Thank you for purchasing a FilaWinder. You will find everything you need to build it, aside from the printed parts. Apart from a 3D printer, the tools you will need are:

2.5mm Hex Driver or Allen Wrench (ball point hex driver highly recommended)

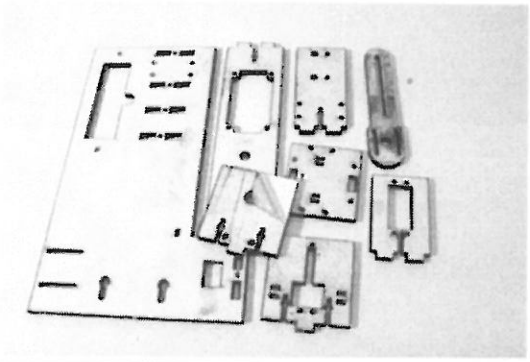
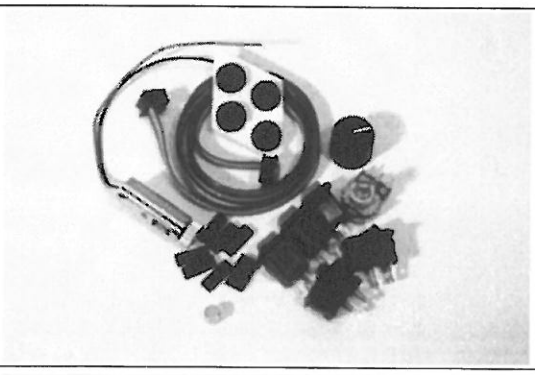
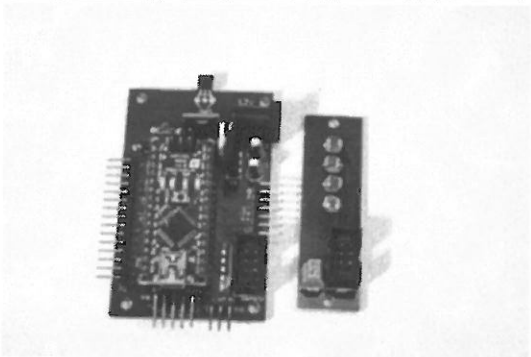
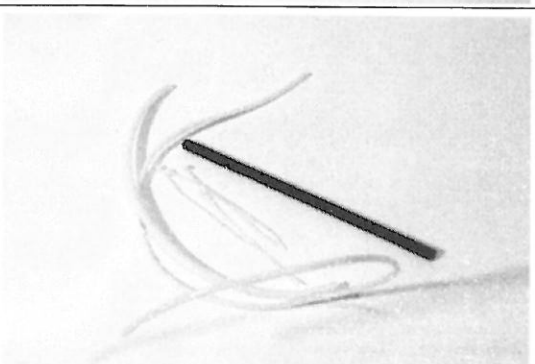
Tiny standard screwdriver such as an eyeglasses screwdriver (for the screws on the terminal block

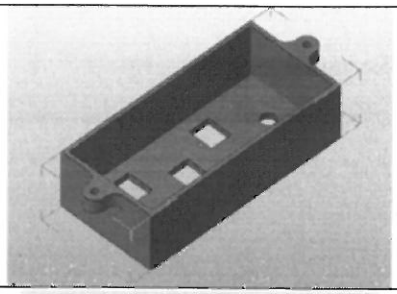
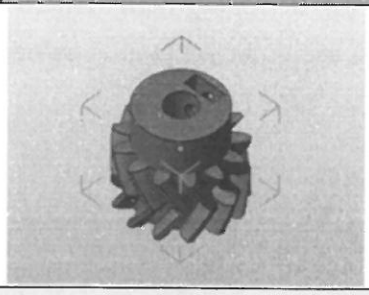
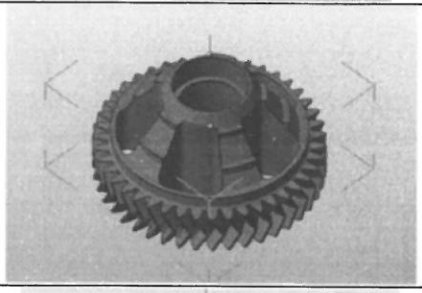
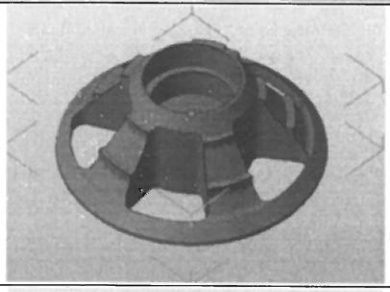
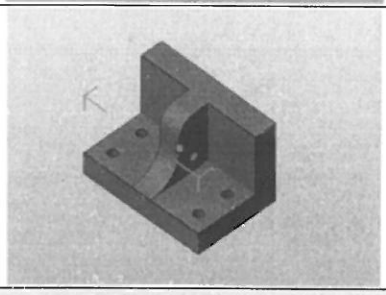
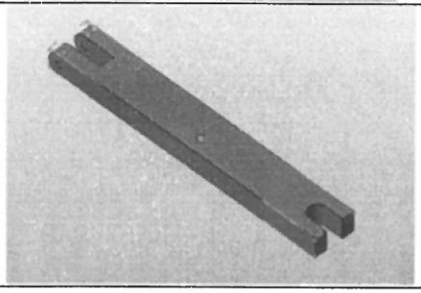
Small Phillips screwdriver

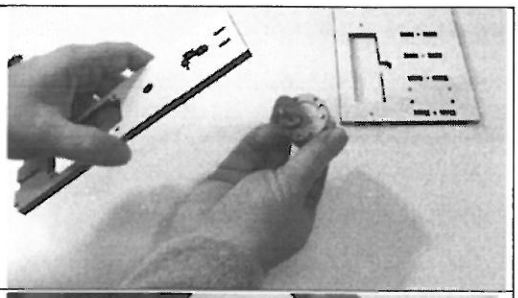
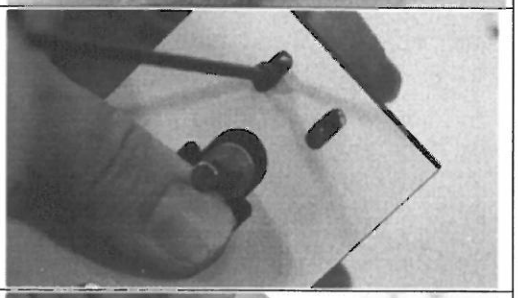
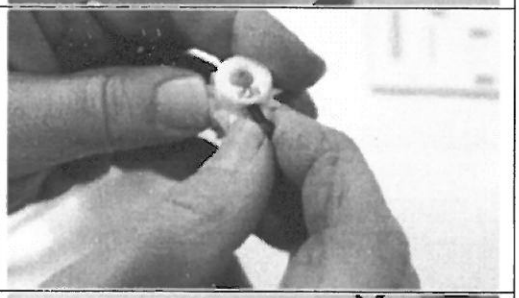
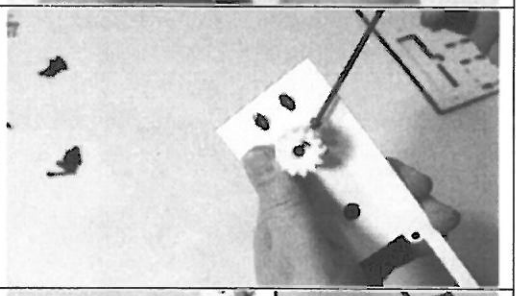
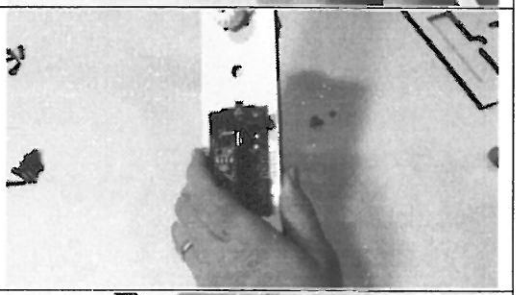
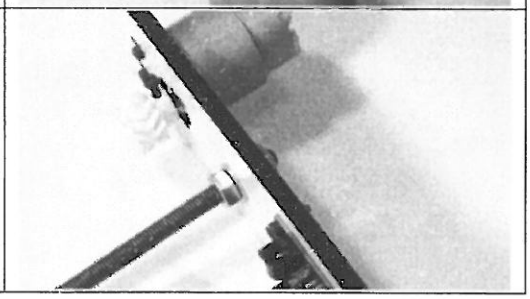
Wire cutter/stripper

