3 Axis CNC Router - 60"x60"x5" - JunkBot

by **russaanderson** on January 1, 2008

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intro: 3 Axis CNC Router - 60"x60"x5" - JunkBot

This Instructable is the first in a series documenting the construction of a DIY 3 axis CNC router. This is also my entry for the Universal Laser Cutter Contest.

The goal of this Instructable is not to show a full step by step progression but rather to pass along my experiences with making my own CNC.

I'm a MFA candidate (art student) at Rutgers University - Mason Gross College of the Arts. I designed this machine for the sculpture department to primarily cut soft material (foam, wax, some plastic and wood). I tried to leave as much room as possible for modification to suit the departments changing needs i.e. repurposing into a CNC plasma-cutter.

The design of my machine is loosely based around the Solsylva.com - *Large Dual Leadscrew Table* plans. I choose these plans a jumping off point - extracting what I needed and adding to the design to fit my needs. Linear motion control, next to the drive train, is often the most expensive system on a CNC device and the Solsylva plans present a simple yet elegant solution to cutting the cost of linear movement buy using roller skate bearings, angle iron, and EMT conduit.

There were a few concepts behind the design of this machine. The first was the use of scrap or existing materials - in essence recycling as much material as possible. The second idea was that any materials I needed to purchase I would try to obtained locally (Local Hardware Stores, Home Depot/Lowes, etc.) - the Solsylva plans are also based around this concept.

College art departments tend to generate a lot of usable scrap/waste. After a student projects are finished, they usually end up back in the scrap bin, metal recycling, or the dumpster. My goal for this project was to use as much of this "waste" material as possible and design the machine around these materials. The dimensions for parts were often times dictated by the size of the scraps available. The finish of this machine was inevitably dictated buy the materials I chose to use. I personally appreciate the scrappy junk-bot aesthetic - but then again I did build it ;)

This is project is a labor of love and a work-in-progress so there are a few things still unfinished - please excuse some of the inconsistencies in the photos as they've been taken at different time throughout the project.

Enough with the college talk and on to the good stuff -

The Machine Specs:

Materials: Recycled Steel and Aluminum.

Total Travel (x,y,z): 60" x 60" x 5"

Motors: 425 oz.in. dual shaft stepper Nema23 mounting.

Router/Spindle: Porter Cable 690 router (1/2" - 1/8" collets) **or** 1/4" trim router.

Motor Drivers/Electronics: Xylotex XS-3525/8S-3

Software: Mach3 (controller), various CAD/CAM software for object creation, tool paths, and g-code.

The table is geared, crank driven with quad lift screws and 1000lb capacity - and it's movable too. It's way overkill, but makes Z hight adjustment a dream. In the future this could become the Z axis if more movement is needed.

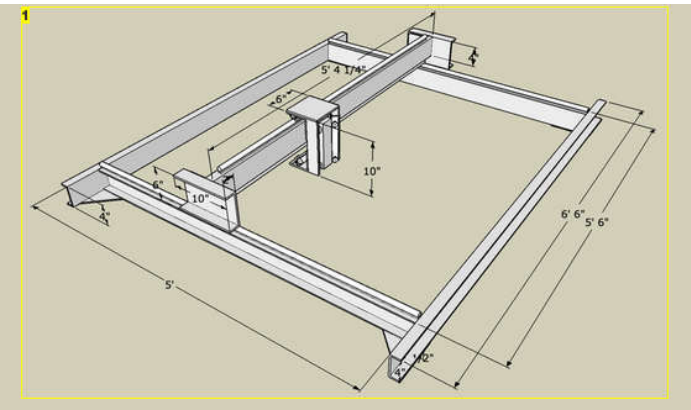
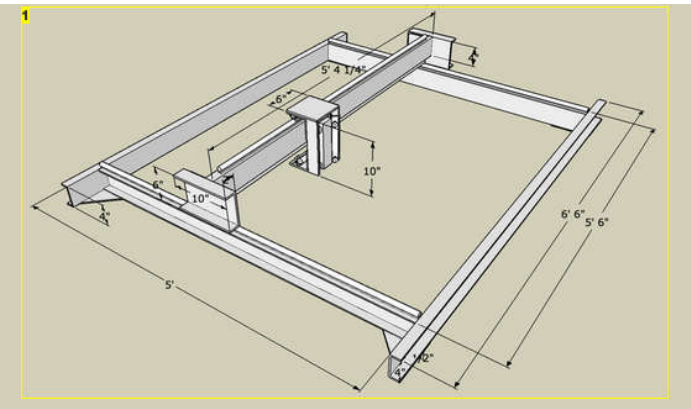


Image Notes
1. The original plan - most of the dimensions stayed true to this drawing. The 3d SketchUp file can be found on this page for download.



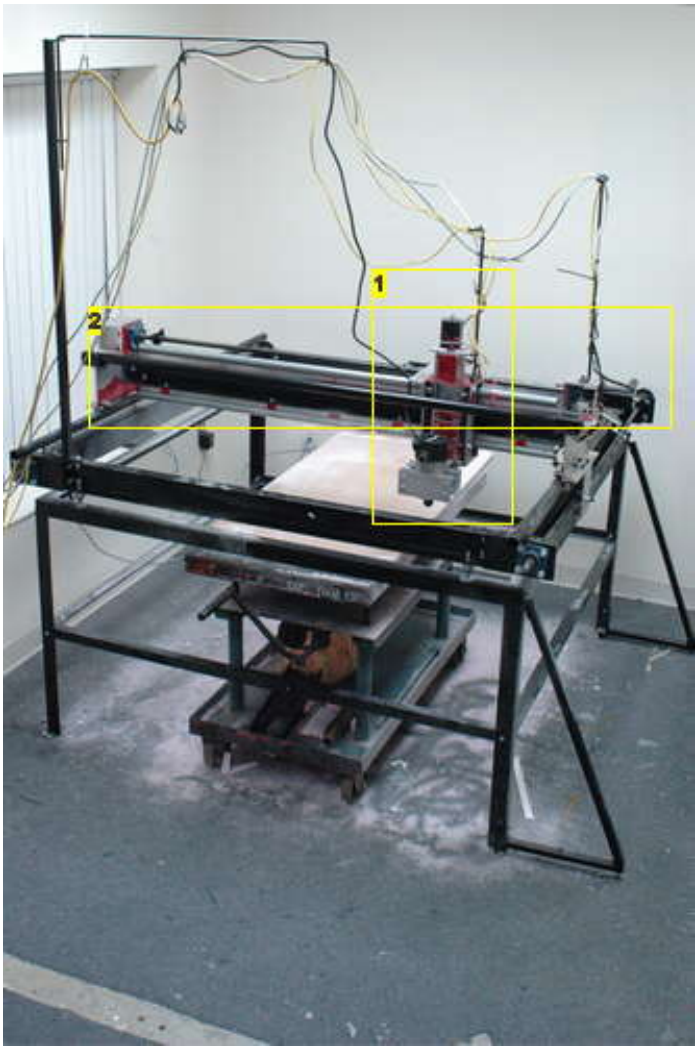


Image Notes
1. Z axis with Porter Cable router attached.
2. X axis and drivetrain.

