

COBBLEBOT BASIC V2

Assembly Guide

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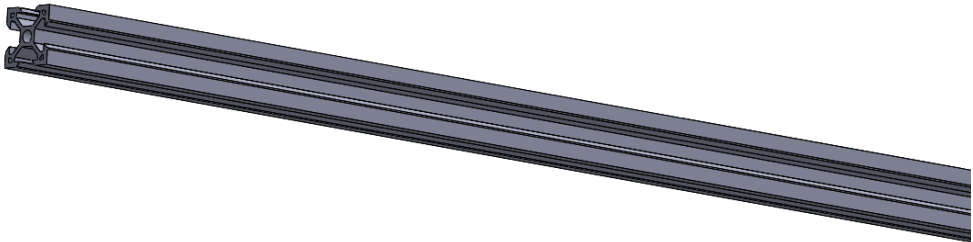
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Build of Materials

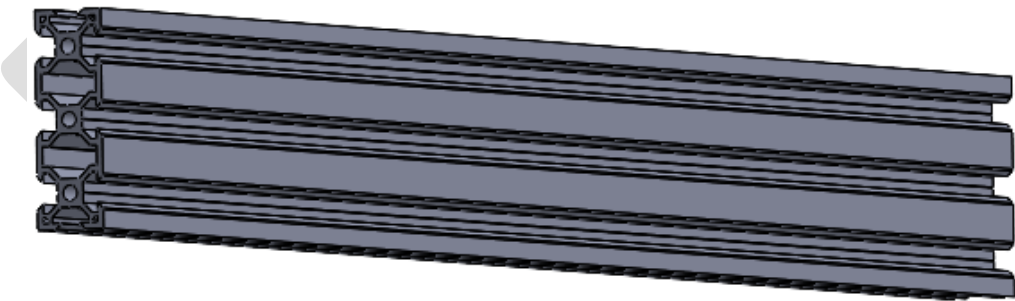
V-Slot Rails

Version 2 of the Cobblebot Basic contains the following rails:

	Version 2
Bed Support & Y Top	4 x 20x20 @ 500mm
X Top	2 x 20x20 @ 560mm
ZY Axis	2 x 20x20 @ 576mm
Y Axis	1 x 20x20 @ 576mm
X Axis	2 x 20x20 @ 551.5mm
Z Axis	4 x 20x20 @ 576mm
Base	2 x 60x20 @ 500mm
Base	2 x 60x20 @ 560mm



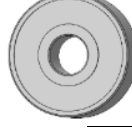




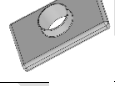






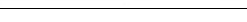


20x20 Rail




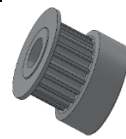

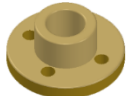


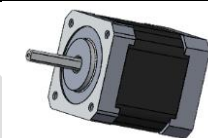


20x60 Rail

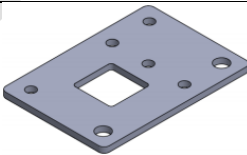
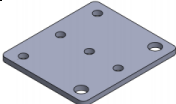
List of Included Hardware

Item	Qty.	Item Description
Solid V-Slot Wheels	28	
Smooth Idler Pulley	3	
625 Bearings	62	
5mm Precision Shims	34	
M5 Nylon Lock Nuts	36	
M5*25mm Low Profile Hex Screw	36	
M5*8mm Low Profile Hex Screw	110	
M5 T-Nuts	110	
M3 T-Nuts	5	
Eccentric Spacers	14	
Aluminum Spacers	14	
M3*10mm Cap Screws	10	
M3*8mm Cap Screws	32	
M3 Nylon Lock Nuts	12	
Zip Ties	4	

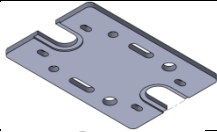
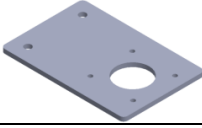

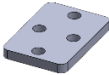
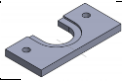
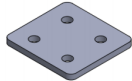

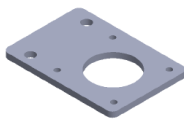

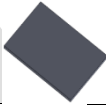
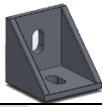
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PTFE Tubing	1	
Rigid Couplers	2	
GT2 Belt 45"	3	
GT2 20T Pulley	3	
TR8*8 Lead Screw	2	
Brass Nuts	2	
Metal Extruder	1	
Hexagon Hotend	1	
NEMA 17 Motors	6	

Cobblebot Gantry and Supports






Z-Gantry Plates	4	
X-Gantry Plates	2	

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Y-Carriage	1	
Z-Motor Mount	2	
Z-Lead Screw Plate	2	
X-Belt Plate	2	
Carriage Clip	1	
Base Join Plates	8	
X/Y-Idler	3	
X/Y-Motor	3	
Bed Clips	4	
Print Bed	1	
90 Degree Corner Brackets	20	
Hardware listed above is for a base unit.		

Part 1: Wheel and Pulley Assemblies**Wheel Assembly**

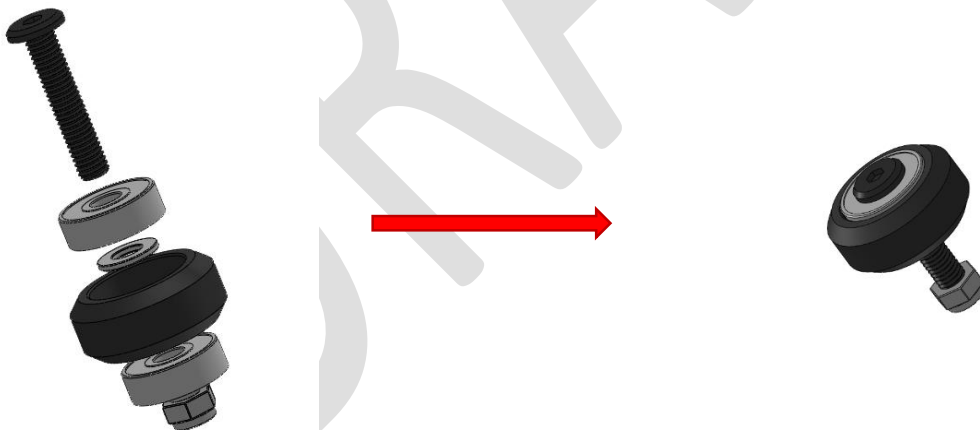
Items Needed

				
28 x Solid V-Slot Wheels	56 x 625 Bearings	28 x M5 Precision Shims	28 x M5 Nylon Locknuts	28 x M5*25mm Low Profile Screw

Each wheel assembly requires:






- 1 x Solid V-Slot Wheel
- 2 x 625 Bearings
- 1 x M5 Precision Shims
- 1 x M5 Nylon Lock Nut
- 1 x M5*25mm Low Profile Screw

Slot the M5*25mm screw through one 625 bearing. Drop a precision shim onto the screw on the bearing side, and insert the bearing into one end of the pulley. Add another 625 bearing onto the other side of the pulley, and lightly tighten the M5 locknut. Set aside the pulley assembly and repeat for the remaining two pulley assemblies.