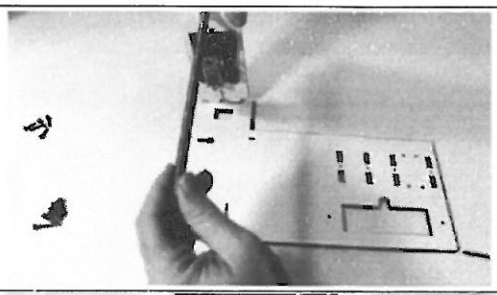
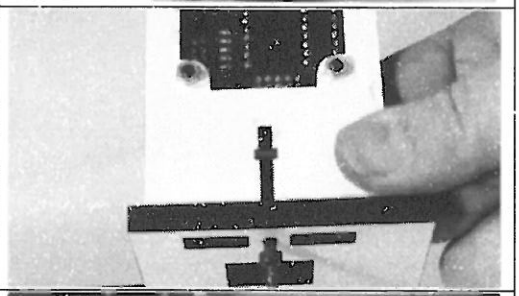
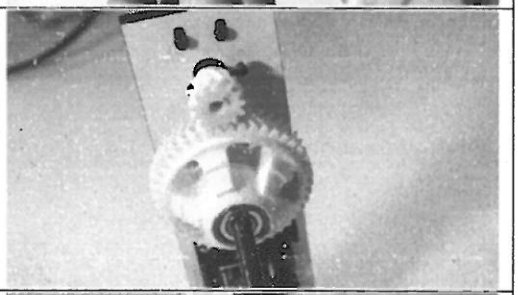
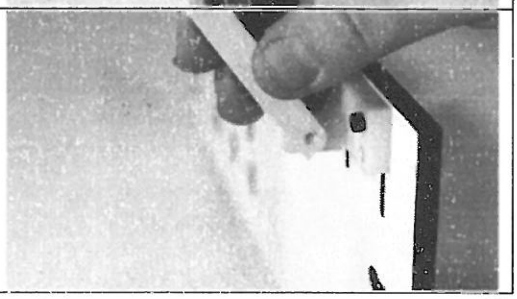
Soldering Iron/Solder- This is for attaching wires to the button, switch and motor terminals. You can do this without a soldering iron by twisting the wires on the terminals and holding them in place with heatshrink tubing, but soldering will provide the most reliable connection.

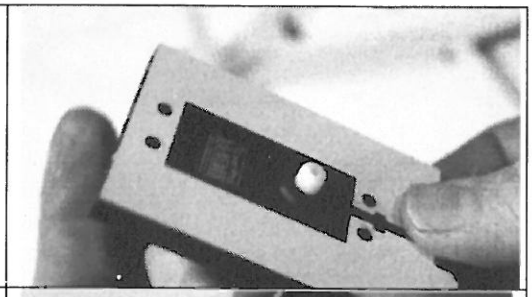
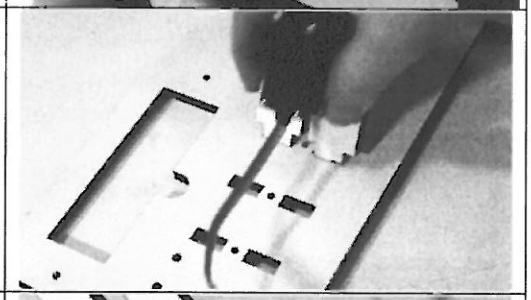
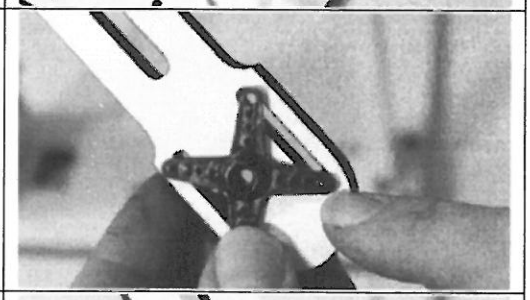
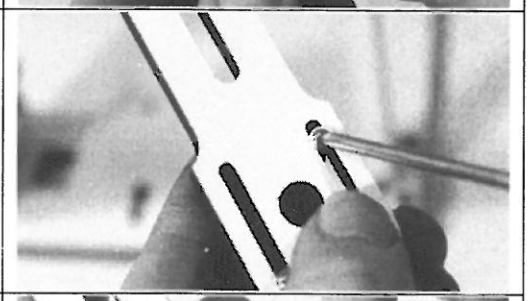
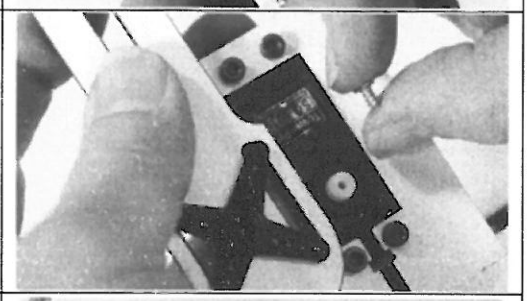
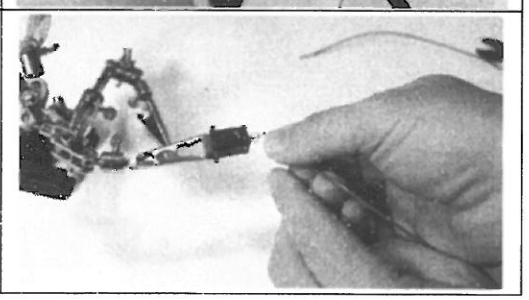
Videos are available at YouTube. Search for "FilaWinder". Links to the videos, pdfs, and STLs are available at www.soliforum.com in the Filastruder section. If you have questions, you can post in the Filastruder section at www.soliforum.com were you can get assistance from myself or the community, or you can email FilaWinder@gmail.com. If you need customer service, please use email.