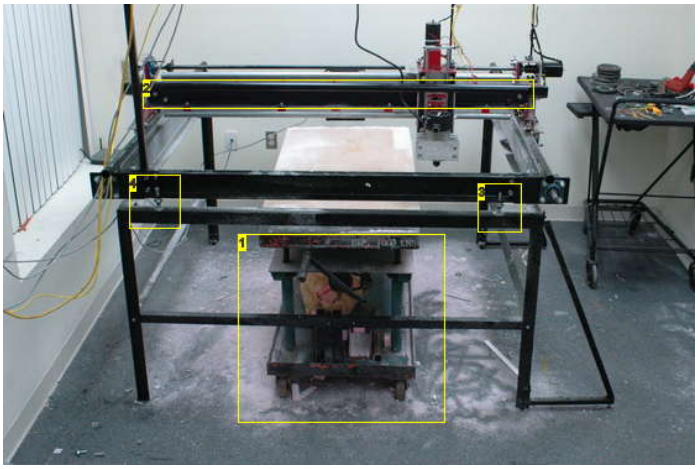


Image Notes
1. The table is geared, crank driven with quad lift screws and 1000lb capacity - and it's movable too.
2. The gantry.
3. Micro adjustment for leveling the machine frame to the movable table.
4. Micro adjustment for leveling the machine frame to the movable table.

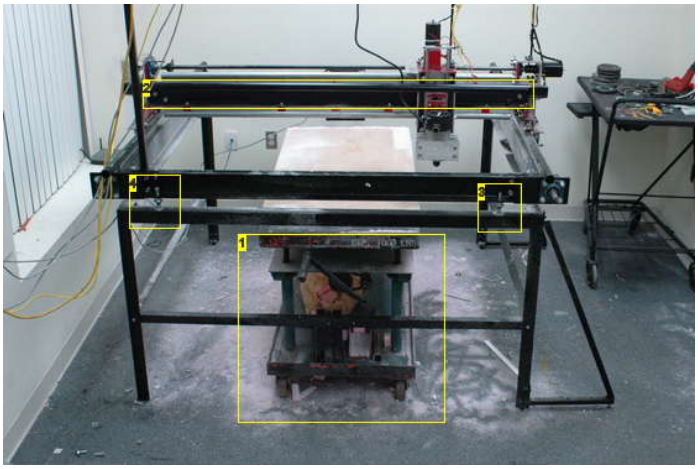


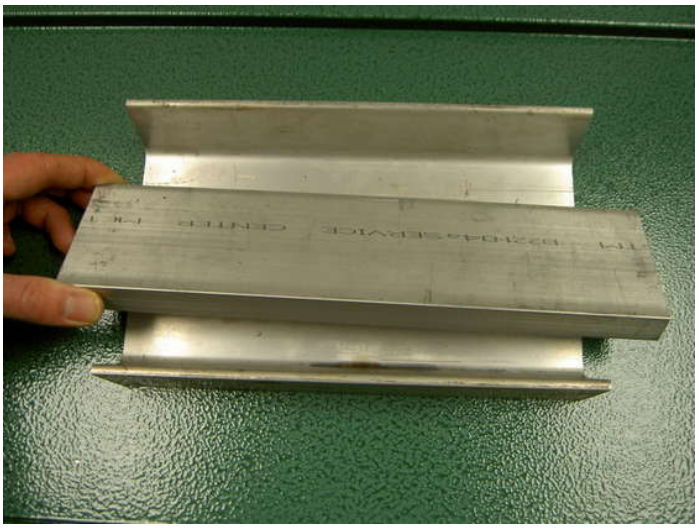
Image Notes
1. Cable management.
2. 1 of 2 lead screws for the Y drivetrain.

File Downloads

cncPlansSketchUp.skp (671 KB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'cncPlansSketchUp.skp']

step 1: The Z axis (up and down).

This step shows the progression of the Z axis - this was the most complex and time consuming assembly to manufacture.



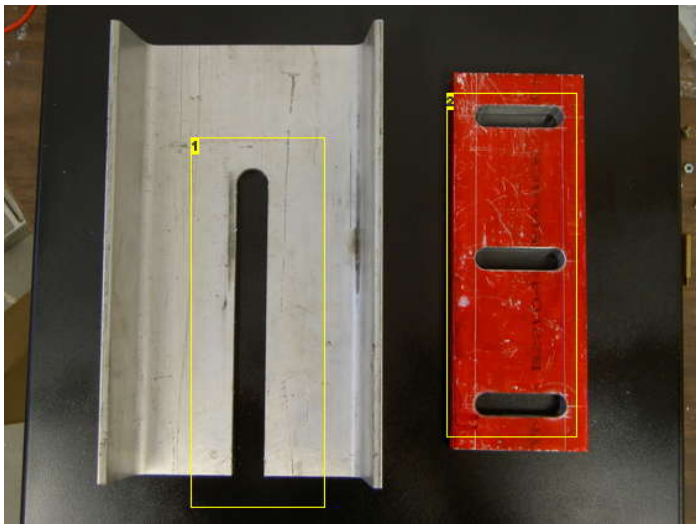


Image Notes
1. All of the slots on the CNC were made on my mill/drill machine.
2. All of the slots on the CNC were made on my mill/drill machine.