Pulley Assemblies

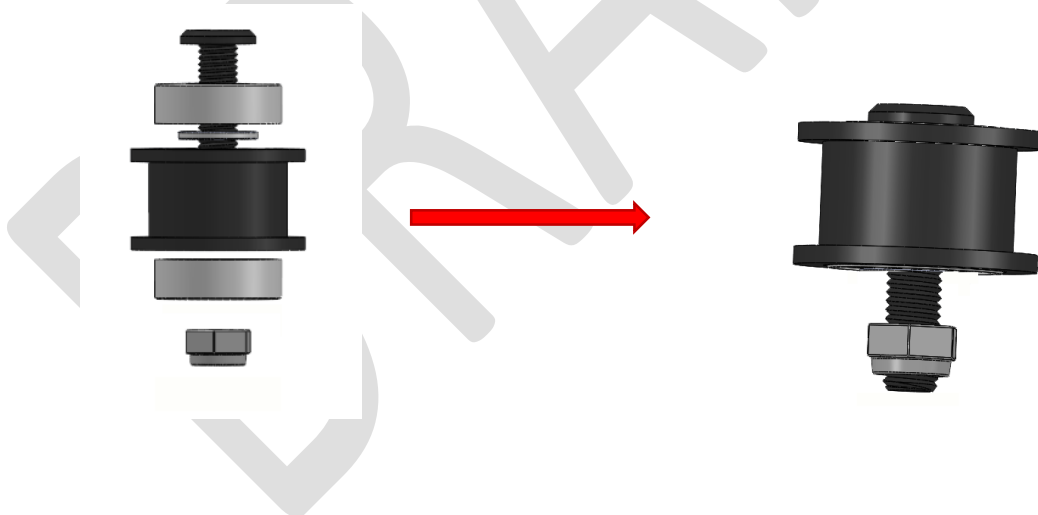
Items Needed

				
3 x Smooth Idler Pulley	6 x 625 Bearings	3 x M5 Precision Shims	3 x M5 Nylon Locknuts	3 x M5*25mm Low Profile Screw

Each pulley assembly requires:



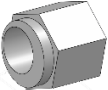



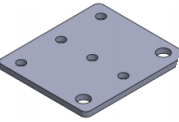

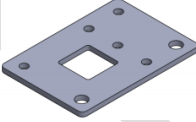

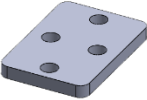
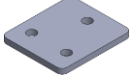



- 1 x Smooth Idler Pulley
- 2 x 625 Bearings
- 1 x M5 Precision Shims
- 1 x M5 Nylon Lock Nut
- 1 x M5*25mm Low Profile Screw

Slot the M5*25mm screw through one 625 bearing. Drop a precision shim onto the screw on the bearing side, and insert the bearing into one end of the pulley. Add another 625 bearing onto the other side of the pulley, and lightly tighten the M5 locknut. Set aside the pulley assembly and repeat for the remaining two pulley assemblies.



Part 2: Gantry Plate, Motor Mounts and Idler Pulley Assemblies

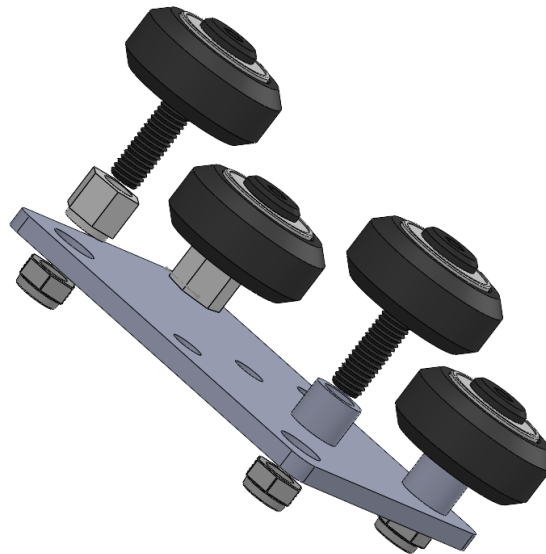
Items Needed

				
12 x M5*8mm Low Profile Screws	12 x M5 T-Nuts	14 x Eccentric Spacers	14 x Alum. Spacers	28 x Wheel Assemblies
				
3 x Idler Pulley Assemblies	2 x X-Gantry	1 x Y-Carriage	4 x Z-Gantry Plates	3 x XY Motor Mount
				
2 x X Belt Plates	3 x XY Idlers	12 x M3*8mm Screws	8 x M5 Nylon Locknuts	4 x M5*25mm Low Profile Screw

X-Gantry Assembly

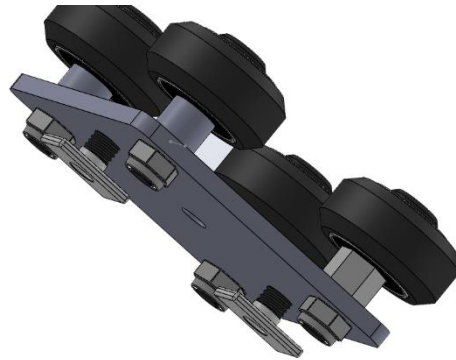
Each of the four outer holes on the corners of the X-gantry should be fitted with an assembled wheel and either an eccentric spacer or an aluminum spacer. If the hole is large, it will receive an eccentric spacer, for which the tip should fit through the hole.

Carefully unscrew the lock nut on a wheel assembly, and fit the end of the M5*25MM screw through the appropriate spacer. Tighten the wheel assembly to the body of the gantry using the nylon lock nuts. The wheels should be tight, but still able to spin freely. If there is too much pressure on the bearings, back down the tension on the lock nuts until the wheel can spin freely.



The two outer holes in the gantry should be outfitted with M5*8MM screws and T-Nuts. The final assembly should match the figure to the right.

Place to the side and repeat the process for the second X-Gantry.



Z-Gantry Assembly

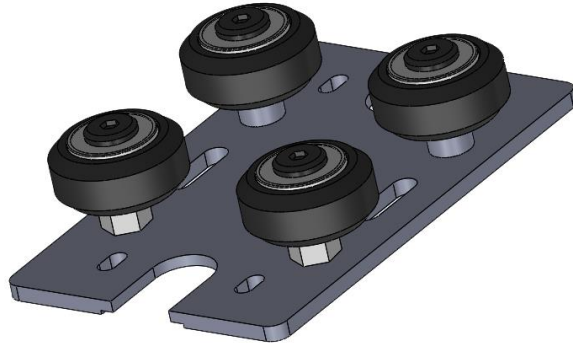
Assemble the Z-gantry using the same method as was used with the X-gantries; the four outer holes will either receive an eccentric spacer or have an aluminum spacer flush against the plate. Ensure the wheels are locked on and roll freely.

Insert two x M5*8MM screws in the two outer holes of the gantry plate, with the head of the screw on the same side as the wheels. Gently twist on two T-Nuts onto the threaded side of the two M5*8MM screws. Repeat for the remaining gantry plates. Note, if the eccentric spacers are difficult to insert in this part, you may need to apply force to get the spacer in the hole using vice grips, a hammer or whatever you have available. Once the eccentric spacer is in the slot, rotate it using a pair of pliers until it can move/rotate freely.



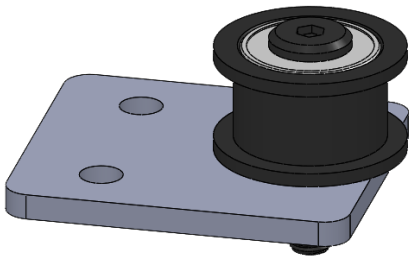
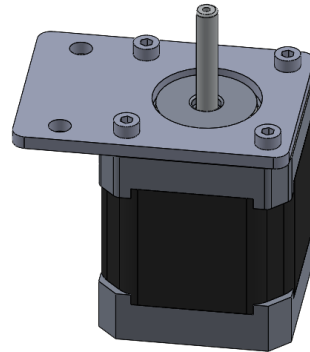
Carriage Assembly

As with the X and Z-Gantry plates, attach four wheel assemblies at the corners, ensuring the wheels roll freely.