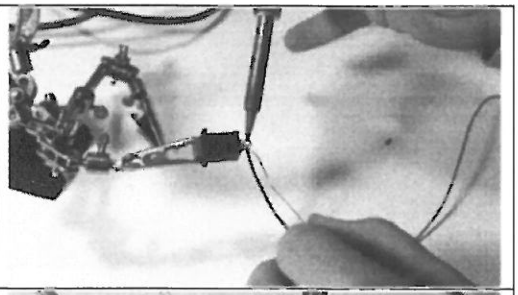
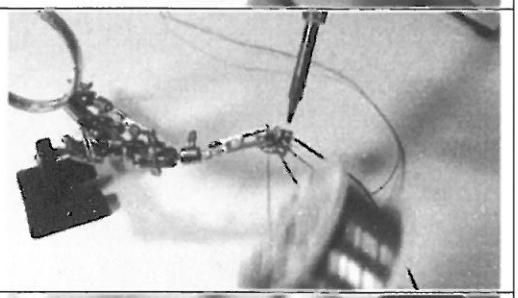
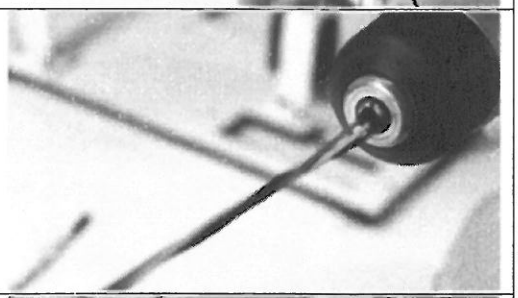
	
	
	
8 Piece Laser Cut Set 2 Packs of wires 1 Servo 1 Gear Motor 1 Power Supply 1 Control Board 1 Sensor Board 1 Laser 1 Ribbon Cable 3 Buttons 2 Switches 1 Potentiometer 6 1x2 Jumper Wires 1 1x3 Jumper Wire 1 Knob	3 Bearings 3 M3x10 Screws 10 M3x12 Screws 6 M3x16 Screws 8 M3x25 Screws 17 M3 Hex Nuts 7 M3 Square Nuts 3 M8 Nuts 2 M8 Washers 1 4mm PTFE Tube 1 6mm PTFE Tube 1 Threaded Rod 1 Magnet 4 Foam Adhesive Bumpers 4 Rubber Adhesive Bumpers

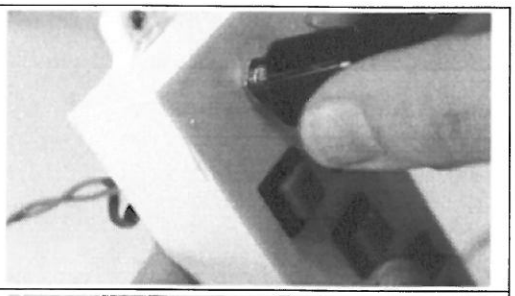
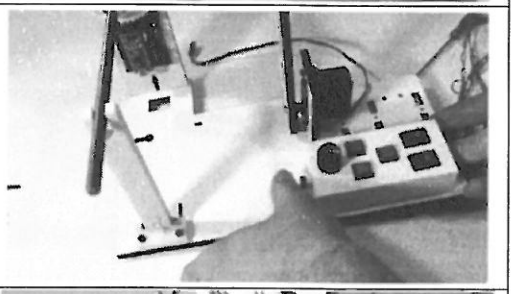
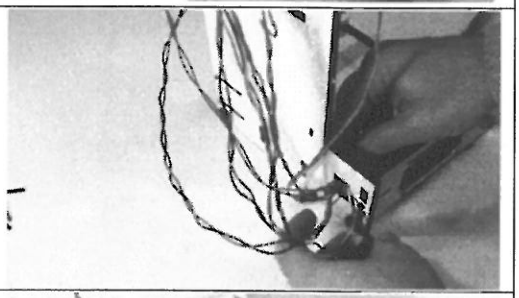
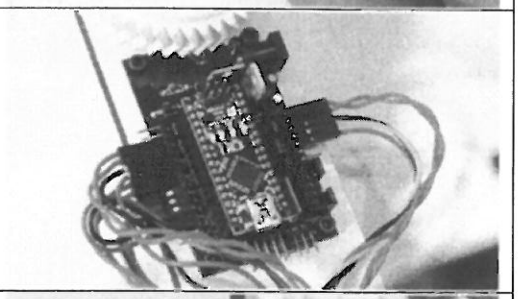
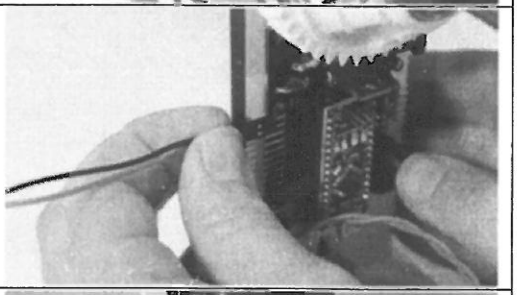
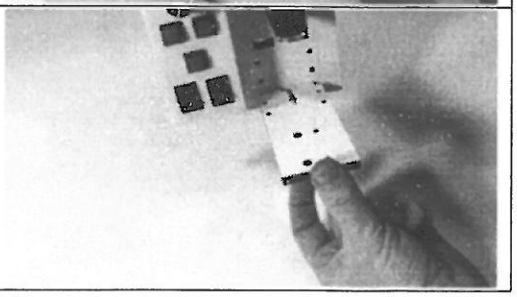
Print the control box face down. Support will be needed for the mounting tabs. The walls are thin enough that the perimeters should cause it to print solid.	
It's best to print the Drive Gear along with other objects so the small layers have time to cool.	
Depending on the printer, it might be a good idea to keep the speed down on the Spool Gear so there is no overshoot when printing the teeth of the gear. There is a single layer face across the middle, which is there to make it possible to print an overhanging ridge. Trim it out with a hobby knife.	
The Spool Hub also has a single layer face in the middle, which should be trimmed out.	
The Support Base should be printed solid. The holes might need to drilled with a 3mm bit, depending on the printer and its calibration.	
The Support Bar doesn't need to be solid, but should have a minimum of 4 perimeters.	