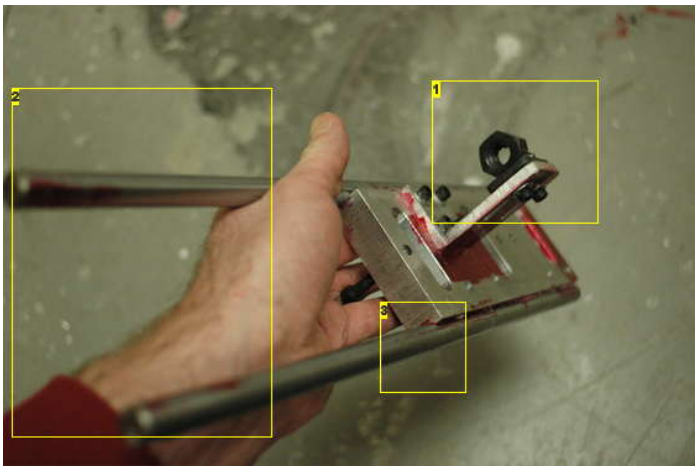


Image Notes
1. Z axis follower nut - an acme nut was tig welded to a steel plate that was drilled and tapped. The bracket that holds the nut is slotted to allow for adjustment and alignment with the Z axis lead screw.
2. Z axis rods - these were the only precision rods in the machine and they came from the scrap bin.
3. The Z axis carriage was milled to mate with the rods.

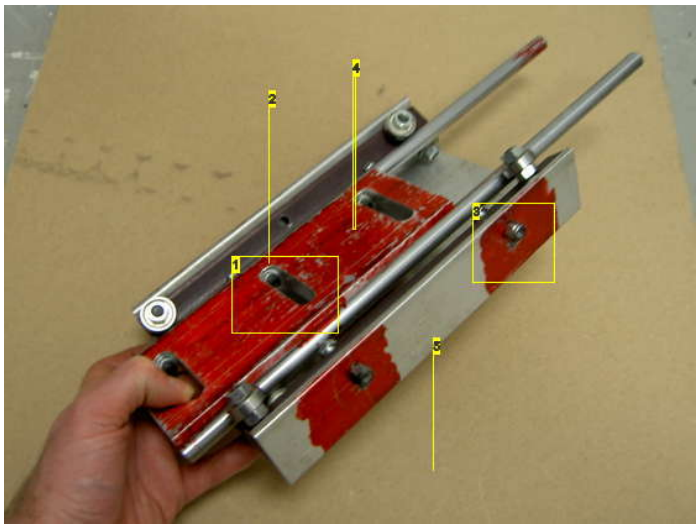


Image Notes
1. These slots are how the Z axis rods are attached - I drilled and taped the rods and used allen head cap bolts to attach them to the Z axis carriage (aka router mounting plate).
2. Allen head cap bolts and washers.
3. The Z axis housing is slotted to allow the Z axis bearing assemblies to be aligned with the Z axis carriage.
4. Z axis carriage.
5. Z axis housing.

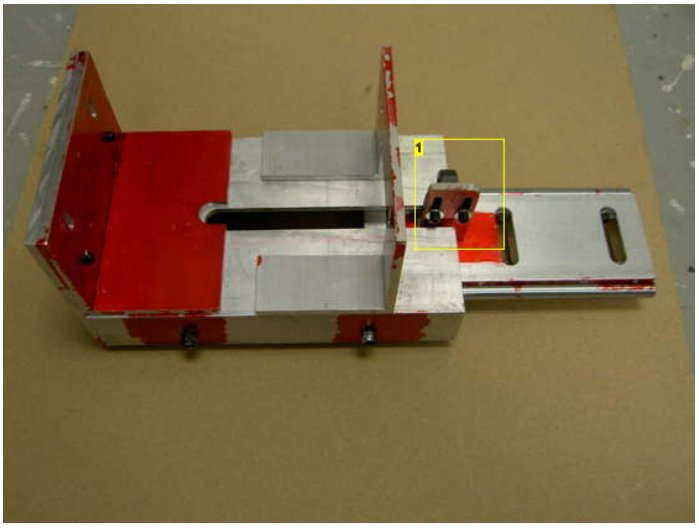
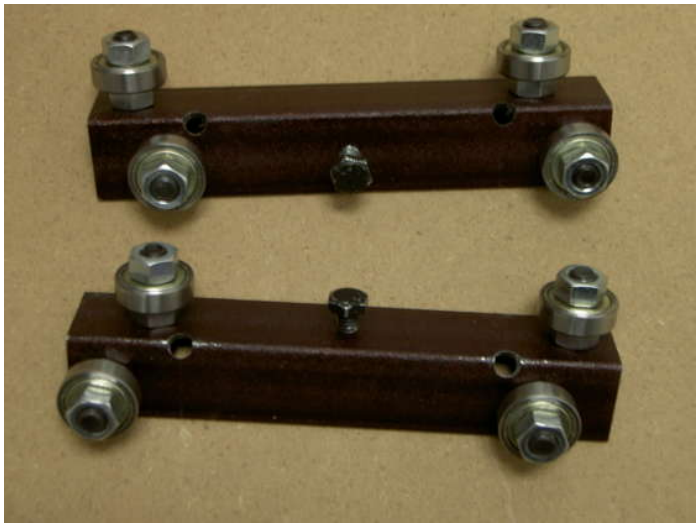
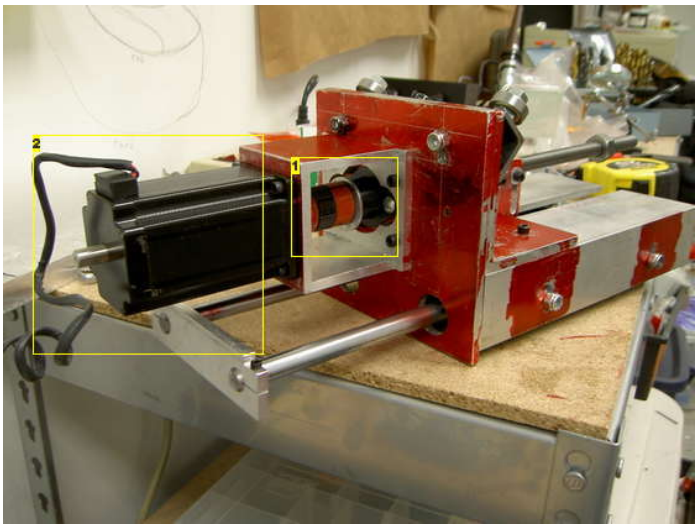


Image Notes
1. Z axis follower nut - an acme nut was tig welded to a steel plate that was drilled and tapped. The bracket that holds the nut is slotted to allow for adjustment and alignment with the Z axis lead screw.