XY-Motor Mount Assemblies

Attach the XY-Motor mount plates to the Nema 17 motors using M3*8mm screws.

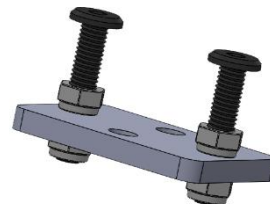


XY Idler Mount Assemblies

Attach the three pulley assemblies to the XY-Idler plates. To attach the assembly, loosen the lock nut off the bottom of the pulley assembly, slot the end of the M5*25mm screw through the single hole in the plate, and screw the locknut on. Tighten up the locknut until it no longer moves but still allows the pulley to turn freely.


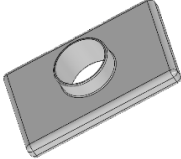
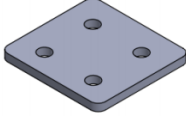


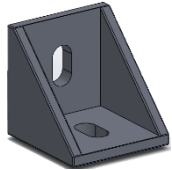
X-Belt Plate Assemblies

Using an 8mm wrench or socket and a 5mm HEX driver or Allen wrench, screw an M5 locknut onto a M5*25mm around 9mm up the threading. Insert the screw into one of the single holes on the edge of the X-Belt Plate and lock in place with an addition M5 locknut. Repeat for the other side. Continue to do this for the remaining X-Belt Plate.

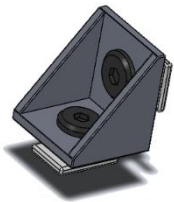


Part 3: Base Frame Assembly

Hardware Needed:

			 20x60 Rails	 20x20 Rails	
48 x M5*8mm Low Profile Screw	56 x M5 T-Nuts	8 x Base Join Plates	2 x 500mm 2 x 560mm	4 x 576mm 2 x 500mm (bed supports)	8x 90 Degree Corner Brackets

The frame of the Cobblebot is constructed using 20x60 rails as a base connected to 20x20 rails in the corners. The 20x20 rails serve as a channel for the Z-gantries to travel up and down. You will use 2 x 20x60 @ 500mm, 2 x 20x60 @ 560mm, and 4 x 20x20 @ 576mm rails. The rails are joined with base join plates for the vertical rails and corner brackets for the bed supports.

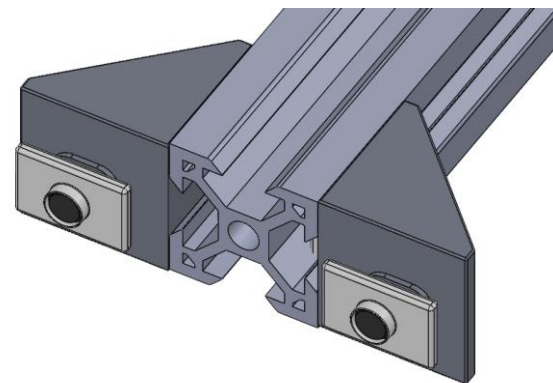


Corner brackets are used to hold linear rails (or other objects) at 90 degree angles. **(Pictured left)** Two M5*8mm screws are placed through the holes in the corner bracket, and held in place using a T-Nut or a M5 nut. For this model, we exclusively use t-nuts to mount the corner brackets to the rails.

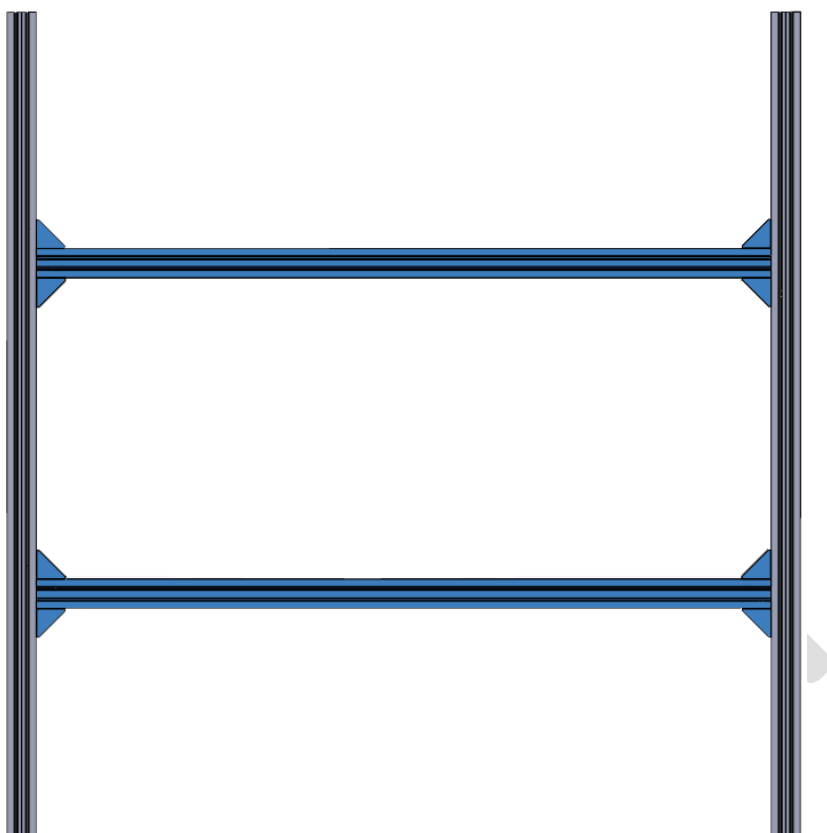
The first step in assembling the base frame is attaching two 20x20@ **500mm** rails perpendicularly between the two **longer** 20x60@**560mm** rails, using the top slot channel of the 20x60s.

Our preferred approach to attaching the bed support rails is to attach four corner brackets to each of the 20x20 rails. Flush the edges of the corner bracket assembly with the edge of the 20x20 rail as shown in the picture.

Lay one of the 20x60@560mm rails flat on the 60mm side, and gently slot the T-nuts for one side of the bed support rails into the top slot of the 20x60. The outer edges of the 20x20 should be approximately 6.25" from the edge of the 20x60 rails. Tighten the M5 screws down, making sure the 20x20 rail is at a true 90° angle to the 20x60. Do the same for the other 20x20 rail. Once the corner brackets have been attached, **INSERT TWO T-NUTS INTO THE TOP SLOT OF EACH OF THE 20x20 RAILS FOR LATER PRINT PLATE ATTACHMENT.** Do this for each of the two 500mm 20x20 rails.

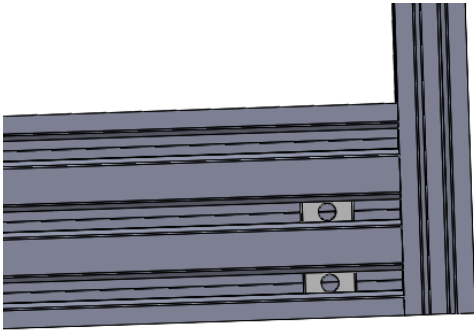
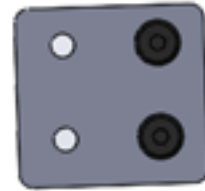


Take the other 20x60 rail, and very gently glide the top slot of the rail through the four corner brackets on the other side of the bed supports. **MEASURE THE DISTANCE** from each end to be sure the bed frame is square, and tighten the remaining screws in the corner bracket assembly.