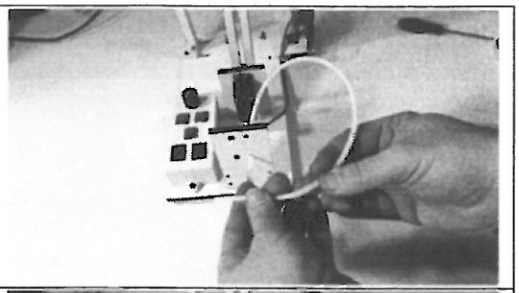
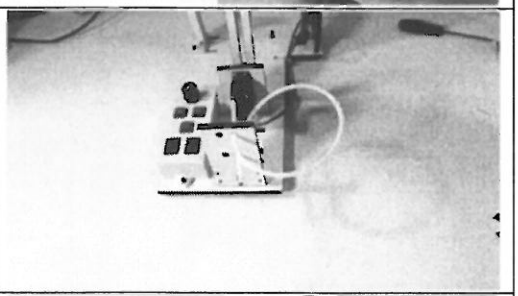
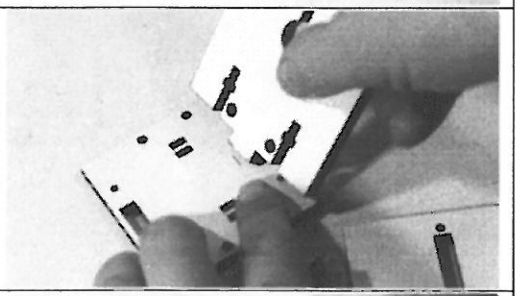
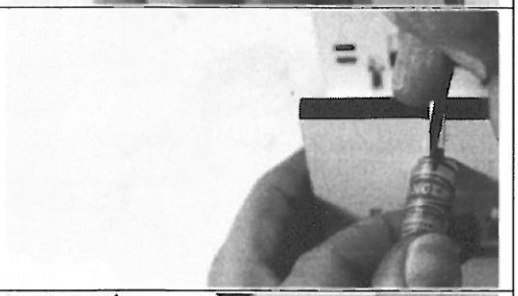
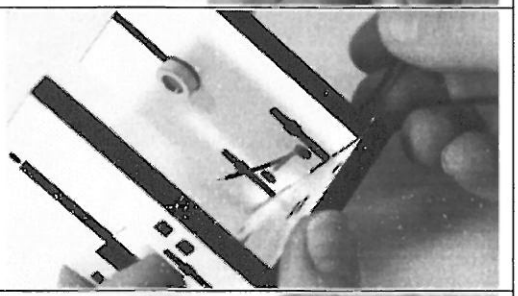
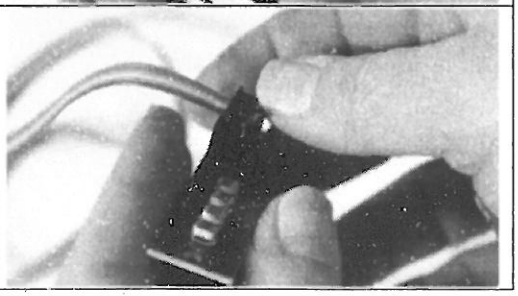
Peel the masking tape from both sides of all of the laser cut pieces. If any soot remains on the white surface it can be wiped away with acetone. Pick up the motor mount and the gear motor with the thick part of the motor near the top. Put the shaft through the large hole and turn the motor until the holes in the motor line up with the slots.	
Use two M3x10 screws through the slots to secure the motor. Tighten them down enough to hold it on, but loose enough to slide in the slots.	
Put a hex nut in the slot on the back of the small drive gear and screw a M3x10 into it just enough to catch a few threads.	
Slide the drive gear on to the motor shaft with the nut facing the motor and positioned over the flat of the shaft. Tighten the screw the rest of the way so that it just contacts the flat of the shaft. If you over tighten, once the screw can't go any further through the nut, the nut will instead rise up and break out of its slot.	
Use 4 M3x12 screws to mount the control board with the hall sensor (the little black square at the edge) pointing toward the motor.	
Thread a M8 nut a few cm onto the threaded rod and add a washer. Put the rod through the hole below the motor and add a washer and M8 nut on the other side.	

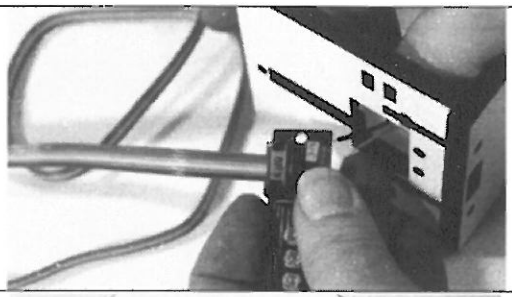
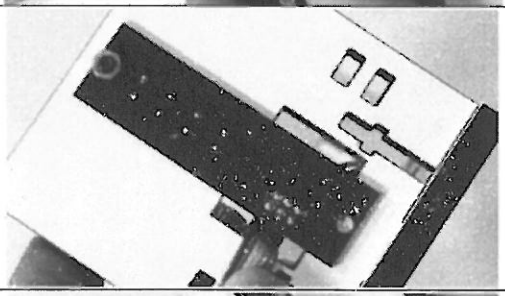
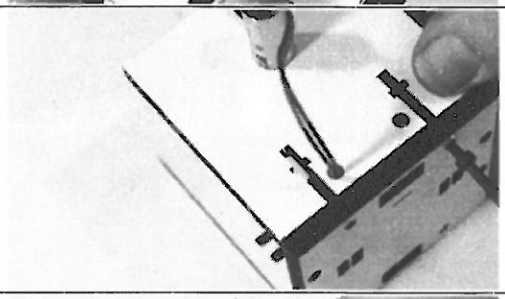
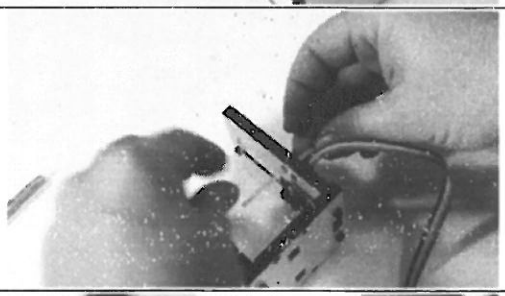
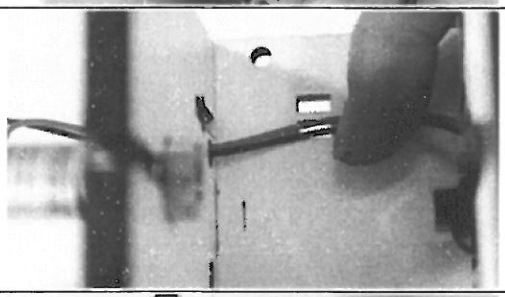
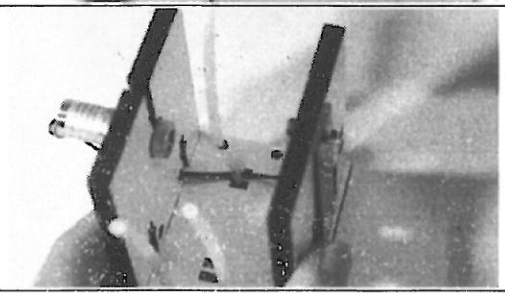
Slide the tabs on the bottom of the motor mount into the slots at the side of the base. It will be a very tight fit, but applying steady pressure and a little sideways rocking will get it to slide in.	
Put a finger under the nut trap and drop a square nut into it. Slide a M3x25 screw through the hole at the bottom of the base into the slot, and thread it through the square nut. Tighten it just enough to be secure. Over tightening could crack the wood.	
Put bearings into the front and back holes of the spool gear.	
Put the magnet on the table and flick it a few times so it spins freely and is able to orient itself to the earth's magnetic field. Make note of the face that points north, perhaps coloring it with a marker. Place the magnet in the small hole on the flat side of the spool gear with the marked pole facing outward. Don't glue the magnet in until you have tested it and are certain the correct pole faces outward.	
Slide the spool gear onto the rod. Note that if you plan to use a spool with a 80mm hub you may need to add a washer between the nut and the spool gear to keep the spool from catching on the electronics. Loosen the motor screws so it can slide down to engage the drive gear with the spool gear. Adjust the position of the drive gear on the motor shaft to line them up if necessary. Tighten the motor screws.	
Mount the support base in the slots across from the motor mount using two M3x16 screws. Use the holes in the base that are not next to the hinge. Use a M3x25 screw to attach the support arm to the base, keeping it loose enough to turn freely.	