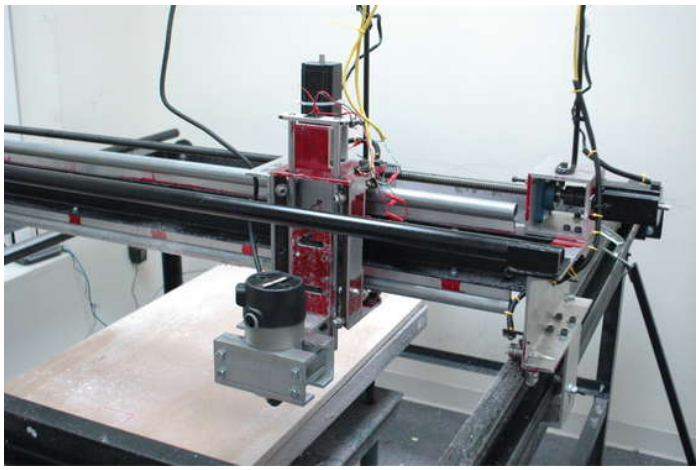
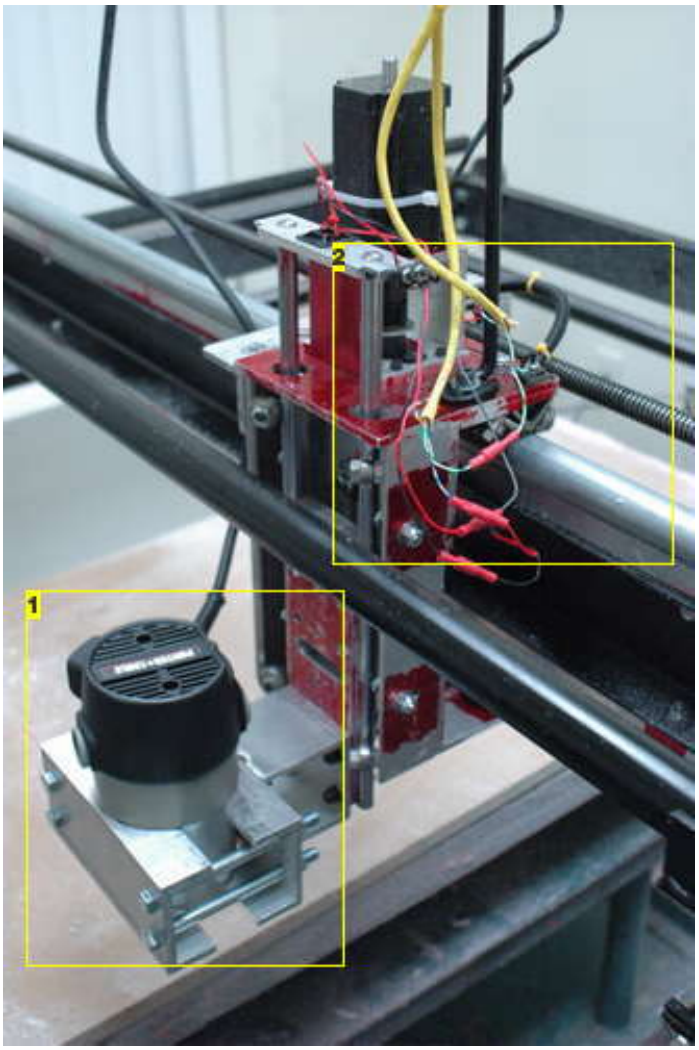


Image Notes
1. Lovejoy shaft connector.
2. 425 oz.in. stepper motor



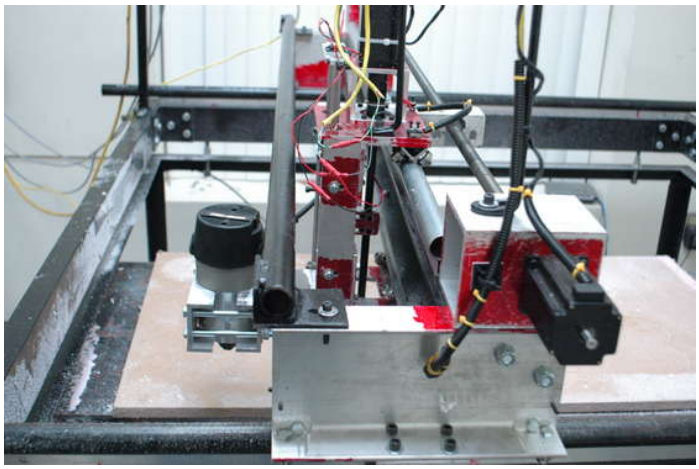


Image Notes
1. Porter Cable router mounted.
2. Limiting switch wires - soon to be tidied-up.

step 2: X and Y axis come together - the frame takes shape.

This is where the machine really starts to take shape.

Image Notes
1. The raw machine frame.

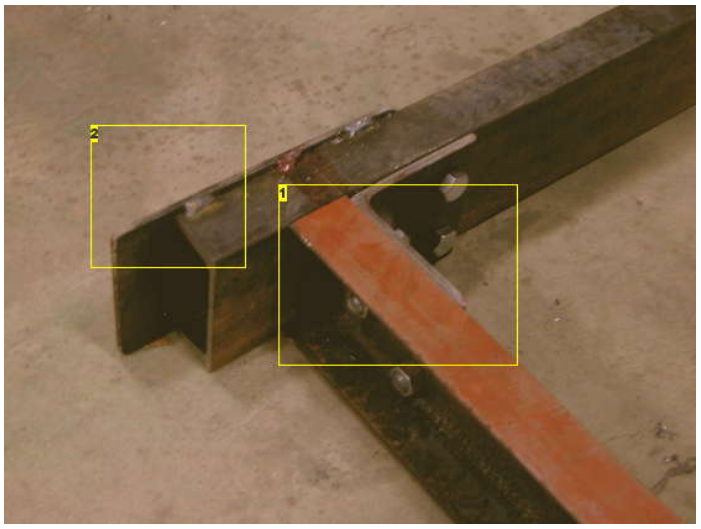


Image Notes
1. The frame drilled bolted together.
2. The]Y axis bearing plate welded to the frame.

