

NOTE: This is version 1.0 of the DIY CNC instruction manual. Later versions will be updated with guiding imagery and direct links to the DIY videos. For now we recommend watching each of the videos first and familiarizing yourself with the attached CAD file. If you have any questions please contact me through the chat feature on owenreed.com.

1. The Frame

- a. Description: The first major step of building a CNC router is constructing the frame. This will serve as the structure that all of the mechanics are built upon so it needs to be sturdy. I used 4x4s which have an approximate dimension of 3.5"x3.5." This is one of the most carpentry intensive parts of the build, but do not worry. Precision is far less important here because we are just building the structural frame.
- b. Procedure:
 - i. Take the two "short base" pieces of wood make 2 45 degree cuts on each of their ends with a saw (or ideally a circular saw)
 1. This should result in each piece of wood looking like a trapezoid with a 1'6" long base and two sides sloping inwards at 45 degrees
 - ii. Repeat step "i" with 2 of the four "long base" pieces of wood.
 - iii. Loosely assemble these 4 pieces of wood so that they form a rectangle on the floor.
 1. The 45 degree faces should match up
 2. One pair of parallel sides should have a length of 2'
 3. The other pair of parallel sides should have a length of 1'6"
 - iv. Now we will be screwing this base together:
 1. For each of the 4 joins we will be using a combination of wood glue and a 90 degree corner brace
 2. We will apply wood glue to each of the two small faces and then press them together forming an "L"
 - a. NOTE: A 2' should only ever be glued to a 1'6" and vice versa
 3. Place the corner brace on the inside of the "L" shaped join and screw it in using 2+" length wood screws
 - a. NOTE: This step will require a helping hand to hold the two 4x4s together
 - b. NOTE: **Always** drill a pilot hole to guide the path of the screw before you screw it in
 4. Repeat step 1-3 for each of the 4 joints
 - a. NOTE: Matching up 4 joints totally perfect is difficult so do not worry if it isn't all aligned. I was incredibly worried about my frame but it all turned out alright. In a later step I will go through a process you can use to fix any misalignments
 - v. Now we are going to screw the side pillars onto the base.
 1. This is a very similar process to the 4 base pieces only significantly easier.

2. You want to place the two pillars abutting both of the long sides of the base following the model in the CAD file.
 - a. NOTE: The front faces of these pillars should be coplanar and should be set back 15 inches from the front of the base. (This is all modeled in the CAD file)
3. Apply wood glue to the joint between the pillars and base
4. In a similar fashion to the base use two 90 degree corner braces on each of the pillars to screw in the pillars to the base with 2+” wood screws
- vi. Now to attach the top bar
 1. Place the top bar on top of the two wood pillars with the front face of the top bar aligning with the front face of the pillars just like in the CAD file
 2. Lift up the top bar and apply hot glue to the area where it rests on the top of the pillars
 3. Screw in the top bar with four 3” screws on each side of the pillar
- vii. Now to attach the mid bar
 1. Place the mid bar between the two pillars so that its top face is approximately 9.5” from the bottom face of the top bar.
 - a. NOTE: It will be a tight fit so feel free to hammer it into place
 2. Use a 90 degree corner brace placed below the mid bar on either side to screw it into the pillars
- viii. Now to drill the holes for the drive shafts
 1. We need to drill a 1” diameter hole through the centerpoint of the topbar facing downwards and the centerpoints of both of the short bases
 2. Procedure for drilling a hole
 - a. Attach 1” wood hole bore to drill
 - b. Mark center point
 - c. Begin drilling from the centerpoint
 - d. If the length of the bore is not large enough to make it all the way through the piece of wood try again from approximately the same point on the other side. Once you've reached the maximum depth again hammering a long sturdy drill bit or screwdriver into the wood meant to be removed should dislodge it.
 - e. If the two holes do not line up perfectly just use the hole bore to drill another hole to expand the removed volume of wood

2. Moving Parts

a. The Y Tray

- i. Screw the top side of the 12”-->24” drawer slide to the Y tray following the instructions of the drawer slide.