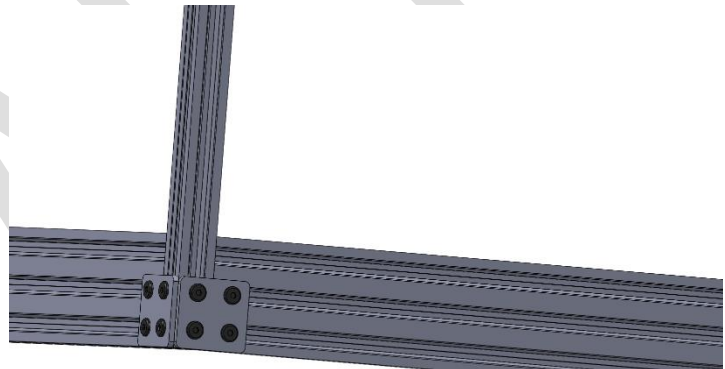
Base Frame Assembly: Bed Supports

Next, we recommend preparing the **eight base join plates** by slotting two M5*8mm screws and securing them with lightly screwed T-nuts (**PICTURED RIGHT**). Insert two T-nuts into the top slot (the 20mm side) of the shorter 500mm 20x60 rails. These will be used later to mount the z-motor plates.



Slot the 500mm 20x60 rail with two T-Nuts, one in each of the bottom two rows (**PICTURED LEFT**). Place a 576mm 20x20 rail flush with the edge of the 20x60. Slide the two pre-slotted T-nuts on the base-join plate down the vertical 20x20 rail all the way down. Line up the two pre-slotted t-nuts on the 20x60 rail with the remaining two holes in the base join plate and tighten them snugly. Do not overtighten at this time.

Make a corner with the 560mm 20x60, following the same steps as above. Make sure everything is flush. Repeat for each of the sides to complete the base frame assembly. Once everything is squared and all corners are flush, tighten the M5 screws down.


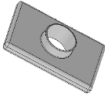

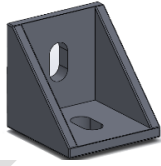


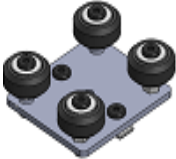



Completed Base Frame Final Assembly

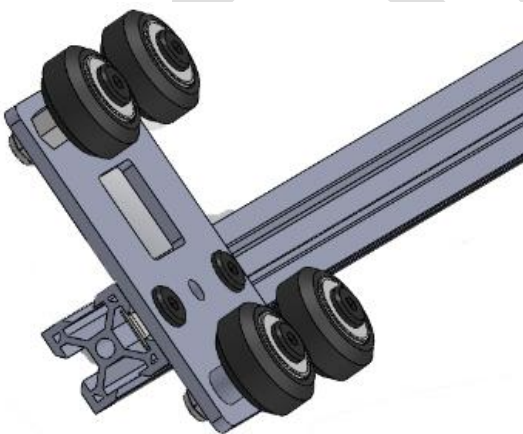
Part 4: Gantry Cage Assembly

Cobblebot uses a tri-axis design for performing print operations. The Z-axis holds the X-axis, which in turn holds the Y-axis. On the Cobblebot, this tri-axis is referred to as the gantry cage. This section describes the procedures used to construct the gantry cage.

Hardware Needed:

		 20x20 Rails		
12x M5*8mm Low Profile Screws	21 x M5 T-Nuts	3 @ 576mm 2 @ 551.5mm	4 x 90 Degree Corner Brackets	1 x Y-Carriage Assembly
				
4x Z-Gantry Assembly	2 x X-Gantry Assembly	1 x 45" GT2 Belt		

Z Gantry Joins

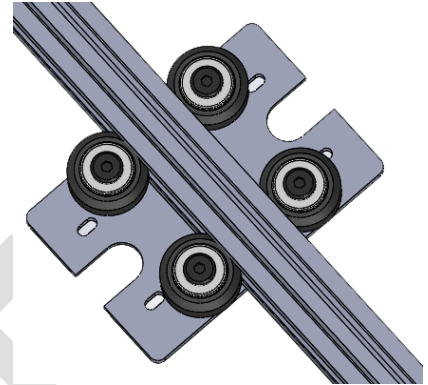


into place on the rail

Attach a 576mm rail to the edge of one of the Z-gantry plates. Do this on both ends of the rail; the wheels should face in the same direction on both sides, away from the 20x20 rail. Repeat for the remaining two Z-gantries. When completed, you should have two separate rails with the square hole facing up, and wheels pointing in opposite directions on the outer edge of the rail. Confirm the spacing on the two Z-gantries is correct by slotting the wheels on each end of the rail over two of the 576mm rails you previously attached to the base (the shortest side) and gliding the gantry up and down the rail. You will need to make sure the eccentric spacer is rotated appropriately to allow the wheels to fit over the 20x20 rail. Once the spacing has been confirmed, tighten the z-gantries

Y-Axis Assembly

Next you should prepare the Y-axis for installation. The Y-Carriage will slide on the rail, with the wheels facing up. Prior to placing the Y-Carriage on the remaining 576mm rail, loop the GT2 belt through the middle holes on each end of the Y-carriage. On each of the slots that will be traveling beneath the rail, loop one end of the GT2 belt down through the slot on the side of the carriage with the teeth of the timing belt facing down. Pull about 2 inches down and leave hanging there. Slide the carriage on the rail, wheels facing up. Move towards the middle of the rail and let it sit. Slot in **FIVE** M5 T-Nuts into the top of the rail to connect your X-Belt Plates and endstop holder with at a later time.



Now on the TOP and END of each side of the rail, attach the X-gantries using 2x M5*8MM screws and 2x M5 T-nuts. The wheels should face UP.

Do not tighten the X-gantries at this time, we want to adjust them in the next step.



Gantry Cage

Now join the Z-gantries together with the two 551.5mm rails (X-Axis rails). The X-gantries should be fitted on the X-axis rails prior to complete attachment of the X-axis rails. There should be two (2) M5 T-nuts slotted on the inside slot of both of the rails, and one (1) M3 T-nut for later attachment of a mechanical end stop. Below is a visual representation of the process:

Step 1: You don't need to actually push the rails all the way through the square cut-out on the Z gantries – the picture is just to show you where the X-axis rails will sit (on the TOP) on the ZY-axis



Step 2:

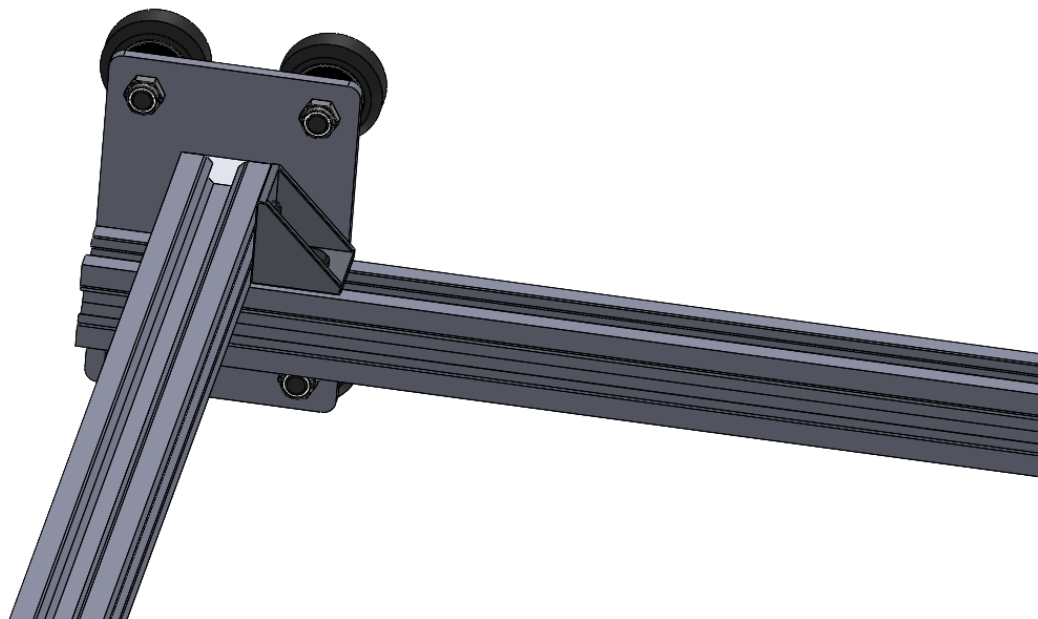
Adjust the X-gantries positioning as required to allow the two Z-gantries to join up properly.



