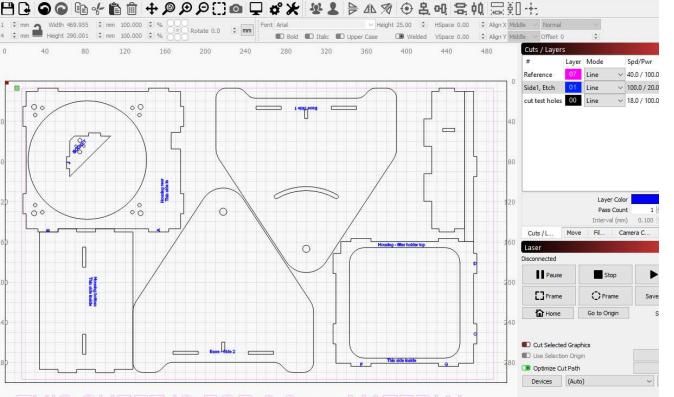
1	Pick a Laser to use. Either Little Blue or Big Red can be used. These instructions were made using Little Blue	
2	Log into the computer (password is "maker") and start LightBurn by selecting its desktop icon.	
3	Open the first file - "Sheet 1 – 300 x 500.lbrn". If you are cutting on Little Blue, it should look like the picture on the right. On Big Red, the design will be mirrored. – don't worry, it's easy to fix, you just select everything in the drawing then select the right/left mirror button. (This is a fact of life we have to face with Little Blue and Big Red. One is right-handed and the other left handed. Sometimes the image needs to be switched.)	

	<p>4 Check that the cutting parameters for etching and cutting are what you want. As with all laser cuts, it's best to make a few small test cuts on your material to verify that the through cuts make it all the way through the material and the etching is not too dark or too light.</p> <p>This design was made with three layers:</p> <p>Reference - This layer is for things that are not cut or etched. A place for notes about the design.</p> <p>Etch – Most parts have their name on them (where they will not show after assembled) and also some labeled slots or tabs to help in assembly. You can choose to turn off output for this layer if you want.</p> <p>cut through – The lines to cut out the parts.</p>	
5	<p>Check optimization settings.</p> <p>In LightBurn's Laser window:</p> <ol style="list-style-type: none"> check that the Optimize Cut Path switch is on (green), then select the Optimization Settings button. <p>Check that the following switches are both on (green).</p> <ol style="list-style-type: none"> Cut inner shapes first – This will cut the holes in the center of each part before the outline is cut. Remove overlapping lines – The tells the laser to not cut lines twice where two parts are positioned so that they share an edge. 	
6	Follow the posted studio procedure for turning on the laser, checking the chiller and air pump, and turning on the ventilation fans.	See the studio monitor if you want a quick refresher on the procedure.

<p>7 Put your material in the laser, move the nozzle to the middle of the material using the control panel buttons, and "Focus" the laser. This really means raising or lowering the bed so that the laser is the right distance from the laser nozzle.</p> <p>On Little Blue, place the "focusing billet" (two sheets of 3.2mm material stacked together) on top of your material and under the laser nozzle. Look for the knob on the front-right inside the laser. Twist it to raise and lower the bed. Adjust it until the nozzle is just about touching the focusing billet. You'll hear the sound of the air exiting the nozzle change as you get to the right place. Remove the focusing billet.</p> <p>On Big Red, see the studio monitor for assistance focusing on your material.</p>	 <p><i>Focusing should always be done before positioning the laser's origin.</i></p>
<p>8 Use the front panel controls to move the red-dot to the back-left corner of the material, about a few mm from the corner.</p> <p><i>If it looks like the red dot is not under the laser nozzle, it might have been bumped and moved. Ask the monitor for assistance repositioning it. The red-dot is just an indicator, not the cutting laser (which is not visible to the human eye).</i></p> <p>On the laser's control panel, press the "Origin button". This tell the laser to remember this position as the place to start when cutting"</p>	
<p>9 Look on the right side of the LightBurn window to find the "Laser Window". Check that the "Start From" is set to "User Origin", and that the Job Origin is set to the upper left corner.</p> <p>Start from: User origin tells the laser to align the job from the origin you just set on the laser's control panel.</p> <p>Job Origin Tells the laser which part of your design should be lined up with the origin set on the laser. The little green square on lightburn is what will be located at the laser's origin.</p>	

	<p>10 Select the Send button in LightBurn's Laser window to copy your file to the laser.</p> <p><i>This allows you to do the rest of the work from the laser itself.</i></p>	
11	<p>Find the "Frame" button on the laser control panel and press it. Watch the red dot travel around the outside of the planned cuts. If the red dot goes off the edge of the material, you need to adjust the position of the material in the laser and hit frame again. Repeat until the red dot stays on the material.</p>	 <p>If you didn't get your user origin set properly, the laser may "go somewhere" other than your origin before following the frame path. If this happens, you may need to reposition the laser and set the user origin again.</p>
12	<p>Close the door of the laser and select on the "Start" button on the Laser's control panel. The laser will etch your parts and then cut them out.</p>	
13	<p>Open the laser and take out all your parts and toss the waste in a garbage can.</p>	

TASK 3 - Cutting and engraving the second sheet

1	<p>Open the "Sheet2 300 x 500.lbrn" file. It should look like the image on the right. Again, you might need to mirror the image if you are cutting on Big Red. See Task 2, Step 3 if you need a refresher.</p>	
2	<p>Follow the same steps you did for the first sheet (Task 2), and you'll have all your laser cut parts.</p>	