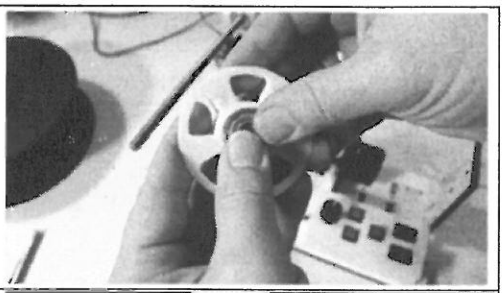
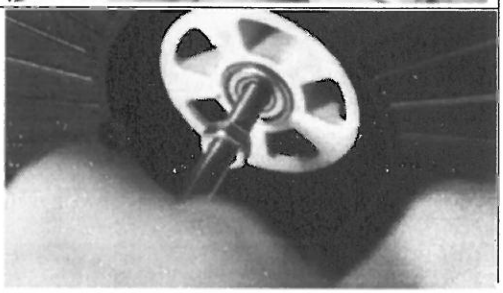
Place the servo mount onto the front of the servo with the wire pointing down and secure it with four M3x12 screws.	
Slide the servo mount into the slots nearest the motor mount. Use a square nut and M3x25 screw in the T-slot to hold it in place.	
Take the cross shaped servo arms and sharp Phillips screws from the servo pack. Use the screws to mount it to the slots at the bottom of the laser cut guide arm with the socket facing away from the wood.	
	
Slide the socket of the servo arm onto the white servo hub and test the guide's range of motion. The guide should turn far enough to touch the base on both sides. Keep adjusting its placement on the servo hub until it does, and secure it with the short screw from the servo pack.	
Take the 2-wire jumpers, the buttons and switches. Hook a wire into the hole in each terminal of the button and bend it over.	

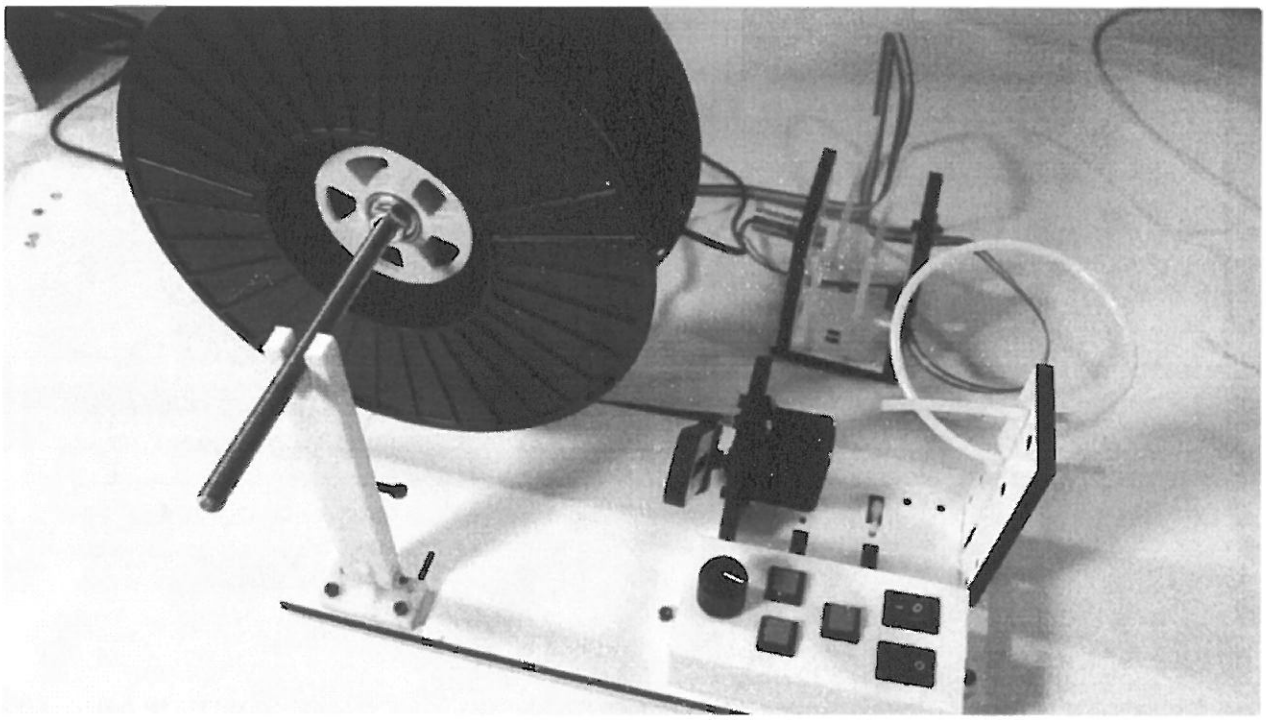
Put a dab of solder on the wire to secure it to the terminal. It doesn't matter which color wire hooks to which terminal. Do the same for the each of the other buttons and switches.	
For the potentiometer, attach the wires in the same order as the connector. It doesn't matter if the order runs left to right or right to left, so long as the middle wire from the connector leads to the middle lug of the potentiometer. It is possible to overheat the potentiometer with the iron, so keep contact as short as possible.	
You can quickly twist the wires by lightly chucking the housing into a drill and spinning it.	
Push the buttons and switches into the control box. Mark the wires with tape, or by writing on the housing so you can identify them at the control board. L for Left, R for Right, C for Center, A for the Auto switch (on the left) and P for the Power switch on the Right.	