Step 3:



Once you have the gantry cage assembled as above, lightly attach the X axis rails to the Z gantry joins using corner brackets on all four corners. Do not overtighten.





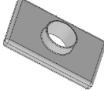
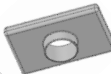

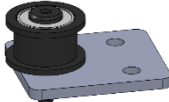
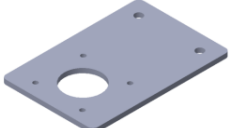
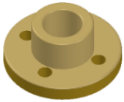

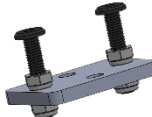
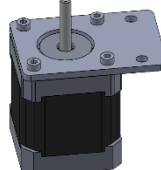



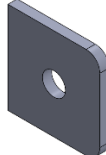
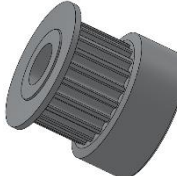


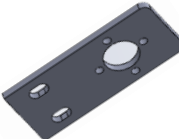
Place the entire gantry cage onto the four 20x20 Z-axis rails and adjust spacing as necessary to allow the cage to travel up and down the length of the printer.

DRAFT

Part 5: The Final Assembly Stretch

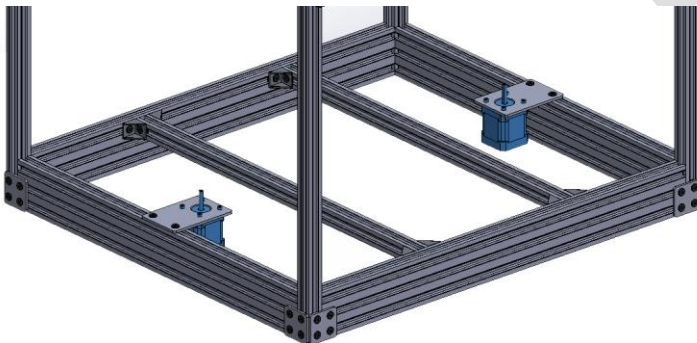
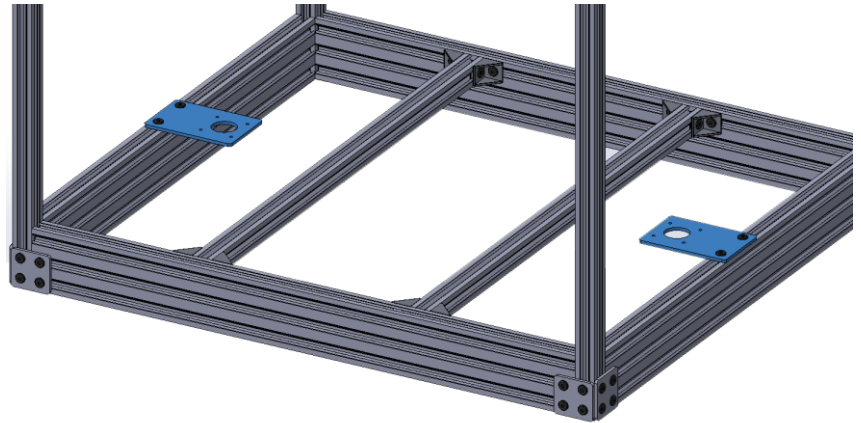
Hardware Needed:

	
1x Base Frame Assembly	1 x Gantry Cage Assembly

				
28 x 8mm M5 Low Profile Hex Screw	4 x M5 T-Nuts	2 x M3 T-nuts	2 x 5mm to 8mm Rigid Couplers	3x XY-Idler Assemblies
				
2 x Z-motor mount	2 x Brass Nuts	2 x 8MM Lead screws	2 x X-Carriage Assemblies	3x XY-Motor Assemblies
				
8 x 10mm M3 Cap Screws	8 x M3 Locknuts	20x20 Rails 2 @ 560mm 2 @ 500mm	4 x Bed clips	3 x GT2 20T Pulley
				
1 x 45" GT2 Belt	6 x Zip Ties	2 x Z-Lead Screw Plates		

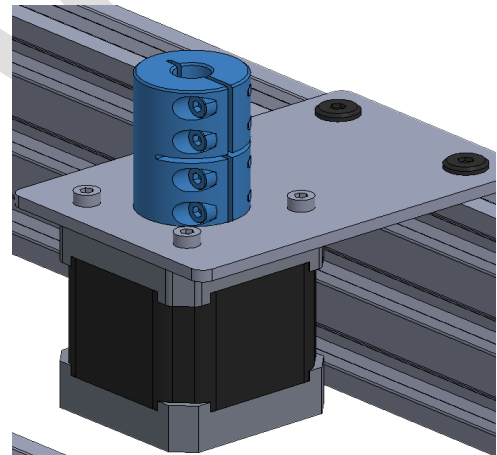
Step 1:

Install the Z-Motor mounts on the top slot of the 500mm 20x60 rails using the Z-motor mount plates, two 8MM M5 screws and the two previously slotted T-Nuts on each side.



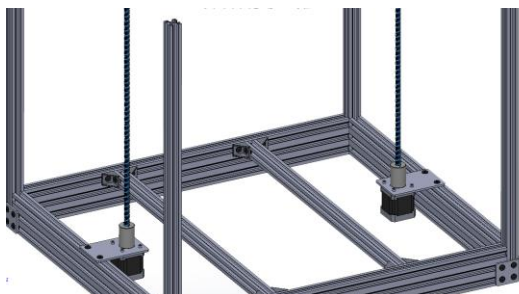
Step 2:

Attach the Nema 17 motors to the bottom of Z-Motor mount plates using four (4) M3*8mm cap screws per motor.



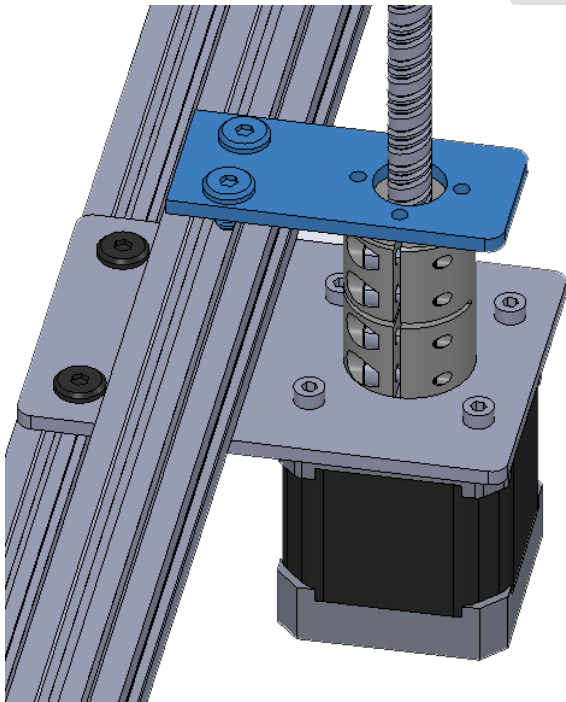
Step 3:

Connect the 5mm to 8mm rigid coupler using the smaller 5mm slot to the Nema shaft.