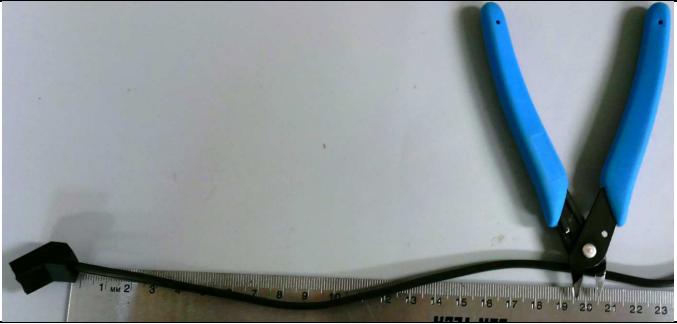
TASK 4 – 3D print the printed parts

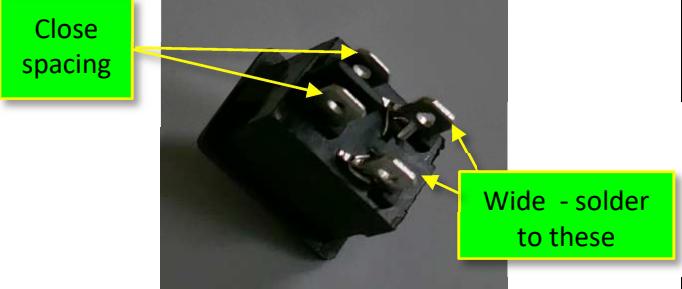
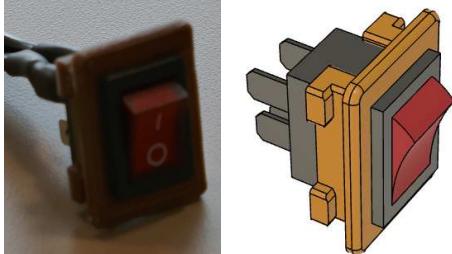
This project uses several 3D printed parts that you'll need to make. The recommended material is PLA, but other materials should also work. The parts are listed below. Slicing details for these parts are left to you. There is a directory with .3MF files that you can use as a reference for slicer settings, but be sure to use settings that are work for the printer you are using.

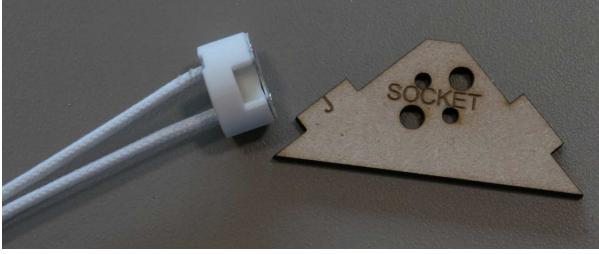
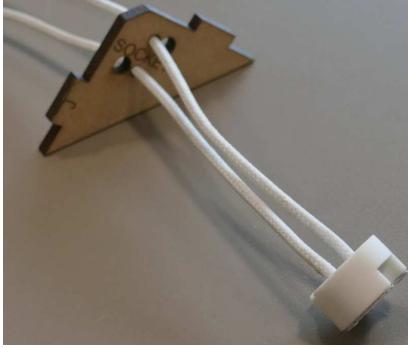
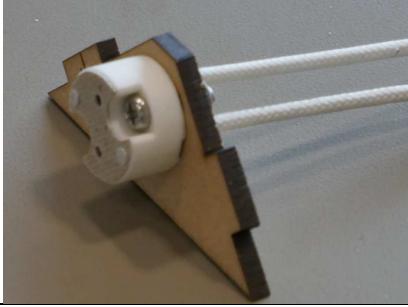
Part file name	Quantity needed	Where it's used
knob.stl	1	This is the knob that's used to hold the desired tilt of the housing.
Nut keeper for knob.stl	1	This part holds the nut that the knob will screw into to hold the desired tilt of the fume extractor.
Nut keeper for pivot – need 2.stl	2	These parts form the axle that the housing rotates on.
Strain relief.stl	1	This part holds the power cord so that if it get's tugged on it will not stress the solder joints on at the switch.
Switch mount.stl	1	This parts holds the switch securely to the front of the housing and make it so you can disassemble the witing if you even need to.

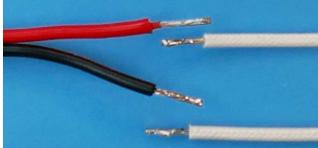
TASK 5 - Assemble the wiring harness

In this task, you'll be assembling a "wiring harness" for the project. You'll be using several parts from the parts kit and also the power cord that is in the box with the fan. Follow all the steps carefully, and be sure to make good solder joints. Also be sure to use the insulated shrink tubing to keep your joints safe.

1	Cut the main power cord. The boxed fan in the kit includes a power cord. We'll be cutting this into two pieces and using both ends. Cut the cord 175mm-200mm from the end that goes into the fan.	
2	Assemble the LED and fan wiring together. <ol style="list-style-type: none">1. Split the cut end of cord connected to the fan connector (you just cut it in the last step) about 35mm back from the end.2. Strip 8mm – 10mm of the insulation from both wires. There are wire strippers in the toolbox.3. Get the red/black zip-cord. Verify that it measures approximately 380mm in length, then split and strip the wires at one end like you did the fan cord.4. Using your fingers, twist the conductor of the red wire with one of the conductors on the fan cord. It does not matter which one you pick.5. Twist the other conductors together in the same way.6. Use the soldering iron to solder each of	