- b. The X Tray
 - i. Screw the top side of the two way drawer slide to the X tray following the instructions of the drawer slide.
 - c. The Z Tray
 - i. Drill a $\frac{7}{8}$ " hole through the centerpoint of each of the Z tray sides
 - ii. Epoxy a ball bearing into one of the holes on one of the sides
 - iii. Glue and screw the two Z tray sides onto the short sides of the Z tray following the CAD file
 - iv. Glue and screw the two Z tray risers onto the long sides of the Z tray following the CAD file
 - v. Screw the top side of the 12"-->24" drawer slide to the Z tray following the instructions of the drawer slide.
 - d. Ball Bearing Holders
 - i. Drill a $\frac{7}{8}$ " hole through each of the center points of each of the ball bearing holders
 - ii. On 3 of the short holders and 1 of the long holders epoxy a ball bearing into hole being careful not to get epoxy on the moving parts of the bearing
3. Assembly
- a. Y Movement system
 - i. Attach two small ball bearing holders with ball bearings in them to the base over the holes following the CAD file
 - ii. Pass the y drive shaft through both of the ball bearings
 - iii. Drill a hole in the Y movement block so that the top of the block can align with the bottom of the Y tray and the hole align with the drive shaft
 - iv. Hammer in Tee nuts into either side of the hole
 - v. Screw the movement block onto the drive shaft
 - vi. Bolt in the drive shaft to the front ball bearing using a regular washer and a lock nut
 - vii. Screw the Y tray drawer slides into the two long base pieces so that the bottom end of the drawer slide is aligned with the front end of the base
 - viii. Use a 2" screw drilled through the center of the Y plate to the movement block
 - b. Z Movement system
 - i. Attach one small ball bearing holder with ball bearings in it to the top of the top bar over the holes following the CAD file
 - ii. Attach one small ball bearing holder without ball bearings in it to the mid bar following the CAD file
 - iii. Place a loose ball bearing into the ball bearing holder that was attached in step "ii"
 - iv. Pass the Z drive shaft through both of the ball bearings
 - v. Drill a hole in the Z movement block so that the top of the block can align with the bottom of the Z tray and the hole align with the drive shaft
 - vi. Hammer in Tee nuts into either side of the hole
 - vii. Screw the movement block onto the drive shaft

- viii. Screw the Z tray drawer slides into the two pillar pieces so that the bottom end of the drawer slide is aligned with the 90 degree brace
 - ix. Use a 2" screw drilled through the center of the Z plate to the movement block
 - c. X Movement system
 - i. Attach one small ball bearing holder with ball bearings in it to the Z side piece without a ball bearing over the hole following the CAD file
 - ii. Pass the X drive shaft through both of the ball bearings
 - iii. Drill a hole in the X movement block so that the top of the block can align with the bottom of the X tray and the hole align with the drive shaft
 - iv. Hammer in Tee nuts into either side of the hole
 - v. Screw the movement block onto the drive shaft
 - vi. Screw the X tray drawer slides into the two Z riser pieces so that the bottom end of the drawer slide is aligned with the 90 degree brace
 - vii. Use a 1" screw drilled through the center of the X plate to the movement block
 - 1. NOTE: make sure this does not poke through to wear the drive shaft is resting
- 4. Motor housings
 - a. Use a hacksaw to trim down each of the drive shafts so they only poke out 1.25" from the outside of the machine
 - b. Screw two of the ball bearing risers into the rear ball bearing plate following the CAD file
 - c. Screw a ball bearing plate without a ball bearing onto these two risers following the cad file
 - d. Attach a motor coupling to the drive shaft so that half of the drive shaft is inside the coupling.
 - e. Attach a nema motor to the top of the outside ball bearing holder following the CAD file so that the motor fits neatly inside the coupling
 - f. Attach the coupling to both the drive shaft and the motor tightly
 - g. Repeat "b-f" for the top ball bearing holder and the side X axis bearing holder following the cad file
- 5. Electronics and buttons
 - a. For the most part you are done with the machine. All that is left is to wire it up and turn it on. An in depth video and electronics diagram is coming soon due to its increased complexity of these steps and the importance of precision and safety when wiring. If you are trying to build this on your own before that diagram is ready please feel free to reach out to me through the website and I would be happy to walk you through it step by step over email, on the phone, or through Zoom.