Step 4: Slot the lead screws into the rigid couplers through the top 8mm holes and tighten.

Step 5: Slide the gantry cage onto the base frame assembly.



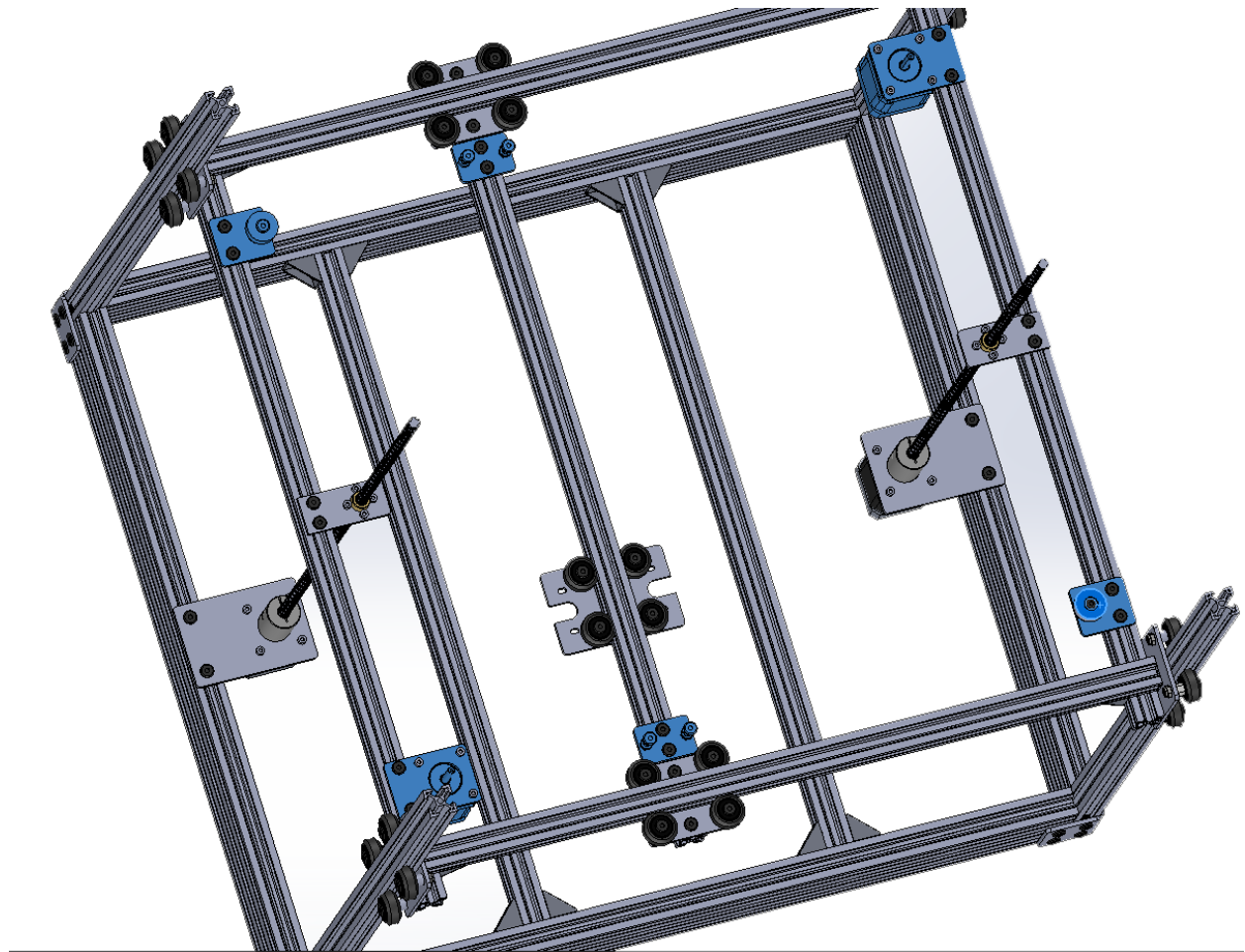
Step 6: Slot in two T-nuts into the top slot each side of the ZY-axis (the 20x20 rails that are inset from the base frame) toward the center of the rail. Slide the Z-Lead Screw Plates over the lead screws and center them over the coupler as shown. Tighten them down, and remove the gantry cage.

Step 7: Attach the brass nuts to the Z-Lead Screw Plates using four M3*10mm screws and four M3 Nylon locknuts a piece.

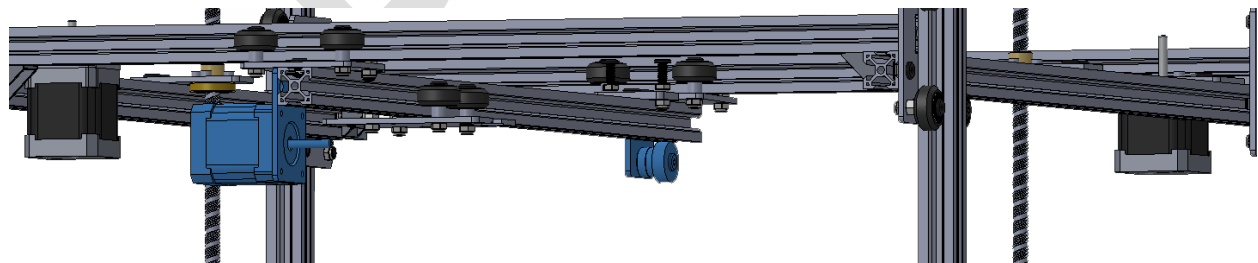
Loosen the top screw in the rigid couplers and remove the lead screws from the couplers. Put the gantry cage back on the base frame assembly, thread the leadscrews through the brass nuts and re-attach them to the rigid couplers below. Make sure the lead screws are level and can be rotated in both directions to bring the gantry cage up and down without any binding issues.