	these pairs of wire together.	
3.	<p>Assemble the wires to the switch. The back of the switch has four connection lugs. Two are widely spaced and two are closely spaced. You'll be soldering your wires to the widely spaced lugs.</p> <p>Follow these steps:</p> <ol style="list-style-type: none"> 1. Prepare the lugs on the switch by applying some solder to the outer side of each one. You can do all for now, or just the two widely spaced ones. Be careful not to heat the lug too long or you might melt the insides of the switch. 2. Get two 25mm long pieces of $\frac{1}{4}$" shrink tubing (the fatter of the two tubes is $\frac{1}{4}$"). 3. Slide one piece of shrink tubing over each of the wire pairs you soldered together in the last step. 4. Keeping the shrink tubing back from the end. Solder one wire pair to each of the widely spaced connection lugs. After soldering, your switch should look like the picture to the right. Note the two pieces of shrink tubing. 5. After the solder joints have cooled, slide the shrink tubing down over the ends of the wires and the lugs on the switch. Your goal is to have no exposed metal. 6. Use the studio heat gun to gently heat the shrink tubing until it shrinks snugly around the lugs and wires. Again, be careful not to melt anything. <p>DO NOT connect anything to the other lugs on the switch yet.</p>	 
4	<p>Put the switch into the switch mount plate. If you didn't print the switch mount yet, you need to do it now or you'll end up unsoldering things to get it on.</p> <p>Poke the loose ends of the wires you just soldered to the switch through the switch mount plate, and snap the switch into the plate. The fuzzy picture at the right is attempting to show this. The picture from the CAD design model is clearer.</p>	
5	Now we'll solder the power cord to the switch. Following the same procedure we used in step 3.	

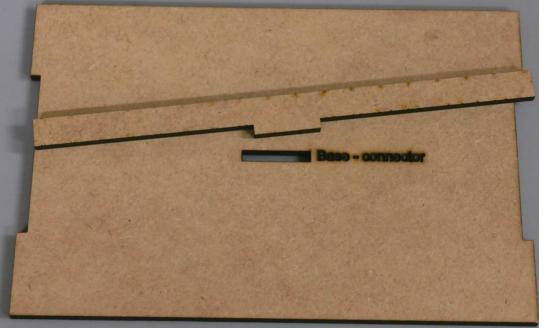
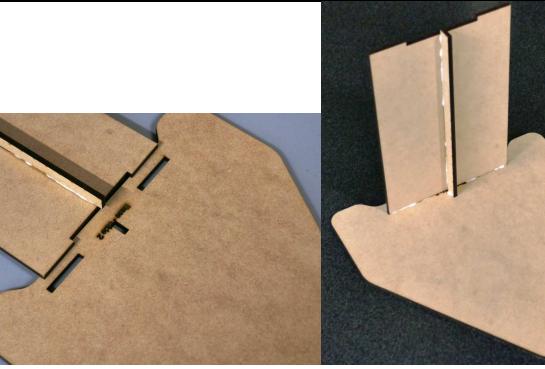
	<p>Get the other piece of the fan power cord (with the wall-plug on it). Separate the two sides of the wire and strip the ends like you did in the last step. Then slide a 25mm piece of $\frac{1}{4}$" shrink tube on each wire and solder one wire to each of the remaining lugs on the switch. Slide the shrink tube over the joints and shrink it like you did the others in Step 3.</p>	
6	<p>Prep the LED Socket. Get the triangular MDF piece that says "SOCKET" on one side and the ceramic bulb socket.</p> <p>The wires from the socket need to be threaded through the two smaller holes in the MDF piece, starting from the side that says SOCKET.</p>	 
7	<p>When socket is pushed up against the MDF, the two holes in the socket will align with the larger holes in the MDF. Get the two M3 x 12mm screws and two M3 nuts and use them to attach the socket to the MDF.</p>	
8	<p>The socket wires will be soldered to the loose ends of the red/black zip cord. Follow these steps.</p> <ol style="list-style-type: none"> Slide the 50mm piece of $\frac{1}{4}$" shrink tube onto the red/black zip cord and push it far down by the switch to keep it out of the way for now. Get the two pieces of $\frac{3}{16}$" shrink tube from the parts kit. Slide one onto each wire of the socket and push them down out of the way. Split the zip cord about 50mm back from the end. Strip about 8mm of insulation from both of the zip cord wires and also the ends of 	 <p>Strip ends and slide on shrink tubing</p>

	<p>the socket wires.</p> <p>5. Tin each of the 4 wire ends with solder.</p> <p>6. Carefully solder one of the socket wires to one of the zip cord wires to make a continuous wire. Take your time and get a good solder joint. Do the same for the other socket and zip cord wire.</p> <p>7. Inspect the joints for any stray wires or little points of solder sticking out and clean them up.</p>	 <p>Tin the ends of the wires with solder</p>  <p>Solder the wires</p>
9	<p>Slide the 3/16" shrink tubes to cover the two solder joints you just made and use the heat gun to shrink the tube in place, fully covering the joints.</p>	 <p>Slide the 3/16" shrink tube over the solder joints</p>  <p>Shrink it with the heat gun</p> <p>Slide the 1/4" shrink tube over both joints</p>
10	<p>Slide the 1/4" shrink tube over the two joints. The fit may be tight so be sure the previous shrink tubing is cool and expect to work it a bit to get it on. Use the heat gun to shrink it in place. You now have double insulation on these joints.</p>	 <p>Slide the 1/4" to cover the other shrink tubing</p>  <p>Shrink it</p>