Insert the potentiometer through the hole from below and secure it with the thin nut. Slide the knob onto the shaft of the potentiometer. This is an important point as I've found that the servo can behave erratically when the potentiometer is turned with the bare hand.	
Mount the control box to the base with two M3x16 screws. You can run the wires through the hole under the base, or up through the notch next to the box to run them over the base if preferred.	
If the wires are run under base, take them up through the hole in the base below the control board. The small hole near the inside corner of the base is for attaching a zip tie to secure the wires. Stick the clear adhesive bumpers to the four corners of the bottom of the base to provide clearance for the wires and screw heads.	
Plug R into Guide Min, L into Guide Max, C into Sensor Cal, A into Auto. Plug the servo into Servo with the brown wire at the bottom. Plug P into PWR on the right side of the board and plug the potentiometer into Knob. If, when first operating the winder you find the knob is working backwards, flip the plug over.	
Put the crimps for two wires into a 2x1 housing, and plug it in to the headers marked Motor. Cut the wires to the length needed to reach the motor and strip the ends. Hook the bare wire through the motor terminals and tack them down with some solder. It doesn't matter which terminal the wires go to. If the motor turns the wrong direction, plug it in with the other wire on +.	
If you will be operating the winder mounted vertically to the wall, insert the intake plate into the slots and secure it with a square nut and M3x25 screw in the t-slot. If the winder will sit horizontally, mount the intake plate flat to the base with two M3x16 screws.	

Cut 12-14" (35cm) of 4mm PTFE if you will be extruding 1.75mm filament. Push one end down through the hole closer to the bottom of the plate, and up through the hole near the top of the plate.	
If you will be extruding 3mm filament, do the same with the 6mm PTFE in the larger holes. The ends of the 6mm PTFE would be closer to being flush with the board.	
Begin building the sensor by pushing the laser mount into the slots ,which have a small line scored near them. Push the sensor mount into the slots on the other side.	
Place something like a flat head screwdriver into the slot at the top of the laser mount and use it as a lever to widen the gap as you push the laser into the hole. When the laser is far enough in for the focus ring to be past the other side, release the lever so the mount grips the laser.	
Run the laser wires through one of the holes near the t-slots and through the center of the sensor mount.	
Plug one end of the ribbon cable into the sensor mount, and the other end into the control board.	

Use a tiny flat head screwdriver to loosen the screws on the terminal block. Insert the laser wires with the red one on the left and tighten the terminals down.	
Mount the sensor to the back of the plate with an M3x12 screw, and run the ribbon cable across the back.	
Secure the laser and sensor mounts with square nuts and M3x25 screws in the t-slots.	
Use a zip tie to secure the ribbon cable to the back of the sensor plate.	
Use another zip tie to secure the laser wires to the base. Stick the soft foam bumpers to the four corners of the underside of the base. They will keep the sensor from getting dragged around by the ribbon cable.	
Cut the remaining 4mm PTFE into 4 pieces about 3.5" (90mm) long and put them into the holes at the sides of the base. These will guide the filament through the sensor.	

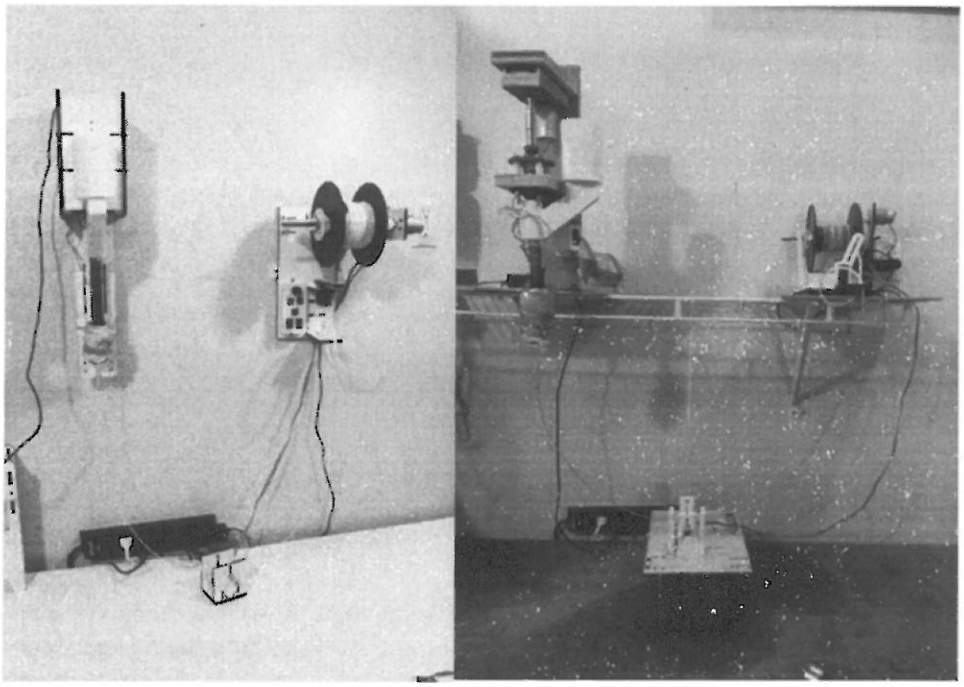
Put the last bearing into the flat side of the spool hub.	
Push the spool up against the spool gear and hold it from the other side with the spool hub. Tighten an M8 nut up against the spool hub with pliers. It should be tight enough that the spool won't slip if the filament gets a little hard to pull, but will slip if it hits a kink that will not go into the tube.	



FilaWinder Setup and Operation

SETUP

The FilaWinder works best with the extruder positioned vertically. The filament will make only one bend on the way to the winder, and will behave more predictably.



The enclosure kit sold at Filastruder.com makes wall mounting easy, with slotted holes that make it convenient to take it on and off the wall. If you don't have wall space to use, you can also set the extruder on a shelf. Cut a short length of board the same width as the Filastruder base and screw it on to the bottom perpendicular to the base with some angle brackets for strength. Place a heavy weight on the board and hang the nozzle over the edge. There are some vertical hoppers on Thingiverse-

http://www.thingiverse.com/thing:109650
http://www.thingiverse.com/thing:160545
http://www.thingiverse.com/thing:219463

If you are wall mounting the winder, set the intake plate into the slots so it is perpendicular to the base. If you set it on a shelf, mount the intake plate flat to the base. The filament should always come up to the intake from below.

Set the extruder and winder at least "18 (.5m) apart, with the sensor half the distance below them so the filament makes a semi circle as it loops to the winder. The filament has a tendency to twist as it

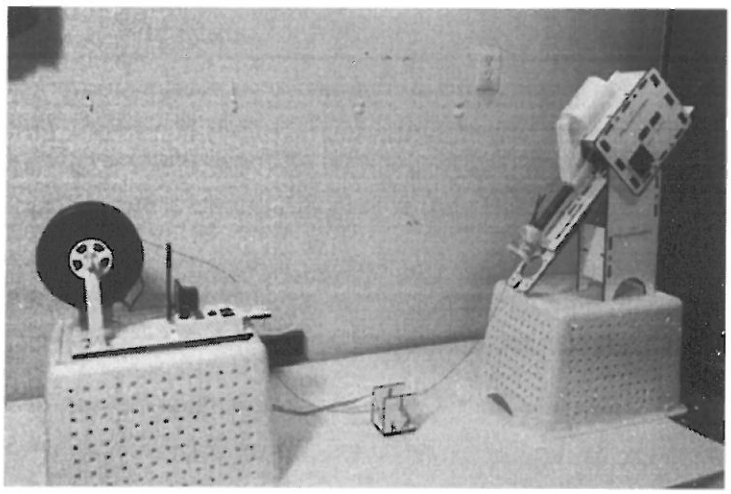
extrudes which can cause the loop to move sideways rather than down. The weight of a longer length of filament hanging between the extruder and winder counters this tendency to twist. As extrusion speeds up relative to the winder you want the loop to drop. If the loop is too short to counteract the twist, it may move sideways instead, failing to trigger the sensor and speed up the spool.