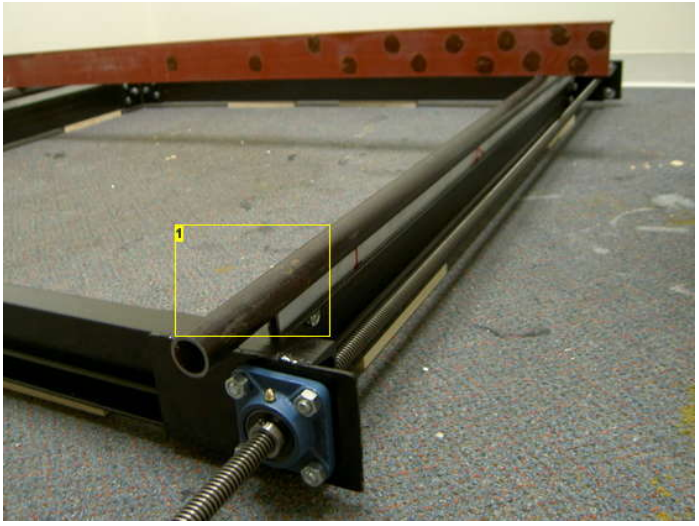


Image Notes
1. Y axis rod drilled and mounted to aluminum channel - then bolted to the frame.

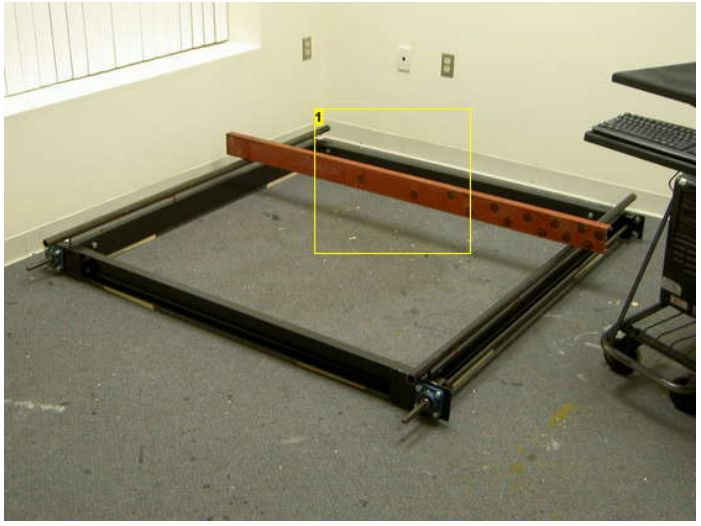
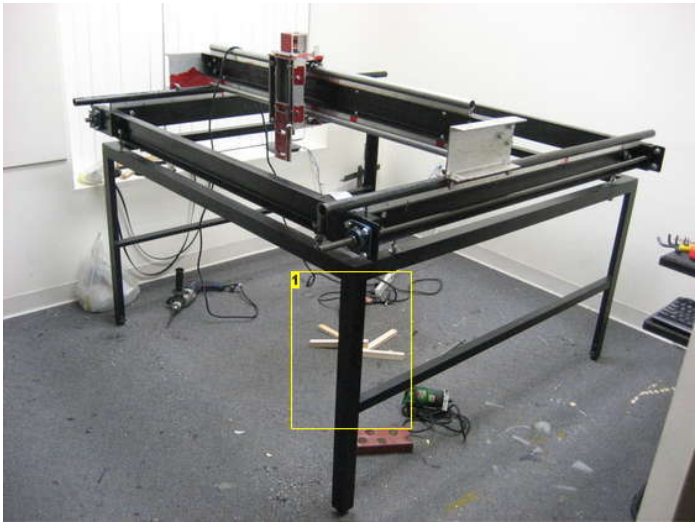


Image Notes
1. The gantry in its rough stage.



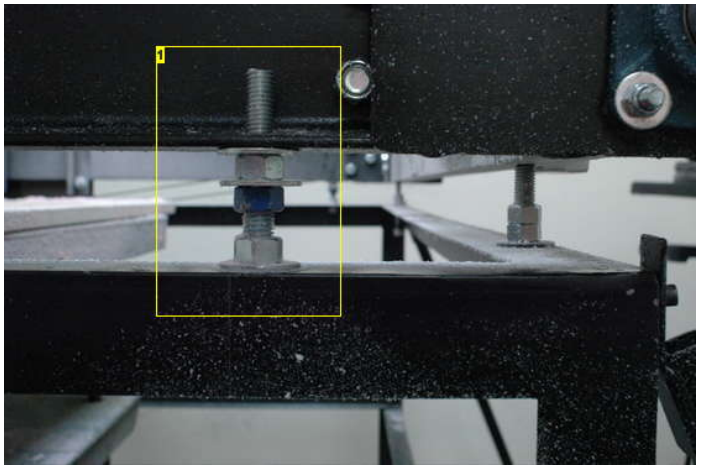


Image Notes
1. The fine adjustment for leveling the machine frame to the movable table.

Image Notes
1. The machine frame is mounted to the support frame.

step 3: The Y axis drivetrain.

I really like the dual lead screw design - it has given us a lot of flexibility to have a movable table underneath the machine. Single lead screws designs usually have the screw running down the middle of the machine with a fixed cutting surface above. This limits the depth of the Z axis to the fixed table height.