11	<p>Your completed wiring assembly should look like the picture on the right.</p>	
12	<p>Verify your assembly. I think this is good to do in four steps.</p> <p>First, use an electrical meter to check that there is no connection between the two prongs on the plug. Do this with the switch in both positions. If there is continuity, something is wrong and must be resolved before moving on. You'll need to inspect each solder joint for errors and make sure you didn't connect to the switch incorrectly.</p> <p>Second - and only after verifying no continuity between the prongs on the cord – plug the cord in. There should be no sparks, loud bangs, or other fireworks. Do this with the switch in both the on and off positions. Only handle the switch when the cord is unplugged, in case there is any exposed metal.</p> <p>Third – plug the bulb into its socket, switch the switch to the on position and plug in the cord. The LED should turn on.</p> <p>Fourth - using the screws and nuts that came in the fan box, secure the finger guards to the fan, then (with the AC cord unplugged) plug in the fan connector into the fan. Make sure the switch is on and plug in the AC cord. The fan should spin and the light should be on. Unplug the AC, turn off the switch and plug the AC back in. The light and fan should both be off.</p>	

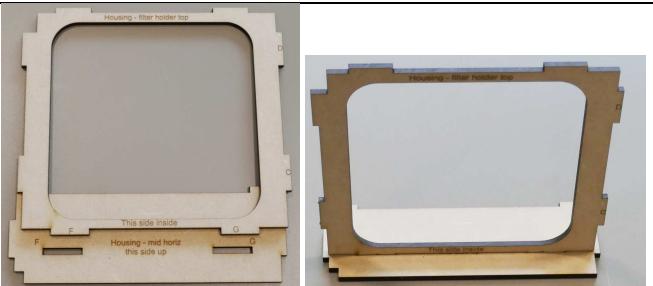
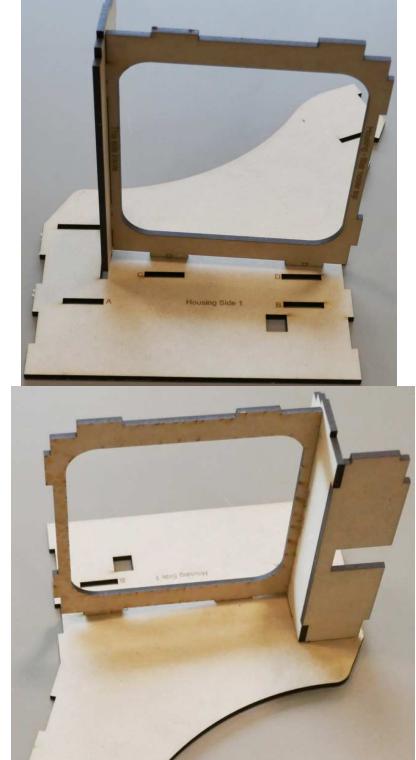
TASK 4 - Assemble the Base

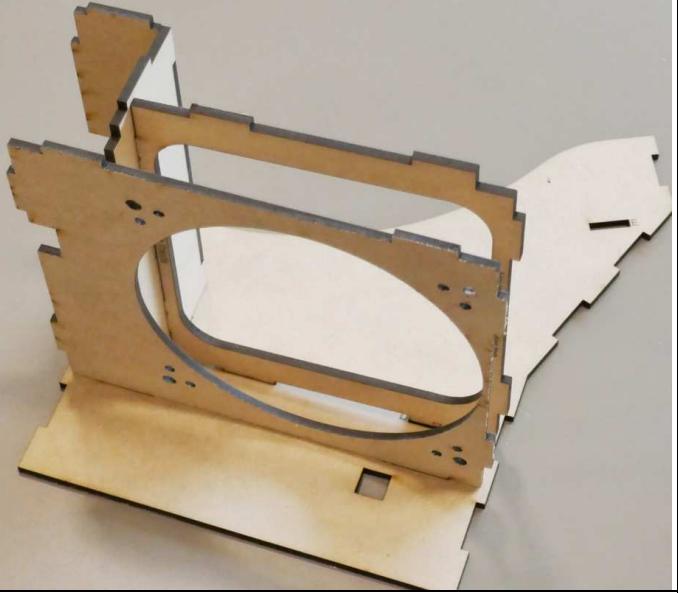
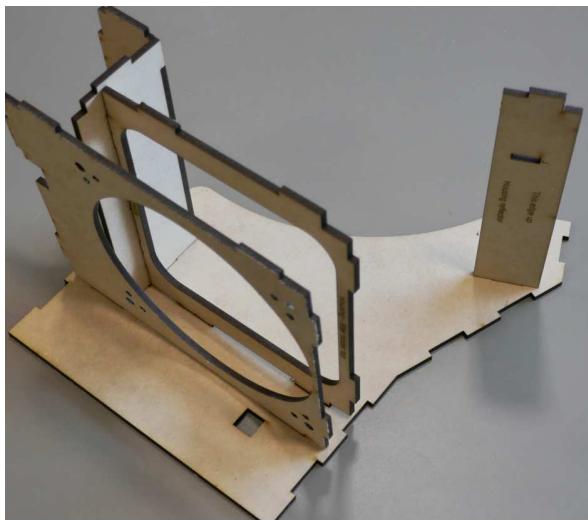
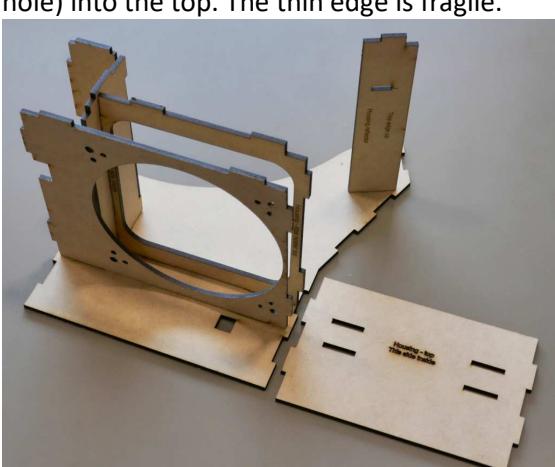
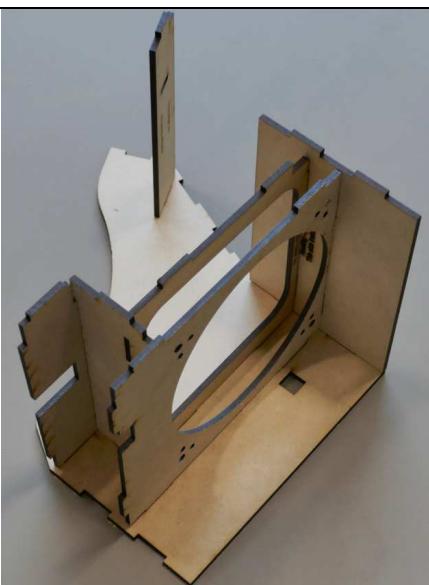
The base is quick and easy to assemble it's a good way to get a feel for whether you'll want to do any trimming on the holes to adjust the tightness of the fit.