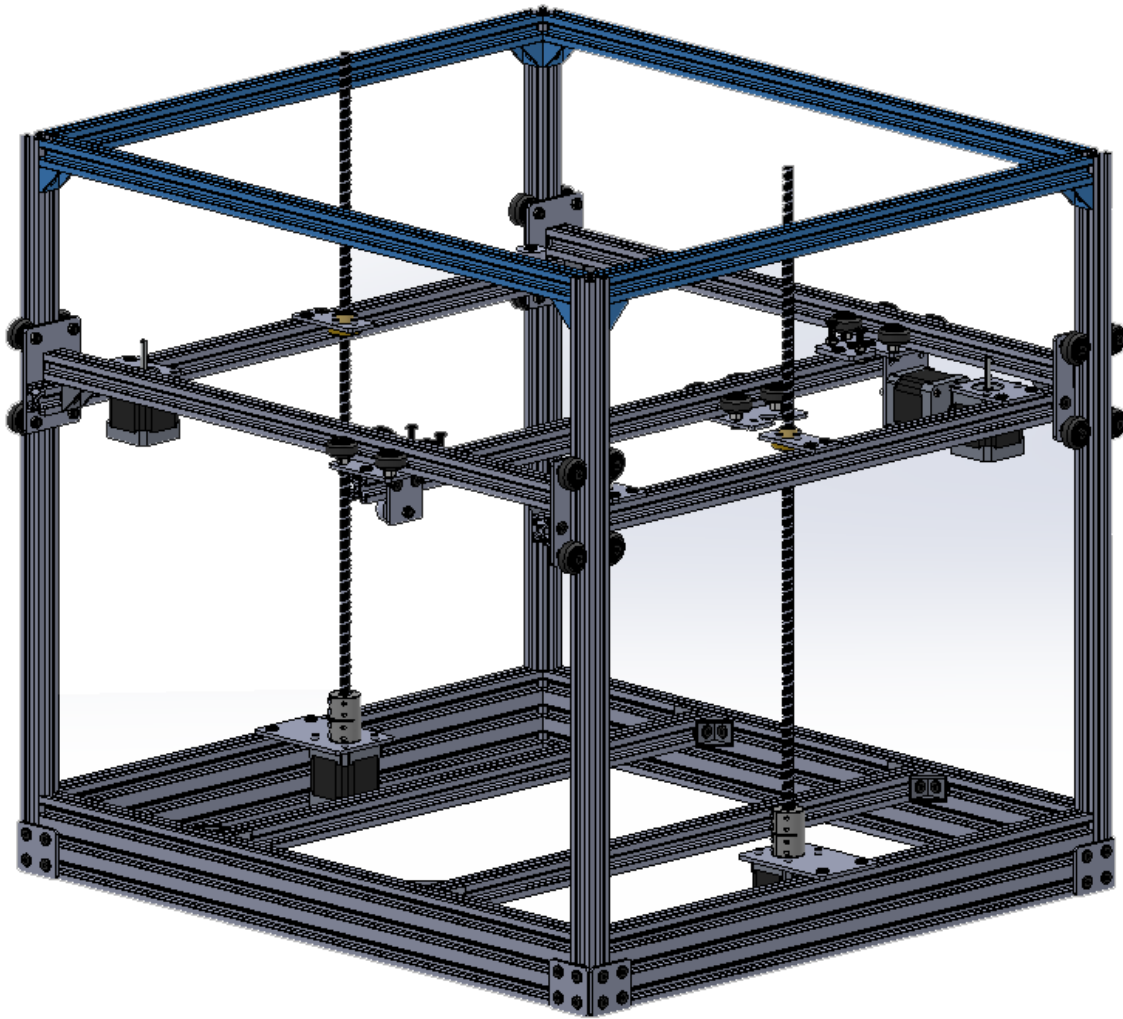
Step 8: Attach the X-Belt Plates to the top channel of the Y-axis rail, flush against the X-carriage plates. Slot in an additional two T-nuts into the top channel on each side of the four corners of the ZY-axis rail (the same rails the Z-Lead Screw Plates were installed to). Install two X-motor assemblies and two XY-idler assemblies with M5*8mm screws and the pre-slotted T-nuts as shown in the picture below:



Step 9: Attach the y-motor mount assembly and the remaining XY-idler mounts on opposite ends of the Y-axis rail as shown below:



Step 10: Install the top support cage to the base frame assembly. **BE SURE TO SLOT IN YOUR TWO M3 T-nuts per extruder into one of the rails at the top, depending on how you wish to feed your filament.** Measure the distance of the between the Z-rails for each side at the top and bottom and make sure there is identical spacing. Adjust the assembly as required to make sure the spacing at the top and bottom of the printer are the same on all sides. This is extremely important to maintain your wheel health and have quality prints.



Step 13:

Place the GT2 gears on the ends of the 3 Nema 17 motors X & Y axis motors and tighten them using a 2mm hex wrench. Loop the GT2 timing belt over the GT2 Pulley and loop it around the stub of the 25mm screw nearest to it on the X-Belt Plate. Tighten the belt at that loop using a zip tie. Loop the other end of the belt around the idler pulley and attach it to the other screw on the X-Belt Plate.

Do the same for the other X-motor/idler mount.



Step 14: The final belt should already be looped through the Y-carriage. Secure one end with a zip tie, and loop the belt it over the idler and GT2 gear. Tighten the belt up and secure the remaining loop to the y-carriage using a zip tie. Note if you did not pre-stage the belt earlier, you will likely need to use small needle nose pliers to pull it through the slot.

Step 15: The final step for hardware assembly involves affixing the print plate to the base. Using the four small bed clips and M5*8mm screws, tighten the bed clips to the edges of the aluminum bed using the 4 pre-slotted T-nuts inserted in the bed supports at the beginning of the assembly.

ELECTRONICS SECTION

End Stop Installation



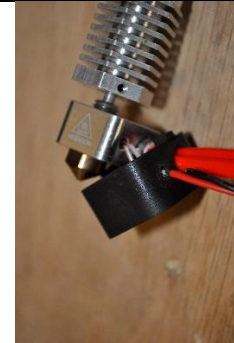

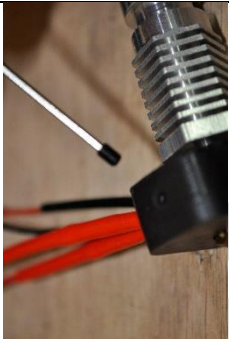

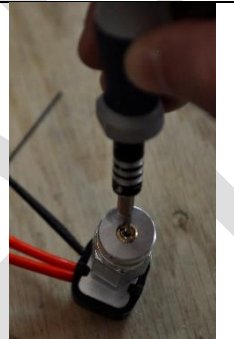


Step 1: Insulate the Mechanical End Stop Solder Points:

Do not mount end stops directly to the aluminum rails. **Insulate them WELL** using electrical tape or (if you already have a printer available) by printing an endstop holder. There are several versions of endstop holders available for this particular model of endstop that are compatible with V-Slot rails.


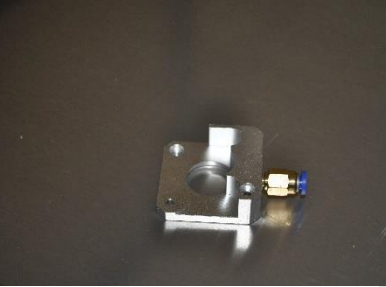




Please make note of the direction the switch is soldered to the board – this will determine the proper way to plug the endstop wires into the ramps 1.4 board. We offer switches soldered in both directions.



Hexagon Installation

			
<p>1. Tighten the nozzle assembly to the hexagon using the small wrench and some vice grips. <u>DO NOT OVER-TIGHTEN!!</u> Doing so may damage your HEXAGON. Very <u>LITTLE</u> force is required to perform this action.</p>	<p>2. Insert thermistor and element through holes in rubber liner.</p>	<p>3. Insert thermistor bulb and heating element into holes in nozzle assembly.</p>	<p>4. Pull liner the rest of the way over nozzle assembly.</p>
			
<p>5. Insert set screw in hole through rubber liner.</p>	<p>6. Tighten the (pre-installed) set screw in that holds nozzle assembly to hexagon.</p>	<p>7. Remove the insert at the top of the hexagon.</p>	<p>8. Screw in the #5 push fit to the top of the hexagon.</p>
			
<p>9. Attach the hexagon to the Y-carriage using 8mm M3s, the carriage clip and M3 lock nuts.</p>			

Extruder Installation

		
<p>1. Mount the extruder mounting plate to the support bar at the top of the Cobblebot printer using 2 x 8mm M3 screws and 2 x M3 T-nuts. (You can actually mount it anywhere you find convenient, this spot is just a suggestion)</p>	<p>2. Screw in push fit to bottom of the extruder face plate.</p>	<p>4. Screw in the 32T gear to the head of the NEMA 17 shaft, with set screws at the top to allow for adjustment.</p>
		
<p>4. Mount the faceplate and Nema 17 to the Extruder. Any orientation but down will work; depending largely on where you want to feed the filament from.</p>	<p>5. Place the idler bearing in the housing (over the shaft) on the idler mount arm.</p>	<p>6. Tighten idler with small nut.</p>
		
<p>7. Slot the large screw through the top of the extruder, the idler arm, compression spring, and the included washer, and screw into the base of the extruder mount. Use a M3 hex wrench to tighten the screw down.</p>	<p>8. Insert the final two M2 screws into the assembly and tighten with an M2 hex wrench. At this time, adjust the gear on the motor shaft so that the center of it is even with the center of the idler pulley.</p>	

Mega 2560 Firmware Installation

You may use any firmware that is compatible with Mega2560 / Ramps 1.4 to control your Cobblebot 3D Printer. We suggest downloading and using **Marlin firmware** @

<https://github.com/MarlinFirmware/Marlin>

Download and install the Arduino IDE @ <http://www.arduino.cc/en/Main/Software>

Install the external u8glib for Arduino IDE: <https://github.com/olikraus/u8glib>

Open Arduino IDE, connect the Mega2560 and your PC via a USB cable, select the appropriate port, and flash the firmware to the Mega 2560 board.