There are a couple of options for setting up on a tabletop. The first is drilling a 90 degree nozzle. Take an undrilled nozzle (available at Filastruder.com) and drill a hole from the back, stopping just short of the face. This is easily done with a drill press where you can set it to stop at a given depth. Then drill another hole sideways into one of the flats to meet up with it. Due to the size of the flats this may not be feasible for 3mm filament. Elevate both the extruder and the winder, with the sensor on the tabletop between them. Here is an example, with an early prototype of the winder-

http://www.youtube.com/watch?v=9tr6OhLTw3U

The other option is setting the winder at a 45 degree angle. If you are using the enclosure kit, there are are plans for a stand on Thingiverse –

http://www.thingiverse.com/thing:192076



Another solution uses PVC pipe to set the extruder at an angle-

http://www.thingiverse.com/thing:165464

The key to consistent filament is to isolate the pulling from the nozzle so there is no variation in the stretching that occurs as the filament is extruded. The loop makes this possible by causing changes in the pulling force to raise and lower the loop rather than stretching the filament directly from the nozzle. The constant adjustment of the spooling speed keeps the bottom of the loop in one place so the weight of filament hanging from the nozzle (and its stretching force) stays constant.

Setting the extruder at a 45 degree angle begins to direct some of the pulling force toward the nozzle and not only on the loop. If you take this approach, make sure the filament still drops down from the nozzle and keep a careful eye on the tolerance.

It is also possible to place the extruder horizontally on the table, level with the sensor. This is a simple, easy setup but is the most likely to produce filament with a wide tolerance and requires more experimentation.

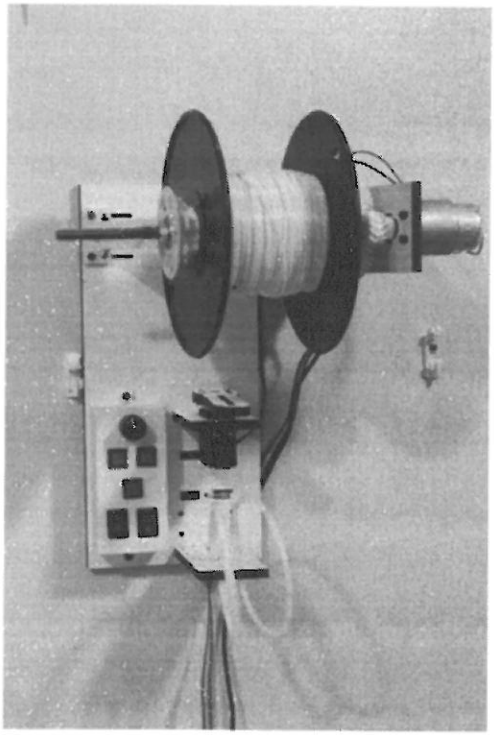
OPERATION

Before turning on the winder put it into Auto mode by setting the left switch to the ON position (|).

Turn on the power by setting the right switch to ON.

Set the left guide limit by holding down the left button and turning the knob until the guide has moved to the left edge of the spool

Set the right guide limit by holding down the right button and turning the knob until the guide has moved to the right edge of the spool.



While in Auto mode, the middle button will set the current position for the guide. Hold the middle button and turn the knob until the guide has moved to the position where you want it to start, usually at one edge of the spool. While spooling, the guide will continue to move in the last direction it moved before the middle button was released. If you want the guide to start at the left side of the spool, hold the middle button and turn the knob left until the guide has moved past the left edge. Then turn the knob right until the guide is just inside the edge of the spool and release the button. As the spool turns, the guide will continue to move left to right until it reaches the right limit.

The left and right limit positions are saved in memory even when the winder is switched off. Once you have found the right positions, you will not need to reset them. It is still a good idea to set the current guide position when turning the winder on just to insure it has a defined starting point.

Turn the knob all the way to the left, and switch to manual mode by setting the left switch to OFF . It's best to keep the spool from turning during the next step

While in Manual mode the knob controls the speed of the spool, and the middle button activates the sensor calibration. Pick up a short length of filament and press and release the middle button. The winder will enter calibration mode for the next five seconds during which you should wave the filament up and down between the laser and the photocells. It will record the lightest and darkest values received during that time, which it will use to recognize the filament's shadow.

When calibration is done, turn the knob up and down to check that the spool motor is working before switching back to Auto.

The spool might begin turning when you switched to Auto. Move the piece of filament down over the sensor. When the shadow passes the top sensor, the spool should stop. As the shadow moves below the middle of the sensor the spool should begin to turn and change speed as you move the filament up and down around the center of the sensor.

Turn on the extruder motor and begin extruding filament. Gently guide the filament over toward the sensor, and clip off the first couple of inches if the end is wiggly and full of bubbles. Move the end of the filament down toward the sensor, and back up toward the winder's intake. The filament should leave the nozzle at an angle toward the sensor as you do this. Try to maintain that same angle as you handle the end of the filament and do your best not to let it harden into waves or kinks. If you are running a fan, blocking the airflow will help prevent kinks from getting set into the filament as you handle it.

When it gets to the winder, push the end of the filament into the tube and keep feeding it through about as fast as it extrudes. Once the end of the filament is constrained by the tube it will start pushing back against the filament at the nozzle due to changes in curvature caused by handling it. Keep guiding the filament on the winder side in a way that maintains the angle coming out of the extruder.

When the end of the filament comes out of the tube, begin pulling it at a steady rate and thread it through the guide arm. Once it reaches the top of the spool, turn off the extruder motor for a few seconds to give yourself some time to work as you tape the end of the filament down to the spool.

Switch the extruder motor back on and let the loop drop between the PTFE guides on the sensor. As the filament reaches the sensor the spool should start turning to maintain the position of the loop. The shape of the loop will probably be uneven from all of the handling, and the bottom will tend to move back and forth between the winder and extruder.

Hold something smooth behind the filament a short distance below the nozzle, such as a piece of PTFE tube or something metal. As the filament tries to push behind the nozzle use that guide to maintain a constant angle of extrusion, forcing the loop to drop rather than move sideways. Don't be so aggressive with this that the filament kinks, however. If you can maintain that angle as the filament travels the full distance from extruder to winder, the loop will maintain a more consistent shape.

This time-lapse video shows the back-and-forth motion that is typical.

http://www.youtube.com/watch?v=TbsIDJNjq2M

Just before the end you can see me steady the loop by using a piece of PTFE tubing to restrain the filament each time it tried to push behind the nozzle.