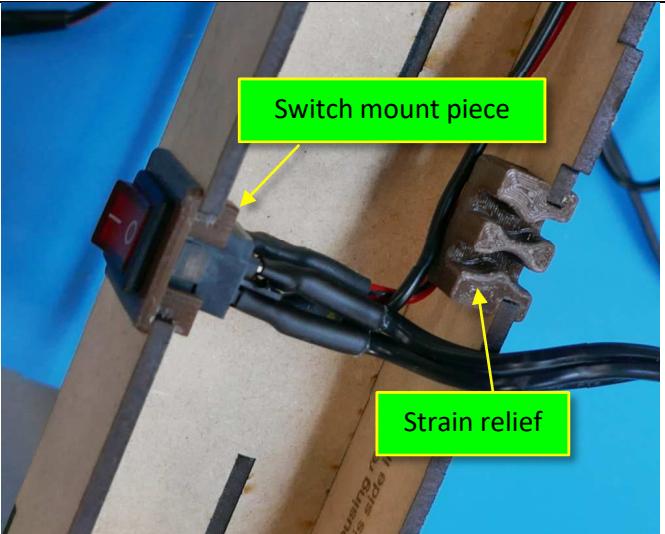
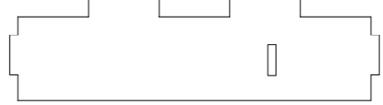
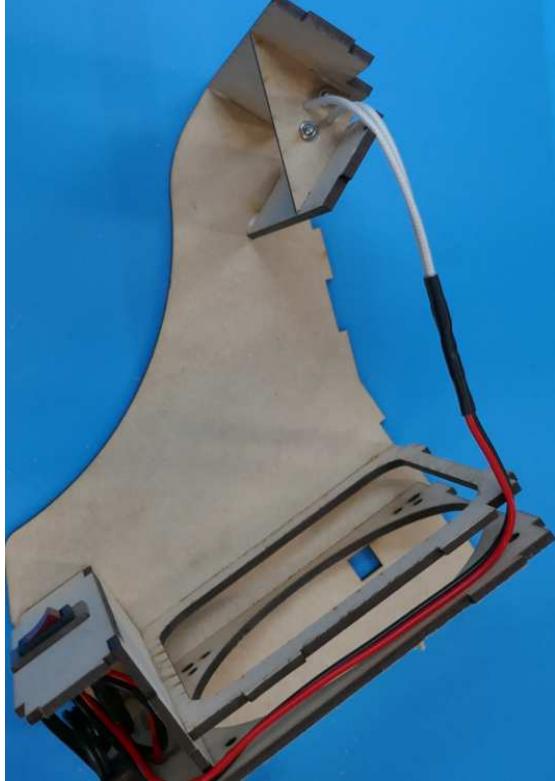
1	Put the air deflector on the crosspiece.	 A photograph of a rectangular piece of brown cardboard with a horizontal slot near the top edge. A small black tab with a hole is inserted into the slot. A label at the bottom right of the image reads "Base - connector".
2	Glue the connector to one side of the base. I used Side 2 for this picture, but either side can be used. The words on the base sides should end up under the glue.	 Two photographs showing the assembly of the base. The top photo shows a hand applying glue to the side of the base. The bottom photo shows the base fully attached to a side panel, with the "Base - connector" label visible on the side panel.
3	Glue on the other side. Again, put the side with words on it inside the glueline to keep the outside looking pretty. Align the sides to they are parallel and put the base aside for the glue to dry.	