There are MANY possible configurations of the firmware, all depending on how you construct your Cobblebot 3D printer. The primary changes to the firmware will be made in the Configuration.h file and are as follows:

```
#define MOTHERBOARD 34
```

```
const bool X_MIN_ENDSTOP_INVERTING = true;
```

```
const bool Y_MIN_ENDSTOP_INVERTING = true;
```

```
const bool Z_MIN_ENDSTOP_INVERTING = true
```

```
//#define DEFAULT_AXIS_STEPS_PER_UNIT {AXIS_STEPS_PER_UNIT_X,  
AXIS_STEPS_PER_UNIT_Y, AXIS_STEPS_PER_UNIT_Z, AXIS_STEPS_PER_UNIT_E}
```

```
#define DEFAULT_AXIS_STEPS_PER_UNIT {80, 80, 400, 94.5}
```

```
#define DEFAULT_MAX_FEEDRATE {500, 500, 2, 40}
```

```
#define DEFAULT_MAX_ACCELERATION {500,500,100,2500}
```

```
#define DEFAULT_ACCELERATION 500
```

```
#define DEFAULT_RETRACT_ACCELERATION 500
```

```
// Travel limits after homing
```

```
#define X_MAX_POS 330
```

```
#define X_MIN_POS 0
```

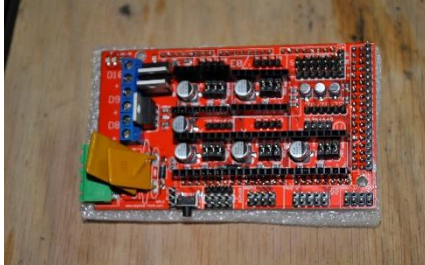

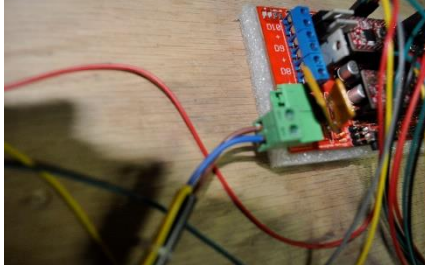
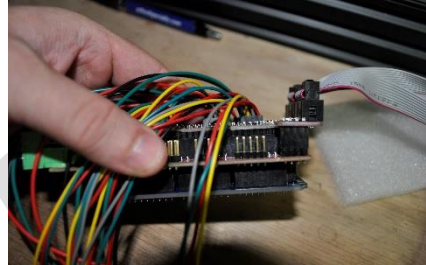
```
#define Y_MAX_POS 330
```

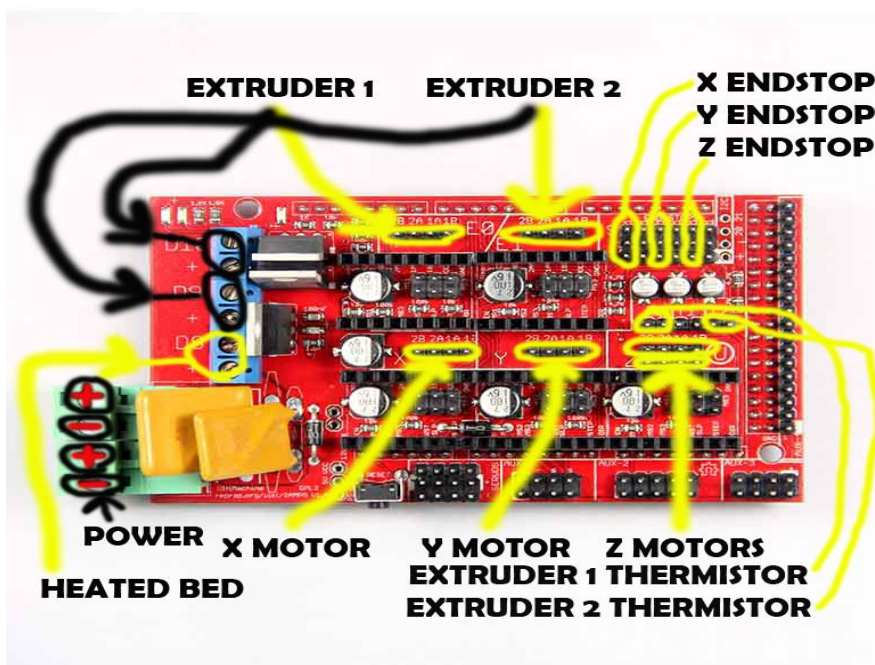
```
#define Y_MIN_POS 0
```

```
#define Z_MAX_POS 330
```

```
#define Z_MIN_POS 0
```

RAMPS Installation

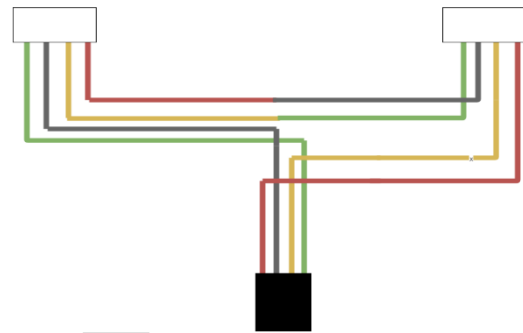
	
<p>1. Install [15] jumpers on each of the pins that are located between the step driver mounts.</p>	<p>2. Install the A4988 drivers, with the potentiometer (screw) facing towards the top of the board, as pictured above. Note, if you received DRV8895 drivers, the potentiometer should face down.</p>
	
<p>4. DC power feed of minimum 5A should be fed in on the bottom right terminal. Positive on left, negative on right.</p>	<p>5. Attach the flashed Mega 2560 to the bottom of the ramps board and the LCD connector and cables to the top ramps board.</p>



X and Z-Motor Wiring

Z-Motors (Same rotation)

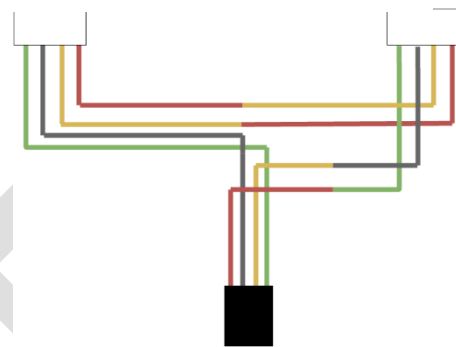
Ramps 1.4 provides two ports for connecting motors. The jumpers on these ports are parallel. Due to the weight of the gantry cage, the Z-motors should instead be placed into series to reduce the power (amps) required to operate the motors. To place the motors into series, you will need to splice the wires in the following configuration:



Series Wiring - Same Rotation

X-Motors (Counter-rotation)

The X-motors are mounted in opposite corners, and require counter-rotation of the motors to achieve proper movement. In order to achieve this, splice the wires into the following configuration:



Series Wiring - Counter Rotation