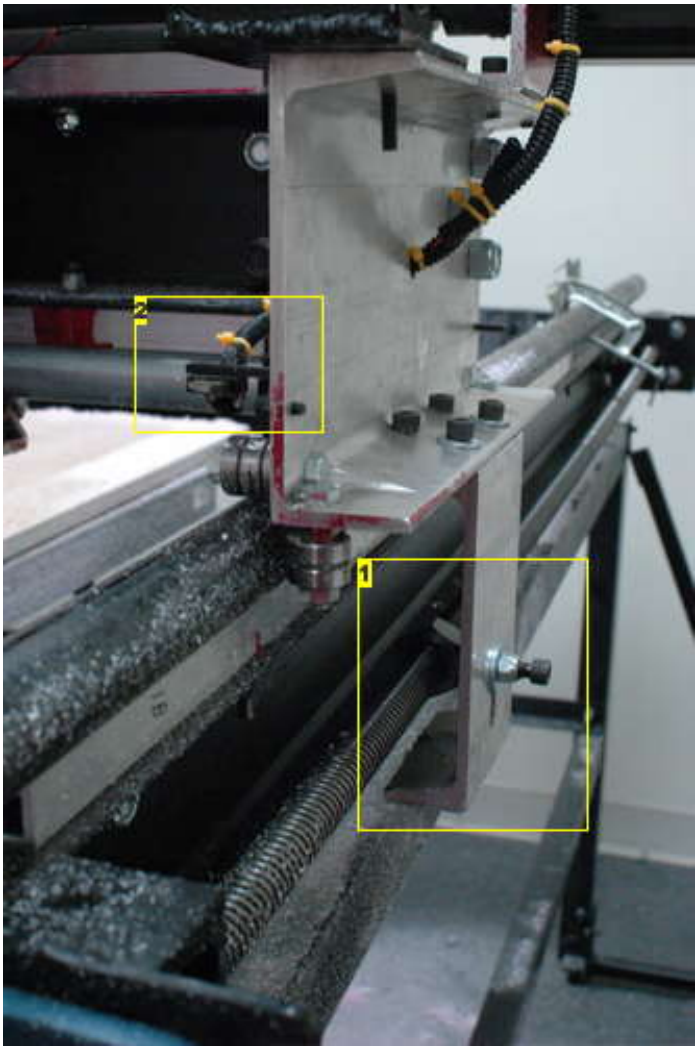


Image Notes
1. The Y axis drivetrain - This is a acme threaded nut that I drilled and tapped and bolted to a piece of aluminum channel. I slotted the hole for the bolt to allow for height adjustment and alignment
2. Y axis limiting swithch.

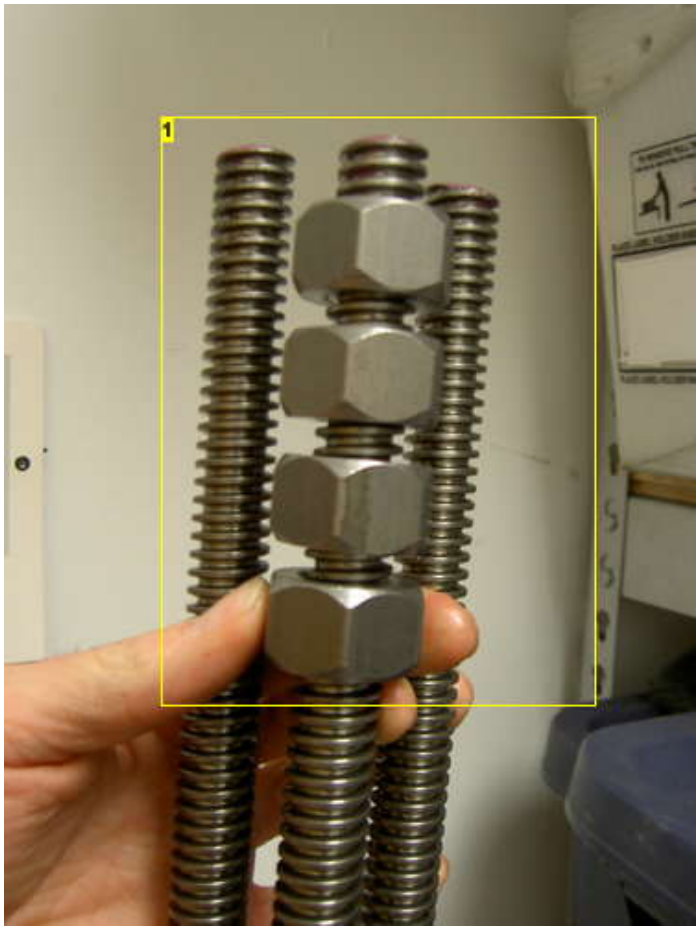
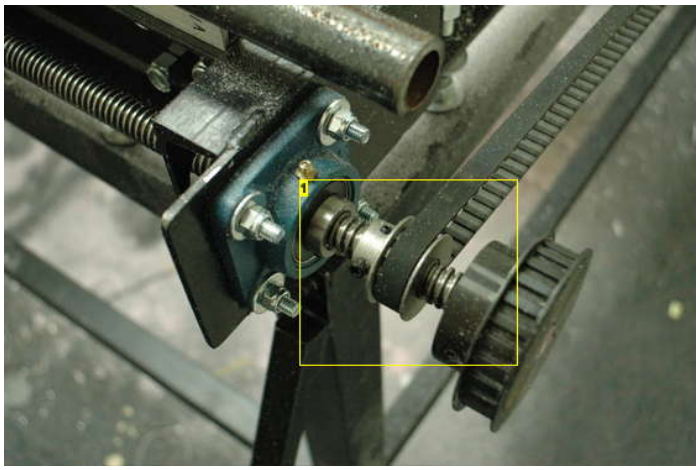


Image Notes
1. Acme screws are use for all of the drivetrain.