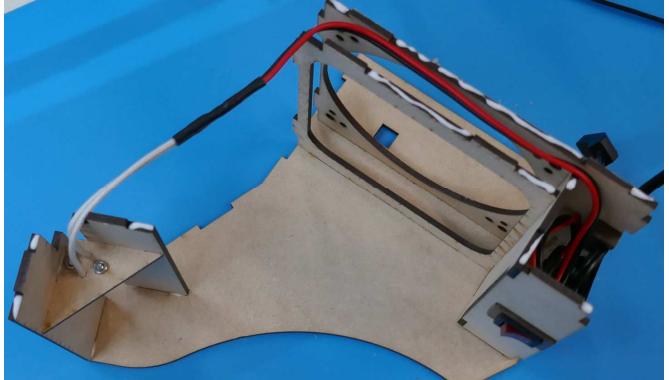
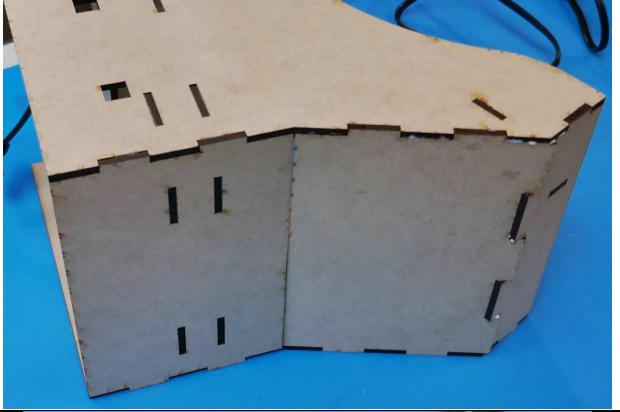
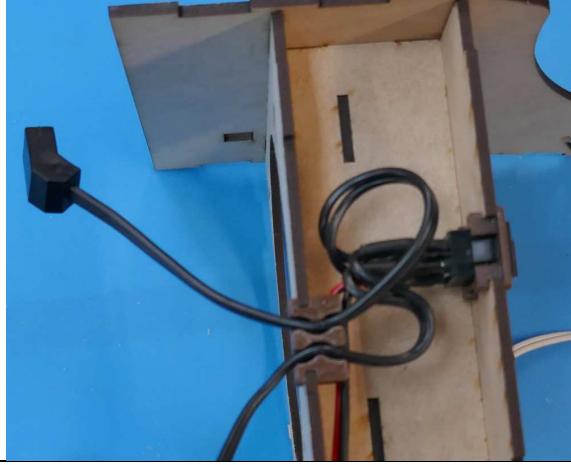
TASK 5 - Assemble the Fan housing

This is where most of the assembly challenge is in this project. Plan to spend 30-45 minutes getting this all glued together and it's best to assemble it all in one session so that everything will end up nice and square in the end. There are a lot of tabs to line up at the same time, so be prepared to take some time and maybe trim a few tabs so they will slide into their slots more easily. Most of the parts are symmetric, but some are not and for these it's important to get them oriented the correct way. The labeling on the parts, the letters on the slots and tabs, and the pictures should all help to make the parts go together without too much fuss. If you do break any parts during assembly, don't sweat it, just cut another one out on the laser.

1	<p>Get the parts labeled "Housing –filter holder top" and "Housing –mid horiz". Line up tab/slots F and G, tthn glue the parts together.</p>	
2	<p>Get the part labeled "Housing – side 1", and your previous assembly. <i>This is a time when it's important to use the correct part. Don't grab Side 2 by accident.</i></p> <p>Also the part called "housing-front". it looks like this:</p>  <p>Align slots/tabs C and D to see where the parts will fit into the side, then turn the whole thing around around.</p> <p>Apply glue the Housing-front, and the bottom edges of the assembly where they will touch the side. Slide all the tabs into their slots and press the pieces tightly together. There should not be any gaps between the side and the other parts.</p>	

<p>3 Get the piece labelled "housing – rear" align tabs/slots A and B, and glue into Side 1. <i>Be sure to orient this part with the labeling facing the other parts or you'll have problems with the wiring.</i> You can apply glue between this part and the other parts already assembled , but it's not necessary for a strong finished assembly.</p>	
<p>4 Get the part labeled "Housing – reflector", align tab and slot E, and glue the part in. Be sure to get this assembled as shown in the picture, with Slot J at the top of the part and the words facing you.</p> 	 <p style="text-align: center;">Assembled</p>
<p>5 Glue in the "housing – top" piece. This part is labeled and should be installed with the words facing in (just for prettiness). Be careful hen pressing the tab on the rear piece (giant round hole) into the top. The thin edge is fragile.</p> 	 <p style="text-align: center;">Assembled</p>