TROUBLESHOOTING

The Guide Won't Move-

Try going through the startup routine again. Set the left and right limits, and set a guide position. Make sure that the spool isn't turning, sometimes having the hall sensor trigger while setting up the guide will cause problems.

If the guide still won't move as the spool turns, the magnet may have the wrong pole facing out. Take the magnet out of the gear and wave it past the hall sensor (the small black square at the top edge of the control board). The guide should move as the magnet nears the sensor. If not, turn the magnet over and try again.

When you know the magnet is facing the correct direction, glue it into the gear. Once my guide stopped working because the magnet slipped out and stuck to the M8 nut. If the magnet slips part way out it will be too close to the sensor and may trigger the guide too often. It's best to keep it flush with the face of the gear.

If the magnet is correct, check the plugs for the left and right buttons, and make sure they are plugged in to the correct headers. Try switching them around.

The Sensors Stop Responding

If the filament gets bumped or jerked and moves quickly past the sensor, it can lose track of its position and may stop responding. If you cast a deep shadow across the sensor by leaning over it, the light values will go beyond its calibration and the program may stop functioning correctly.

Turn off the extruder motor and use the manual control to pull the filament above the sensor. Turn the winder off, set it to Auto, then turn it back on. Set the guide position and direction back to where it left off. Before you hit the middle button to set the guide position, turn the knob to approximately where it will need to be. If you left the knob turned all the way down from controlling the motor, the guide will fly off to the side as soon as you press the button.

Switch to manual and calibrate the sensors. Switch back to Auto and turn the extruder motor back on. The winder should go back to operating as normal.
When left alone, the sensors should function properly without fail as long as the lighting conditions in the room stay constant. Each time I have seen the sensor fail it has been by own fault from interfering with the filament or leaning over it to check the diameter.

The Motor is Turning but the Spool is Not

If there is a bit of a wave in the filament or it begins to get too thick, it will get harder to pull through the tube. If the nut holding the spool hub isn't tight enough, the gear can slip against the spool, spinning as the spool remains still. Tighten the spool hub nut with a wrench until the spool presses against the gear hard enough to be turned by it.

Ideally the spool will be held tight enough that the gear will turn it through a difficult patch of filament, but slip if it hits a kink that cannot fit through the tube. You can also reduce the tension of the filament by making the PTFE loop wider.

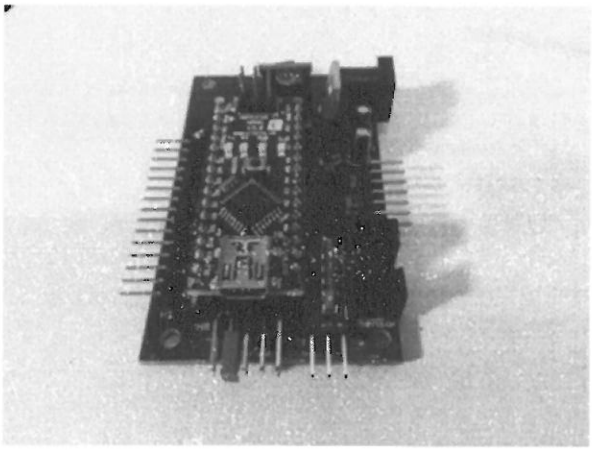
If the spool is tight, but not turning consistently, check the drive gear. If the set screw was tightened too much, the nut may have risen up the screw and broken its slot. This will loosen its hold on the motor shaft, so the shaft might intermittently slip inside the drive gear.

Troubleshooting Mode

If the winder is not working as it should, troubleshooting mode can help see what is going on. Enable it by placing a jumper between pin D11 and the ground pin below it. The pins are located below the USB port, second pair from the left.

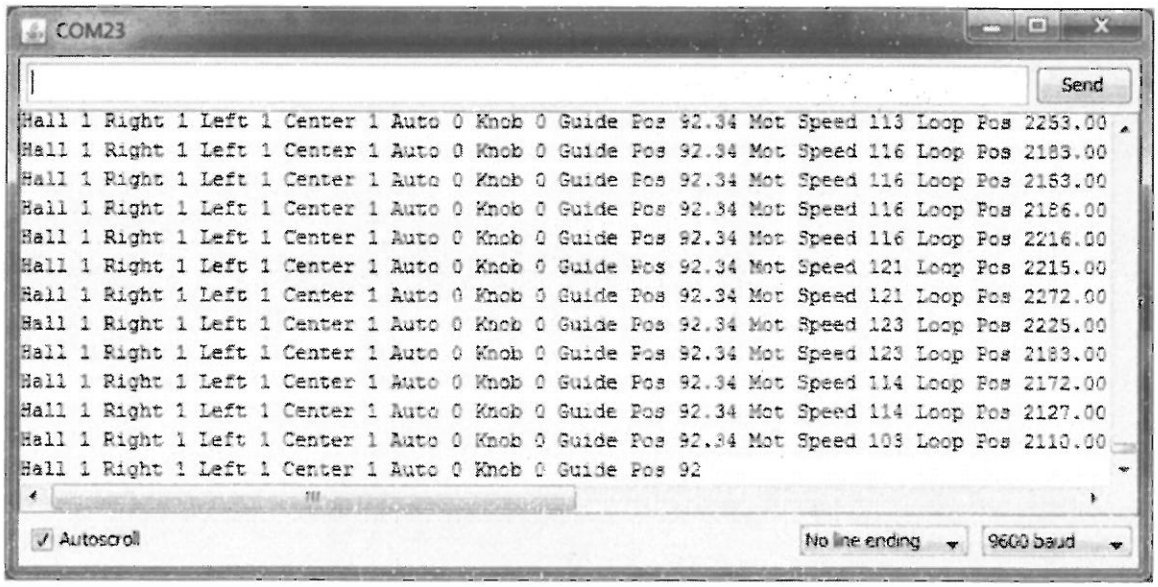
Download and install the Arduino software from http://arduino.cc/.

Plug in the USB, and under the Tools Menu, go to Serial Port and choose the port that was assigned when you plugged the winder in.



Under Tools choose Serial Monitor. This will open up a window as shown-

When a button is pressed, its value will change from 1 to 0. Hall will change from 1 to 0 when the magnet is detected. The knob value ranges from 0 to 1024 as you turn it, and Mot Speed will show the speed value sent to the motor, from 0 to 255. Loop position shows the position of the filament as detected along the sensors. 0 is the top, 3000 is the bottom, and while in Auto mode the winder will try to keep the filament at 1500.



When you press the center button in manual to calibrate, the output will pause until the calibration is finished. Then it will display the minimum and maximum brightness values detected be each of the sensors.

3MM Filament

When spooling 3mm filament, the guide needs to move further with each rotation. Enable 3mm mode for the guide by placing the jumper on D12 and ground, as shown-

Since the filament is stiffer, it needs to be guided more gradually. Use the wooden extension piece to position the intake plate further from the guide so it doesn't have to make such a tight bend.