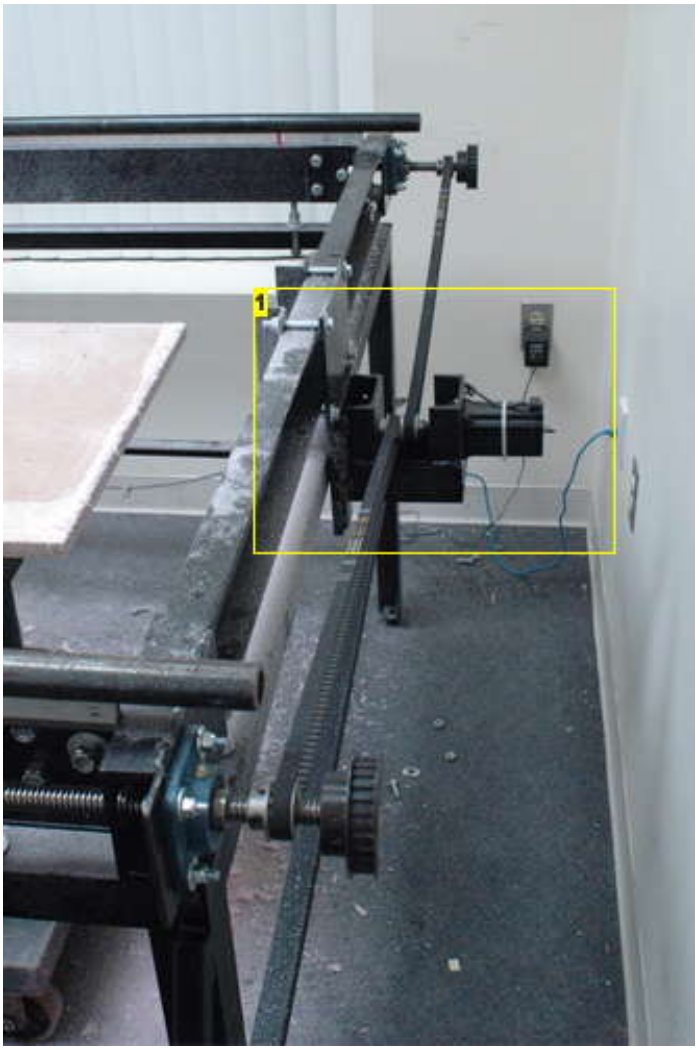
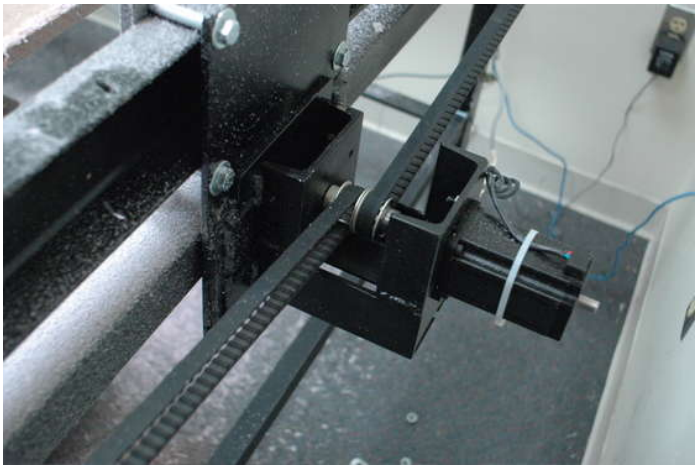


Image Notes
1. Y axis stepper motor and gearbox.



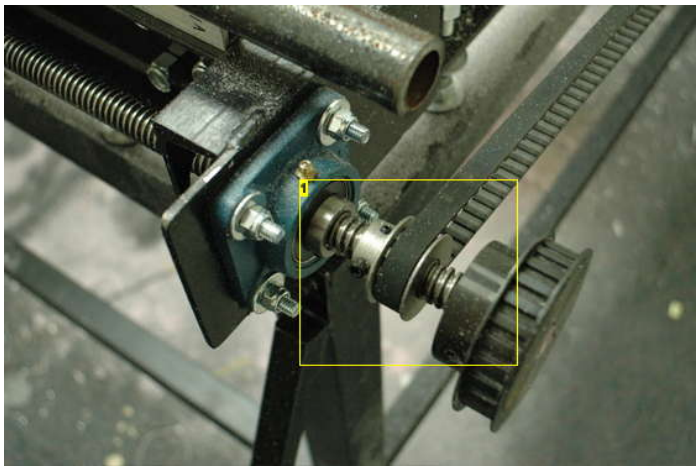
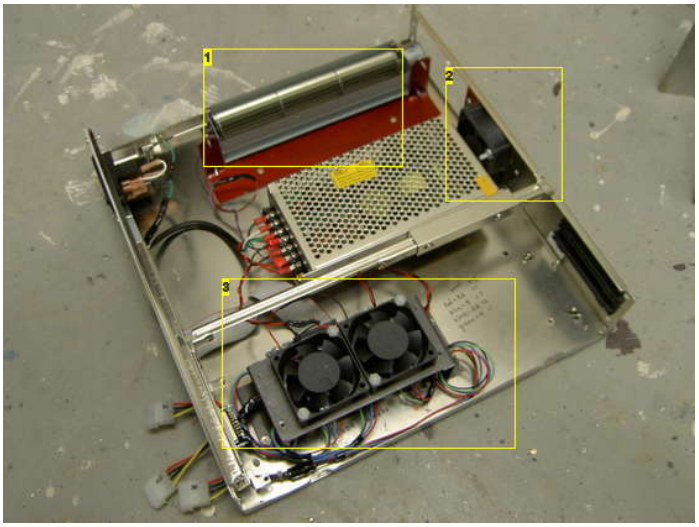


Image Notes
1. Y axis geared pulley and 1 of 2 drive belts.

step 4: The driver board and box - cooling overkill.

This box has a few too many fans. At the time I was unsure of how hot this was going to run, so I decided to error on the side of overkill - I think 4 fans is enough.

With the execption of the xylotex driver board and power supply, everything in this assembly was fabricated or from a recycled source.



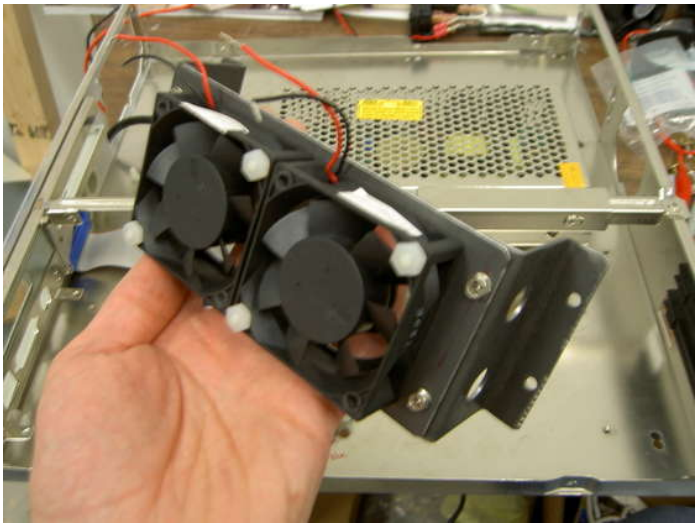
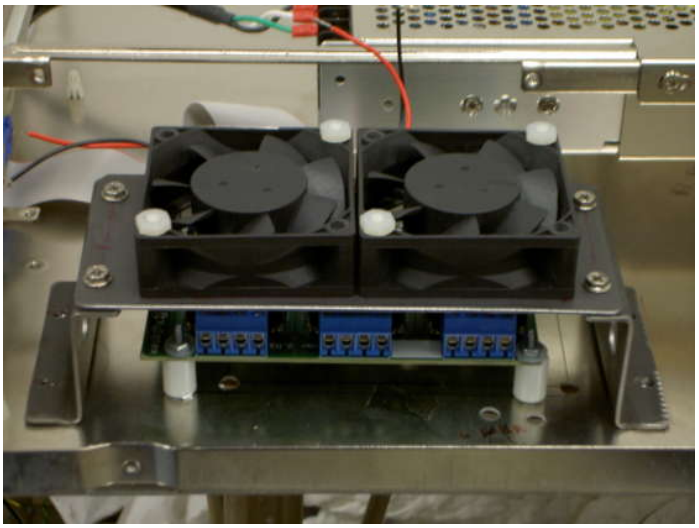