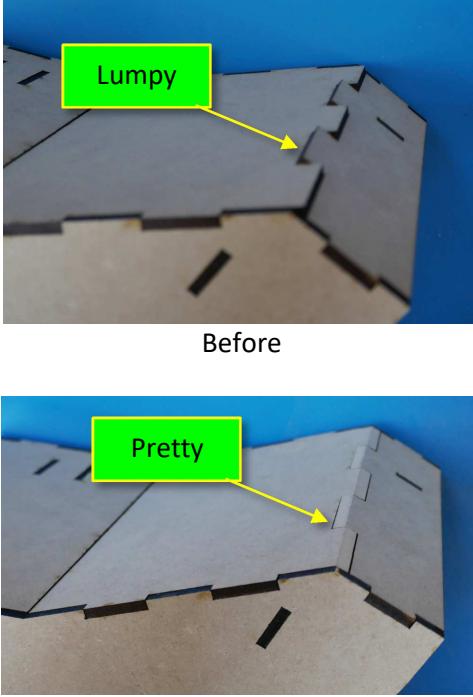
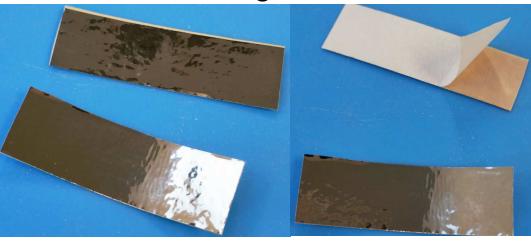
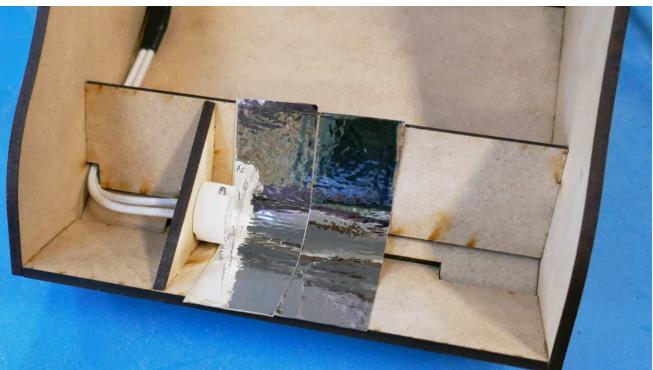
<p>6</p> <p>At this point, the assembly should be mostly stable, but will still be a bit wobbly. It's time to add the wiring harness and some plastic parts. <i>When you assemble these plastic parts to the MDF, you might need to trim either the plastic or the MDF to get them to slide together easily. They are designed for a snug fit, but printer variations or artifacts can affect the fit.</i></p> <p>The plastic part you printed and snapped the switch into should slide nicely into the rectangular opening in the housing-front, as shown in the picture at right. <i>Best to orient it so the "O" on the switch is at the end where the opening in the MDF is. This will make the on/off orientation more logical in the final product.</i></p> <p>At this point, also slide in the 3D printed "strain relief" in the opening kind of opposite the switch hole. If the fit is so loose, the part falls out, save installing it for later.</p>	 <p>A close-up photograph of the assembly. A red push-button switch is mounted on a blue MDF board. A black cable with red and black wires is connected to the switch. A grey plastic part, labeled 'Switch mount piece' with a yellow arrow and green box, is inserted into a rectangular opening in the MDF. Another grey plastic part, labeled 'Strain relief' with a yellow arrow and green box, is inserted into an adjacent opening. The background shows a blue surface and some other components.</p>
<p>7</p> <p>Get the piece called "housing – hood front". It looks like this:</p>  <p>Put it aside, but be ready to grab it.</p> <p>Align tab J of the triangular piece of MDF you screwed to the LED socket, with slot J on the housing reflector you already glued to side 1, and press them together . You don't need glue on this joint.</p> <p>Align the slot on the hood front piece with the other tab on the LED socket MDF and press it in. Again, no glue needed.</p> <p>Now, glue the bottom edge of the hood front to side 1, and route the wires as shown in the picture at right.</p> <p>This is now your assembly at its wobbliest, and you're about to end that.</p>	 <p>A photograph of the assembly from a different angle. The blue MDF board with the switch and strain relief is visible. A large, light-colored triangular piece of material, identified as the 'hood front', is attached to the bottom of the MDF. Wires are visible, some red and some black, being routed through the assembly. The background is blue.</p>

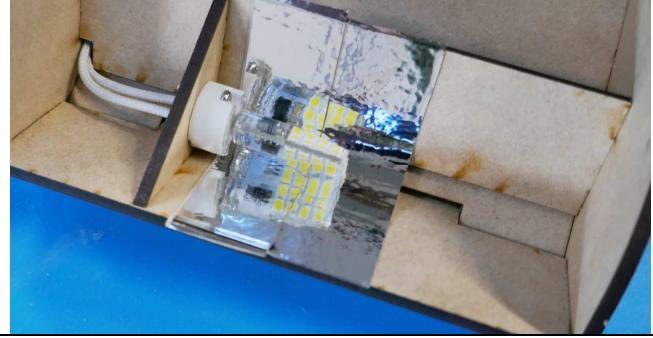
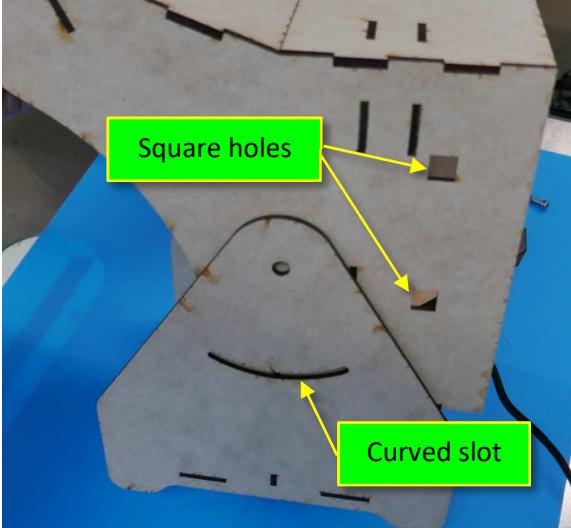
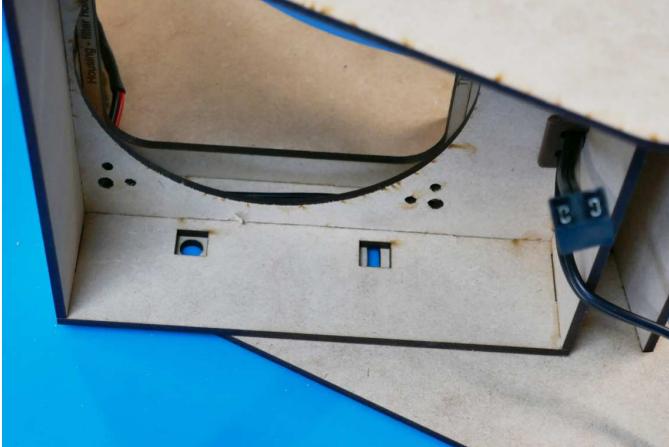
8	<p>Get Side 2.</p> <p>Before adding glue, practice fitting it to all the tables and slots in the other pieces. <i>I found that it really helped to chamfer the leading edges of all the tabs to help them slide together. If all of your other tab/slot connections were really tight, You'll probably want to do this too.</i></p> <p><i>Also, watch out for the red/black zipcord getting pinched and preventing the parts from coming together.</i></p> <p>Once you've worked out how to get all those tabs and slots aligned, apply glue as shown in the picture at right and put on Side 2.</p>	 <p>For this picture, I did not have the top glued on yet. (10 points to Gryffindor if you noticed this)</p>
9	Get the housing –top piece and glue it in as shown.	
10	Before gluing on the bottom, the two power cords need to be pushed into the strain relief as shown in the picture. <i>It takes a little shoving because the fit is tight, but that's the point.</i>	