Image Notes
1. 1 Fan
2. 2 Fan
3. 3 and 4 fan.



step 5: The first project out of the machine.

This was the first 2D project to come out of the machine - It sits as a trophy next to our controller computer.

You can see a video this being cut on here.

Also the first 3D cut can be viewed here.

Related Instructables

How to Make a Three Axis CNC Machine (Cheaply and Easily) by Stuart.Mcfarlan

Make a CNC Hot Wire Foam Cutter from parts available at your local hardware store by tbarnea

CNC Stomp Pad Project | CNC Programming | G-Code Programming | CNC Plasma Cutting by ivanirons

Laser Hair regrowth by Gamer6460

Custom Electronic Dictionary (slideshow) by ultrauber

Homebrew Laser Cutter made by Zach Radding by TimAnderson

Laser show for poor man by AP Digital light

Electro-Graf by Q-Branch

Comments

15 comments **Add Comment**

Slisgrinder says:
Jul 20, 2008. 9:01 PM **REPLY**

can u cut metal with this thing?
or does it depend on the the drill it self?

servant74 says:
Jun 28, 2008. 1:54 PM **REPLY**

A neat 'wood' version is on buildyourcnc.com ... good complete instructions too!

Yea, they would like to sell a version, but their free instructions are pretty good.
This metal version would probably last better longer term.

eagleeyes1963 says:
Apr 2, 2008. 9:15 AM **REPLY**

cool do you sale the plans for this cnc machine

zerocoolzmax says: Mar 26, 2008. 10:16 AM **REPLY**

hi there Russ
my name is Robin Anderson ,
I'm interested in building your cnc router design , but was hoping i could get more information from u about the parts you used if by any chance a parts list . the problem is insouth africa we tend not to get some of these parts and i'd really like to build your model as it seems very sturdy and it has a nice work area .
if you could help i'd be very greatful.

---

ivanirons says: Jan 22, 2008. 8:10 PM **REPLY**

I dig that leveling table idea. I have never seen anyone do that before.
Does it work well?
How often do you use it?

Ivan Irons
CNC Information Community Website

---

russaanderson says: Jan 23, 2008. 9:22 PM **REPLY**

It does work well - and I use it a lot - it's great for getting material in and out of the machine with out having to fuss with the Z axis.

GorillazMiko says: Jan 2, 2008. 2:48 PM **REPLY**

Woah, amazing job! That last picture looks **really** cool.

---

carlie says: Jan 2, 2008. 1:30 PM **REPLY**

Very cool!

LinuxH4x0r says: Jan 2, 2008. 8:09 AM **REPLY**

Sorry, check the date. Its too late for the laser cutter. And besides you already have a cnc!

---

canida says: Jan 2, 2008. 11:21 AM **REPLY**

Our servers aren't on Pacific time. ;)

---

russaanderson says: Jan 2, 2008. 9:33 AM **REPLY**

According to the rules for the contest I have until "Tuesday, 1 January 2008 at 11:59 pm PST" - I posted 2:56am EST which it technically 11:56 pm PST.

I really don't have a CNC - I built this for Mason Gross School of Art where I'm attending school - once I graduate (4 months and counting) I will no longer have access to it - so I really do need this laser cutter to continue my work... but then again I'm sure a lot of people really need this laser cutter.

---

k5dkh says: Jan 17, 2008. 1:05 AM **REPLY**

Great job on the table. is it possible to get a bill of material and dimensions of the table. Could not download the sketch file.

---

russaanderson says: Jan 17, 2008. 7:50 AM **REPLY**

Thanks - however, I can't take credit for building the table. I think it was commercially manufactured lifting table used for lifting and moving heavy objects (it has a 1000lb rating on the side). Our metal shop was using it as table for their chop-saw. I build them a new stand for the saw and re-purposed the lift table for our CNC.

The table is about 24"x36" +/- with a about 18" of vertical travel. It is crank powered and chain driven (soon to be motorized). Four 1 1/2" (+/-) acme screws provide the lifting power. It sits on 4 heavy duty casters, which has its pluses and minuses:

Pluses - it's movable/removable.

Minuses - it's not connected to the machine. Movement in the machine is not transmitted to the table, which sounds like a good thing but really it translates to inaccuracies in the part being milled - Imagine someone constantly bumping into you while you were trying to draw a straight line with a pencil on a piece of paper that is taped to a table. Every time you were bumped it would cause you to move the pencil on the fixed piece of paper in an unattended direction i.e. wiggly line. This is why we have to brace our machine so much ;)

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russaanderson says: Jan 2, 2008. 10:00 AM **REPLY**

Also... there really is a big difference between a CNC Router and a Laser Cutter - CNC Routers physically touch the material being cut which requires a great deal more setup time making sure the part doesn't move while being milled. However, the CNC Router excels at 3D cutting.

The Laser Cutter is the microwave of machining - you place the material in, click print and wait for the "beep" - done!... on the other hand the Laser Cutters really don't do 3D very well.

Both machines are indispensable in the shop.

LinuxH4x0r says:

Jan 2, 2008. 12:53 PM **REPLY**

Good point about the cnc. If I don't win I will probably build one.

Sorry about the date, on the recent page it said the 2nd.
Good luck! (I'll never win against yours)