<p>11 Finally, get the bottom and glue it in as shown. The fit of the parts should be tight enough that they will hold once you press them tightly together. If there are any joints that are being obstinate, use clamps or some blue tape to hold them in place while the glue dries.</p> <p>Whew! That's the last of the nasty gluing. Take a break while the glue dries.</p>	
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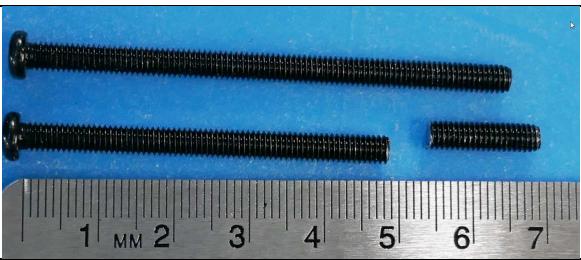
TASK 6 – Final Assembly

All of the tricky work is completed, so now all that needs to be done is to put the rest of this thing together.

<p>1 Optional prettifying step.</p> <p>Where the hood-top and hood-front come together, the fingers of the joints overlay in a "lumpy" way.</p> <p>I used a small hand plane to carefully remove the lumps to make this joint look better. You can do this too, if you want. You could also use a sharp chisel, a rasp, a file, or sandpaper.</p>	 <p>Before</p> <p>After</p>
<p>2 Get the two strips of reflector tape from the parts bag. Peel off the backing and apply to the Apply the reflector tape to the inside of the hood behind the light socket.</p> 	

3	Get the LED bulb from the bag and put it into the socket.	
4	Get the three plastic "nut keepers" that you printed, and three M4 nuts from the parts bag. Press a nut into the hex recess in each.	 <p>Pivot Knob keeper</p>
5	<p>Slide the glued (be sure the glue is dry) housing between the sides of the base. The fit should be snug. <i>Be sure to align the side of the housing that has two square holes with the side of the base that has the curved slot, unless you want to take it apart again.</i></p>  <p>Square holes Curved slot</p>	 <p>Slide the housing in until the upper square hole aligns with the sound hole in the base and the other square hole aligns with the slot.</p>

6	<p>Get 2 M4 x 10 button head screws and 2 M4 washers from the parts bag. Also grab the pivot nut keepers (the ones with the cylinder sticking out) you just put the nuts into.</p> <p>Put one pivot nut keeper into the square hole so that the round part fits into the hole in the base. Put an washer on the M4 screw and screw it into the nut from the outside of the base. Do the same on the other side with the other pivot, screw and washer.</p>	 
7	<p>Time to assemble the knob. Get the M4 x12 cap head screw from the parts bag and the knob you printed. Insert the screw into the knob and push it all the way in, making sure the threaded part exits straight from the bottom of the knob. Lock the screw in place with some epoxy or hot-melt glue. I prefer epoxy, but hot melt glue is less messy.</p>	 
8	<p>Get the knob nut keeper that you pressed the M4 nut into earlier. Out this in the bottom square hole in the housing (below the one pivot). Screw the knob into the nut from the outside of the base.</p>	

9	<p>Almost there. Just need to add the fan and finger guards. The first step is to slip one of the fan guards in through the square hole in the front of the housing. Be sure the little jogs in the legs go towards the back, as shown in the picture at right, or you'll have to take it out and flip it over. <i>Yes, it will fit without bending anything.</i></p> <p>It's important to put this guard in place because it keeps the filter from smooshing into the fan blades.</p>	
10	<p>The M3 screws that come with the fan are too long for this design, so they need to be cut down to 50mm.</p>	
11	<p>It's time to put in the fan, but it will be easier to connect the fan's power cord before putting in the screws. I found the connection to be a bit fussy and it's easier to finesse it when the fan isn't screwed in. There is no required orientation for the connector, but I liked mine aligned as shown in the picture (taken after the fan was screwed into position).</p>	
12	<p>Orient the fan as shown in the picture, with the power cord at the lower right side. Use the 4 screws you cut down to 50mm earlier. Each one goes through the fan grill, the fan, the rear MDF piece of the housing, the other fan grill, and finally one of the M3 nuts that came with the fan.</p> <p><i>Yes, it is possible to hold those nuts in place while getting the screws started. This is a little bit of a dexterity test, but as the next-to-last step, it will make finishing up that much more sweet. Be sure the threads were cleaned up from when you cut the screws to length. No reason to make it harder than it has to be.</i></p>	

- 13** Last step – Push the filter material in from the front, tucking the corners behind the filter holder.



That's it, you're all done. And ready for fun.